



TESTING LABORATORY
CERTIFICATE #4820.01



FCC PART 15.247

RSS-GEN, ISSUE 5, MARCH 2019 AMENDMENT 1

RSS-247, ISSUE 2, FEBRUARY 2017

TEST REPORT

For

Broan-NuTone LLC

926 West State Street Hartford Wisconsin 53027 United States

FCC ID: 2ADLL-1103228
IC: 2143B-1103228

Report Type: Original Report	Product Name: MODULE RGB+W LED W SPEAKER
Report Number: <u>RDG201028050-00B</u>	
Report Date: <u>2020-11-19</u>	
Reviewed By:	Ivan Cao 
Test Laboratory: Bay Area Compliance Laboratories Corp. (Dongguan) No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China Tel: +86-769-86858888 Fax: +86-769-86858891 www.baclcorp.com.cn	

TABLE OF CONTENTS

GENERAL INFORMATION.....	4
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT)	4
OBJECTIVE	4
RELATED SUBMITTAL(S)/GRANT(S)	4
TEST METHODOLOGY	4
MEASUREMENT UNCERTAINTY	5
TEST FACILITY	5
DECLARATIONS.....	5
SYSTEM TEST CONFIGURATION.....	6
DESCRIPTION OF TEST CONFIGURATION	6
EQUIPMENT MODIFICATIONS	6
EUT EXERCISE SOFTWARE	6
EQUIPMENT MODIFICATIONS	7
SUPPORT EQUIPMENT LIST AND DETAILS	7
SUPPORT CABLE LIST AND DETAILS	7
BLOCK DIAGRAM OF TEST SETUP	8
SUMMARY OF TEST RESULTS.....	9
FCC §15.247 (i) & §1.1310 & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE).....	10
APPLICABLE STANDARD	10
RSS-102 § 2.5.2 - EXEMPTION LIMITS FOR ROUTINE EVALUATION – RF EXPOSURE EVALUATION	11
APPLICABLE STANDARD	11
FCC §15.203 & RSS-GEN CLAUSE 6.8 - ANTENNA REQUIREMENT	12
APPLICABLE STANDARD	12
ANTENNA INFORMATION AND CONNECTOR CONSTRUCTION.....	12
FCC §15.207 (a) & RSS-GEN CLAUSE 8.8– AC LINE CONDUCTED EMISSIONS.....	13
APPLICABLE STANDARD	13
EUT SETUP	13
EMI TEST RECEIVER SETUP.....	13
TEST PROCEDURE	13
CORRECTED AMPLITUDE & MARGIN CALCULATION	14
TEST EQUIPMENT LIST AND DETAILS.....	14
TEST DATA	15
FCC §15.209, §15.205, §15.247(d) & RSS-247 CLAUSE 5.5, RSS-GEN CLAUSE 8.10- SPURIOUS EMISSIONS.....	17
APPLICABLE STANDARD	17
EUT SETUP	17
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP	18
TEST PROCEDURE	18
CORRECTED AMPLITUDE & MARGIN CALCULATION	18
TEST EQUIPMENT LIST AND DETAILS.....	19
TEST DATA	19
FCC §15.247(a) (2) & RSS-247 CLAUSE 5.2 a) &RSS-GEN CLAUSE 6.7–6 dB EMISSION BANDWIDTH AND 99% OCCUPIED BANDWIDTH.....	25
APPLICABLE STANDARD	25

TEST PROCEDURE	26
TEST EQUIPMENT LIST AND DETAILS.....	26
TEST DATA	27
FCC §15.247(b) (3)& RSS-247 CLAUSE 5.4 d) - MAXIMUM PEAK CONDUCTED OUTPUT POWER	31
APPLICABLE STANDARD	31
TEST PROCEDURE	31
TEST EQUIPMENT LIST AND DETAILS.....	31
TEST DATA	32
FCC §15.247(d)& RSS-247 CLAUSE 5.5 – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE.....	33
APPLICABLE STANDARD	33
TEST PROCEDURE	33
TEST EQUIPMENT LIST AND DETAILS.....	33
TEST DATA	34
FCC §15.247(e) & RSS-247 CLAUSE 5.2 b - POWER SPECTRAL DENSITY	36
APPLICABLE STANDARD	36
TEST PROCEDURE	36
TEST EQUIPMENT LIST AND DETAILS.....	36
TEST DATA	37

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	MODULE RGB+W LED W SPEAKER
EUT Model:	1103228
Operation Frequency:	2402-2480MHz
Maximum Peak Output Power (Conducted):	1.64 dBm
Modulation Type:	GFSK
Antenna Gain^Δ :	-0.61dBi
Rated Input Voltage:	AC 120V
Serial Number:	RDG201028050-RF -S1
EUT Received Date:	2020.10.31
EUT Received Status:	Good

Objective

This report is prepared on behalf of **Broan-NuTone LLC** in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules and RSS-247, Issue 2, February 2017, RSS-Gen, Issue 5, March 2019 Amendment 1 of the Innovation, Science and Economic Development Canada.

The tests were performed in order to determine the Bluetooth BDR and EDR mode of EUT compliance with FCC Rules Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules and RSS-247, Issue 2, February 2017, RSS-Gen, Issue 5, March 2019 Amendment 1 March 2019 Amendment 1 of the Innovation, Science and Economic Development Canada.

Related Submittal(s)/Grant(s)

FCC Part 15C DSS submissions with FCC ID: 2ADLL-1103228
RSS-247 FHSs submissions with IC: 2143B-1103228

Test Methodology

All measurements detailed in this test report were performed in accordance with ANSI C63.10-2013 "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices" and KDB 558074 D01 15.247 Meas Guidance v05r02. And RSS-247, Issue 2, February 2017, RSS-Gen, Issue 5, March 2019 Amendment 1 of the Innovation, Science and Economic Development Canada.

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Dongguan).

Measurement Uncertainty

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.61dB
Power Spectral Density, conducted	±0.61 dB
Unwanted Emissions, radiated	30M~200MHz: 4.55 dB, 200M~1GHz: 5.92 dB, 1G~6GHz: 4.98 dB, 6G~18GHz: 5.89 dB, 18G~26.5G: 5.47 dB, 26.5G~40G: 5.63 dB
Unwanted Emissions, conducted	±1.5 dB
Temperature	±1 °C
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%
AC Power Lines Conducted Emission	3.12 dB (150 kHz to 30 MHz)

Note: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 897218, the FCC Designation No. : CN1220.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062D.

Declarations

BACL is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with a triangle symbol “△”. Customer model name, addresses, names, trademarks etc. are not considered data.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

This report cannot be reproduced except in full, without prior written approval of the Company.

This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

This report may contain data that are not covered by the accreditation scope and shall be marked with an asterisk “★”.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in Engineering Mode, which was provided by the manufacturer.

For Bluetooth LE mode, 40 channels are provided for testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404	...	...
...	...	...	...
...	...	...	...
..	...	38	2478
19	2440	39	2480

EUT was tested with channel 0, 19 and 39.

Equipment Modifications

No modification was made to the EUT tested.

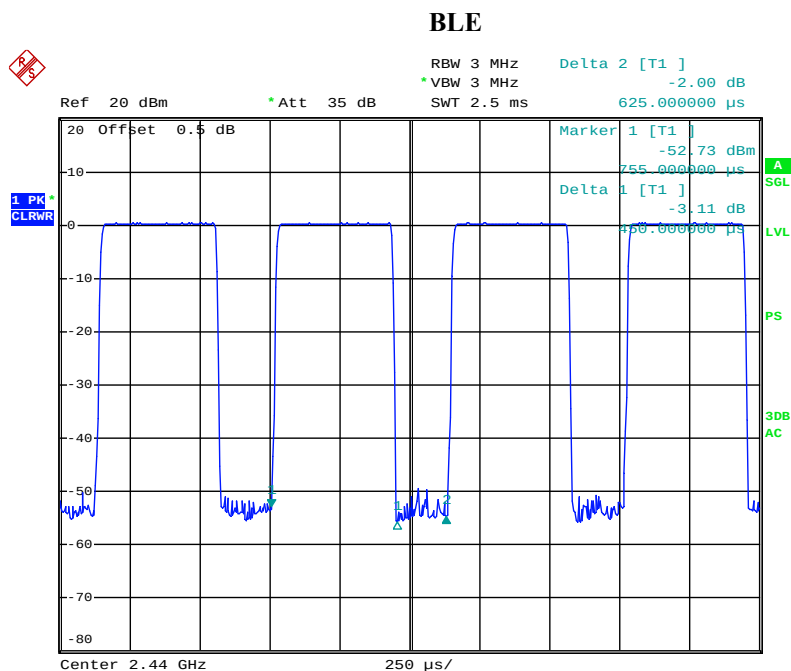
EUT Exercise Software

The software "Blue test 3.exe" was used for testing and the maximum power was configured as below which was provided by the manufacturer^Δ :

Channel	Frequency (MHz)	Power Level Setting
Low	2402	default
Middle	2440	default
High	2480	default

The duty cycle as below:

T _{on} (ms)	T _{on+off} (ms)	Duty Cycle (%)
0.450	0.625	72



Date: 11.NOV.2020 18:56:04

Equipment Modifications

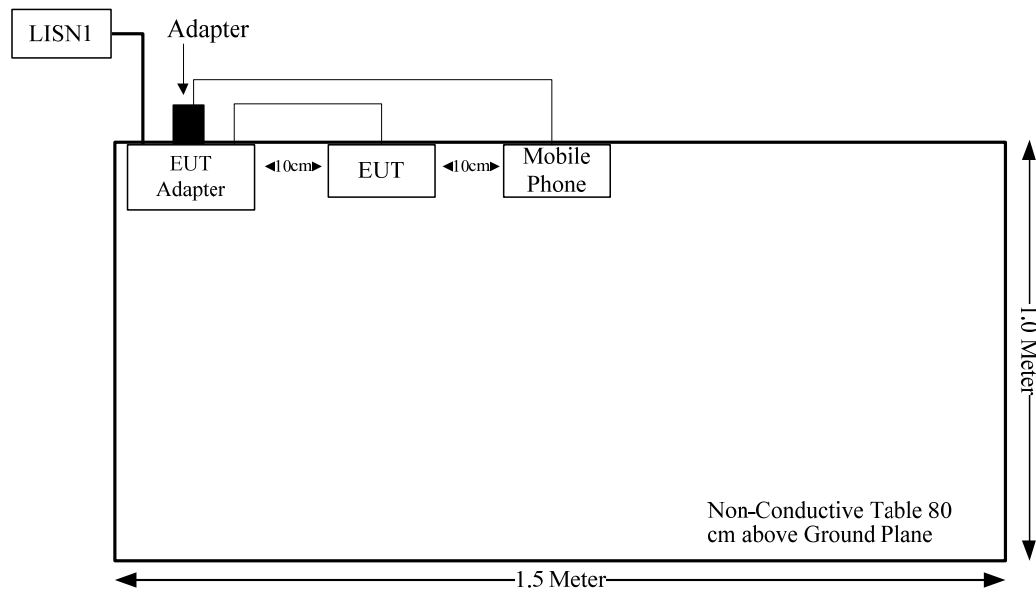
No modification was made to the EUT.

Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
light one	Phone	light one	78522695223
Huajin	adapter	HJ-0501500W2	HJ-0501500W2

Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
DC Cable	No	No	0.3	Adaper	EUT
USB Cable	No	No	0.8	Adaper	Mobile Phone

Block Diagram of Test Setup

SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
§15.247 (i) & §1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliance
RSS-102 Clause 2.5.2	Exemption Limits For Routine Evaluation-RF Exposure Evaluation	Compliance
FCC§15.203, RSS-Gen Clause 6.8	Antenna Requirement	Compliance
FCC§15.207 (a), RSS-Gen Clause 8.8	AC Line Conducted Emissions	Compliance
FCC§15.205, §15.209, FCC §15.247(d), RSS-247 Clause 5.5 RSS-Gen Clause 8.10	Spurious Emissions	Compliance
FCC§15.247 (a)(2), RSS-247 Clause 5.2 a) RSS-Gen Clause 6.7	6 dB Bandwidth	Compliance
FCC§15.247(b)(3), RSS-247 Clause 5.4 d)	Maximum Conducted Output Power	Compliance
FCC§15.247(d), RSS-247 Clause5.5	100 kHz Bandwidth of Frequency Band Edge	Compliance
FCC§15.247(e), RSS-247 Clause5.2 b)	Power Spectral Density	Compliance

FCC §15.247 (i) & §1.1310 & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247(i) and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500	/	/	f/1500	30
1500–100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculation formula:

Prediction of power density at the distance of the applicable MPE limit

$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm²);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Calculated Data:

Frequency (MHz)	Antenna Gain		Conducted output power including Tune-up Tolerance		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
	(dBi)	(numeric)	(dBm)	(mW)			
2402-2480	-0.61	0.87	2	1.58	20.00	0.0003	1.0

Result: The device meet FCC MPE at 20 cm distance

RSS-102 § 2.5.2 - EXEMPTION LIMITS FOR ROUTINE EVALUATION – RF EXPOSURE EVALUATION

Applicable Standard

According to RSS-102 § (2.5.2):

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Calculated Data:

Frequency (MHz)	Antenna Gain	Conducted output power including Tune-up Tolerance	EIRP		Exemption limits (mW)
	(dBi)		(dBm)	(mW)	
2402-2480	-0.61	2	1.39	1.38	2676

So the device is compliance exemption from Routine Evaluation Limits –RF exposure Evaluation.

Result: Compliance

FCC §15.203 & RSS-GEN CLAUSE 6.8 - ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

According to RSS-Gen §6.8, The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

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

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer. The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

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

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

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

Antenna Information And Connector Construction

The EUT has one internal antenna arrangement, fulfill the requirement of this section. Please refer to below information and the EUT photos:

Antenna Type	input impedance (Ohm)	Antenna Gain /Frequency Range
PCB	50	-0.61 dBi/2.4~2.5GHz

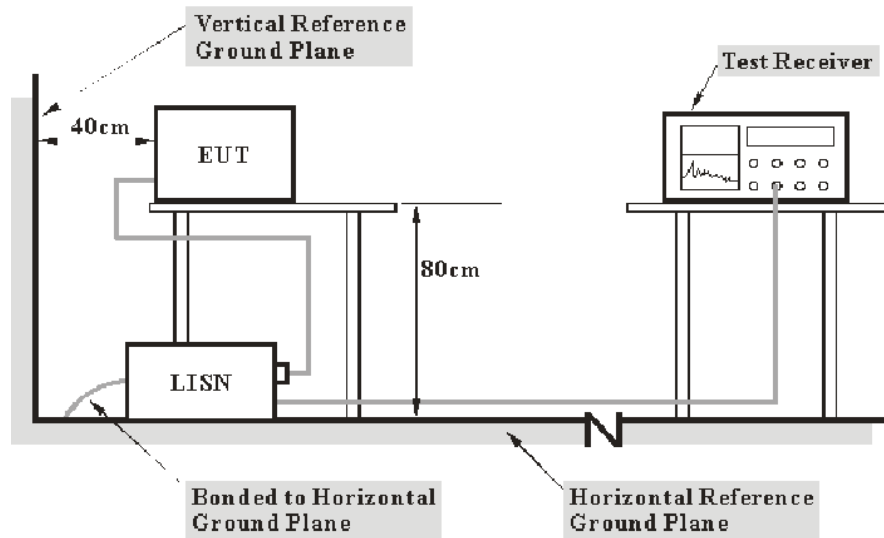
Result: Compliance.

FCC §15.207 (a) & RSS-GEN CLAUSE 8.8– AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207(a), RSS-Gen§8.8.

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 and the RSS-Gen limits.

The spacing between the peripherals was 10 cm.

The EUT was connected to the main lisn with a 120 V/60 Hz AC power source.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the EUT was connected to the first LISN.

The frequency and amplitude of the six highest ac power-line conducted emissions relative to the limit, measured over all the current-carrying conductors of the EUT power cords, and the operating frequency or frequency to which the EUT is tuned (if appropriate), should be reported, unless such emissions are more than 20 dB below the limit. AC power-line conducted emissions measurements are to be separately carried out only on each of the phase (“hot”) line(s) and (if used) on the neutral line(s), but not on the ground [protective earth] line(s). If less than six emission frequencies are within 20 dB of the limit, then the noise level of the measuring instrument at representative frequencies should be reported. The specific conductor of the power-line cord for each of the reported emissions should be identified. Measure the six highest emissions with respect to the limit on each current-carrying conductor of each power cord associated with the EUT (but not the power cords of associated or peripheral equipment that are part of the test configuration). Then, report the six highest emissions with respect to the limit from among all the measurements identifying the frequency and specific current-carrying conductor identified with the emission. The six highest emissions should be reported for each of the current-carrying conductors, or the six highest emissions may be reported over all the current-carrying conductors.

Corrected Amplitude & Margin Calculation

The basic equation is as follows:

$$V_C = V_R + A_C + VDF$$

$$C_f = A_C + VDF$$

Herein,

V_C (cord. Reading): corrected voltage amplitude

V_R : reading voltage amplitude

A_C : attenuation caused by cable loss

VDF : voltage division factor of AMN

C_f : Correction Factor

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

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

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	LISN	ENV 216	101614	2020-09-12	2021-09-12
R&S	EMI Test Receiver	ESCI	101121	2020-07-07	2021-07-07
MICRO-COAX	Coaxial Cable	C-NJNJ-50	C-0200-01	2020-09-05	2021-09-05
R&S	Test Software	EMC32	Version 9.10.00	N/A	N/A

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

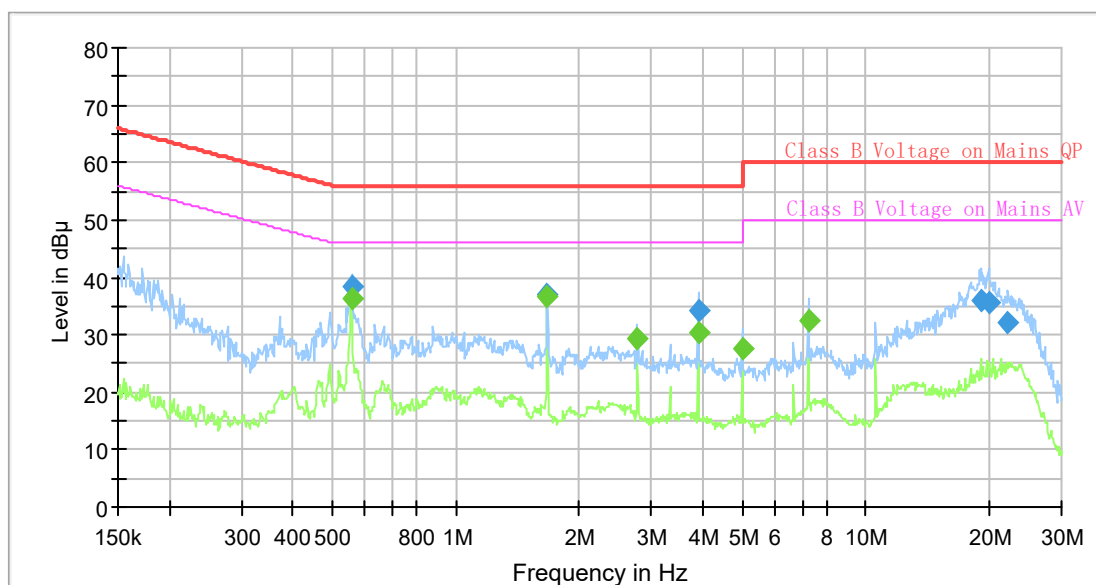
Test Data

Environmental Conditions

Temperature:	24.1°C
Relative Humidity:	57%
ATM Pressure:	101.3kPa
Test by:	Barry Yang
Test Date:	2020-11-05

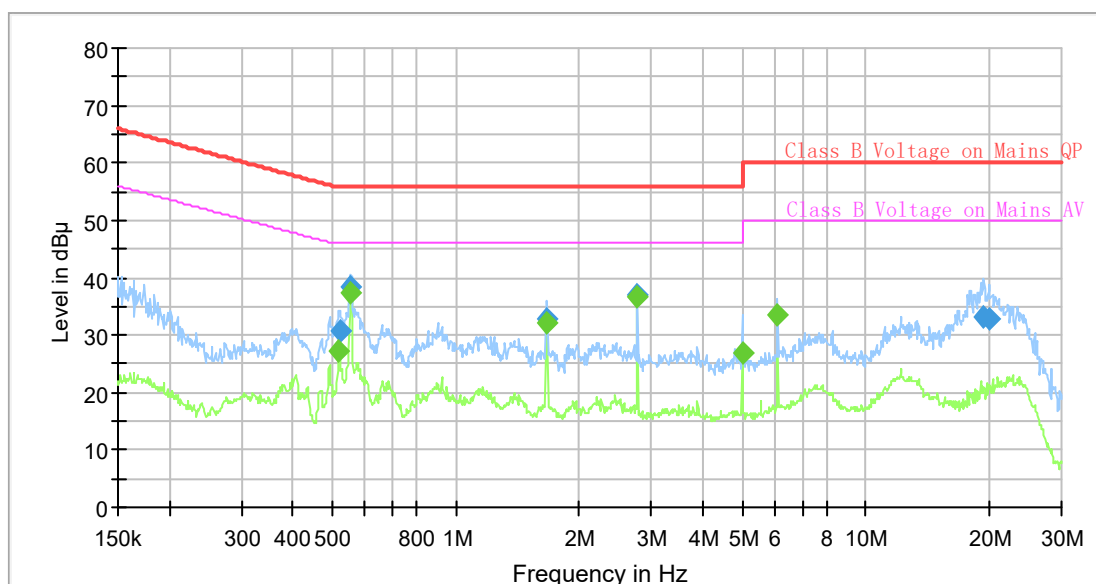
Test Mode: Transmitting

AC120 V, 60 Hz, Line:



Final Result

Frequency (MHz)	QuasiPeak (dB μ V)	Average (dB μ V)	Limit (dB μ V)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.556885	---	36.42	46.00	9.58	9.000	L1	9.6
0.556885	38.30	---	56.00	17.70	9.000	L1	9.6
1.668396	---	36.63	46.00	9.37	9.000	L1	9.7
1.668396	37.18	---	56.00	18.82	9.000	L1	9.7
2.774836	---	29.20	46.00	16.80	9.000	L1	9.7
3.895198	34.19	---	56.00	21.81	9.000	L1	9.7
3.895198	---	30.41	46.00	15.59	9.000	L1	9.7
4.998419	---	27.57	46.00	18.43	9.000	L1	9.7
7.229716	---	32.56	50.00	17.44	9.000	L1	9.8
19.025550	35.84	---	60.00	24.16	9.000	L1	10.0
19.899024	35.66	---	60.00	24.34	9.000	L1	10.0
22.206757	32.02	---	60.00	27.98	9.000	L1	10.0

AC120 V, 60 Hz, Neutral:**Final Result**

Frequency (MHz)	QuasiPeak (dB µV)	Average (dB µV)	Limit (dB µV)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.519327	---	27.22	46.00	18.78	9.000	N	9.6
0.521923	30.75	---	56.00	25.25	9.000	N	9.6
0.554114	---	37.28	46.00	8.72	9.000	N	9.6
0.554114	38.34	---	56.00	17.66	9.000	N	9.6
1.668396	---	32.10	46.00	13.90	9.000	N	9.6
1.668396	32.85	---	56.00	23.15	9.000	N	9.6
2.774836	37.17	---	56.00	18.83	9.000	N	9.6
2.774836	---	36.73	46.00	9.27	9.000	N	9.6
4.998419	---	26.84	46.00	19.16	9.000	N	9.6
6.102041	---	33.68	50.00	16.32	9.000	N	9.6
19.408925	33.03	---	60.00	26.97	9.000	N	9.9
19.998519	32.97	---	60.00	27.03	9.000	N	9.9

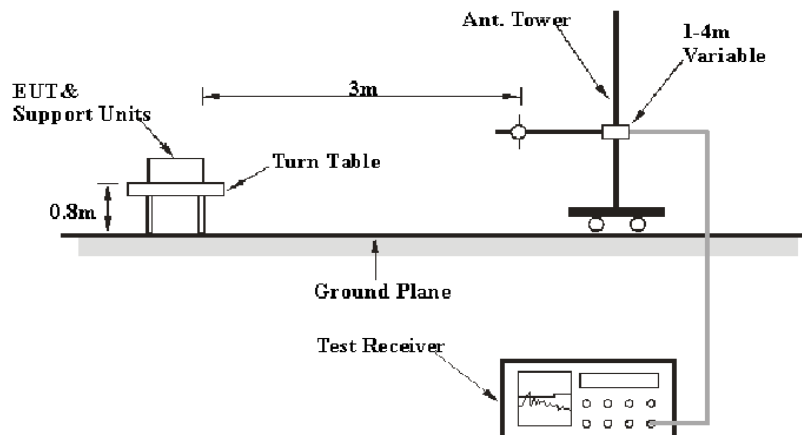
FCC §15.209, §15.205, §15.247(d) & RSS-247 CLAUSE 5.5, RSS-GEN CLAUSE 8.10- SPURIOUS EMISSIONS

Applicable Standard

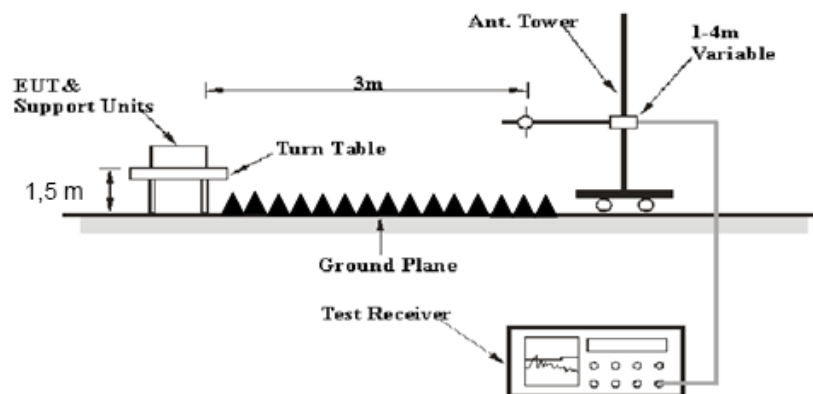
FCC §15.247 (d); §15.209; §15.205, RSS-247 §5.5, RSS-GEN §8.10.

EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emission tests were performed in the 10 meters chamber test site for the range 30MHz to 1GHz and the 3 meters chamber B test site for above 1GHz, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247, the RSS-247 §5.5, RSS-Gen §8.10 limits..

The spacing between the peripherals was 10 cm.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

30MHz-1000MHz:

Measurement	RBW	Video B/W	IF B/W
QP	120 kHz	300 kHz	120kHz

1GHz- 25GHz:

Measurement	Duty cycle	RBW	Video B/W
PK	Any	1MHz	3 MHz
Ave.	>98%	1MHz	10 Hz
	<98%	1MHz	1/T

Note: T is minimum transmission duration

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

Test Procedure

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

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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

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

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiation Below 1GHz					
Sunol Sciences	Antenna	JB3	A060611-2	2020-08-25	2023-08-25
R&S	EMI Test Receiver	ESCI	100224	2020-09-12	2021-09-12
Unknown	Coaxial Cable	C-NJNJ-50	C-1000-01	2020-09-05	2021-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2020-09-05	2021-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0530-01	2020-09-24	2021-09-24
Sonoma	Amplifier	310N	185914	2020-10-13	2021-10-13
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Radiation Above 1GHz					
ETS-Lindgren	Horn Antenna	3115	000 527 35	2018-10-12	2021-10-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-01 1304	2017-12-06	2020-12-05
Agilent	Spectrum Analyzer	E4440A	SG43360054	2020-07-07	2021-07-07
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2020-09-05	2021-09-05
Unknown	Coaxial Cable	C-2.4J2.4J-50	C-0700-02	2020-06-27	2021-06-27
Mini-Circuit	Amplifier	ZVA-213-S+	54201245	2020-09-05	2021-09-05
Quinstar	Amplifier	QLW-18405536-JO	15964001001	2020-06-27	2021-06-27
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
E-Microwave	Band-stop Filters	OBSF-2400-2483.5-S	OE01601525	2020-06-16	2021-06-16
Micro-tronics	High Pass Filter	HPM50111	S/N-G217	2020-06-16	2021-06-16

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data

Environmental Conditions

Test Items	Radiation Below 1GHz	Radiation Above 1GHz
Temperature:	27.4°C	26°C
Relative Humidity:	41%	29%
ATM Pressure:	101.2 kPa	101.6 kPa
Tester:	Asa Chen	Bond Qin
Test Date:	2020-11-06	2020-11-11

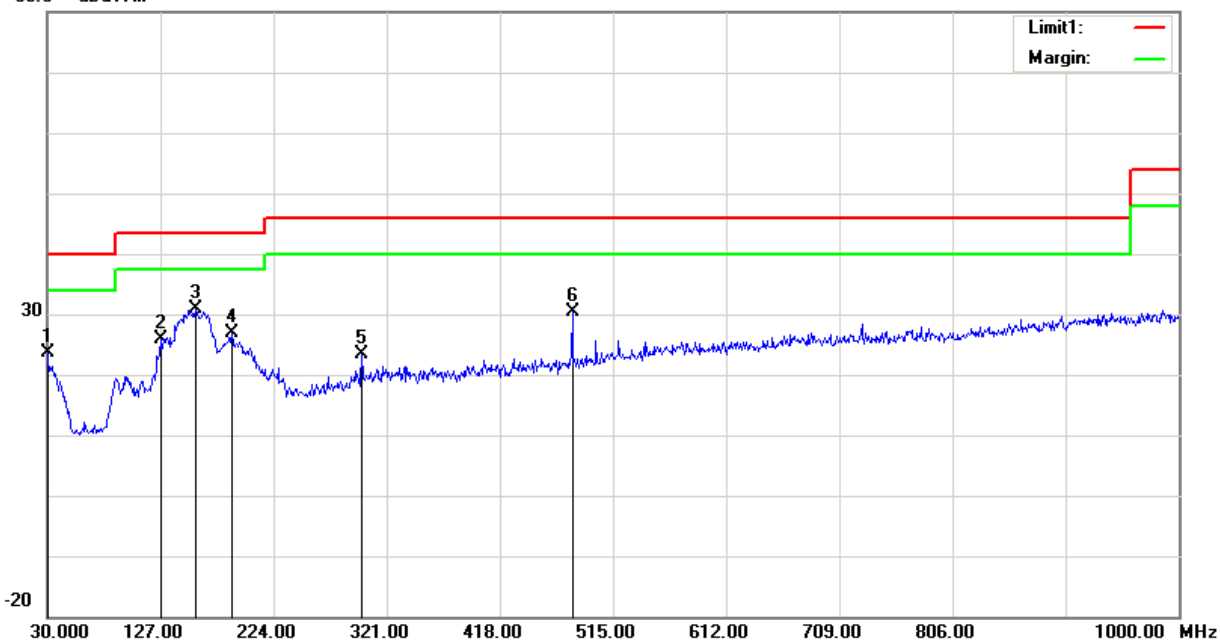
Test Mode: Transmitting

Test Result: Compliance. Please refer to the following table and plots.

1) 30MHz-1GHz(High channel was the worst)

Horizontal:

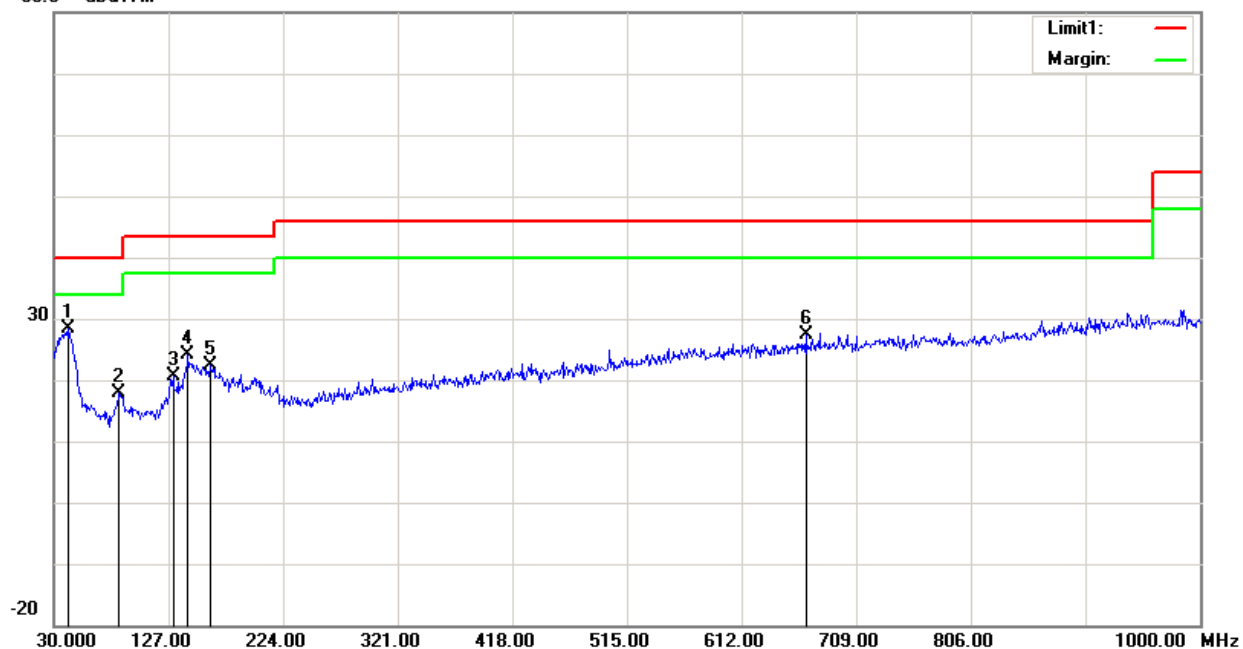
80.0 dBuV/m



Frequency (MHz)	Receiver Reading (dBuV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBuV/m)	Limit (dBuV/m)	Margin (dB)
30.0000	27.78	peak	-4.10	23.68	40.00	16.32
127.0000	36.56	peak	-10.68	25.88	43.50	17.62
157.0700	40.31	peak	-9.37	30.94	43.50	12.56
188.1100	37.38	peak	-10.43	26.95	43.50	16.55
299.6600	30.65	peak	-7.38	23.27	46.00	22.73
480.0800	34.22	peak	-3.82	30.40	46.00	15.60

Vertical:

80.0 dBuV/m



Frequency (MHz)	Receiver Reading (dBuV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBuV/m)	Limit (dBuV/m)	Margin (dB)
42.6100	39.44	peak	-11.05	28.39	40.00	11.61
85.2900	33.23	peak	-15.37	17.86	40.00	22.14
130.8800	30.28	peak	-9.64	20.64	43.50	22.86
143.4900	33.14	peak	-9.02	24.12	43.50	19.38
161.9200	31.86	peak	-9.48	22.38	43.50	21.12
666.3200	27.43	peak	-0.12	27.31	46.00	18.69

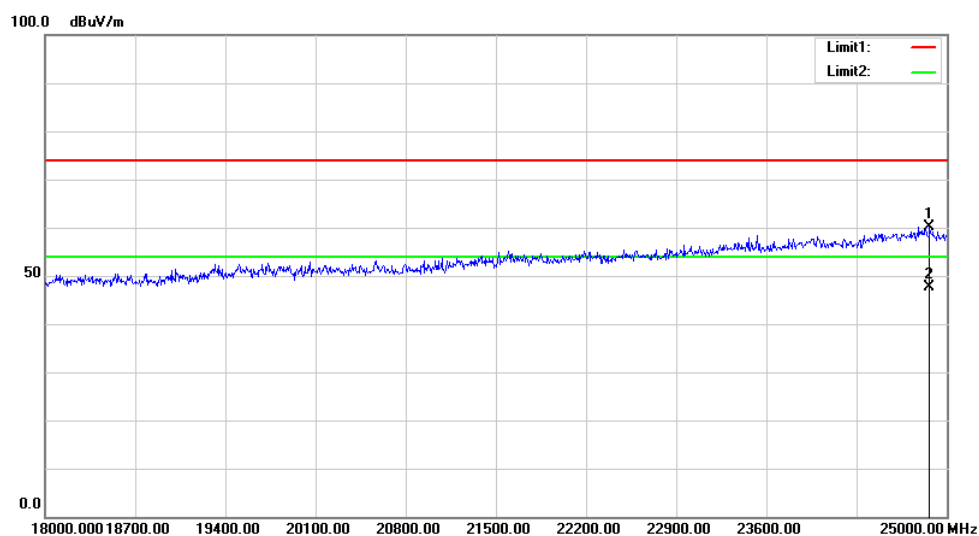
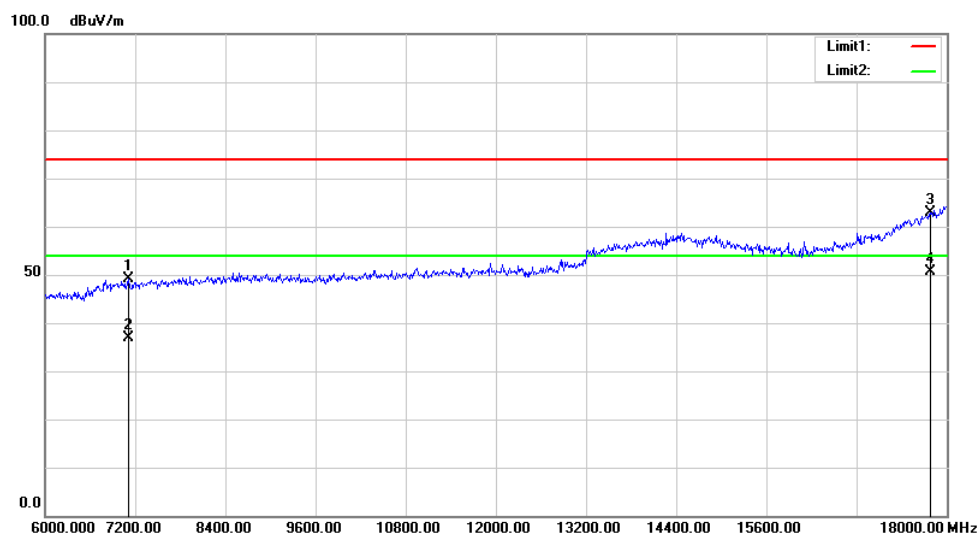
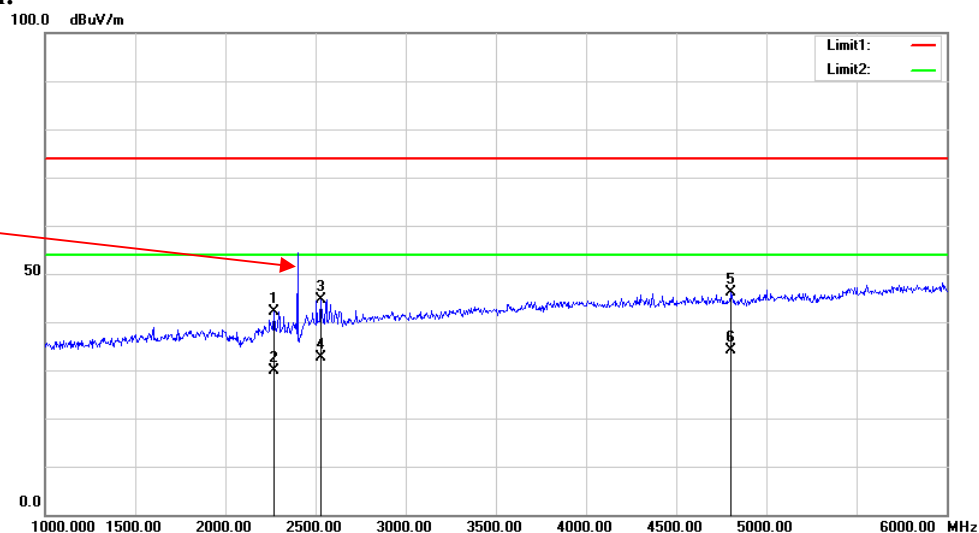
2) 1-25GHz:

Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2402.00	67.50	PK	H	28.10	1.80	0.00	97.40	N/A	N/A
2402.00	62.40	AV	H	28.10	1.80	0.00	92.30	N/A	N/A
2402.00	67.99	PK	V	28.10	1.80	0.00	97.89	N/A	N/A
2402.00	63.62	AV	V	28.10	1.80	0.00	93.52	N/A	N/A
2390.00	26.10	PK	V	28.08	1.80	0.00	55.98	74.00	18.02
2390.00	13.80	AV	V	28.08	1.80	0.00	43.68	54.00	10.32
4804.00	38.91	PK	V	32.91	3.17	25.60	49.39	74.00	24.61
4804.00	28.69	AV	V	32.91	3.17	25.60	39.17	54.00	14.83
7206.00	36.39	PK	V	35.74	4.82	25.60	51.35	74.00	22.65
7206.00	24.52	AV	V	35.74	4.82	25.60	39.48	54.00	14.52
Middle Channel: 2440 MHz									
2440.00	70.10	PK	H	28.18	1.82	0.00	100.10	N/A	N/A
2440.00	65.35	AV	H	28.18	1.82	0.00	95.35	N/A	N/A
2440.00	70.54	PK	V	28.18	1.82	0.00	100.54	N/A	N/A
2440.00	65.91	AV	V	28.18	1.82	0.00	95.91	N/A	N/A
4880.00	38.43	PK	V	33.06	3.27	25.66	49.10	74.00	24.90
4880.00	28.52	AV	V	33.06	3.27	25.66	39.19	54.00	14.81
7320.00	36.63	PK	V	36.03	4.62	25.72	51.56	74.00	22.44
7320.00	24.25	AV	V	36.03	4.62	25.72	39.18	54.00	14.82
High Channel: 2480 MHz									
2480.00	67.87	PK	H	28.26	1.84	0.00	97.97	N/A	N/A
2480.00	62.52	AV	H	28.26	1.84	0.00	92.62	N/A	N/A
2480.00	68.25	PK	V	28.26	1.84	0.00	98.35	N/A	N/A
2480.00	63.67	AV	V	28.26	1.84	0.00	93.77	N/A	N/A
2483.50	26.95	PK	V	28.27	1.84	0.00	57.06	74.00	16.94
2483.50	14.67	AV	V	28.27	1.84	0.00	44.78	54.00	9.22
4960.00	38.33	PK	V	33.22	3.23	25.63	49.15	74.00	24.85
4960.00	28.10	AV	V	33.22	3.23	25.63	38.92	54.00	15.08
7440.00	36.59	PK	V	36.34	4.41	25.85	51.49	74.00	22.51
7440.00	24.36	AV	V	36.34	4.41	25.85	39.26	54.00	14.74

Worst Test plots(Low channel)

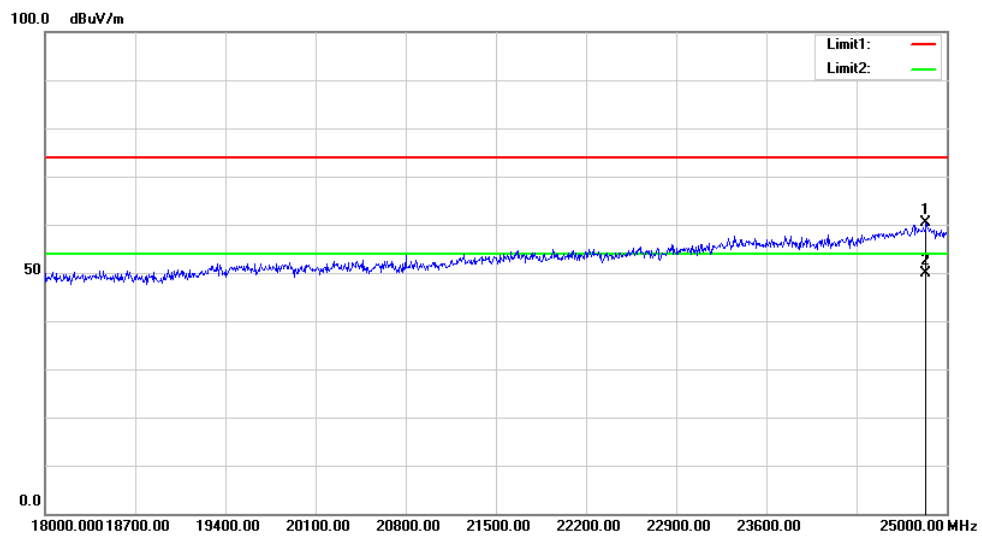
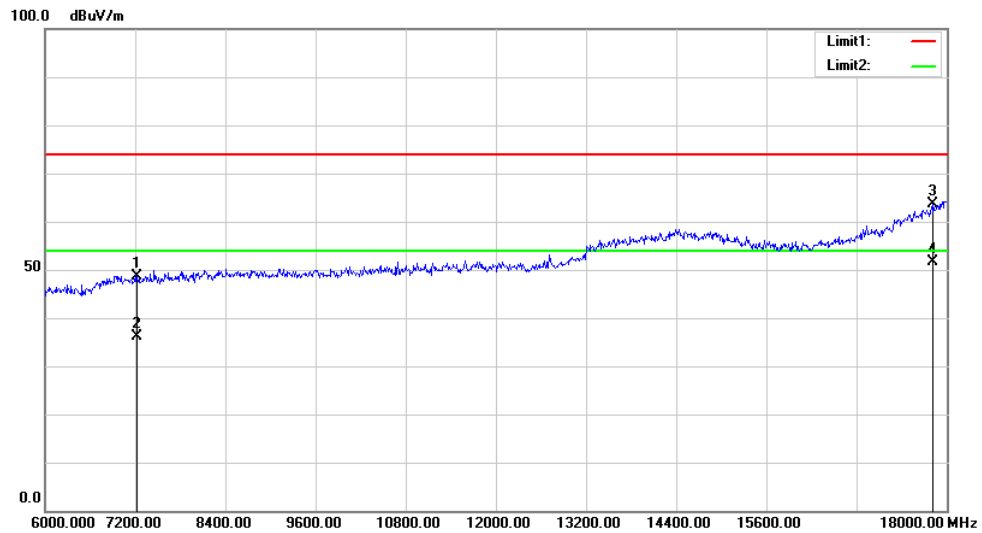
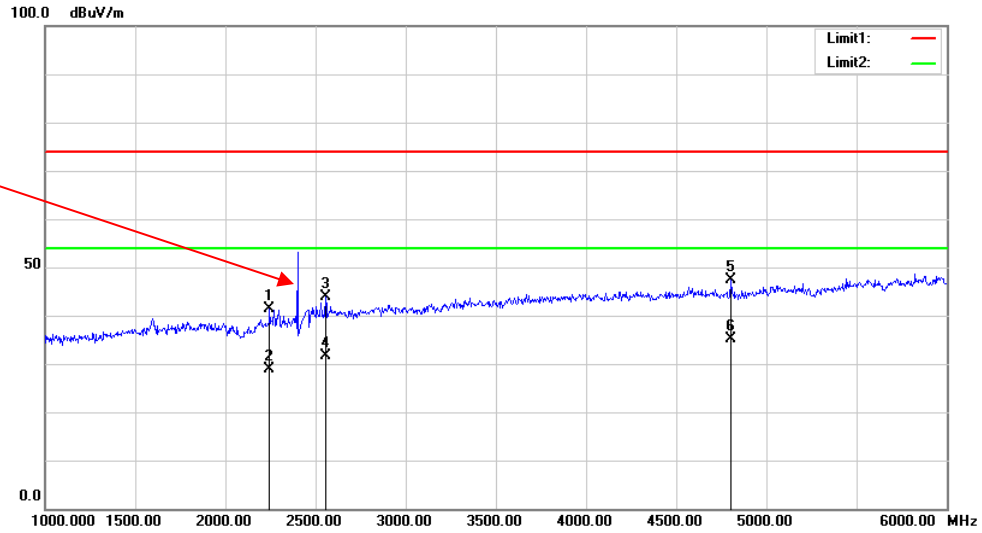
Horizontal:

Fundamental
Test with Band
Rejection Filter



Vertical:

Fundamental
Test with Band
Rejection Filter



FCC §15.247(a) (2) & RSS-247 CLAUSE 5.2 a) & RSS-GEN CLAUSE 6.7–6 dB EMISSION BANDWIDTH AND 99% OCCUPIED BANDWIDTH

Applicable Standard

According to FCC §15.247(a) (2)

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.

According to RSS-247 §5.2 a)

The minimum 6 dB bandwidth shall be 500 kHz.

According to RSS-Gen §6.7

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

In some cases, the “x dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level 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, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

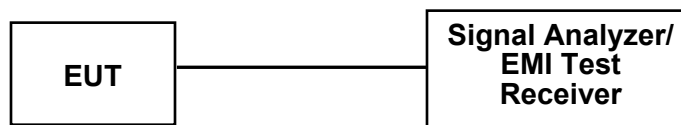
Test Procedure

6dB bandwidth test:

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW) $\geq 3 \times \text{RBW}$.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- 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.

99% Occupied bandwidth test:

Use Occupied bandwidth test function, measure the 99% Occupied bandwidth.
Repeat above procedures until all frequencies measured were complete.



Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU 26	200256	2020-07-07	2021-07-07
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41005011	Each time	N/A

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

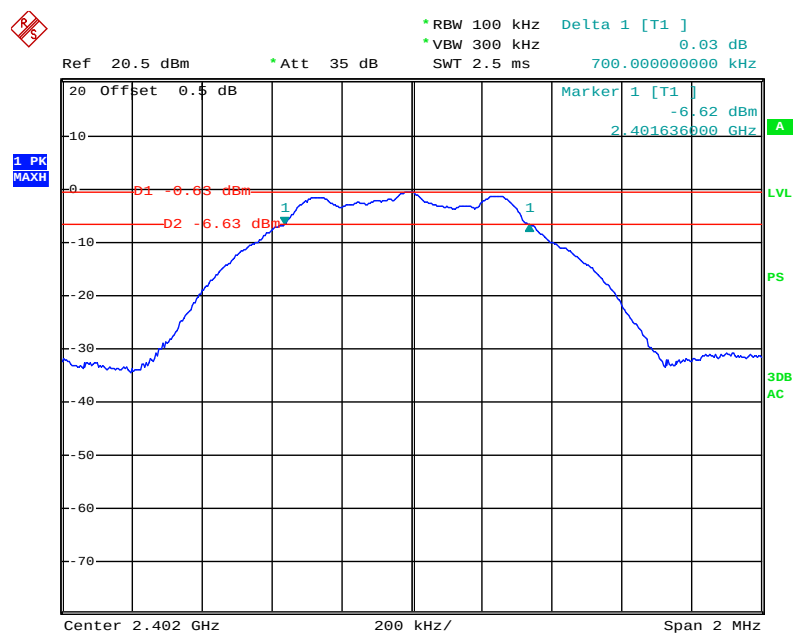
Test Data**Environmental Conditions**

Temperature:	26.3°C
Relative Humidity:	41%
ATM Pressure:	101.6Pa
Tester:	James Chen
Test Date:	2020-11-11

Test Mode: Transmitting

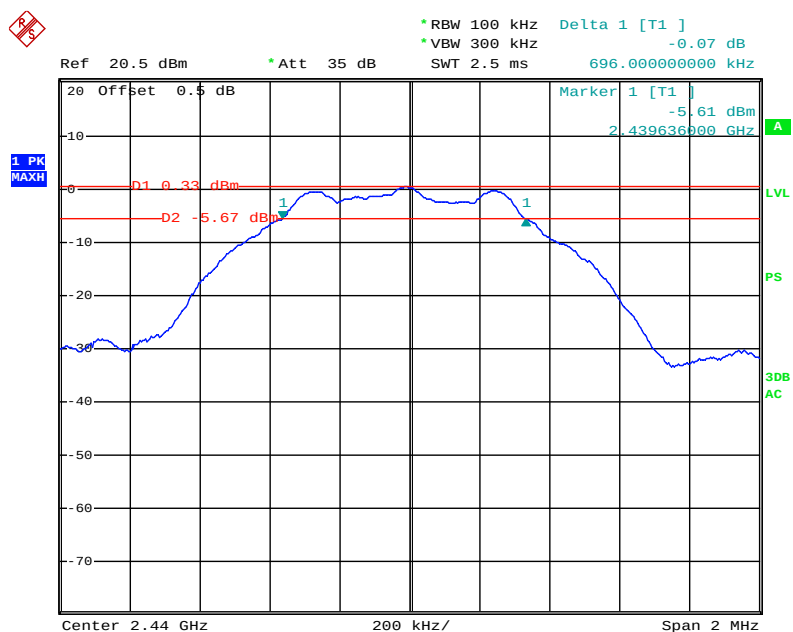
Test Result: Compliant. Please refer to the following table and plots.

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)	Limit (MHz)
Low	2402	0.700	1.208	≥ 0.5
Middle	2440	0.696	1.208	≥ 0.5
High	2480	0.696	1.032	≥ 0.5

6dB bandwidth:**Low Channel**

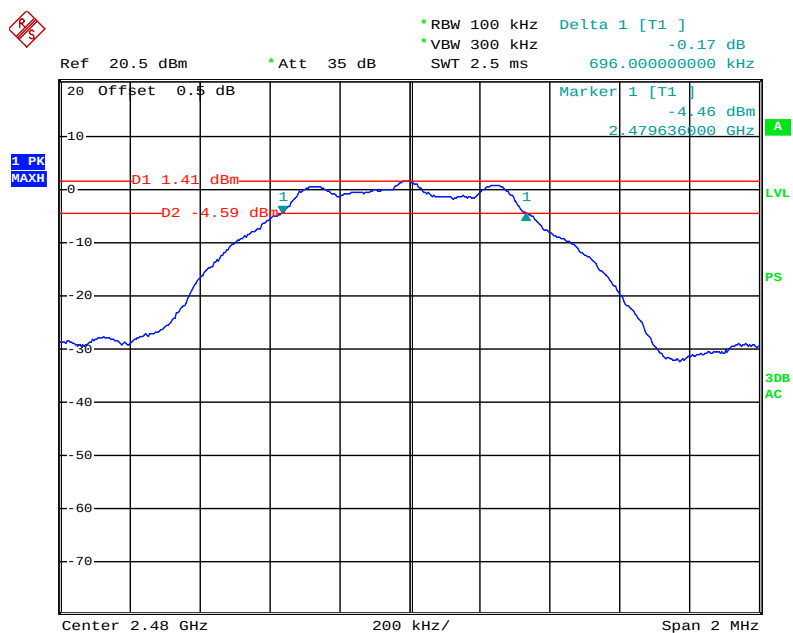
Date: 11.NOV.2020 18:51:00

Middle Channel

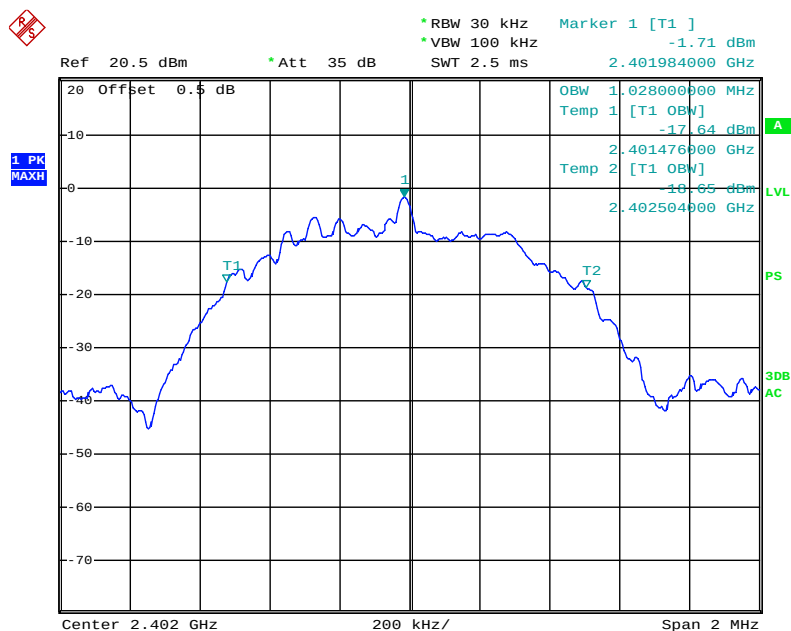


Date: 11.NOV.2020 18:53:52

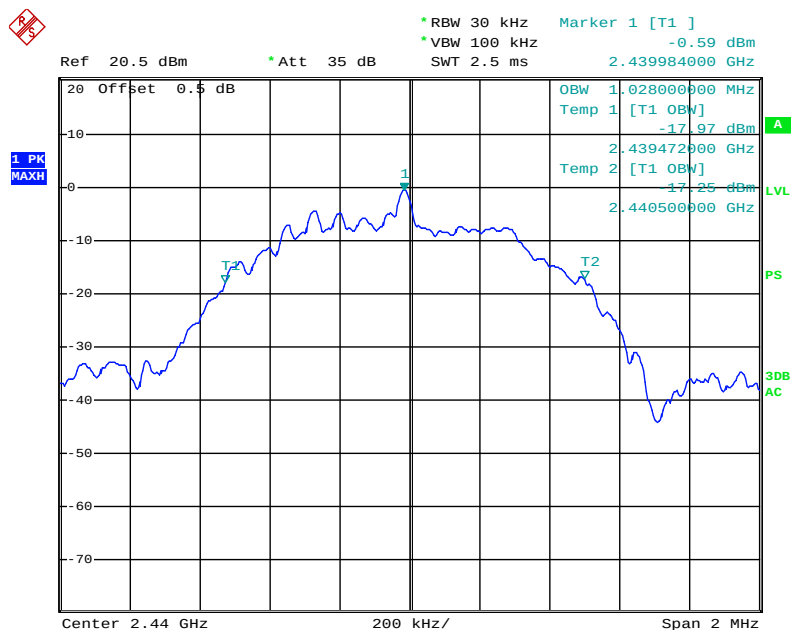
High Channel



Date: 11.NOV.2020 18:52:20

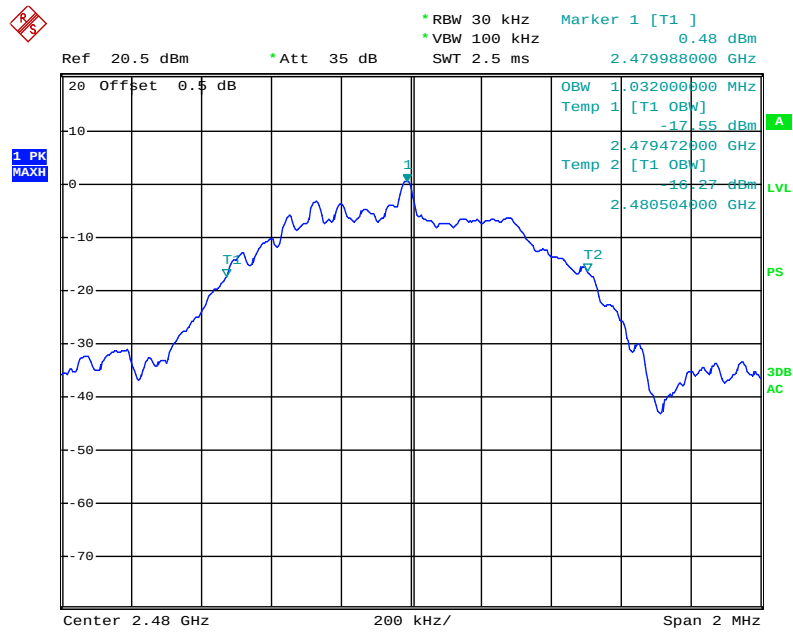
99% Occupied bandwidth:**Low Channel**

Date: 11.NOV.2020 18:51:15

Middle Channel

Date: 11.NOV.2020 18:54:06

High Channel



Date: 11.NOV.2020 18:52:34

FCC §15.247(b) (3)& RSS-247 CLAUSE 5.4 d) - MAXIMUM PEAK CONDUCTED OUTPUT POWER

Applicable Standard

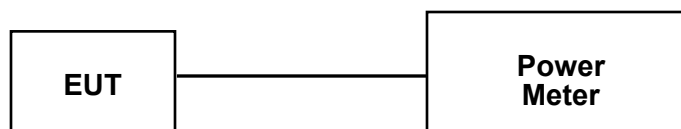
According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted 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 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 1W. Except as provided in Section 5.4(e), the e.i.r.p. shall not exceed 4 W.

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to test equipment.
3. Add a correction factor to the display.
4. Set the power Meter to test Peak output power, record the result as peak power.
5. Set the power meter to test average output power, record the result as average power.



Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41005011	Each time	N/A
Agilent	USB Wideband Power Sensor	U2021XA	MY54080014	2020-09-12	2021-09-12

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

Temperature:	26.3°C
Relative Humidity:	41%
ATM Pressure:	101.6Pa
Tester:	James Chen
Test Date:	2020-11-11

Test Mode: Transmitting

Frequency (MHz)	Peak Conducted Output power (dBm)	Peak Conducted Output power Limit (dBm)	EIRP (dBm)	EIRP Limit For ISED (dBm)
2402	-0.38	21	-0.99	36
2440	0.54	21	-0.07	36
2480	1.64	21	1.03	36

Note: The data above was tested in conducted mode, the antenna gain is -0.61 dBi.

FCC §15.247(d)& RSS-247 CLAUSE 5.5 – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

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 RSS-247 Clause 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(d), 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.

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU 26	200256	2020-07-07	2021-07-07
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41005011	Each time	N/A

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

Temperature:	26.3°C
Relative Humidity:	41%
ATM Pressure:	101.6Pa
Tester:	James Chen
Test Date:	2020-11-11

Test mode: Transmitting

Test Result: Compliant. Please refer to following plots.

Delta 1 [T1]

Ref 20.5 dBm * Att 35 dB

* RBW 100 kHz * VBW 300 kHz

SWT 2.5 ms

-45.42 dB

-2.752000000 MHz

20 Offset 0.5 dB

Marker 1 [T1]

-0.62 dBm

2.401984000 GHz

1 PK MAXH

-26.62 dBm

Center 2.4 GHz

800 kHz/

Span 8 MHz

Date: 11.NOV.2020 18:51:57

The spectrum plot shows a signal with a peak at 2.479972 GHz. The peak is labeled with a green '1' and a green arrow. The peak level is -18.55 dBm. The plot includes a grid and various measurement parameters.

Parameters and Settings:

- Ref: 20.5 dBm
- Att: 35 dB
- RBW: 100 kHz
- VBW: 300 kHz
- SWT: 2.5 ms
- Delta 1 [T1]: -49.43 dB
- Marker 1 [T1]: 1.44 dBm
- 2.479972000 GHz
- Center: 2.4835 GHz
- 1.4 MHz/
- Span: 14 MHz

Date: 11.NOV.2020 18:53:19

FCC §15.247(e) & RSS-247 CLAUSE 5.2 b - POWER SPECTRAL DENSITY**Applicable Standard**

According to FCC§15.247(e):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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

According to RSS-247 §5.2 b):

- b) The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT was set without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set the RBW = 3 kHz, VBW = 10 kHz, Set the span to 1.5 times the DTS bandwidth.
4. Use the peak marker function to determine the maximum amplitude level.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU 26	200256	2020-07-07	2021-07-07
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41005011	Each time	N/A

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

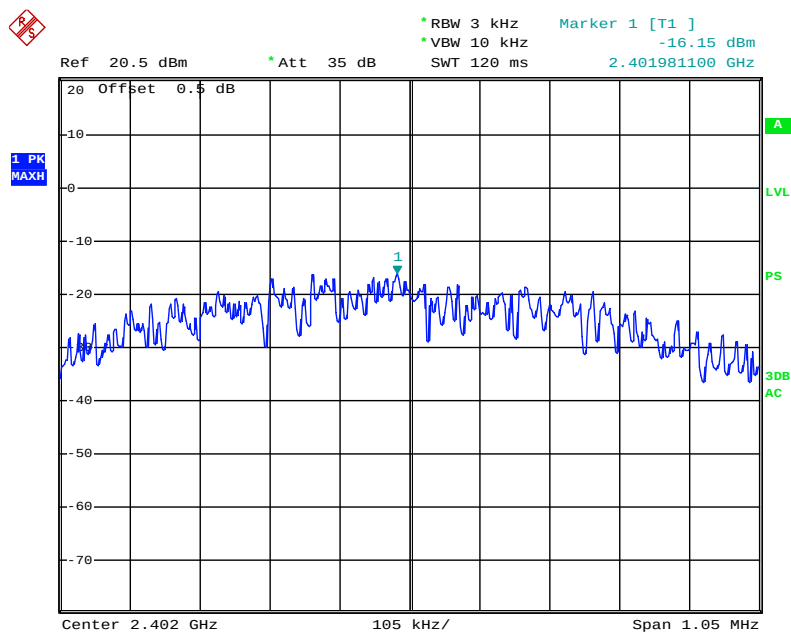
Test Data**Environmental Conditions**

Temperature:	26.3°C
Relative Humidity:	41%
ATM Pressure:	101.6Pa
Tester:	James Chen
Test Date:	2020-11-11

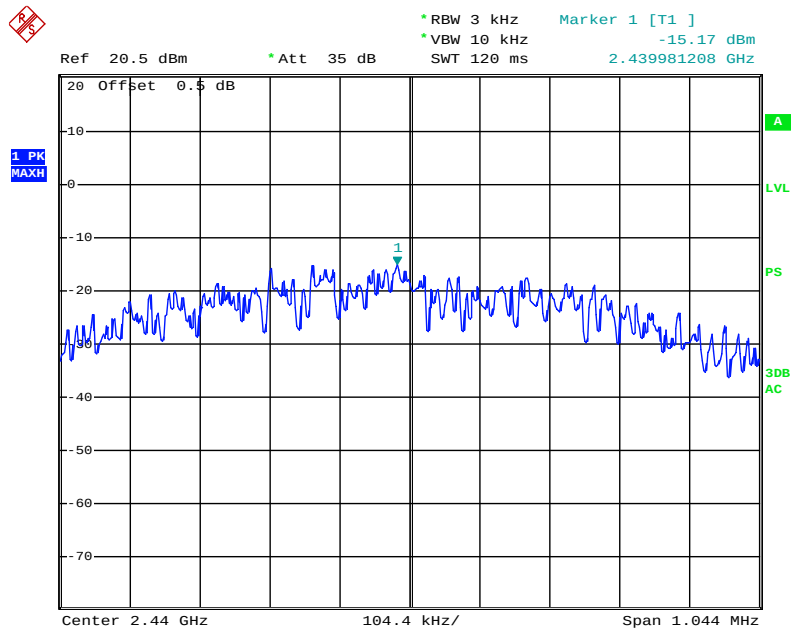
Test Mode: Transmitting

Test Result: Compliance. Please refer to the following table and plots

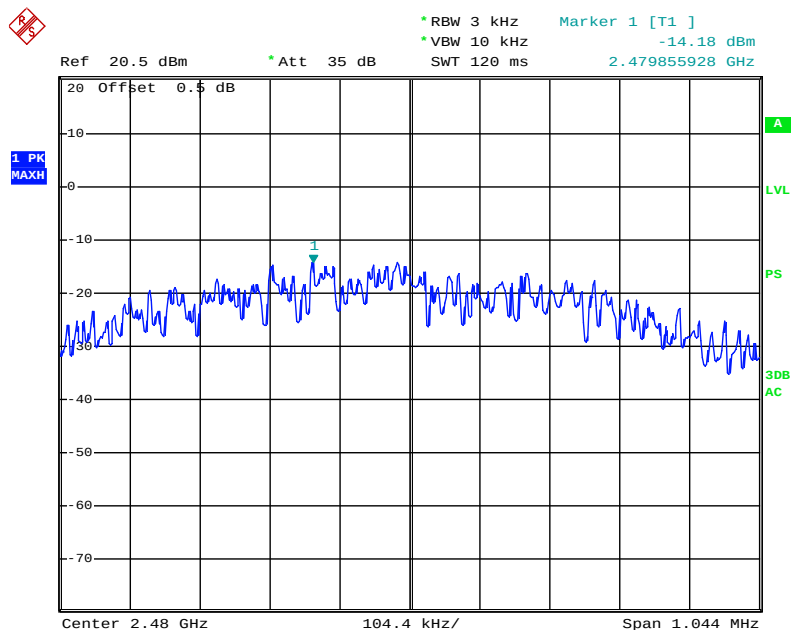
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	2402	-16.15	≤8
Middle	2440	-15.17	≤8
High	2480	-14.18	≤8

Power Spectral Density, Low Channel

Date: 11.NOV.2020 18:51:42

Power Spectral Density, Middle Channel

Date: 11.NOV.2020 18:54:32

Power Spectral Density, High Channel

Date: 11.NOV.2020 18:53:01

******* END OF REPORT *******