



FCC PART 15.245
ISED C RSS-210, ISSUE 9, NOVEMBER 2017
TEST AND MEASUREMENT REPORT

For
Fujitsu Component Limited

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Nagano-shi, Nagano, 381-8501 Japan

FCC ID: SQK-7RAZXX
IC: 337L-7RAZXX

Report Type: Original Report		Product Type: 24 GHz Doppler Sensor Module
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Report Number:	R1910282-245 Rev A	
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Note: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This report **must not** be used by the customer to claim product certification, approval, or endorsement by A2LA*, NIST, or any agency of the Federal Government.

* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk “*” 08/12

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1910282-245	Original Report	2019-11-20
1	R1910282-245 Rev A	Updated Company Name	2020-01-06

1 GENERAL DESCRIPTION

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Fujitsu Component Limited.*, and their product model: FWM7RAZ01, FCC ID: SQK-7RAZXX; IC: 337L-7RAZXX or the “EUT” as referred to in this report. It is a 24 GHz Doppler Sensor Module. The EUT operates in the frequency range from 24.075 – 24.175 GHz.

1.2 Objective

This report is prepared on behalf of *Fujitsu Component Limited* in accordance Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission’s rules and ISED RSS-210 Issue 9, November 2017.

The objective is to determine compliance with FCC 15.245 and ISED RSS-210 Issue 9, November 2017 for RF Exposure, Antenna Requirements, Emission Bandwidth, Fundamental Field Strength and Radiated Spurious Emissions.

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.

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 ° 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 - ISED) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;

- Chinese Taipei (Republic of China – Taiwan):
 - o BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
 - o NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
 - o EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
 - o Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
 - o Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA)
APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
 - o ENERGY STAR Recognized Test Laboratory – US EPA
 - o Telecommunications Certification Body (TCB) – US FCC;
 - o Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I;

2 SYSTEM TEST CONFIGURATION

2.1 Justification

The EUT was configured for testing in accordance to ANSI C63.10-2013.

The EUT was tested in the normal (native) operating mode to represent *worst-case* results during the final qualification test.

2.2 EUT Exercise Software

N/A

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 Local Support Equipment

Manufacturer	Description	Model	Serial Number
BK Precision	DC Power Supply	1740	26502000233

2.5 Support Equipment

There was no support equipment included, or intended for use with EUT during these tests.

2.6 Interface Ports and Cabling

Cable Description	Length (m)	To	From
Power Cable	< 1 m	Power Supply	EUT

3 SUMMARY OF TEST RESULTS

Results reported relate only to the product tested.

FCC and ISED Rules	Description of Test	Results
FCC §2.1091 ISED RSS-102	RF Exposure	Compliant
FCC §15.203 ISED RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207 ISED RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §15.215 ISED RSS-Gen §6.7	Emission Bandwidth	Compliant
FCC §15.245 ISED RSS-210 §F.1	Fundamental Field Strength	Compliant
FCC §15.205, §15.209, §15.245 ISED RSS-210 §F.1, RSS- Gen §8.9, §8.10	Radiated Spurious Emissions	Compliant

4 FCC §2.1091 & ISED RSS-102 - RF EXPOSURE

4.1 Applicable Standard

According to FCC §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

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 (minutes)
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

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 MHz⁶ 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

Maximum Radiated Field Strength measured at 0.5meters (dBuV/m): 123.705

Maximum EIRP(mW): 19.558

Prediction distance (cm): 20

Prediction frequency (MHz): 24126

Power density of prediction frequency at 20.0 cm (mW/cm²): 0.00389

MPE limit for uncontrolled exposure at prediction frequency (mW/cm²): 1.0

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 20 cm is 0.00389 mW/cm². Limit is 1 mW/cm².

4.4 RF exposure evaluation exemption for IC

Maximum EIRP power = 19.558 mW which is lesser than 5 W.
Therefore the RF exposure Evaluation is not required.

5 FCC §15.203 & ISEDC RSS-GEN §6.8 - ANTENNA REQUIREMENTS

5.1 Applicable Standards

According to FCC §15.203:

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

According to ISEDC RSS-Gen §6.8: Transmitter Antenna

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

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

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

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

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

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

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

5.2 Antenna Description

The antennas used by the EUT are permanently attached antennas.

Frequency Range (GHz)	Maximum Antenna Gain (dBi)	External/Internal/Integral	Antenna Type/Pattern
24.075-24.175	12	Integral	2x4 Patch Array Antenna

6 FCC §15.207 & ISEDC RSS-GEN §8.8 - AC LINE CONDUCTED EMISSIONS

6.1 Applicable Standards

As per FCC §15.207 Conducted limits:

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

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 ^{Note1}	56 to 46 ^{Note2}
0.5-5	56	46
5-30	60	50

Note1: Decreases with the logarithm of the frequency.

Note2: A linear average detector is required

6.2 Test Setup

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

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

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

6.3 Test Procedure

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

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

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

6.4 Corrected Amplitude and Margin Calculation

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

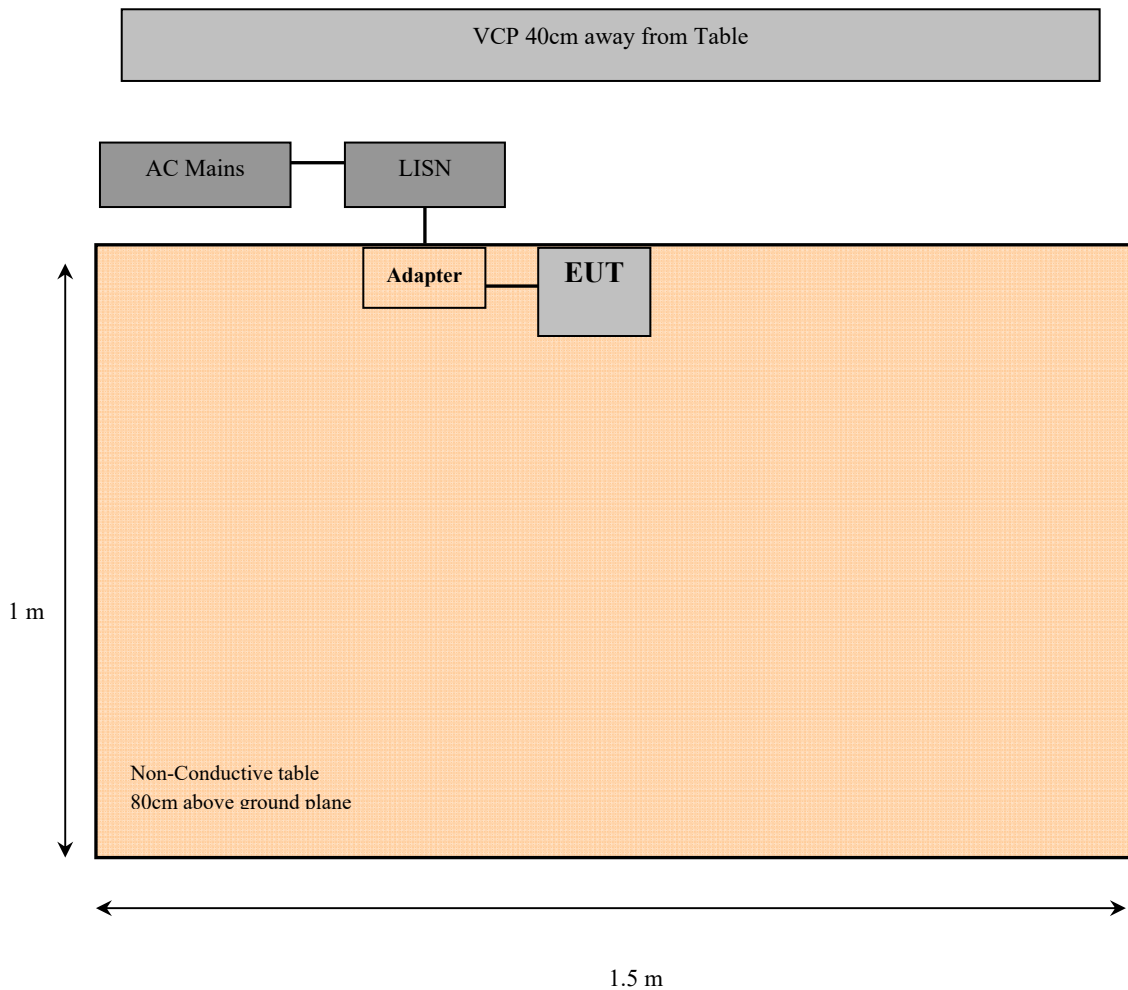
$$CA = A_i + CL + \text{Atten}$$

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

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

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

6.5 Test Setup Block Diagram



6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde and Schwarz	Receiver, EMI Test	ESCI 1166.5950.03	100338	2018-07-05	2 years
Rohde and Schwarz	Impulse Limiter	ESH3-Z2	101964	2019-07-31	1 year
Solar Electronics Company	High Pass Filter	Type 7930-100	7930150204	2019-02-25	1 year
Suirong	30 ft conductive emission cable	LMR 400	-	N/R	N/A
FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2019-04-11	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

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

6.7 Test Environmental Conditions

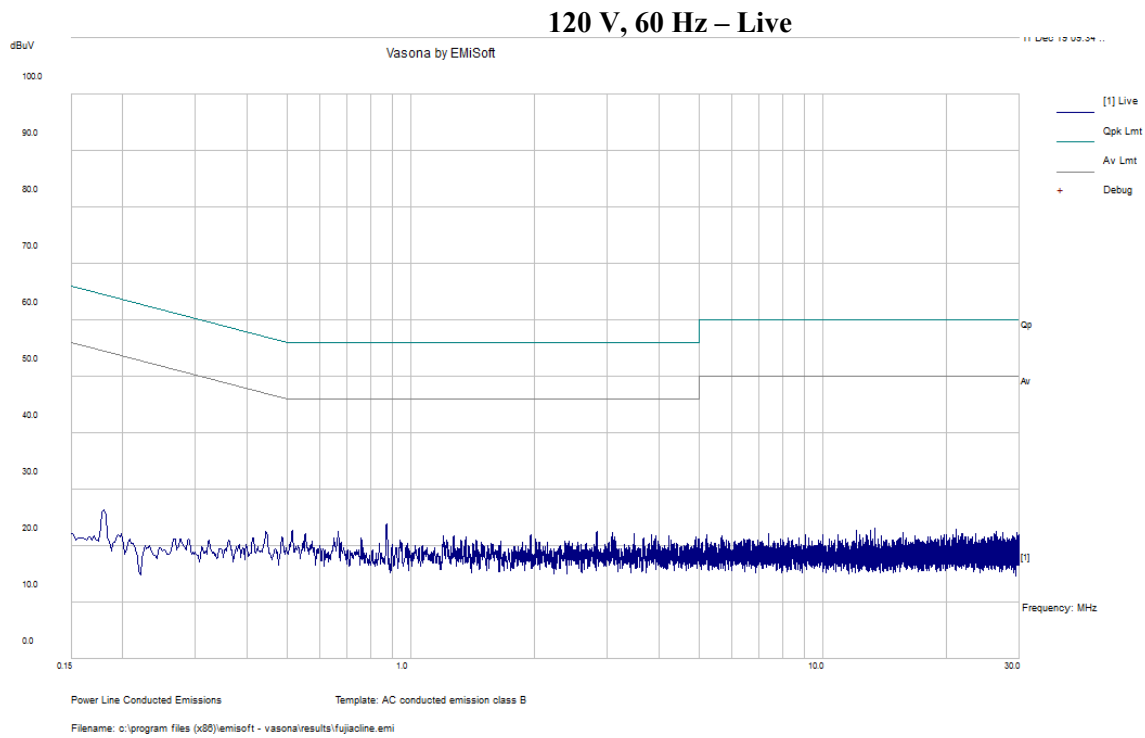
Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	101.31 kPa

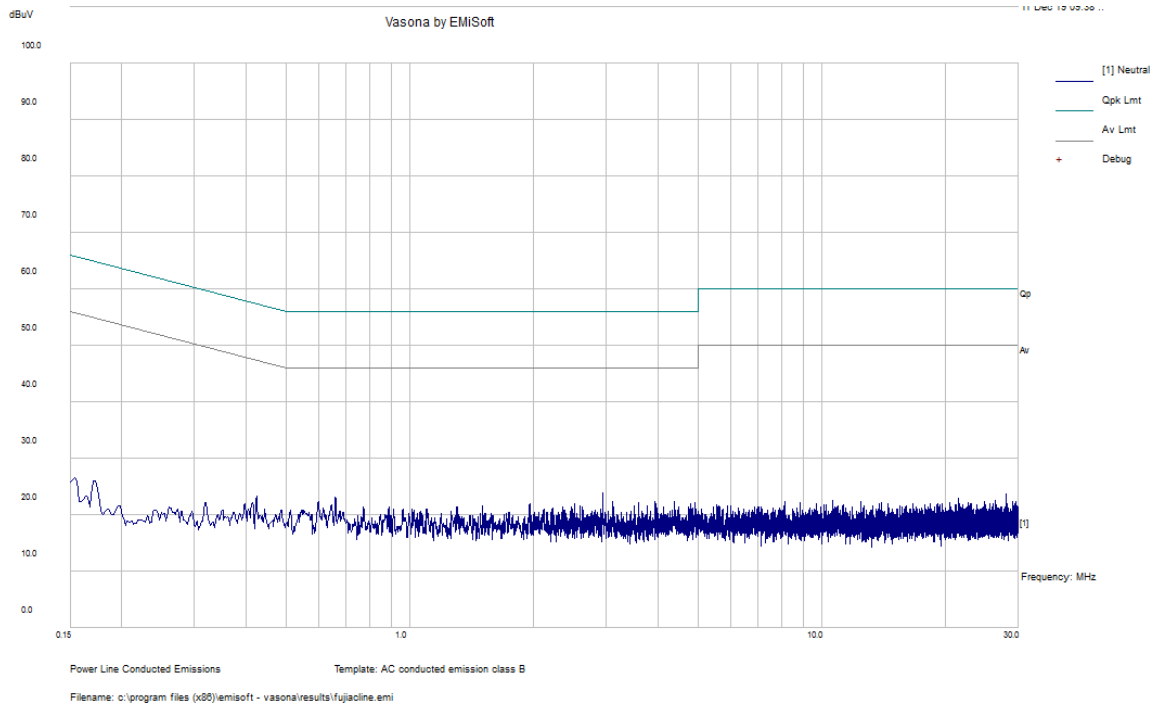
The testing was performed by Christian McCaig on 2019-12-11 in 5m chamber 3

6.8 Summary of Test Results

According to following plots, the EUT complied with the FCC 15C standard's conducted emissions limits. As shown in the following plots, all emissions are more than 20 dB below the limit. According to FCC §15.35 (o), the amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

6.9 Conducted Emissions Test Plots and Data



120 V, 60 Hz – Neutral

7 FCC §15.215 & RSS-GEN §6.7 – EMISSION BANDWIDTH

7.1 Applicable Standards

According to FCC §15.215(c), Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

According to RSS-GEN §6.6, The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

7.2 Measurement Procedure

Span = approximately 2 to 5 times the 99% occupied bandwidth, centered on a hopping channel

RBW = 1% to 5 % of the 99% occupied bandwidth

VBW = 3RBW

Sweep = auto

Detector function = peak

Trace = max hold

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the minimum emission or emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

7.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSV40	1321.3008K39-101203-UW	2019-08-05	1 year
-	RF cable	-	-	Each time ¹	N/A
AH Systems	Pre-amplifier	PAM 1840 VH	170	2019-09-24	1 year
Wisewave	Antenna, Horn	ARH-2823-02	10555-02	2017-12-15	2 year

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

Statement of Traceability: **BACL Corp.** attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 09 June 2016) "A2LA Policy on Metrological Traceability".

7.4 Test Environmental Conditions

Temperature:	23° C
Relative Humidity:	42 %
ATM Pressure:	102.5 KPa

The testing was performed by Christian McCaig on 2019-11-16 in 5m chamber 3.

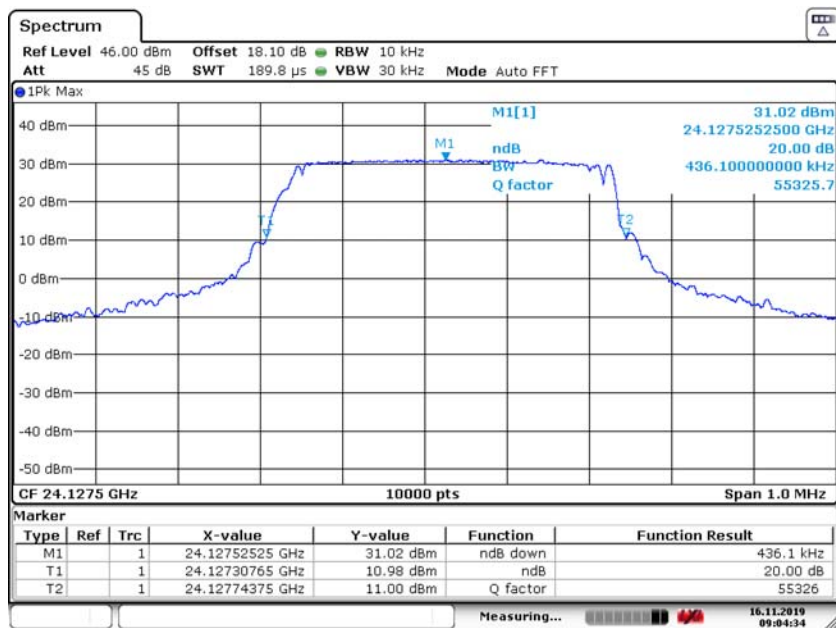
7.5 Test Results

Frequency (MHz)	99% OBW (kHz)	20 dB OBW (kHz)	20 dB OBW Result
24126	371.5	436.1	Pass ¹

Please refer to the following plots for detailed test results.

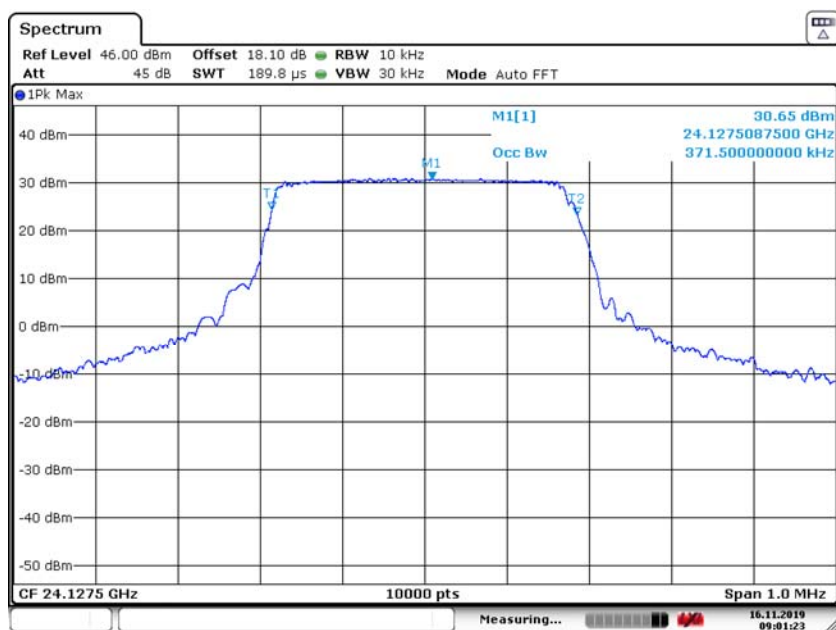
Note¹: Worst case channel used to show compliance

20dB BW



Date: 16.NOV.2019 09:04:34

99% OBW



Date: 16.NOV.2019 09:01:24

8 FCC 15.245(B) & ISEDC RSS-210 ANNEX F §F.1 – FUNDAMENTAL FIELD STRENGTH

8.1 Application Standards

According to FCC § 15.245(b).

(a) Operation under the provisions of this section is limited to intentional radiators used as field disturbance sensors, excluding perimeter protection systems.

(b) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (millivolts/meter)
902–928	500	1.6
2435–2465	500	1.6
5785–5815	500	1.6
10500–10550	2500	25.0
24075–24175	2500	25.0

(1) Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:

(2) Field strength limits are specified at a distance of 3 meters.

(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

(4) The emission limits shown above are based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply.

According to ISEDC RSS-210 ANNEX F §F.1

F.1 Field Disturbance Sensors

This section sets out requirements for field disturbance sensors operating in the frequency bands shown in Table F1.

Perimeter protection systems, which employ a leaky transmission line as the radiating source, are excluded from the requirements of this annex.

The equipment shall comply with the following emission limits:

The average field strength measured at 3 m shall not exceed the limits shown in Table F1

Table F1 — Field Strengths for Field Disturbance Sensors Operating at Different Frequencies

Fundamental Frequencies (MHz)	Field Strength (mV/m)	
	Fundamental Emissions	Harmonic Emissions
902-928	500	1.6
2435-2465	500	1.6
5785-5815	500	1.6
10500-10550	2500	25
24075-24175	2500	25

8.2 Test Setup

The radiated emissions tests were performed in the 3-meter semi-anechoic chamber test site, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart C limits.

8.3 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-06-26	1 year
-	RF cable	-	-	Each time ¹	N/A
AH Systems	Pre-amplifier	PAM 1840 VH	170	2019-09-24	1 year
Wisewave	Antenna, Horn	ARH-2823-02	10555-02	2017-12-15	2 year

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

Statement of Traceability: *BACL Corp.* attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 09 June 2016) “A2LA Policy on Metrological Traceability”.

8.4 Environmental Conditions

Temperature:	20-22 °C
Relative Humidity:	42-46 %
ATM Pressure:	102 kPa

The testing was performed by Christian McCaig from 2019-11-05 to 2019-11-07 in 5m chamber 3.

8.5 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:

$$\text{RBW} = 100 \text{ kHz} / \text{VBW} = 300 \text{ kHz} / \text{Sweep} = \text{Auto}$$

Above 1000 MHz:

- (1) Peak: $\text{RBW} = 1\text{MHz} / \text{VBW} = 1\text{MHz} / \text{Sweep} = \text{Auto}$
- (2) Average: $\text{RBW} = 1\text{MHz} / \text{VBW} > 1/T \text{ Hz} / \text{Sweep} = \text{Auto}$

Where T is the period of the transmitting signal

8.6 Corrected Amplitude and Margin Calculation

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

$$\text{CA} = \text{Ai} + \text{AF} + \text{CL} + \text{Atten} - \text{Ga}$$

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

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

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

8.7 Test Result

Measured at 0.5 meter

Frequency (GHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Pre-Amp. (dB)	Cord. Reading (dBμV/m)	FCC		Comments
			Height (cm)	Polarity (H/V)	Factor (dB/m)			Limit (dBμV/m)	Margin (dB)	
Low Channel										
24.11	120.85	-	-	V	35.325	32.86	123.315	143.52	-20.205	PK
Middle Channel										
24.126	121.16	-	-	V	35.325	32.78	123.705	143.52	-19.815	PK
High Channel										
24.142	121.02	-	-	V	35.325	32.71	123.635	143.52	-19.885	PK

Note1: Peak measurements were made and compared to average limits to demonstrate passing in worst case situations.

Note2: Measurement was taken in 0.5 meter, the distance factor has been considered into the limit.

9 FCC §15.205, §15.209, §15.245 & ISEDC RSS-210 ANNEX F, RSS-GEN §8.9, §8.10– RADIATED SPURIOUS EMISSIONS

9.1 Application Standards

According to FCC § 15.245 and ISEDC RSS-210 Annex F

Operation within the bands 902–928 MHz, 2435–2465 MHz, 5785–5815 MHz, 10500–10550 MHz, and 24075–24175 MHz.

(a) Operation under the provisions of this section is limited to intentional radiators used as field disturbance sensors, excluding perimeter protection systems.

(b) The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency (MHz)	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (millivolts/meter)
902–928	500	1.6
2435–2465	500	1.6
5785–5815	500	1.6
10500–10550	2500	25.0
24075–24175	2500	25.0

(1) Regardless of the limits shown in the above table, harmonic emissions in the restricted bands below 17.7 GHz, as specified in §15.205, shall not exceed the field strength limits shown in §15.209. Harmonic emissions in the restricted bands at and above 17.7 GHz shall not exceed the following field strength limits:

(i) For the second and third harmonics of field disturbance sensors operating in the 24075-24175 MHz band and for other field disturbance sensors designed for use only within a building or to open building doors, 25.0 mV/m.

(ii) For all other field disturbance sensors, 7.5 mV/m.

(iii) Field disturbance sensors designed to be used in motor vehicles or aircraft must include features to prevent continuous operation unless their emissions in the restricted bands, other than the second and third harmonics from devices operating in the 24075-24175 MHz band, fully comply with the limits given in §15.209. Continuous operation of field disturbance sensors designed to be used in farm equipment, vehicles such as fork lifts that are intended primarily for use indoors or for very specialized operations, or railroad locomotives, railroad cars and other equipment which travels on fixed tracks is permitted. A field disturbance sensor will be considered not to be operating in a continuous mode if its operation is limited to specific activities of limited duration (e.g., putting a vehicle into reverse gear, activating a turn signal, etc.).

(2) Field strength limits are specified at a distance of 3 meters.

(3) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209 and RSS-Gen, whichever is the lesser attenuation.

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

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423		4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	960 – 1240	5.35 – 5.46
2.1735 – 2.1905	25.5 – 25.67	1300 – 1427	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1435 – 1626.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1645.5 – 1646.5	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1660 – 1710	9.3 – 9.5
6.215 – 6.218	108 – 121.94	1718.8 – 1722.2	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2200 – 2300	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2310 – 2390	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2483.5 – 2500	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	2690 – 2900	17.7 – 21.4
8.37625 – 8.38675	162.0125 – 167.17	3260 – 3267	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3.332 – 3.339	23.6 – 24.0
12.29 – 12.293	240 – 285	3.3458 – 3.358	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4	3.600 – 4.400	36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.209(a) and RSS-Gen: 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.

9.2 Test Setup

The radiated emissions tests were performed in the 3-meter semi-anechoic chamber test site, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart C limits.

9.3 Environmental Conditions

Temperature:	20-22 °C
Relative Humidity:	42-46 %
ATM Pressure:	102 kPa

The testing was performed by Christian McCaig from 2019-11-05 to 2019-11-07 in 5m chamber 3.

9.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950.03	100338	2018-07-05	2 year
Agilent	Analyzer, Spectrum	E4446A	US44300386	2019-06-26	1 year
Sunol Science Corp	System Controller	SC99V	011003-1	N/R	N/R
Sunol Sciences	Antenna, Biconi-Log	JB1	A013105-3	2018-02-26	2 year
Sunol Sciences	Antenna, Horn	DRH-118	A052704	2019-04-02	2 years
HP	Pre-Amplifier	8449B	3008A01978	2019-09-27	1 year
Wisewave	Antenna, Horn	ARH-4223-02	10555-01	2018-01-18	2 years
AH Systems	Pre-amplifier	PAM 1840 VH	170	2019-09-24	1 year
Wisewave	Antenna, Horn	ARH-2823-02	10555-02	2017-12-15	2 year
-	RF cable	-	-	Each time ¹	N/A
OML Inc.	Harmonic Mixer Set	M03HWA, M05HWA, M08HWA, M12HWA, M19HWA	170615-1	N/R	N/R
Agilent	Amplifier, Pre	8447D	2944A10187	2019-04-11	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

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

Statement of Traceability: **BACL Corp.** attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with A2LA Policy P102 (dated 09 June 2016) "A2LA Policy on Metrological Traceability".

9.5 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:

$$\text{RBW} = 100 \text{ kHz} / \text{VBW} = 300 \text{ kHz} / \text{Sweep} = \text{Auto}$$

Above 1000 MHz:

- (1) Peak: $\text{RBW} = 1\text{MHz} / \text{VBW} = 1\text{MHz} / \text{Sweep} = \text{Auto}$
- (2) Average: $\text{RBW} = 1\text{MHz} / \text{VBW} > 1/T \text{ Hz} / \text{Sweep} = \text{Auto}$

Where T is the period of the transmitting signal

9.6 Corrected Amplitude and Margin Calculation

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

$$\text{CA} = \text{Ai} + \text{AF} + \text{CL} + \text{Atten} - \text{Ga}$$

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

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

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

9.7 Summary of Test Results

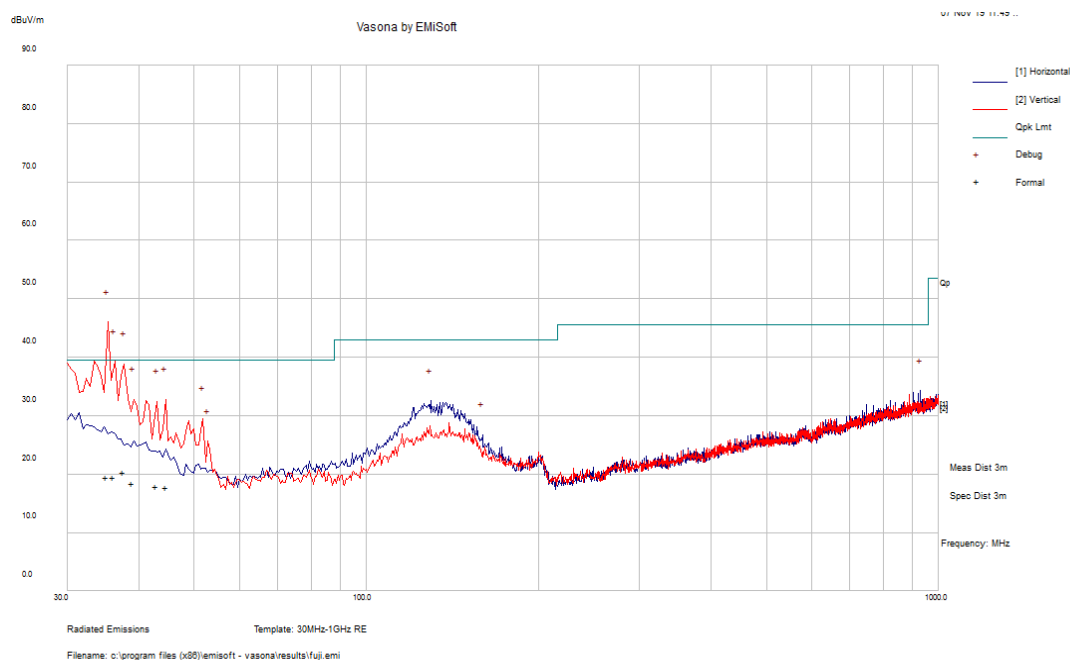
According to the data hereinafter, the EUT complied with FCC Title 47, Part 15C standard's radiated emissions limits, and had the worst margin of:

Mode: Transmitting			
Margin (dB)	Frequency (GHz)	Polarization (Horizontal/Vertical)	channel
-0.755	143.73	Vertical	Middle Channel

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

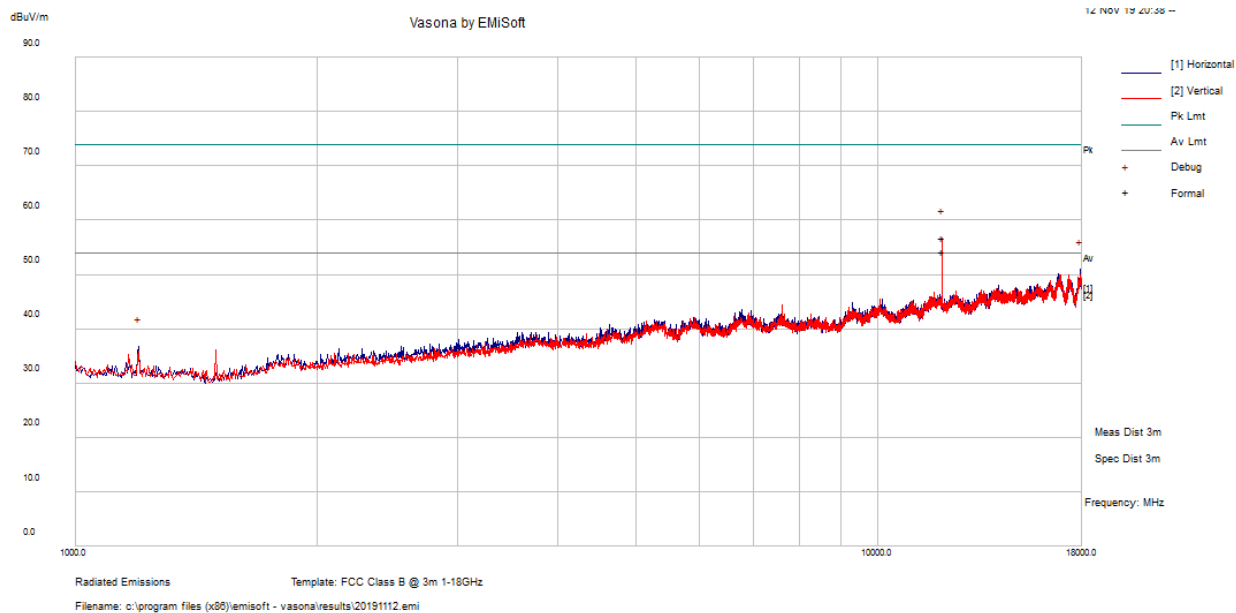
9.8 Radiated Emissions Test Results

1) 30 MHz – 1 GHz Worst Case, Measured at 3 meters(Note4)



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
35.1315	19.54	165	V	68	58.15	-38.61	QP
36.06325	19.51	197	V	274	58.15	-38.64	QP
37.59075	20.29	215	V	153	58.15	-37.86	QP
38.99425	18.39	195	V	323	58.15	-39.76	QP
44.701	17.75	160	V	297	58.15	-40.4	QP
42.8585	17.92	127	V	301	58.15	-40.23	QP

2) 1 GHz – 18 GHz Worst Case Scan at 3 Meters (Note4)



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Average Limit (dBμV/m)	Margin (dB)	Meas. Detector
12063.67	56.85	173	V	50	73.705	-16.855	PK
12063.67	54.13	173	V	50	73.705	-19.575	AVG

3) 18 GHz – 26.5 GHz, Measured at 0.5 Meter

Frequency (GHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Total Gain (dB)	Cord. Reading (dBμV/m)	FCC & ISEDC		Meas. Detector
			Height (cm)	Polarity (H/V)	Factor (dB/m)			Avg. Limit (dBμV/m)	Margin (dB)	
Low Channel										
24.075	53.18	-	-	V	35.325	32.88	55.625	73.315	-17.69	PK
24.175	50.12	-	-	V	35.325	32.43	53.015	73.315	-20.3	PK
Middle Channel										
24.075	50.36	-	-	V	35.325	32.88	52.805	73.705	-20.9	PK
24.175	52.73	-	-	V	35.325	32.43	55.625	73.705	-18.08	PK
High Channel										
24.075	48.9	-	-	V	35.325	32.88	51.345	73.635	-22.29	PK
24.175	55.29	-	-	V	35.325	32.43	58.185	73.635	-15.45	PK

4) 26.5 GHz – 40 GHz, Measured at 0.5 Meter

Frequency (GHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Total Gain (dB)	Cord. Reading (dBμV/m)	FCC & ISEDC		Meas. Detector
			Height (cm)	Polarity (H/V)	Factor (dB/m)			Avg. Limit (dBμV/m)	Margin (dB)	
Low Channel										
36.167	61.59	-	-	V	40.557	32.51	69.637	73.315	-3.678	PK
Middle Channel										
36.192	61.07	-	-	V	40.557	32.62	69.007	73.705	-4.698	PK
High Channel										
36.216	61.34	-	-	V	40.557	32.6	69.297	73.635	-4.338	PK

5) 40 GHz – 60 GHz, Measured at 0.5 Meter

Frequency (GHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cord. Reading (dBμV/m)	FCC & ISEDC		Meas. Detector
			Height (cm)	Polarity (H/V)	Factor (dB/m)		Avg. Limit (dBμV/m)	Margin (dB)	
Low Channel									
48.22	22.68	-	-	V	38.89	61.57	103.52	-41.95	PK
40.3	27.03	-	-	V	36.33	63.36	73.315	-9.955	PK
Middle Channel									
48.252	22.86	-	-	V	38.89	61.75	103.52	-41.77	PK
40.93	27.66	-	-	V	36.33	63.99	73.705	-9.715	PK
High Channel									
48.284	23.02	-	-	V	38.89	61.91	103.52	-41.61	PK
40.47	27.39	-	-	V	36.33	63.72	73.635	-9.915	PK

6) 60 GHz – 90 GHz, Measured at 0.5 Meter

Frequency (GHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cord. Reading (dBμV/m)	FCC & ISEDC		Meas. Detector
			Height (cm)	Polarity (H/V)	Factor (dB/m)		Avg. Limit (dBμV/m)	Margin (dB)	
Low Channel									
72.33	21.49	-	-	V	38.96	60.45	103.52	-43.07	PK
61.35	27.66	-	-	V	44.88	72.54	73.315	-0.775	PK
Middle Channel									
72.378	21.36	-	-	V	38.96	60.32	103.52	-43.2	PK
60.9	27.15	-	-	V	44.88	72.03	73.705	-1.675	PK
High Channel									
72.426	20.36	-	-	V	38.96	59.32	103.52	-44.2	PK
60.95	27.4	-	-	V	44.88	72.28	73.635	-1.355	PK

7) 90 GHz – 100 GHz, Measured at 0.5 Meter

Frequency (GHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cord. Reading (dBμV/m)	FCC & ISEDC		Meas. Detector
			Height (cm)	Polarity (H/V)	Factor (dB/m)		Avg. Limit (dBμV/m)	Margin (dB)	
Middle Channel(Note4)									
92.33	15.36	-	-	V	51.24	66.6	73.705	-7.105	PK

Note1: The limit for the Emissions radiated outside of the specified frequency bands, except for 2nd and 3rd harmonics is 50dB down from the fundamental. The Limit for the Field strength of harmonics is 25 mV/m.

Note2: Peak measurements were made and compared to average limits to demonstrate passing in worst case situations.

Note3: Measurement was taken in 0.5 meter, the distance factor has been considered into the limit

Note4: Worst case channel was used to show compliance where one channel was used.

10 ANNEX A – EUT TEST SETUP PHOTOGRAPHS

Please refer to the attachment

11 ANNEX B – EXTERNAL EUT PHOTOGRAPHS

Please refer to the attachment

12 ANNEX C – INTERNAL EUT PHOTOGRAPHS

13 ANNEX D (INFORMATIVE) – A2LA ELECTRICAL TESTING CERTIFICATE



Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories. This laboratory also meets A2LA R222 - Specific Requirements EPA ENERGY STAR Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 2nd day of October 2018.

A handwritten signature in blue ink.

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

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

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

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

--- END OF REPORT ---