FCC PART 15, SUBPART C
ISEDC RSS-247, ISSUE 3, AUGUST 2023

TEST AND MEASUREMENT REPORT

For

Somewear Labs, Inc.

350 Brannan Street, Suite 350,
San Francisco, CA 94107, USA

FCC ID: 2AQYN-SWL2
IC: 24246-SWL2

Report Type:	**Product Type:**
Original Report	Satellite Communication Device

Prepared By:	Libass Thiaw Test Engineer
Report Number:	R2403043-DTS
Report Date:	2024-05-17
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ACCREDITED
CERTIFICATE #3297.02

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2403043-DTS	Original Report	2024-05-17

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report was prepared on behalf of *Somewear Labs, Inc.*, and their product model: Somewear Labs Node with FCC ID: 2AQYN-SWL2, IC: 24246-SWL2 or the "EUT" as referred to in this report. It is a Satellite Communication Device and mesh radio that operates in the 902-928 MHz band. Device also supports Iridium, and BT radio modules. Iridium 9603 and Ublox Nora B101.

Original results are used in cases of leveraging original module certification. After spot checking to ensure the power is consistent with original certifications, it was determined that original test reports accurately represent test results under the new conditions.

1.2 Mechanical Description of EUT

The EUT measures approximately 13.4 cm (Length), 6.2 cm (Width), and 2.5 cm (Height) and weighs 0.20kg.
The data gathered was from a production sample provided by Somewear Labs with with S/N: NFBBJEXC4744

1.3 Objective

This report was prepared on behalf of *Somewear Labs, Inc.*, in accordance with Part 2, Subpart J, and Part 15, Subpart C of the Federal Communication Commission's rules and ISEDC RSS-247 Issue 3, August 2023.

The objective was to determine compliance with FCC Part 15.247 and ISEDC RSS-247 for Antenna Requirements, RF Exposure, AC Line Conducted Emissions, Conducted & Radiated Spurious Emissions, Emission Bandwidth, Output Power, Power Spectral Density, and 100 kHz Bandwidth of Band edges.

1.4 Related Submittal(s)/Grant(s)

FCC Part 25, RSS-170, Equipment Class: TNB with FCC ID: 2AQYN-SWL2, IC: 24246-SWL2
FCC Part 15C, RSS-247, Equipment Class: DTS with FCC ID: 2AQYN-SWL2, IC: 24246-SWL2

1.5 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.6 Measurement Uncertainty

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

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5%
RF output power, conducted	±0.57 dB
Power Spectral Density, conducted	±1.48 dB
Unwanted Emissions, conducted	±1.57 dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2ºC
Humidity	±5%
DC and low frequency voltages	±1.0%
Time	±2%
Duty Cycle	±3%

1.7 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.8 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- ***An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2017 by A2LA (Test Laboratory Accreditation Certificate Number 3297.02),*** 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 17025:2017 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 17025:2017 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 3297.03)*** 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 3297.01)*** 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 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 in accordance to ANSI C63.10.

2.2 EUT Exercise Software

The EUT has built-in test firmware.

Lora 1

Channel Frequency (MHz)	Power Setting
914	High
916	High
918	High

Lora 2

Channel Frequency (MHz)	Power Setting
920	High
922	High
924	High

2.3 Duty Cycle Correction Factor

According to KDB 558074 D01 DTS Meas Guidance v05r02 section 6.0:

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (T) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed T at any time that data is being acquired (i.e., no transmitter off-time is to be considered).

Lora 1

Radio frequency (MHz)	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
916	34.52	35.45	97.38	0.115

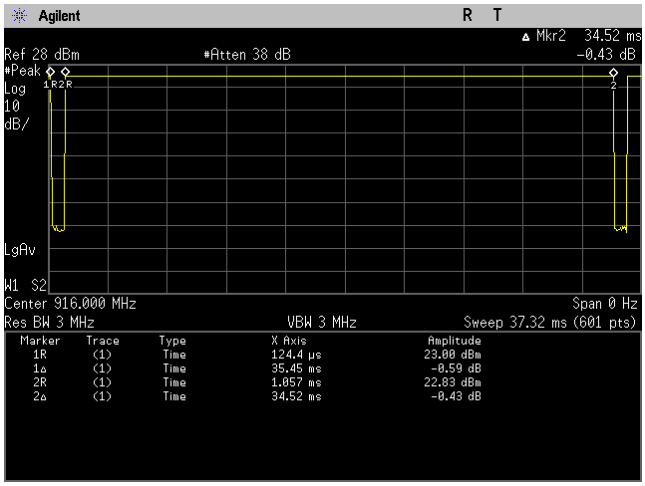
Lora 2

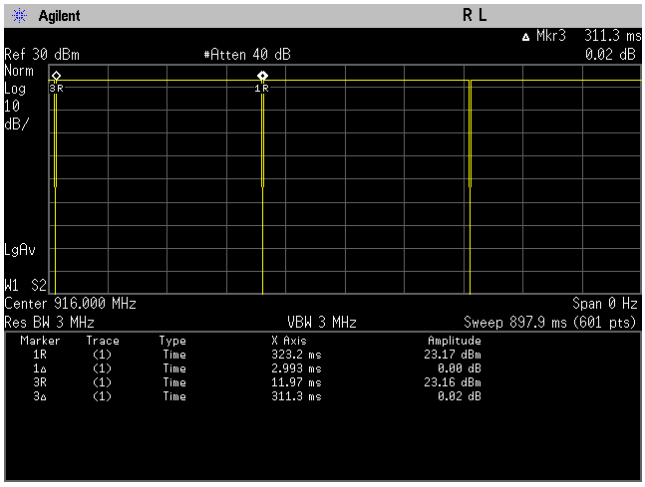
Radio frequency (MHz)	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
922	34.47	35.43	97.29	0.119

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

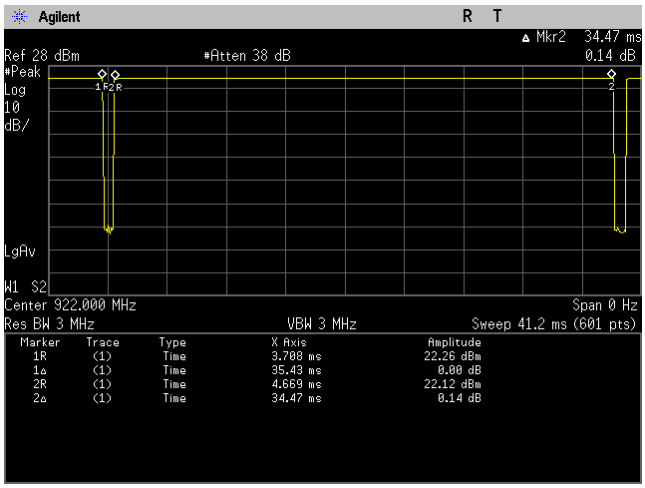
Please refer to the following plot.
Note: Each plot is followed by another measurement with an increased sweep time in order to observe the periodic nature of the signal

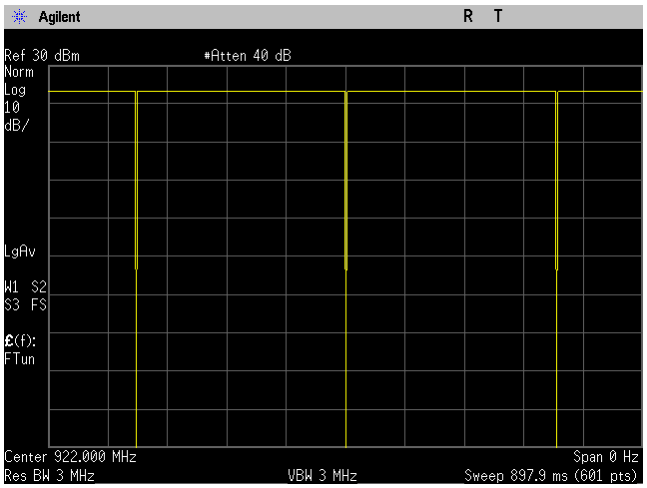
916MHz Duty Cycle Lora 1





922MHz Duty Cycle Lora 2





2.4 Equipment Modifications

None

2.5 Remote Support Equipment

None

2.6 Local Support Equipment

Manufacturer	Model	Serial Number
Dell	Laptop	N/A

2.7 Interface Ports and Cabling

Cable Descriptions	Length (m)	From	To
USB to TTL Serial	< 1 m	EUT	Laptop

3 Summary of Test Results

Results reported relate only to the product tested.

FCC & ISEDC Rules	Description of Test	Results
FCC §15.203 ISEDC RSS-Gen §6.8	Antenna Requirements	Compliant
FCC §2.1093, §15.247(i) ISED RSS-102	RF Exposure	Note[1]
FCC §15.207 ISEDC RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §15.209, §15.247(d) ISEDC RSS-247 §5.5 RSS-Gen §8.9, §8.10	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2) ISEDC RSS-247 §5.2 RSS-Gen §6.7	6 dB & 99% Emission Bandwidth	Compliant
FCC §15.247(b)(3) ISEDC RSS-247 §5.4	Average Output Power	Compliant
FCC §15.247(e) ISEDC RSS-247 §5.2(2)	Power Spectral Density	Compliant
FCC §15.247(d) ISEDC RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §2.1051, §15.247 (d) ISEDC RSS-247 §5.5	Spurious Emissions at Antenna Port	Compliant

Note[1]: For RF Exposure, please refer to SWL-2FCC SAR Report: SAR.20240406

BACL is responsible for all the information provided in this report, except when information is provided by the customer as identified in this report. Information provided by the customer, e.g., antenna gain, can affect the validity of results.

4 FCC §15.203 & ISEDC RSS-Gen §6.8 - Antenna Requirements

4.1 Applicable Standards

According to FCC §15.203:

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

And according to FCC §15.247 (b) (4), if transmitting antennas of directional gain greater than 6 dBi are used the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to ISEDC RSS-Gen §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 license-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

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

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

4.2 Antenna Description

Lora 1

External/Internal/ Integral	Frequency Range (MHz)	Antenna Type	Model	Maximum Antenna Gain (dBi)
Integral	902-928 MHz	Surface Mount	2JE49a	3.7
External	902-928 MHz	Magnetic Mount	2J6924Ma-300LL100-C43NBST_300D302-C906N_CU017570	1.5

Lora 2

External/Internal/ Integral	Frequency Range (MHz)	Antenna Type	Model	Maximum Antenna Gain (dBi)
Integral	902-928 MHz	Surface Mount	2JE49	2.9
External	902-928 MHz	Magnetic Mount	2J6924Ma-300LL100-C43NBST_300D302-C906N_CU017570	1.5

Note: each radio has the option to either transmit through internal or external.
Note: Antenna gain is information provided by customer.

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

5.1 Applicable Standards

As per FCC §15.207 and ISEDC RSS-Gen Section 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 ISEDC RSS-Gen §8.8 limits.

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

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

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:

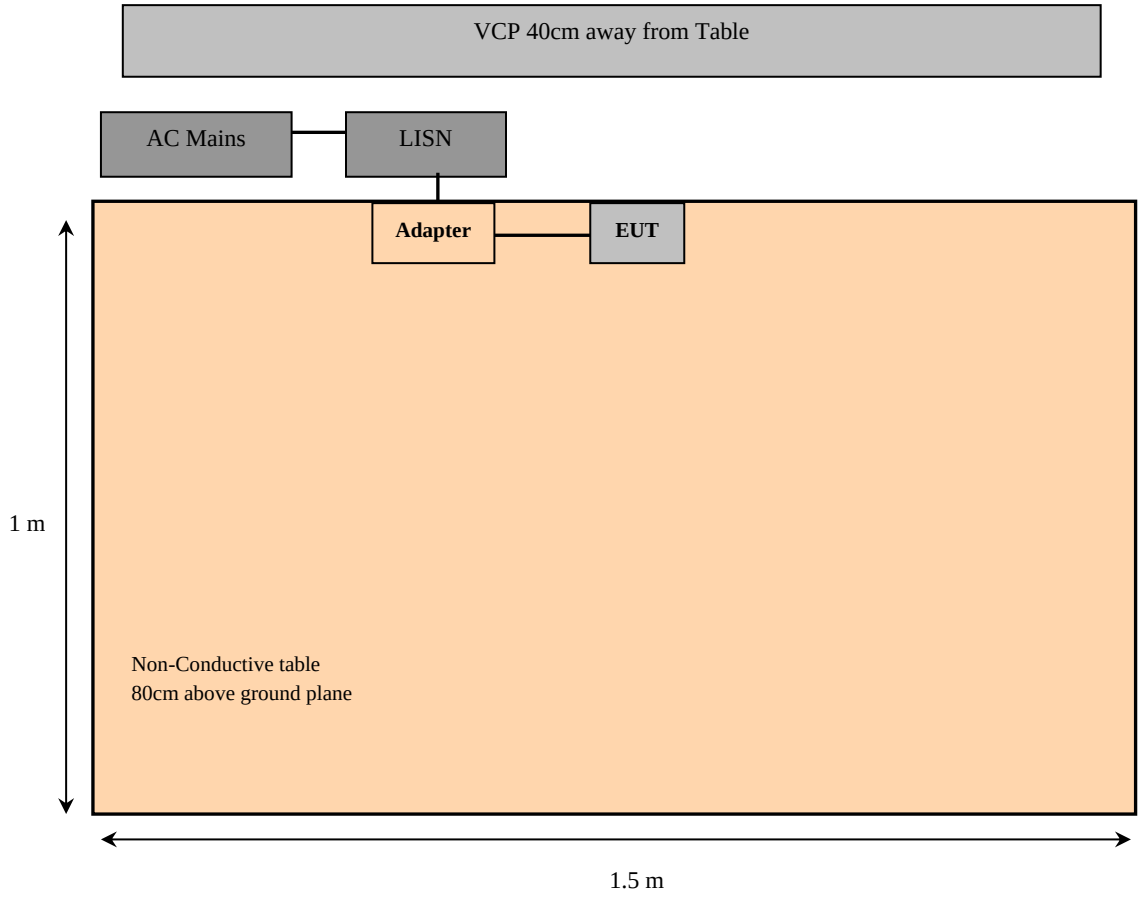
$$CA = Ai + CL + Atten$$

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

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
310	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950.03	100338	2023-05-11	1 year
680	Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101964	2024-03-22	1 year
724	Solar Electronics Company	High Pass Filter	Type 7930-100	7930150202	2024-03-22	1 year
732	FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2023-09-12	1 year
1425	Fairview Microwave	Micro-Coax Cable	FMC0101223-240	210241	2024-01-12	1 year
348	California Instruments	AC Power Source	5001ix-208	57079	Calibration not Required	Calibration not Required

Note[1]: cables, attenuators and notch filters included in the test set-up were 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

5.7 Test Environmental Conditions

Temperature:	21.9 to 22.0ºC
Relative Humidity:	49.6 to 50.4%
ATM Pressure:	101.9 kPa

The testing was performed by Devin Oppenheimer on 03-26-2024 on the Ground Plane test site.

5.8 Summary of Test Results

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

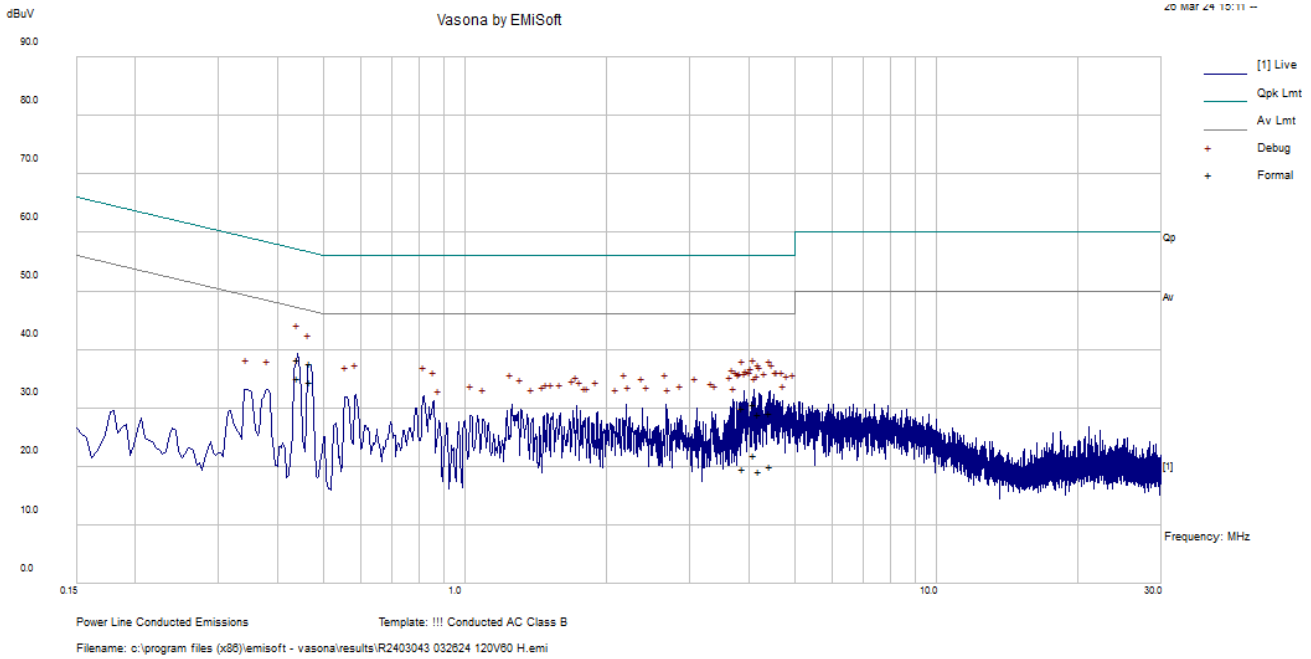
Worst Mode: LoRa 1

Worst Case – AC Line: 120 V, 60 Hz			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Hot/Neutral)**	**Range (MHz)**
-10.64	0.442227	Hot	0.15 to 30

Please refer to the tables and plots in the next section for detailed test results.

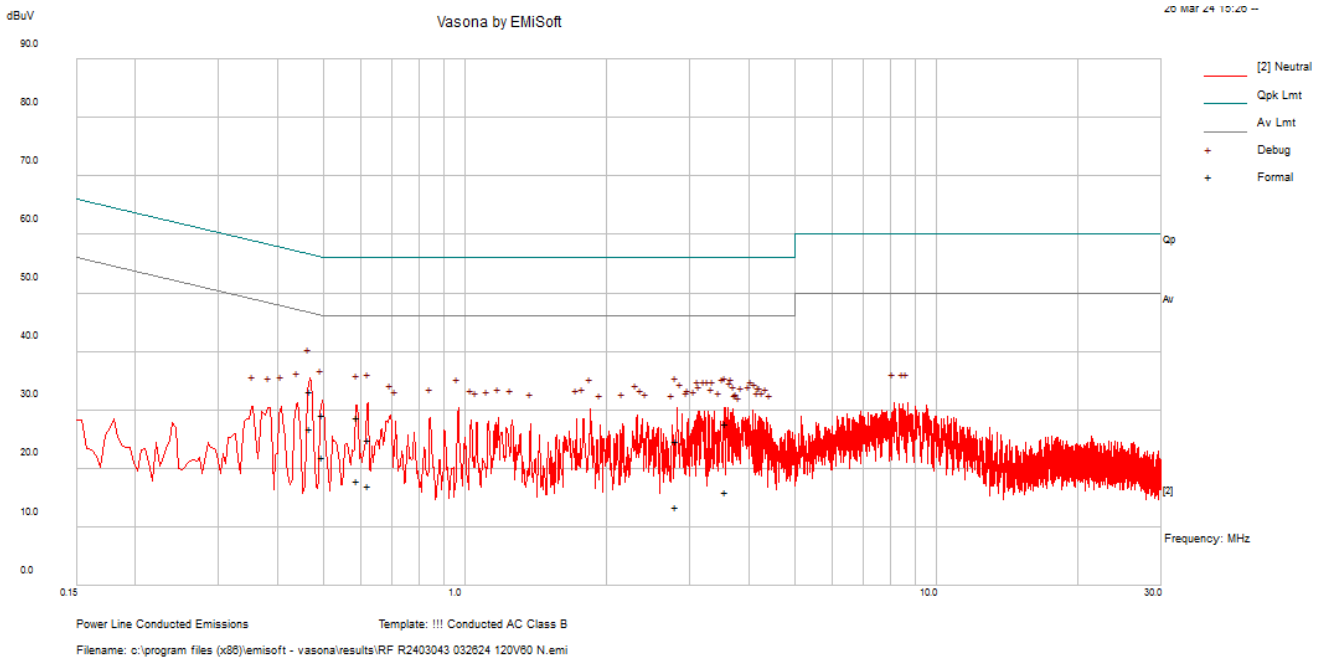
5.9 Conducted Emissions Test Plots and Data

AC Line: 120 V, 60 Hz – Hot Conductor – Lora 1



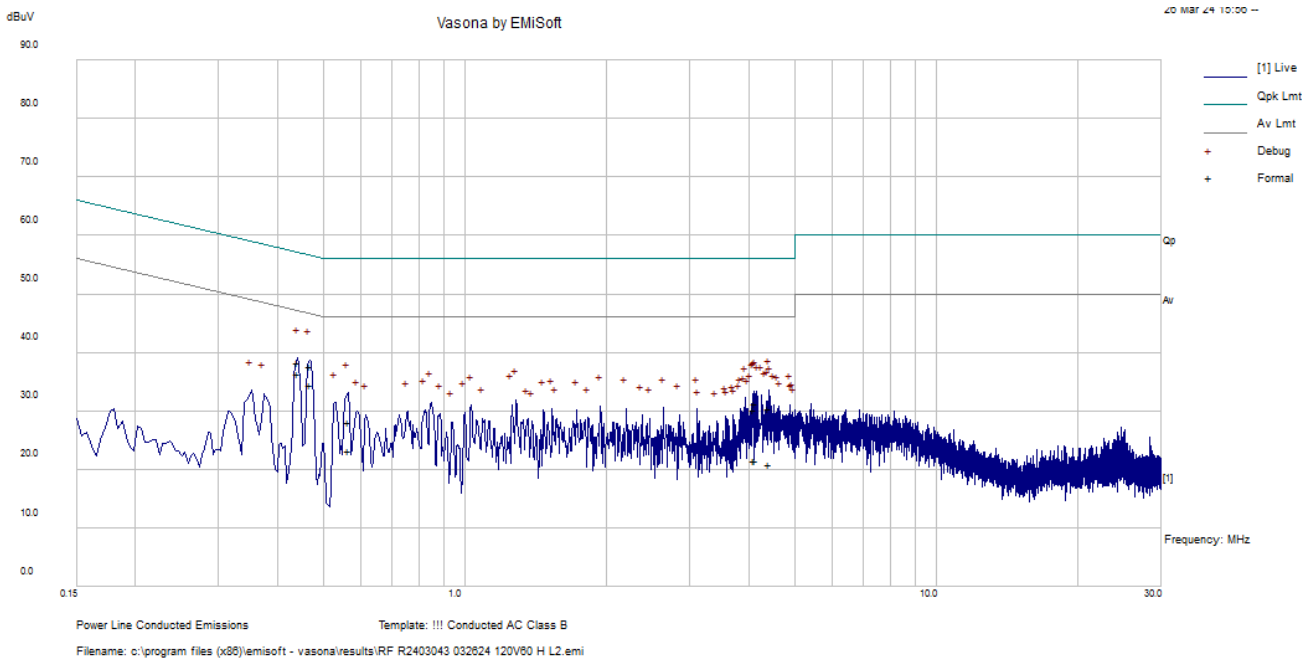
Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.443343	27.55	10.72	38.28	57	-18.72	QP
0.468222	27.01	10.71	37.73	56.55	-18.82	QP
4.107034	19.95	10.65	30.59	56	-25.41	QP
3.900001	19.27	10.62	29.89	56	-26.11	QP
4.437931	18.36	10.69	29.05	56	-26.95	QP
4.201923	18.27	10.66	28.93	56	-27.07	QP
0.443343	24.39	10.72	35.12	47	-11.88	Ave
0.468222	23.71	10.71	34.43	46.55	-12.12	Ave
4.107034	11.32	10.65	21.97	46	-24.03	Ave
3.900001	8.98	10.62	19.61	46	-26.39	Ave
4.437931	9.41	10.69	20.11	46	-25.89	Ave
4.201923	8.4	10.66	19.06	46	-26.94	Ave

AC Line (via AC/DC Adapter): 120 V, 60 Hz – Neutral Conductor Lora 1



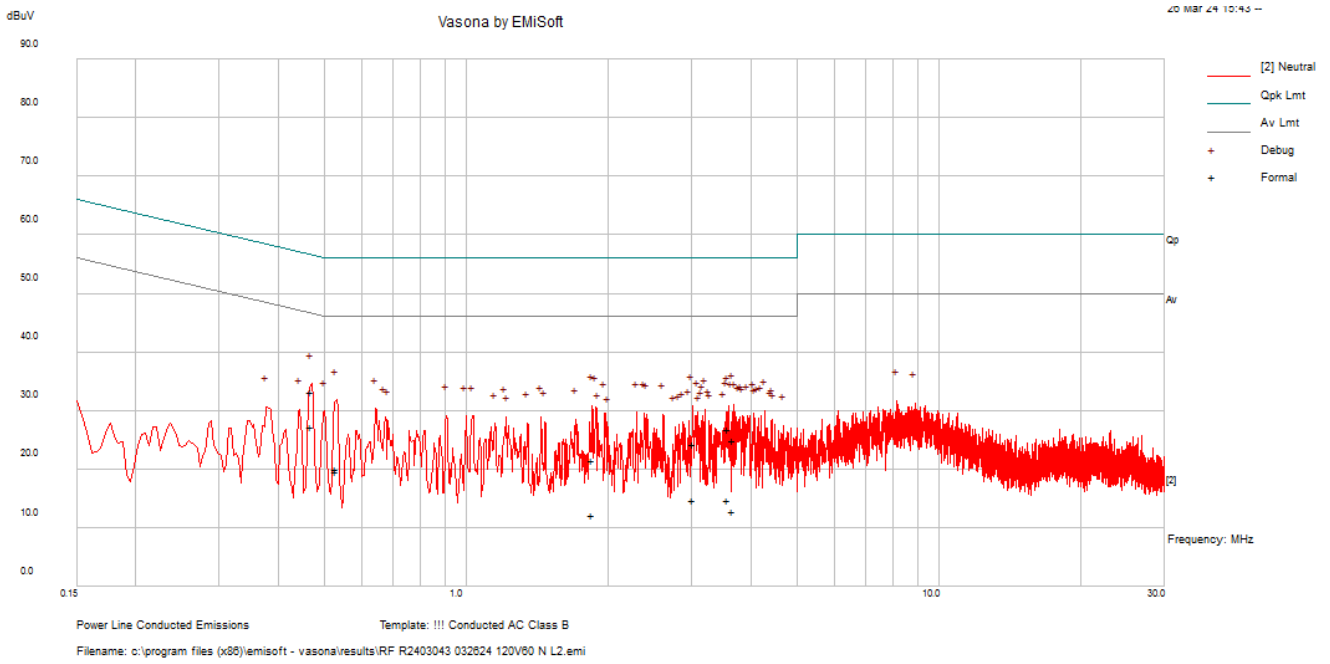
Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.468762	22.37	10.71	33.09	56.54	-23.45	QP
0.498434	18.55	10.7	29.25	56.03	-26.78	QP
0.623379	14.33	10.63	24.97	56	-31.03	QP
0.591397	17.97	10.65	28.62	56	-27.38	QP
3.577155	17.16	10.57	27.74	56	-28.26	QP
2.808297	14.22	10.48	24.71	56	-31.29	QP
0.468762	16.1	10.71	26.82	46.54	-19.72	Ave
0.498434	11.32	10.7	22.02	46.03	-24.01	Ave
0.623379	6.34	10.63	16.97	46	-29.03	Ave
0.591397	7.22	10.65	17.87	46	-28.13	Ave
3.577155	5.49	10.57	16.06	46	-29.94	Ave
2.808297	3.03	10.48	13.52	46	-32.48	Ave

AC Line: 120 V, 60 Hz – Hot Conductor – Lora 2



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.468762	27	10.71	37.71	56.54	-18.83	QP
0.442227	27.63	10.72	38.36	57.02	-18.66	QP
4.408691	19.71	10.69	30.4	56	-25.6	QP
4.140378	20.58	10.65	31.23	56	-24.77	QP
4.109001	19.56	10.65	30.21	56	-25.79	QP
0.566249	17.44	10.67	28.11	56	-27.89	QP
0.468762	23.77	10.71	34.49	46.54	-12.05	Ave
0.442227	25.65	10.72	36.38	47.02	-10.64	Ave
4.408691	10.11	10.69	20.8	46	-25.2	Ave
4.140378	10.77	10.65	21.42	46	-24.58	Ave
4.109001	10.83	10.65	21.48	46	-24.52	Ave
0.566249	12.55	10.67	23.22	46	-22.78	Ave

AC Line (via AC/DC Adapter): 120 V, 60 Hz – Neutral Conductor Lora 2



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.470567	22.53	10.71	33.24	56.5	-23.26	QP
0.529623	9.24	10.68	19.92	56	-36.08	QP
3.660422	14.24	10.58	24.83	56	-31.17	QP
3.020533	13.66	10.51	24.17	56	-31.83	QP
1.845475	11.12	10.42	21.54	56	-34.46	QP
3.57542	16.2	10.57	26.77	56	-29.23	QP
0.470567	16.56	10.71	27.27	46.5	-19.23	Ave
0.529623	8.98	10.68	19.66	46	-26.34	Ave
3.660422	2.16	10.58	12.75	46	-33.25	Ave
3.020533	4.23	10.51	14.74	46	-31.26	Ave
1.845475	1.68	10.42	12.1	46	-33.9	Ave
3.57542	4.05	10.57	14.63	46	-31.37	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	16.42 – 16.423	960 – 1240	4. 5 – 5. 15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5. 35 – 5. 46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 –167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3 3458 – 3 358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

As per ISEDC RSS-Gen 8.9,

Except when the requirements applicable to a given device state otherwise, emission from licence-exempt transmitters shall company with the field strength limits shown in the table below. Additional, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exemption Transmitters at Frequencies above 30 MHz

Frequency (MHz)	**Field Strength (µv/m at 3 meters)**
30-88	100
88-216	150
216-960	200
Above 960*	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for license-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

As per ISEDC RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

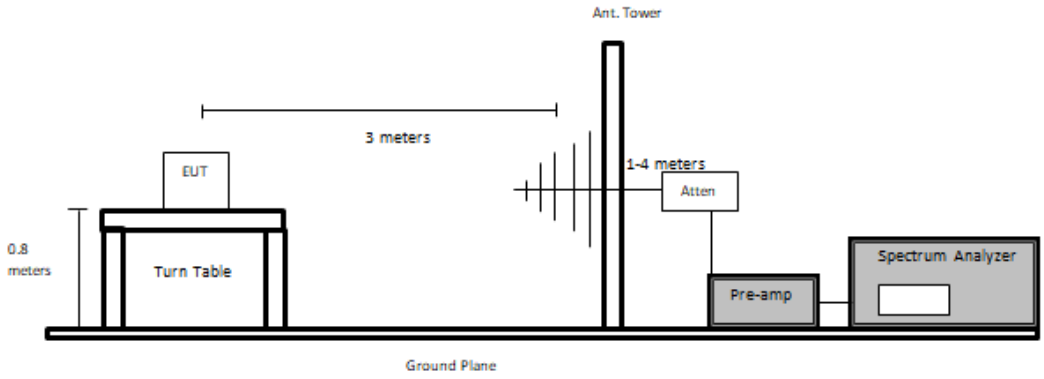
6.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart C and ISEDC RSS-247 limits.

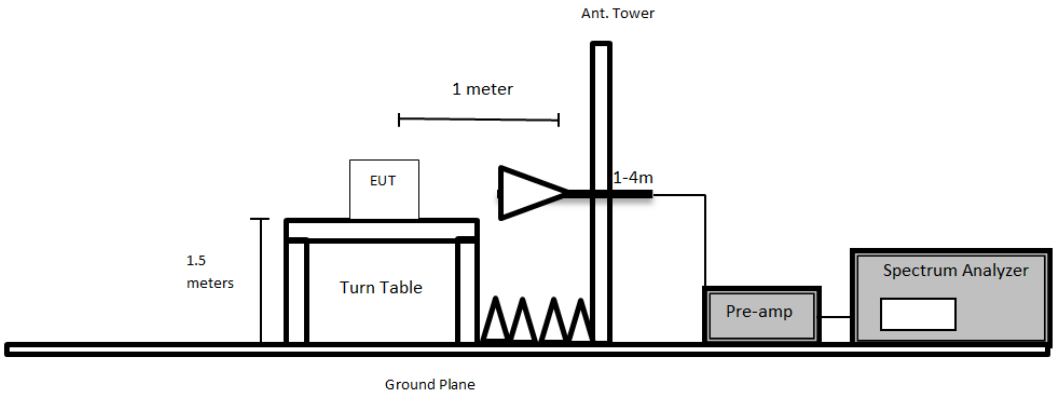
The spacing between the peripherals was 10 centimeters.

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

Below 1 GHz:



Above 1 GHz at 1m:



6.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords was 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 should be changed the polarization both of horizontal and vertical.

The spectrum analyzer or receiver is 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

For emissions below 1 GHz and for above 1GHz scans.

The Corrected Amplitude (CA) is calculated by adding the Correction Factor to the S.A. Reading. The basic equation is as follows:

CA = S.A. Reading + Correction Factor

For example, a corrected amplitude of 40.3 dBuV/m = S.A. Reading (32.5 dBuV) + Correction Factor (7.8 dB/m)

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

CA = Ai + AF + CL + Atten – Ga

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

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

Margin = Corrected Amplitude – Limit

6.5 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
310	Rohde & Schwarz	EMI Test Receiver	ESCI	100044	2023-06-16	1 year
316	Sonoma Instruments	Preamplifier 10 kHz - 2.5 GHz	317	260406	2024-02-27	6 months
321	Sunol Sciences	Biconilog Antenna	JB3	A020106-2; 1504	2023-12-18	2 years
1186	Pasternack	Coaxial Cable, RG214	PE3062-1050CM	-	2023-10-04	1 year
1245	-	6dB Attenuator	PE7390-6	01182018A	2023-12-18	2 years
811	Hewlet Packard	RF Limiter	11867A	MY42243052	2024-02-13	1 year
1248	Pasternack	RG214 COAX Cable	PE3062	-	2023-10-04	1 year
1249	Time Microwave	LMR-400 Cable Dc-3 GHz	AE13684	2k80612-5 6fts	2023-10-09	1 year
624	Agilent	Spectrum Analyzer	E4446A	MY48250238	2023-05-12	13months
658	HP/ Agilant	Pre Amplifier 1-26.5 GHz	8449B OPT HO2	3008A01103	2023-12-01	6 months
827	AH Systems	Pre-Amplifier 18-40 GHz	PAM 1840 VH	170	2023-11-08	1 year
90	Wisewave	Horn Antenna	ARH-4223-02	10555-01	2023-05-02	2 years
1192	ETS Lindgren	Horn Antenna	3117	00218973	2022-09-29	2 years
1247	Uti flex	Micro - Coax	-	-	2023-12-01	6 months
1329	Pasternack	2.92mm short coaxial cable	PE360-12	-	2023-11-28	6 months
1346	RFMW	2.92mm 10ft RF cable	KMSE-160SAW-240.0-KSME	-	2023-11-03	1 year
327	Sunol Sciences	System Controller	SC110V	122303-1	NR	NR
1075	Sunol Sciences	Boresight Tower	TLT3	050119-7	NR	NR
1388	Sunol Sciences	Flush Mount Turntable	FM	112005-2	NR	NR

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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

6.6 Test Environmental Conditions

Temperature:	21-23ºC
Relative Humidity:	38-44.5%
ATM Pressure:	101.8 kPa

The testing was performed by Will Hu from 2024-02-28 to 2024-03-13 and by Arturo Reyes on 2024-03-13, and Xavier Kelley on 2024-05-15 in 5m chamber 3.

6.7 Summary of Test Results

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

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Transmitting Channel**
-0.02	2771.42	Horizontal	LORA 2: 924 MHz

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

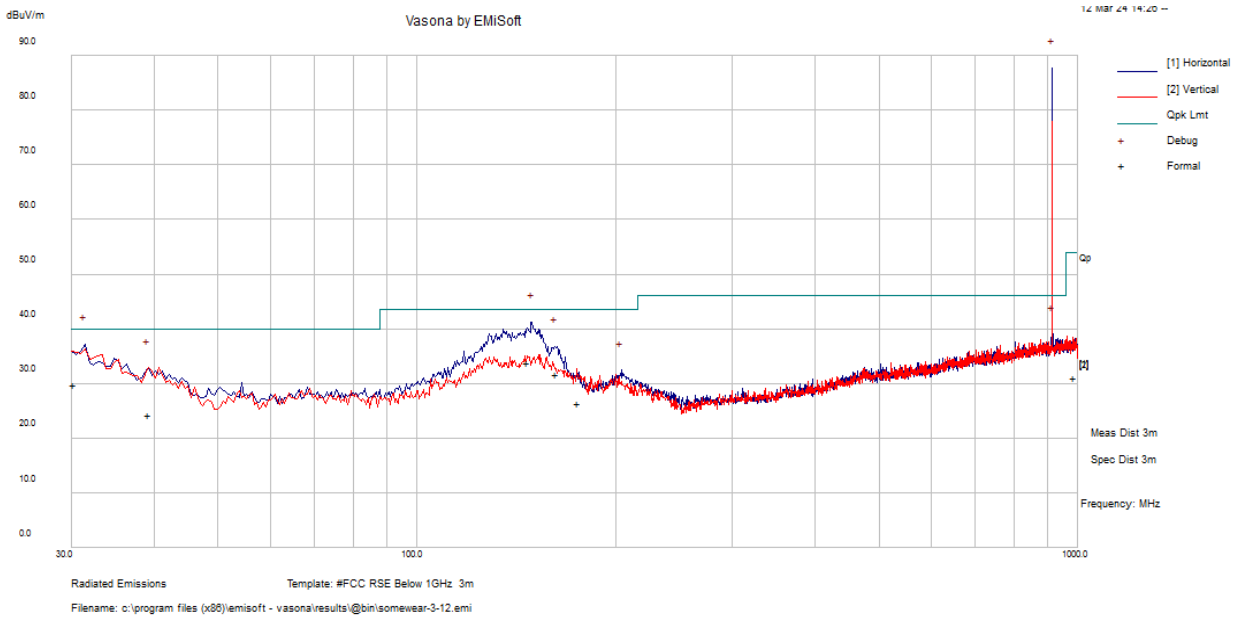
6.8 Radiated Emissions Test Results

***Note**:Full 15.209 evaluations were performed with appropriate transmit antennas in chamber for testing above 1GHz. For testing below 1GHz, testing was performed conducted in lieu of radiated per ANSIC63.10-2013 with applying worst case-antenna gain options. Testing below 1GHz was performed into a load in chamber in order to evaluate the cabinet emissions.*

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

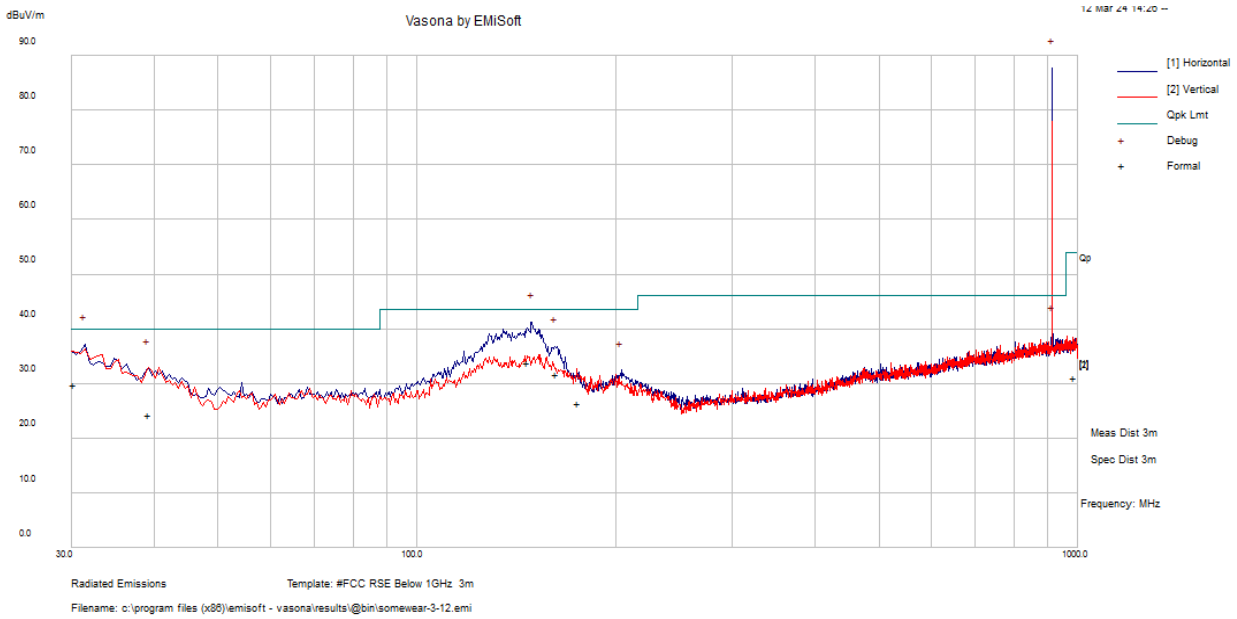
***Note:** Pre-scans were performed on all shown configurations in order to determine worst-case results. Following this, a formal scan was performed on the worst-case detailed below*
***Note:** "External Antenna" is used to refer to the use of the external LoRa antenna.*

Worst Case: LORA 1, 918 MHz



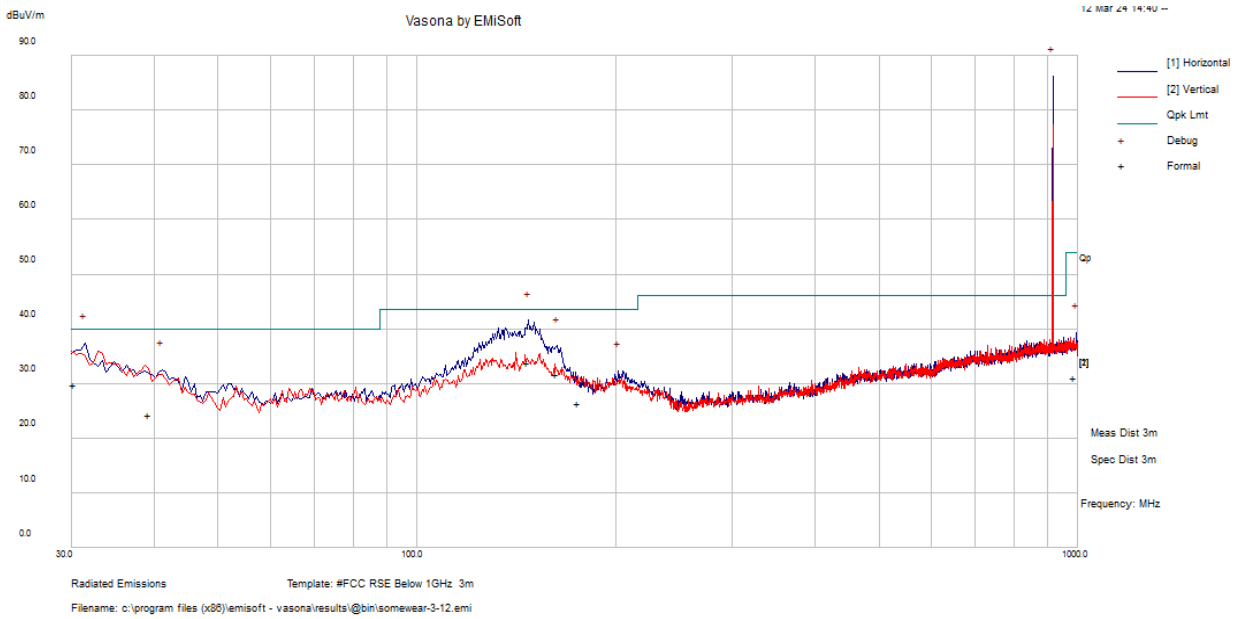
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
147.294	43.5	-8.59	34.91	221	H	102	43.5	-8.59	QP
31.542	31.11	-2.24	28.87	272	V	254	40	-11.13	QP
162.58925	41.46	-8.99	32.47	180	H	280	43.5	-11.03	QP
41.19825	34.47	-8.83	25.64	297	H	306	40	-14.36	QP
202.16875	34.54	-9.36	25.18	116	H	323	43.5	-18.32	QP
996.2515	29.58	1.31	30.89	200	V	97	54	-23.11	QP

LORA 1, 914 MHz



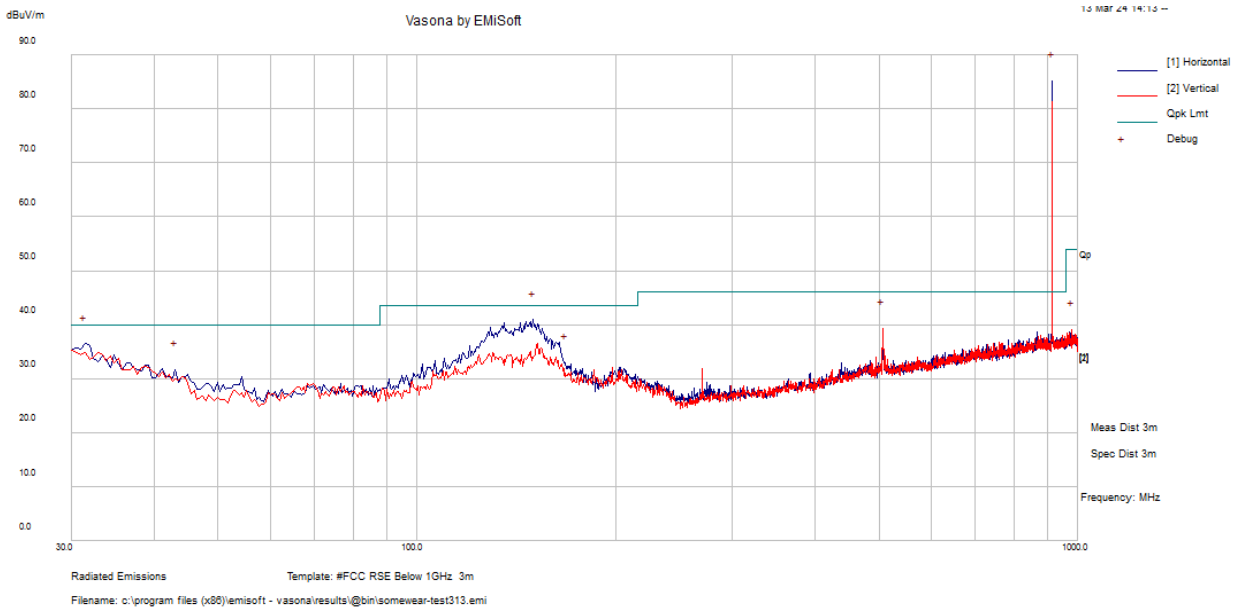
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
149.31	49.82	-8.64	41.18	200	H	360	43.5	-2.32	Peak
31.455	39.34	-2.17	37.17	200	H	360	40	-2.83	Peak
161.92	45.77	-8.97	36.8	300	H	360	43.5	-6.7	Peak
916.58	36.44	2.53	38.97	100	H	360	46	-7.03	Peak
39.215	40.29	-7.45	32.84	200	H	360	40	-7.16	Peak
203.63	42.16	-9.77	32.39	300	H	360	43.5	-11.11	Peak

LORA 1, 916 MHz



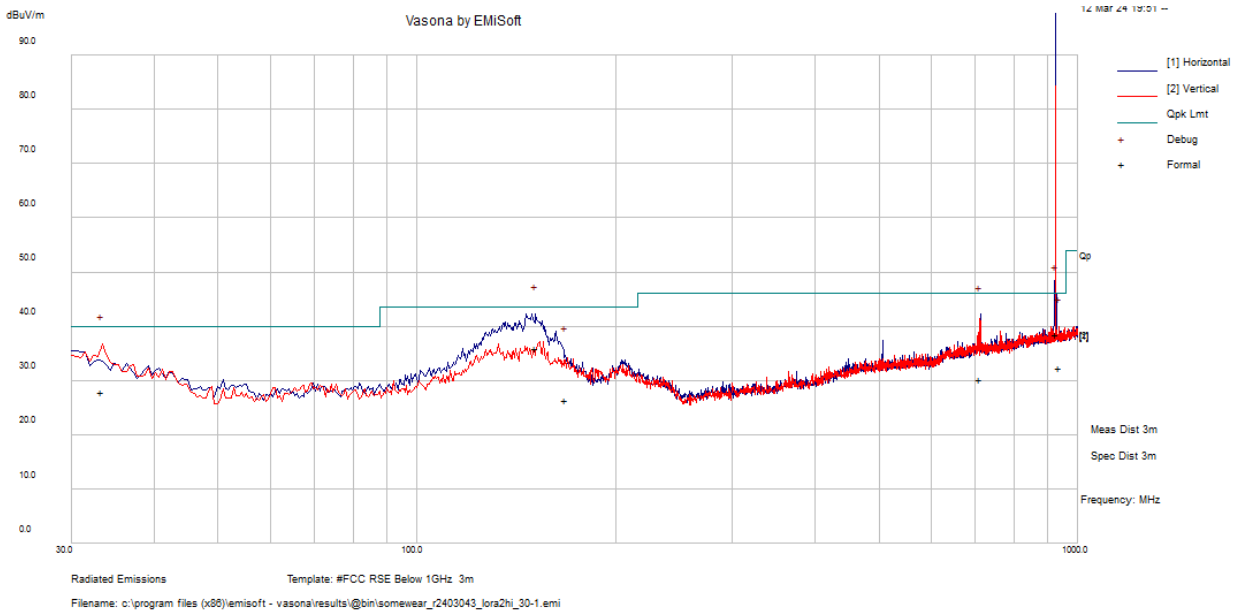
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
147.37	50.12	-8.59	41.53	200	H	360	43.5	-1.97	Peak
31.455	39.63	-2.17	37.46	300	H	360	40	-2.54	Peak
162.89	45.9	-9.01	36.89	300	H	360	43.5	-6.61	Peak
41.155	41.36	-8.8	32.56	300	H	360	40	-7.44	Peak
201.69	41.57	-9.23	32.34	300	H	360	43.5	-11.16	Peak
996.12	37.98	1.31	39.29	100	H	360	54	-14.71	Peak

Colocation: LORA 1: 914 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



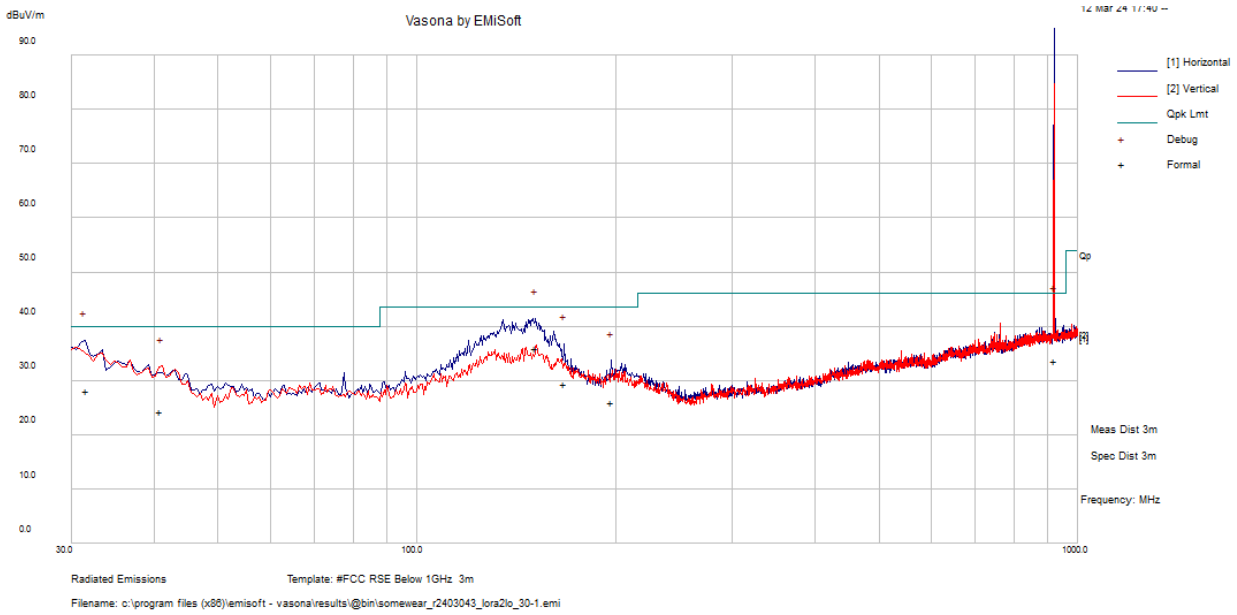
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
149.795	49.53	-8.66	40.87	200	H	360	43.5	-2.63	Peak
31.455	38.61	-2.17	36.44	300	H	360	40	-3.56	Peak
506.27	41.81	-2.5	39.31	200	V	360	46	-6.69	Peak
43.095	41.86	-10.16	31.7	300	H	360	40	-8.3	Peak
167.74	42.26	-9.3	32.96	200	H	360	43.5	-10.54	Peak
979.145	35.64	3.41	39.05	300	V	360	54	-14.95	Peak

Worst Case: LORA 2, 924 MHz



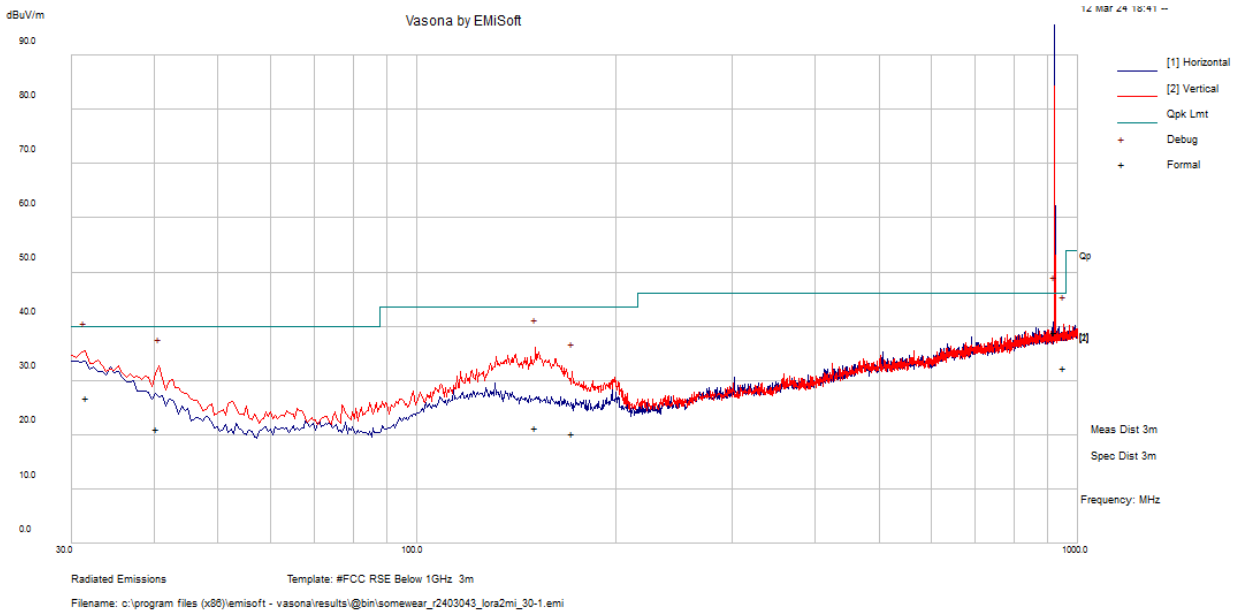
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
927.03675	34.15	4.3	38.45	164	H	34	46	-7.55	QP
151.47425	44.18	-8.16	36.02	204	H	314	43.5	-7.48	QP
33.303	31.26	-3.35	27.91	233	V	320	40	-12.09	QP
711.9245	28.14	2.03	30.17	261	H	171	46	-15.83	QP
935.99025	27.93	4.47	32.4	230	V	194	46	-13.6	QP
167.86275	35.07	-8.71	26.36	266	H	335	43.5	-17.14	QP

LORA 2, 920 MHz



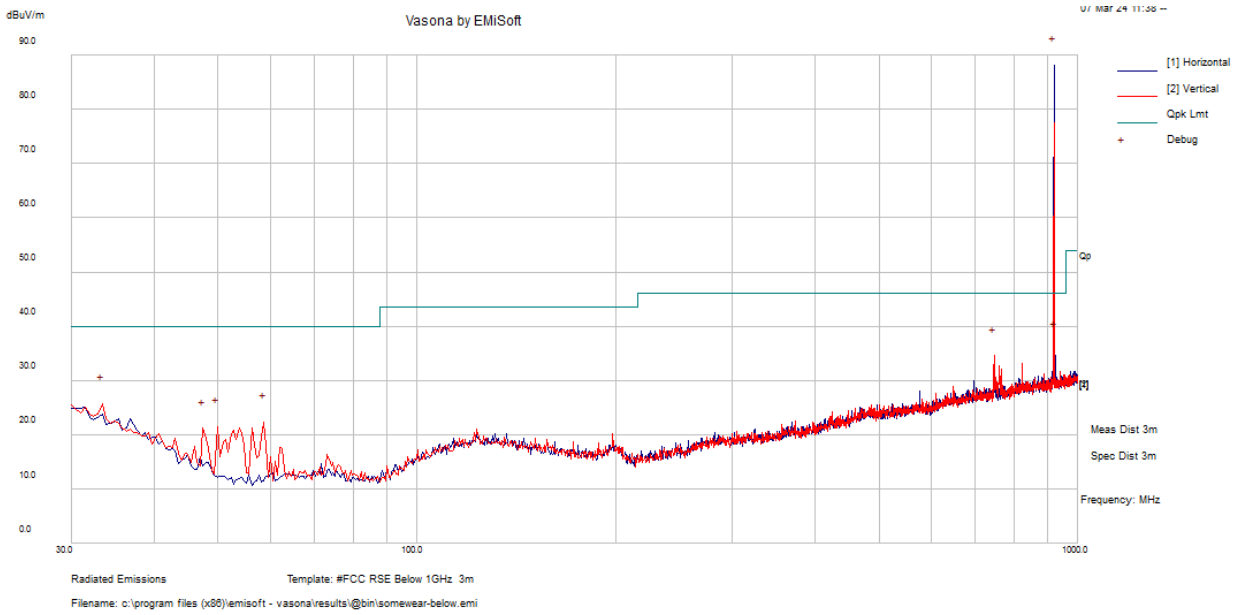
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
151.12475	44.03	-8.15	35.88	187	H	352	43.5	-7.62	QP
31.651	30.24	-2.22	28.02	132	H	76	40	-11.98	QP
921.6845	29.44	4.18	33.62	126	H	36	46	-12.38	QP
167.418	38.14	-8.69	29.45	268	H	144	43.5	-14.05	QP
40.98925	32.75	-8.48	24.27	230	V	203	40	-15.73	QP
197.0285	33.98	-7.99	25.99	296	H	51	43.5	-17.51	QP

LORA 2, 922 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
924.095	34.72	4.24	38.96	100	H	352	46	-7.04	QP
31.69575	29.02	-2.25	26.77	162	V	127	40	-13.23	QP
952.6315	27.7	4.64	32.34	192	V	137	46	-13.66	QP
40.49425	29.24	-8.15	21.09	266	V	302	40	-18.91	QP
151.24475	29.37	-8.15	21.22	167	V	160	43.5	-22.28	QP
171.75025	29.15	-8.96	20.19	226	V	60	43.5	-23.31	QP

Colocation: LORA 2: 920 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



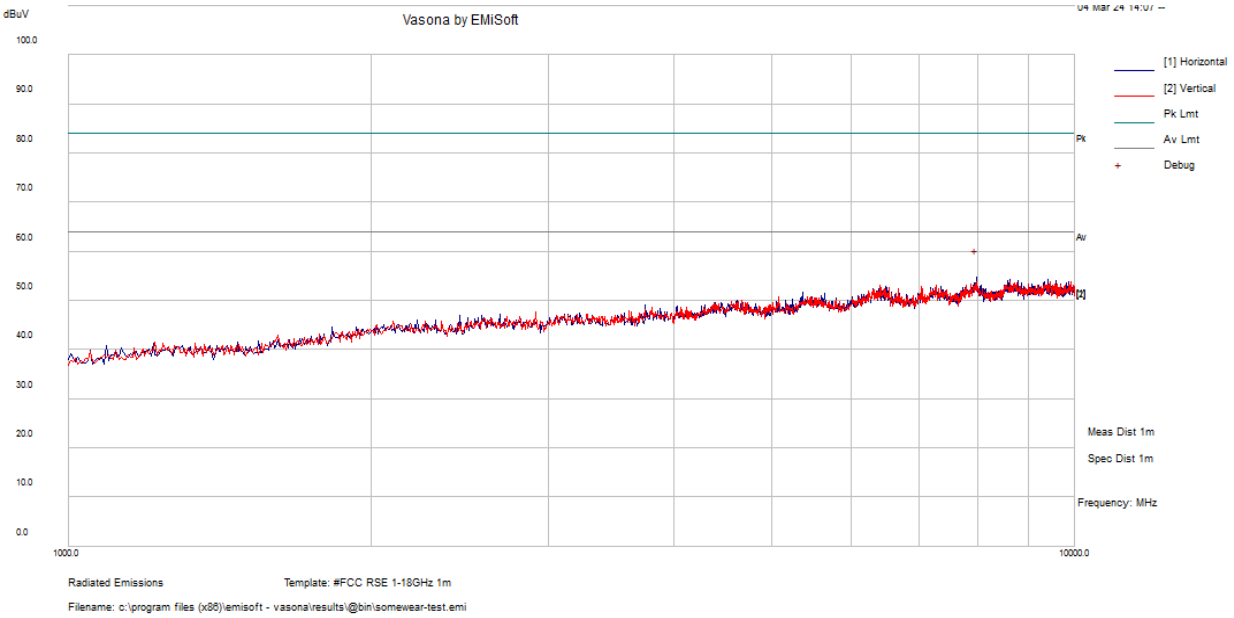
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
135.924	41.94	-7.74	34.2	195	H	84	43.5	-9.3	QP
31.46125	30.44	-2.17	28.27	148	V	331	40	-11.73	QP
922.864	32.58	2.62	35.2	159	H	174	46	-10.8	QP
785.37325	28.01	1.17	29.18	218	V	54	46	-16.82	QP
696.373	28.24	0.58	28.82	105	H	353	46	-17.18	QP
39.0085	32.84	-7.3	25.54	244	H	168	40	-14.46	QP

2) 1 – 10 GHz, Measured at 1 meter

FCC/IC Limits for 1 GHz to 26.5 GHz				
Applicability	**(dBm)**	**(uV/m at 3meters)**	**(dBuV/m at 3meters)**	**(dBuV/m at 1meter)[2]**
Restricted Band Average Limit	-	500	54	63.54
Restricted Band Peak Limit[1]	-	-	74	83.54

Note[1]: Restricted Band Peak Limit is defined to be 20dB higher than Average Limit.
Note[2]: Limits at 1 meter are determined by applying a Distance correction factor accounts for extrapolation from 1 meters to 3 meters. Formula used is as follows: 20*log(3meters/1meter) = 9.54 (According to ANSI C63.10-2013 Section 9.4)

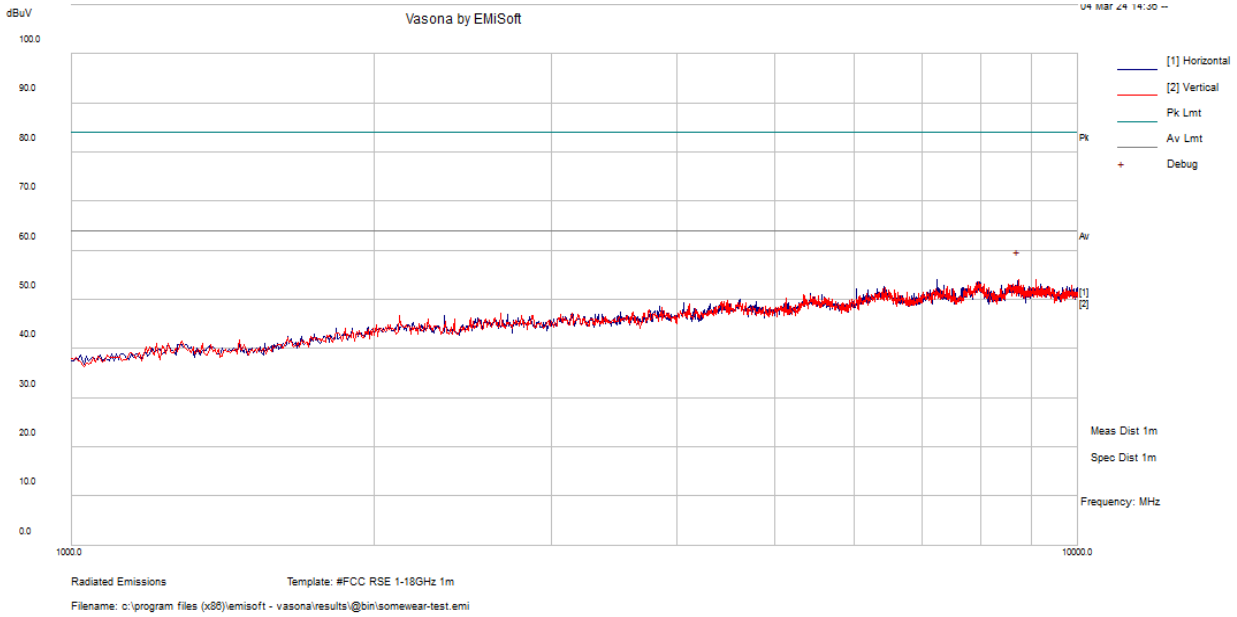
LORA 1: 914 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
7980.625	47.92	6.71	54.63	200	H	360	63.54	-8.91	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

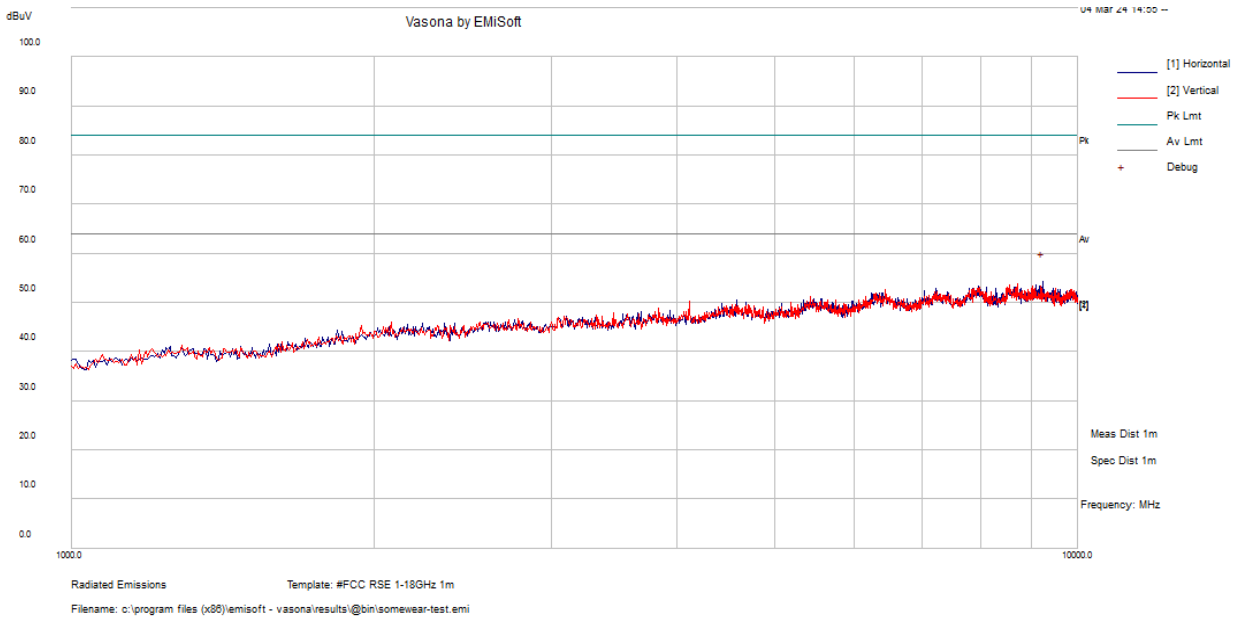
LORA 1: 916 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
8723.125	46.91	7.2	54.11	100	V	360	63.54	-9.43	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

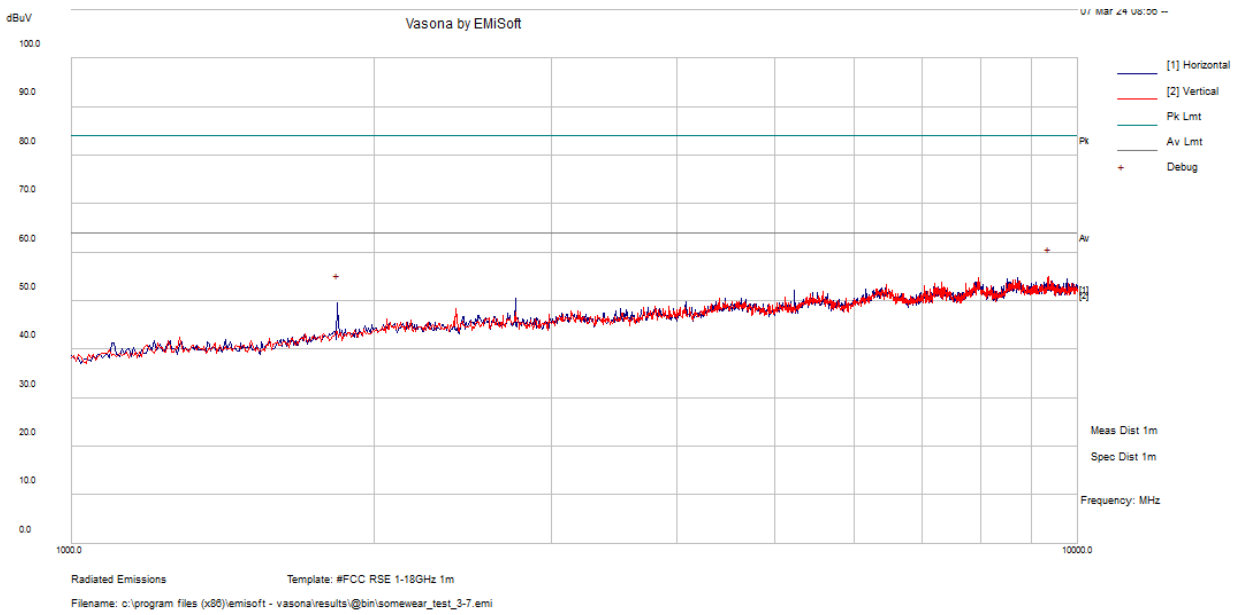
LORA 1: 918 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
9223.75	47.11	7.24	54.35	300	H	360	63.54	-9.19	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

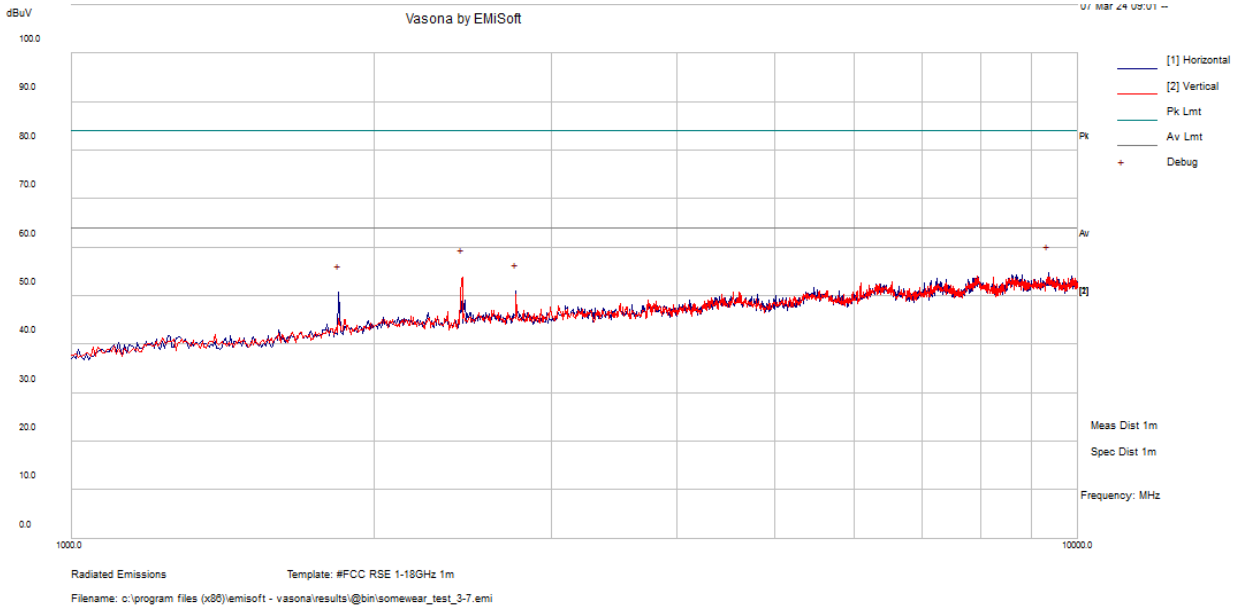
LORA 2: 920 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
9353.125	47.73	7.34	55.07	200	V	360	63.54	-8.47	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

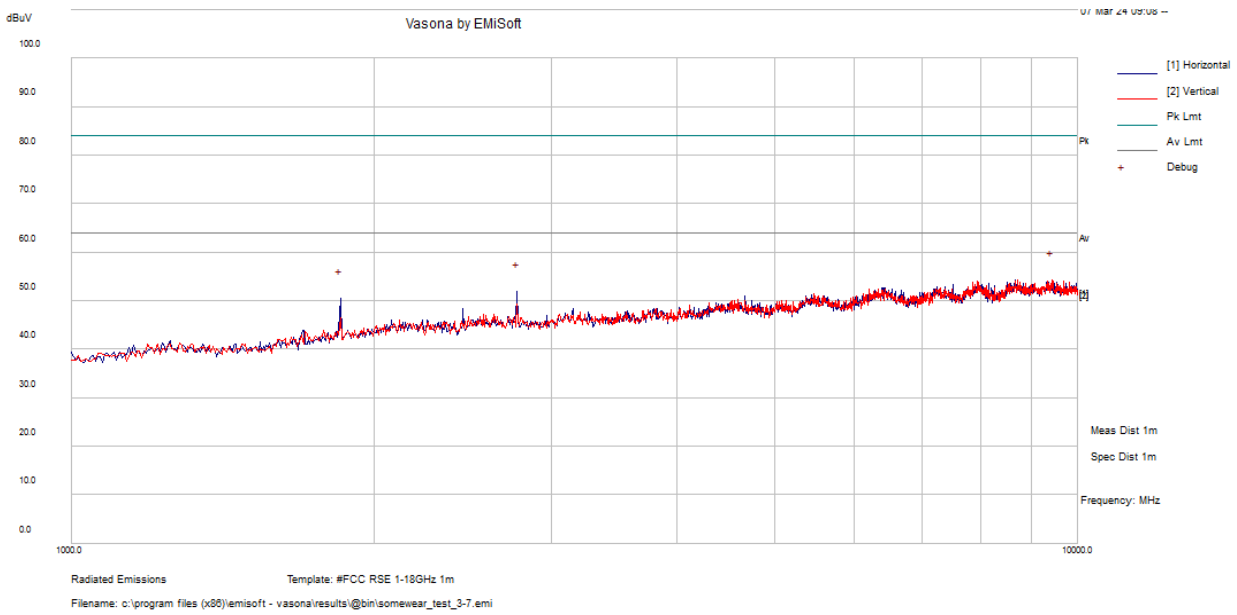
LORA 2: 922 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
9341.875	47.37	7.33	54.7	200	H	0	63.54	-8.84	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

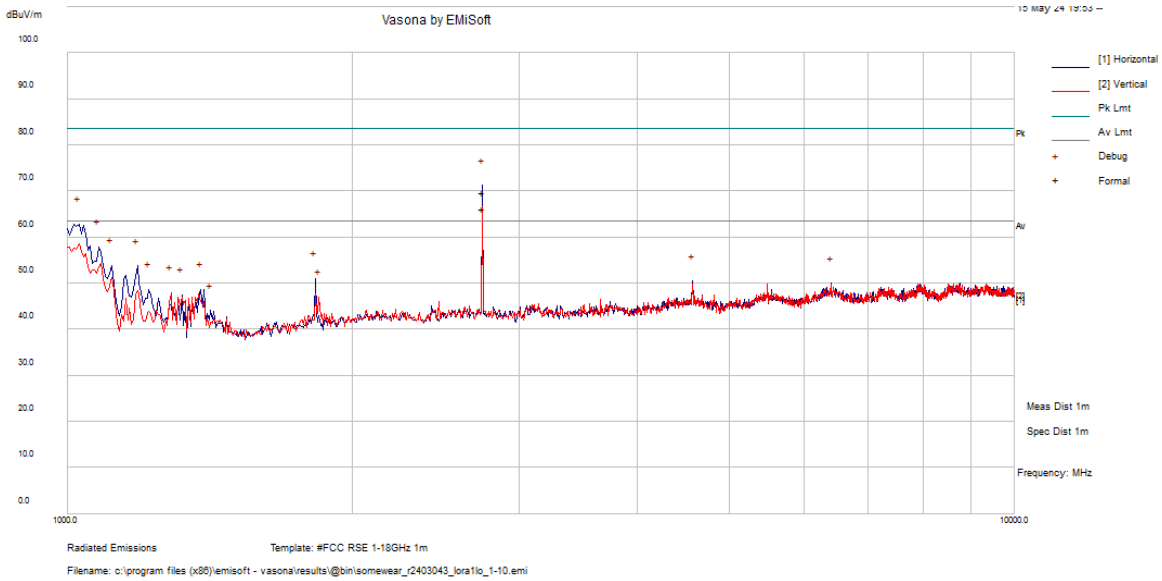
LORA 2: 924 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
9415	46.96	7.41	54.37	200	V	0	63.54	-9.17	Peak

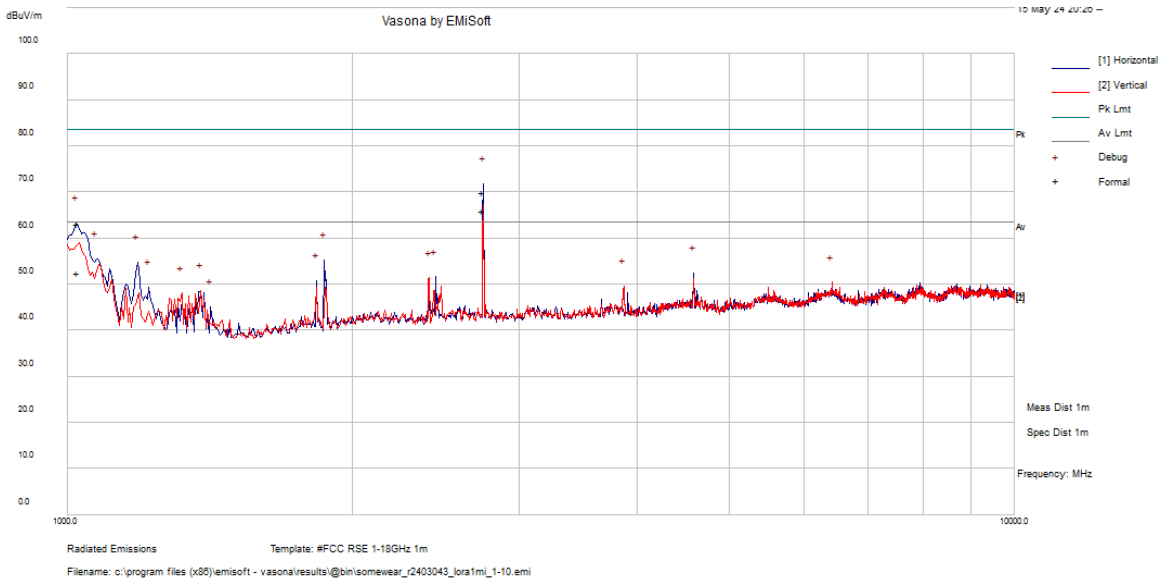
Note: Peak measurement was to compare to the average limit to show compliance.

External Antenna LORA 1: 914 MHz



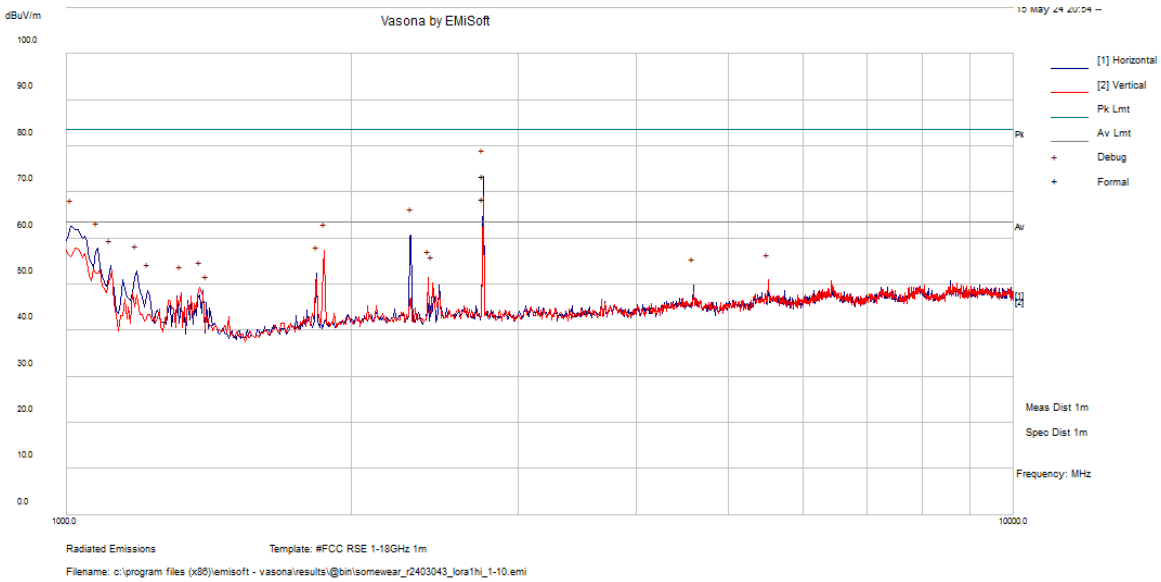
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
2742.31	73.55	-3.88	69.66	154	H	316	83.54	-13.88	Peak
2742.31	66.93	-3.88	63.05	154	H	316	63.54	-0.49	Average

External Antenna LORA 1: 916 MHz



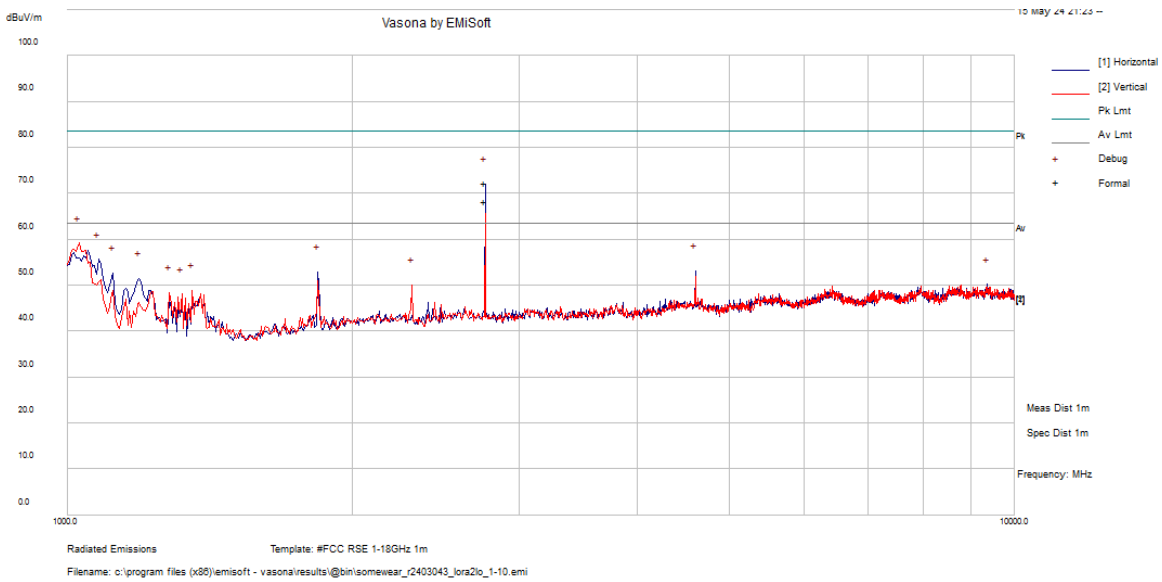
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
2747.51	72.91	-3.89	69.02	152	H	318	83.54	-14.52	Peak
1023.61	75.63	-12.61	63.01	101	H	211	83.54	-20.53	Peak
2747.51	66.77	-3.89	62.88	152	H	318	63.54	-0.66	Average
1023.61	65.04	-12.61	52.42	101	H	211	63.54	-11.12	Average

External Antenna LORA 1: 918 MHz



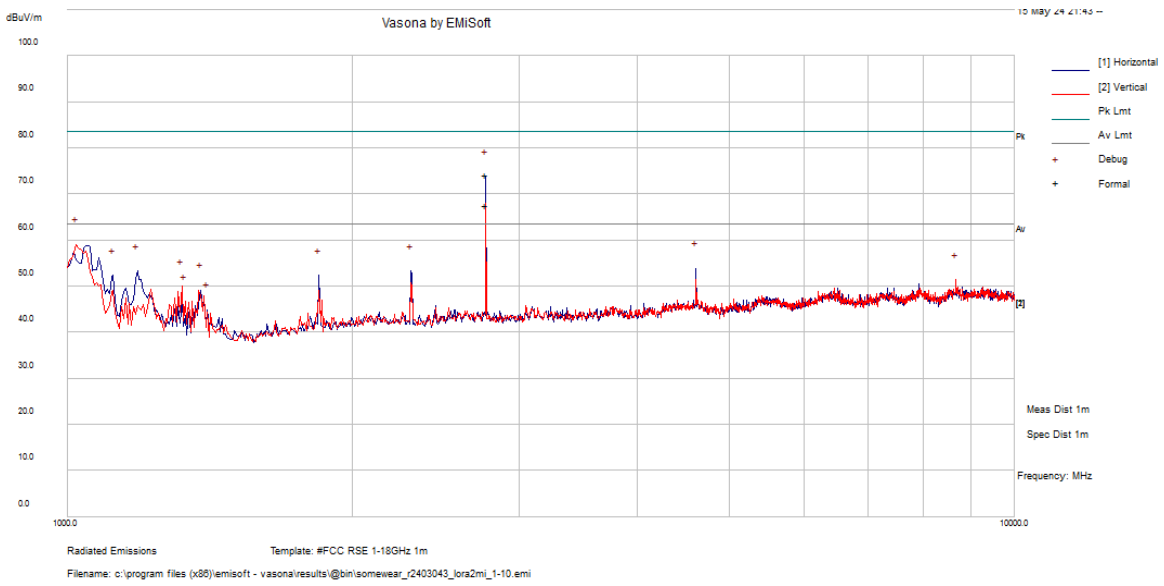
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
2754.62	75.48	-3.9	71.58	237	H	283	83.54	-11.96	Peak
2754.62	67.29	-3.9	63.39	237	H	283	63.54	-0.15	Average

External Antenna LORA 2: 920 MHz



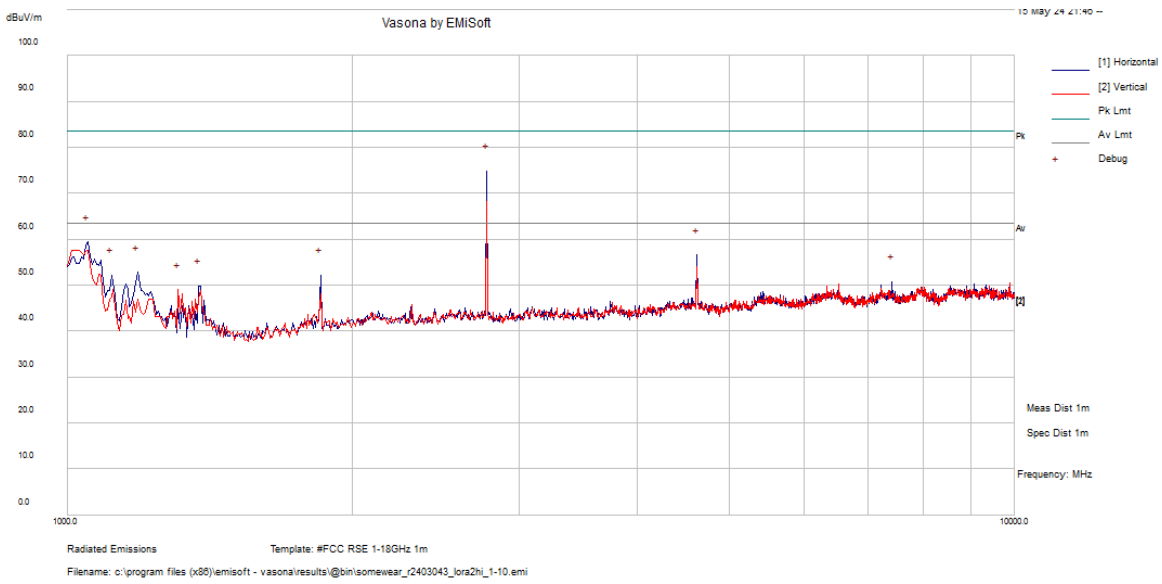
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
2759.538	75.2	-3.91	71.3	240	H	56	83.54	-12.24	Peak
2759.538	67.09	-3.91	63.19	240	H	56	63.54	-0.35	Average

External Antenna LORA 2: 922 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
2765.24	76.14	-3.87	72.26	177	H	70	83.54	-11.28	Peak
2765.24	67.35	-3.87	63.47	177	H	70	63.54	-0.07	Average

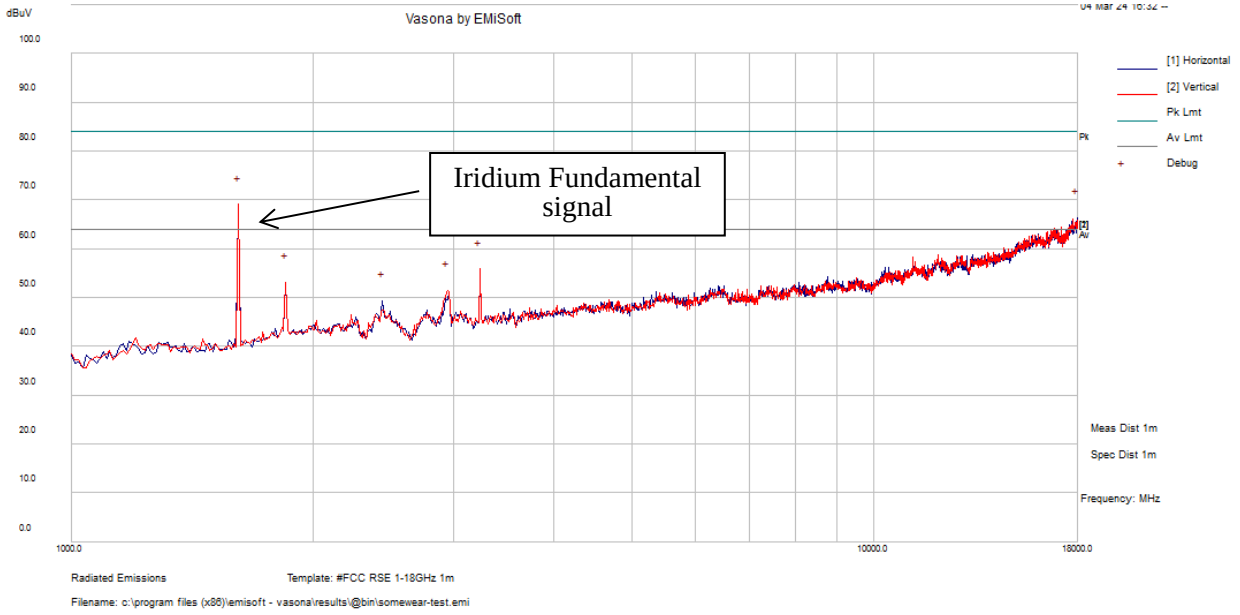
External Antenna LORA 2: 924 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
2771.42	76.22	-3.84	72.37	236	H	58	83.54	-11.17	Peak
2771.42	67.37	-3.84	63.52	236	H	58	63.54	-0.02	Average

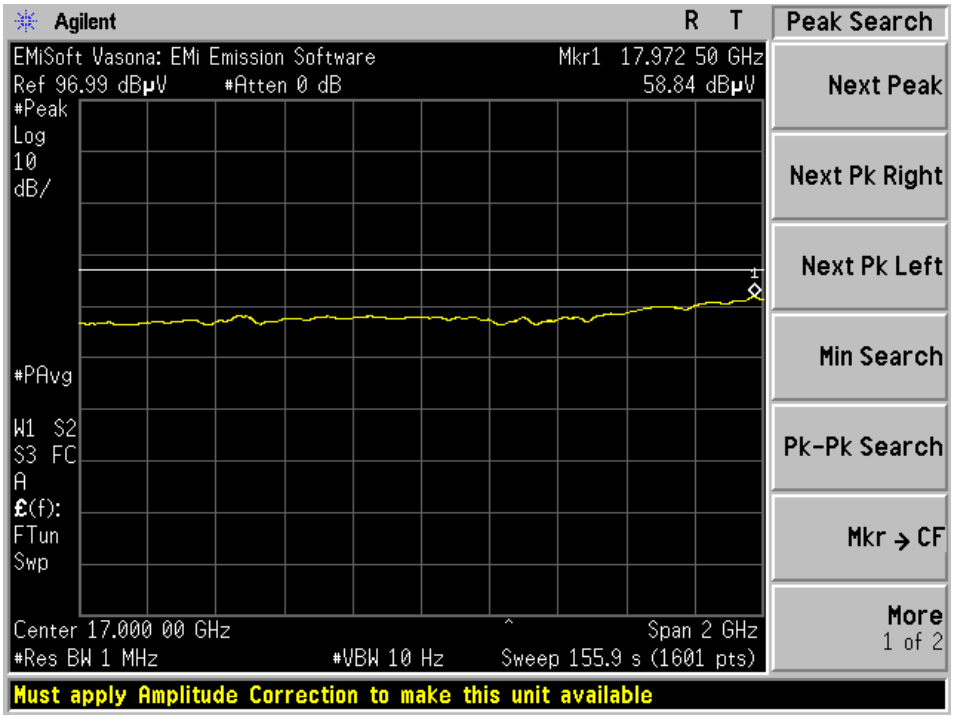
3) 1 – 18 GHz, Measured at 1 meter

Colocation: LORA 1: 914 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



Note: Peak measurement was to compare to the average limit to show compliance.

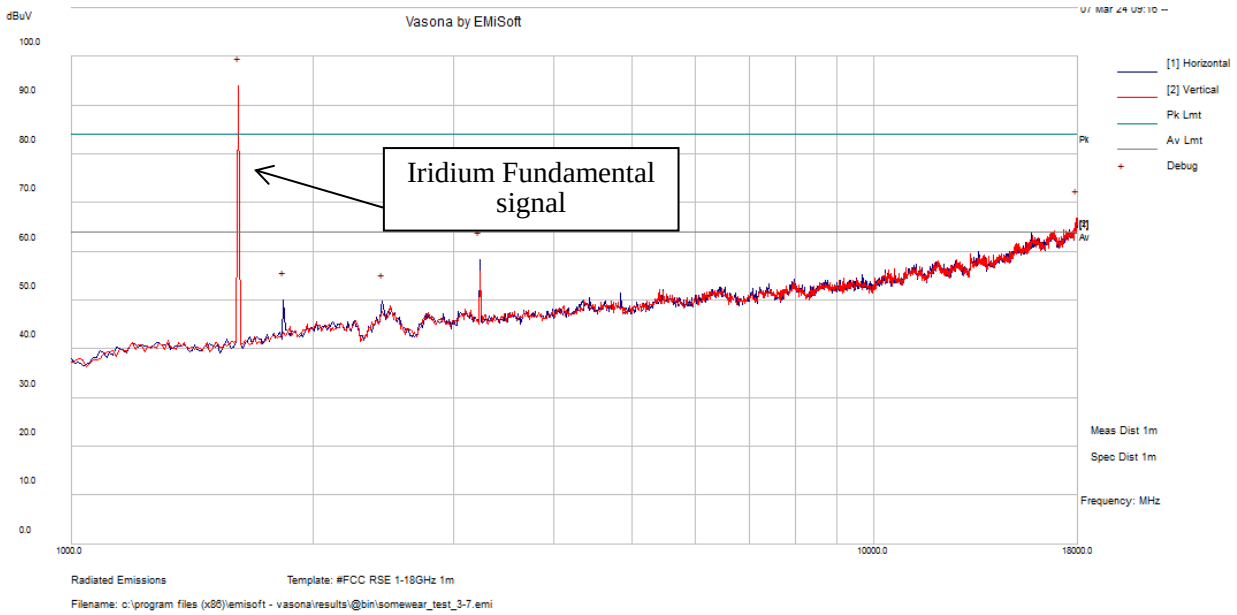
Average plot for 16 – 18 GHz



Note: above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz

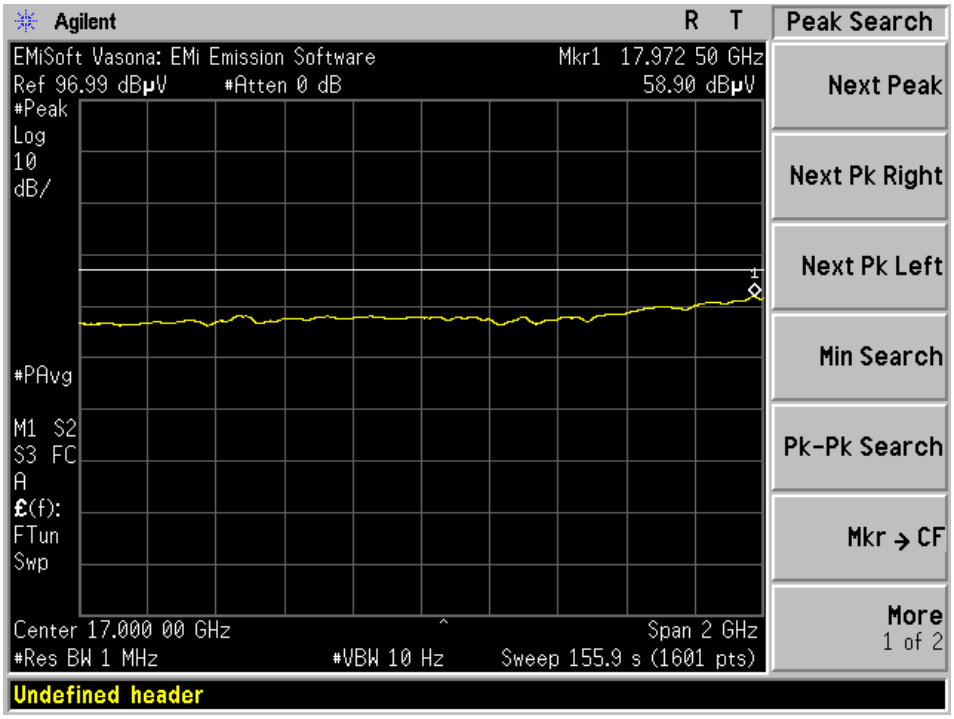
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
17972.50	48.73	10.11	58.84	200	V	360	63.54	-4.7	Avg

Colocation: LORA 2: 920 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



Note: Peak measurement was to compare to the average limit to show compliance.

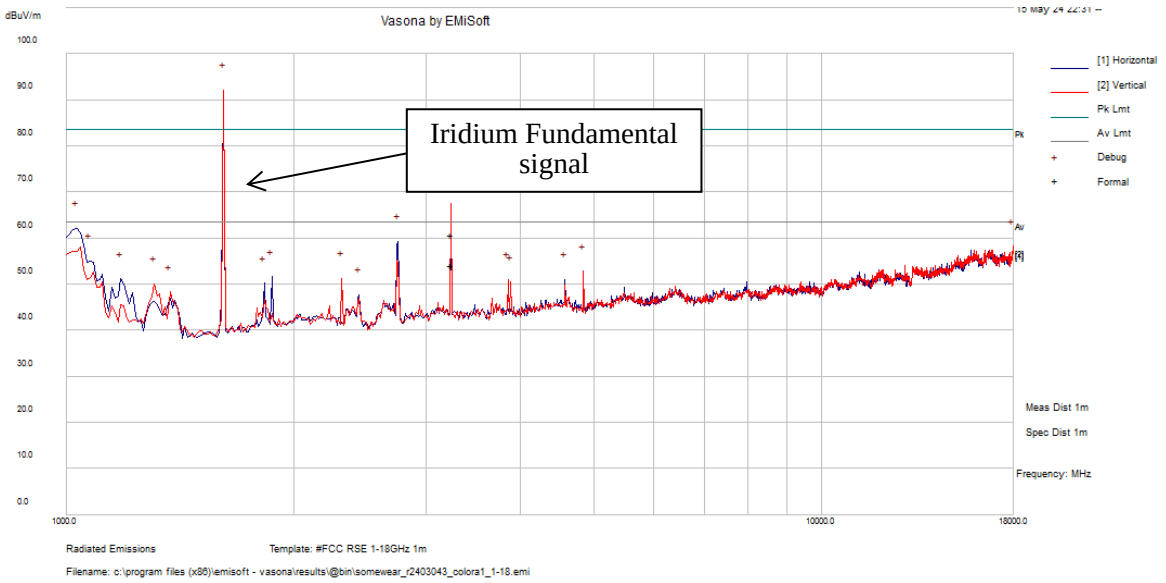
Average plot for 16 – 18 GHz



Note: above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz

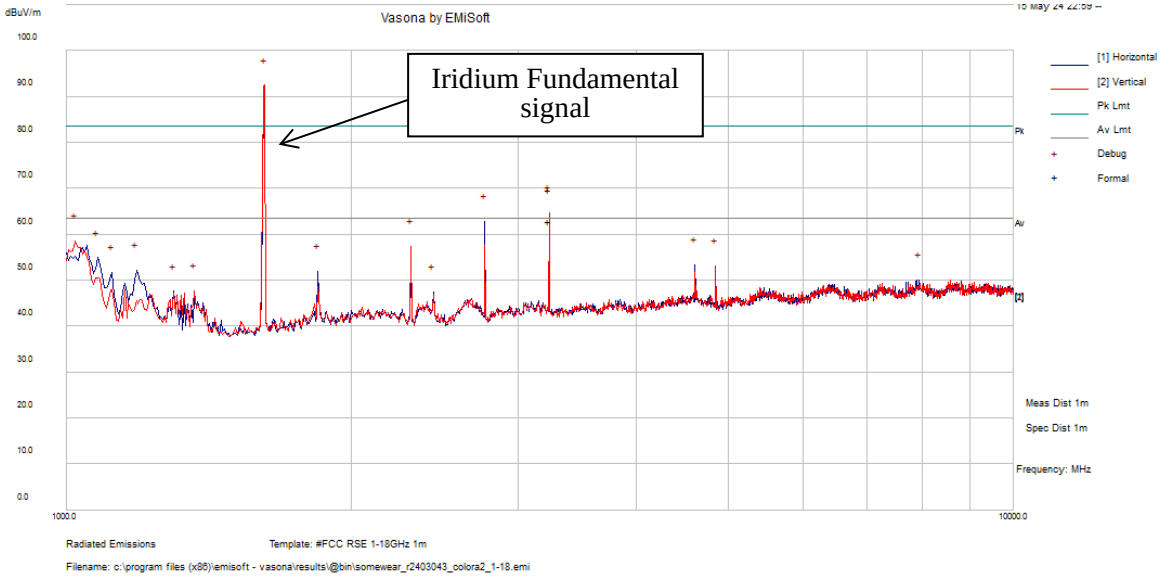
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
17972.50	48.79	10.11	58.90	200	V	360	63.54	-4.64	Avg

Colocation: External Antenna LORA 1: 914 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
3232.123	64.23	-3.5	60.73	158	V	327	83.54	-22.81	Peak
3232.123	57.65	-3.5	54.15	158	V	327	63.54	-9.39	Average

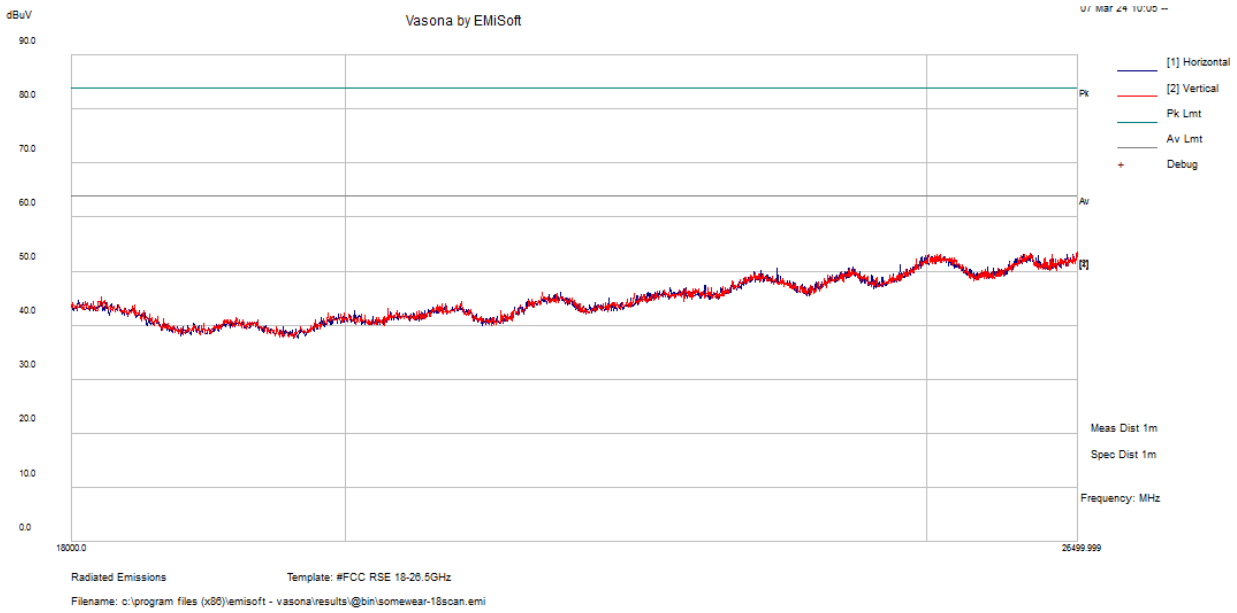
Colocation: External Antenna LORA 2: 920 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
3232.083	73.28	-3.5	69.78	195	V	318	83.54	-13.76	Peak
3232.083	66.26	-3.5	62.75	195	V	318	63.54	-0.79	Average

4) 18 – 26.5 GHz, Measured at 1 meter

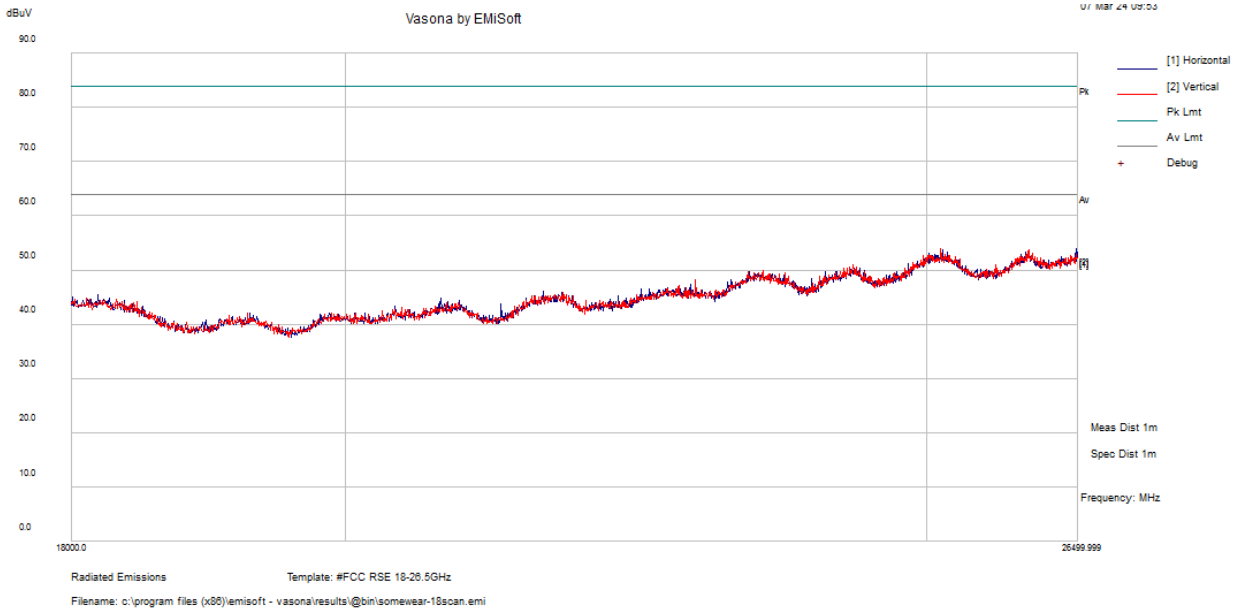
Colocation: LORA 1: 914 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



Frequency (MHz))	S.A. Reading (dBuV	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
25124.06	46.11	7.26	53.37	200	V	360	63.54	-10.18	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

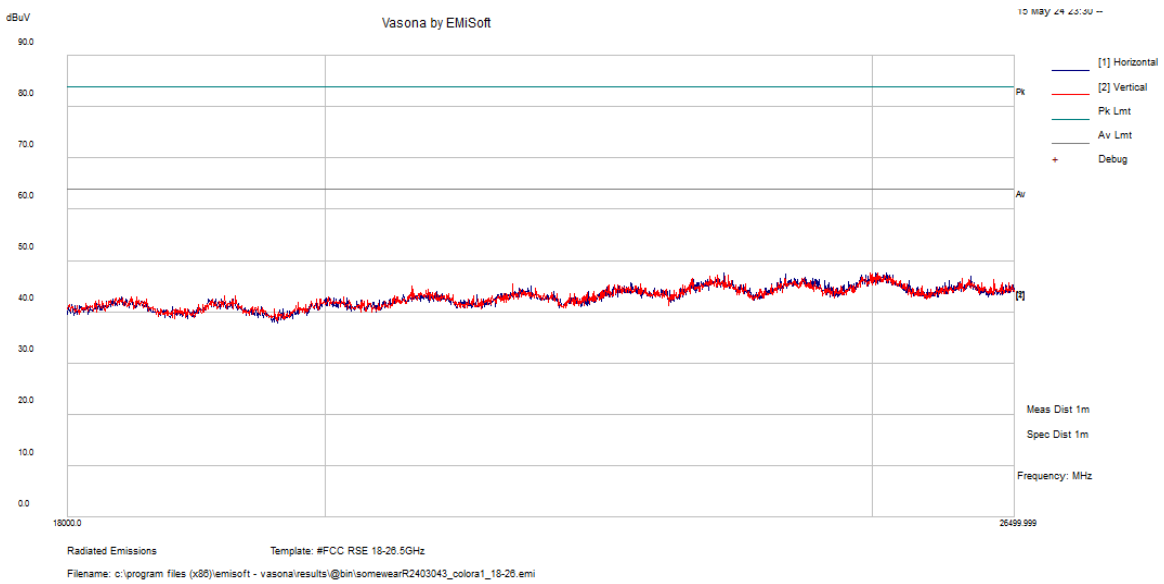
Colocation: LORA 2: 922 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



Frequency (MHz))	S.A. Reading (dBuV	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
25124.06	46.11	7.26	53.37	200	V	360	63.54	-10.18	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

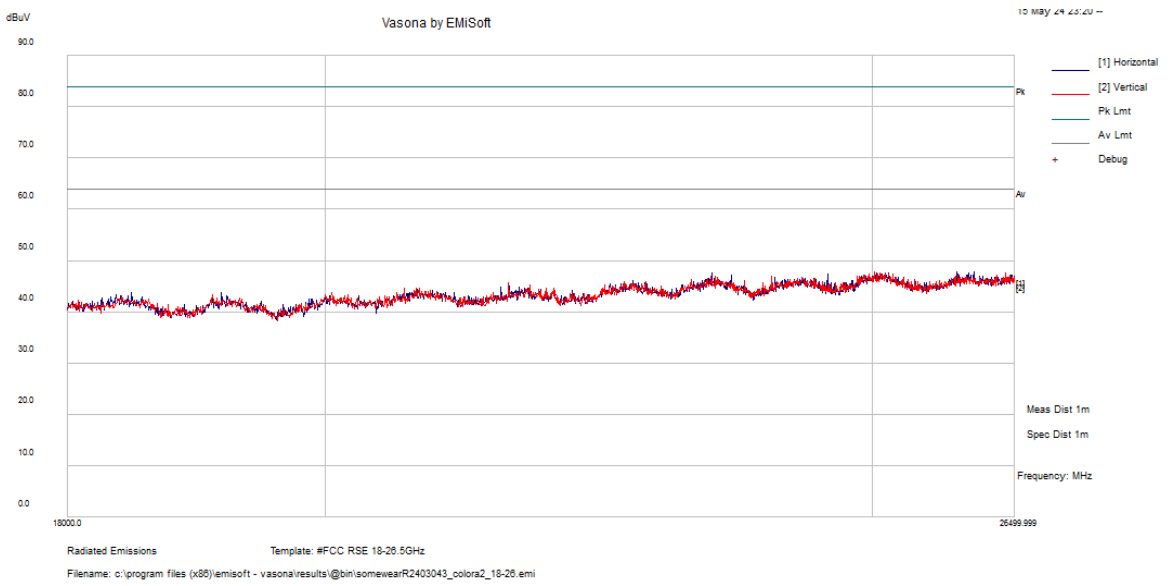
Colocation: External Antenna LORA 1: 914 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



Frequency (MHz))	S.A. Reading (dBuV	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Commen t
23536.45	41.52	5.74	47.26	200	V	7	63.54	-16.28	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

Colocation: External Antenna LORA 2: 922 MHz, Iridium: 1616.02 MHz, GFSK(1M): 2402 MHz



Frequency (MHz))	S.A. Reading (dBuV	Correction Factor	Corrected Amplitude (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµ V/m)	Margin (dB)	Comment
24549.779	40.42	6.6	47.01	200	V	7	63.54	-16.53	Peak

Note: Peak measurement was to compare to the average limit to show compliance.

7 FCC §15.247(a) (2) & ISEDC RSS-247 §5.2, RSS-Gen §6.7 - Emission Bandwidth

7.1 Applicable Standards

According to FCC §15.247(a) (2) and ISEDC RSS-247 §5.2: the minimum 6 dB bandwidth shall be 500 kHz.

7.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Measure Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth.

7.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Spectrum Analyzer	E4446A	MY48250238	05-15-2023	1 year
-	-	SMA cable	-	-	Each time[1]	N/A

Note[1]: 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

7.4 Test Environmental Conditions

Temperature:	21ºC
Relative Humidity:	39%
ATM Pressure:	102.0 kPa

The testing was performed by Libass Thiaw from 03-21-2024 to 04-02-2024 at RF Bench

7.5 Test Results

Lora 1

Channel	Frequency (MHz)	99% OBW (kHz)	6 dB OBW (kHz)
Low	914	517.9599	641.167
Middle	916	519.8279	642.395
High	918	520.0984	644.841

Lora 2

Channel	Frequency (MHz)	99% OBW (kHz)	6 dB OBW (kHz)
Low	920	524.5721	571.199
Middle	922	525.4999	573.031
High	924	541.2367	589.171

Please refer to Annex A for detailed test results.

8 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4 - Output Power

8.1 Applicable Standards

According to FCC §15.247(b) (3): For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to RSS-247 §5.4: For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

8.2 Measurement Procedure

The measurements are based on ANSI C63.10-2013, Section 11.9.2.2.2.

8.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Spectrum Analyzer	E4446A	MY48250238	05-15-2023	1 year
-	-	SMA cable	-	-	Each time[1]	N/A

Note[1]: 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

8.4 Test Environmental Conditions

Temperature:	21ºC
Relative Humidity:	39%
ATM Pressure:	102.0 kPa

The testing was performed by Libass Thiaw from 03-21-2024 to 04-02-2024 at RF Bench

8.5 Test Results

Lora 1

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Limit (dBm)	EIRP (dBm)	EIRP Limit(dBm)
Low	914	26.825	30	30.525	36
Middle	916	26.775	30	30.475	36
High	918	27.065	30	30.765	36

Lora 2

Channel	Frequency (MHz)	Conducted Output Power (dBm)	Limit (dBm)	EIRP (dBm)	EIRP Limit(dBm)
Low	920	26.659	30	29.559	36
Middle	922	26.949	30	29.849	36
High	924	27.059	30	29.959	36

Note: EIRP (dBm) = Output Power (dBm) + Antenna Gain (dBi)
Note: Duty Cycle Correction Factor was already included in Conducted Output Power (dBm) measurements

Please refer to Annex B for detailed test results.

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

9.1 Applicable Standards

According to ECFR §15.247(e) and RSS-247 §5.2 (2) , for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

9.2 Measurement Procedure

The measurements are based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8.4: Maximum power spectral density level in the fundamental emission.

9.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Spectrum Analyzer	E4446A	MY48250238	05-15-2023	1 year
-	-	SMA cable	-	-	Each time[1]	N/A

Note[1]: equipment 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

9.4 Test Environmental Conditions

Temperature:	23ºC
Relative Humidity:	42%
ATM Pressure:	102.7 kPa

The testing was performed by Libass Thiaw from 03-21-2024 to 04-02-2024 at RF Bench

9.5 Test Results

Lora 1

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	914	6.959	8
Middle	916	6.581	8
High	918	6.814	8

Lora 2

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	920	6.519	8
Middle	922	5.867	8
High	924	6.338	8

Note: Duty Cycle Correction Factor was already included in Conducted Output Power (dBm) measurements

Please refer to Annex C for detailed test results.

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

10.1 Applicable Standards

According to FCC §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c).

According to ISEDC RSS-247 §5.5.In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

10.2 Measurement Procedure

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation

RBW = 100 kHz
VBW = 300 kHz
Sweep = coupled
Detector function = peak
Trace = max hold

10.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Spectrum Analyzer	E4446A	MY48250238	05-15-2023	1 year
-	-	SMA cable	-	-	Each time[1]	N/A

Note[1]: 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

10.4 Test Environmental Conditions

Temperature:	21ºC
Relative Humidity:	39%
ATM Pressure:	102.0 kPa

The testing was performed by Libass Thiaw from 03-21-2024 to 04-02-2024 at RF Bench.

10.5 Test Results

Please refer to Annex D for detailed test results.

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

11.1 Applicable Standards

For FCC §15.247(d) and ISEDC RSS-247 §5.5, 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)).

11.2 Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

11.3 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
624	Agilent	Spectrum Analyzer	E4446A	MY48250238	05-15-2023	1 year
-	-	SMA cable	-	-	Each time[1]	N/A

Note[1]: 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 the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

11.4 Test Environmental Conditions

Temperature:	21ºC
Relative Humidity:	39%
ATM Pressure:	102.0 kPa

The testing was performed by Libass Thiaw from 03-21-2024 to 04-02-2024 at RF Bench.

11.5 Test Results

Please refer to Annex D for detailed test results.

12 Annex E (Normative) - Test Setup Photographs

Please refer to the attachment

13 Annex F (Normative) - EUT External Photographs

Please refer to the attachment

14 Annex G (Normative) - EUT Internal Photographs

Please refer to the attachment

15 Annex H (Normative) - 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 17025:2017 *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 21st day of December 2022.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2024

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

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