



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

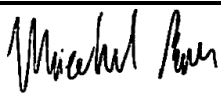

## TEST REPORT

For

**Roku, Inc.**

1173 Coleman Avenue,  
San Jose, CA 95110, USA

**FCC ID: TC2-R1051**  
**IC: 5959A-R1049**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Remote Controller
<b>Prepared By:</b> Michael Papa RF Test Engineer	
<b>Report Number:</b> R2310133-247	
<b>Report Date:</b> 2024-02-15	
<b>Reviewed By:</b> Christian McCaig RF Lead Engineer	
Bay Area Compliance Laboratories Corp. 1274 Anvilwood Avenue, Sunnyvale, CA 94089, USA Tel: (408) 732-9162 Fax: (408) 732-9164	



Note: This test report was prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. This test report shall not be used by the customer to claim product certification, approval, or endorsement by A2LA or any agency of the United States Government or any foreign government.

\* This test report may contain data and test methods that are not covered by BACL's scope of accreditation as of the test report date shown above. These items are marked within the test report text with an asterisk "\*"

## TABLE OF CONTENTS

<b>1 General Description.....</b>	<b>5</b>
1.1 Product Description for Equipment Under Test (EUT) .....	5
1.2 Objective.....	5
1.3 Mechanical Description of EUT .....	5
1.4 Related Submittal(s)/Grant(s) .....	5
1.5 Test Methodology .....	6
1.6 Measurement Uncertainty .....	6
1.7 Test Facility Registrations .....	6
1.8 Test Facility Accreditations .....	6
<b>2 System Test Configuration.....</b>	<b>9</b>
2.1 Justification.....	9
2.2 EUT Exercise Software.....	9
2.3 Duty Cycle Correction Factor .....	10
2.4 Equipment Modification .....	13
2.5 Local Support Equipment .....	13
2.6 Remote Support Equipment.....	13
2.7 Interface Ports and Cabling.....	13
<b>3 Summary of Test Results .....</b>	<b>14</b>
<b>4 FCC §15.203 &amp; ISEDC RSS-Gen §6.8 - Antenna Requirements .....</b>	<b>15</b>
4.1 Applicable Standards .....	15
4.2 Antenna Description .....	15
<b>5 FCC §15.207 &amp; ISEDC RSS-Gen §8.8 - AC Line Conducted Emissions.....</b>	<b>16</b>
5.1 Applicable Standards .....	16
5.2 Test Setup .....	16
5.3 Test Procedure .....	16
5.4 Corrected Amplitude & Margin Calculation.....	17
5.5 Test Setup Block Diagram.....	17
5.6 Test Equipment List and Details.....	18
5.7 Test Environmental Conditions .....	18
5.8 Summary of Test Results .....	18
5.9 Conducted Emissions Test Plots and Data.....	19
<b>6 FCC §15.35(b), §15.205, §15.209, §15.247(d) &amp; ISEDC RSS-247 §5.5, RSS-Gen §8.9, §8.10- Spurious Radiated Emissions.....</b>	<b>21</b>
6.1 Applicable Standards .....	21
6.2 Test Setup .....	24
6.3 Test Procedure .....	24
6.4 Setup Diagrams.....	24
6.5 Corrected Amplitude and Margin Calculation.....	25
6.6 Test Equipment List and Details.....	27
6.7 Test Environmental Conditions .....	28
6.8 Summary of Test Results .....	28
6.9 Radiated Emissions Test Results .....	29
<b>7 FCC §15. 247(a) (2) &amp; ISEDC RSS-247 §5.2, RSS-Gen §6.7 - Emission Bandwidth.....</b>	<b>53</b>
7.1 Applicable Standards .....	53
7.2 Measurement Procedure.....	53
7.3 Test Setup Block Diagram .....	54
7.4 Test Equipment List and Details.....	54
7.5 Test Environmental Conditions .....	54
7.6 Test Results.....	55
<b>8 FCC §15.247(b)(3) &amp; ISEDC RSS-247 §5.4 - Maximum Output Power .....</b>	<b>56</b>
8.1 Applicable Standards .....	56
8.2 Measurement Procedure.....	56
8.3 Test Setup Block Diagram .....	57
8.4 Test Equipment List and Details.....	57

8.5	Test Environmental Conditions .....	57
8.6	Test Results.....	58
<b>9</b>	<b>FCC §15.247(d) &amp; ISED RSS-247 §5.5 - 100 kHz Spurious Emissions at Antenna Terminal .....</b>	<b>59</b>
9.1	Applicable Standards .....	59
9.2	Measurement Procedure.....	59
9.3	Test Setup Block Diagram .....	59
9.4	Test Equipment List and Details.....	60
9.5	Test Environmental Conditions .....	60
9.6	Test Results.....	60
<b>10</b>	<b>FCC §15.247(e) &amp; ISED RSS-247 §5.2(2) – Peak Power Spectral Density .....</b>	<b>61</b>
10.1	Applicable Standards .....	61
10.2	Measurement Procedure.....	61
10.3	Test Setup Block Diagram .....	62
10.4	Test Equipment List and Details.....	62
10.5	Test Environmental Conditions .....	63
10.6	Test Results.....	63
<b>11</b>	<b>Appendix A (Normative) – EUT Test Setup Photographs .....</b>	<b>67</b>
<b>12</b>	<b>Appendix B (Normative) – External Photographs.....</b>	<b>68</b>
<b>13</b>	<b>Appendix C (Normative) – Internal Photographs .....</b>	<b>69</b>
<b>14</b>	<b>Appendix D (Normative) - A2LA Electrical Testing Certificate .....</b>	<b>70</b>

**DOCUMENT REVISION HISTORY**

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2310133-247	Original Report	2024-02-15

## 1 General Description

### 1.1 Product Description for Equipment Under Test (EUT)

This test was prepared on behalf of *Roku, Inc.*, and their product model: RC-OS1, FCC ID: TC2-R1051, IC: 5959A-R1049, the “EUT” as referred to in this report. The EUT is a remote controller device.

<b>Model Number</b>	RC-OS1
<b>FCC ID</b>	TC2-R1051
<b>IC</b>	5959A-R1049
<b>Radio Description</b>	Remote Controller
<b>Operating Frequency</b>	2.4~2.48GHz
<b>Modes supported</b>	802.11b/g/n20
<b>Omnidirectional Antenna Gain</b>	2.3dBi

### 1.2 Objective

This report is prepared on behalf of *Roku, Inc.*, in accordance with Part 2, Subpart J, and Part 15, Subpart C of the Federal Communication Commission’s rules and ISED RSS-247 Issue 3, August 2023.

The objective was to determine compliance with FCC Part 15.247 and ISED RSS-247 for Antenna Requirement, RF Exposure, AC Line Conducted Emissions, Emission Bandwidth, Radiated & Conducted Spurious Emissions, 100 kHz Band Edges, Maximum Output Power, and Peak Power Spectrum Density

In order to determine compliance, the manufacturer or a contracted laboratory makes measurements and takes the necessary steps to ensure that the equipment complies with the appropriate technical standards.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product maybe which result in lowering the immunity should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing and/or I/O cable changes, etc.).

### 1.3 Mechanical Description of EUT

**Dimensions:** 140 mm (Length) 45 mm (Width) 15 mm (Height).

**Serial Number:** 20EFBDF4F50

**EUT Photos:** See Attachments Appendix B and Appendix C.

### 1.4 Related Submittal(s)/Grant(s)

FCC Part 15, Subpart E, Equipment Class: NII with FCC ID: TC2-R1051, IC: 5959A-R1049

## 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	±0.57 dB
Power Spectral Density, conducted	±1.48dB
Unwanted Emissions, conducted	±1.57dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 ° C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %
Duty Cycle	±3 %

## 1.7 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, 3<sup>rd</sup>-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 17025:2005 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report..

BACL's ISO/IEC 17025:2005 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment [including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

**B- A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 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 - ISED) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - o BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - o NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - o EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
  - o Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - o Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - o ENERGY STAR Recognized Test Laboratory – US EPA
  - o Telecommunications Certification Body (TCB) – US FCC;
  - o Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I;



## 2 System Test Configuration

### 2.1 Justification

The EUT was configured for testing according to ANSI C63.10-2013 and FCC KDB 558074 D01 DTS Meas Guidance v05r02.

The EUT was tested in a testing mode to represent worst-case results during the final qualification test.

### 2.2 EUT Exercise Software

The test utility used was the “UI\_mptool”, provided by *Roku, Inc.*, the software is compliant with the standard requirements being tested against.

Radio	Channel	Frequency (MHz)	Modulation	Power Setting
2.4 GHz Wi-Fi	Low	2412	802.11b	115
	Middle	2437		116
	High	2462		116
	Low	2412	802.11g	96
	Middle	2417		100
	Middle	2437		117
	Middle	2457		102
	High	2462		99
	Low	2412	802.11n20	88
	Middle	2417		97
	Middle	2437		119
	Middle	2457		101
	High	2462		98

*Data Rates Tested:*

*802.11b mode: 1Mbps*

*802.11g mode: 6Mbps*

*802.11n HT20 mode: MCS0*

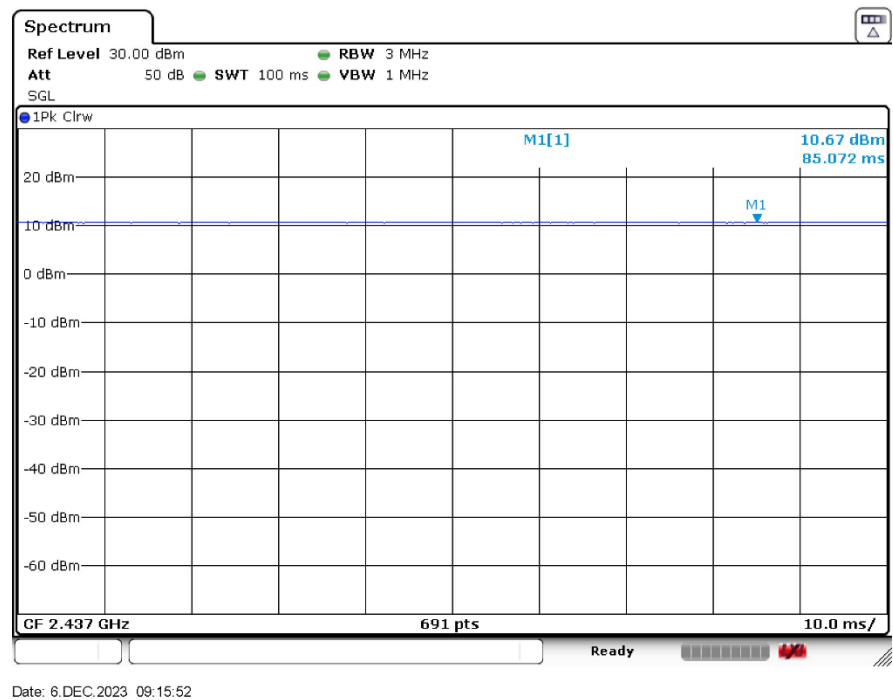
### 2.3 Duty Cycle Correction Factor

All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximum-power transmission duration, T, are required for each tested mode of operation.

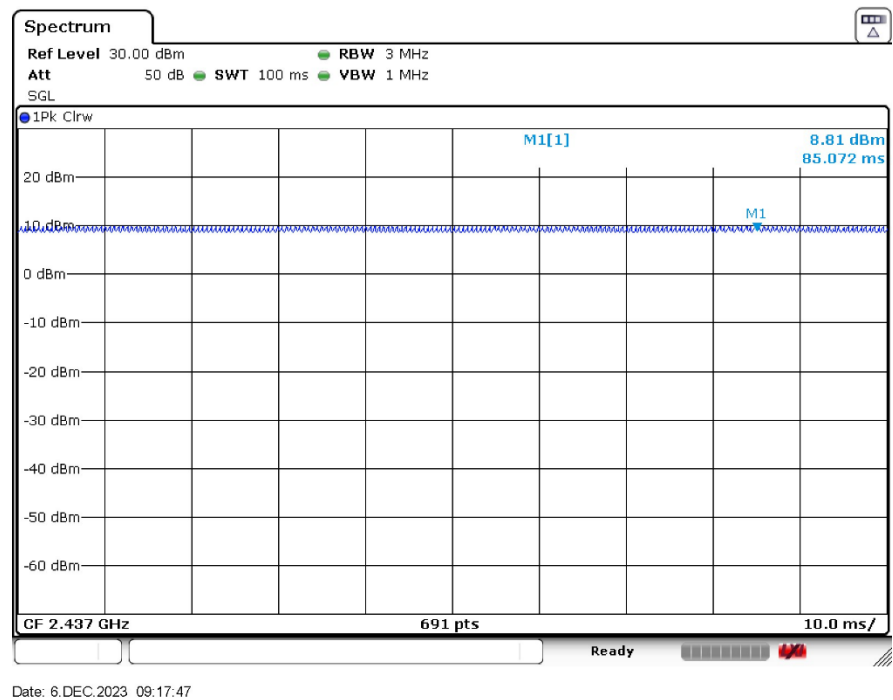
Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11b	-	-	100	0
802.11g	-	-	100	0
802.11n20	-	-	100	0

Note: Duty Cycle Correction Factor =  $10 \cdot \log(1/\text{duty cycle})$   
Please refer to the following plots.

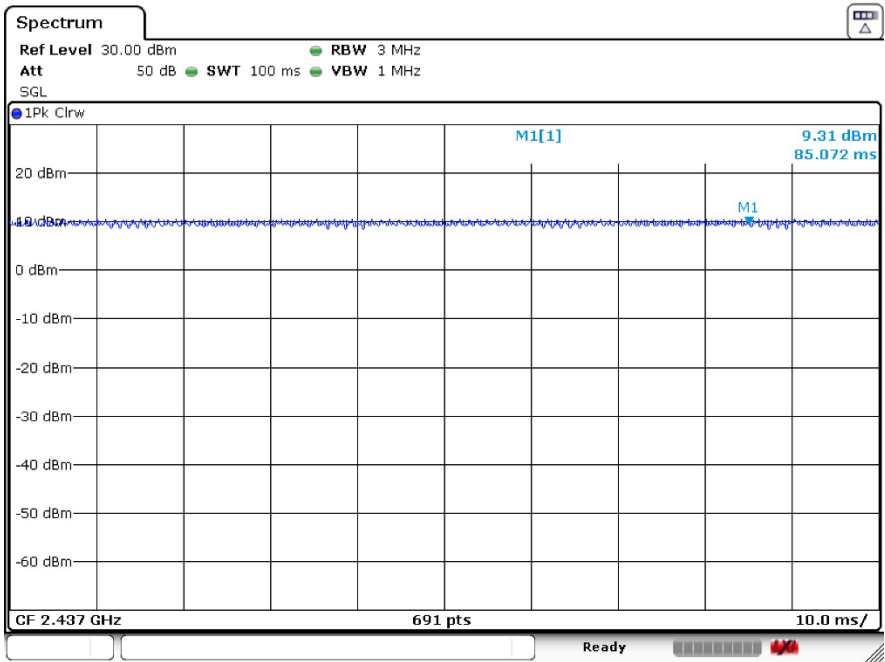
802.11b mode



802.11g mode



802.11n20 mode



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## 2.4 Equipment Modification

None.

## 2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude 5410

## 2.6 Remote Support Equipment

Manufacturer	Description	Model
Roku, Inc.	Remote Serial Dongle	2326000233
Roku, Inc.	AC/DC Adaptor	-

## 2.7 Interface Ports and Cabling

Cable Descriptions	Length (m)	From	To
USB	1.5	Laptop	Remote Serial Dongle
USB	1.5	Remote Serial Dongle	EUT
USB Power cable	1.5	EUT	AC/DC Adaptor

### 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) ISEDC RSS-102	RF Exposure	Compliant <sup>1</sup>
FCC §15.207 ISEDC RSS-Gen §8.8	AC Line Conducted Emissions	Compliant
FCC §2.1053, §15.35(b), §15.205, §15.209, §15.247(d) ISEDC RSS-247 §5.5 ISEDC 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	Maximum Output Power	Compliant
FCC §15.247(d) ISEDC RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(e) ISEDC RSS-247 §5.2(2)	Peak Power Spectral Density	Compliant
FCC §2.1051, §15.247 (d) ISEDC RSS-247 §5.5	Spurious Emissions at Antenna Port	Compliant

Note<sup>1</sup>: Please refer to Report Number *R2310133-SAR* and issued by Bay Area Compliance Labs for results.

*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	Part Number	Antenna Type	Frequency Range (MHz)	Maximum Antenna Gain (dBi)
Integral	ANT162442DT- 2001A2	Trace	2.4~2.48GHz	2.3dBi

## 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 §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  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 <sup>Note1</sup>	56 to 46 <sup>Note2</sup>
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 ISED 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 (via AC/DC Adapter) 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 Correction Factor (CF) to indicated Amplitude (Ai) reading. The basic equation is as follows:

$$CA = A_i + CF$$

For example, a corrected amplitude of 46.2 dBuV = Indicated Reading (32.5 dBuV) + Correction Factor (13.7 dB)

The Correction Factor is calculated by adding Cable loss (CL) and attenuation of the impulse limiter and the high pass filter. The basic equation is as follows:

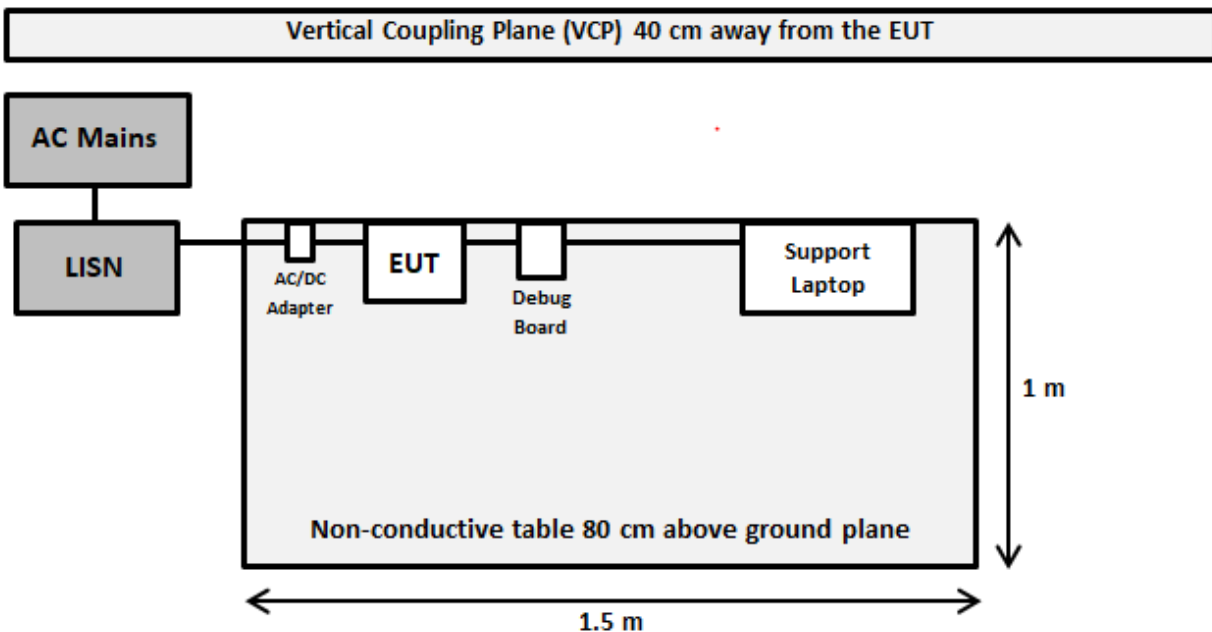
$$CF = CL + \text{Attenuator}$$

For example, a corrected amplitude of 13.7 dB = Cable Loss (3.7 dB) + Attenuation (10 dB)

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

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

## 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	EMI Test Receiver	ESCI 1166.5950K03	100044	2023-06-16	1 year
681	Rohde & Schwarz	Impulse Limiter	ESH3-Z2	101962	2023-07-12	6 months
726	Solar Electronics Company	High Pass Filter	Type 7930-100	7930150204	2023-07-24	6 months
732	FCC	LISN	FCC-LISN-50-25-2-10-CISPR16	160129	2023-09-12	1 year
1226	Fairview Microwave	Micro-Coax Cable	FMC0101223-240	210241	2023-06-28	6 months

**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

<b>Temperature:</b>	18.3 to 18.7 °C
<b>Relative Humidity:</b>	62.1 to 62.3 %
<b>ATM Pressure:</b>	102.6 kPa

The testing was performed by Steven Lianto on 2023-12-04 in the 5 meter chamber 3.

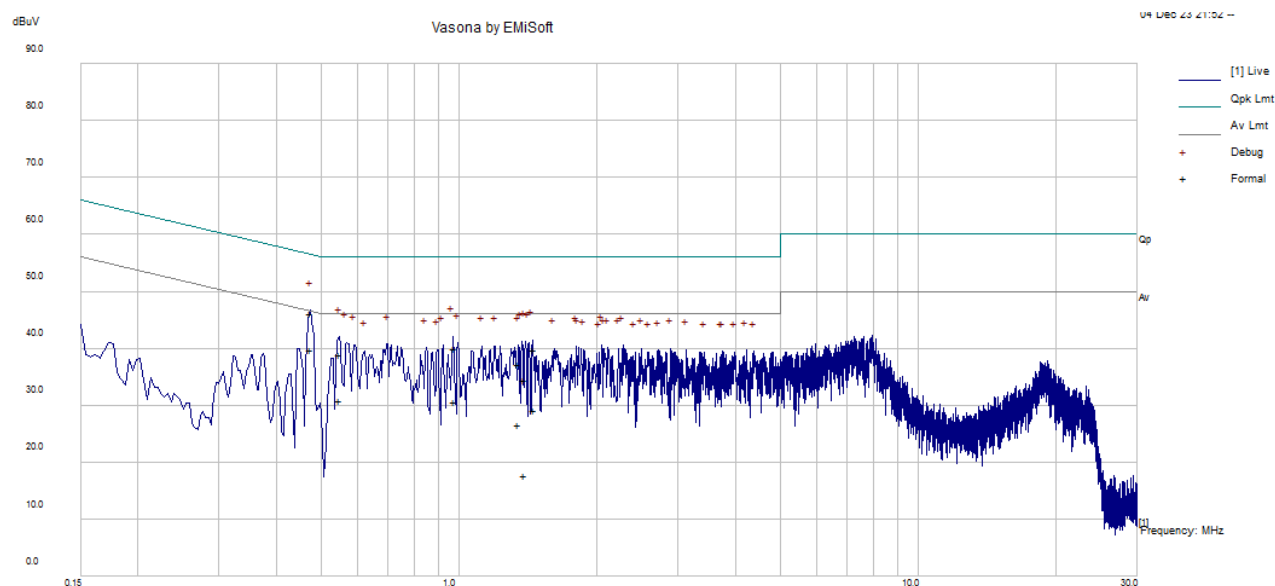
## 5.8 Summary of Test Results

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

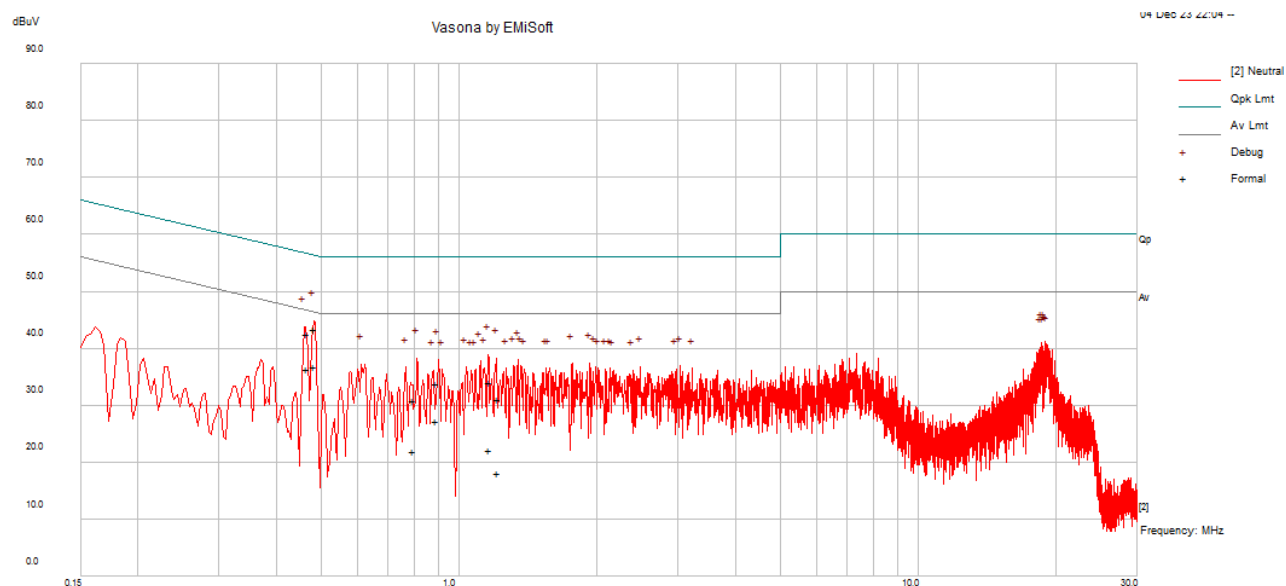
Worst Case(802.11n20 @ 2437MHz) – AC Line (via AC/DC Adapter): 120V, 60Hz			
Margin (dB)	Frequency (MHz)	Conductor Mode (Hot/Neutral)	Range (MHz)
-6.7	0.475505	Hot	0.15 to 30

## 5.9 Conducted Emissions Test Plots and Data

### AC Line (via AC/DC Adapter): 120V, 60Hz – Hot Conductor



Frequency (MHz)	Ai. Reading (dBμV)	Correction Factor (dB)	Corrected Amplitude (dBμV)	Limit (dBμV)	Margin (dB)	Detector
0.475505	35.9	10.33	46.23	56.42	-10.19	QP
0.977297	29.76	10.17	39.93	56	-16.07	QP
0.548245	28.73	10.28	39	56	-17	QP
1.460905	29.61	10.08	39.68	56	-16.32	QP
1.385984	24.31	10.09	34.4	56	-21.6	QP
1.349405	27.19	10.1	37.29	56	-18.71	QP
<b>0.475505</b>	<b>29.4</b>	<b>10.33</b>	<b>39.72</b>	<b>46.42</b>	<b>-6.7</b>	<b>Ave</b>
0.977297	20.41	10.17	30.58	46	-15.42	Ave
0.548245	20.52	10.28	30.79	46	-15.21	Ave
1.460905	19.08	10.08	29.15	46	-16.85	Ave
1.385984	7.6	10.09	17.69	46	-28.31	Ave
1.349405	16.46	10.1	26.55	46	-19.45	Ave

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

Frequency (MHz)	Ai. Reading (dBuV)	Correction Factor (dB)	Corrected Amplitude (dBμV)	Limit (dBμV)	Margin (dB)	Detector
0.48493	33.05	10.32	43.36	56.25	-12.89	QP
0.466087	32.24	10.34	42.57	56.58	-14.01	QP
1.167225	23.99	10.14	34.13	56	-21.87	QP
0.796418	20.72	10.21	30.92	56	-25.08	QP
1.218093	20.95	10.13	31.07	56	-24.93	QP
0.894992	23.69	10.19	33.89	56	-22.11	QP
0.48493	26.58	10.32	36.9	46.25	-9.36	Ave
0.466087	26.01	10.34	36.34	46.58	-10.24	Ave
1.167225	11.93	10.14	22.07	46	-23.93	Ave
0.796418	11.72	10.21	21.92	46	-24.08	Ave
1.218093	8.06	10.13	18.18	46	-27.82	Ave
0.894992	16.99	10.19	27.18	46	-18.82	Ave

## 6 FCC §15.35(b), §15.205, §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(b): 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) 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 ISSED RSS-Gen 8.9,

Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General field strength limits at frequencies above 30 MHz

Frequency (MHz)	Field Strength (μV/m at 3 m)
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 6 – General field strength limits at frequencies below 30 MHz

Frequency	Field Strength (micro volts/meter)	Measurement Distance (meters)
9 – 490 kHz <sup>Note 1</sup>	6.37/F (F in kHz)	300
490 – 1705 kHz	63.7/F (F in kHz)	30
1.705 – 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

As per ISSED RSS-Gen 8.10(c),

Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

Table 7 – Restricted frequency bands<sup>Note 1</sup>

MHz	MHz	GHz
0.090 – 0.110	149.9 – 150.05	9.0 – 9.2
0.495 – 0.505	156.52475 – 156.52525	9.3 – 9.5
2.1735 – 2.1905	156.7 – 156.9	10.6 – 12.7
3.020 – 3.026	162.0125 – 167.17	13.25 – 13.4
4.125 – 4.128	167.72 – 173.2	14.47 – 14.5
4.17725 – 4.17775	240 – 285	15.35 – 16.2
4.20725 – 4.20775	322 – 335.4	17.7 – 21.4
5.677 – 5.683	399.9 – 410	22.01 – 23.12
6.215 – 6.218	608 – 614	23.6 – 24.0
6.26775 – 6.26825	960 – 1427	31.2 – 31.8
6.31175 – 6.31225	1435 – 1626.5	36.43 – 36.5
8.291 – 8.294	1645.5 – 1646.5	Above 38.6
8.362 – 8.366	1660 – 1710	
8.37625 – 8.38675	1718.8 – 1722.2	
8.41425 – 8.41475	2200 – 2300	
12.29 – 12.293	2310 – 2390	
12.51975 – 12.52025	2483.5 – 2500	
12.57675 – 12.57725	2655 – 2900	
13.36 – 13.41	3260 – 3267	
16.42 – 16.423	3332 – 3339	
16.69475 – 16.69525	3345.8 – 3358	
16.80425 – 16.80475	3500 – 4400	
25.5 – 25.67	4500 – 5150	
37.5 – 38.25	5350 – 5460	
73 – 74.6	7250 – 7750	
74.8 – 75.2	8025 – 8500	
108 – 138		

Note 1: Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

As per ISSED 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 and 10-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.

The spacing between the peripherals was 10 centimeters.

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

## 6.3 Test Procedure

For the radiated emissions test, the EUT host and all support equipment power cords were connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT was set 3 meter away from the testing antenna, which was varied from 1-4 meters, and the EUT was placed on a turntable, which was 0.8 meters and 1.5 meters above the ground plane for below and above 1000 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna's polarity should be changed between horizontal and vertical.

The spectrum analyzer or receiver was set as:

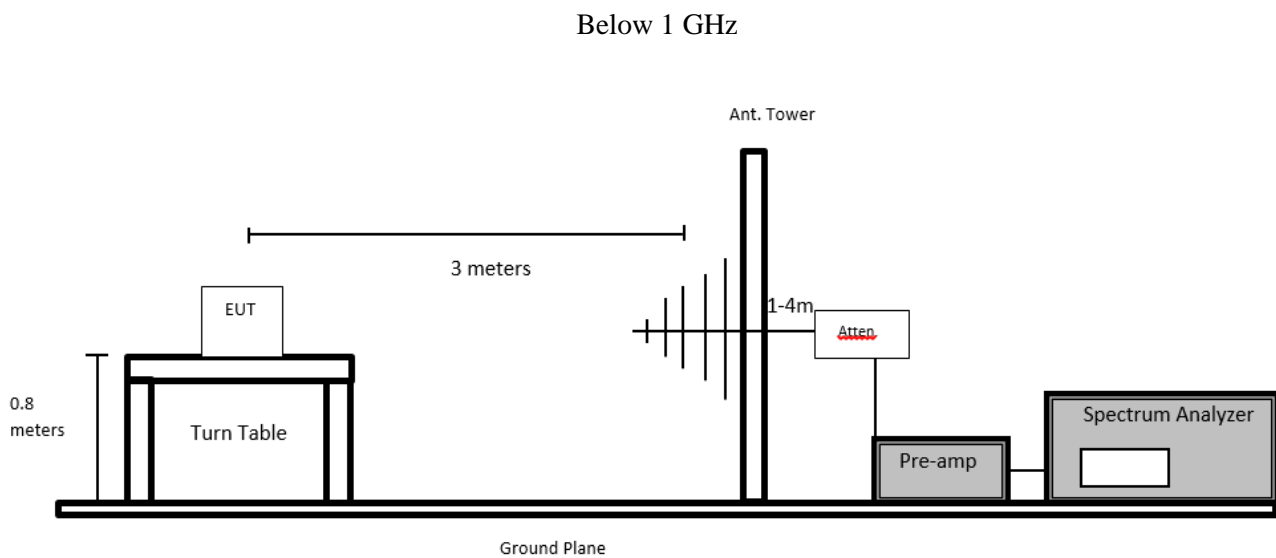
Below 1000 MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

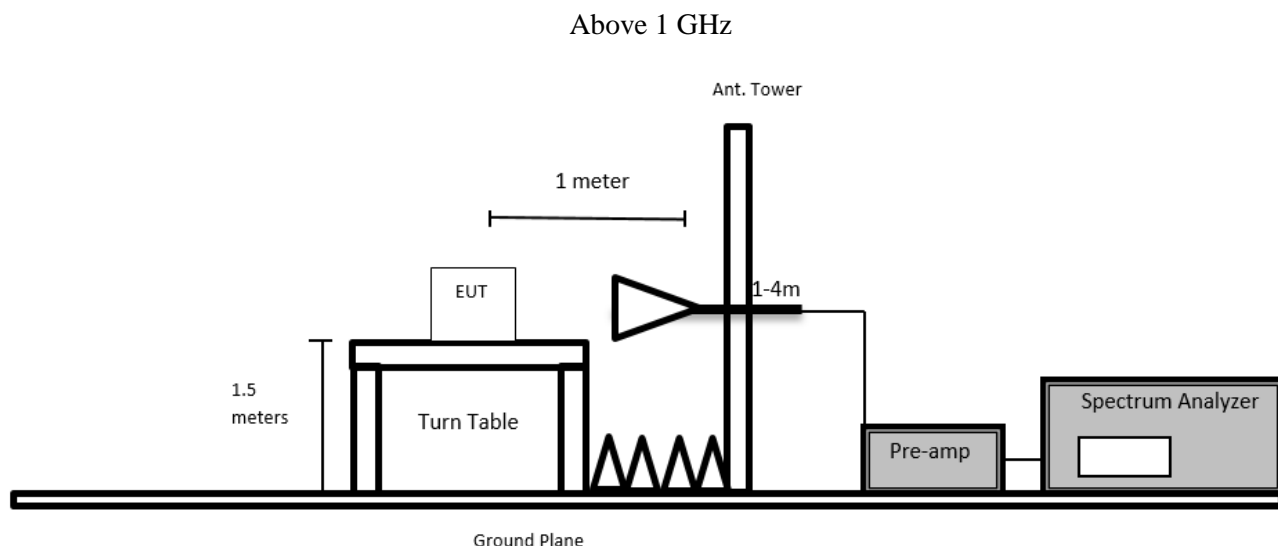
Above 1000 MHz:

- (1) Peak: RBW = 1MHz / VBW = 1MHz / Sweep = Auto
- (2) Average: RBW = 1MHz / VBW = 10Hz or 1/T / Sweep = Auto

## 6.4 Setup Diagrams







## 6.5 Corrected Amplitude and 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:

$$CA = \text{S.A. Reading} + \text{Correction Factor}$$

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:

$$\text{Correction Factor} = AF + CL + \text{Atten} - Ga$$

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:

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

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:

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

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

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

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

## 6.6 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	2023-09-26	6 months
658	HP/ Agilent	Pre Amplifier	8449B OPT HO2	3008A01103	2023-06-13	6 months
1247	Uti flex	Micro - Coax	N/A	N/A	2023-06-13	6 months
827	AH Systems	Preamplifier	PAM 1840 VH	170	2023-05-17	6 months
307	Sunol Sciences	Biconilog Antenna	JB3	A020106-3; 01182018A	2022-03-21	2 years
1334	Micro-Tronics	Notch Filter	BRM50702	G361	2023-01-12	1 year
-	-	6dB Attenuator	PE7390-6	01182018A	2022-03-21	2 years
1192	ETS Lindgren	Horn Antenna	3117	00218973	2022-09-29	2 years
90	Wisewave	Antenna, Horn	ARH-4223-02	10555-01	2023-05-02	2 years
1186	Pasternack	Coaxial Cable, RG214	PE3062-1050CM	N/A	2023-10-03	6 months
1246	Hewlet Packard	RF Limiter	11867A	01734	2023-04-13	1 year
1248	Pasternack	RG214 COAX Cable	PE3062	N/A	2023-10-04	6 months
1249	Time Microwave	LMR-400 Cable Dc-3 GHz	AE13684	2k80612-5 6fts	2023-10-09	6 months
1346	RFMW	2.92mm 10ft RF cable	KMSE-160SAW-240.0-KSME	N/A	2023-11-03	6 months <sup>1</sup>
1354	RFMW	2.92mm 10ft RF Cable DC to 40 GHz	P1CA-29M29M-F150-120	N/A	2023-02-24	1 year
1295	Carlisle	10m Ultra Low Loss Coaxial Cable	UFB142A-1-3937-200200	64639890912-001	2023-10-31	6 months <sup>1</sup>

Note<sup>1</sup>: equipment was only used for testing performed on 2023-11-07

**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".*

## 6.7 Test Environmental Conditions

<b>Temperature:</b>	21.4 - 22.6 ° C
<b>Relative Humidity:</b>	52.1-54.2%
<b>ATM Pressure:</b>	101.8 kPa

*The testing was performed by Will Hu from 2023-10-30 to 2023-11-07 in 5m chamber 3.*

## 6.8 Summary of Test Results

According to the data hereinafter, the EUT complied with the FCC Part 15.209, 15.247 and ISEDC RSS-247 standards, radiated emissions limits, and had the worst margin of:

<b>Mode: Transmitting</b>			
<b>Margin (dB)</b>	<b>Frequency (MHz)</b>	<b>Polarization (Horizontal/Vertical)</b>	<b>Configuration</b>
-0.7	2462	V	802.11b

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

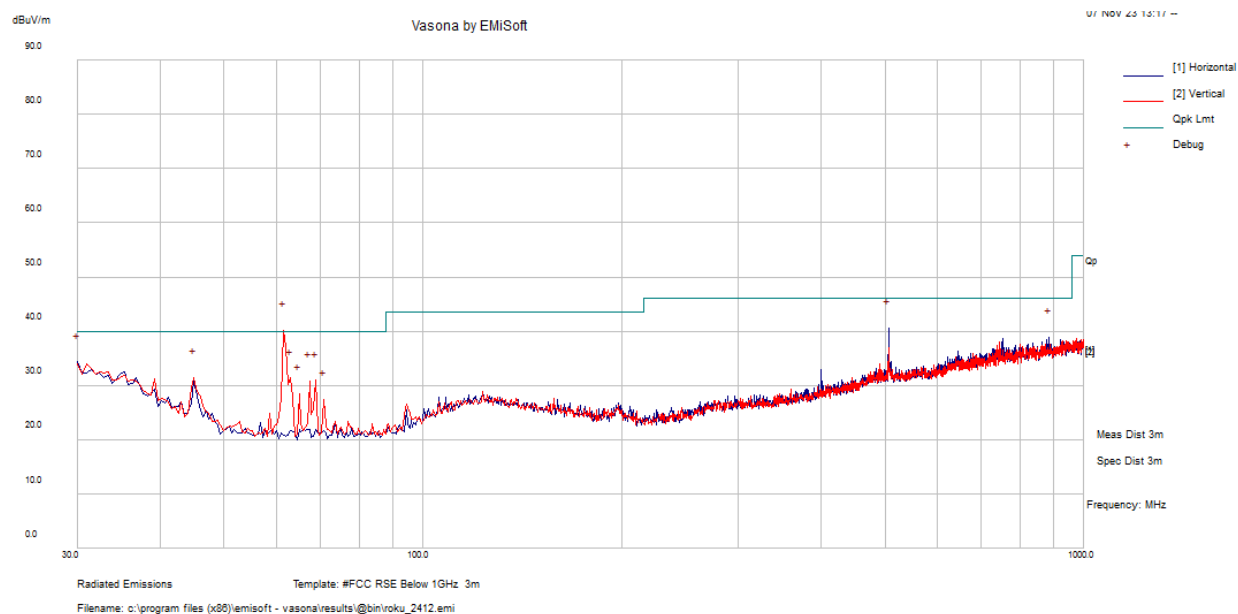
## 6.9 Radiated Emissions Test Results

*Note: Below test data are the radiated cabinet emissions, for conducted in-lieu of radiated measurements performed at the antenna port please refer to ANNEX B and ANNEX C.*

*Note: Lowest frequency emitted by device is above 30MHz, thus below 30MHz spurious is not needed*

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

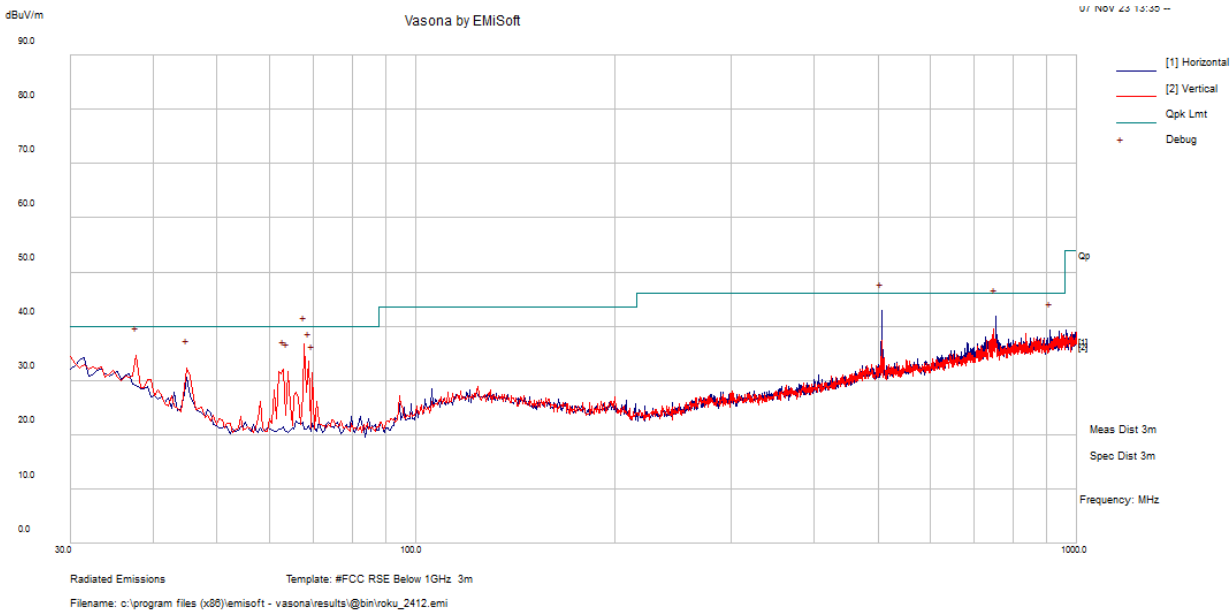
**Modulation: b mode, frequency channel: 2412 MHz**



### Prescan data

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Measurement
61.525	52.79	-13.59	39.2	V	100	0	40	-0.8	Peak
506.27	42.57	-1.96	40.61	H	100	0	46	-5.39	
30	35.32	-0.97	34.35	H	100	0	40	-5.65	
886.51	35.64	3.25	38.89	H	300	0	46	-7.11	
45.035	42.22	-10.75	31.47	V	100	0	40	-8.53	
62.98	44.8	-13.5	31.3	V	300	0	40	-8.7	

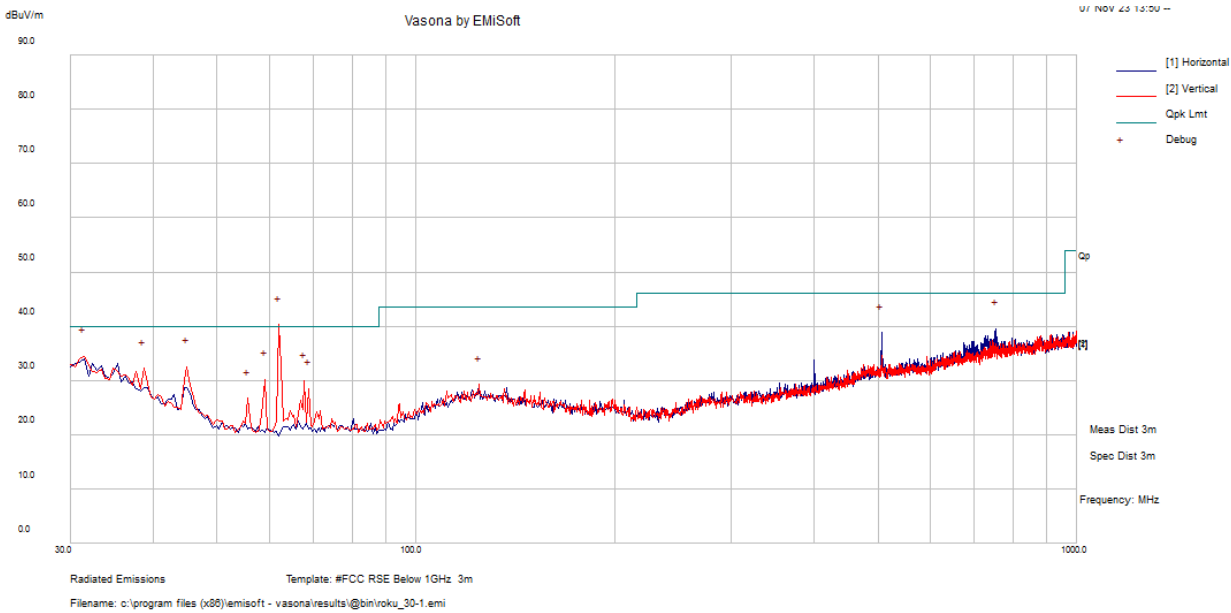
Modulation: b mode, frequency channel 2437 MHz



Prescan data

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBuV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBuV/m)	Margin (dB)	Measurement
506.27	44.79	-1.96	42.83	H	100	0	46	-3.17	Peak
67.83	49.98	-13.3	36.68	V	100	0	40	-3.32	
753.135	39.91	1.88	41.79	H	100	0	46	-4.21	
37.76	40.97	-6.27	34.7	V	300	0	40	-5.3	
68.8	46.88	-13.27	33.61	V	300	0	40	-6.39	
910.76	35.8	3.41	39.21	H	300	0	46	-6.79	

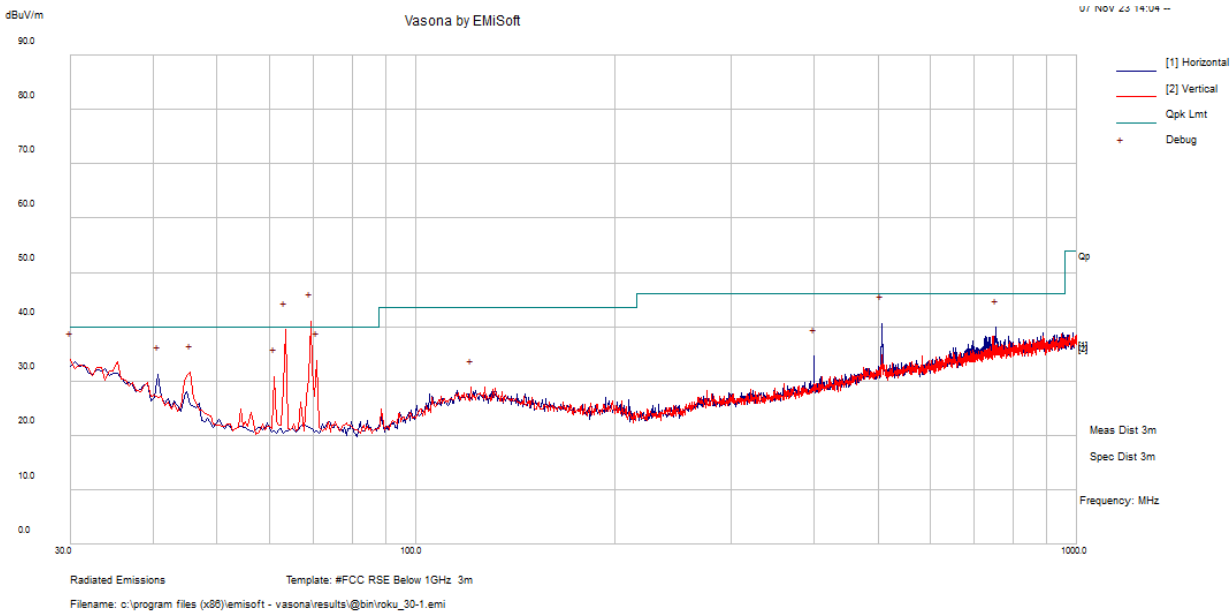
Modulation: b mode, frequency channel 2462 MHz



Prescan data

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Measurement
62.01	52.86	-13.56	39.3	V	100	0	40	-0.7	Peak
31.455	36.54	-2.06	34.48	V	100	0	40	-5.52	
754.105	37.68	1.86	39.54	H	100	0	46	-6.46	
506.27	40.73	-1.96	38.77	H	100	0	46	-7.23	
45.035	43.3	-10.74	32.56	V	100	0	40	-7.44	
38.73	39.2	-6.97	32.23	V	300	0	40	-7.77	

Modulation: 802.11n20 mode, frequency channel 2412 MHz



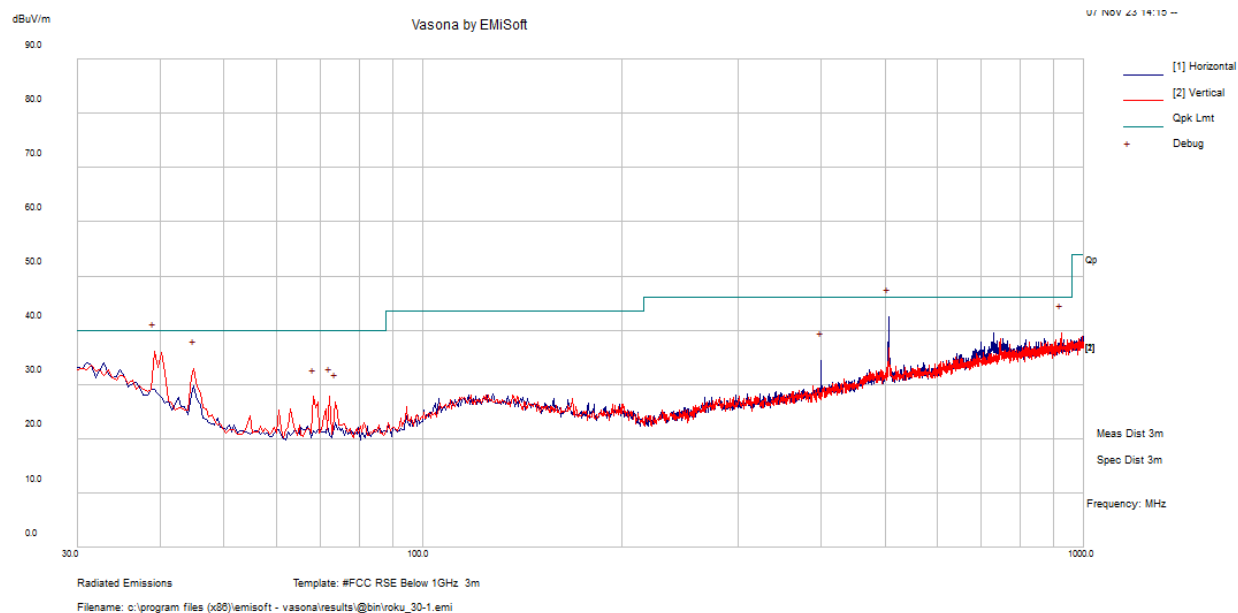
Note: g mode, channel =2412 is the worst case for 2.4 GHz band.

Formal data

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Measurement
69.369	29.84	-13.26	16.58	V	218	43	40	-23.42	Quasi Peak
70.7415	29.88	-13.25	16.63	V	280	159	40	-23.37	
30	29.7	-0.97	28.72	V	230	77	40	-11.28	
63.41075	90.38	-13.47	16.91	V	122	255	40	-23.09	
754.1413	32.78	1.87	34.65	H	151	152	46	-11.35	
506.3055	44.07	-1.96	42.11	H	118	154	46	-3.89	



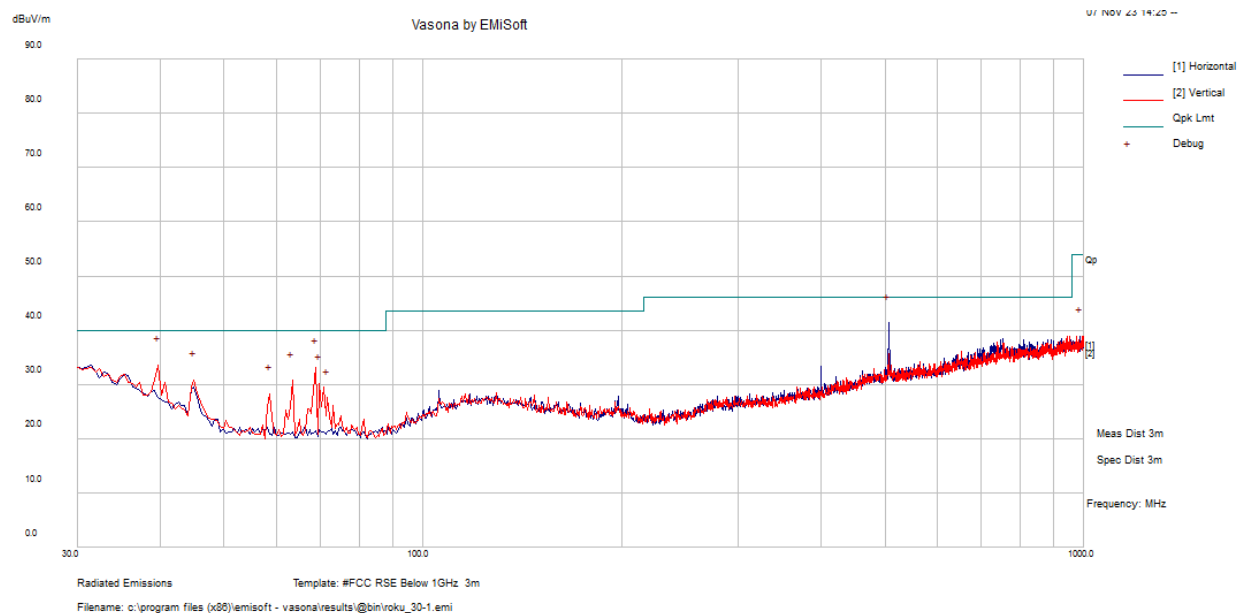
## 802. 11n20 mode, frequency channel 2437 MHz



## Prescan data

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBuV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBuV/m)	Margin (dB)	Measurement
506.27	44.51	-1.95	42.56	H	100	0	46	-3.44	Peak
39.215	43.43	-7.32	36.11	V	300	0	40	-3.89	
923.37	35.93	3.57	39.5	V	100	0	46	-6.5	
45.035	43.67	-10.75	32.92	V	100	0	40	-7.08	
400.055	39.48	-5.11	34.37	H	100	0	46	-11.63	
72.195	41.1	-13.23	27.87	V	100	0	40	-12.13	

## 802.11n20 mode, frequency channel 2462 MHz



## Prescan data

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Measurement
506.27	43.27	-1.95	41.32	H	100	0	46	-4.68	Peak
39.7	41.26	-7.67	33.59	V	300	0	40	-6.41	
68.8	46.47	-13.26	33.21	V	300	0	40	-6.79	
45.035	41.58	-10.75	30.83	V	100	0	40	-9.17	
63.465	44.17	-13.47	30.7	V	100	0	40	-9.3	
69.77	43.49	-13.25	30.24	V	300	0	40	-9.76	

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

Note 1: Restricted Band Peak Limit is defined to be 20dB higher than Average Limit.

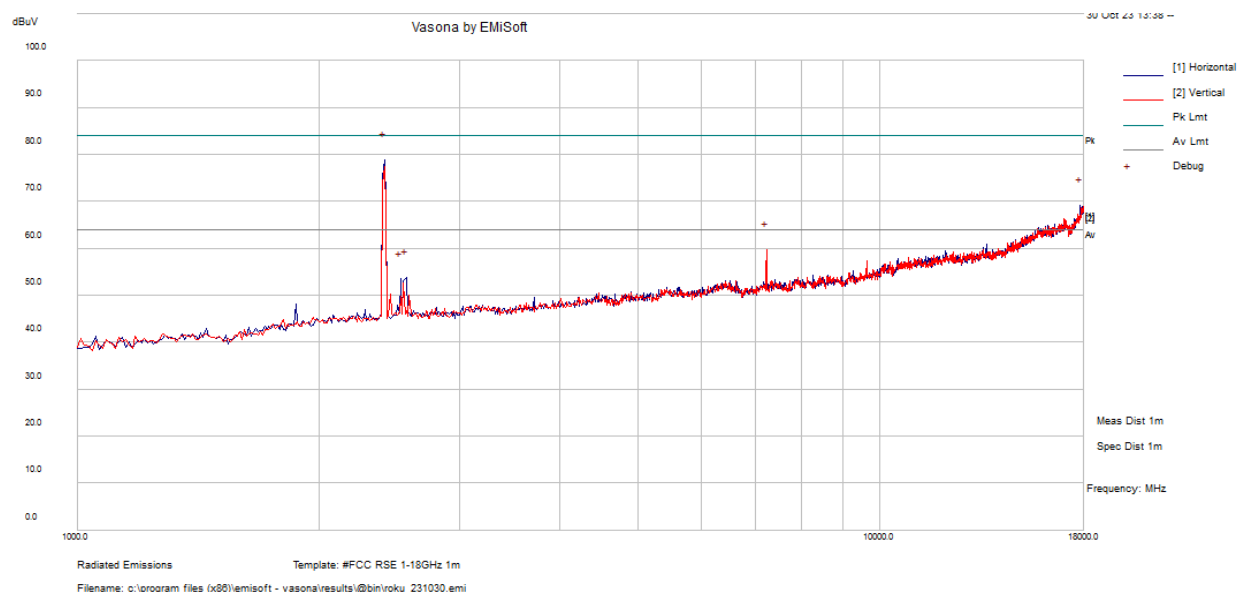
Note 2: Limits at 1 meter are determined by applying a Distance correction factor accounts for extrapolation from 1 meters to 3 meters. Formula used is as follows:  $20 \cdot \log(3\text{meters}/1\text{meter}) = 9.54$  (According to ANSI C63.10-2013 Section 9.4). i.e.  $54[\text{dBuV/m at 3m}] + 9.54\text{dB} = 63.54[\text{dBuV/m at 1m}]$

Note 3 :  $\text{dBuV/m} = 20 \cdot \log(\text{V/m}) + 120$ . Thus  $20 \cdot \log((500[\text{uV/m}]/1000000)) + 120 = 54[\text{dBuV/m}]$

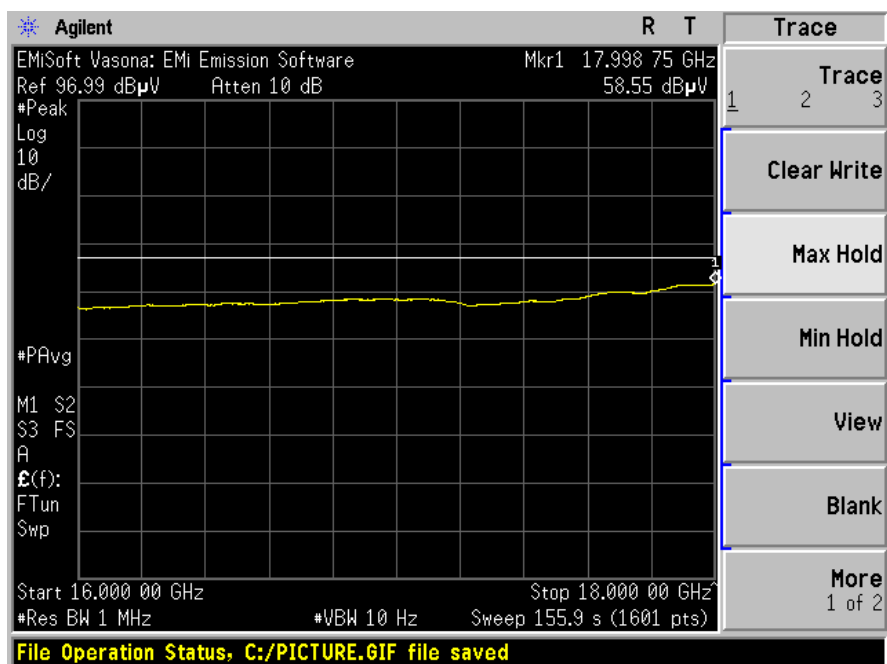
Note 4: Ports terminated for radiated measurements.

## 2) 1 – 18 GHz, Measured at 1 meter

**Worst case: Modulation: b mode, frequency channel: 2412 MHz**



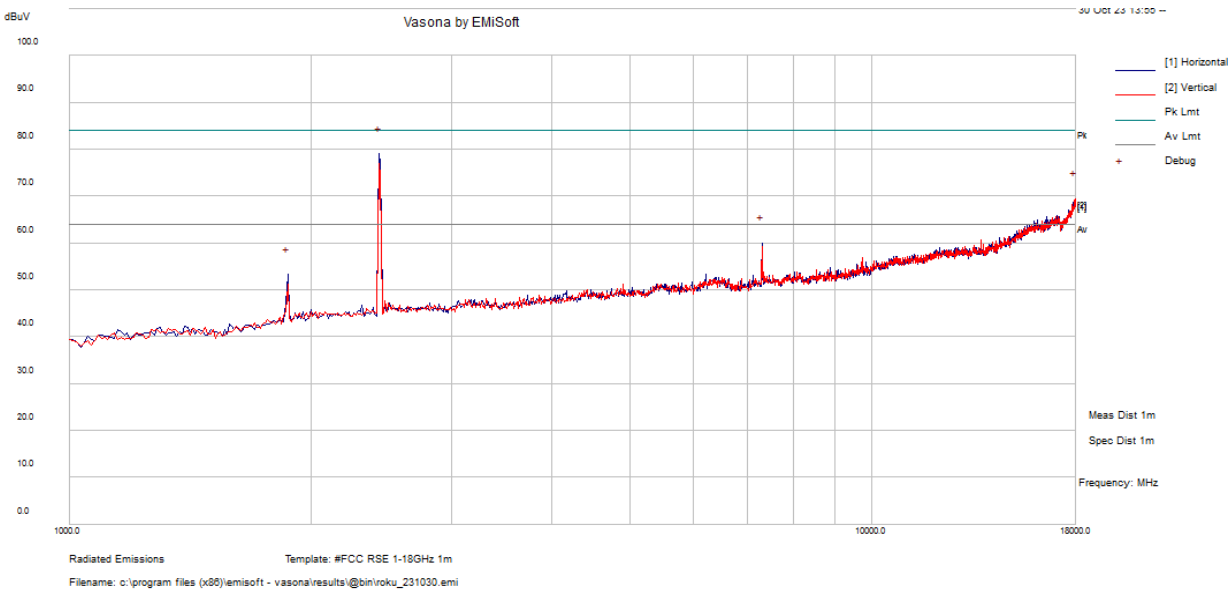
**Note: above plot shows all peak emissions below 16GHz pass under average limits**



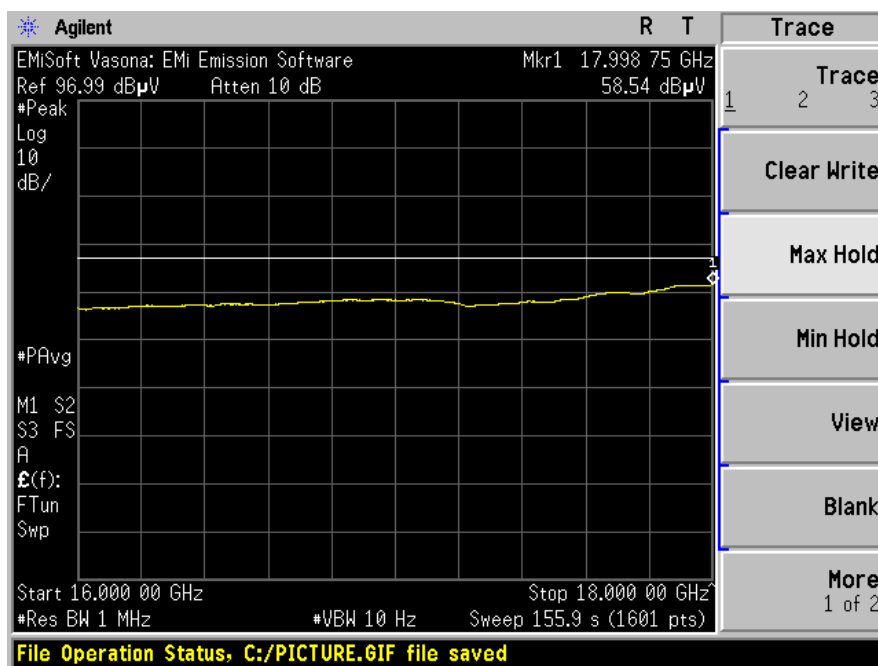
**Note:** above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz.

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Detector (Peak /Ave.)
17999	47.58	21.66	69.24	H	150	0	83.54	-24.3	Peak
17999	36.89	21.66	58.55	H	150	0	63.54	-4.99	Average

Modulation: b mode, frequency channel 2437 MHz



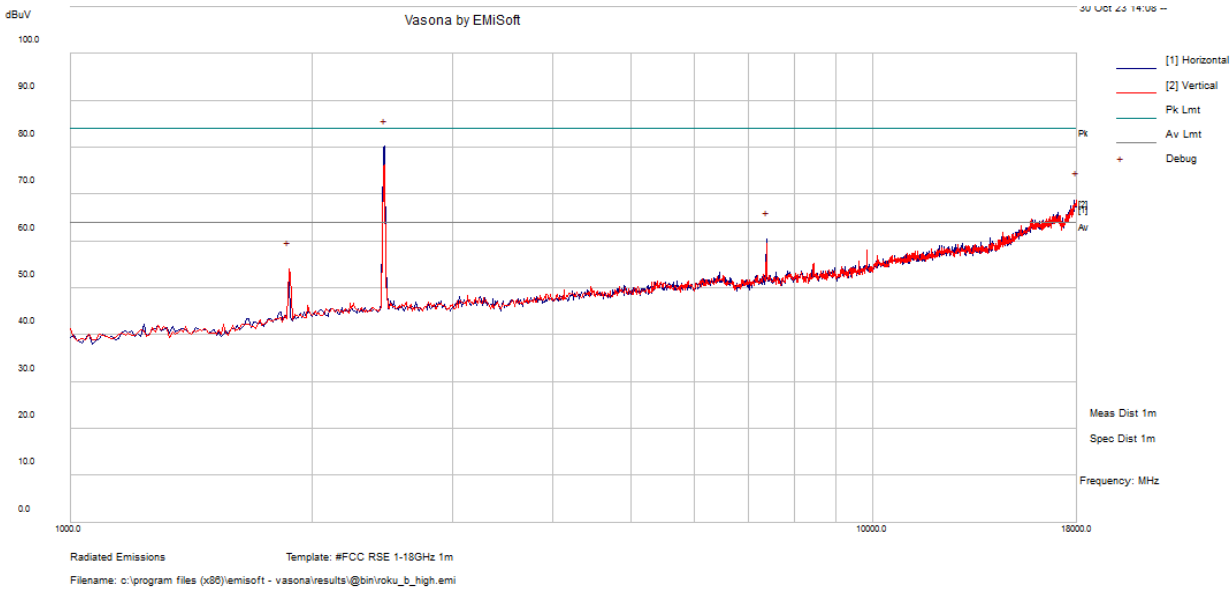
**Note: above plot shows all peak emissions below 16GHz pass under average limits**



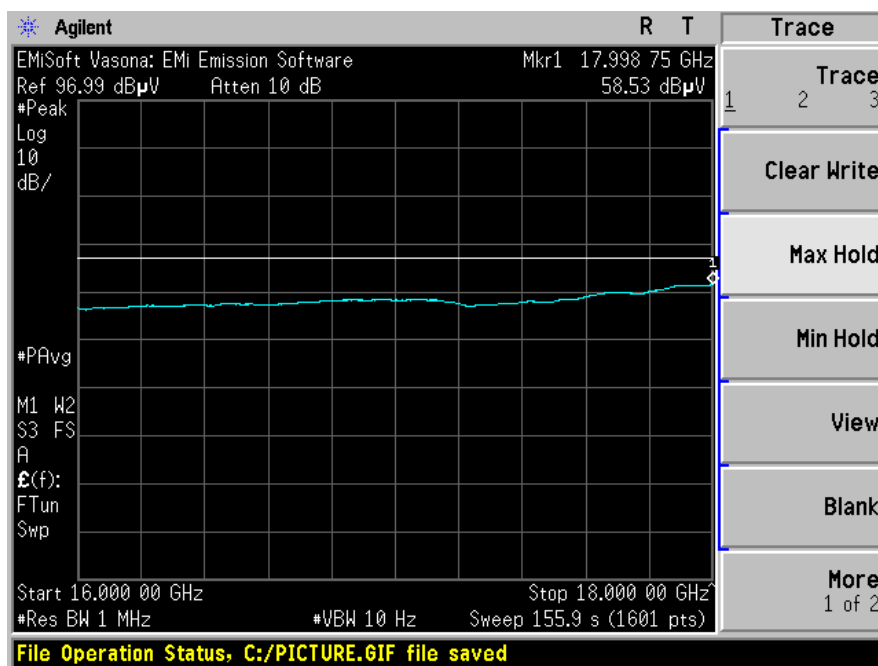
**Note:** above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz.

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBuV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBuV/m)	Margin (dB)	Detector (Peak /Ave.)
17999	47.72	21.66	69.38	H	150	0	83.54	-14.16	Peak
17999	36.88	21.66	58.54	H	150	0	63.54	-5	Average

Modulation: b mode, frequency channel 2462 MHz



**Note: above plot shows all peak emissions below 16GHz pass under average limits**

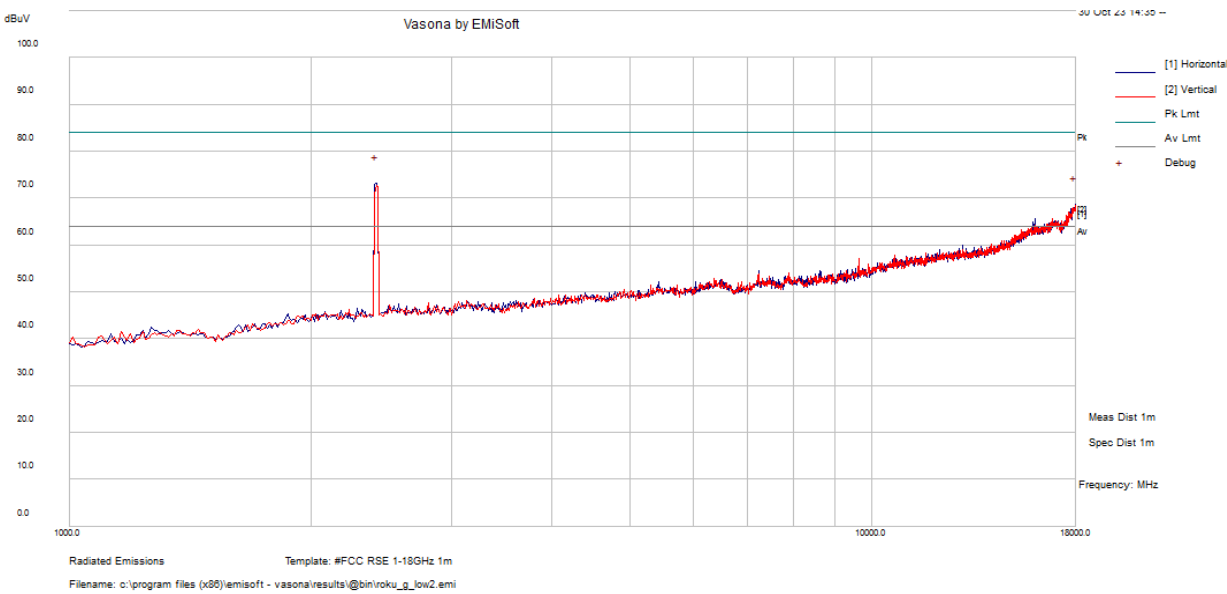


Note: above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz.

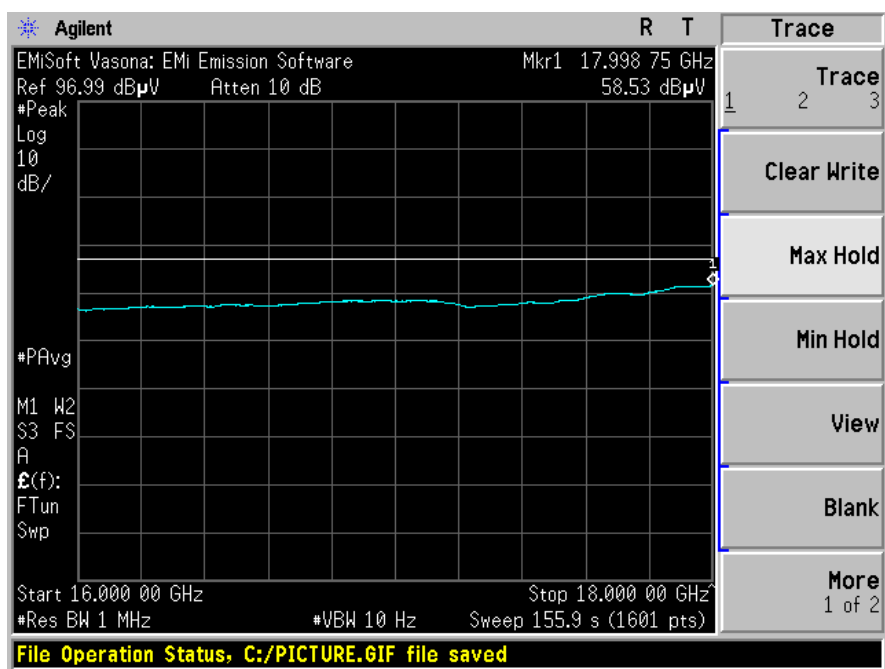
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Detector (Peak /Ave.)
17999	47.31	21.66	68.97	H	150	0	83.54	-14.57	Peak
17999	36.87	21.66	58.53	H	150	0	63.54	-5.01	Average



802. 11n20 mode, frequency channel 2412 MHz



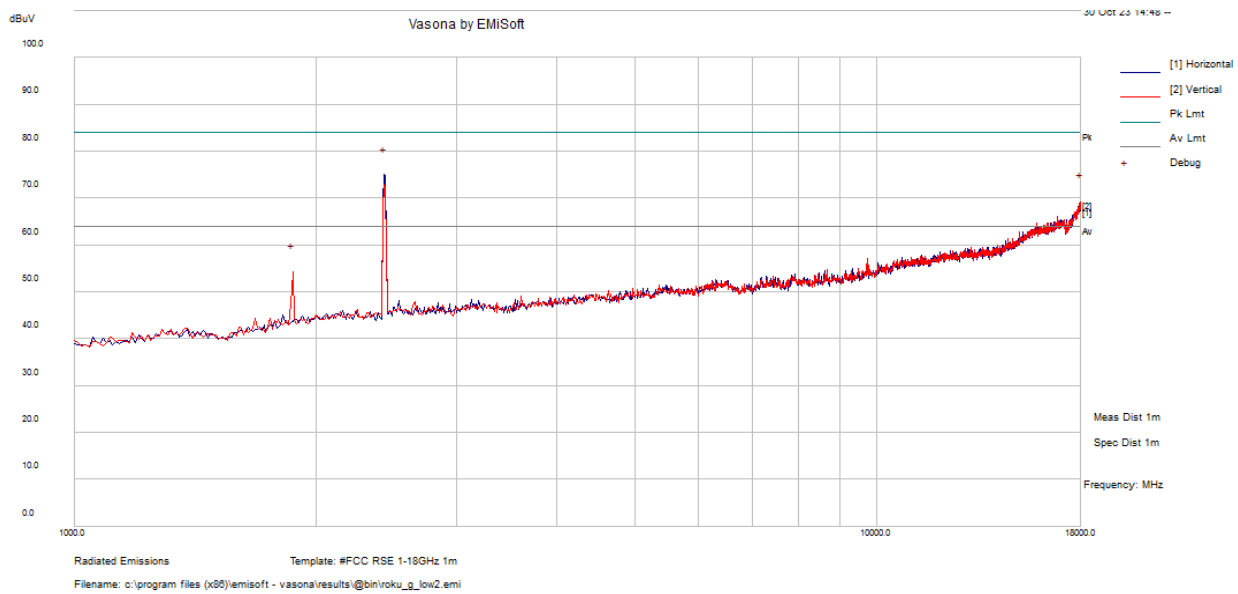
**Note: above plot shows all peak emissions below 16GHz pass under average limits**



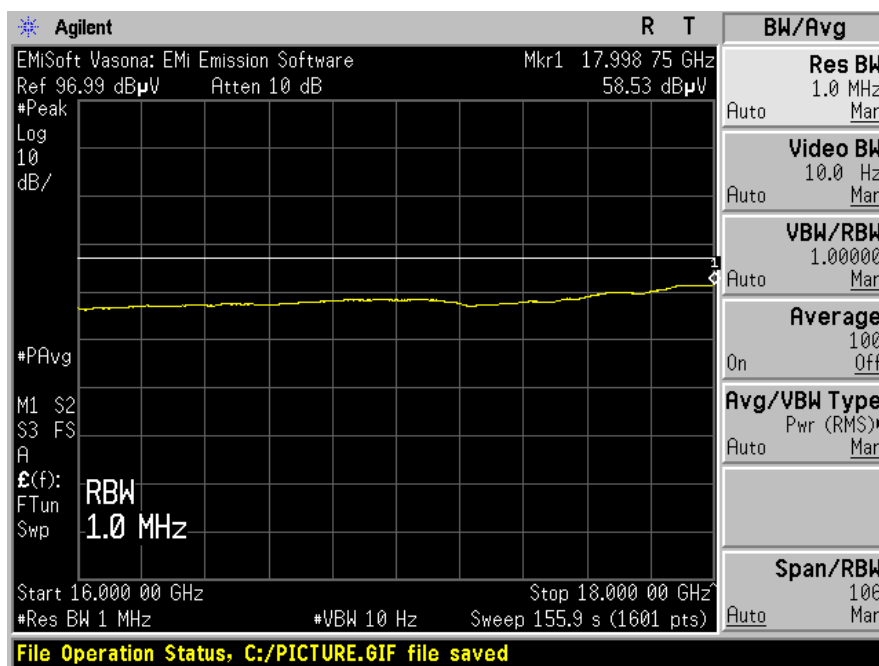
**Note:** above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz.

Frequency (MHz)	S.A. Reading (dB $\mu$ V)	Correction Factor (dB/m)	Corrected Amplitude (dB $\mu$ V/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dB $\mu$ V/m)	Margin (dB)	Detector (Peak /Ave.)
17999	47.11	21.66	68.77	H	150	0	83.54	-14.77	Peak
17999	36.87	21.66	58.53	H	150	0	63.54	-5.01	Average

### 802. 11n20 mode, frequency channel 2437 MHz



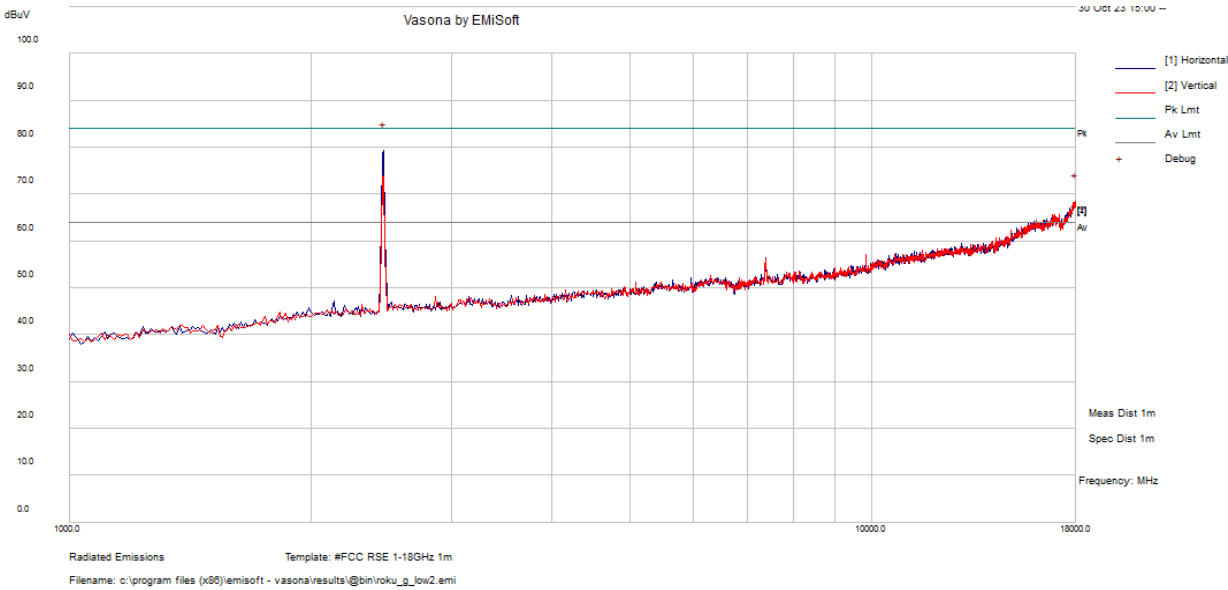
**Note: above plot shows all peak emissions below 16GHz pass under average limits**



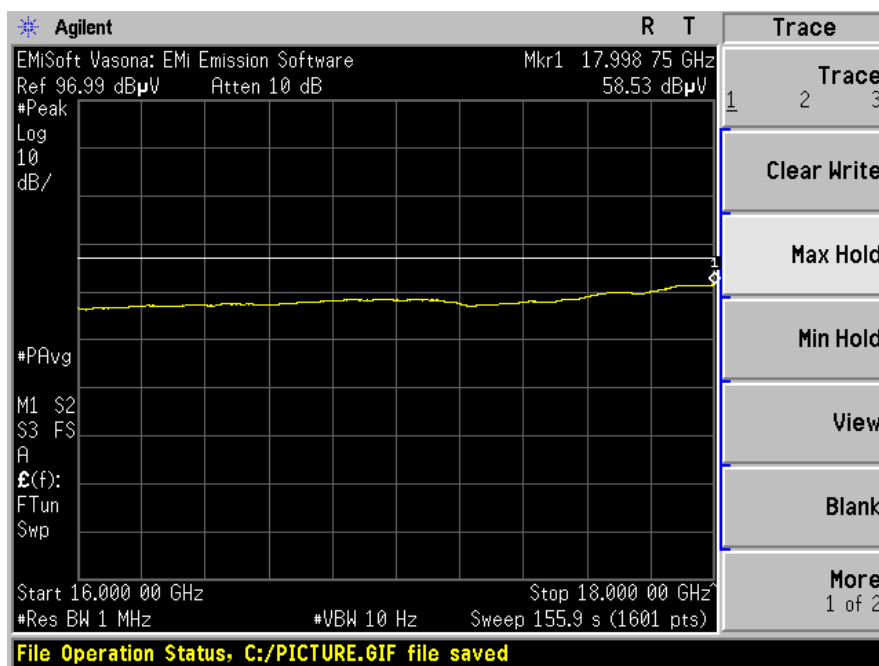
Note: above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz.

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Detector (Peak /Ave.)
17999	47.77	21.66	69.43	H	150	0	83.54	-14.11	Peak
17999	36.87	21.66	58.53	H	150	0	63.54	-5.01	Average

802. 11n20 mode, frequency channel 2462 MHz



**Note: above plot shows all peak emissions below 16GHz pass under average limits**

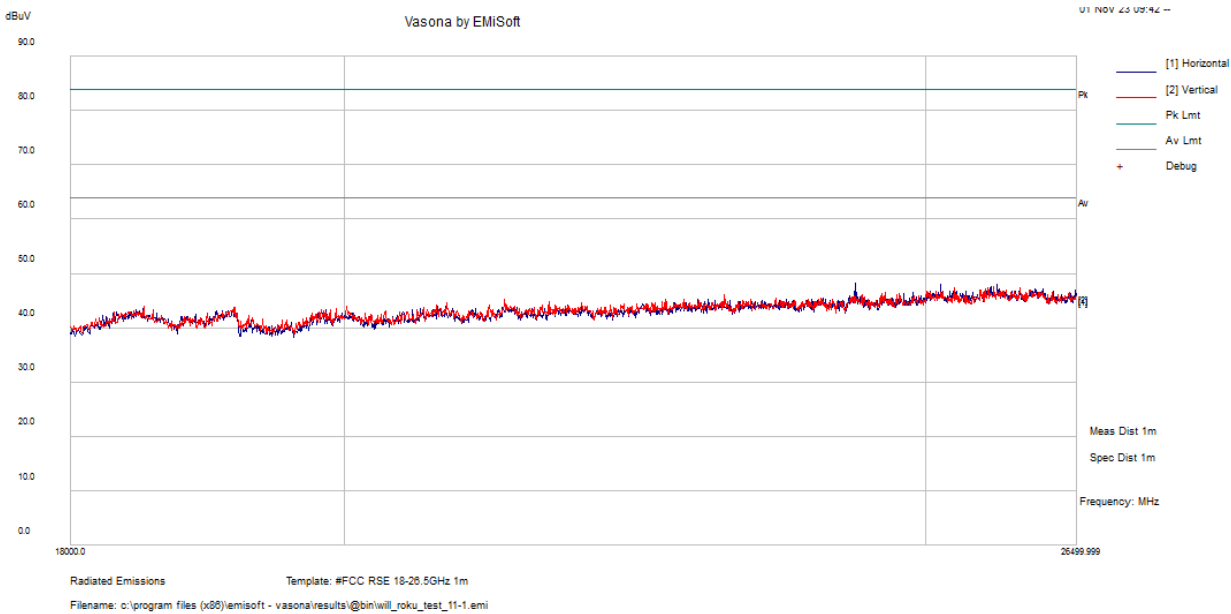


Note: above plot shows reduced VBW to make average measurements comparing to average limits and thus show compliance in range of 16-18GHz.

Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Detector (Peak /Ave.)
17999	46.85	21.66	68.51	H	150	0	83.54	-15.03	Peak
17999	36.87	21.66	58.53	H	150	0	63.54	-5.01	Average

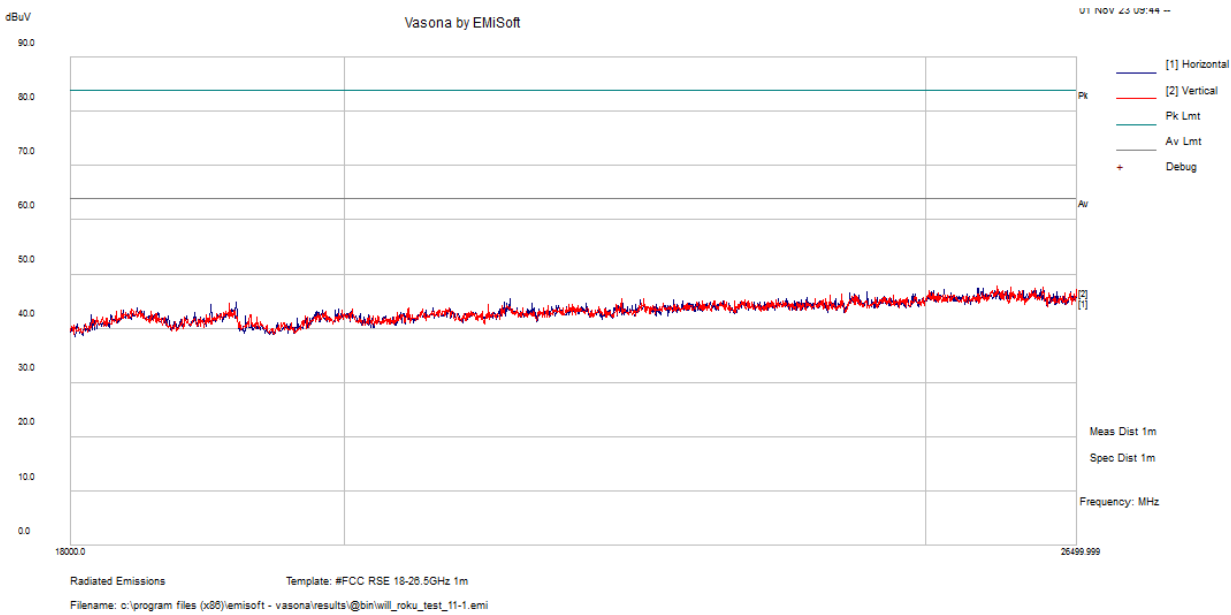
3) 18 - 26.5 GHz, Measured at 1 meter

B mode, frequency channel: 2412 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Detector (Peak /Ave.)
26499	40.74	7.79	48.53	H	150	0	63.54	-15.01	Peak compared to Average Limit

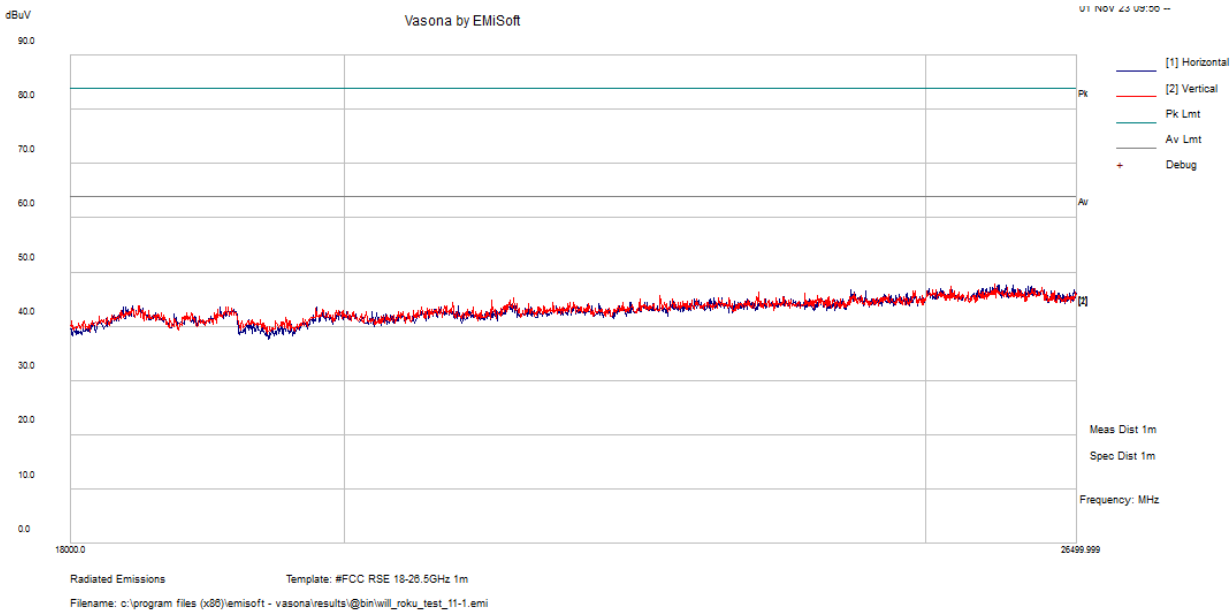
B mode, frequency channel 2437 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Detector (Peak /Ave.)
26499	41.43	7.79	49.22	H	150	0	63.54	-14.32	Peak compared to Average Limit

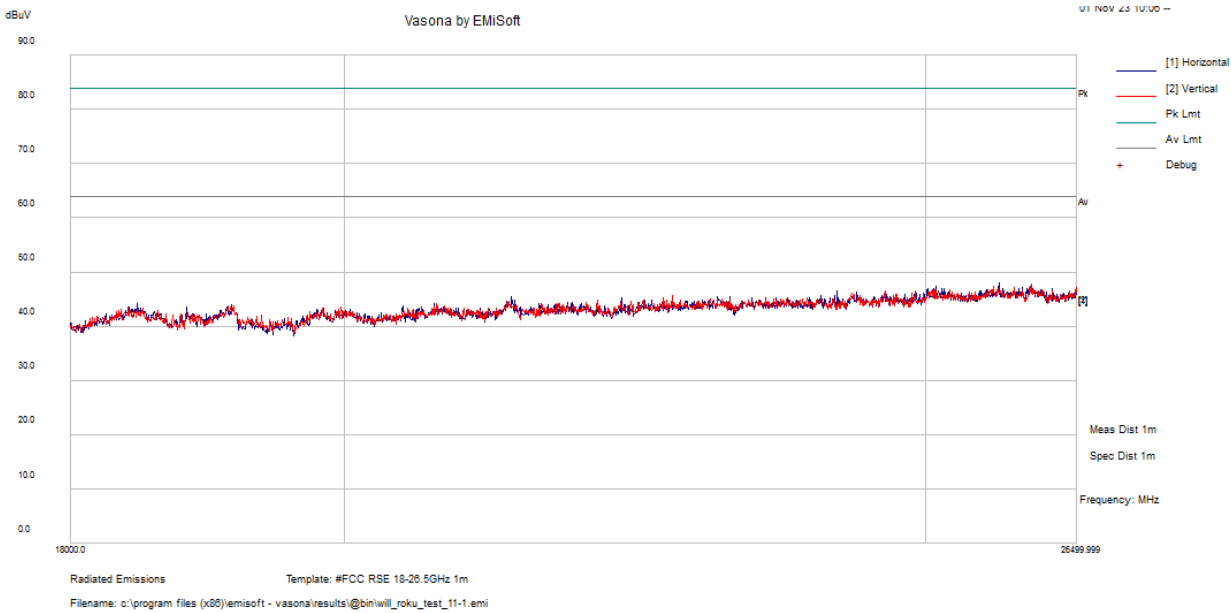


B mode, frequency channel 2462 MHz



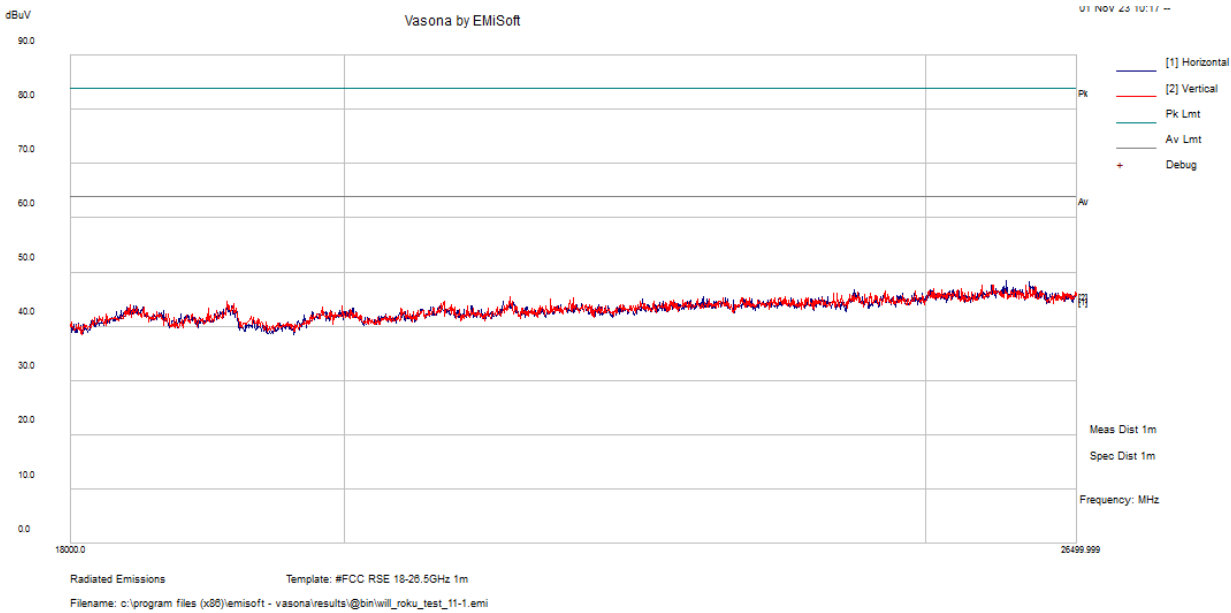
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Detector (Peak /Ave.)
26499	40.97	7.79	48.76	H	150	0	63.54	-14.78	Peak compared to Average Limit

802. 11n20 mode, frequency channel 2412 MHz



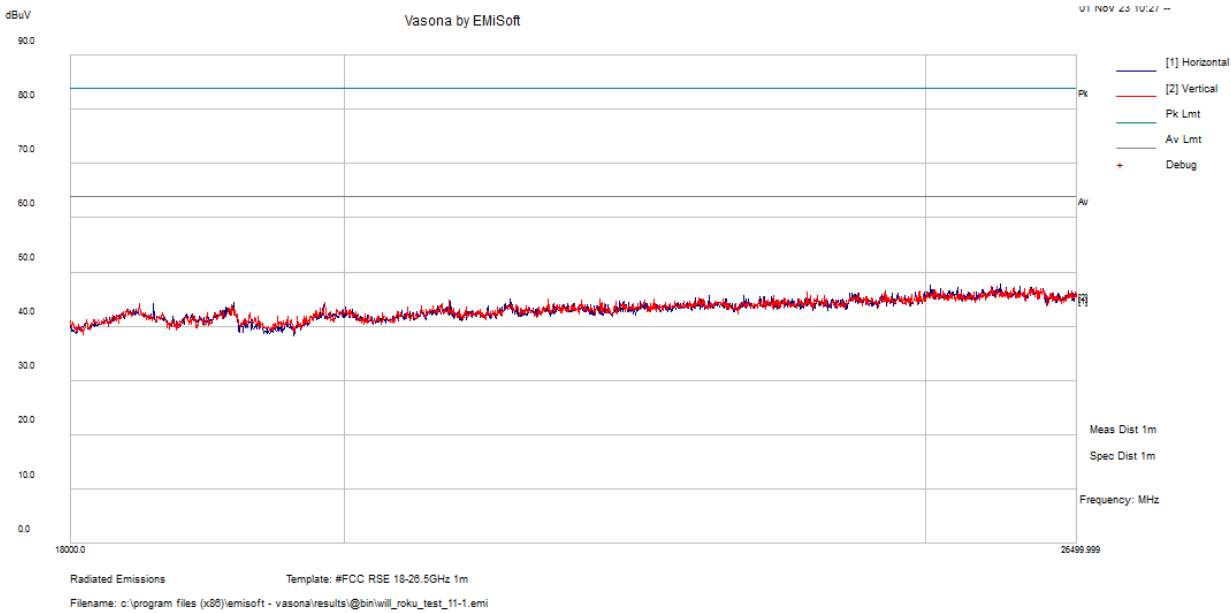
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Detector (Peak /Ave.)
26499	41.33	7.79	49.12	H	150	0	63.54	-14.42	Peak compared to Average Limit

802. 11n20 mode, frequency channel 2437 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Detector (Peak /Ave.)
26499	40.94	7.79	48.73	H	150	0	63.54	-14.81	Peak compared to Average Limit

802. 11n20 mode, frequency channel 2462 MHz



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Detector (Peak /Ave.)
26499	40.74	7.79	48.19	H	150	0	63.54	-15.01	Peak compared to Average Limit

## 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 Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8: DTS bandwidth.

As per ANSI C63.10 Clause 11.8: DTS bandwidth

One of the following procedures may be used to determine the modulated DTS bandwidth.

Option 1:

- a. Set RBW = 100 kHz.
- b. Set the VBW  $\geq [3 \times \text{RBW}]$ .
- c. Detector = peak.
- d. Trace mode = max hold.
- e. Sweep = auto couple.
- f. Allow the trace to stabilize.
- g. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Option 2:

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described in 11.8.1 (i.e., RBW = 100 kHz, VBW  $\geq 3 \times \text{RBW}$ , and peak detector with maximum hold) is implemented by the instrumentation function.

When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be  $\geq 6$  dB.

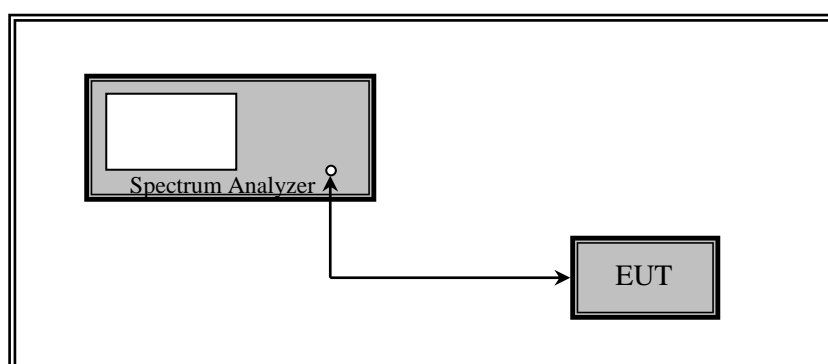
As per ANSI C63.10 Clause 6.9.3:

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

- a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than  $[10 \log (\text{OBW}/\text{RBW})]$  below the reference level. Specific guidance is given in 4.1.5.2.
- d) Step a) through step c) might require iteration to adjust within the specified range.
- e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

- g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
- h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

### 7.3 Test Setup Block Diagram



### 7.4 Test Equipment List and Details

BACL No	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
00424	Agilent	Spectrum Analyzer	E4440A	US45303 156	2022-12-19	12 Months

**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”.

### 7.5 Test Environmental Conditions

<b>Temperature:</b>	20.8°C
<b>Relative Humidity:</b>	34%
<b>ATM Pressure:</b>	102.9 kPa

The testing was performed by Michael Papa from 2023-10-31 to 2023-11-15 at RF test site.

## 7.6 Test Results

Channel	Frequency (MHz)	6 dB OBW (MHz)	99% OBW (MHz)	6 dB OBW limit (kHz)	Result
802.11b					
Low	2412	10.10	15.05	$\geq 500$	Pass
Middle	2437	10.19	15.76	$\geq 500$	Pass
High	2462	10.13	14.98	$\geq 500$	Pass
802.11g					
Low	2412	16.53	17.28	$\geq 500$	Pass
Middle	2437	16.63	30.45	$\geq 500$	Pass
High	2462	16.61	17.22	$\geq 500$	Pass
802.11n20					
Low	2412	17.84	18.05	$\geq 500$	Pass
Middle	2437	17.94	33.50	$\geq 500$	Pass
High	2462	17.71	18.25	$\geq 500$	Pass

*Note: See Annex A for 6dB OBW and 99OBW test results*

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

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### **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).

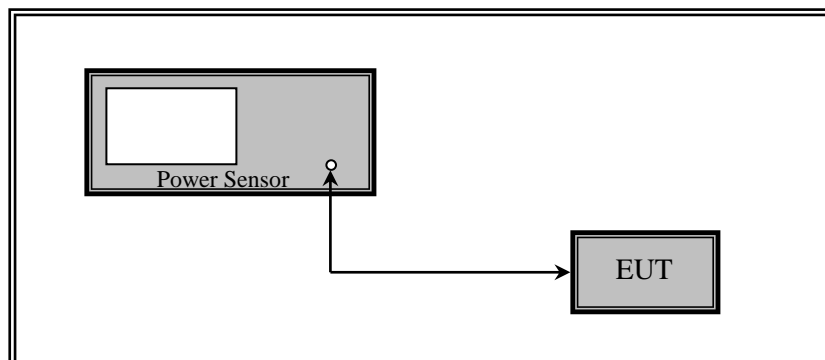
### **8.2 Measurement Procedure**

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

11.9.2.3.2 Method AVGPM-G Method AVGPM-G is a measurement using a gated RF average power meter. Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.



### 8.3 Test Setup Block Diagram



### 8.4 Test Equipment List and Details

BACL No	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
697	ETS-LINDGREN	Power Sensor	7002-006	160097	2023-02-20	12 Months

**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".

### 8.5 Test Environmental Conditions

<b>Temperature:</b>	20.8°C
<b>Relative Humidity:</b>	34%
<b>ATM Pressure:</b>	102.9 kPa

The testing was performed by Michael Papa from 2023-10-31 to 2023-11-15 at RF test site.

## 8.6 Test Results

Channel	Frequency (MHz)	Antenna Gain (dBi)	Conducted Average Output Power (dBm)	Output Power Limit (dBm)	EIRP (dBm)	EIRP Limit (dBm)	Result
802.11b							
Low	2412	2.3	16.41	<30	18.71	<36	Pass
Middle	2437	2.3	16.88	<30	19.18	<36	Pass
High	2462	2.3	16.44	<30	18.74	<36	Pass
802.11g							
Low	2412	2.3	10.63	<30	15.84	<36	Pass
Middle	2417	2.3	15.14	<30	17.44	<36	Pass
Middle	2437	2.3	17.98	<30	20.28	<36	Pass
Middle	2457	2.3	15.04	<30	17.34	<36	Pass
High	2462	2.3	13.28	<30	15.72	<36	Pass
802.11n20							
Low	2412	2.3	11.42	<30	13.72	<36	Pass
Middle	2417	2.3	15.63	<30	17.93	<36	Pass
Middle	2437	2.3	18.19	<30	20.49	<36	Pass
Middle	2457	2.3	15.90	<30	18.20	<36	Pass
High	2462	2.3	13.14	<30	15.44	<36	Pass

Note:  $EIRP [dBm] = \text{Conducted Output Power [dBm]} + \text{Antenna Gain [dBi]}$

Note: For eirp limit,  $dBm = 10 \log(\text{Power [mW]} / 1mW) = 10 \log(4000mW / 1mW) = 36dBm$

Note: Duty Cycle correction factor has already been added to the measurement.

## 9 FCC §15.247(d) & ISEDC RSS-247 §5.5 - 100 kHz Spurious Emissions at Antenna Terminal

### 9.1 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.

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.

### 9.2 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

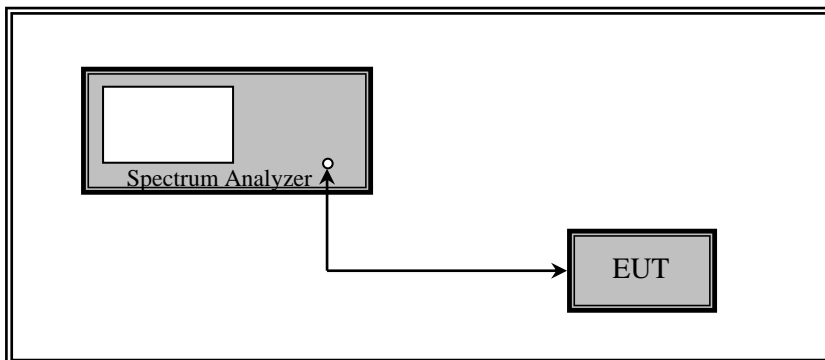
VBW = 300 kHz

Sweep = coupled

Detector function = peak

Trace = max hold

### 9.3 Test Setup Block Diagram



## 9.4 Test Equipment List and Details

BACL No	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
00424	Agilent	Spectrum Analyzer	E4440A	US45303 156	2022-12-19	12 Months

**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".*

## 9.5 Test Environmental Conditions

Temperature:	20.8°C
Relative Humidity:	34%
ATM Pressure:	102.9 kPa

*The testing was performed by Michael Papa from 2023-10-31 to 2023-11-15 at RF test site.*

## 9.6 Test Results

Please refer to Annex D for detailed test results.

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## 10 FCC §15.247(e) & ISEDC RSS-247 §5.2(2) – Peak Power Spectral Density

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### 10.1 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.

### 10.2 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.

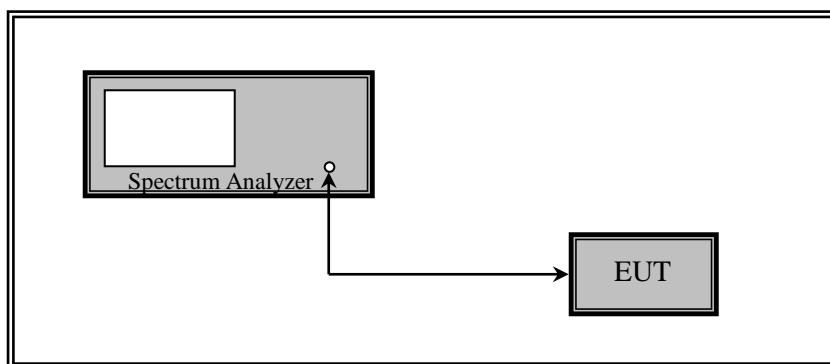
As per ANSI C63.10 Clause 11.10: Maximum power spectral density level in the fundamental emission

Some regulatory requirements specify a conducted PSD limit within the DTS bandwidth during any time interval of continuous transmission.<sup>88</sup> Such specifications require that the same method as used to determine the conducted output power shall be used to determine the power spectral density. If maximum peak conducted output power was measured, then the peak PSD procedure 11.10.2 (method PKPSD) shall be used. If maximum conducted output power was measured, then one of the average PSD procedures shall be used, as applicable based on the following criteria (the peak PSD procedure is also an acceptable option):

**Method PKPSD (peak PSD):** The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

- a. Set analyzer center frequency to DTS channel center frequency.
- b. Set the span to 1.5 times the DTS bandwidth.
- c. Set the RBW to  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- d. Set the VBW  $\geq [3 \times \text{RBW}]$ .
- e. Detector = peak.
- f. Sweep time = auto couple.
- g. Trace mode = max hold.
- h. Allow trace to fully stabilize.
- i. Use the peak marker function to determine the maximum amplitude level within the RBW.
- j. If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

### 10.3 Test Setup Block Diagram



### 10.4 Test Equipment List and Details

BACL No	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
00424	Agilent	Spectrum Analyzer	E4440A	US45303 156	2022-12-19	12 Months

**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”.

## 10.5 Test Environmental Conditions

<b>Temperature:</b>	20.8°C
<b>Relative Humidity:</b>	34%
<b>ATM Pressure:</b>	102.9 kPa

The testing was performed by Michael Papa from 2023-10-31 to 2023-11-15 at RF test site.

## 10.6 Test Results

Channel	Frequency (MHz)	Peak PSD [dBm/10kHz]	Limit (dBm/3kHz)	Result
802.11b				
Low	2412	-3.99	<8	Pass
Middle	2437	-2.31	<8	Pass
High	2462	-3.87	<8	Pass
802.11g				
Low	2412	-11.49	<8	Pass
Middle	2437	-3.32	<8	Pass
High	2462	-8.85	<8	Pass
802.11n20				
Low	2412	-10.28	<8	Pass
Middle	2437	-3.24	<8	Pass
High	2462	-9.02	<8	Pass

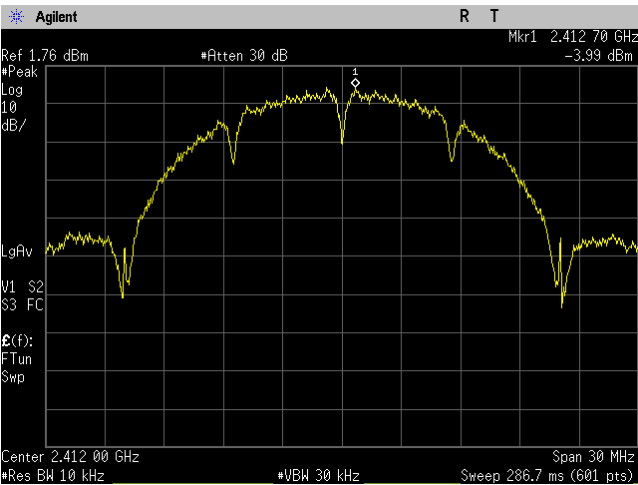
Note: The RBW was set to 10kHz in lieu of 3 kHz to demonstrate compliance.

Note: Peak PSD was used to demonstrate worst-case compliance

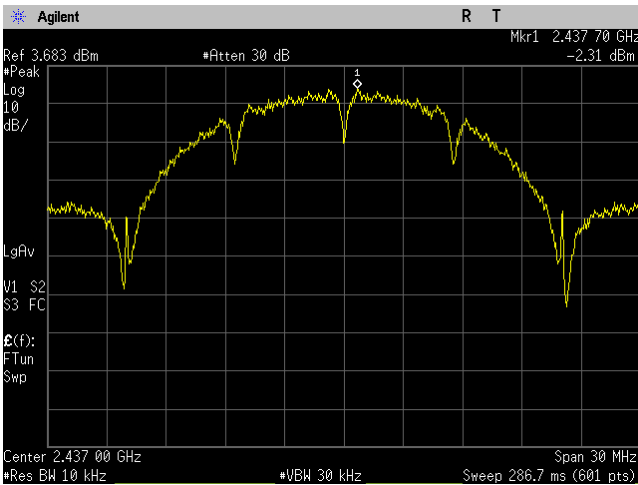
Note: See following plots for Power Spectrum Density test results.

802.11b

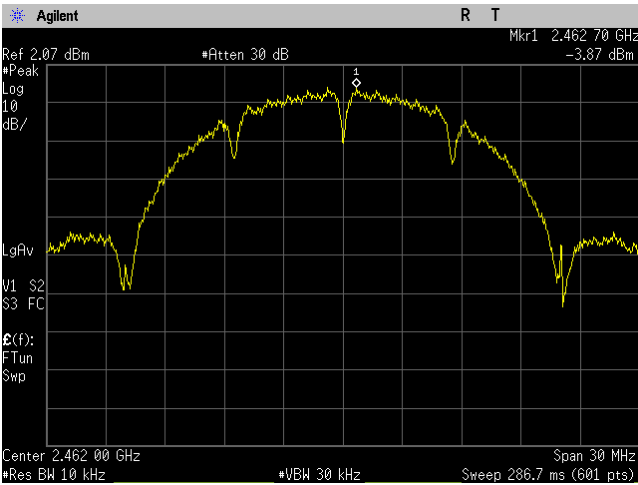
Low Channel: 2412 MHz



Middle Channel: 2437 MHz



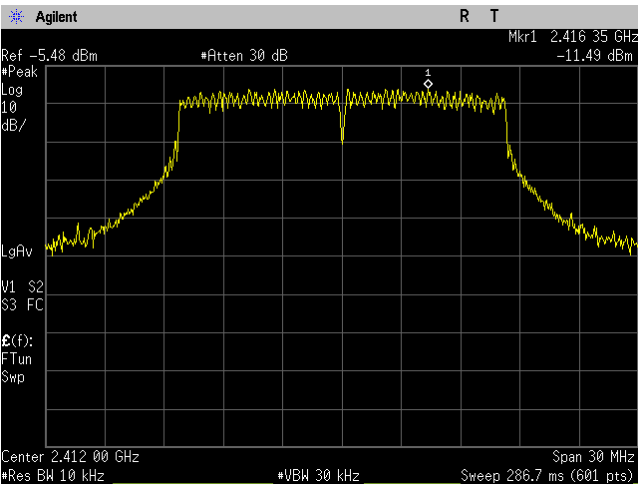
High Channel: 2462 MHz



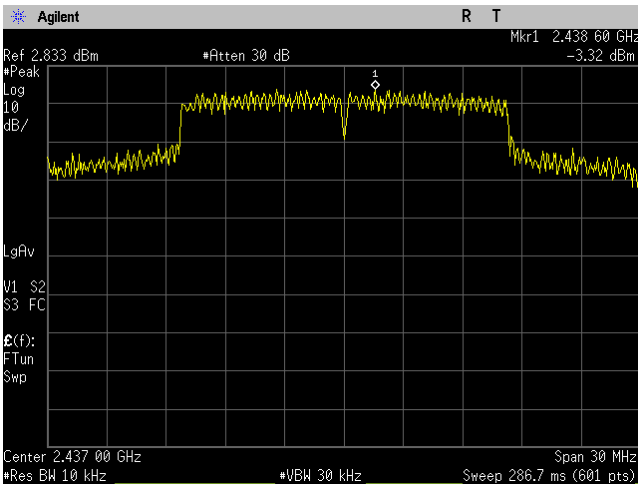


802.11g

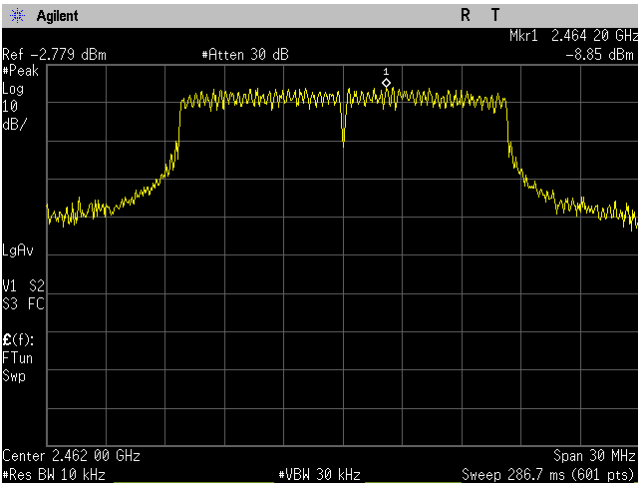
Low Channel: 2412 MHz



Middle Channel: 2437 MHz

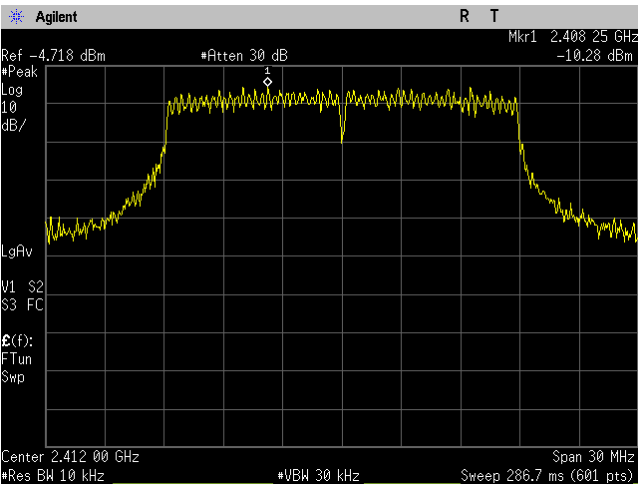


High Channel: 2462 MHz

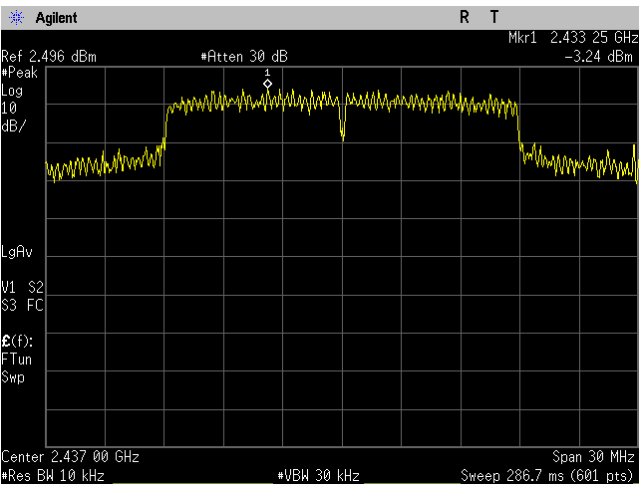


802.11n20

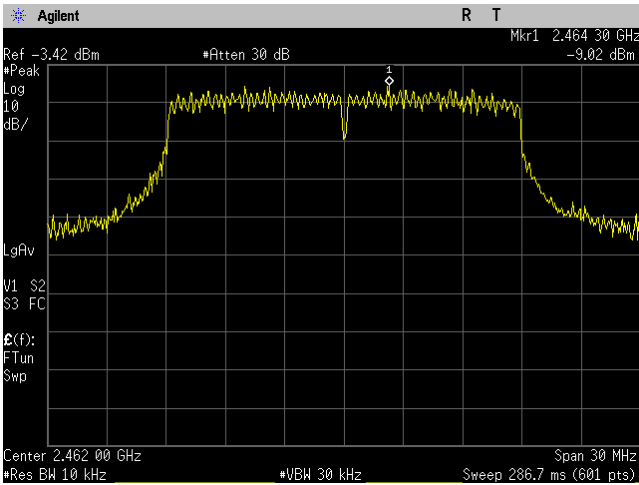
Low Channel: 2412 MHz



Middle Channel: 2437 MHz



High Channel: 2472 MHz



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## **11 Appendix A (Normative) – EUT Test Setup Photographs**

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Please refer to the attachment.

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## **12 Appendix B (Normative) – External Photographs**

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Please refer to the attachment

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## **13 Appendix C (Normative) – Internal Photographs**

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Please refer to the attachment

## 14 Appendix D (Normative) - A2LA Electrical Testing Certificate



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

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

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