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

TEST REPORT

For

Zebra Technologies Corporation

3 Overlook Point
Lincolnshire, IL 60069, USA

FCC ID: I28-WYSBHVDXP
IC: 3798B-WYSBHVDXP

Report Type: Class II Permissive Change		**Product Type:** WLAN/BT Module
Prepared By:	Xavier Kelley RF Test Engineer	
Report Number:	R2403263-247	
Report Date:	2024-05-17	
Reviewed By:	Christian McCaig RF Lead Engineer	
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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2403263-247	Class II Permissive Change	2024-05-17

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test report was prepared on behalf of Zebra Technologies Corporation, and their product model: WYSBHVDXP, FCC ID: I28-WYSBHVDXP, IC: 3798B-WYSBHVDXP or the "EUT" as referred to in this report. The EUT is WLAN/BT module. The EUT was installed in host device model number: ZT421. Modules can also be installed in similar model ZT411

1.2 Mechanical Description of the EUT

The EUT Host device (ZT421) dimension measured approximately 495 mm (L) x 269 mm (W) x 324 mm (H) and weights approximately 16.33 kg.

The radio module (model: WYSBHVDXP) dimension measured approximately 16 mm (L) x 14 mm (W).

The data gathered was from a production sample provided by Zebra Technologies Corporation with S/N: 99N231400819

1.3 Objective

This report was prepared on behalf of Zebra Technologies Corporation 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.

This project is a Permissive Change II submission for the purpose of enabling colocation of the WiFi/BT module (FCC ID: I28-WYSBHVDXP**,** IC: 3798B-WYSBHVDXP) with RFID module (FCC ID: I28-RFIDM6EMTT, IC: 3798B-RFIDM6EMTT).

1.4 Related Submittal(s)/Grant(s)

FCC Part 15.407, RSS-247, Equipment Class: NII with FCC ID: I28- WYSBHVDXP and IC: 3798B-WYSBHVDXP.

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 and FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

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	±0.86 dB
Power Spectral Density, conducted	±0.86 dB
Unwanted Emissions, conducted	±2.76 dB
All emissions, radiated	±4.94 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ºC
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 according to ANSI C63.10-2013 and FCC KDB 558074 D01 DTS Meas Guidance v05r02.

2.2 EUT Exercise Software

The test software used was "Toolbox – version 1.84.21488 CI" provided by Zebra Technologies Corporation, The software is compliant with the standard requirements being tested against.

Radio	Mode	Channel	Frequency (MHz)	Power Setting
RFID	-	-	902.75	Default
2.4 GHz WiFi	802.11b	6	2437	17
BT	GFSK	0	2402	Default

Data rates used:
802.11b: 1 Mbps

2.3 Equipment Modifications

No modifications were made to the EUT during testing.

2.4 Local Support Equipment

Manufacturer	Description	Model	Serial Number
Dell	Laptop	Latitude E7440	GCP4P A03 DPC

2.5 Remote Support Equipment

None

2.6 Power Supply and Line Filters

None

2.7 Interface Ports and Cabling

Cable Description	Length (m)	From	To
USB-A to USB-B	< 1	EUT	Laptop
Power Cable	2	EUT	Power Outlet

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 §2.1091, §15.247(i) ISEDC RSS-102	RF Exposure	Compliant
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

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 isotopically 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

External/Internal/ Integral	Antenna Type	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
External	Omni-Directional	2400-2483.5	3dBi

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:

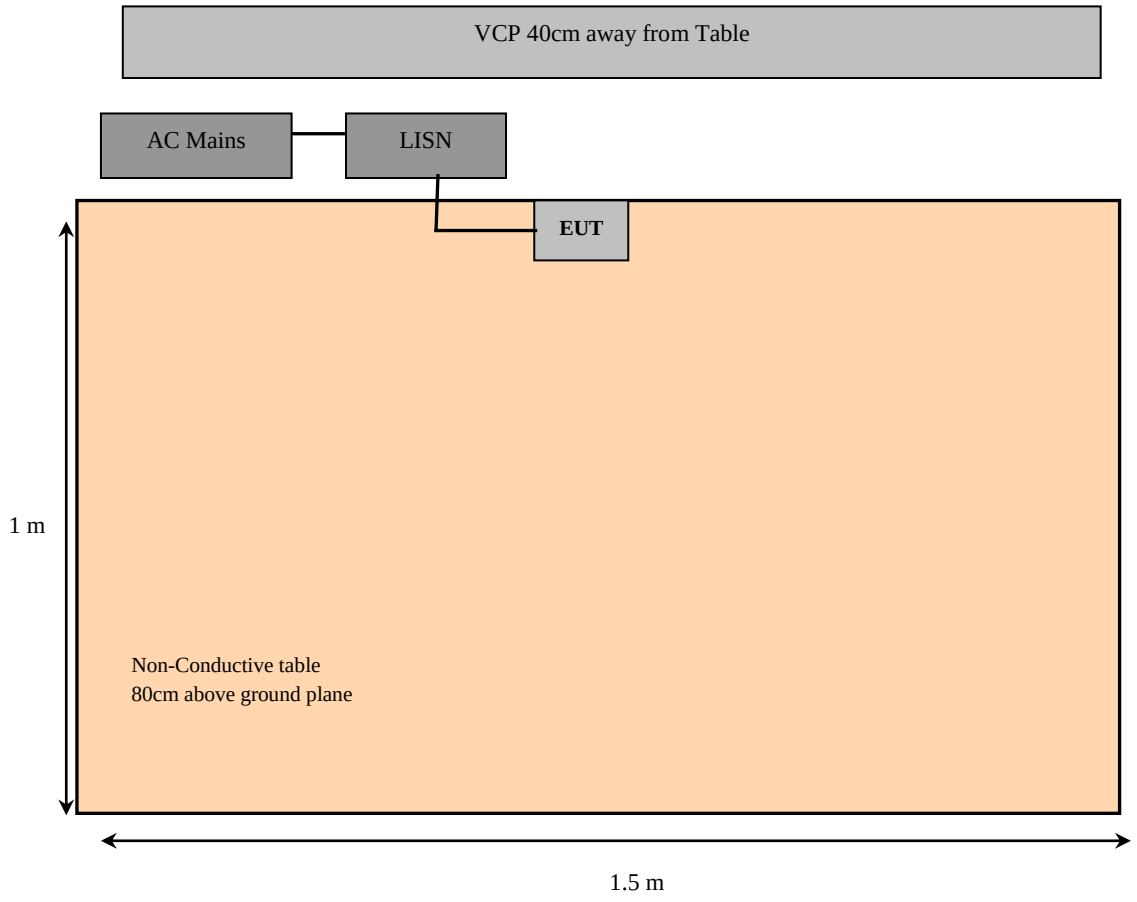
$$CA = Ai + CL + Atten$$

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
124	Rohde & Schwarz	Receiver, EMI Test	ESCI 1166.5950K03	100044	2023-06-16	1 year
681	Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101962	2024-03-22	6 months
725	Solar Electronics Company	High Pass Filter	Type 7930-100	7930150203	2024-01-03	6 months
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:	23.1 to 24.1 ℃
Relative Humidity:	54.0-56.1 %
ATM Pressure:	101.9 kPa

The testing was performed by Libass Thiaw from 2024-05-15 to 2024-05-16 in Ground Plane

5.8 Summary of Test Results

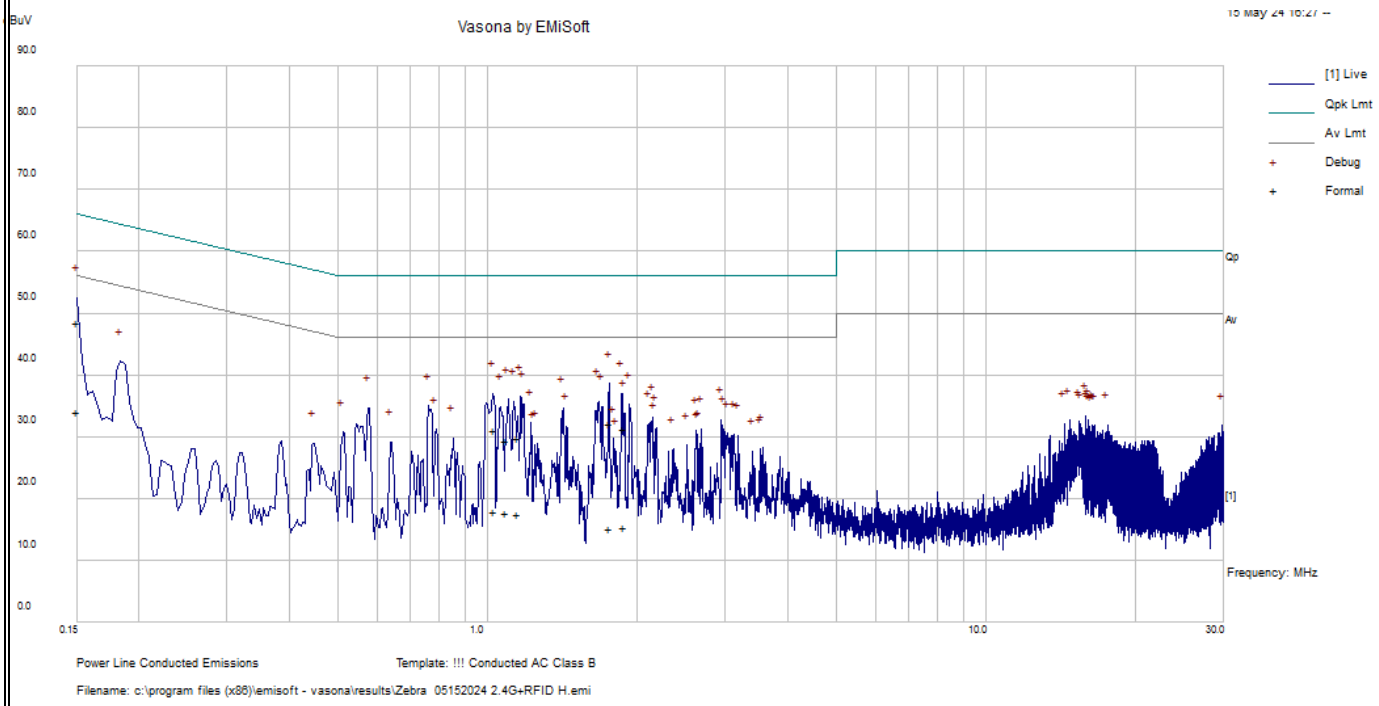
According to the recorded data in following table, the EUT complied with the FCC 15C and ISEDC RSS-Gen standard's conducted emissions limits, with the margin reading of:

Worst Case – AC Line: 120V, 60Hz			
Margin (dB)	**Frequency (MHz)**	**Conductor Mode (Hot/Neutral)**	**Range (MHz)**
-7.29	**0.193279**	Neutral	0.15 to 30

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

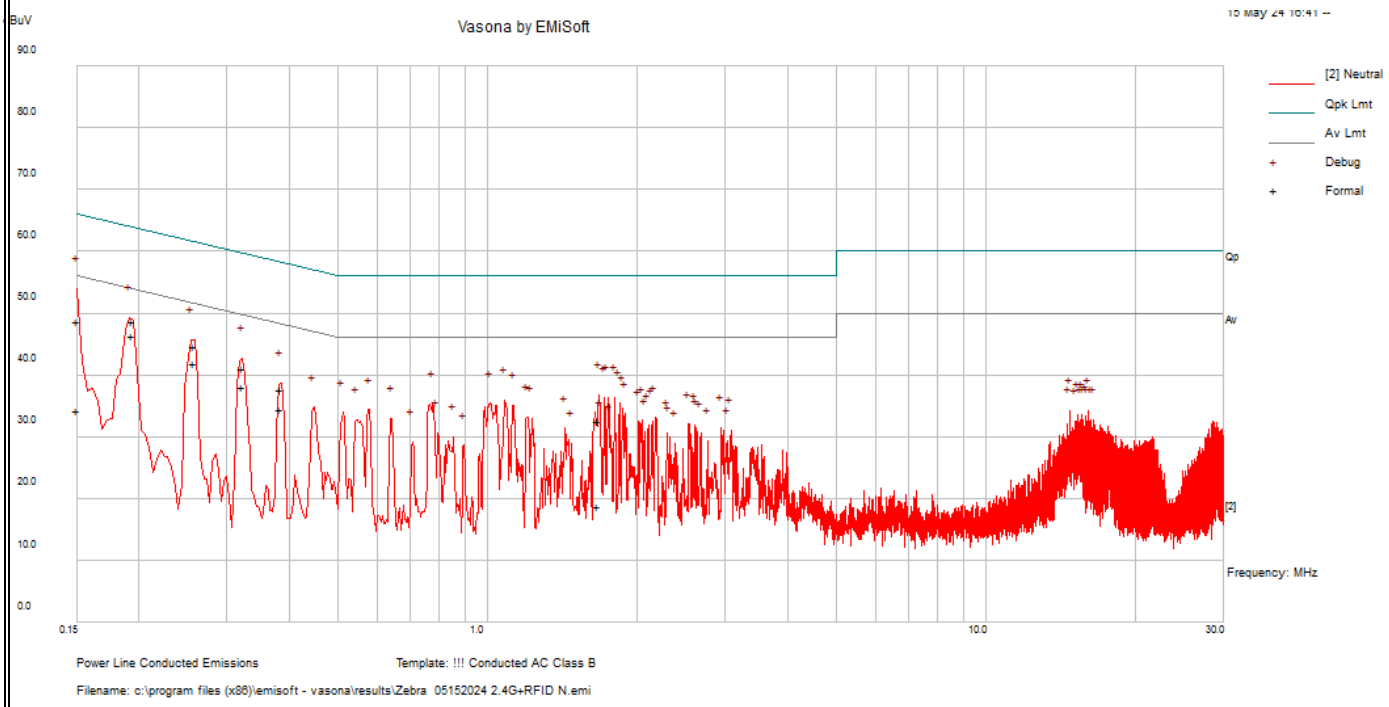
5.9 Conducted Emissions Test Plots and Data]

AC Line: RFID+2.4GHz Wi-Fi: 120V, 60Hz – Hot Conductor



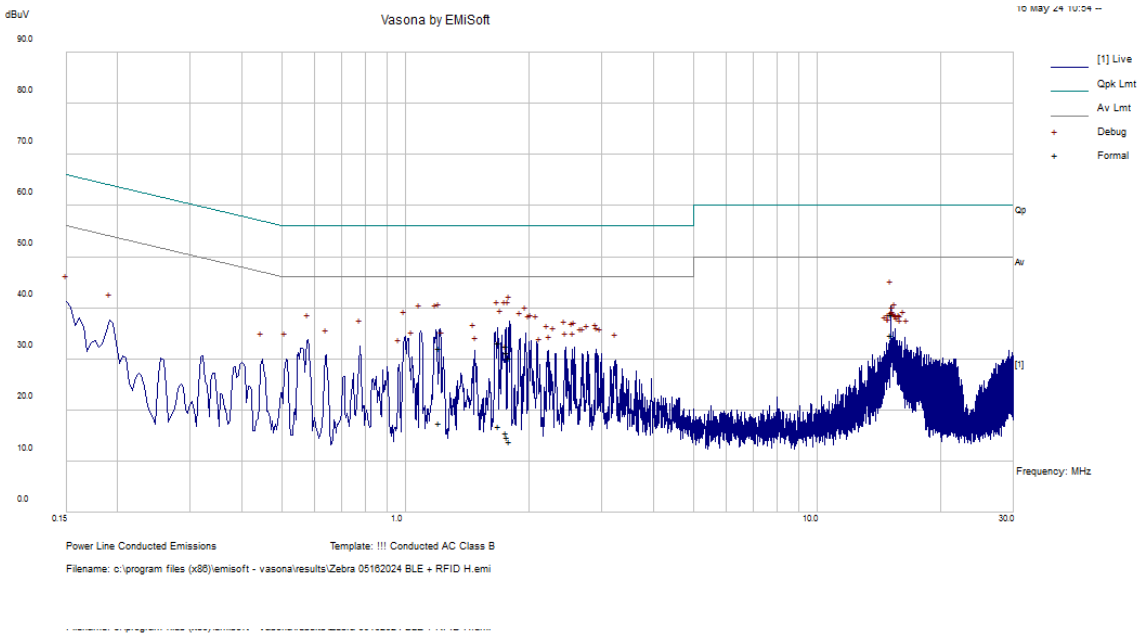
Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.150236	36.46	11.93	48.39	65.99	-17.6	QP
1.760395	21.99	10.14	32.13	56	-23.87	QP
1.878923	21.19	10.14	31.33	56	-24.67	QP
1.031763	20.91	10.21	31.12	56	-24.88	QP
1.153952	19.49	10.19	29.68	56	-26.32	QP
1.088315	19.26	10.2	29.46	56	-26.54	QP
0.150236	22.07	11.93	34	55.99	-21.99	Ave
1.760395	4.89	10.14	15.03	46	-30.97	Ave
1.878923	5.17	10.14	15.31	46	-30.69	Ave
1.031763	7.73	10.21	17.94	46	-28.06	Ave
1.153952	7.25	10.19	17.44	46	-28.56	Ave
1.088315	7.47	10.2	17.67	46	-28.33	Ave

AC Line: RFID+2.4GHz Wi-Fi:: 120V, 60Hz – Neutral Conductor



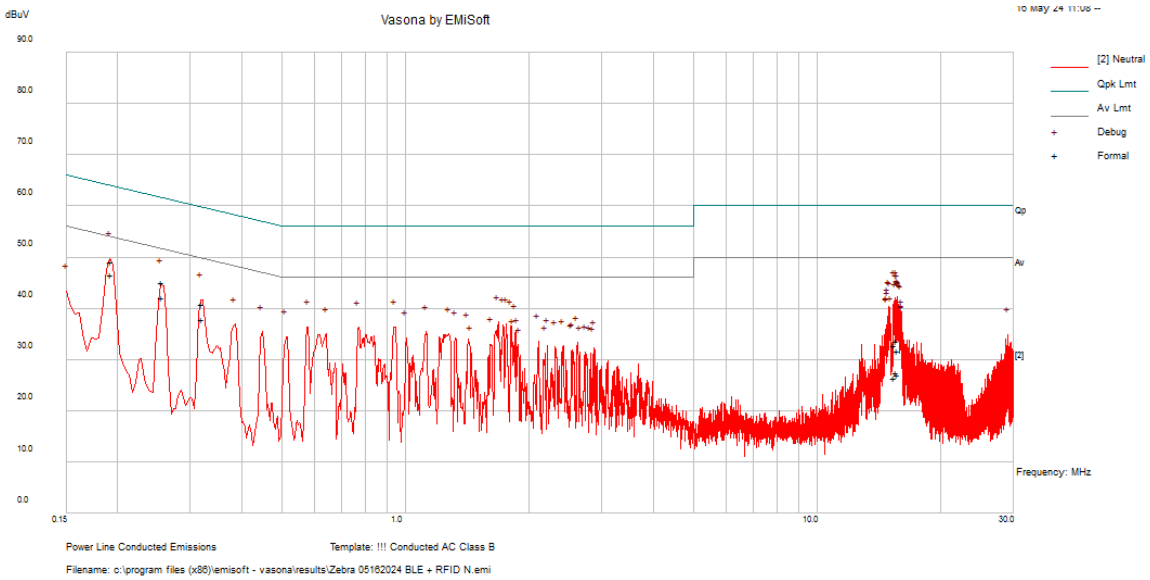
Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.150237	36.86	11.93	48.79	65.99	-17.2	QP
0.193639	37	11.76	48.76	63.88	-15.12	QP
0.257668	33.55	11.22	44.77	61.51	-16.74	QP
0.321577	30.26	10.73	40.99	59.67	-18.68	QP
1.671282	22.41	10.15	32.56	56	-23.44	QP
0.384113	27.11	10.5	37.61	58.19	-20.58	QP
0.150237	22.3	11.93	34.23	55.99	-21.76	Ave
0.193639	34.59	11.76	46.35	53.88	-7.53	Ave
0.257668	30.72	11.22	41.94	51.51	-9.57	Ave
0.321577	27.3	10.73	38.03	49.67	-11.64	Ave
1.671282	8.58	10.15	18.73	46	-27.27	Ave
0.384113	23.87	10.5	34.37	48.19	-13.82	Ave

AC Line: RFID+BT: 120V, 60Hz – Hot Conductor



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
1.78853	20.02	10.14	30.16	56	-25.84	QP
15.09623	28.41	10.28	38.69	60	-21.31	QP
1.767986	21.18	10.14	31.32	56	-24.68	QP
1.761616	22.5	10.14	32.64	56	-23.36	QP
1.68315	22.98	10.15	33.13	56	-22.87	QP
1.207892	22.03	10.18	32.21	56	-23.79	QP
1.78853	3.79	10.14	13.93	46	-32.07	Ave
15.09623	24.38	10.28	34.66	50	-15.34	Ave
1.767986	4.59	10.14	14.73	46	-31.27	Ave
1.761616	5.42	10.14	15.56	46	-30.44	Ave
1.68315	6.64	10.15	16.79	46	-29.21	Ave
1.207892	7.24	10.18	17.42	46	-28.58	Ave

AC Line: RFID+BT: 120V, 60Hz – Neutral Conductor



Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.193279	37.3	11.76	49.06	63.89	-14.83	QP
0.256426	33.76	11.23	44.99	61.55	-16.56	QP
15.61916	23.33	10.31	33.64	60	-26.36	QP
15.41628	22.4	10.29	32.69	60	-27.31	QP
0.32033	30.16	10.74	40.9	59.7	-18.8	QP
15.66721	21.31	10.31	31.62	60	-28.38	QP
0.193279	**34.84**	**11.76**	**46.6**	**53.89**	**-7.29**	**Ave**
0.256426	30.82	11.23	42.05	51.55	-9.5	Ave
15.61916	17.23	10.31	27.54	50	-22.46	Ave
15.41628	16.06	10.29	26.35	50	-23.65	Ave
0.32033	27.06	10.74	37.8	49.7	-11.9	Ave
15.66721	16.73	10.31	27.04	50	-22.96	Ave

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

6.1 Applicable Standards

According to FCC §15.247(i) and §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 MHzFootnote6 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 1.31×10^{-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.

6.2 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

6.3 RF Exposure Evaluation Exemption for FCC

Worst Case Co-location MPE Calculation:

Radio	Max EIRP (dBm)	Evaluated Distance (cm)	Worst-Case Exposure Level	Limit	Worst-Case Ratios	Sum of Ratios	Limit
Worst Case							
BT	15	20	0.006mW/cm^2	1.0 mW/cm^2	0.6%	4.59%	100%
2.4GHz Wi-Fi	20	20	0.0199 mW/cm^2	1.0 mW/cm^2	1.99%		
5GHZWi-Fi	20	20	0.0199 mW/cm^2	1.0 mW/cm^2	1.99%		
RFID*	-7.89	20	0.0000321 mW/cm^2	0.6 mW/cm^2	0.0054%		

6.4 RF Exposure Evaluation Exemption for IC

BT

Maximum EIRP power = 12 dBm + 3 dBi = 15 dBm which is lesser than $1.31\times10^{-2}f^{0.6834}$ = 2.68 W = 34.28 dBm.

2.4GHz WiFi

Maximum EIRP power = 17 dBm + 3 dBi = 20 dBm which is lesser than $1.31\times10^{-2}f^{0.6834}$ = 2.68 W = 34.28 dBm.

5GHz WiFi

Maximum EIRP power = 15 dBm + 5 dBi = 20 dBm which is lesser than $1.31\times10^{-2}f^{0.6834}$ = 4.52 W = 36.55 dBm.

RFID

Maximum EIRP power = 28.11 dBm + [-36 dBi] = -7.89 dBm which is lesser than $1.31\times10^{-2}f^{0.6834}$ = 1.38 W = 31.39 dBm.

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

7.1 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 license-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.

7.2 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.

7.3 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

7.4 Corrected Amplitude & Margin Calculation

For emissions below 1 GHz,

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 Correction Factor is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) together. This calculation is done in the measurement software, and reported in the test result section. The basic equation is as follows:

Correction Factor = AF + CL + Atten – Ga

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

For emission above 1 GHz,

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

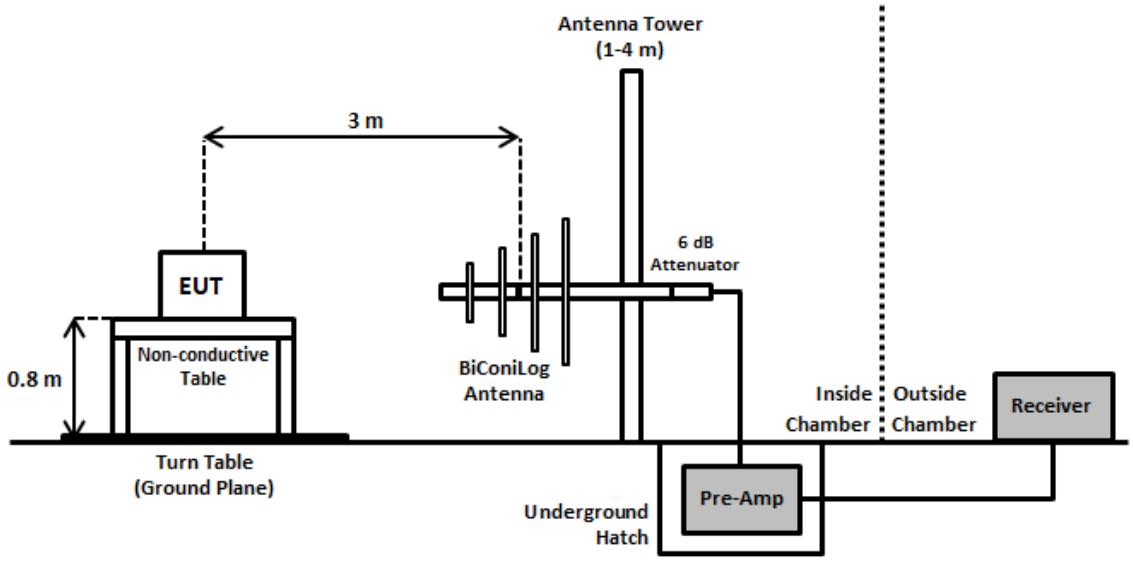
For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

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:

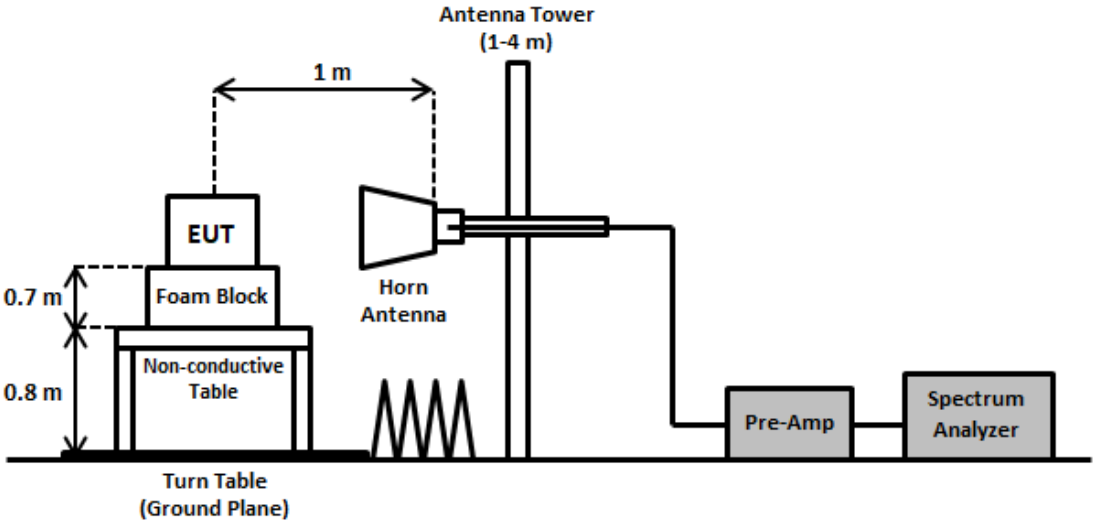
Margin = Corrected Amplitude – Limit

7.5 Test Setup Block Diagram

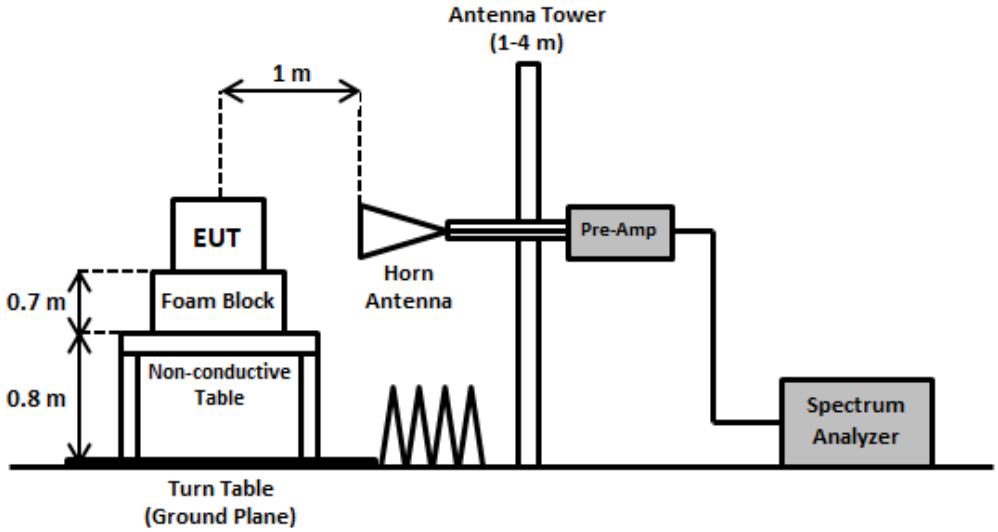
30 MHz to 1000 MHz



1 GHz to 18 GHz



18 GHz – 26.5 GHz



7.6 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Interval
624	Agilent	Spectrum Analyzer	E4446A	MY48250238	2023-05-12*	1 year
124	Rhode & Schwarz	EMI Test Receiver	ESCI	100044	2023-06-16	1 year
327	Sunol Sciences	System Controller	SC110V	122303-1	N/R	N/R
1075	Sunol Sciences	Boresight Tower	TLT3	050119-7	N/R	N/R
1388	Sunol Sciences	Flush Mount Turntable	FM	112005-2	N/R	N/R
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	N/A	2024-04-09	6 months
1245	-	6dB Attenuator	PE7390-6	01182018A	2023-12-18	2 years
1246	Hewlet Packard	RF Limiter	11867A	01734	2024-04-09	1 year
1248	Pasternack	RG214 COAX Cable	PE3062	N/A	2024-04-04	6 months
1249	Time Microwave	LMR-400 Cable Dc-3 GHz	AE13684	2k80612-5 6fts	2024-04-09	6 months
658	HP/ Agilant	Pre Amplifier	8449B OPT HO2	3008A01103	2023-12-01	6 months
1192	ETS Lindgren	Horn Antenna	3117	00218973	2022-09-29	2 years
1247	Uti flex	Micro - Coax	N/A	N/A	2023-12-01	6 months
1295	Carlisle	10m Ultra Low Loss Coaxial Cable	UFB142A-1-3937-200200	64639890912-001	2023-10-31*	6 months
672	Micro -Tronics	2.4-2.6 GHz Notch Filter	BRM50701	160	2024-03-06	1 year
827	AH Systems	Preamplifier	PAM 1840 VH	170	2023-11-08*	6 months
91	Wisewave	Antenna, Horn	ARH-4223-02	10555-02	2024-03-14	2 years
1334	Micro-Tronics	2400-2500 MHz Notch Filter	BRM50702	G361	2024-01-05	1 year

Note: cable and notch filters included in the test set-up will be checked each time before testing.
*Note: This equipment was only used for testing interval 1.

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".*

7.7 Test Environmental Conditions

Temperature:	23.1 to 24.1 ℃
Relative Humidity:	54.0-56.1 %
ATM Pressure:	101.9 kPa

Testing Interval 1: The testing was performed by Xavier Kelley on 2024-04-23 to 2024-04-25

Testing Interval 2: Additional testing from 30 MHz to 1 GHz was performed by Xavier Kelley on 2024-05-15

7.8 Summary of Test Results

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

Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, Channel**
-5.43	245.7993	Horizontal	BT + RFID

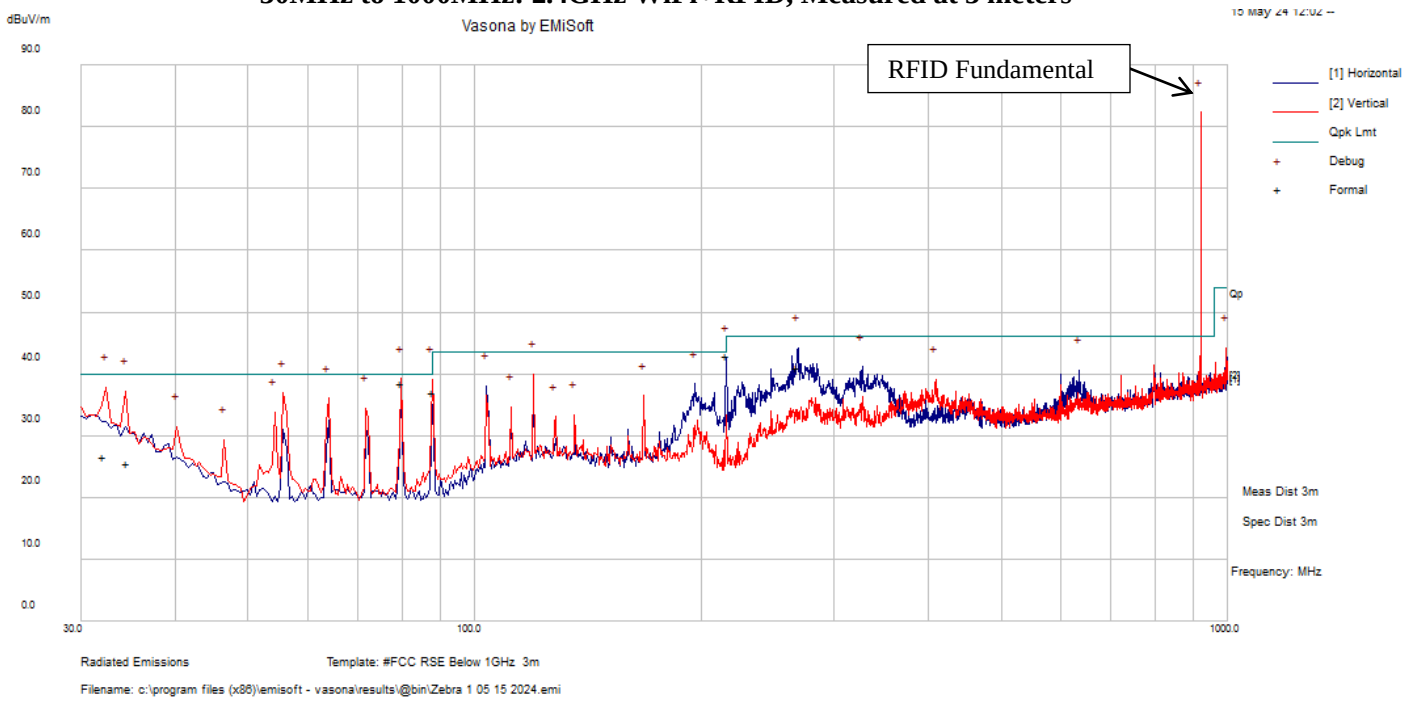
Mode: Transmitting			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Mode, Channel**
-1.48	80.01025	Vertical	2.4GHz Wi-Fi (802.11b, Channel 6) + RFID

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

7.9 Radiated Emissions Test Results

Note 1: The worst case mode for 2.4GHz WiFi was determined to be 802.11b, Channel 6, 2437 MHz
Note 2: The worst case mode for BT was determined to be GFSK, Channel 0, 2402 MHz

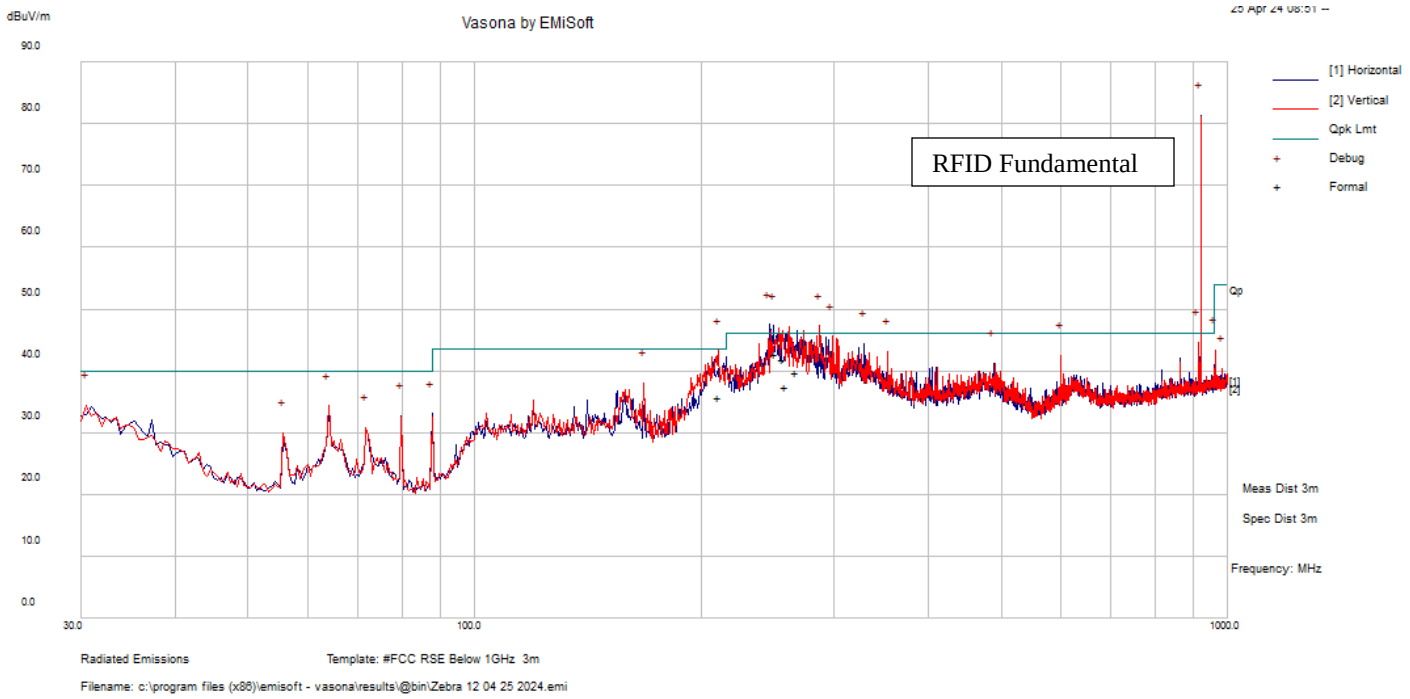
30MHz to 1000MHz: 2.4GHz WiFi+RFID, Measured at 3 meters



Formally Assessed Peaks

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comments (Peak/QP/ Average)
80.01025	52.44	-13.91	38.52	V	281	166	40	-1.48	QP
216.0035	52.75	-9.85	42.9	H	122	89	46	-3.1	QP
87.96125	50.53	-13.56	36.97	V	122	218	40	-3.03	QP
268.4018	48.2	-7.24	40.96	H	126	101	46	-5.04	QP
32.179	29.14	-2.61	26.53	V	265	352	40	-13.47	QP
34.5045	29.7	-4.06	25.64	V	135	332	40	-14.36	QP

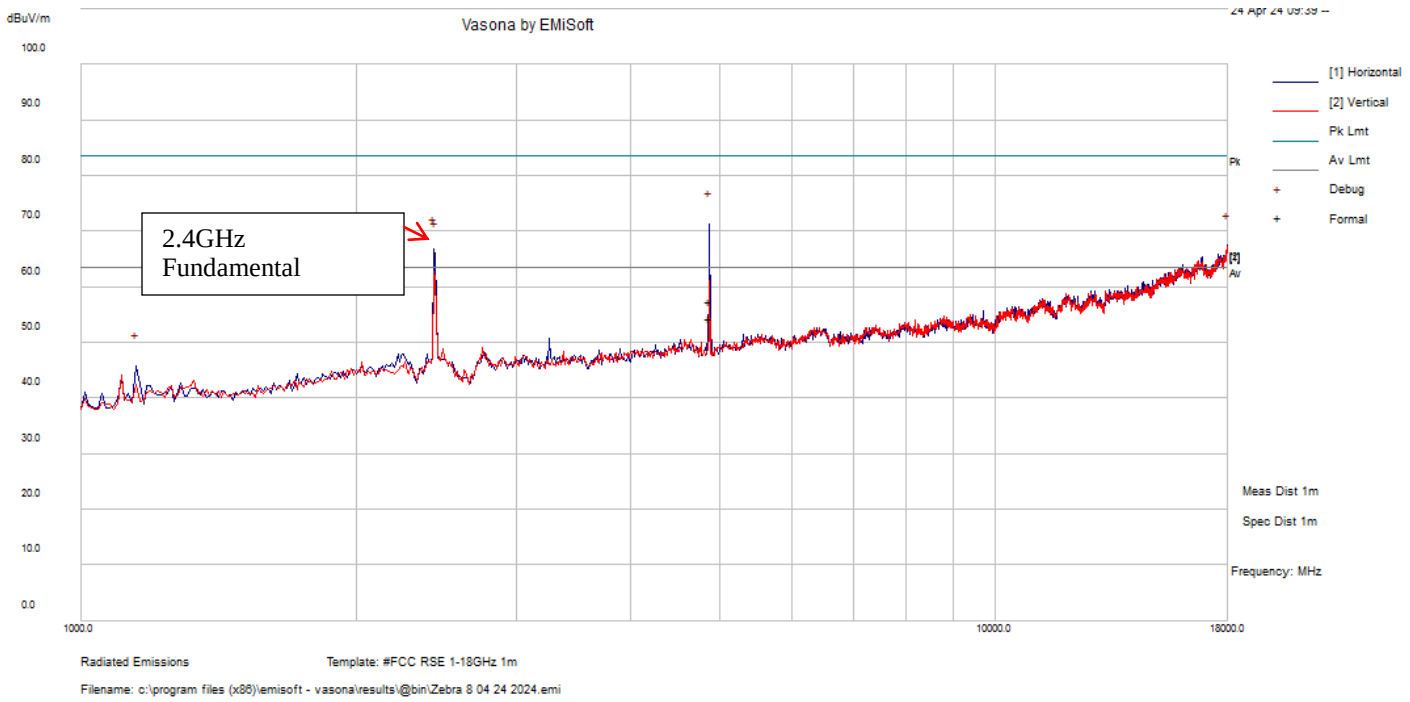
30MHz to 1000MHz: BT+RFID, Measured at 3 meters



Formally Assessed Peaks

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comments (Peak/QP/ Average)
245.7993	49.21	-8.64	40.57	H	130	278	46	-5.43	QP
249.9135	47.59	-8.63	38.95	H	122	245	46	-7.05	QP
286.856	37.31	-6.69	30.62	V	130	7	46	-15.38	QP
210.905	46.21	-9.99	36.22	V	120	280	43.5	-7.28	QP
298.205	45.11	-6.55	38.56	V	122	250	46	-7.44	QP
297.1	44.09	-6.55	37.54	V	125	250	46	-8.46	QP

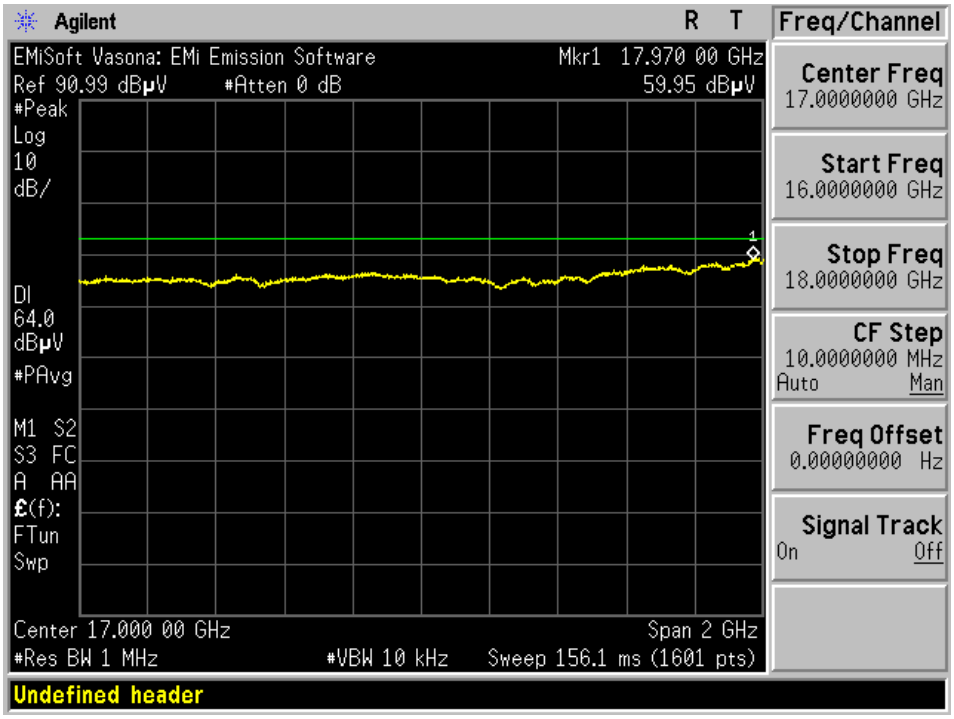
1GHz to 18GHz: 2.4GHz WiFi+RFID, Measured at 1 meter



Formally Assessed Peaks

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comments (Peak/QP/ Average)
4877.243	54.25	3.07	57.32	H	166	24	83.54	-26.22	Peak
4877.243	51.31	3.07	54.38	H	166	24	63.54	-9.16	Average

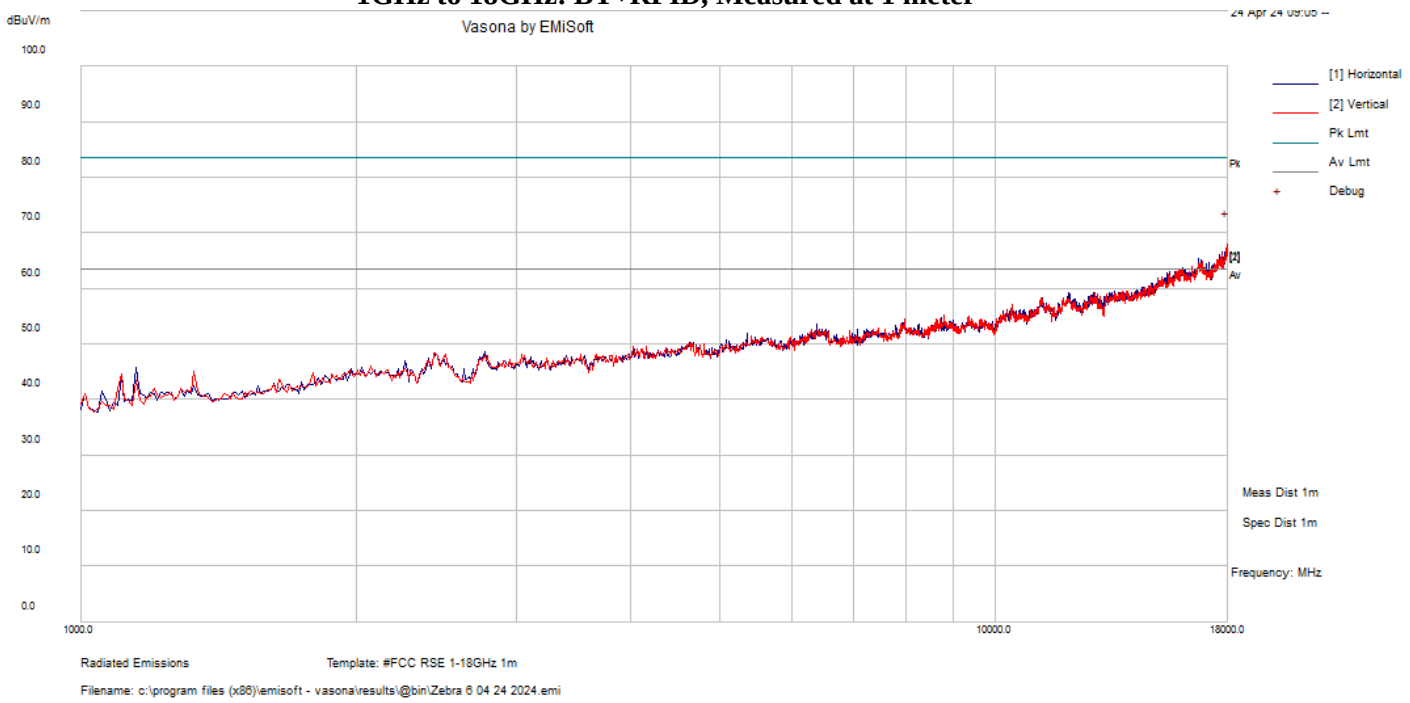
Note: above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz



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

Note: above plot is performed using a maxhold while rotating across all orienations including Horizontal and Vertical of the measurement antenna

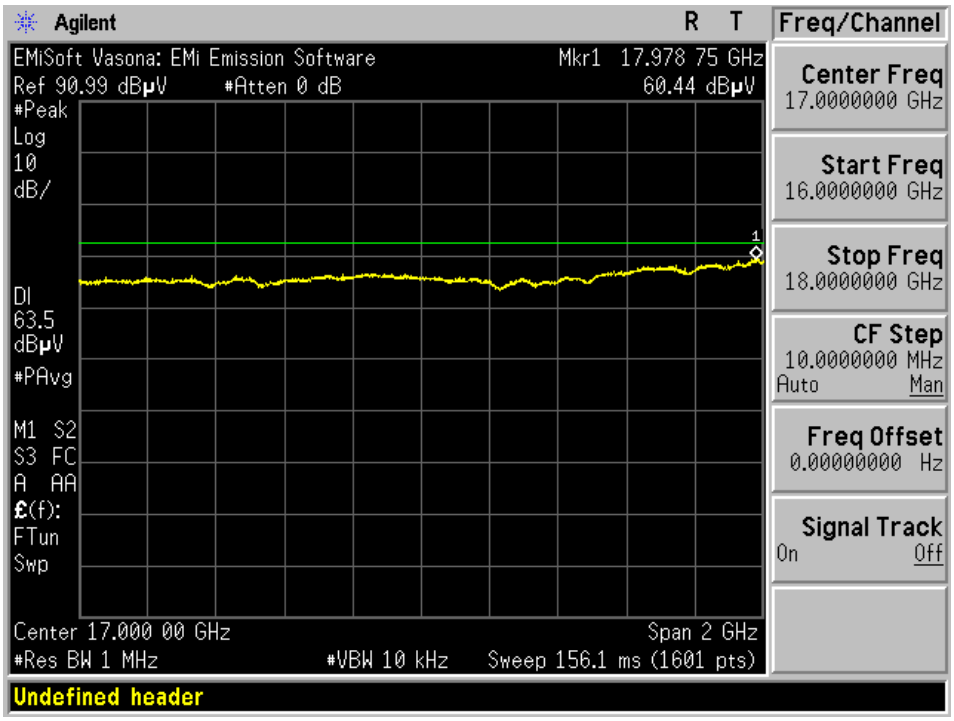
1GHz to 18GHz: BT+RFID, Measured at 1 meter



Debug Measurements

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comments (Peak/QP/ Average)
1061.043	51.25	-10.85	40.4	V	100	7	63.54	-23.14	Peak
1111.265	52	-9.89	42.11	V	100	7	63.54	-21.43	Peak
1157.154	51.74	-9.77	41.96	V	100	7	63.54	-21.58	Peak
1337.072	49.27	-8	41.27	V	100	7	63.54	-22.27	Peak

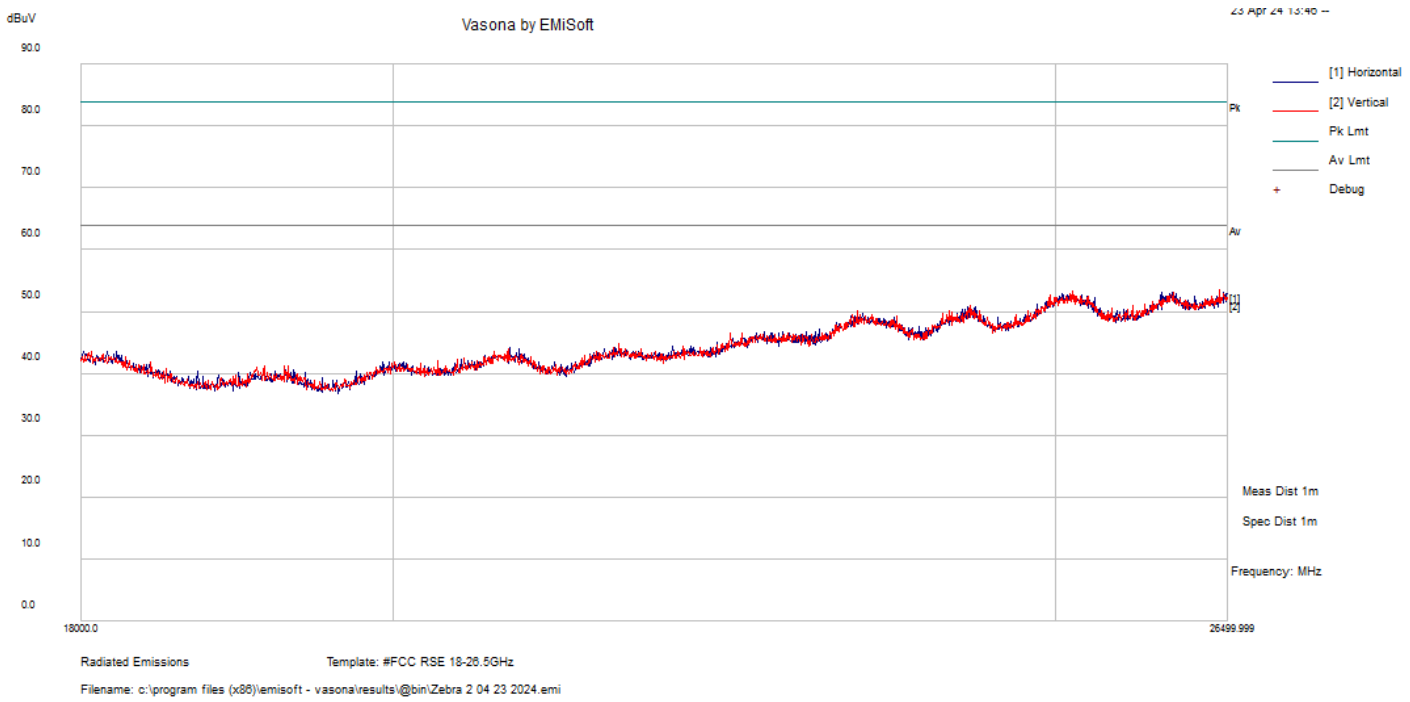
Note: above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz



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

Note: above plot is performed using a maxhold while rotating across all orienations including Horizontal and Vertical of the measurement antenna

18GHz to 26.5GHz: 2.4GHz WiFi+RFID, Measured at 1 meter

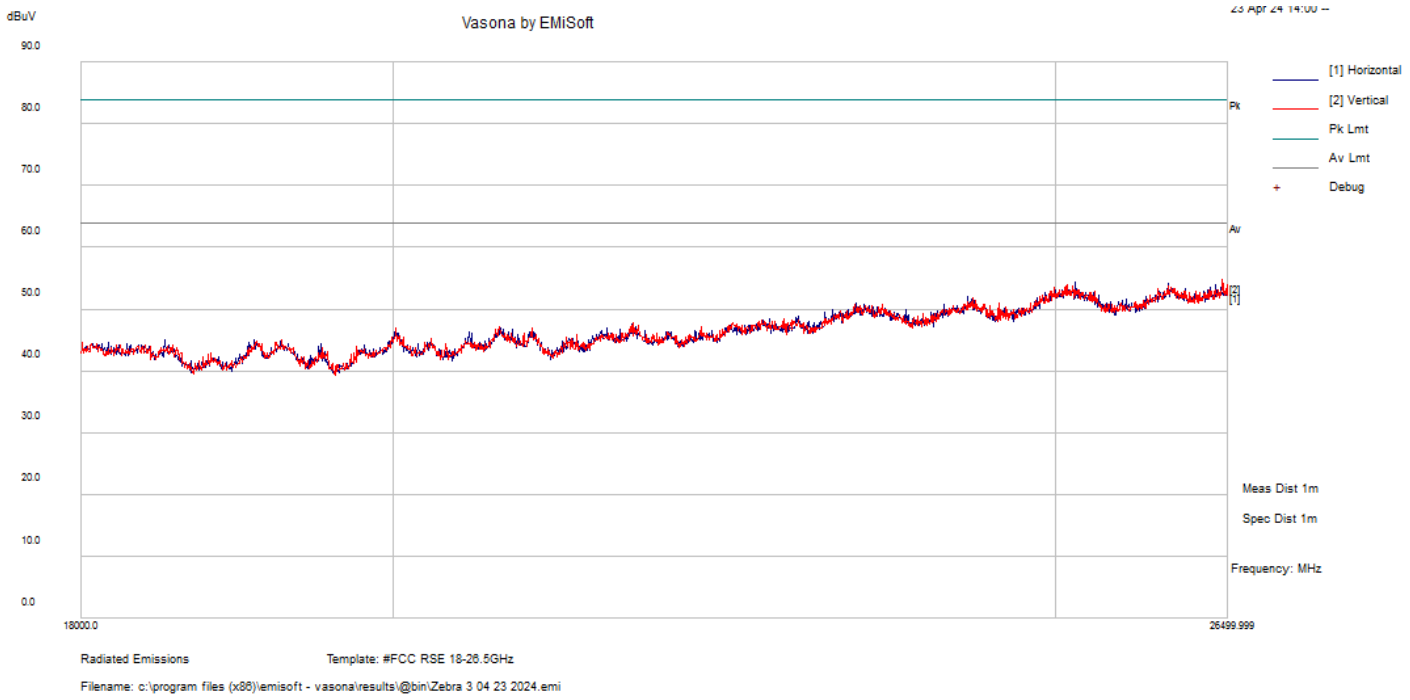


Debug Measurements

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comments (Peak/QP/ Average)
18673.68	28.26	9.52	37.67	V	100	7	63.54	-25.87	Peak
20016.18	31	9.8	40.8	V	100	7	63.54	-22.74	Peak
21596.73	32.17	11.44	43.61	V	100	7	63.54	-19.93	Peak
23091.25	32.67	13.86	46.47	V	100	7	63.54	-17.07	Peak
25025.68	35.09	16.29	51.39	V	100	7	63.54	-12.15	Peak
26423.24	33.93	17.74	51.67	V	100	7	63.54	-11.87	Peak

Note: above plot shows all peak emissions pass under average limits

18GHz to 26.5GHz: BT+RFID Measured at 1 meter



Debug Measurements

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Antenna Polarity (H/V)	Antenna Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comments (Peak/QP/ Average)
18319.57	32.74	10.44	43.19	V	100	7	63.54	-20.35	Peak
18771.44	31.61	9.09	40.7	V	100	7	63.54	-22.84	Peak
20202.85	33.68	9.35	43.03	V	100	7	63.54	-20.51	Peak
21693	34.36	11.8	46.16	V	100	7	63.54	-17.38	Peak
23378.82	36.19	14.02	50.2	V	100	7	63.54	-13.34	Peak
26214.56	34.49	14.21	52.22	V	100	7	63.54	-11.32	Peak

Note: above plot shows all peak emissions pass under average limits

8 Annex A (Normative) – Test Setup Photographs

Please refer to the attachment.

9 Annex B (Normative) – EUT Host External Photographs

Please refer to the attachment.

10 Annex C (Normative) – EUT Internal Photographs

Please refer to the attachment.

11 Annex D (Normative) – A2LA Electrical Testing Certificate

Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIACE 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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