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

TEST AND MEASUREMENT REPORT

For

ABB, Inc.

3055 Orchard Dr.

San Jose, CA 95134, USA

FCC ID: P9J-642401
IC: 4751A-642401

Report Type:	**Product Type:**
Permissive Change Report	Radio Module

Prepared By:	Chin Ming Lui Test Engineer
Report Number:	R1711215-247
Report Date:	2018-04-21
Reviewed By:	Xiao Lin RF Lead

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1711215	Permissive Change	2018-04-03
1	R1711215	Updated Model number	2018-04-21

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *ABB, Inc.*, and their product model: Bluefin 2G, FCC ID: P9J-642401, IC: 4751A-642401or the "EUT" as referred to in this report. The Host router model is TropOS 2420. The TropOS 2420 consists of 2 modules Bluefin 2G and Bluefin 5G (FCC ID: P9J-645801 IC ID: 4751A-645801).

1.2 Objective

This report is prepared on behalf of *ABB, Inc.,* in accordance with Part 2, Subpart J, and Part 15, Subparts C of the Federal Communication Commission's rules and IC RSS-247 Issue 2, February 2017.

The objective is to determine compliance with FCC Part 15.247 and IC RSS-247 rules to allow for colocation for 2 modules in the final product:

- Bluefin 5G module: FCC ID: P9J-645801, IC: 4751A-645801
- Bluefin 2G module: FCC ID: P9J-642401, IC: 4751A-642401

1.3 Related Submittal(s)/Grant(s)

N/A

1.4 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 D01v04 Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under Section 15.247.

1.5 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 º C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %
Duty Cycle	±3 %

1.6 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.

1.7 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/EU US-EU EMC & Telecom MRA CAB (NB)
  - Radio & Teleterminal Equipment (R&TTE) Directive 1995/5/EC US -EU EMC & Telecom MRA CAB (NB)
  - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
  - 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, FCC KDB 558074 D01 DTS Meas Guidance v04, and FCC KDB 789033 D02 General U-NII Test Procedures New Rules v02r01.

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 test firmware used was Putty provided by *ABB, Inc.,* the software is compliant with the standard requirements being tested against.

2.3 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E7450

2.4 Support Equipment

Manufacturer	Description	Model	Serial Number
Netgear	Gigabit Switch	ProSAFE GS108v4	3TX1487Y85301
Dell	Laptop	Latitude E5430	CW4V3X1

2.5 Interface Ports and Cabling

Cable Description	Length (m)	Qty.	To	From
Ethernet Cable	< 1 m	1	Laptop	EUT
RF Cable	< 1 m	1	EUT	PSA
Ethernet Cable	2 m	3	Gigabit Switch	EUT
Serial Cable	< 1 m	1	Laptop	EUT
Serial-to-USB Cable	< 1 m	2	Laptop	EUT

3 Summary of Test Results

Results reported relate only to the product tested.

FCC & IC Rules	Description of Test	Results
FCC §2.1091, §15.247(i) IC RSS-102	RF Exposure	Compliant
FCC §15.207 IC RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §2.1053, §15.205, §15.209, §15.247 (d) IC RSS-247 §5.5 IC RSS-Gen §8.9 & §8.10	Radiated Spurious Emissions	Compliant

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

4.1 Applicable Standards

According to §2.1091 (Mobile Devices) RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minute)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

Note: f = frequency in MHz
* = Plane-wave equivalent power density

According to ISED RSS-102 Issue 5:

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

4.2 MPE Prediction

Predication of MPE limit at a given distance, Equation from OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

4.3 MPE Results

For transmission with 2.4 GHz, and 5 GHz

2.4 GHz

Maximum peak output power at antenna input terminal (dBm):	28.27
Maximum peak output power at antenna input terminal (mW):	671.43
Prediction distance (cm):	35
Predication frequency (MHz):	2412
Maximum Antenna Gain, typical (dBi):	7.5
Maximum Antenna Gain (numeric):	5.623
Power density of prediction frequency at prediction distance (mW/cm^2):	0.2453
Power density of prediction frequency at prediction distance (W/m^2):	2.453
FCC limit (mW/cm^2):	1.00

5 GHz

Maximum peak output power at antenna input terminal (dBm):	27.98
Maximum peak output power at antenna input terminal (mW):	628.058
Prediction distance (cm):	35
Predication frequency (MHz):	5785
Maximum Antenna Gain, typical (dBi):	8
Maximum Antenna Gain (numeric):	6.31
Power density of prediction frequency at prediction distance (mW/cm^2):	0.2574
Power density of prediction frequency at prediction distance (W/m^2):	2.574
FCC limit (mW/cm^2):	1.00

FCC Multi Transmitter MPE Evaluation

FCC: 0.2453/1 +0.2574/1 = 0.503≤1.0

Note: Please refer to BACL Report number R1409232-247, Issued date: 2014-12-22 and Report number R1409231-407, Issued date: 2015-04-06

IC RF Exposure Evaluation

23.60 + 11 dBi = 34.60 dBm < $1.31\times10^{-2}f^{0.6834}$ = 4.8570 W = 36.864 dBm

Note: Please refer to BACL Report number R1703109-247, Issued date: 2017-06-21

Conclusion

In order to meet the multi-transmitter RF Exposure requirement, all transceiver modules must be installed with a separation distance of no less than **35** cm from all persons.

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

5.1 Applicable Standards

As per FCC §15.207 and IC RSS-Gen §8.8 Conducted limits:

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 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

5.2 Test Setup

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

External I/O cables were draped along the edge of the test table and bundle when necessary.

The AC/DC power adapter of the EUT was connected with LISN-1 which provided 120 V / 60 Hz AC power.

5.3 Test Procedure

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

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

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

5.4 Corrected Amplitude & Margin Calculation

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

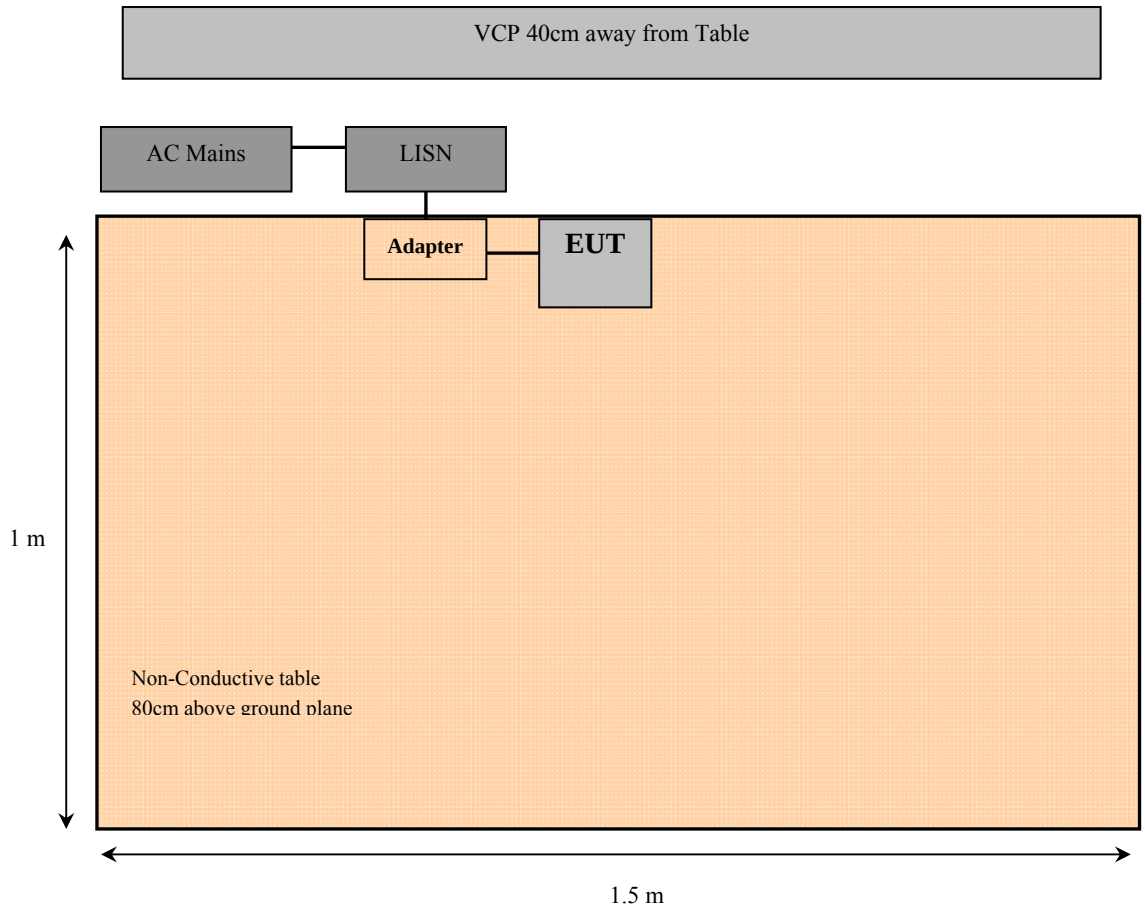
CA = Ai + CL + Atten

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Cable Loss (3.7 dB) + Attenuator (10 dB)

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

Margin = Corrected Amplitude – Limit

5.5 Test Setup Block Diagram



5.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2016-02-04	2 years
Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101964	2017-07-24	1 year
Keysight Technologies	RF Limiter	11867A	MY42242931	2017-01-12	1 year
Solar Electronics Company	High Pass Filter	Type 7930-100	7930150204	2017-03-13	1 year
Suirong	30 ft conductive emission cable	LMR 400	-	N/R	N/A
FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2017-04-24	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

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

5.7 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	101.31 kPa

The testing was performed by Chin Ming Lui on 2017-11-30 in 5 chamber 3.

5.8 Summary of Test Results

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

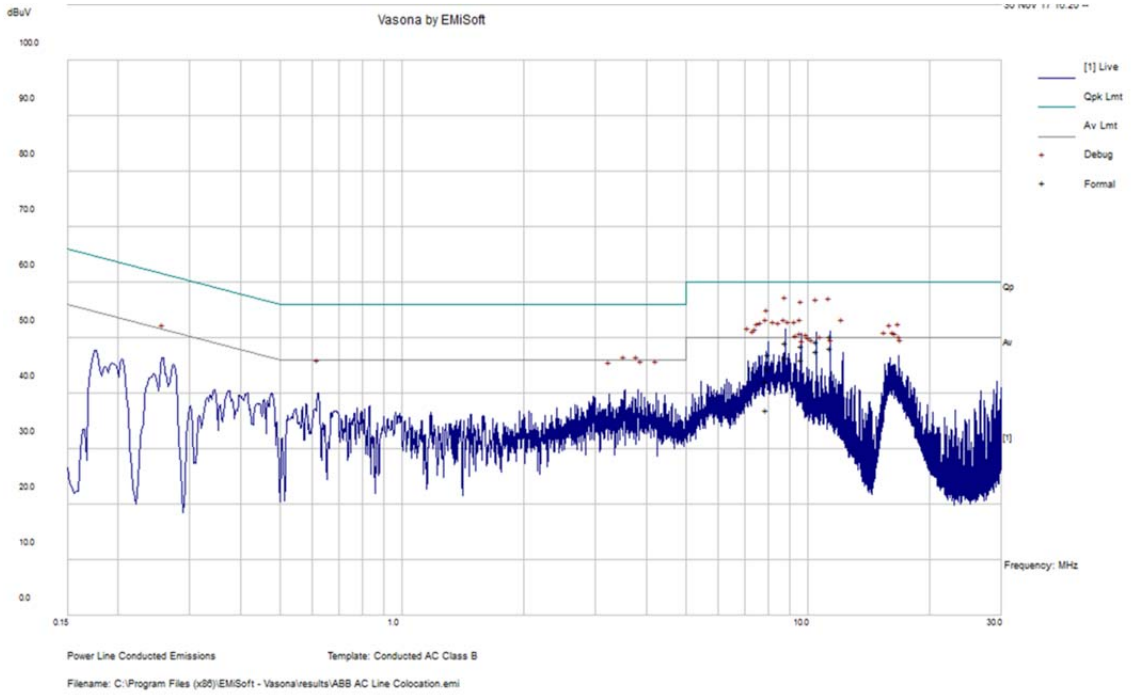
2.4 & 5 GHz Wi-Fi Colocation

Connection: AC/DC adapter connected to 120 V/60 Hz, AC			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Live/Neutral)**	**Range (MHz)**
-1.38	11.36682	Neutral	0.15-30

5.9 Conducted Emissions Test Plots and Data

2.4 GHz and 5 GHz Wi-Fi Colocation

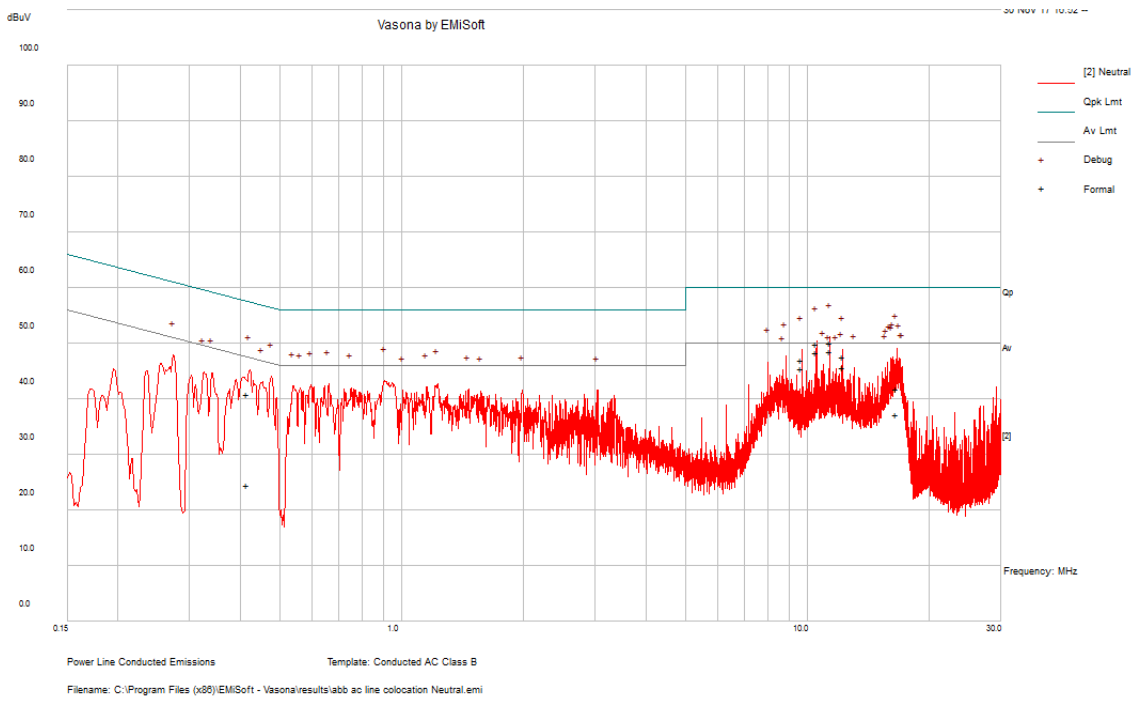
120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
8.82082	49.12	Line	60	-10.88	QP
11.34229	50.31	Line	60	-9.69	QP
10.50405	49.39	Line	60	-10.61	QP
9.664729	48.6	Line	60	-11.4	QP
7.987874	47.01	Line	60	-12.99	QP
7.924098	42.32	Line	60	-17.68	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
8.82082	46.38	Line	50	-3.62	Ave.
11.34229	48.14	Line	50	-1.86	Ave.
10.50405	47.69	Line	50	-2.31	Ave.
9.664729	46.04	Line	50	-3.96	Ave.
7.987874	44.62	Line	50	-5.38	Ave.
7.924098	36.99	Line	50	-13.01	Ave.

120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
11.36682	50.21	Neutral	60	-9.79	QP
10.52553	49.9	Neutral	60	-10.1	QP
16.60088	41.92	Neutral	60	-18.08	QP
12.21014	47.53	Neutral	60	-12.47	QP
9.686909	47.02	Neutral	60	-12.98	QP
0.415577	40.83	Neutral	57.54	-16.7	QP

Frequency (MHz)	Corrected Amplitude (dBuV)	Conductor (Line/Neutral)	Limit (dBuV)	Margin (dB)	Detector (QP/Ave.)
11.36682	48.62	Neutral	50	-1.38	Ave.
10.52553	48.32	Neutral	50	-1.68	Ave.
16.60088	37.2	Neutral	50	-12.8	Ave.
12.21014	45.79	Neutral	50	-4.21	Ave.
9.686909	45.42	Neutral	50	-4.58	Ave.
0.415577	24.52	Neutral	47.54	-23.01	Ave.

6 FCC §15.209, §15.247(d) & ISEDC 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 Part 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(d), 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 IC 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

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2016-02-04	2 years
Agilent	Analyzer, Spectrum	E4446A	US44300386	2017-04-20	1 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2015-07-11	30 Months
EMCO	Antenna, Horn	3115	9511-4627	2016-01-28	2 years
Agilent	Amplifier, Pre	8447D	2944A06639	2017-06-28	1 year
IW	AOBOR Hi frequency Co AX Cable	DC 1531	KPS-1501A3960KPS	2017-08-05	1 year
-	SMA cable	-	C0002	Each time[1]	N/A
-	N-Type Cable	-	C00012	Each time[1]	N/A
-	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

Note[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 Environmental Conditions

Temperature:	20-22 ºC
Relative Humidity:	42-50 %
ATM Pressure:	102.7 kPa

The testing was performed by Chin Ming Lui on 2017-11-29 and 2017-12-13 in 5m chamber 3.

6.7 Summary of Test Results

According to the data hereinafter, the EUT complied with FCC Title 47, Part 15.247 and ISEDC RSS-247 standard's radiated emissions limits, and had the worst margin of:

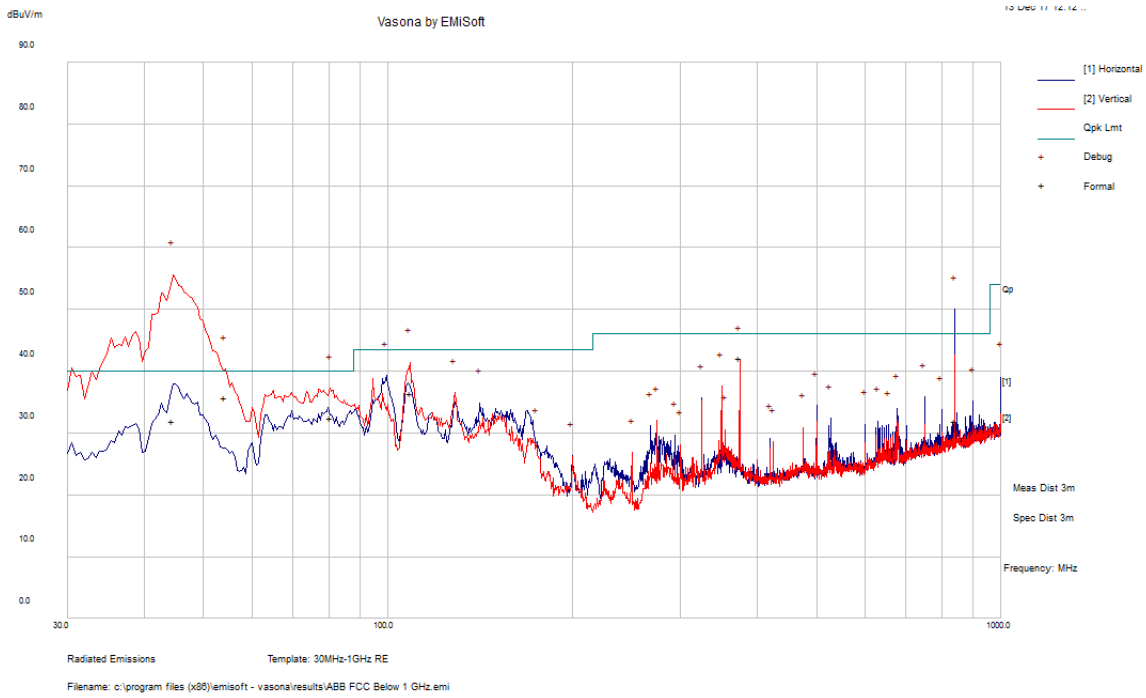
2.4 & 5 GHz Wi-Fi Colocation

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, channel**
-4.84	11570	Horizontal	Colocation

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



Colocation:

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
44.5595	31.98	293	V	302	40	-8.02	QP
840.2623	31.99	103	H	86	46	-14.01	QP
54.20325	35.79	115	V	89	40	-4.21	QP
108.8053	36.54	136	V	291	43.5	-6.96	QP
80.58575	32.55	213	V	16	40	-7.45	QP
375.0095	42.22	284	H	118	46	-3.78	QP

Note: Only 6 emissions were present because the other emissions were 20 dB below the limit.

2) 1–25 GHz Measured at 3 meters

Colocation:

Frequency (MHz)	S.A. Reading (dBµV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBµV/m)	FCC/IC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBµV/m)	Margin (dB)	
Low Channel, 2412 MHz, 1 Mbps, Power Setting = 29 and Middle Channel, 5785 MHz, MCS0, Power Setting = 26.5											
4824	47.59	214	300	H	32.54	6.49	36.361	50.26	74.00	-23.74	PK
4824	40.18	214	300	H	32.54	6.49	36.361	42.85	54.00	-11.15	AV
4824	48.33	184	100	V	32.56	6.49	36.361	51.02	74.00	-22.98	PK
4824	41.97	184	100	V	32.56	6.49	36.361	44.66	54.00	-9.34	AV
7236	46.50	125	157	H	36.91	7.83	36.38	54.86	74.00	-19.14	PK
7236	36.21	125	157	H	36.91	7.83	36.38	44.57	54.00	-9.43	AV
7236	48.67	129	203	V	36.88	7.83	36.38	57.01	74.00	-17.00	PK
7236	39.84	129	203	V	36.88	7.83	36.38	48.18	54.00	-5.83	AV
9648	45.07	0	100	H	37.83	11.68	36.433	58.14	74.00	-15.86	PK
9648	32.91	0	100	H	37.83	11.68	36.433	45.98	54.00	-8.02	AV
9648	45.63	0	100	V	37.81	11.68	36.433	58.69	74.00	-15.31	PK
9648	33.26	0	100	V	37.81	11.68	36.433	46.32	54.00	-7.68	AV
11570	44.20	0	100	H	38.46	13.54	35.14	61.06	74.00	-12.94	PK
11570	32.30	0	100	H	38.46	13.54	35.14	49.16	54.00	-4.84	AV
11570	43.41	0	100	V	38.38	13.54	35.14	60.19	74.00	-13.82	PK
11570	31.30	0	100	V	38.38	13.54	35.14	48.08	54.00	-5.93	AV

7 Exhibit A - FCC & IC Equipment Labeling Requirements

7.1 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.

7.2 IC Label Requirements

As per IC 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").
- YYYYYYYYYY 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.

7.3 FCC ID & IC Label Contents and Location

TropOS 2420
PRODUCT NO:
24203060D

INPUT: 7-32VDC, 10W ⎓

Class B
CONTAINS FCC ID: P9J-642401
CONTAINS FCC ID: P9J-645801
IC: 4751A-642401 m/n: Bluefin 2G
IC: 4751A-645801 m/n: Bluefin 5G

NOTE: Installer must be a trained technical professional.

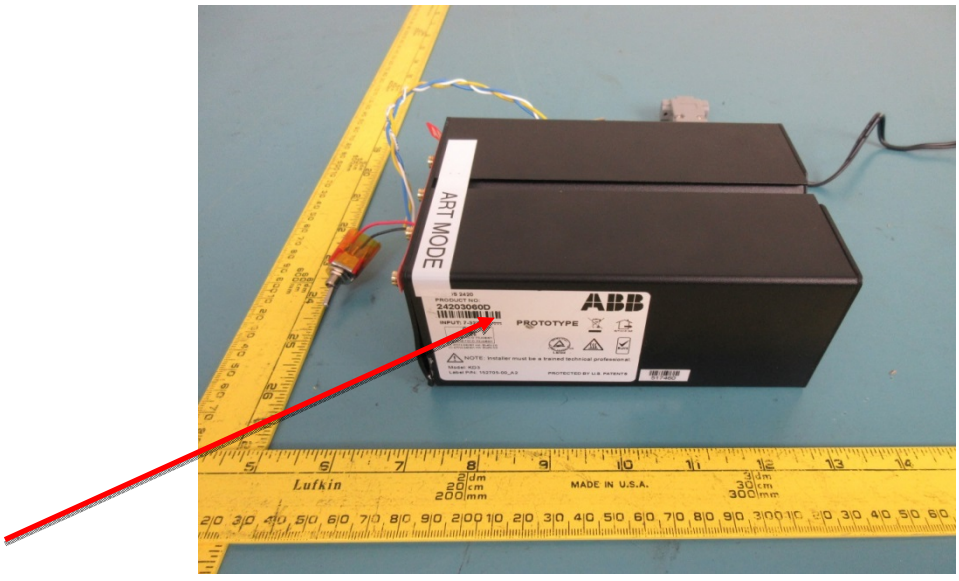
C US Listed

Class I, Division 2, Groups A, B, C, and D; Ex nA IIA T4A Gc
Class I, Zone 2; AEx nA IIA T4 Gc
Ambient range: Tamb = -40°C to +75°C

WARNING – EXPLOSION HAZARD. DO NOT CONNECT OR DISCONNECT WHEN ENERGIZED.
AVERTISSEMENT – RISQUE D'EXPLOSION. NE PAS BRANCHER OU DÉBRANCHER LORSQUE LE CIRCUIT EST SOUS TENSION.

WARNING – EXPLOSION HAZARD. DO NOT REMOVE OR REPLACE WHILE CIRCUIT IS LIVE UNLESS THE AREA IS FREE OF IGNITIBLE CONCENTRATIONS.
AVERTISSEMENT – RISQUE D'EXPLOSION. NE PAS RETIRER OU REMPLACER LORSQUE LE CIRCUIT EST SOUS TENSION, À MOINS QUE LE MILIEU SOIT LIBRE DE SUBSTANCES INFLAMMABLES CONCENTRÉES.

Model: KD3 Label P/N: 152705-00_A3 **PROTECTED BY U.S. PATENTS**



8 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 A2LA *R222 - Specific Requirements - EPA ENERGY STAR Accreditation Program*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 30th day of August 2016.

Senior Director of Quality & Communications
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2018

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

--- END OF REPORT ---