





FCC PART 15, SUBPART C
ISED C RSS-247, ISSUE 2, FEBRUARY 2017
TEST REPORT

For

Emotiv Inc.

490 Post Street, Suite 824,
San Francisco, CA 94102, USA

FCC ID: 2ADIIH-INSIGHT02
IC: 12769A-INSIGHT02

Report Type: Original Report	Product Type: Mobile BCI Headset, Gaming Interface
Prepared By: Deepak Mishra Test Engineer	
Report Number: R2106012-247	
Report Date: 2021-08-02	
Reviewed By: Christian McCaig RF Project Engineer	
Bay Area Compliance Laboratories Corp. 1274 Anvilwood Avenue, Sunnyvale, CA 94089, USA Tel: +1 (408) 732-9162 Fax: +1 (408) 732-9164	



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

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

TABLE OF CONTENTS

1 General Description.....	5
1.1 Product Description for Equipment Under Test (EUT).....	5
1.2 Objective.....	5
1.3 Related Submittal(s)/Grant(s)	5
1.4 Test Methodology	5
1.5 Measurement Uncertainty	6
1.6 Test Facility Registrations	6
1.7 Test Facility Accreditations	6
2 System Test Configuration.....	9
2.1 Justification.....	9
2.2 EUT Exercise Software.....	9
2.3 Duty Cycle Correction Factor	9
2.4 Equipment Modifications.....	11
2.5 Local Support Equipment	11
2.6 Remote Support Equipment.....	11
2.7 Power Supply/Adapter	11
2.8 Interface Ports and Cabling.....	11
3 Summary of Test Results	12
4 FCC §15.203 & ISEDC RSS-Gen §6.8 - Antenna Requirements	13
4.1 Applicable Standards	13
4.2 Antenna Description	13
5 FCC §2.1093 & ISEDC RSS-102 - RF Exposure	14
5.1 Applicable Standards	14
5.2 RF Exposure Evaluation Exemption for FCC.....	15
5.3 RF Exposure Evaluation Exemption for ISED	15
6 FCC §15.209, §15.247(d) & ISEDC RSS-247 §5.5, RSS-Gen §8.9, §8.10 - Spurious Radiated Emissions.....	16
6.1 Applicable Standards	16
6.2 Test Setup	17
6.3 Test Procedure	18
6.4 Corrected Amplitude & Margin Calculation.....	18
6.5 Test Setup Block Diagram	19
6.6 Test Equipment List and Details.....	20
6.7 Test Environmental Conditions	21
6.8 Summary of Test Results	21
6.9 Radiated Emissions Test Results	22
7 FCC §15.247(a) (2) & ISEDC RSS-247 §5.2 - Emission Bandwidth	26
7.1 Applicable Standards	26
7.2 Measurement Procedure.....	26
7.3 Test Setup Block Diagram	26
7.4 Test Equipment List and Details.....	26
7.5 Test Environmental Conditions	27
7.6 Test Results.....	27
8 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4 (4) - Output Power Measurement	34
8.1 Applicable Standards	34
8.2 Measurement Procedure.....	34
8.3 Test Setup Block Diagram	34
8.4 Test Equipment List and Details.....	35
8.5 Test Environmental Conditions	35
8.6 Test Results.....	35
9 FCC §15.247(d) and ISEDC RSS-247 §5.5 – 100 kHz Bandwidth of Band Edges.....	39

9.1	Applicable Standards	39
9.2	Measurement Procedure.....	39
9.3	Test Setup Block Diagram	39
9.4	Test Equipment List and Details.....	40
9.5	Test Environmental Conditions	40
9.6	Test Results.....	40
10	FCC §15.247(d) & ISEDC RSS-247 §5.5 - Spurious Emissions at Antenna Terminals	43
10.1	Applicable Standards	43
10.2	Test Procedure	43
10.3	Test Setup Block Diagram.....	43
10.4	Test Equipment List and Details.....	43
10.5	Test Environmental Conditions	44
10.6	Test Results.....	44
11	FCC §15.247(e) & ISEDC RSS-247 §5.2(2) - Power Spectral Density	48
11.1	Applicable Standards	48
11.2	Measurement Procedure.....	48
11.3	Test Setup Block Diagram	48
11.4	Test Equipment List and Details.....	48
11.5	Test Environmental Conditions	49
11.6	Test Results.....	49
12	Annex A (Normative) - Test Setup Photographs	53
13	Annex B (Normative) - EUT External Photographs.....	54
14	Annex C (Normative) - EUT Internal Photographs	55
15	Annex D (Normative) - A2LA Electrical Testing Certificate.....	56

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2106012-247	Original Report	2021-07-26
1	R2106012-247	Updated 17065 technical review comments	2021-08-02

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test report was prepared on behalf of *Emotiv Inc* and their product: *EMOTIV INSIGHT*, model: 2.0, or the “EUT” as referred to in this report. The EUT is a consumer EEG headset for brain computer interface applications, they measure the tiny electrical impulses of the brain from the surface of the scalp using conductive polymer electrodes and transmit via Bluetooth to the a PC/ Mobile. The EUT contains a Bluetooth LE radio.

Measurements were taken from a conducted sample with serial number: R2106012-1 and a radiated sample with serial number: R2106012-2

1.2 Objective

This report was prepared on behalf of *Emotiv Inc*, in accordance with Part 2, Subpart J, and Part 15, Subpart and C of the Federal Communication Commission’s rules and ISED RSS-247 Issue 2, February 2017.

The objective was to determine compliance with FCC Part 15.247 and ISED RSS-247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

N/A

1.4 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

1.5 Measurement Uncertainty

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

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

1.6 Test Facility Registrations

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

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

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

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

1.7 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2005 by A2LA (Test Laboratory Accreditation Certificate Number 3297.01), 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 3297.02) 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 3297.03) 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.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power, peak power and PPSD across all data rates bandwidths, and modulations.

2.2 EUT Exercise Software

NRF Connect was used and software is compliant with the standard requirements being tested against.

Modulation	Data Rate	Frequency (MHz)	Power Setting	Packet Length Setting
BLE	1 Mbps	2402	+2 dBm	37
		2440	+2 dBm	37
		2480	+2 dBm	37
	2 Mbps	2402	+2 dBm	63
		2440	+2 dBm	63
		2480	+2 dBm	63

2.3 Duty Cycle Correction Factor

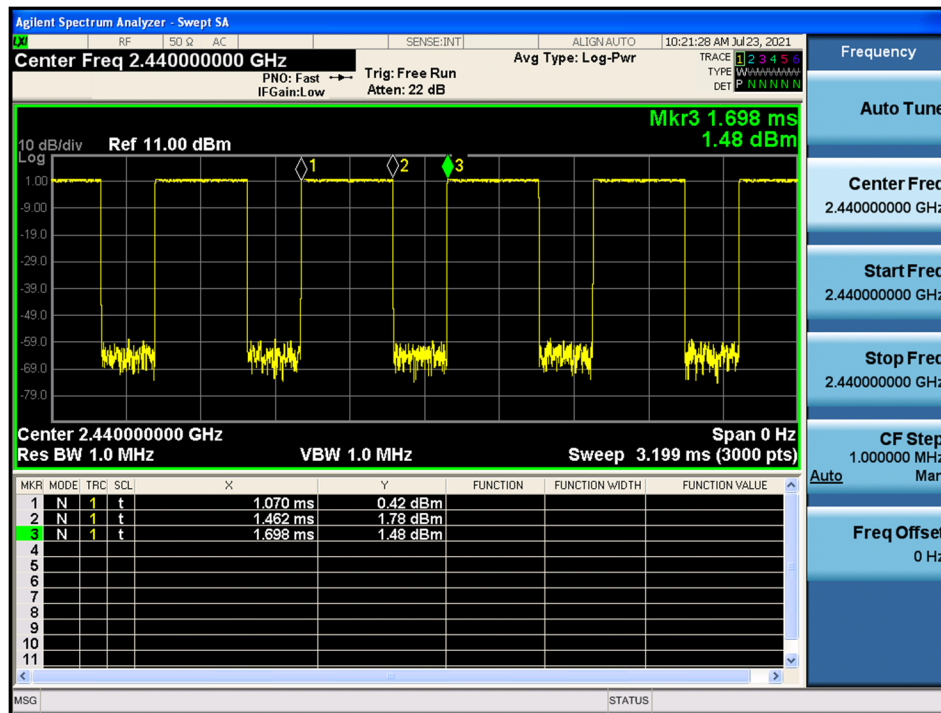
According to KDB 558074 D01 DTS Meas Guidance v05r02 section 6.0:

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

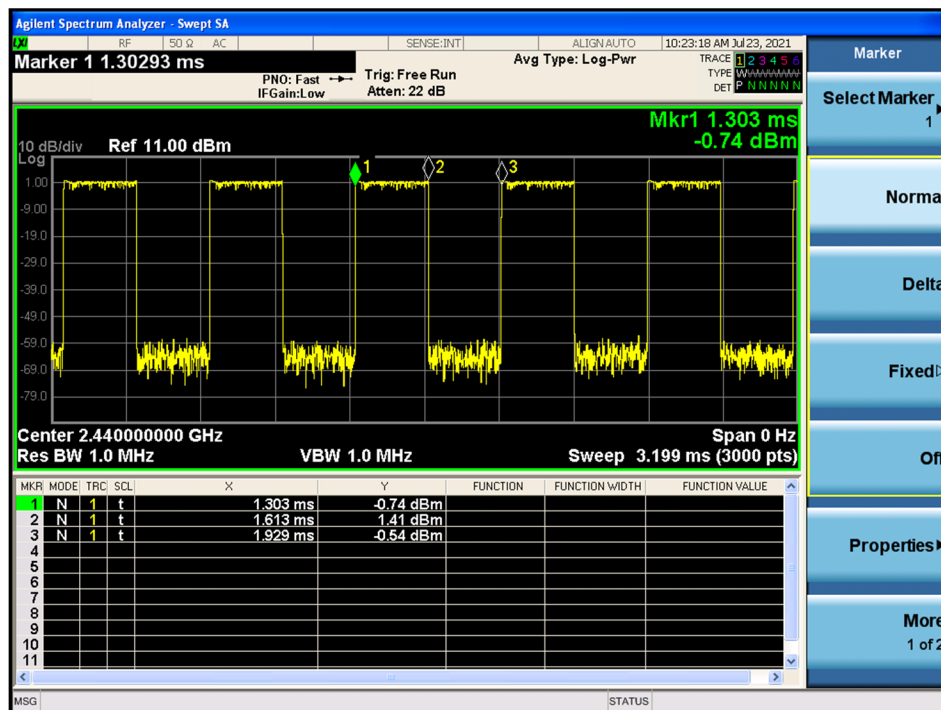
Radio Rate	Packet Length Setting	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
1 Mbps	37	0.392	0.628	62.42	2.05
2 Mbps	63	0.31	0.626	49.52	3.05

Duty Cycle = On Time (ms)/ Period (ms)
Duty Cycle Correction Factor (dB) = $10 \cdot \log(1/\text{Duty Cycle})$
Please refer to the following plots.

1 Mbps



2 Mbps



2.4 Equipment Modifications

None

2.5 Local Support Equipment

Manufacturer	Description	Model
Dell	Laptop	Latitude E6410

2.6 Remote Support Equipment

Manufacturer	Description	Model
Sparkfun	3.3V UART-USB serial adaptor	SerialBasic

2.7 Power Supply/Adapter

N/A

2.8 Interface Ports and Cabling

Description	Length (m)	To	From
Jumper Wires	<1m	EUT	Debug board
USB Cable	<1m	Debug board	Laptop

3 Summary of Test Results

Results reported relate only to the product tested.

FCC & ISEDC Rules	Description of Test	Results
FCC §15.203 ISEDC RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207 ISEDC RSS-Gen §8.8	AC Line Conducted Emissions	N/A ¹
FCC §2.1091, §15.247(i) ISEDC RSS-102	RF Exposure	Compliant
FCC §2.1053, §15.205, §15.209, §15.247 (d) ISEDC RSS-247 §5.5 ISEDC RSS-Gen §8.9 and §8.10	Radiated Spurious Emissions	Compliant
FCC §15.247(a)(2) ISEDC RSS-247 §5.2(1)	6 dB and 99% Emission Bandwidth	Compliant
FCC §2.1051, §15.247 (d) ISEDC RSS-247 §5.5	Spurious Emissions at Antenna Terminal	Compliant
FCC §15.247(d) ISEDC RSS-247 §5.5	100 kHz Bandwidth of Frequency Band Edge	Compliant
FCC §15.247(b)(3) ISEDC RSS-247 §5.4(4)	Maximum Output Power	Compliant
FCC §15.247(e) ISEDC RSS-247 §5.2(2)	Peak Power Spectrum Density	Compliant

Note¹: Device is battery powered and cannot transmit while charging. AC Line testing is not applicable.

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

4.1 Applicable Standards

According to FCC §15.203:

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

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

According to ISEDC RSS-Gen §6.8: Transmitter Antenna

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

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

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

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

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

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

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

4.2 Antenna Description

External/Internal/ Integral	Frequency Range (MHz)	Antenna Type	Maximum Antenna Gain (dBi)
Internal	2400-2483.5 MHz	Punched Metal	-0.6

Antenna gain is information provided by customer.

5 FCC §2.1093 & ISEDC RSS-102 - RF Exposure

5.1 Applicable Standards

According to FCC KDB 447498 D01 General RF Exposure Guidance v06 Section 4.3.1, Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition, listed below, is satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The minimum test separation distance is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander (see 5) of section 4.1). To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, typically in the SAR measurement or SAR analysis report, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for the SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops & tablets etc.

- 1) The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$\left[\frac{\text{(max. power of channel, including tune-up tolerance, mW)}}{\text{(min. test separation distance, mm)}} \right] \cdot \left[\sqrt{f(\text{GHz})} \right] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

- f (GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

- 2) At 100 MHz to 6 GHz and for test separation distances > 50 mm, the SAR test exclusion threshold is determined according to the following, and as illustrated in Appendix B:
 - a) $[\text{Power allowed at numeric threshold for 50 mm in step 1)} + (\text{test separation distance} - 50 \text{ mm}) \cdot (f(\text{MHz})/150)] \text{ mW}$, at 100 MHz to 1500 MHz
 - b) $[\text{Power allowed at numeric threshold for 50 mm in step 1)} + (\text{test separation distance} - 50 \text{ mm}) \cdot 10] \text{ mW}$ at > 1500 MHz and ≤ 6 GHz
- 3) At frequencies below 100 MHz, the following may be considered for SAR test exclusion, and as illustrated in Appendix C:
 - a) The power threshold at the corresponding test separation distance at 100 MHz in step 2) is multiplied by $[1 + \log(100/f(\text{MHz}))]$ for test separation distances > 50 mm and < 200 mm
 - b) The power threshold determined by the equation in a) for 50 mm and 100 MHz is multiplied by $\frac{1}{2}$ for test separation distances ≤ 50 mm

- c) SAR measurement procedures are not established below 100 MHz. When SAR test exclusion cannot be applied, a KDB inquiry is required to determine SAR evaluation requirements for any test results to be acceptable.

According to ISSED RSS-102 Issue 5 Section 2.5.1 Exemption Limits for Routine Evaluation-SAR Evaluation:

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in table below,

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71	101	132	162	193
450	52	70	88	106	123
835	17	30	42	55	67
1900	7	10	18	34	60
2450	4	7	15	30	52
3500	2	6	16	32	55
5800	1	6	15	27	41

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223	254	284	315	345
450	141	159	177	195	213
835	80	92	105	117	130
1900	99	153	225	316	431
2450	83	123	173	235	309
3500	86	124	170	225	290
5800	56	71	85	97	106

5.2 RF Exposure Evaluation Exemption for FCC

The maximum conducted output power measured from the EUT is 2.92 dBm (1.96 mW), the antenna gain is -0.6 dBi. Therefore, the maximum output power is 2.92 dBm (1.96 mW). According to FCC KDB 447498,

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] [\sqrt{f(\text{GHz})}] = (1.96 \text{ mW}/5\text{mm}) * \sqrt{2.48} = 0.617$, which is less than 3.0. Therefore, FCC SAR testing is excluded.

5.3 RF Exposure Evaluation Exemption for ISSED

The maximum output power = 2.92 dBm (1.96 mW) which is less than 4 mW. Therefore, ISSED SAR testing is not required.

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

6.1 Applicable Standards

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

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

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5.35 – 5.46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 – 167.17	3332 – 3339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	33458 – 3358	23.6 – 24.0
12.29 – 12.293	240 – 285	3600 – 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 ISED RSS-Gen 8.9,

Except when the requirements applicable to a given device state otherwise, emission from licence-exempt transmitters shall comply 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 Licence-Exemption Transmitters at Frequencies above 30 MHz

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

6.2 Test Setup

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

6.3 Test Procedure

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

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

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

The spectrum analyzer or receiver is set as:

Below 1000 MHz:

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

Above 1000 MHz:

- (1) Peak: $\text{RBW} = 1\text{MHz} / \text{VBW} = 1\text{MHz} / \text{Sweep} = \text{Auto}$
- (2) Average: $\text{RBW} = 1\text{MHz} / \text{VBW} = 10\text{Hz} / \text{Sweep} = \text{Auto}$

6.4 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:

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

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:

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

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:

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

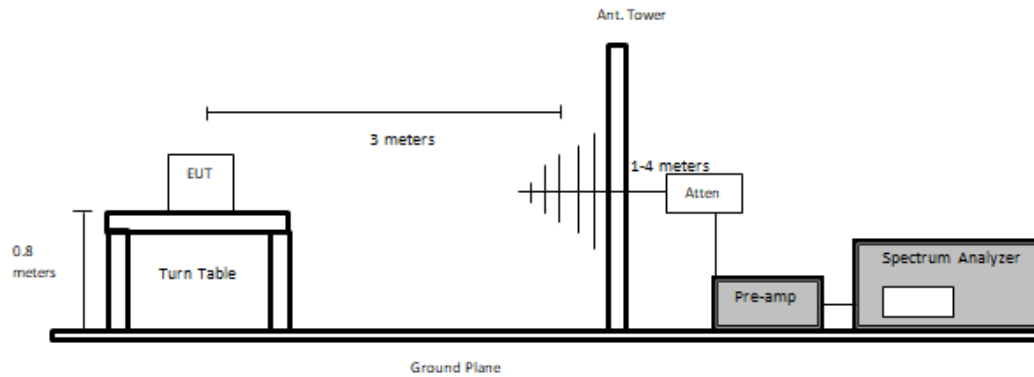
For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

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:

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

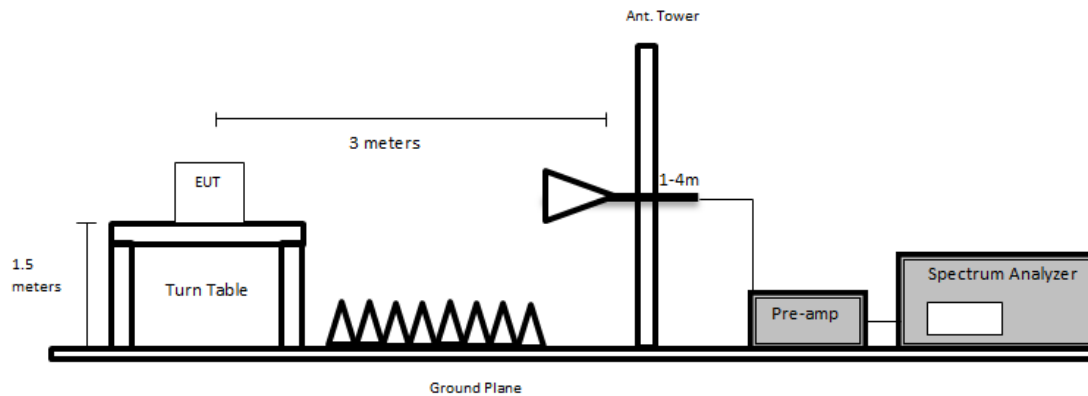
6.5 Test Setup Block Diagram

Below 1GHz:

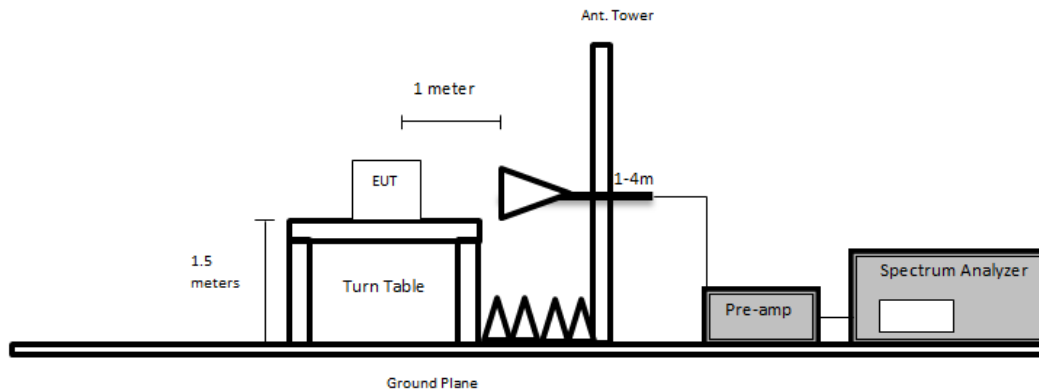


Above 1GHz:

At 3 meters:



At 1 meter:



6.6 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Agilent	Spectrum Analyzer	E4446A	MY48250238	2021-02-12	1 year
Rhode & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100044	2021-05-14	2 years
BACL	5m3 Sensitivity Box	1	2	2020-10-27	1 year
Sunol Sciences	System Controller	SC99V	011003-1	N/R	N/A
Sunol Sciences	Biconilog Antenna	JB3	A020106-2	2019-11-20	2 years
ETS Lindgren	Horn Antenna	3117	00218973	2019-02-13	2.5 years
Wisewave	Antenna, Horn	ARH-2823-02	10555-01	2020-02-05	2 years
-	SMA cable	-	-	Each time ¹	N/A
-	RF cable	-	-	Each time ¹	N/A
IW Incorporated	157 Series 2.92 SM (x2) Armored 33 ft. Cable	KPS-1571AN-3960-KPS	DC 1917	2021-03-03	1 year
IW Incorporated	157 Series Cable Armored with 2.92mm Male Plugs on Both Sides	KPS-1571AN-2400	DC 1922	2020-06-06	18 months
MDP Digital	Times Microwave LMR 400 UltraFex Coaxial Cable 35'	LMR400UF	BACL1904161	2020-05-20	18 months
Agilent	Preamplifier	8449B	3147A00400	2021-03-02	1 year
AH Systems	Pre-Amplifier	PAM 1840 VH	170	2020-11-09	1 year
HP	Pre Amplifier	8447D	2443A04374	2020-08-17	1 year
Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

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

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

6.7 Test Environmental Conditions

Temperature:	19 °C
Relative Humidity:	34 %
ATM Pressure:	102.2 kPa

The testing was performed by Allen Huang and Giriraj Gurjar from 2021-06-16 to 2021-07-16 at 5-meter chamber 3.

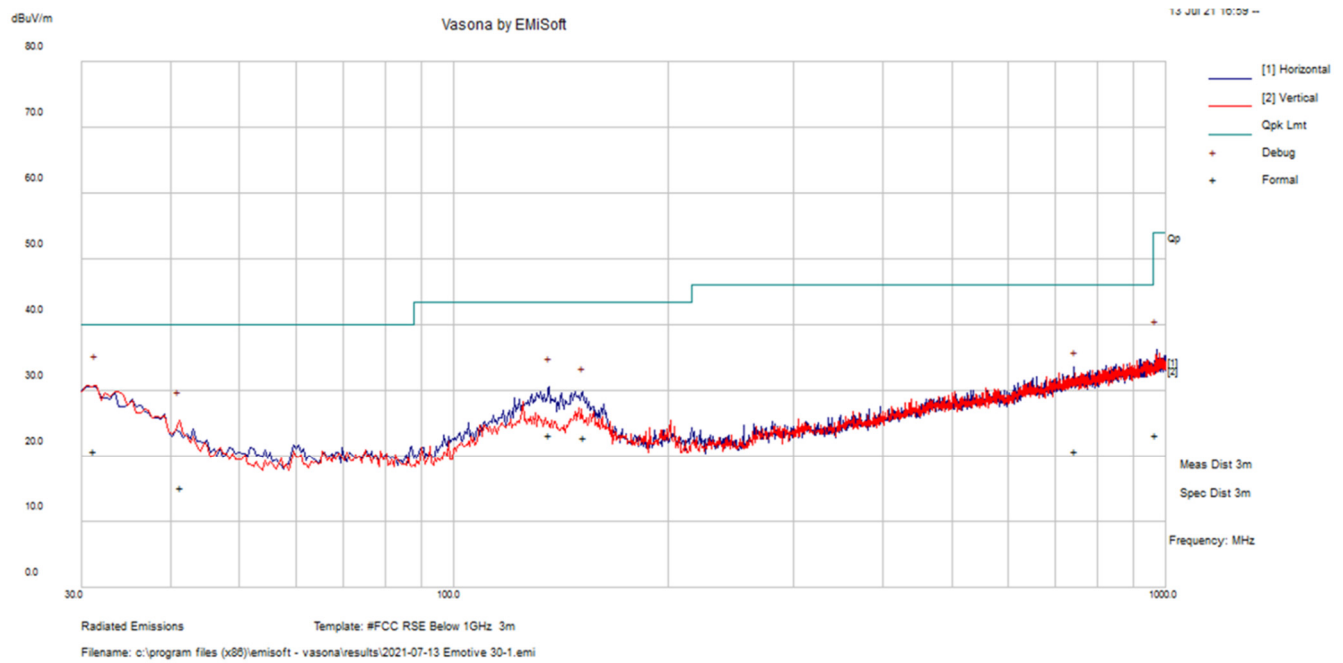
6.8 Summary of Test Results

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

Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Transmitting Channel (MHz)
-2.00	7320	Vertical	2440, 1 Mbps

6.9 Radiated Emissions Test Results

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



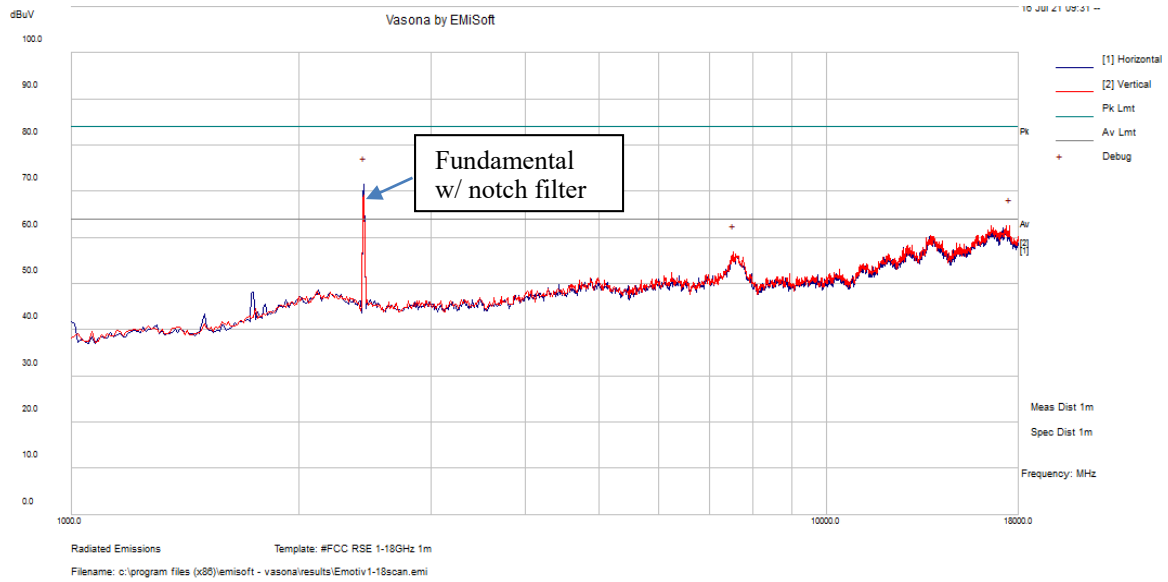
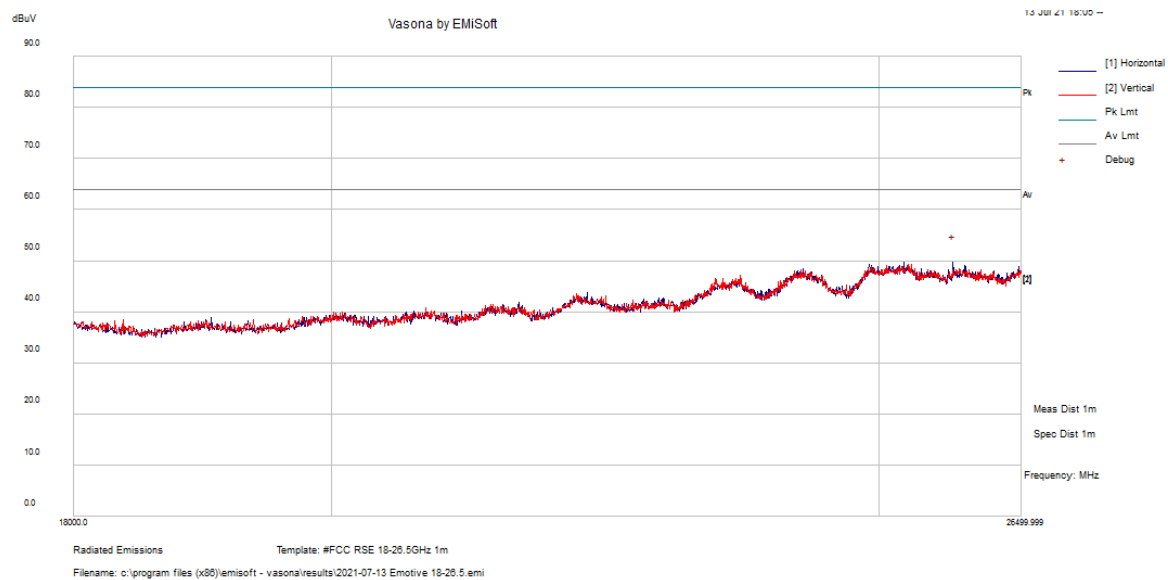
Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comment
31.26725	19.28	1.51	20.79	119	V	226	40	-19.21	Pass
136.12075	28.24	-4.89	23.35	216	H	49	43.5	-20.15	Pass
747.43725	17.6	3.29	20.89	122	H	255	46	-25.11	Pass
152.27525	28.63	-5.81	22.82	277	H	343	43.5	-20.68	Pass
41.33825	21.31	-6.21	15.1	258	V	177	40	-24.9	Pass
969.25025	17.51	5.75	23.26	227	H	16	54	-30.74	Pass

2) 1–26.5 GHz, Measured at 3 Meters**1 Mbps:**

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/ISED		Note
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel Frequency: 2402 MHz											
2390	47.39	285	225	H	32.6	5.663	36.863	48.79	74	-25.21	Peak
2390	47.69	270	150	V	32.6	5.663	36.863	49.09	74	-24.91	Peak
2390	37.51	285	225	H	32.6	5.663	36.863	38.91	54	-15.09	Ave
2390	37.38	270	150	V	32.6	5.663	36.863	38.78	54	-15.22	Ave
4804	44.46	230	230	H	35	9.826	35.707	53.58	74	-20.42	Peak
4804	44.55	50	150	V	35	9.826	35.707	53.67	74	-20.33	Peak
4804	35.14	230	230	H	35	9.826	35.707	44.26	54	-9.74	Ave
4804	35.34	50	150	V	35	9.826	35.707	44.46	54	-9.54	Ave
Middle Channel Frequency: 2440 MHz											
4880	46.05	145	150	H	35.3	8.336	35.707	53.979	74	-20.021	Peak
4880	46.15	340	165	H	35.3	8.336	35.707	54.079	74	-19.921	Peak
4880	36.88	145	150	H	35.3	8.336	35.707	44.809	54	-9.191	Ave
4880	36.54	340	165	H	35.3	8.336	35.707	44.469	54	-9.531	Ave
7320	45.64	150	150	H	36.1	13.869	36.483	59.126	74	-14.874	Peak
7320	45.71	185	110	V	36.1	13.869	36.483	59.196	74	-14.804	Peak
7320	37.31	150	150	H	36.1	13.869	36.483	50.80	54	-3.20	Ave
7320	38.51	185	110	V	36.1	13.869	36.483	52.00	54	-2.00	Ave
High Channel Frequency: 2480 MHz											
2483.5	46.90	285	220	H	33	5.763	36.863	48.80	74	-25.20	Peak
2483.5	50.38	40	150	V	33	5.763	36.863	52.28	74	-21.72	Peak
2483.5	36.66	285	220	H	33	5.763	36.863	38.56	54	-15.44	Ave
2483.5	36.91	40	150	V	33	5.763	36.863	38.81	54	-15.19	Ave
4960	45.94	145	150	H	35.4	8.336	35.707	53.97	74	-20.03	Peak
4960	46.07	340	165	V	35.4	8.336	35.707	54.10	74	-19.90	Peak
4960	36.71	145	150	H	35.4	8.336	35.707	44.74	54	-9.26	Ave
4960	36.15	340	165	V	35.4	8.336	35.707	44.18	54	-9.82	Ave
7440	45.67	80	150	H	36.1	13.459	36.483	58.75	74	-15.25	Peak
7440	46.16	355	155	V	36.1	13.459	36.483	59.24	74	-14.76	Peak
7440	37.20	80	150	H	36.1	13.459	36.483	50.28	54	-3.72	Ave
7440	38.82	355	155	V	36.1	13.459	36.483	51.90	54	-2.10	Ave

2 Mbps:

Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre- Amp. (dB)	Cord. Reading (dBμV/m)	FCC/ISED		Note
			Height (cm)	Polarity (H/V)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)	
Low Channel Frequency: 2402 MHz											
2390	46.84	335	215	H	32.6	5.663	36.863	48.24	74	-25.76	Peak
2390	46.94	0	150	V	32.6	5.663	36.863	48.34	74	-25.66	Peak
2390	38.03	335	215	H	32.6	5.663	36.863	39.43	54	-14.57	Ave
2390	38.25	0	150	V	32.6	5.663	36.863	39.65	54	-14.35	Ave
4804	46.16	0	150	H	35	8.516	35.707	53.97	74	-20.03	Peak
4804	46.60	185	110	V	35	8.516	35.707	54.41	74	-19.59	Peak
4804	37.54	0	150	H	35	8.516	35.707	45.35	54	-8.65	Ave
4804	39.06	185	110	V	35	8.516	35.707	46.87	54	-7.13	Ave
Middle Channel Frequency: 2440 MHz											
4880	46.17	340	150	H	35.3	8.866	35.707	54.629	74	-19.371	Peak
4880	46.18	140	150	H	35.3	8.866	35.707	54.639	74	-19.361	Peak
4880	38.09	340	150	H	35.3	8.866	35.707	46.55	54	-7.45	Ave
4880	37.85	140	150	H	35.3	8.866	35.707	46.309	54	-7.691	Ave
7320	46.35	155	150	H	36.1	13.869	36.483	59.836	74	-14.164	Peak
7320	46.83	185	110	V	36.1	13.869	36.483	60.316	74	-13.684	Peak
7320	37.37	155	150	H	36.1	13.869	36.483	50.86	54	-3.14	Ave
7320	38.41	185	110	V	36.1	13.869	36.483	51.90	54	-2.10	Ave
High Channel Frequency: 2480 MHz											
2483.5	50.01	340	150	H	33	5.763	36.863	51.91	74	-22.09	Peak
2483.5	51.69	35	150	V	33	5.763	36.863	53.59	74	-20.41	Peak
2483.5	39.76	340	150	H	33	5.763	36.863	41.66	54	-12.34	Ave
2483.5	41.50	35	150	V	33	5.763	36.863	43.40	54	-10.60	Ave
4960	45.49	360	150	H	35.4	8.646	35.707	53.83	74	-20.17	Peak
4960	44.98	140	150	V	35.4	8.646	35.707	53.32	74	-20.68	Peak
4960	36.98	360	150	H	35.4	8.646	35.707	45.32	54	-8.68	Ave
4960	36.84	140	150	V	35.4	8.646	35.707	45.18	54	-8.82	Ave
7440	45.86	80	150	H	36.1	13.459	36.483	58.94	74	-15.06	Peak
7440	46.79	360	150	V	36.1	13.459	36.483	59.87	74	-14.13	Peak
7440	37.85	80	150	H	36.1	13.459	36.483	50.93	54	-3.07	Ave
7440	38.05	360	150	V	36.1	13.459	36.483	51.13	54	-2.87	Ave

1 – 18 GHz Worst Case Pre-Scan, Measured at 1 meter**18 – 26.5 GHz Worst Case Pre-Scan, Measured at 1 meter**

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

7.1 Applicable Standards

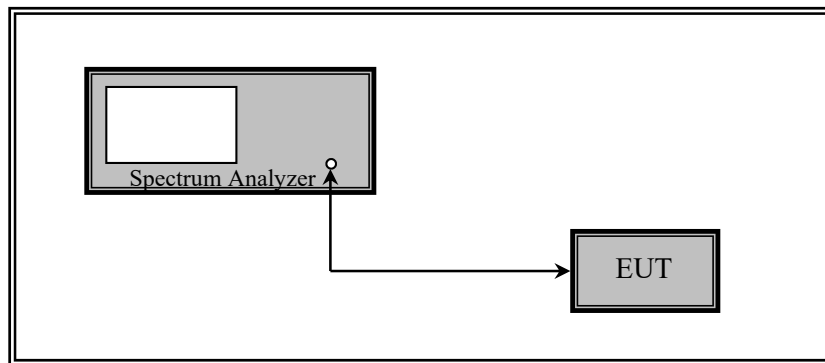
According to ECFR §15.247(a) (2) and ISEDC RSS-247 §5.2(a), systems using digital modulation techniques may operate in the 902~928 MHz, 2400~2483.5 MHz, and 5725~5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz

7.2 Measurement Procedure

The 6 dB bandwidth, i.e., DTS bandwidth, measurements were 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 8.2: DTS bandwidth.

The 99% occupied bandwidth was measured in accordance with IC RSS-Gen Issue 5, Section 6.7.

7.3 Test Setup Block Diagram



7.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
-	RF cable	-	-	Each time ¹	N/A

Note¹: Equipment was calibrated for each test.

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

Temperature:	24° C
Relative Humidity:	45 %
ATM Pressure:	101.6 KPa

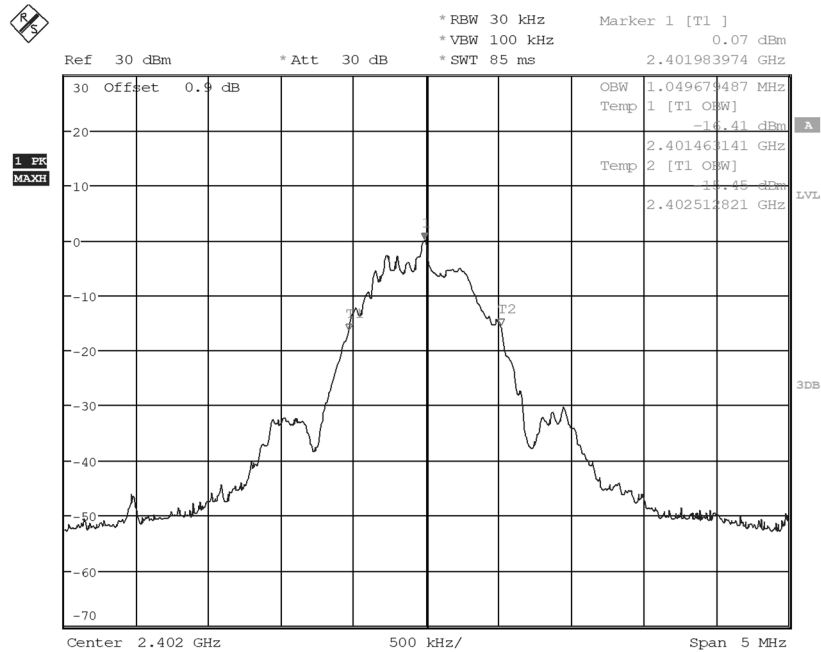
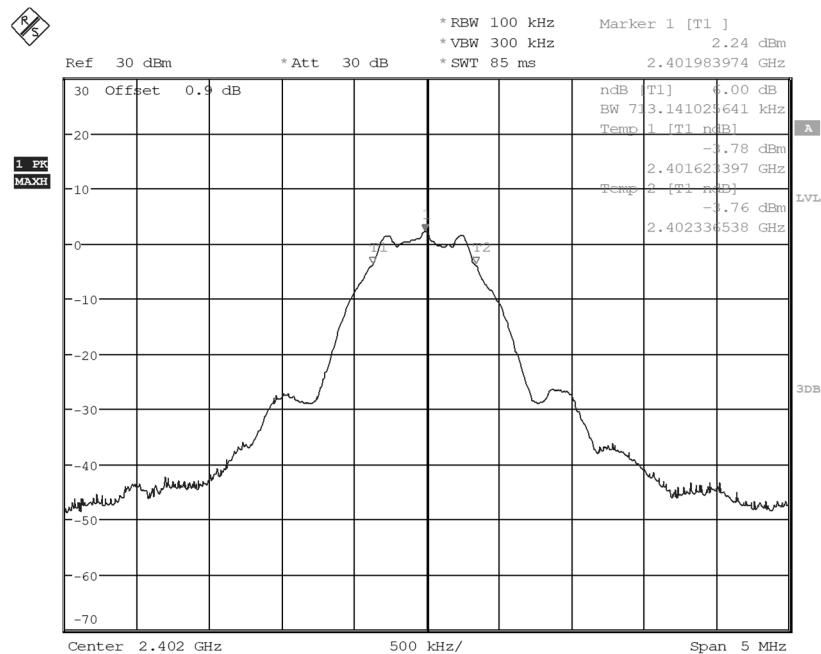
The testing was performed by Deepak Mishra on 2021-07-07 and 2021-07-08 in RF site.

7.6 Test Results

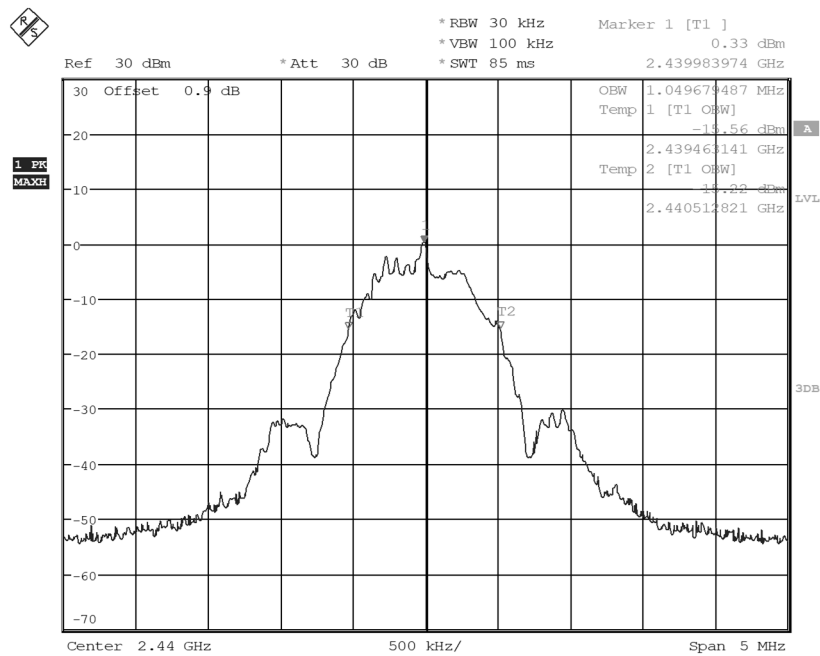
99% and 6 dB Bandwidth

Mode	Channel	Frequency (MHz)	99% OBW (MHz)	6 dB BW (kHz)	6 dB BW limit (kHz)
1 Mbps	Low	2402	1.05	713	>500
	Middle	2440	1.05	705	>500
	High	2480	1.05	705	>500
2 Mbps	Low	2402	2.05	1154	>500
	Middle	2440	2.05	1154	>500
	High	2480	2.05	1154	>500

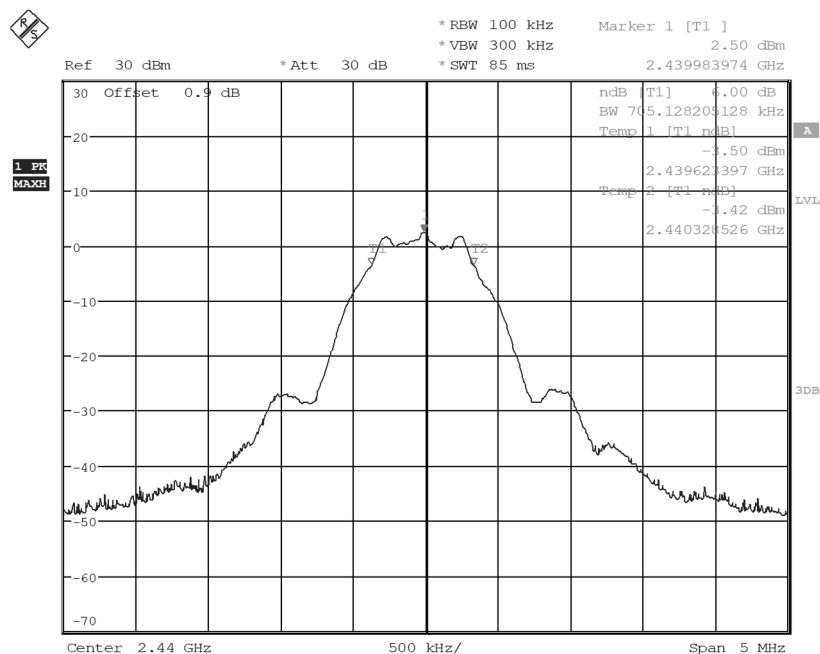
Please refer to the following plots.

1 Mbps**2402 MHz 99% OBW****2402 MHz 6 dB OBW**

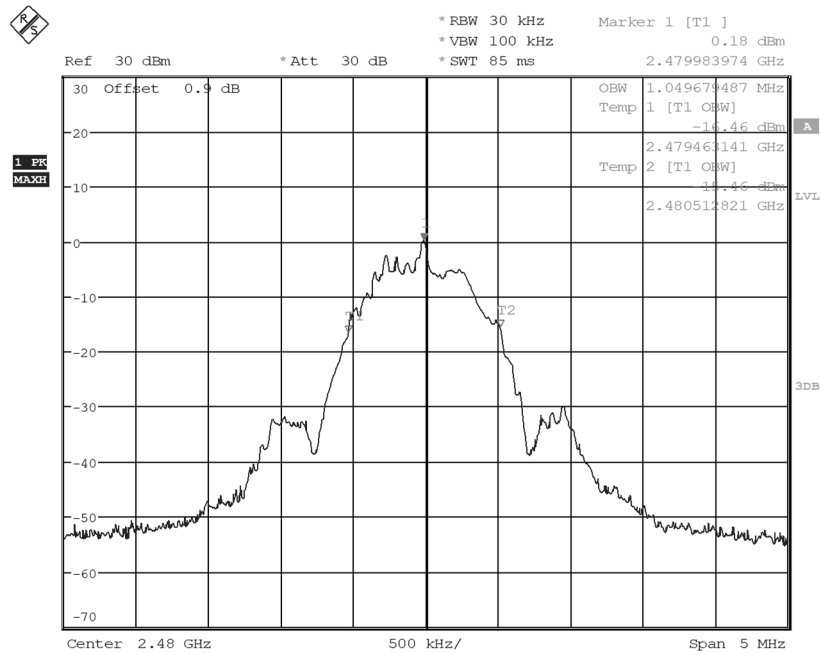
2440 MHz 99% OBW



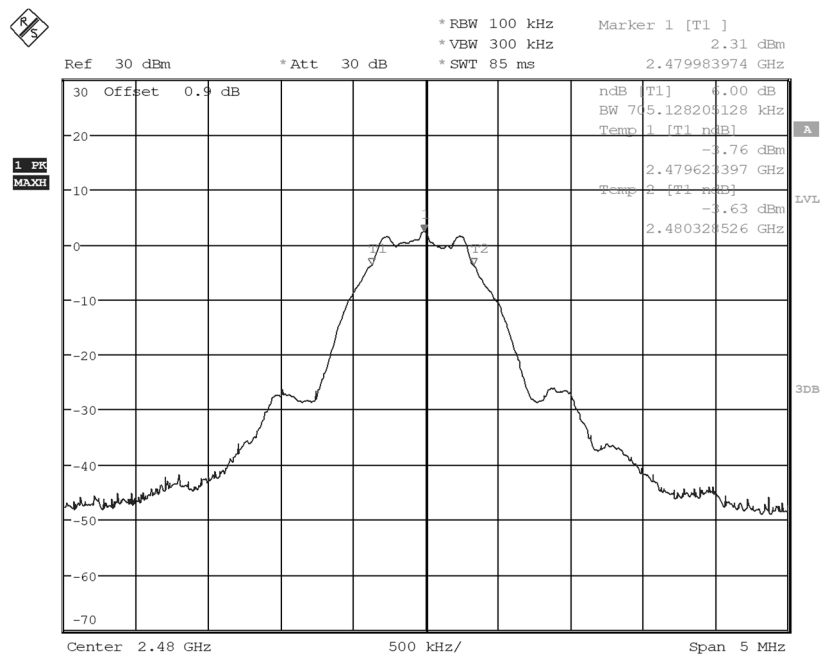
2440 MHz 6 dB OBW

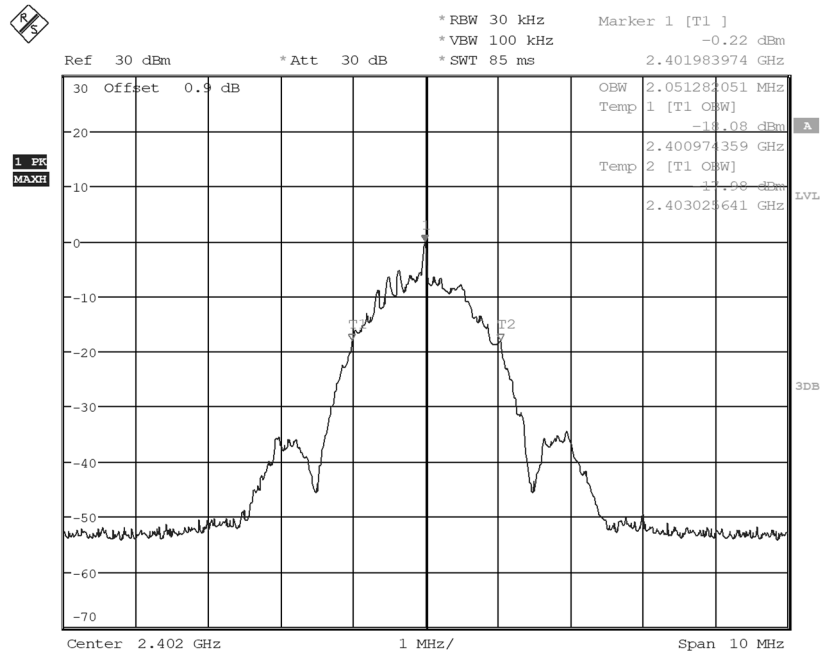
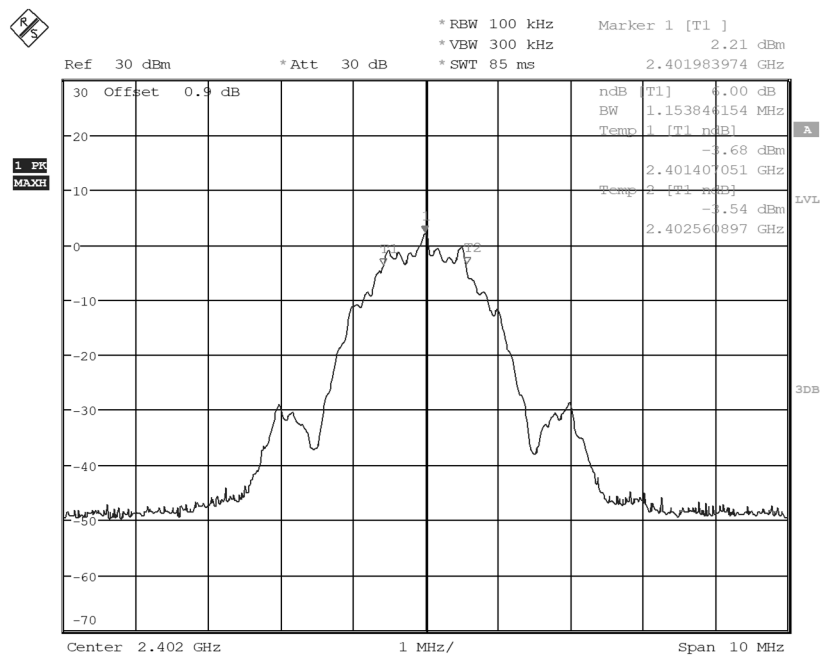


2480 MHz 99% OBW

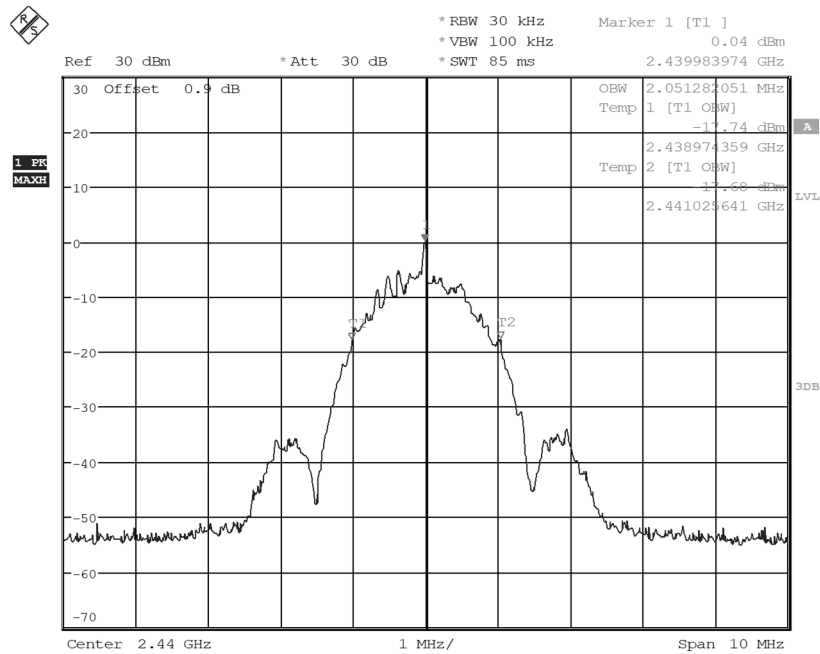


2480 MHz 6 dB OBW

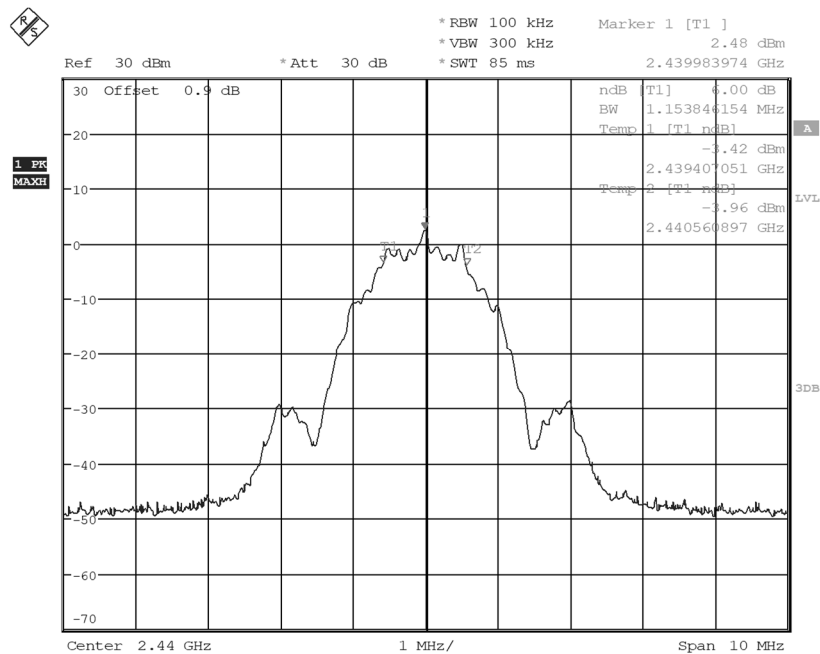


2 Mbps**2402 MHz 99% OBW****2402 MHz 6 dB OBW**

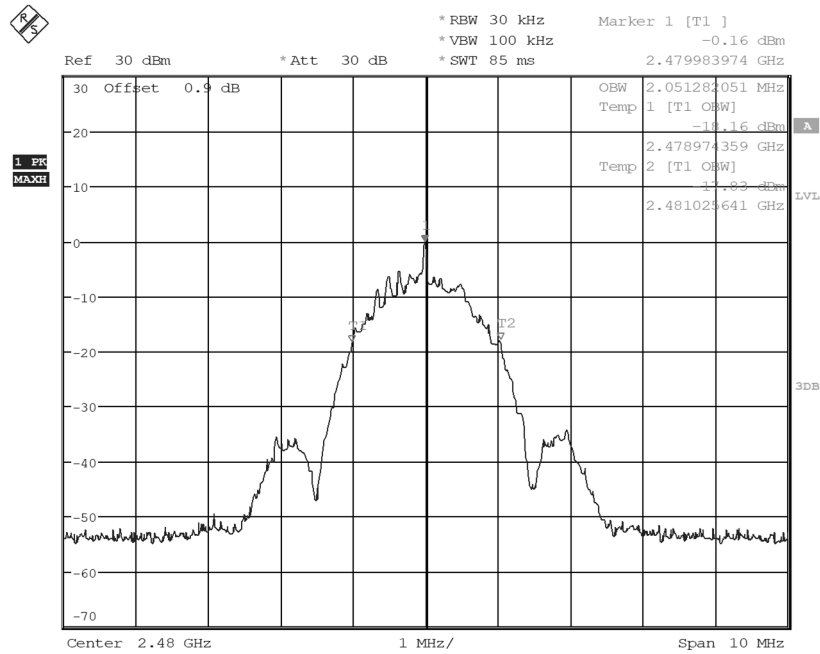
2440 MHz 99% OBW



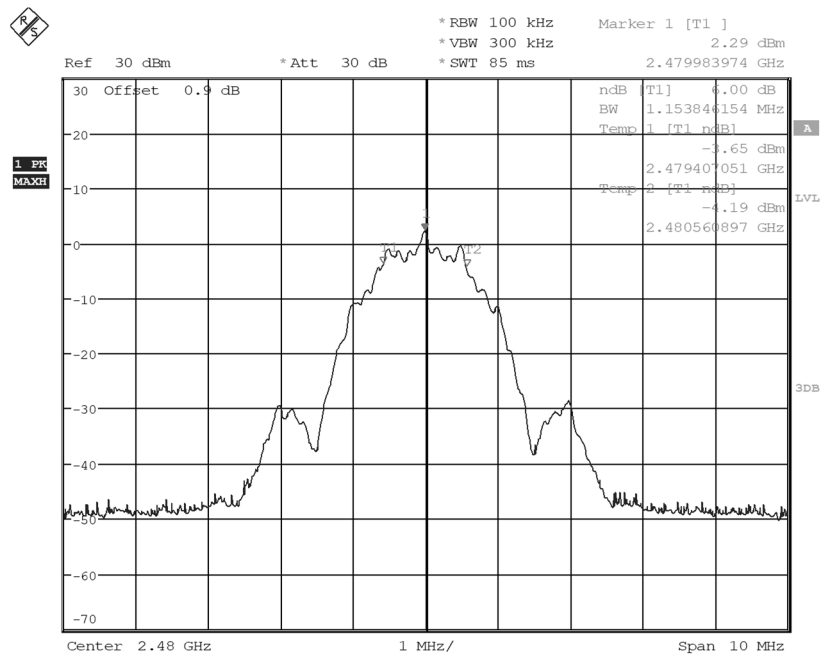
2440 MHz 6 dB OBW



2480 MHz 99% OBW



2480 MHz 6 dB OBW



8 FCC §15.247(b) (3) & ISEDC RSS-247 §5.4 (4) - Output Power Measurement

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 syMbpsols 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(d): 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

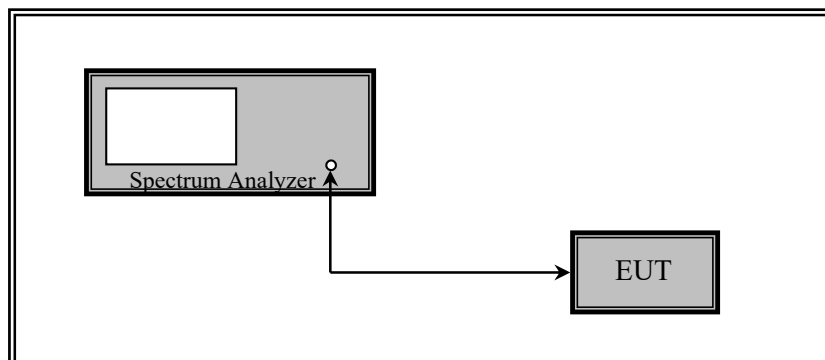
The measurements were based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8.3: DTS fundamental emission output power.

Corrected Average Field Strength (dBμV/m) = Measured Average Field Strength (dBμV) + Cable Loss (dB) + Antenna Factor (dB/m)

EIRP (dBm) = Field Strength (dBμV/m) + 20log(D(m)) - 104.77

Conducted Output Power = EIRP – Antenna Gain

8.3 Test Setup Block Diagram



8.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
	RF cable	-	-	Each time ¹	N/A

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

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

8.5 Test Environmental Conditions

Temperature:	24° C
Relative Humidity:	45 %
ATM Pressure:	101.6 KPa

The testing was performed by Deepak Mishra on 2021-07-07 and 2021-07-08 in RF site.

8.6 Test Results

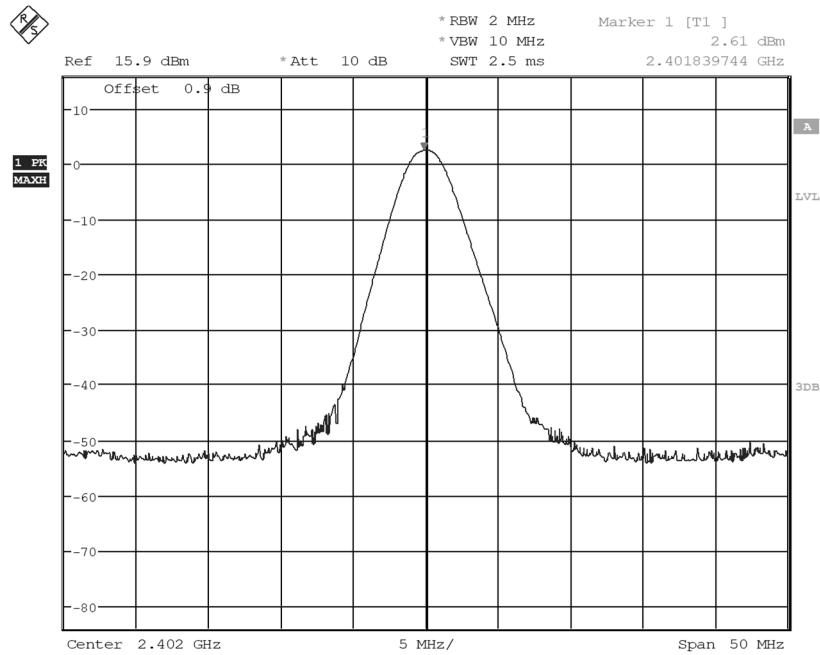
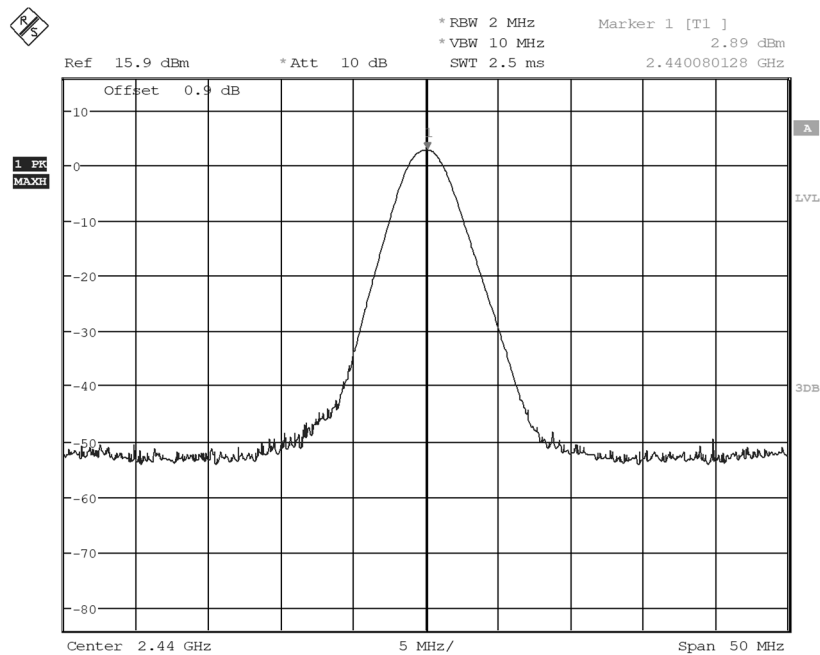
1 Mbps

Channel	Frequency (MHz)	Conducted Peak Power (dBm)	Limit (dBm)
Low	2402	2.61	30
Middle	2440	2.89	30
High	2480	2.74	30

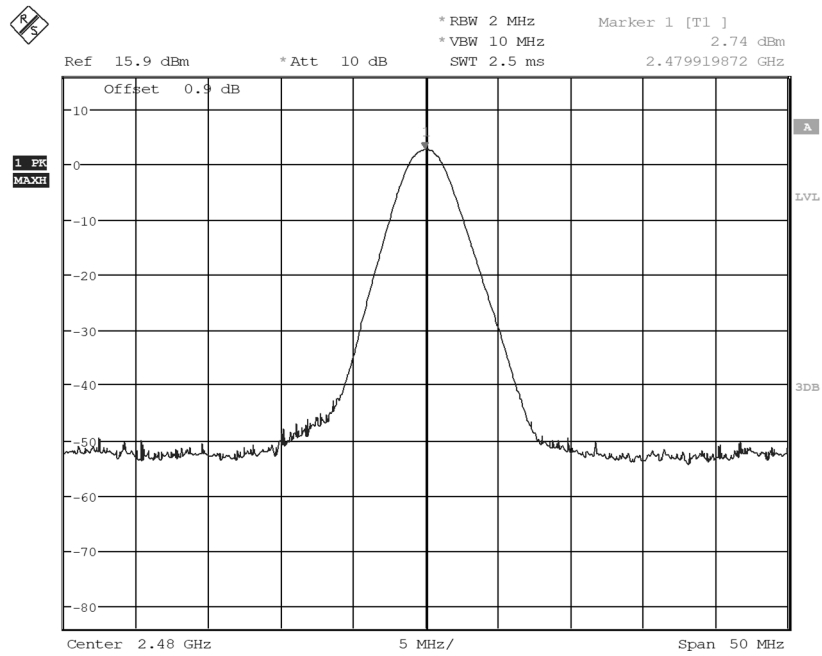
2 Mbps

Channel	Frequency (MHz)	Conducted Peak Power (dBm)	Limit (dBm)
Low	2402	2.65	30
Middle	2440	2.92	30
High	2480	2.69	30

Please refer to the following plots.

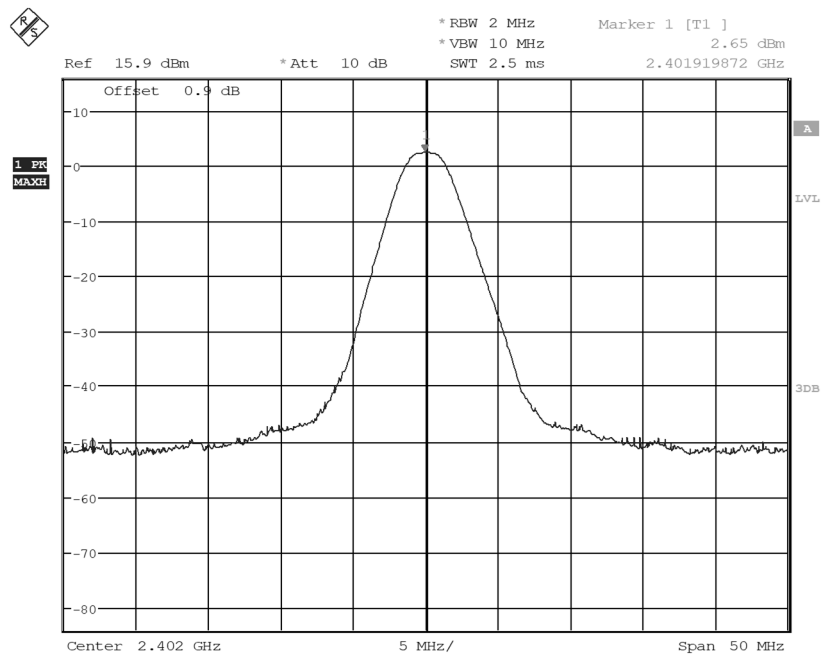
1 Mbps**2402 MHz****2440 MHz**

2480 MHz

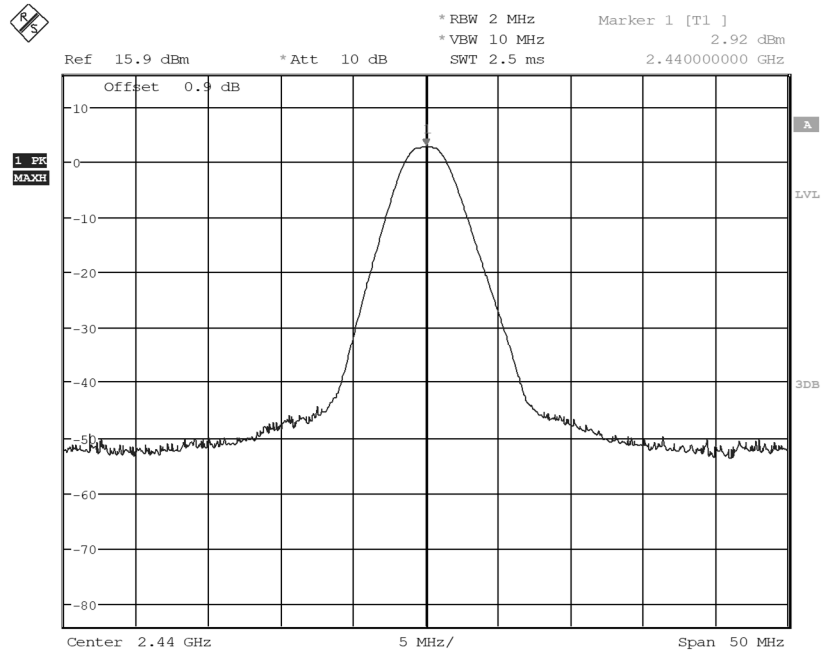


2Mbps

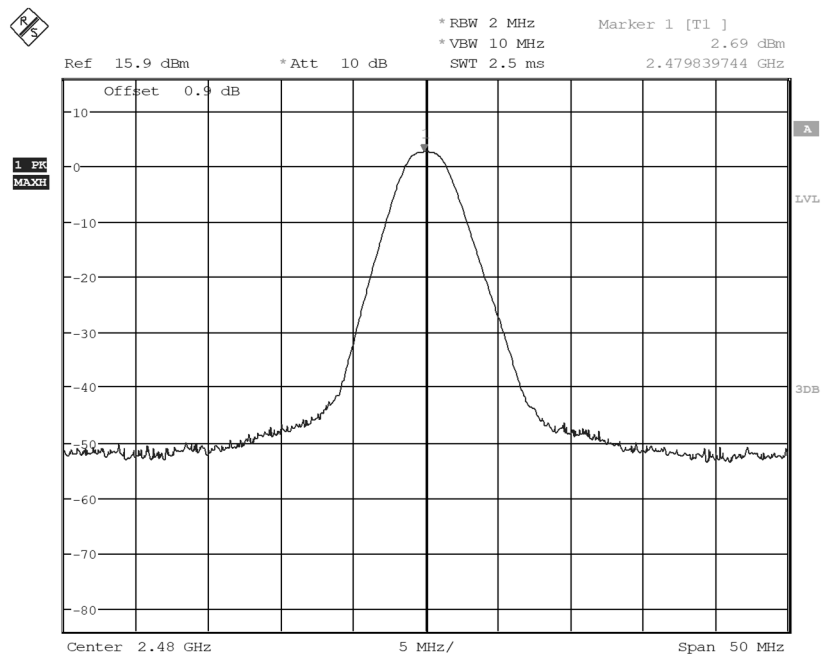
2402 MHz



2440 MHz



2480 MHz



9 FCC §15.247(d) and ISEDC RSS-247 §5.5 – 100 kHz Bandwidth of Band Edges

9.1 Applicable Standards

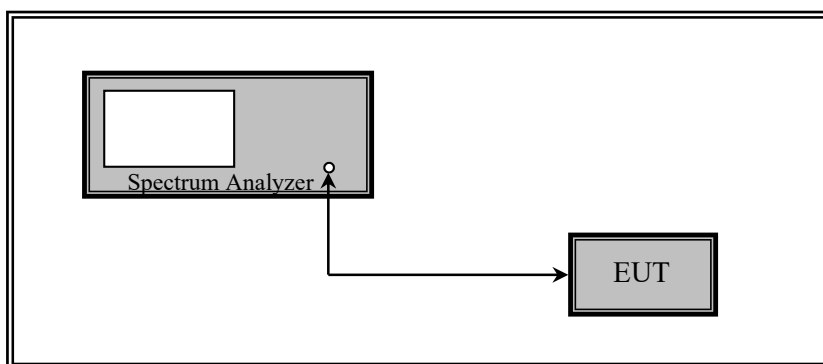
According to FCC §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within 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)).

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

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 8.7: DTS band-edge emission measurements.

9.3 Test Setup Block Diagram



9.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
	RF cable	-	-	Each time ¹	N/A

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

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

9.5 Test Environmental Conditions

Temperature:	24° C
Relative Humidity:	45 %
ATM Pressure:	101.6 KPa

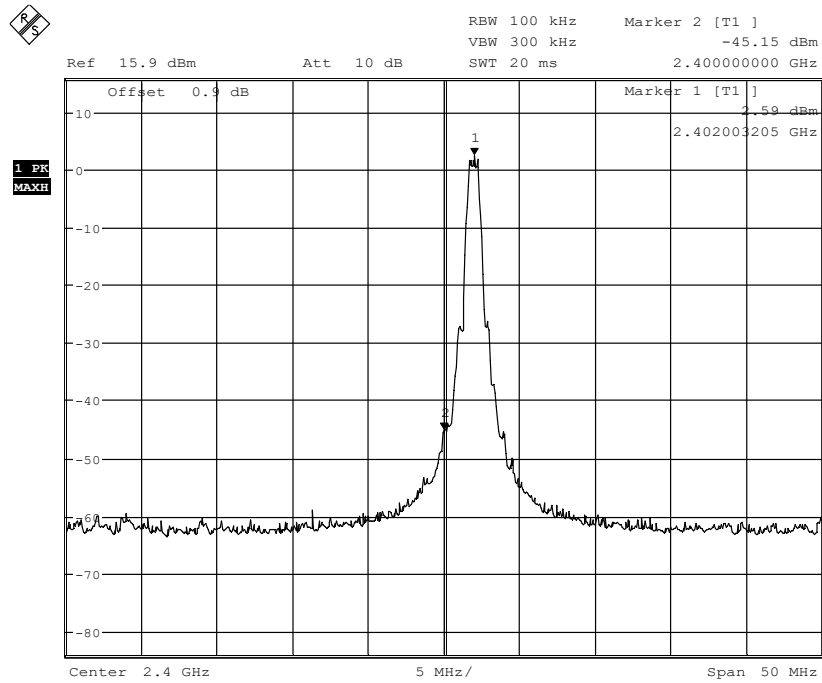
The testing was performed by Deepak Mishra on 2021-07-07 and 2021-07-08 in RF site.

9.6 Test Results

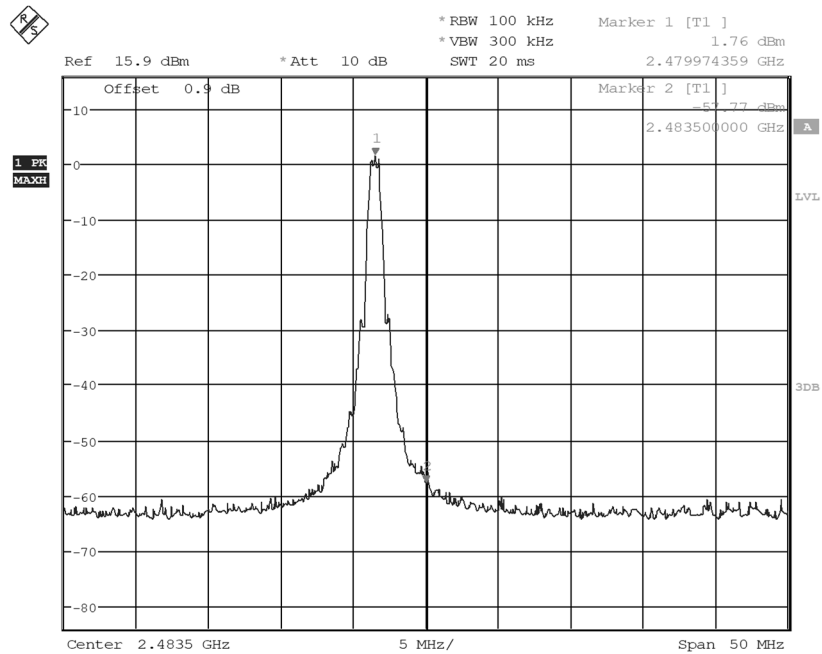
Please refer to the following plots

1 Mbps

2402 MHz

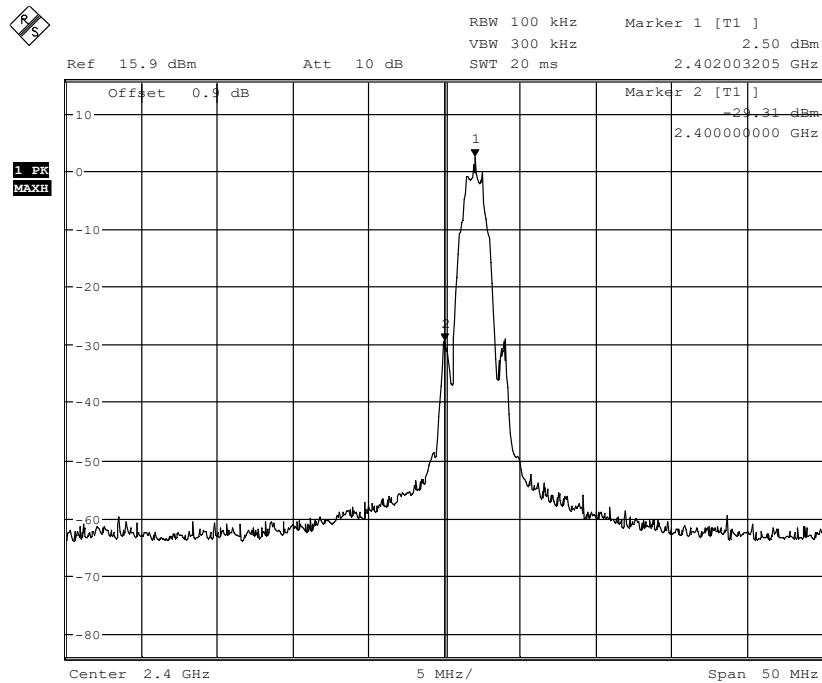


2480 MHz

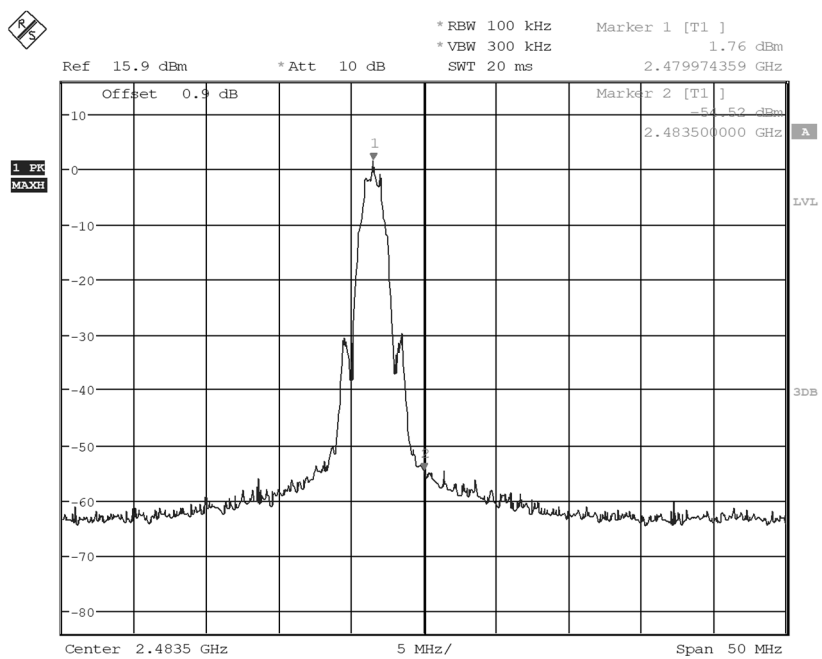


2Mbps

2402 MHz



2480 MHz



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

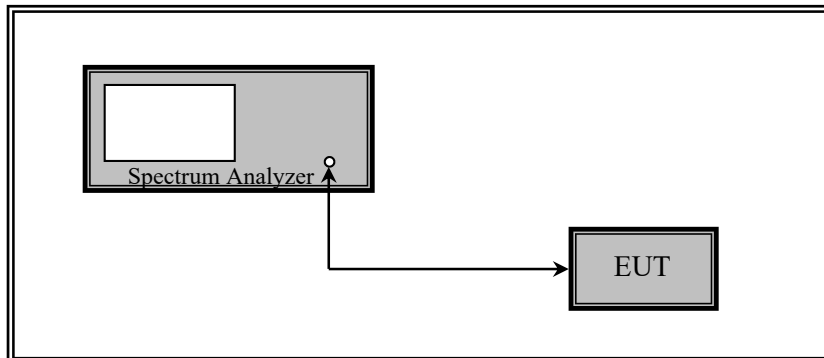
10.1 Applicable Standards

For FCC §15.247(d) and ISEDC RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

10.2 Test Procedure

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

10.3 Test Setup Block Diagram



10.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
	RF cable	-	-	Each time ¹	N/A

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

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

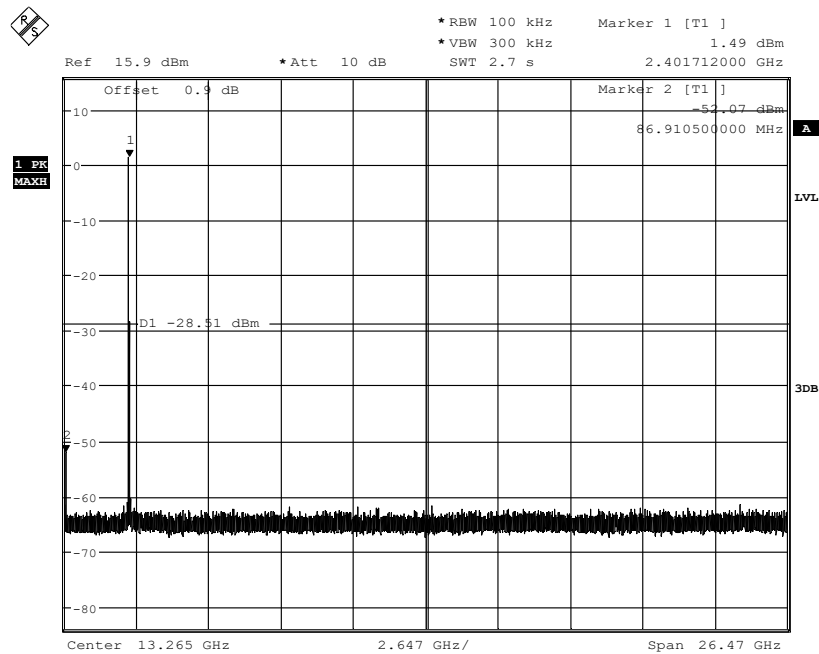
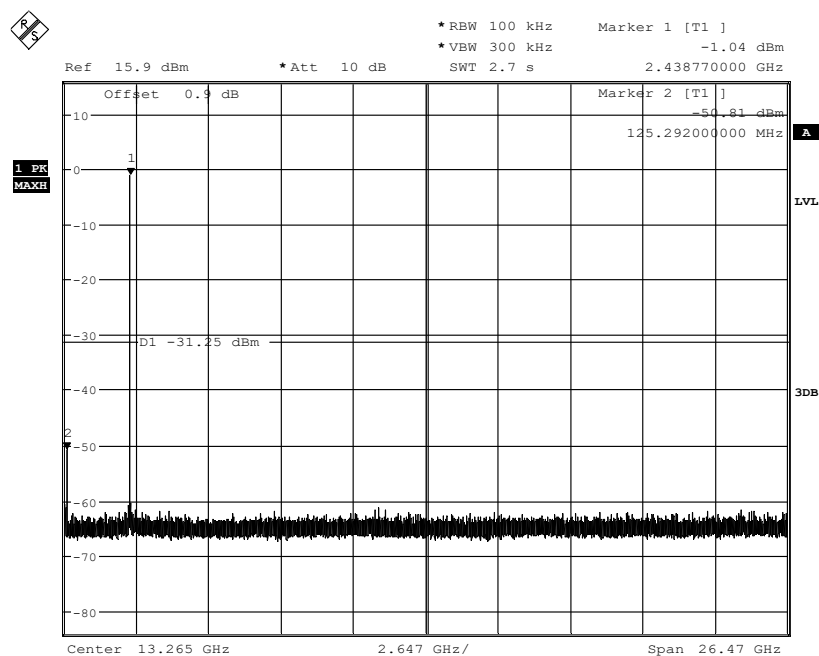
10.5 Test Environmental Conditions

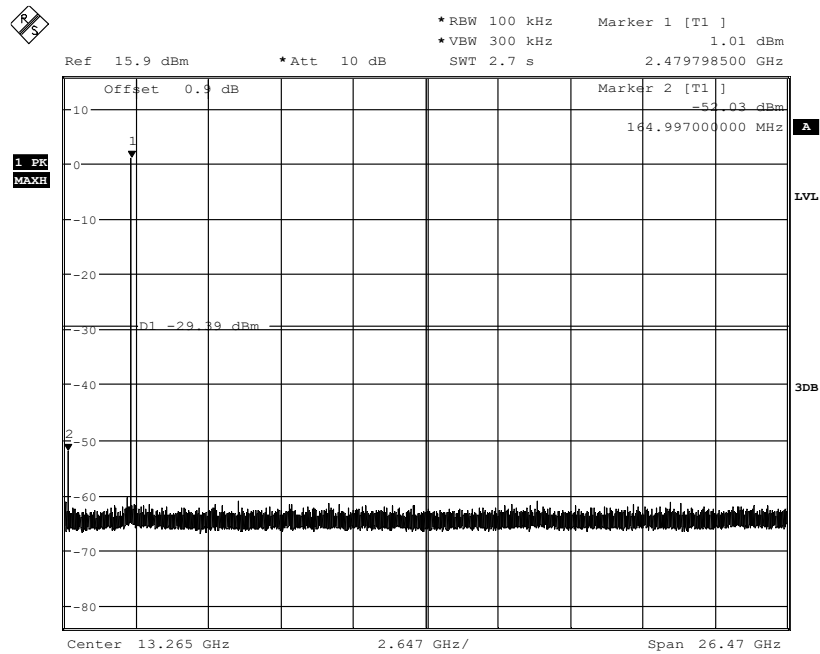
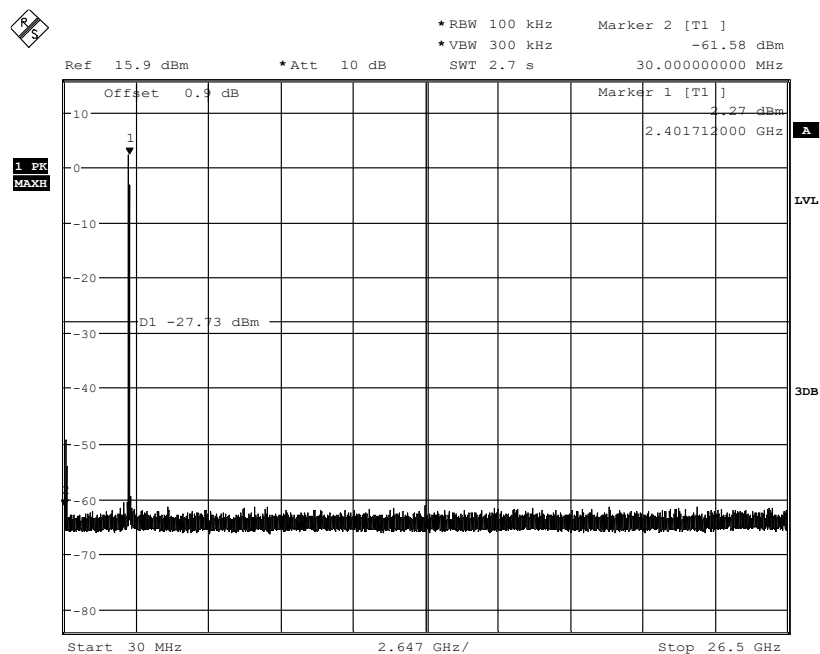
Temperature:	22.8° C
Relative Humidity:	50 %
ATM Pressure:	101.4 KPa

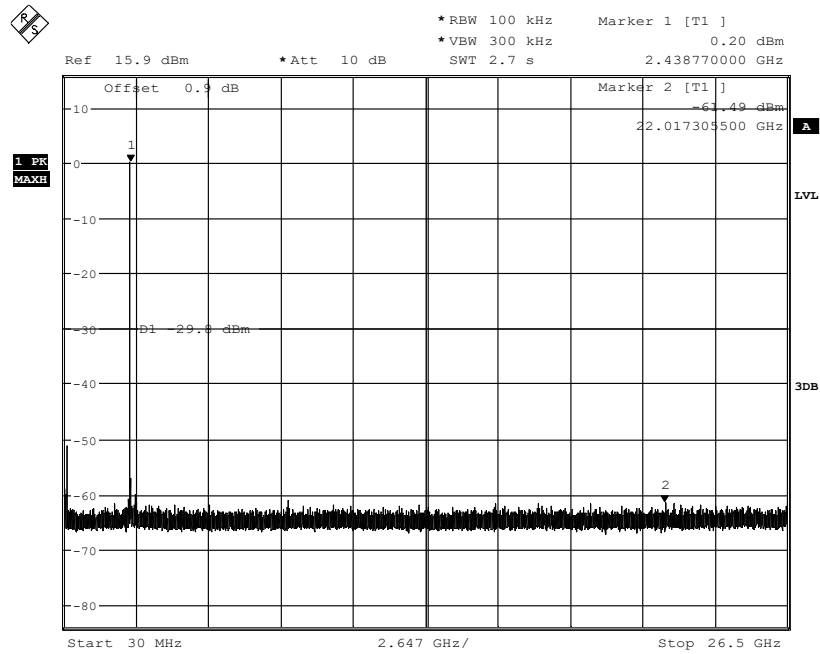
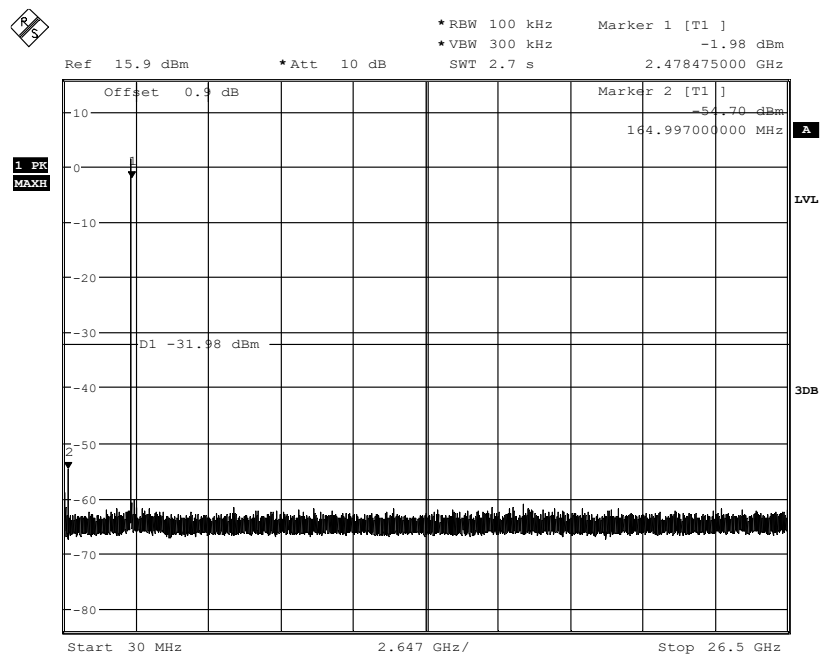
The testing was performed by Deepak Mishra on 2021-07-07 at RF test site.

10.6 Test Results

Please refer to the following plots

1 Mbps Low Channel: 2402 MHz**1 Mbps Middle Channel: 2440**

1 Mbps High Channel: 2480 MHz**2 Mbps Low Channel: 2402 MHz**

2 Mbps Middle Channel: 2440 MHz**2 Mbps High Channel: 2480 MHz**

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

11.1 Applicable Standards

According to FCC §15.247(e) and RSS-247 §5.2(b), 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.

11.2 Measurement Procedure

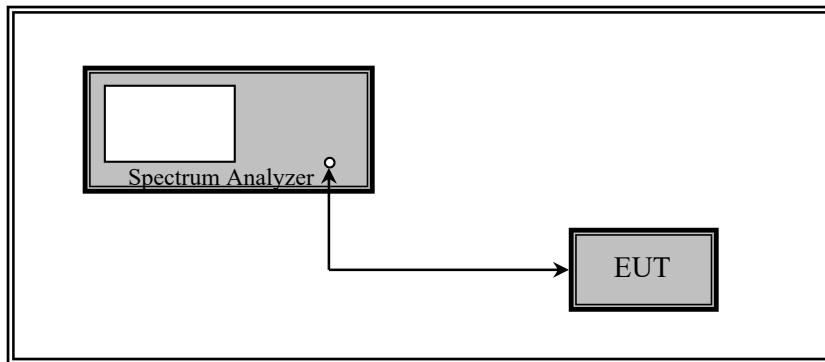
The measurements were based on FCC KDB 558074 D01 DTS Meas Guidance v05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 section 8.4: DTS maximum power spectral density level in the fundamental emission.

Corrected Average Field Strength (dBμV/m) = Measured Average Field Strength (dBμV) + Cable Loss (dB) + Antenna Factor (dB/m)

EIRP (dBm) = Field Strength (dBμV/m) + 20log(D(m)) - 104.77

Conducted Output Power = EIRP – Antenna Gain

11.3 Test Setup Block Diagram



11.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
Rohde & Schwarz	Signal Analyzer	FSQ26	200749	2019-11-07	2 years
	RF cable	-	-	Each time ¹	N/A

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

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

11.5 Test Environmental Conditions

Temperature:	24° C
Relative Humidity:	45 %
ATM Pressure:	101.6 KPa

The testing was performed by Deepak Mishra on 2021-07-07 and 2021-07-08 in RF site.

11.6 Test Results

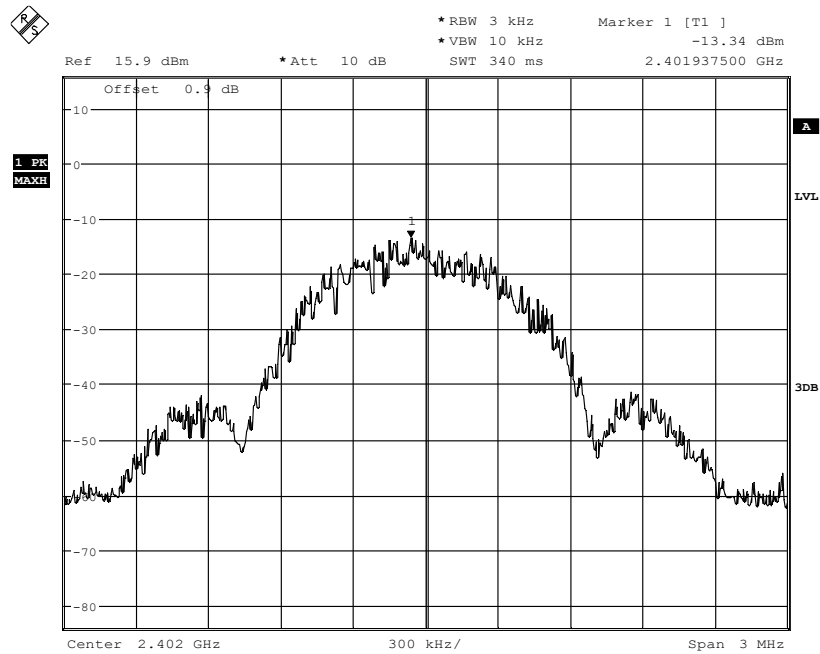
1 Mbps

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	2402	-13.34	8
Middle	2440	-13.17	8
High	2480	-13.28	8

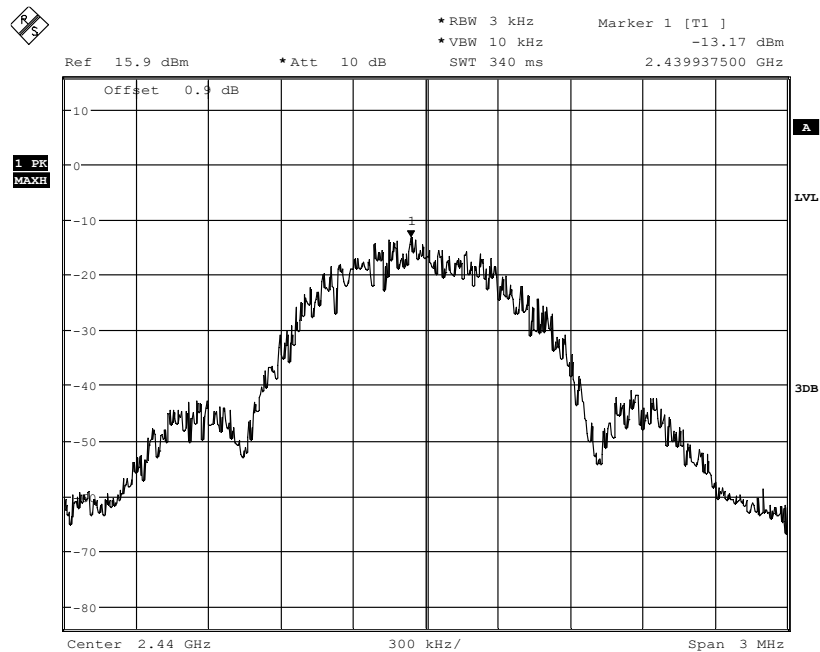
2 Mbps

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	2402	-15.84	8
Middle	2440	-15.99	8
High	2480	-15.72	8

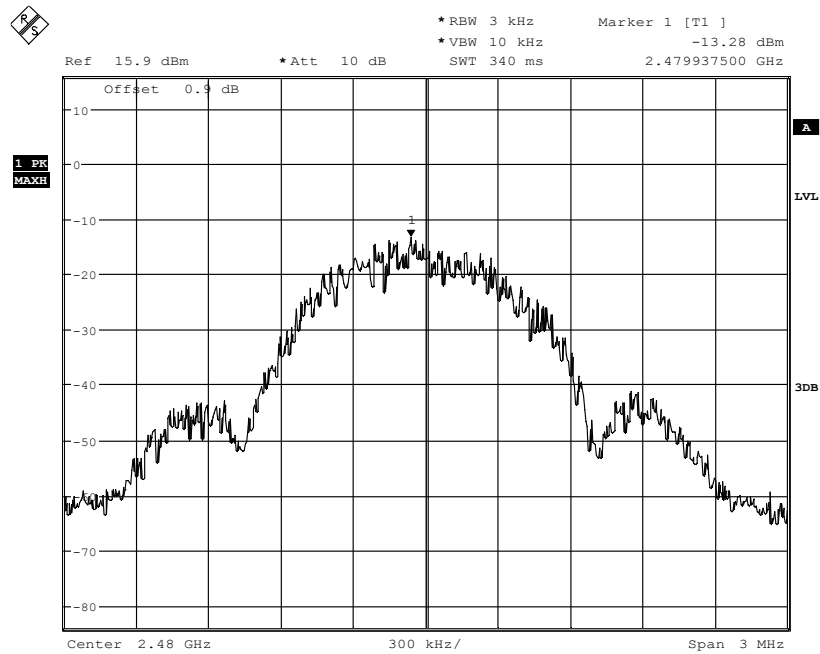
2402 MHz



2440 MHz

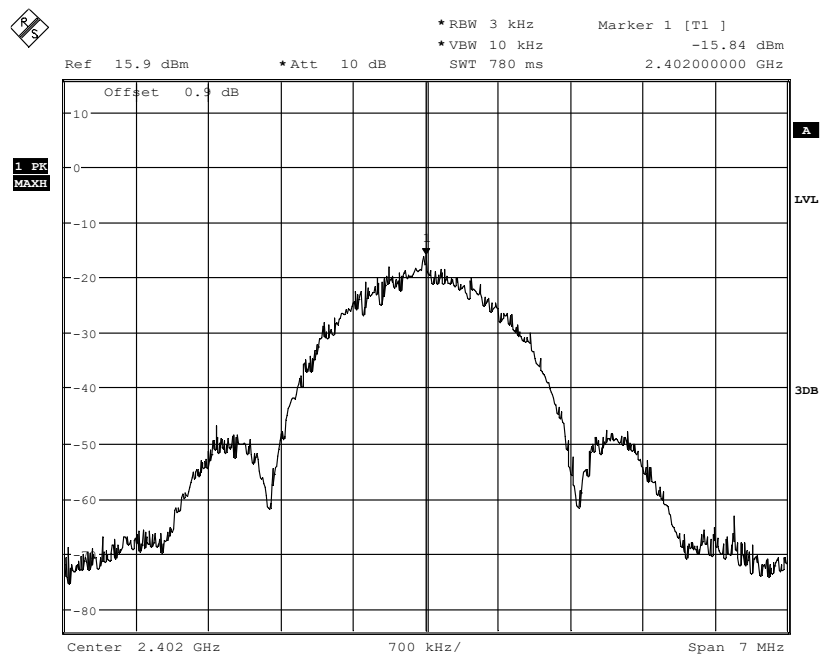


2480 MHz PSD

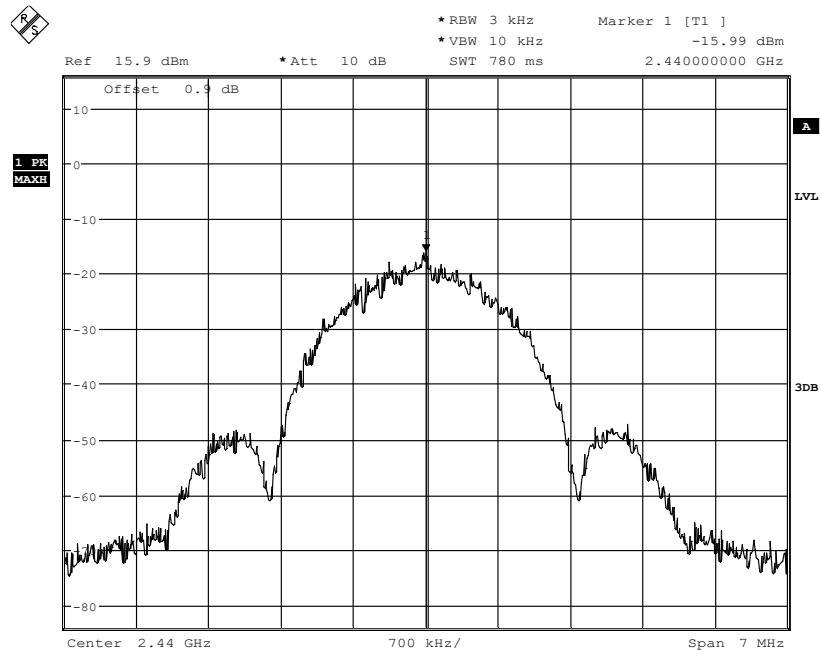


2Mbps

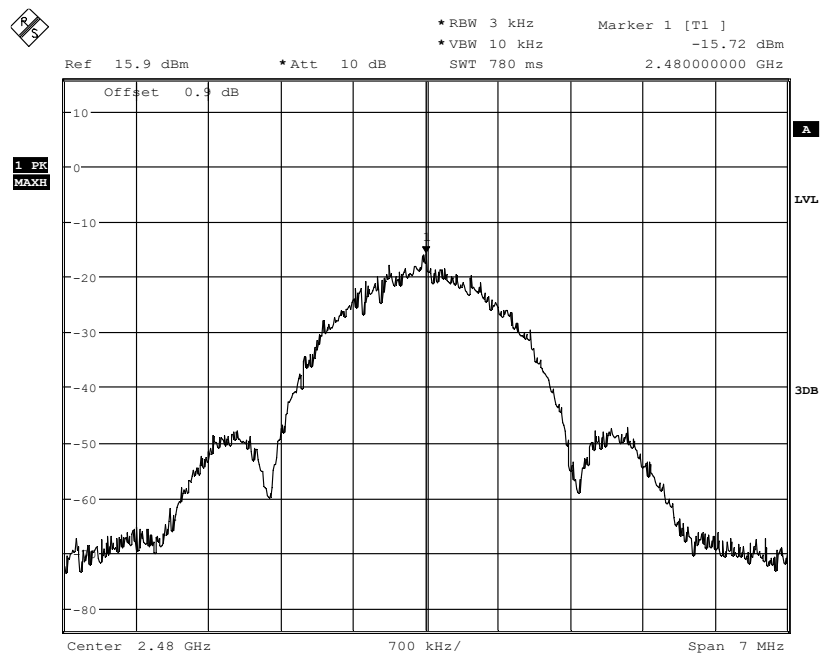
2402 MHz PSD



2440 MHz PSD



2480 MHz PSD



12 Annex A (Normative) - Test Setup Photographs

Please refer to the attachment

13 Annex B (Normative) - EUT External Photographs

Please refer to the attachment

14 Annex C (Normative) - EUT Internal Photographs

Please refer to the attachment

15 Annex D (Normative) - A2LA Electrical Testing Certificate



Accredited Laboratory

A2LA has accredited

BAY AREA COMPLIANCE LABORATORIES CORP.

Sunnyvale, CA

for technical competence in the field of

Electrical Testing

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



Presented this 10th day of March 2021.

A blue ink signature of Trace McInturff.

Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3297.02
Valid to September 30, 2022

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

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

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

--- END OF REPORT ---