FCC PART 15 SUBPART B
ISED ICES-003 ISSUE 6
TEST REPORT

For

Trimble Navigation Limited

935 Stewart Drive,

Sunnyvale, CA 94085, USA

FCC ID: JUP-90912

Report Type:	**Product Type:**
Original Report	GNSS Receiver

Prepared By:	Vincent Chiu Test Engineer
Report Number:	R1611011
Report Date:	2017-05-30
Reviewed By:	Kevin Wang EMC Lead

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1611011	Original Report	2017-05-30

1 General Information

1.1 General Statements

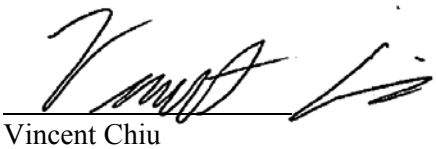
Bay area Compliance Laboratory Corp. [BACL] hereby makes the following Statements:

- The Unit(s) described in this Test Report were received at BACL's facilities on 05 March 2017. Testing was performed on the Unit(s) described in this Test Report during the period 30 March through 12 April 2017.
- 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 Purpose

The purpose of this Test Report is to document the compliance of the Trimble, Inc. Model R10i to the requirements of 47 CFR Part 15 Subpart B for Class B Devices and Innovation, Science, and Economic Development Canada ICES-003 Issue 6 (Jan. 2016) for Class B Devices. The objective of the testing performed was to determine the compliance of the EUT in accordance with the FCC Rules (i.e., 47 CFR Part 15 Subpart B Sections 15.107 and 15.109) using the CISPR 22 Edition 3 Class B limits for conducted and radiated emissions, ICES-003 Issue 6 (Jan. 2016) per Section 6.1 Table 2 for powerline conducted emissions limits; per Section 6.2.1 Table 5 for Radiated Emissions at frequencies below 1 GHz; and, per Section 6.2.2 Table 7 for Radiated Emissions at frequencies above 1 GHz, subject to the upper frequency limitations stated in Section 6.2 Table 3, using the test methods in the latest version of ANSI C63.4 (i.e., ANSI BC63.4-2014). This Test Report references the applicable Electromagnetic Emissions requirements.

THE DATA CONTAINED IN THIS TEST REPORT WAS COLLECTED AND COMPILED BY:



Vincent Chiu
[Test Engineer]

Shoaib Khan
[Test Engineer]

1.3 Agent for the Responsible Party

None

1.4 Responsible Party

Company Name: Trimble Navigation Limited
Contact: Tony Phan
Street Address: 935 Stewart Drive
City/State/Zip: Sunnyvale, CA 94085.
Country: USA
Telephone: +1(408)-481-8491
E-mail: tony_phan@trimble.com
Website: www.trimble.com

1.5 Product Description of the Equipment under Test (EUT)

The EUT was a GNSS Receiver with integrated Cellular, BT/Wi-Fi Combo, and optional UHF radio module. The Highest frequency is 2.48 GHz. The Model of EUT is R10-2; FCC ID: JUP-90912.

1.6 Mechanical Description of the EUT

Dimensions: approximately 11.9 cm (L) x 11.9 cm (W) x 13.6 cm (H)
Weight: approximately 1.12 Kg.
Serial Number: 90912-60
EUT Photos: See Annex C of this Test Report.

1.7 EUT Input Power

EUT AC Adaptor:
Input: 100-240V~50-60Hz, 1.4A Max.
Output: 19 VDC, 3.43 A

1.8 Related Submittal(s)/Grant(s)

This product contains 3 certified RF modules, FCC ID: QIPPHS8-P; FCC ID: Z64-WL18DBMOD and FCC ID: KEAXDLM

1.9 Test Methodology

All of the measurements contained in this Test Report were made in accordance with ANSI C63.4-2014 "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz". All tests were performed at the Bay Area Compliance Laboratories Corp. facilities in Sunnyvale California.

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: (Industry Canada - IC) 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;

1.12 Measurement Uncertainties

All measurements involve uncertainties. In the case of EMC Emissions tests, the influence quantities (factors) that make a significant contribution to the measurement uncertainties are detailed in the latest version of CISPR 16-4-2 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modelling – Measurement instrumentation uncertainty" (i.e., CISPR 16-4-2:2011-06 + C1:2013-04 +A1:2014-02).

Based on the uncertainty models given in the latest version of CISPR16-4-2, and, based on the calibration uncertainties of the specific instruments and facilities used at BACL to perform the measurements documented in this Test Report, the following estimates have been made of BACL's Measurement Uncertainties for the measurements documented in this Test Report.

Type of Measurement	**BACL Typical U_{LAB} Value** (for a k=2 Coverage Factor, equivalent to ~ 95% level of confidence)	**U_{CISPR} Value** worst-allowable values, per Table 1 of the latest version of CISPR 16-4-2 (for a k=2 Coverage Factor, equivalent to ~ 95% level of confidence)
Conducted Disturbance (Mains Port) 150 kHz to 30 MHz (i.e., AC/DC Line Conducted Emissions measurements made with an LISN)	**3.3 dB**	**3.4 dB**
Radiated Disturbance on an OATS 30 MHz – 1000 MHz (i.e., Radiated Emissions measured in a SAC at 10 metres distance)	**5.8 dB**	**6.3 dB**
Radiated Disturbance on an OATS 1 GHz – 6 GHz (i.e., Radiated Emissions measured in a FAR at 3 metres distance)	**5.1 dB**	**5.2 dB**
Radiated Disturbance on an OATS 6 GHz – 18 GHz (i.e., Radiated Emissions measured in a FAR at 3 metres distance)	**5.4 dB**	**5.5 dB**

2 System Test Configuration

2.1 Justification

The EUT and its Support Equipment were configured as a system and were arranged in accordance with the ANSI C63.4-2014 Standard.

2.2 EUT Mode of Operation

The EUT had all of its ports connected to items of support equipment. The EUT was set to communicate with all five signals as well as all items of support equipment.

2.3 EUT Exercising Software

The EUT and support equipment were pre-installed with exercising software by the customer. The exercising software was located on the laptop. From the laptop, CSGSuite and WebGui were used for Wi-Fi, Bluetooth, GPS, and UHF transmits and receives. The GSM signal was monitored through the CMW500 and horn antenna. As long as five signals were operational and running, the unit required no further exercising software.

2.4 Method of Monitoring

In accordance with the customer's instructions, the GPS, Wi-Fi, Bluetooth, and UHF signal were monitored on the laptop through their respective software. The GSM signal was monitored through the horn antenna and the CMW500. The software was monitored visually to make sure all signals were constantly communicating and connected.

2.5 Local Support Equipment

Manufacturer	Description	Model	Serial Number
Trimble Inc.	GNSS Antenna	Zephyr 3	1551021181
Panatron	DC Block	T10609-1-N	-
HP	Power Supply	6216C	-
Trimble Inc.	Radiator	-	-
N/A	BT/Wi-Fi dongle	BW-1518	-
Dell	Laptop	Latitude E6430	7L42TY1
Dell	Laptop Adapter	DA90PS1	48661-77M
Trimble Inc.	GNSS receiver	SPS855	5619R04263
Adapter Tech	AD/DC adapter	ATS065T-A190	-
Laird Technologies	410-470MHz whip antenna	44085-60	-
Laird Technologies	410-470MHz duck antenna	84302	-

2.6 EUT Internal Configuration Details

Manufacturer	Description	Model	FCC ID
Cinterion	Cellular Module	PHS8-P	QIPPHS8-P
TI	Wi-Fi/BT Combo Module	WL1837MOD	Z64-WL18DBMOD
Trimble	UHF Module	XDLM-0	KEAXDLM

2.7 External I/O Cabling List and Details

Cable Description	Length (m)	From	To
UHF Cable	25.0	EUT	Laptop
Data/Power Cable	6.0	EUT	AC Adapter
AC Power Cable	2.0	AC Adapter	AC Power
USB Cable and Extension	25.0	EUT	BT/Wi-Fi Dongle
Coax Cable	25.0	GNSS Antenna	DC Block
Coax Cable	5.0	DC Block	Radiator

2.8 EUT External Power Supply List and Details

Manufacturer	Description	Model	Serial Number
Adapter Tech	AD/DC adapter	ATS065T-A190	-

3 Summary of Test Results

FCC Part 15B ISED ICES-003 Issue 6	Descriptions of Test	Result(s)
FCC §15.107 ISED ICES-003 Issue 6, §6.1 Table 2	AC Line Conducted Emissions	Compliant with the Class B Limits
FCC §15.109 ISED ICES-003 Issue 6, §6.2.2 Table 7	Radiated Emissions	Compliant with the Class B Limits

4 FCC §15.107 & ISED ICES-003 Issue 6 §6.1 - AC Line Conducted Emissions

4.1 Applicable Standards

As per FCC §15.107: Conducted Limits

(a) Except for Class A digital devices, for equipment 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 band edges.

Table 1- Limits for conducted disturbance at the mains ports of class B ITE

Frequency range (MHz)	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50
*Decreases with the logarithm of the frequency.		

As per the Innovation, Science, and Economic Development Canada ICES-003 Issue 6 (Jan. 2016) Section 6.1 Table 2 Limits for powerline conducted emissions:

Class B: An ITE that does not meet the conditions for Class A operation shall comply with the Class B conducted limits set out in Table 2.

Table 2 - Class B Conducted Limits

Frequency range (MHz)	Class B Conducted Limit (dB μV/)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*Decreases with the logarithm of the frequency.

4.2 EUT Setup

The conducted emissions tests were performed in the BACL 10-meter Semi-Anechoic Chamber, using a test setup that was in accordance with ANSI C 63.4-2014. The specifications used were in accordance with the Innovation, Science, and Economic Development Canada ICES-003 Issue 6 (Jan. 2016) Table 2 Class B limits

The spacing between the peripherals (if any) was 10 cm.

The external I/O cables (if any) were draped along the test table and bundled as required.

The EUT's External USB Power Adapter was connected (via the LISN) to an EMI-filtered 120 VAC / 60 Hz AC power receptacle in the BACL 10-meter Semi-Anechoic Chamber

4.3 Test Procedure

The procedures detailed in ANSI C63.4-2014 Clauses 7.3.3 and 11.8.2, were used to determine the mode of operation and cable positions of the EUT system that produce the emission with the highest amplitude relative to the limit. This arrangement was used when the final ac power-line conducted emissions measurements were made on the EUT.

Using the mode of operation and arrangement of the EUT system determined in ANSI C63.4-2014 Clause 7.3.3, the procedure detailed in ANSI C63.4-2014 Clause 11.8.3 was used to perform final ac power-line conducted emission measurements. Specifically, this procedure required the automated measurement and recording of the six highest emissions relative to the limit on each of the current-carrying conductors of each of the power cords of the equipment that comprised the EUT over the frequency range specified by the procuring or regulatory agency.

4.4 Corrected Amplitude and Margin Calculations

The Corrected Amplitude (CA) values listed in the following data tables were calculated by adding the LISN Insertion Loss (LL) to the Cable Loss (CL) to the High Pass Filter and Impulse Limiter Loss (HPLA) to the "raw" measured Amplitude (Am) reading. The basic equation is as follows:

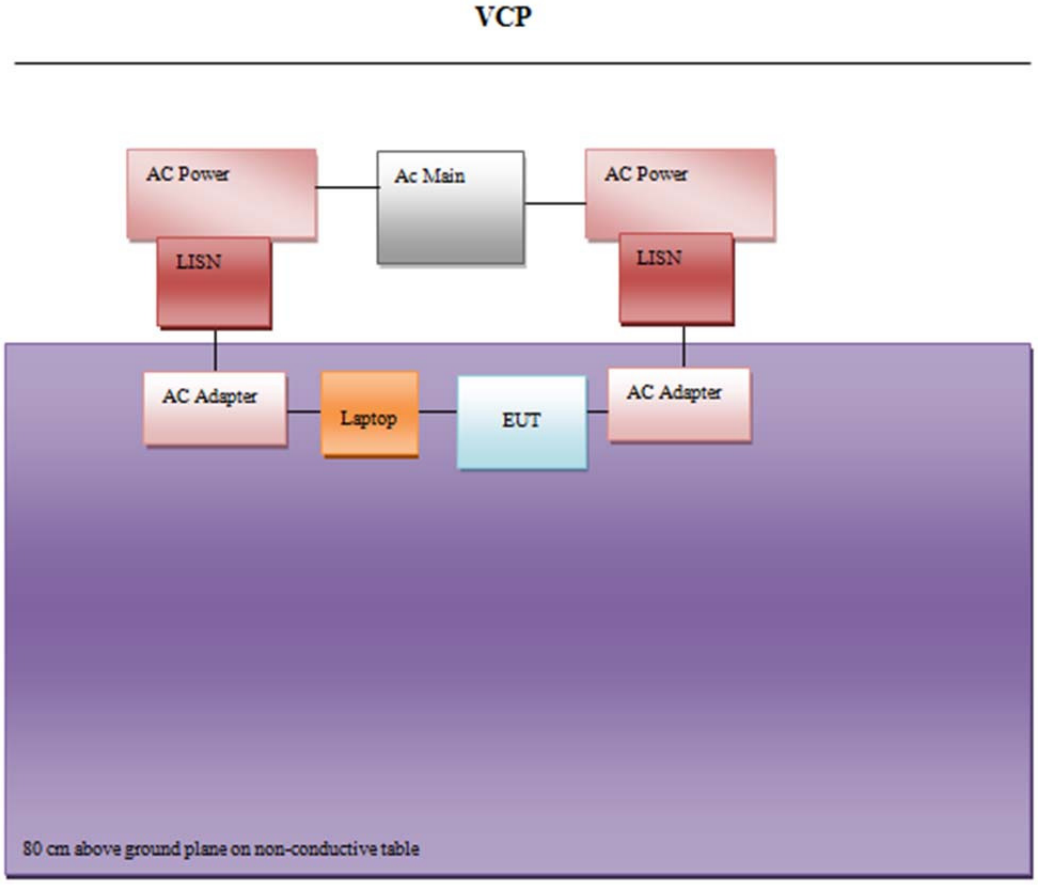
CA = Am + LL + CL + HPIL

For example, if (at some frequency) we had a measured Amplitude reading (Am) of 50.0 dBµV, a LISN Insertion Loss of 0.3, a Cable Loss (CL) of 1.8 dB, and a High Pass Filter and Impulse Limiter Loss (HPIL) of 0.4 dB, the a corrected amplitude (CA) would be 52.5 dBµV (i.e., 50.0 + 0.3 + 1.8 + 0.4 = 52.5 dBµV).

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

Margin (dB) = Corrected Amplitude (dBµV) - Applicable Limit (dBµV)

4.5 Test Setup Block Diagram



4.6 EMI Measurement Software

The EMI Measurement software package used to perform this test was the EMIsoft® VASONA® Version 6.00

4.7 Test Equipment List and Details

BACL Asset #	Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
00732	FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2016-04-11	1year
00679	Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101963	2016-07-14	1 year
00724	Solar Electronics Company	High Pass Filter	Type 7930-100	7930150202	2017-03-13	1 year
00322	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100337	2015-06-18	2 years
00691	Wireless Solutions	Conducted Emission Cable	LMR 400	691	2016-06-29	1year

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".

4.8 Test Environmental Conditions & Test Personnel

Test Date:	2017-03-31
Test Site:	10m Chamber 1
Temperature:	15 º C
Relative Humidity:	49 %
Barometric Pressure:	101.8 kPa
Test Personnel:	Vincent Chiu

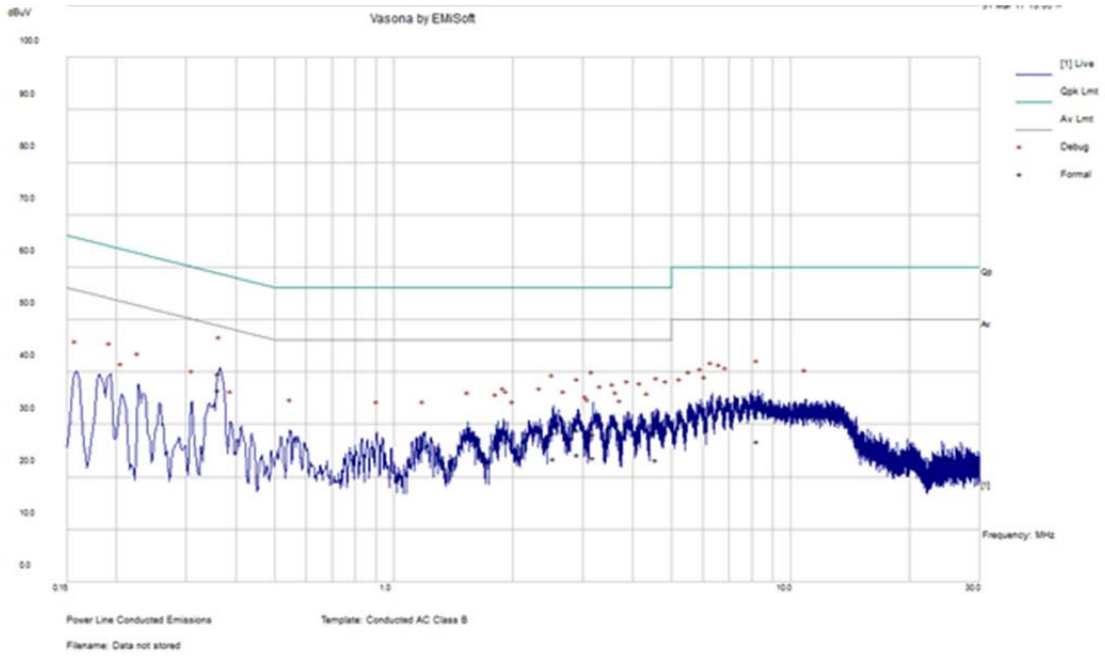
4.9 Summary of Test Results

Based upon the measurements made, it was determined that the EUT complied with the applicable FCC Part 15 Subpart B Class B and ISED ICES-003 Issue 6 (Jan. 2016) Table 2 Class B Conducted Emissions Limits. The EUT's worst margin reading of:

FCC & ISED ICES-003 Issue 6, Conducted Emissions - Worst Case:					
Conductor (Hot/Neutral)	**Frequency (MHz)**	**Highest Corrected QP Amplitude (dBµV)**	**Worst-Case QP Margin (dB)**	**Highest Corrected Ave. Amplitude (dBµV)**	**Worst-Case Ave. Margin (dB)**
Line	0.36	39.69	-18.99	36.57	-12.12
Neutral	0.36	37.71	-20.95	35.04	-13.62

4.10 Conducted Emissions Test Plots and Data

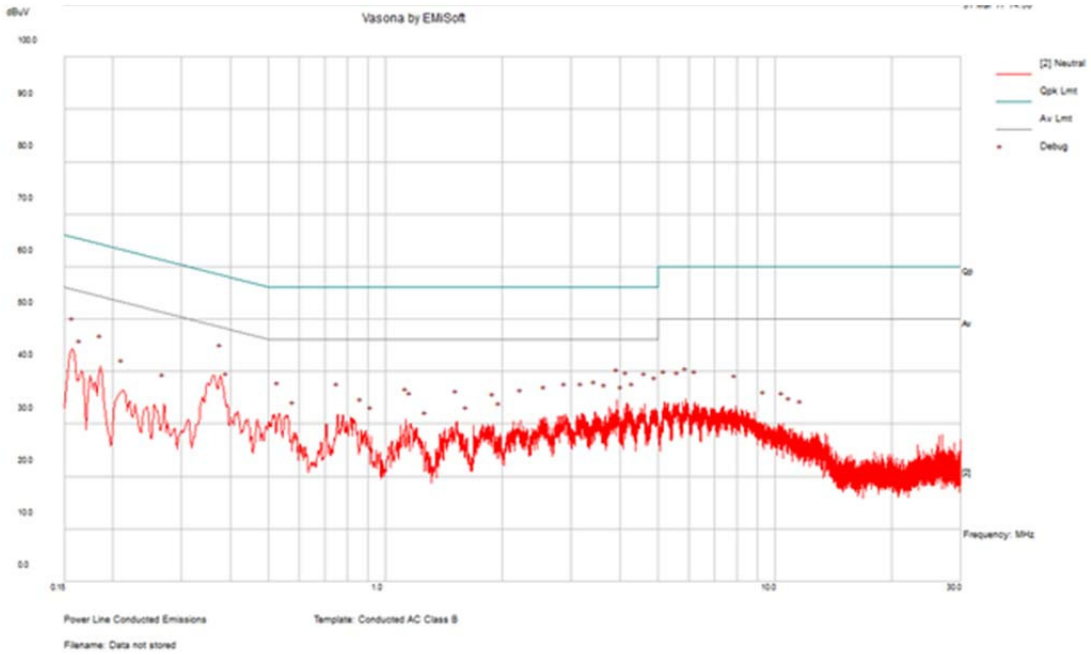
Conducted Emissions: 120 V, 60 Hz – Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Note
0.361887	39.69	Line	58.69	-18.99	QP
2.90977	28.93	Line	56	-27.07	QP
4.582616	28.6	Line	56	-27.40	QP
2.536153	28.39	Line	56	-27.61	QP
3.186288	28.3	Line	56	-27.70	QP
8.271864	31.62	Line	60	-28.38	QP

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Line/Neutral)	Limit (dBµV)	Margin (dB)	Note
0.361887	36.57	Line	48.69	-12.12	Ave.
2.90977	24.33	Line	46	-21.67	Ave.
3.186288	23.67	Line	46	-22.33	Ave.
2.536153	23.51	Line	46	-22.49	Ave.
4.582616	23.3	Line	46	-22.70	Ave.
8.271864	26.81	Line	50	-23.19	Ave.

Conducted Emissions: 120 V, 60 Hz – Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Hot/Neutral)	Limit (dBµV)	Margin (dB)	Note
0.363119	37.71	Neutral	58.66	-20.95	QP
4.160654	29.54	Neutral	56	-26.46	QP
4.929362	29.54	Neutral	56	-26.46	QP
4.62194	28.9	Neutral	56	-27.1	QP
0.173302	37.32	Neutral	64.8	-27.49	QP
3.947408	28.35	Neutral	56	-27.65	QP

Frequency (MHz)	Corrected Amplitude (dBµV)	Conductor (Hot/Neutral)	Limit (dBµV)	Margin (dB)	Note
0.363119	35.04	Neutral	48.66	-13.62	Ave.
4.929362	24.35	Neutral	46	-21.65	Ave.
4.160654	23.56	Neutral	46	-22.44	Ave.
4.62194	22.13	Neutral	46	-23.87	Ave.
3.947408	22.06	Neutral	46	-23.94	Ave.
0.173302	13.71	Neutral	54.8	-41.09	Ave.

5 FCC §15.109 & ISED ICES-003 Issue 6 – Radiated Emissions

5.1 Applicable Standards

As per FCC §15.109: Radiated Emission Limits

a) Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of emission (MHz)	Field strength (microvolts/meter)
30-88	100
88-216	150
216-960	200
Above 960	500

(g) As an alternative to the radiated emission limits shown in paragraphs (a) and (b) of this section, digital devices may be shown to comply with the standards contained in Third Edition of the International Special Committee on Radio Interference (CISPR), Pub. 22, "Information Technology Equipment—Radio Disturbance Characteristics—Limits and Methods of Measurement" (incorporated by reference, *see* §15.38). In addition:

(1) The test procedure and other requirements specified in this part shall continue to apply to digital devices.

(2) If, in accordance with §15.33 of this part, measurements must be performed above 1000 MHz, compliance above 1000 MHz shall be demonstrated with the emission limit in paragraph (a) or (b) of this section, as appropriate. Measurements above 1000 MHz may be performed at the distance specified in the CISPR 22 publications for measurements below 1000 MHz provided the limits in paragraphs (a) and (b) of this section are extrapolated to the new measurement distance using an inverse linear distance extrapolation factor (20 dB/decade), e.g., the radiated limit above 1000 MHz for a Class B digital device is 150 μV/m, as measured at a distance of 10 meters.

(3) The measurement distances shown in CISPR Pub. 22, including measurements made in accordance with this paragraph above 1000 MHz, are considered, for the purpose of §15.31(f)(4) of this part, to be the measurement distances specified in this part.

Note: The CISPR 22 Third Edition Class B Radiated Emissions Limits were applied from 30 MHz to 1 GHz (i.e., from 30 MHz to 230 MHz, a Limit of 30 dBμV/m was applied at a 10 m measurement distance; from 230 MHz to 1000 MHz, a 37 dBμV/m limit was applied at a 10 m measurement distance). Above 1000 MHz, the FCC limit of 500 μV/m (54 dBμV/m) was applied at a 3 m measurement distance.

As per the Innovation, Science, and Economic Development Canada ICES-003 Issue 6 (Jan. 2016) Section 6.2 Table 3 Frequency Limits for Radiated Emissions:

Radiated emissions from an ITE shall be measured from the lowest frequency generated, or used, in the device or 30 MHz, whichever is higher, up to the frequency determined in accordance with Table 3.

Table 3 – Frequency Range of Measurement Highest Frequency Generated or Used in Device	Upper Frequency of Radiated Measurement
Below 1.705 MHz	No radiated testing required
1.705 MHz – 108 MHz	1 GHz
108 MHz – 500 MHz	2 GHz
500 MHz – 1 GHz	5 GHz
Above 1 GHz	5th harmonic of the highest frequency or 40 GHz, whichever is lower.

At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified in this Section. Measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be demonstrated that measurements at a distance of 30 meters or less are not practical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements).

As per the Innovation, Science, and Economic Development Canada ICES-003 Issue 6 (Jan. 2016) Section 5(a) (ii) (i.e., CAN/CSA-CISPR 22-10 Class B Radiated Emissions Limits:

CAN/CSA-CISPR 22-10 Class B Radiated Emissions Limits as stated in
Table 6 – Limits for radiated disturbance of class B ITE at a measuring distance of 10 m

Frequency (MHz)	Class B Radiated Limit (dBµV/m) Quasi-Peak Detector
30 to 230	30
230 to 1000	37
NOTE 1 The lower limit shall apply at the transition frequency. NOTE 2 Additional provisions may be required for cases where interference occur	

As per the Innovation, Science, and Economic Development Canada ICES-003 Issue 6 (Jan. 2016) Section 6.2.2 Table 7 Class B Radiated Emissions Limits above 1 GHz:

Class B: An ITE that does not meet the conditions for Class A equipment shall comply with the Class B radiated limits set out in Table 7 determined at a distance of 3 meters.

Table 7 – Class B Radiated Limits above 1 GHz Frequency (MHz)

Frequency (MHz)	Class B Radiated Limit (dBµV/m)	
	Linear Average Detector	Peak Detector
> 1000	54	74

The radiated emissions tests were performed in the BACL 10-meter Anechoic Chamber, using a test setup in accordance with ANSI C63.4-2014 measurement procedures.

SPECIAL NOTE: A "Boresight Mast" was used to ensure that the emissions from the EUT remained within the 3 dB Beamwidth of the Double-Ridge Guide Horn Antenna used to make measurements above 1 GHz. Additionally, at frequencies above 1 GHz, loose-laid RF Absorber was placed on the Chamber Ground Plane to ensure that those measurements were made under conditions that approximated free-space.

The spacing between the peripherals (if any) was 10 cm.
The external I/O cables (if any) were draped along the test table and bundled as required.

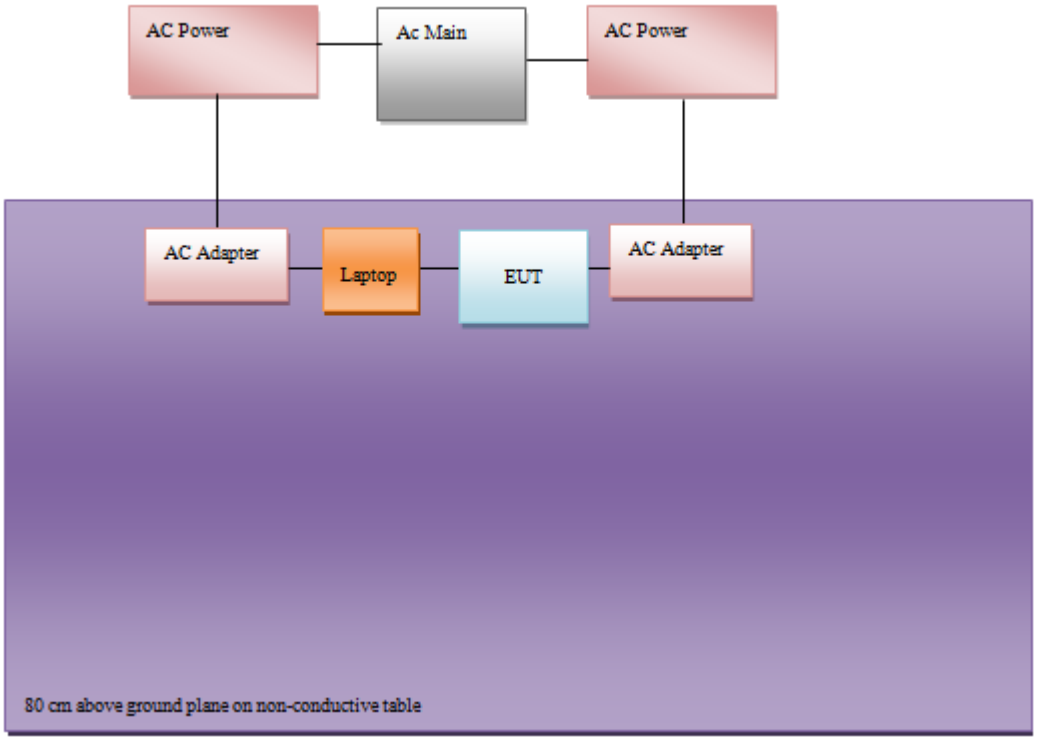
The procedures detailed in ANSI C63.4-2014 Clauses 8.3.1 and 11.9.2, were used to determine the mode of operation and cable positions of the EUT system that produce the emissions with the highest amplitudes relative to the limit. This arrangement was used when the final ac radiated emissions measurements were made on the EUT.

Using the mode of operation and cable position arrangement of the EUT system determined in ANSI C63.4-2014 Clause 8.3.1, the procedure detailed in ANSI C63.4-2014 Clause 11.9.3 was used to perform the final radiated emission measurements. In particular, the six highest emissions relative to the limit in the frequency range were recorded.

It should be noted that, in addition to cable manipulations, a maximizing procedure that included varying the receive antenna height and the turntable azimuth was employed while making all final compliance measurements on the EUT.

All measurement data was initially collected and recorded under computer control using the VASONA® EMI Software package, with the EMI Receiver/Spectrum Analyzer in Peak Detection mode. From 30 MHz to 1 GHz, Quasi-peak measurements were made only when a Peak emission was found to be - 6 dB or higher with respect to the applicable specification limits. Above 1 GHz, both Peak and CISPR (Linear) Average measurement were collected and recorded under computer control using the VASONA® EMI Software package.

5.2 Test Setup Block Diagram



5.3 Corrected Amplitude and Margin Calculations

The Corrected Amplitude (CA) was calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator and RF Limiter Loss Factor (AL) to the "raw" Amplitude (Am) reading, and then subtracting the Preamplifier Gain (Gp). The basic equation is as follows:

$$CA = Am + AF + CL + AL - Gp$$

For example, if (at some frequency and measurement distance) we had a measured Amplitude reading (Am) of 50.0 dBµV/m, an Antenna Factor of 17.0 dB/m, a Cable Loss (CL) of 5.8 dB, an Attenuator and RF Limiter Loss (AL) of 0.4 dB, and a Preamplifier Gain of 32.5 dB, the corrected amplitude (CA) would be 40.7 dBµV/m (i.e., 50.0 + 17.0 + 5.8 + 0.4 – 32.5 = 40.7 dBµV/m).

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

Margin (dB) = Corrected Amplitude (dBµV/m) - Applicable Limit (dBµV/m)

5.4 Test Equipment List and Details

BACL Asset #	Manufacturers	Descriptions	Models	Serial Numbers	Calibration Dates	Calibration Interval
00711	Keysight Technologies	RF Limiter	11867A	MY42243052	2016-01-18	1 Year
00310	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100338	2016-02-04	2 Years
00311	Sunol Sciences	Controller, System	SC104V	113005-1	Cal. Not required	Cal. Not required
00321	Sunol Sciences	Antenna, BiConiLog	JB3	A020106-2	2015-07-11	2 Years
00445	Sonoma Instrument	Amplifier	315	303125	2016-07-23	1 Year
00784	ETS LINGEREN	Horn Antenna built in Pre Amp	3117-PA	203557	2015-10-05	2 years
00831	Rohde & Schwarz	EMI Test Receiver	1302.6005K40	100433	2016-08-09	1 year
00601	UTiFLEX	High Frequency Cable	223458-002	223458-001	2016-06-06	1 year

***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".

5.5 EMI Measurement Software

The EMI Measurement software package used to perform this test was the EMIsoft® VASONA® Version 6.00.

5.6 Test Environmental Conditions & Test Personnel

Test Date(s)	2017-03-31
Test Site	10m Chamber 1
Temperature:	15 º C
Relative Humidity:	49 %
Barometric Pressure:	101.8 kPa
Test Personnel:	Vincent Chiu

5.7 Summary of Test Results

Based upon the measurements made, it was determined that the EUT complied with the applicable FCC Part 15 Subpart B Class B and ISED ICES-003 Issue 6 (Jan. 2016) Class B Radiated Emissions Limits. The EUT's worst margin reading was:

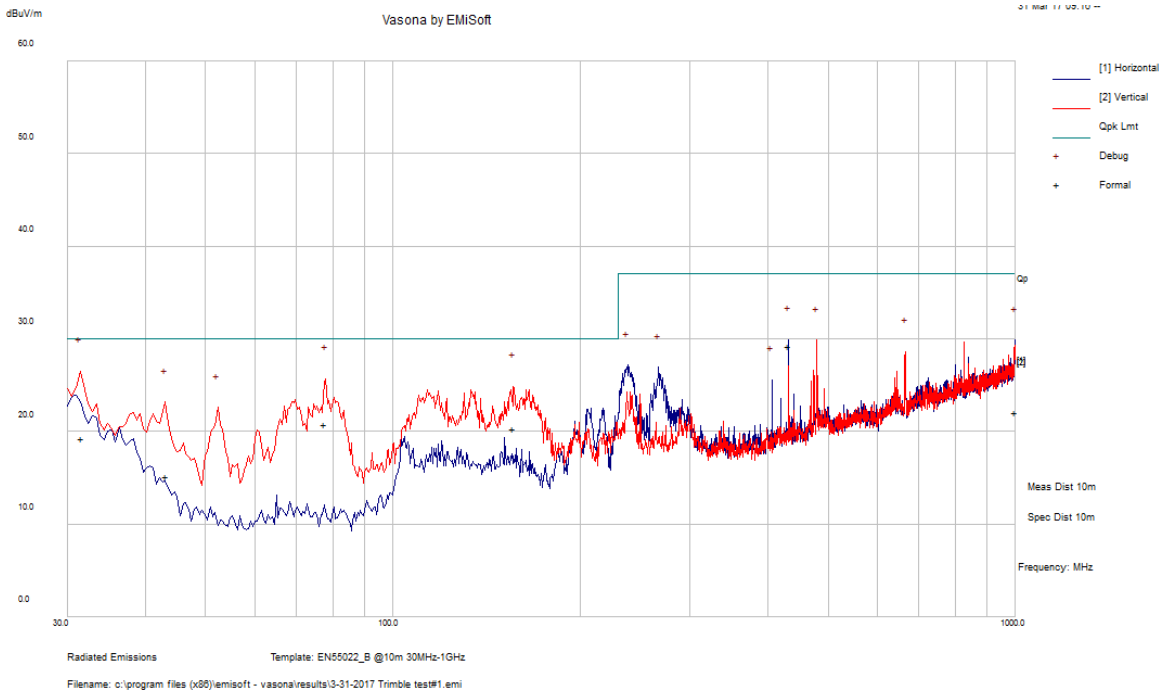
FCC 15B & ISED ICES-003 Issue 6 Radiated Emissions-Worst Case (30 MHz – 1 GHz)			
Frequency (MHz)	**Polarization (Horizontal/Vertical)**	**Highest Corrected QP Amplitude (dBµV/m)**	**Worst-Case QP Margin (dB)**
432.00	Horizontal	29.29	-7.71

FCC 15B & ISED ICES-003 Issue 6 Radiated Emissions-Peak Worst Case (Above 1 GHz)			
Frequency (MHz)	**Polarization (Horizontal/Vertical)**	**Highest Corrected PK Amplitude (dBµV/m)**	**Worst-Case PK Margin (dB)**
1328.164	Vertical	56.38	-17.62

FCC15B & ISED ICES-003 Issue 6 Radiated Emissions-CISPR Average Worst Case (Above 1 GHz)			
Frequency (MHz)	**Polarization (Horizontal/Vertical)**	**Highest Corrected Ave. Amplitude (dBµV/m)**	**Worst-Case Ave. Margin (dB)**
6000.584	Vertical	43.08	-10.92

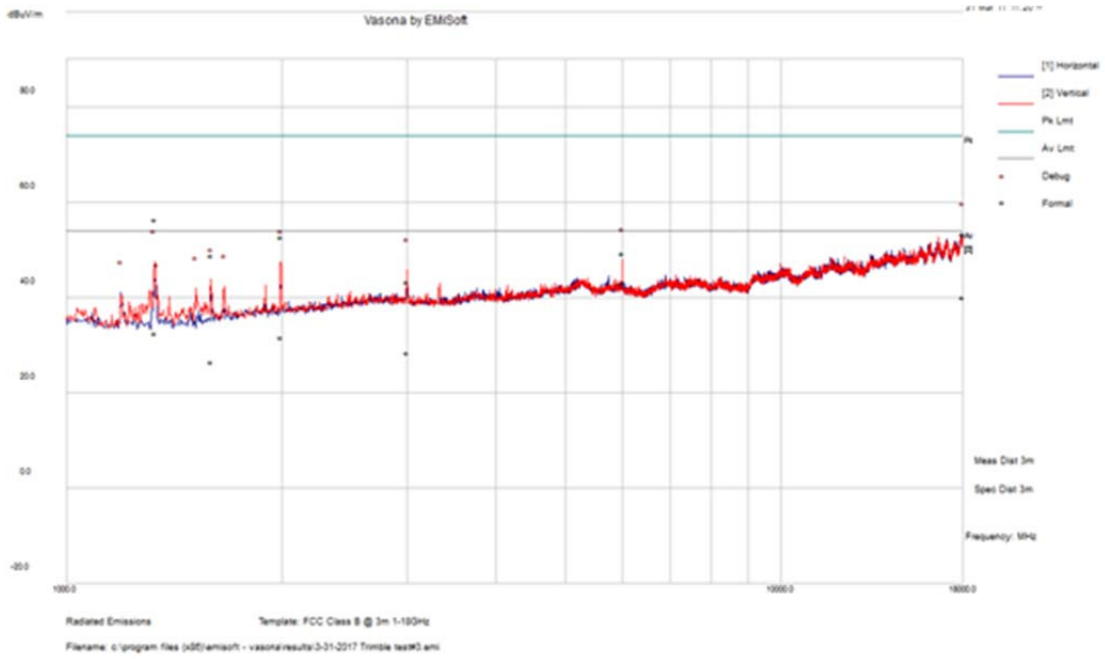
5.8 Radiated Emissions Test Plots and Data

30-1000 MHz Peak Pre-Scan (measured at a 10 meter distance) Plot



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Test Antenna		Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Note
		Height (cm)	Polarity (H/V)				
432.0005	29.29	328	H	358	37	-7.71	QP
77.8515	20.8	105	V	85	30	-9.20	QP
156.0178	20.28	99	V	270	30	-9.72	QP
31.70225	19.25	104	V	44	30	-10.75	QP
43.28175	15.16	119	V	339	30	-14.84	QP
998.589	22.13	401	H	281	37	-14.87	QP

1 GHz- 18 GHz Peak Pre-scan (measured at a 3 meter distance) Plot



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Test Antenna		Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Note
		Height (cm)	Polarity (H/V)				
1328.164	56.38	113	V	149	74	-17.62	Peak
17988.32	53.35	151	H	361	74	-20.65	Peak
1995.338	52.74	109	V	69	74	-21.26	Peak
6000.584	49.19	180	V	52	74	-24.81	Peak
1594.672	48.91	181	V	20	74	-25.09	Peak
2997.858	43.33	170	V	145	74	-30.67	Peak

Frequency (MHz)	Corrected Amplitude (dBµV/m)	Test Antenna		Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Note
		Height (cm)	Polarity (H/V)				
6000.584	43.08	V	180	52	54	-10.92	Ave.
17988.32	39.99	H	151	361	54	-14.01	Ave.
1328.164	32.55	V	113	149	54	-21.45	Ave.
1995.338	31.75	V	109	69	54	-22.25	Ave.
2997.858	28.54	V	170	145	54	-25.46	Ave.
1594.672	26.46	V	181	20	54	-27.54	Ave.