FCC PART 15, SUBPART C
ISED RSS-247, ISSUE 2, FEBRUARY 2017

TEST AND MEASUREMENT REPORT

For

ShotTracker, Inc.

7220 W. Frontage Rd.,
Merriam, KS 66203

FCC ID: 2AC4B-S6P1
IC: 12327A-S6P1

Report Type:	**Product Type:**
Original Report	Location Player Sensor

Prepared By:	Jin Yang Test Engineer
Report Number:	R1609071-247 (BLE)
Report Date:	2018-05-04
Reviewed By:	Xiao Lin RF Engineer
	Bay Area Compliance Laboratories Corp. 1274 Anvilwood Avenue, Sunnyvale, CA 94089, USA Tel: (408) 732-9162 Fax: (408) 732-9164

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1609071-247 (BLE)	Original Report	2017-01-04
1	R1609071-247 (BLE)	Updated Rules to RSS-247 Issue 2	2018-05-04

1 General Description

1.1 General Statements

Bay area Compliance Laboratory Corp. [BACL] hereby makes the following Statements:

- The Unit(s) described in this Test Report were received at BACL's facilities on 6 June 2016 and was in working condition upon arrival. Testing was performed on the Unit(s) described in this Test Report during the period 15 June through 22 July 2016.
- The Test Results reported herein apply only to the Unit(s) actually tested, and to substantially identical Units.
- This Test Report must not be used to claim product endorsement by A2LA, or any agency of the U.S. Government, or by any other foreign government.
- This Test Report is the property of BACL, and shall not be reproduced, except in full, without prior written approval of BACL.

1.2 Objective

This report is prepared on behalf of *ShotTracker, Inc,* and their product *Location Player Sensor*, Model: *S6P1*, *FCC ID: 2AC4B-S6P1, IC: 12327A-S6P1* or the "EUT" as referred to in this report. The report is prepared in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission's rules and ISEDC RSS-247 Issue 2, February 2017.

The objective is to determine compliance with FCC Part 15.247 and ISEDC 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.

1.3 Agent for the Responsible Party

None

1.4 Responsible Party

Company Name:	ShotTracker
Contact:	Davyeon Ross
Street Address:	7220 W. Frontage Rd.,
City/State/Zip:	Merriam, KS 66203
Country:	US
Telephone:	(931) 221-5939
E-mail:	davyeon@shottracker.com

1.5 Product Description for Equipment Under Test (EUT)

The EUT was a location tracking device which contents one 2.4GHz BLE chip and one UWB chip.

1.6 Mechanical Description of EUT

Dimensions: approximately 40mm (L) x 28 mm (W) x 15 mm (H)
Weight: 18 grams.
Serial Number: R1609071-1 by BACL.
EUT Photos: See Annex C of this Test Report.

1.7 Related Submittal(s)/Grant(s)

FCC Part 15, Subpart F, Equipment UWB with *FCC ID: 2AC4B-S6P1, IC: 12327A-S6P1*

1.8 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.

1.9 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	±1.48 dB
Unwanted Emissions, conducted	±1.57 dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ºC
Humidity	±5 %
DC and low frequency voltages	±1 %
Time	±2 %
Duty Cycle	±3 %

1.10 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.

1.11 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 & 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 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 & 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):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - EMC Directive 2014/30/EC US-EU EMC & Telecom MRA CAB
  - Radio & Teleterminal Equipment (R&TTE) Directive 1995/5/EC US -EU EMC & Telecom MRA CAB
- 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 Development Authority - IDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
- 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

The customer used the Light Blue App to control the transmitter.

2.3 Equipment Modifications

A SMA port was attached to the output signal before the antenna of the EUT to perform conducted measurements.

2.4 EUT Internal Configuration Details

Manufacturer	Description	Model
DecaWave	UWB Transceiver	DW1000
Nordic Semiconductor	2.4GHz Transceiver	nRF52

2.5 Interface Ports and Cabling

Cable Description	Length (m)	To	From
RF Cable	<1M	EUT	PSA

2.6 Support Equipment

Client used his own iPhone to control the device.

2.7 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

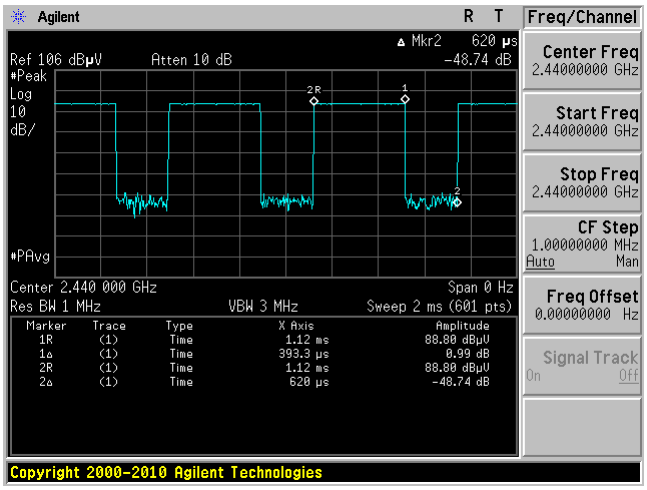
cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (T) 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)
BLE	0.3933	0.6200	63.44	1.98

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

Please refer to the following plots.

BLE



3 Summary of Test Results

Results reported relate only to the product tested.

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

Note: all the testing data was measured based on RSS-247 Issue 1. Since all the ISED Rules keep the same between RSS-247 Issue 1 and Issue 2, all the measured results are compliant per RSS-247 Issue 2.

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

4.1 Applicable Standards

According to FCC §15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

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 §8.3: Transmitter Antenna

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

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

Testing shall be performed using the highest gain antenna of each combination of license-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. [9] When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

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

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

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

4.2 Antenna Description

The EUT uses permanently attached antennas.

Radio	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
BLE	2400-2483.5	0.5

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

5.1 Applicable Standards

FCC §2.1093, §15.247(i)

According to KDB 447498 D01 General RF Exposure Guidance: 4.3.1. Standalone SAR test exclusion considerations.
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:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR

ISEDC RSS-102

Table 1: SAR evaluation — Exemption limits for routine evaluation based on frequency and separation distance[4,5]

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 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

5.2 Test Result

For FCC:

Maximum output power is -3.70 dBm (0.4266mW)

Based on below equation

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR

(0.4266/5)*(√2.48) =0.134 which is less than 7.5

So this device meets the SAR exclusion condition.

For ISEDC:

The maximum e.i.r.p of this device is -3.70 dBm + 0.5 dBi = -3.20 dBm (0.479 mW) which is less than 10mW, so this device meets the exemption limits for SAR evaluation.

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

6.1 Applicable Standards

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) and RSS-Gen except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410 608 – 614	960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

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, emissions from license-exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Frequency (MHz)	Field Strength (µV/m at 3 metres)
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 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.

6.2 Test Setup

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

6.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords were connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

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

The spectrum analyzer or receiver was set as:

Below 1000 MHz:

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

6.4 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

Margin = Corrected Amplitude - Limit

6.5 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
124	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100044	2015-07-23	2 years
424	Agilent	Analyzer, Spectrum	E4440A	US45303156	2016-01-19	1 year
323	Sunol Sciences	Controller, System	SC104V	011003-1	Cal. Not required	N/A
317	Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2015-07-11	2 years
187	A.R.A.	Antenna, Horn	DRG-118/A	1132	2015-09-21	2 years
238	HP	Pre- Amp	8447D	2944A06639	2016-06-28	1 year
691	Wireless Solutions	Conducted Emission Cable	LMR 400	691	2016-06-29	1year
778	IW	AOBOR Hi frequency Co AX CabelCable	DC 1531	KPS-1501A3960KPS	2016-08-05	1 year
91	Wisewave	Horn Antenna	ARH-4223-02	10555-02	2013-09-20	3 years
-	-	SMA cable	-	C0001	Each time[1]	N/A
32	Agilent	Pre-Amplifier	8449B	3147A00400	2016-03-30	1year

[1] *cable and attenuator included in the test set-up will be checked each time before testing.*

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

6.6 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-09-08&09
Test Site:	5M Chamber 3
Temperature:	23° C
Relative Humidity:	42 %
Barometric Pressure:	102.7 kPa
Test Personnel:	Jin Yang

6.7 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:

BLE

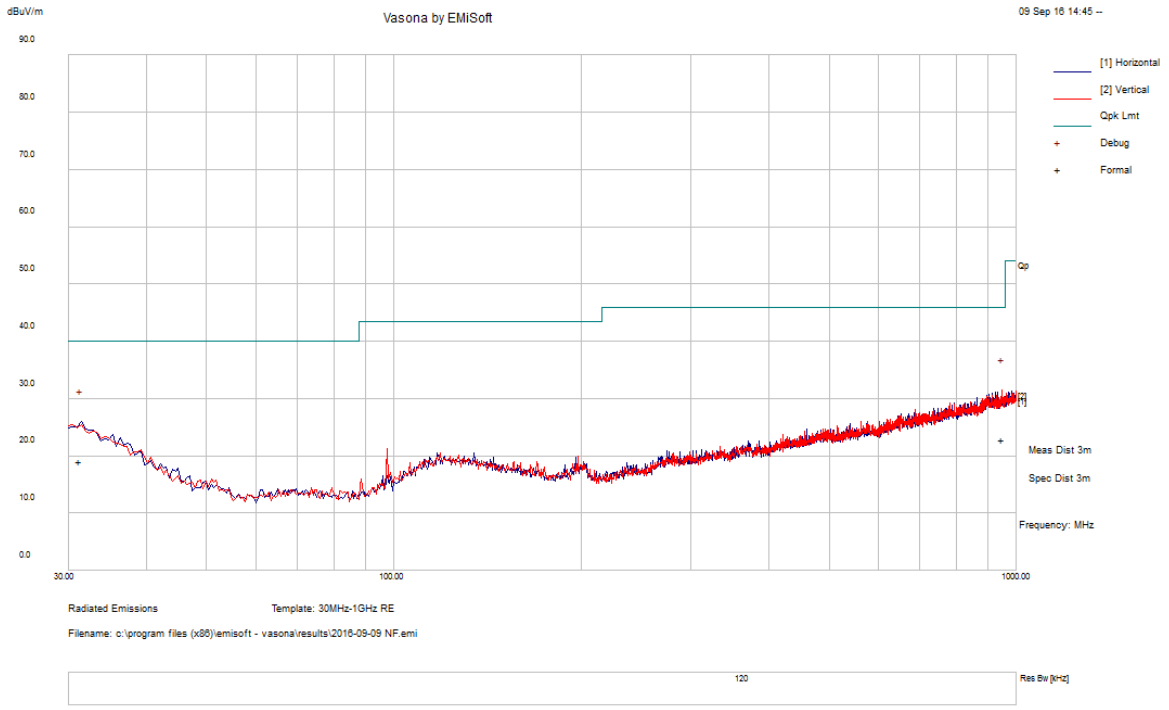
Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Channel**
-3.08	2390	Horizontal	Low

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

6.8 Radiated Emissions Test Results

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

BLE



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
31.32025	19.11	105	H	327	40	-20.89	QP
949.326	23.01	112	V	127	46	-22.99	QP

Note: Only two emissions are show because the other emissions are 20 dB below the limit.

2) 1–25 GHz Measured at 3 meters

BLE

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/ISEDC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel 2402 MHz											
2402	55.32	121	134	H	29.05	5.22	0.00	89.59	N/A	N/A	PK
2402	52.71	121	134	H	29.05	5.22	0.00	86.98	N/A	N/A	AV
2402	44.13	168	150	V	29.05	5.22	0.00	78.40	N/A	N/A	PK
2402	40.73	168	150	V	29.05	5.22	0.00	75.00	N/A	N/A	AV
2390	27.97	121	134	H	28.98	5.22	0.00	62.17	74.00	-11.83	PK
2390	16.72	121	134	H	28.98	5.22	0.00	50.92	54.00	-3.08	AV
4804	50.56	121	134	H	32.48	7.88	36.64	54.28	74.00	-19.72	PK
4804	34.61	121	134	H	32.48	7.88	36.64	38.33	54.00	-15.67	AV
7206	45.43	121	134	H	36.72	10.45	36.42	56.18	74.00	-17.82	PK
7206	33.35	121	134	H	36.72	10.45	36.42	44.10	54.00	-9.90	AV
9608	47.28	121	134	H	37.78	11.37	36.66	59.77	74.00	-14.23	PK
9608	35.15	121	134	H	37.78	11.37	36.66	47.64	54.00	-6.36	AV
Middle Channel 2440 MHz											
2440	54.37	118	134	H	29.19	5.22	0.00	88.78	N/A	N/A	PK
2440	51.61	118	134	H	29.19	5.22	0.00	86.02	N/A	N/A	AV
2440	46.61	173	156	V	29.19	5.22	0.00	81.02	N/A	N/A	PK
2440	43.07	173	156	V	29.19	5.22	0.00	77.48	N/A	N/A	AV
4880	46.83	118	134	H	32.60	7.93	36.63	50.73	74.00	-23.27	PK
4880	34.05	118	134	H	32.60	7.93	36.63	37.95	54.00	-16.05	AV
7320	45.75	118	134	H	37.15	10.67	36.43	57.14	74.00	-16.86	PK
7320	32.73	118	134	H	37.15	10.67	36.43	44.12	54.00	-9.88	AV
9760	47.93	118	134	H	37.89	11.46	36.69	60.59	74.00	-13.41	PK
9760	34.96	118	134	H	37.89	11.46	36.69	47.62	54.00	-6.38	AV
High Channel 2480 MHz											
2480	55.09	126	129	H	29.34	5.22	0.00	89.65	N/A	N/A	PK
2480	52.28	126	129	H	29.34	5.22	0.00	86.84	N/A	N/A	AV
2480	44.80	166	148	V	29.34	5.22	0.00	79.36	N/A	N/A	PK
2480	41.04	166	148	V	29.34	5.22	0.00	75.60	N/A	N/A	AV
2483.5	28.22	126	129	H	29.35	5.35	0.00	62.92	74.00	-11.08	PK
2483.5	15.92	126	129	H	29.35	5.35	0.00	50.62	54.00	-3.38	AV
4960	46.84	126	129	H	32.85	7.97	36.59	51.07	74.00	-22.93	PK
4960	34.32	126	129	H	32.85	7.97	36.59	38.55	54.00	-15.45	AV
7440	45.95	126	129	H	37.04	10.82	36.45	57.36	74.00	-16.64	PK
7440	33.66	126	129	H	37.04	10.82	36.45	45.07	54.00	-8.93	AV
9920	47.09	126	129	H	38.00	11.54	36.70	59.93	74.00	-14.07	PK
9920	34.28	126	129	H	38.00	11.54	36.70	47.12	54.00	-6.88	AV

Note: Duty Cycle Correction Factor has been added to the measurement.

7 FCC §15.247(a) (2) & ISED RSS-247 §5.2 -Emission Bandwidth

7.1 Applicable Standards

According to FCC §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.

7.2 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.

7.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
***Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

7.4 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-09-09
Test Site:	RF Site
Temperature:	22° C
Relative Humidity:	42 %
Barometric Pressure:	102.6 kPa
Test Personnel:	Jin Yang

.

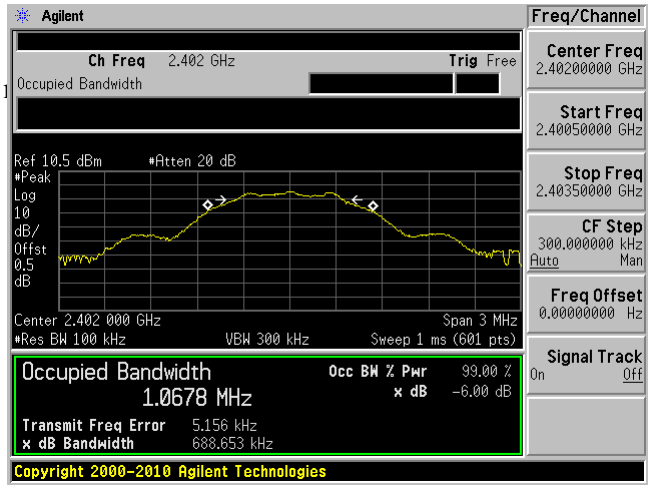
7.5 Test Results

Channel	Frequency (MHz)	99% OBW (MHz)	6 dB Bandwidth (kHz)	6 dB Bandwidth Limit (kHz)
BLE				
Low	2402	1.0678	688.653	500
Middle	2440	1.0744	688.615	500
High	2480	1.0740	688.663	500

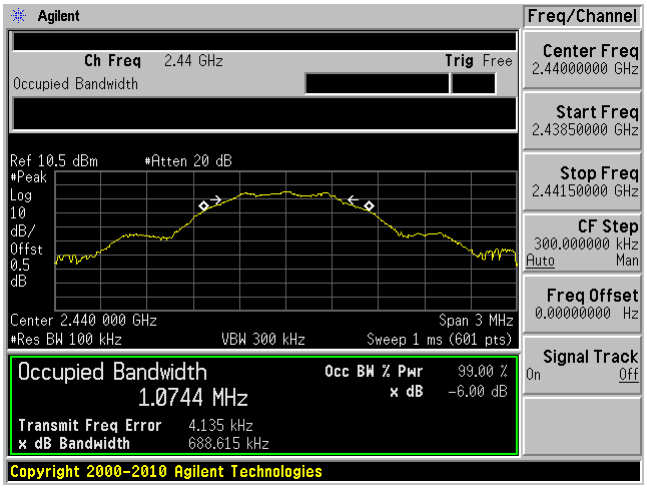
Please refer to the following plots for detailed test results.

BLE

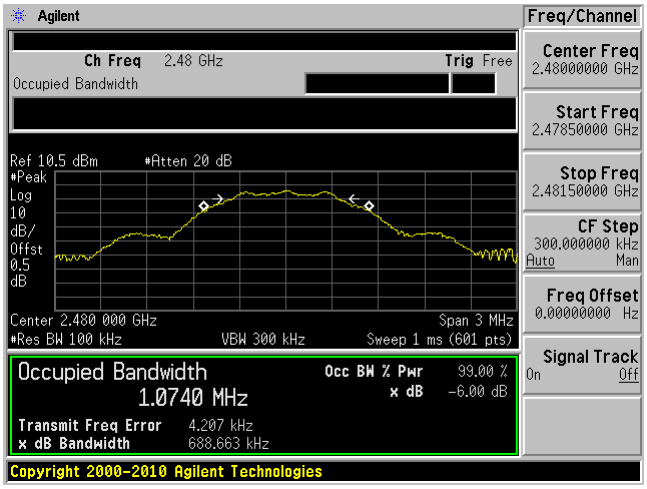
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



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

8.1 Applicable Standards

According to FCC §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.

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 9: Fundamental emission output power.

8.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

8.4 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-09-09
Test Site:	RF Site
Temperature:	22° C
Relative Humidity:	42 %
Barometric Pressure:	102.6 kPa
Test Personnel:	Jin Yang

.

8.5 Test Results

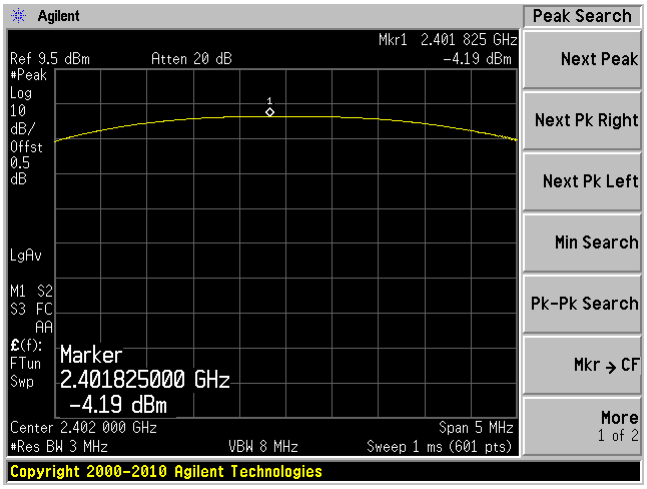
Peak Output Power

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)
BLE			
Low	2402	-4.19	30
Middle	2440	-4.04	30
High	2480	-3.70	30

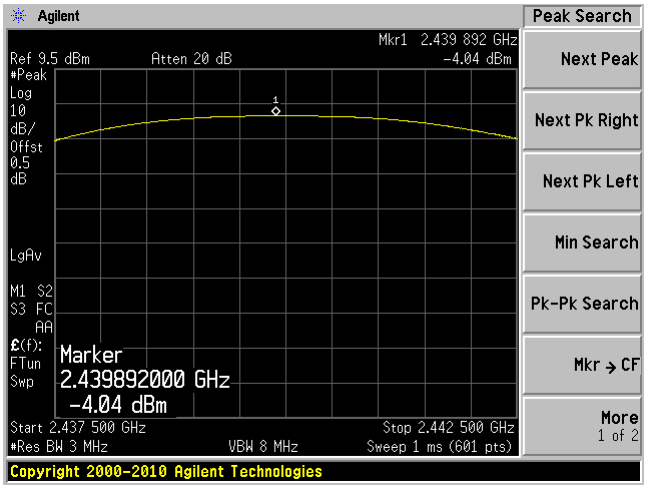
Please refer to the following plots for detailed BLE test results.

BLE

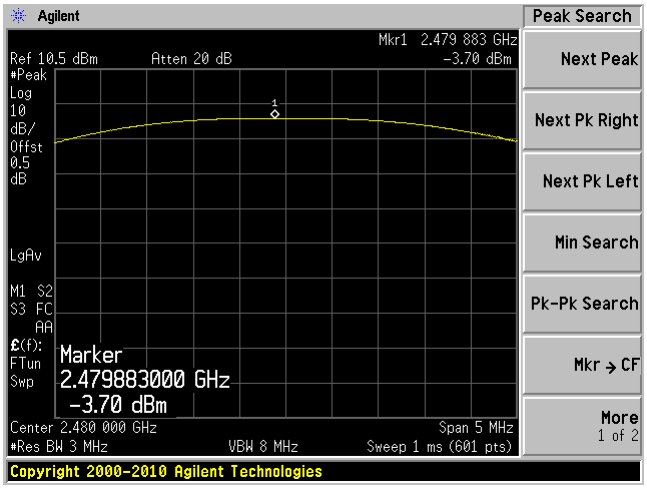
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



9 FCC §15.247(d) & ISED RSS-247 §5.5 – 100 kHz Bandwidth of Band Edges

9.1 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.

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 13: Band-edge measurements.

9.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
***Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

9.4 Test Location, Date, Personnel and Environmental Conditions

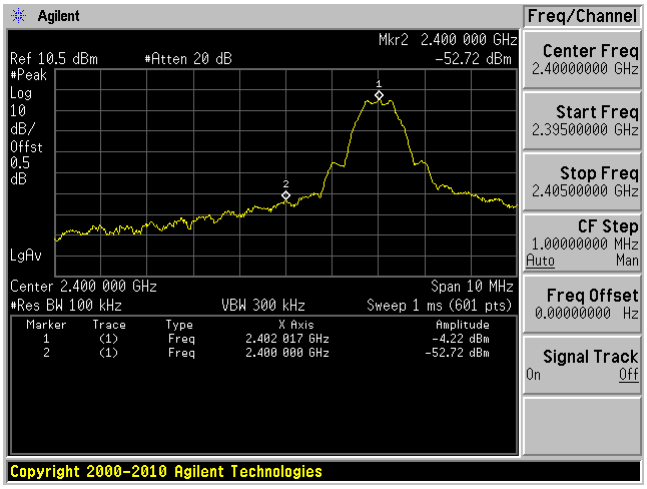
Test Date:	2016-09-09
Test Site:	RF Site
Temperature:	22° C
Relative Humidity:	42 %
Barometric Pressure:	102.6 kPa
Test Personnel:	Jin Yang

.

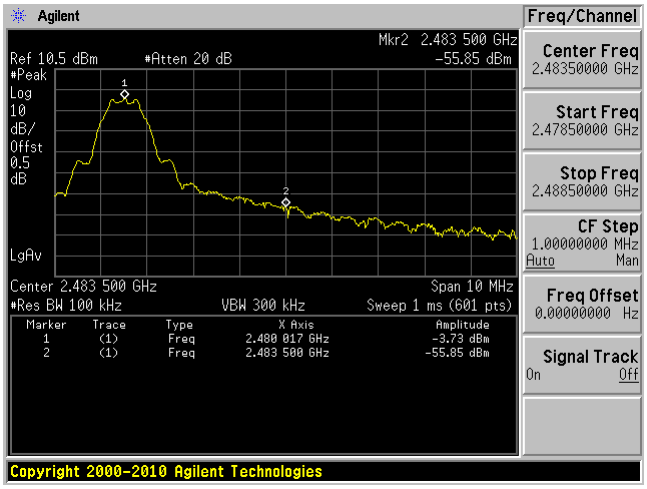
9.5 Test Results

BLE

Low Channel 2402 MHz



High Channel 2480 MHz



10 FCC §15.247(e) & ISED RSS-247 §5.2(2) – Power Spectral Density

10.1 Applicable Standards

According to FCC §15.247(e) and RSS-247 §5.2 (2), 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.

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 10: Maximum power spectral density level in the fundamental emission.

10.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
***Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

10.4 Test Location, Date, Personnel and Environmental Conditions

Test Date:	2016-09-09
Test Site:	RF Site
Temperature:	22° C
Relative Humidity:	42 %
Barometric Pressure:	102.6 kPa
Test Personnel:	Jin Yang

.

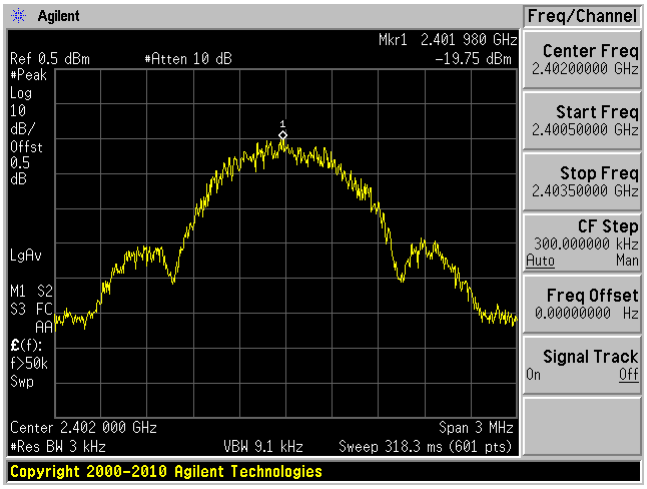
10.5 Test Results

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
BLE			
Low	2402	-19.75	8
Middle	2440	-19.73	8
High	2480	-19.20	8

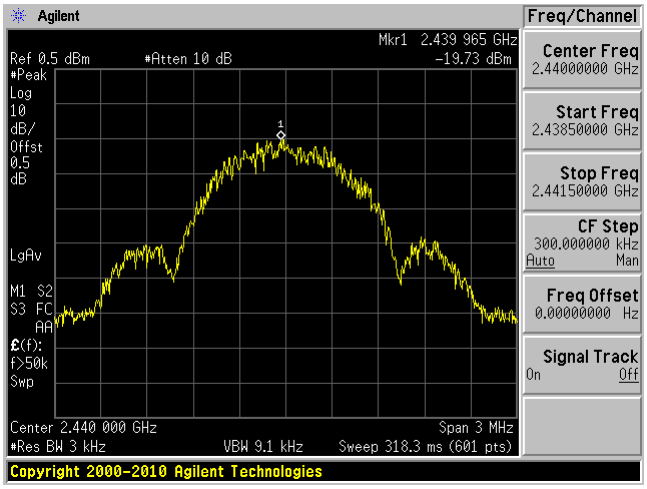
Please refer to the following plots for detailed test results

BLE

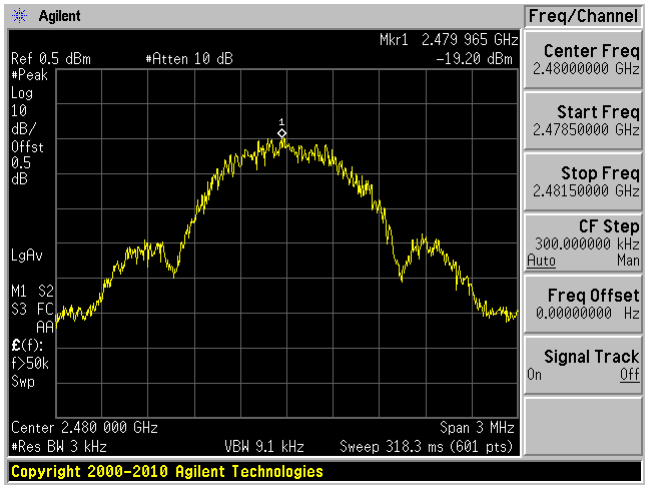
Low Channel 2402 MHz



Middle Channel 2440 MHz



High Channel 2480 MHz



11 FCC §15.247(d) & ISED RSS-247 §5.5 & ISEDC RSS-GEN §8.9 – Spurious Emissions at Antenna Terminals

11.1 Applicable Standards

For FCC §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. 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.

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

11.3 Test Equipment List and Details

BACL Asset #	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Analyzer, Spectrum	E4446A	MY48250238	2015-11-12	1 year
-	-	U. FL to SMA pigtail	-	-	Each time[1]	N/A

[1] cable and attenuator included in the test set-up will be checked each time before testing.
Statement of Traceability: BACL Corp. *attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.*

11.4 Test Location, Date, Personnel and Environmental Conditions

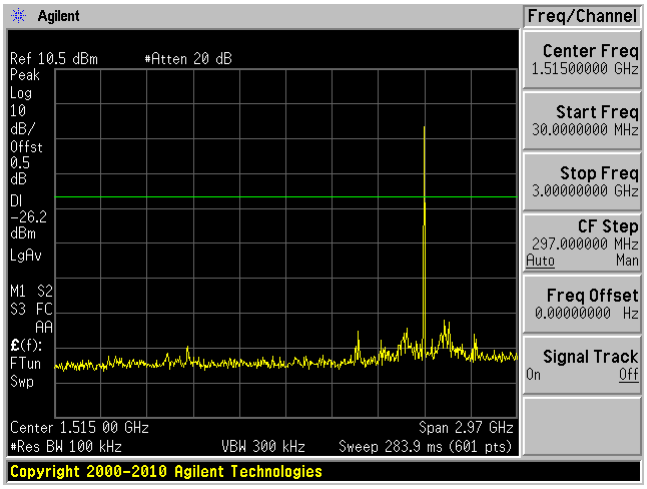
Test Date:	2016-09-09
Test Site:	RF Site
Temperature:	22° C
Relative Humidity:	42 %
Barometric Pressure:	102.6 kPa
Test Personnel:	Jin Yang

11.5 Test Results

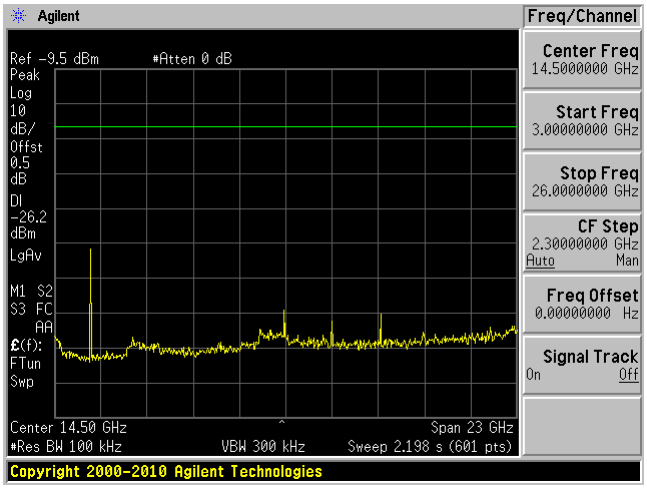
Please refer to following plots.

BLE

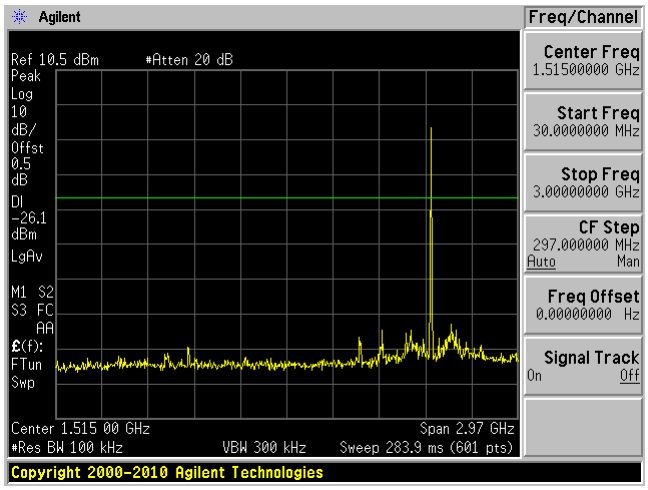
Low Channel 30 MHz – 3 GHz



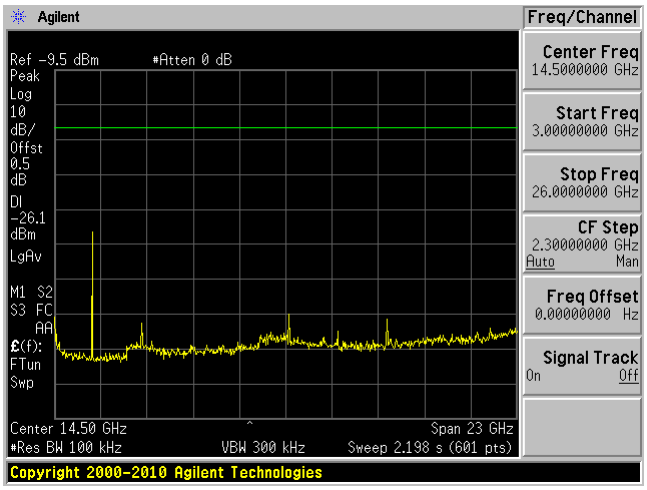
Low Channel 3 GHz – 26 GHz



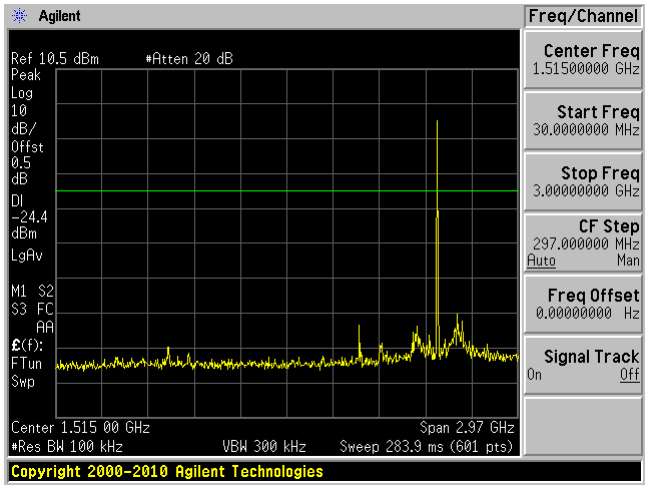
Middle Channel 30 MHz – 3 GHz



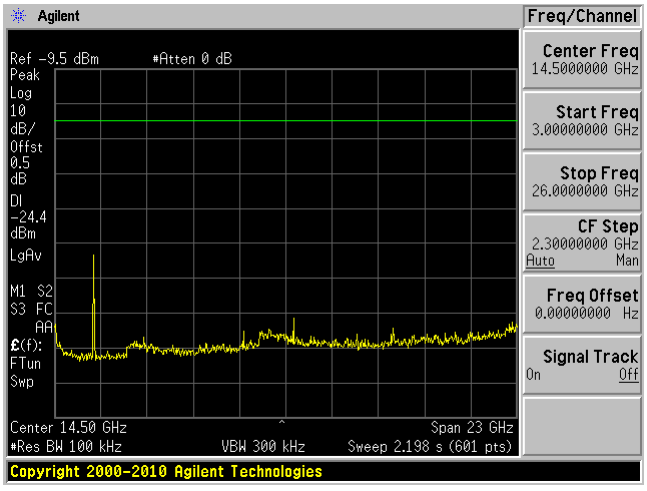
Middle Channel 3 GHz – 26 GHz



High Channel 30 MHz – 3 GHz



High Channel 3 GHz – 26 GHz



12 Appendix A (Normative) - FCC & ISED Equipment Labeling Requirements

12.1 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.

12.2 ISEDC Label Requirements

As per ISEDC RSP-100 Section3.1, the certification number shall appear as follows:

IC: XXXXXX-YYYYYYYY

Where:

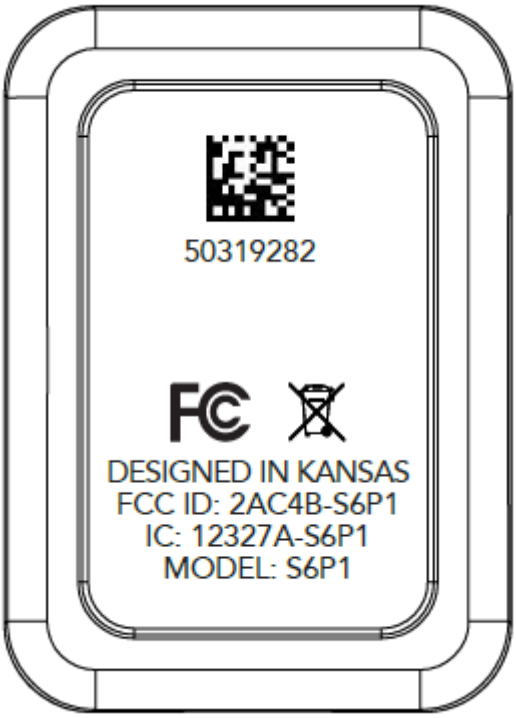
- The letters "IC:" indicate that this is an Innovation, Science and Economic Development Canada's certification number, but they are not part of the certification number. XXXXXXYYYYYYYYYY is the ISED certification number.
- XXXXXX is the CN assigned by Innovation, Science and Economic Development Canada. 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").

- YYYYYYYYYYY 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.

12.3 FCC ID & ISEDC Label Contents and Location



13 Appendix (Normative) - EUT Photographs

Please refer to attachments:
Annex B: Test Setup Photographs
Annex C: EUT External Photographs
Annex D: EUT Internal Photographs

14 Annex A (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.

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