



TESTING LABORATORY
CERTIFICATE #4820.01



FCC PART 15.247

TEST REPORT

For

Terraprima Group Limited

7 Blackhorse Lane, London, E17 6DS, United Kingdom

FCC ID:2AVA5LADYBIRD

Report Type: Original Report	Product Name: LADYBIRD
Report Number: RDG191212003-00A	
Report Date: 2020-01-07	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	LADYBIRD
EUT Model:	P
Mutiple Models:	L, T, R
Operation Frequency:	902.3-914.9MHz
Maximum Peak Output Power (Conducted):	9.47 dBm
Modulation Type:	LoRa
Rated Input Voltage:	DC 4.5V from Battery
Serial Number:	RDG191212003-RF-S2
EUT Received Date:	2019-12-13
EUT Received Status:	Good

Note: Model P was selected for fully testing, the detailed information about the difference among L, T, R and model P can be referred to the declaration letter which was stated and guaranteed by the manufacturer.

Objective

This report is prepared on behalf of *Terraprima Group Limited* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules.

The tests were performed in order to determine the EUT compliance with FCC Rules Part 15, Subpart C, and section 15.203, 15.205, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

FCC Part 15C DTS submissions with FCC ID: 2AVA5LADYBIRD

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".

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
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.

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.

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SYSTEM TEST CONFIGURATION

Description of Test Configuration

The device was a hopping transmitter with LoRa125kHz mode.

The system was configured for testing in an engineering mode.64 hopping channels are employed:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	902.3	17	905.5	33	908.7	49	911.9
2	902.5	18	905.7	34	908.9	50	912.1
3	902.7	19	905.9	35	909.1	51	912.3
4	902.9	20	906.1	36	909.3	52	912.5
5	903.1	21	906.3	37	909.5	53	912.7
6	903.3	22	906.5	38	909.7	54	912.9
7	903.5	23	906.7	39	909.9	55	913.1
8	903.7	24	906.9	40	910.1	56	913.3
9	903.9	25	907.1	41	910.3	57	913.5
10	904.1	26	907.3	42	910.5	58	913.7
11	904.3	27	907.5	43	910.7	59	913.9
12	904.5	28	907.7	44	910.9	60	914.1
13	904.7	29	907.9	45	911.1	61	914.3
14	904.9	30	908.1	46	911.3	62	914.5
15	905.1	31	908.3	47	911.5	63	914.7
16	905.3	32	908.5	48	911.7	64	914.9

Channel 1, 32, 64 were selected to test.

EUT Exercise Software

The software ' Murataloramoduletesttool(v0.0.01).exe ' was used for testing, which was provided by manufacturer and the maximum power was configured as below table:

Channel	Frequency (MHz)	Power level Setting
Low	902.3	Default
Middle	908.5	Default
High	914.9	Default

Equipment Modifications

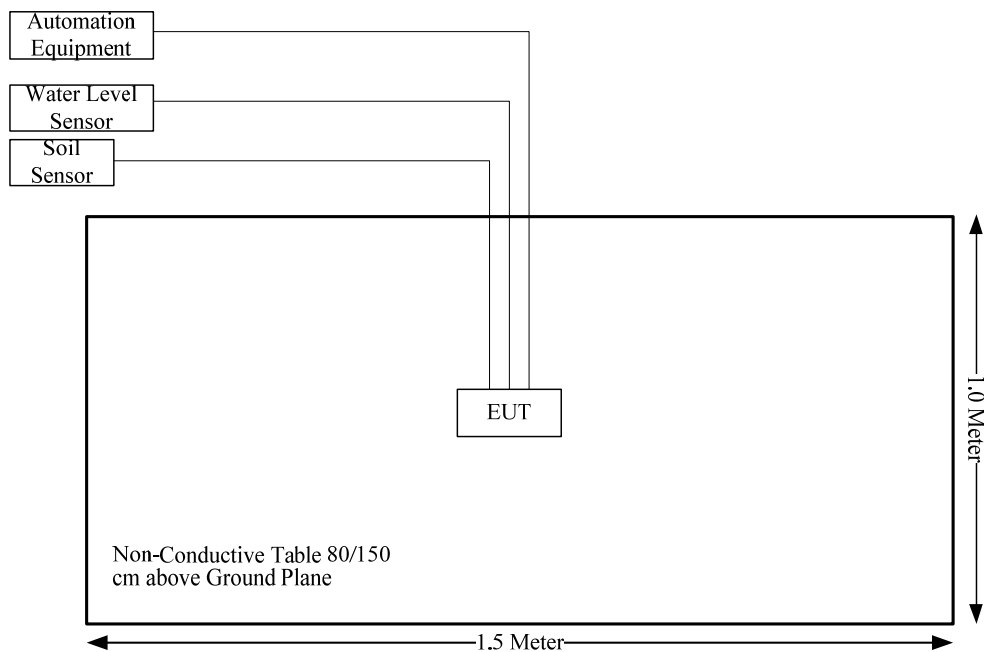
No modification was made to the EUT.

Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
Terra Prima	automation equipment	/	/
Terra Prima	Water Level Sensor	/	/
Terra Prima	Soil Sensor	/	/

External Cable

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
2 Pin male Cable	Yes	No	5.0	EUT	automation equipment
3 Pin male Cable	Yes	No	5.0	EUT	Water Level Sensor
5 Pin male Cable	Yes	No	5.0	EUT	Soil Sensor

Block Diagram of Test Setup

SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
FCC§15.247 (i) & §1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliance
FCC§15.203	Antenna Requirement	Compliance
FCC§15.207 (a)	Conducted Emissions	Not Applicable
FCC§15.205, §15.209, FCC §15.247(d)	Spurious Emissions	Compliance
FCC §15.247 (a)(1)	Emission Bandwidth	Compliance
FCC §15.247(a)(1)	Channel Separation Test	Compliance
FCC§15.247(a)(1)(i)	Time of Occupancy (Dwell Time)	Compliance
FCC§15.247(a)(1)(i)	Quantity of hopping channel Test	Compliance
FCC§15.247(b)(2)	Peak Output Power Measurement	Compliance
FCC§15.247(d)	Band Edges	Compliance

Not Applicable: the device was powered by battery.

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:

Mode	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)			
125 kHz	902.3-914.9	1.04	1.27	10	10.00	20.00	0.003	0.6
500 kHz	903-914.2	1.04	1.27	10	10.00	20.00	0.003	0.6

Note: 125 kHz and 500 kHz modes can't transmission Simultaneously.

Result: The device meet FCC MPE at 20 cm distance

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 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 user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
- b. Antenna must use a unique type of connector to attach to the EUT.
- c. Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

Antenna Information And Connector Construction

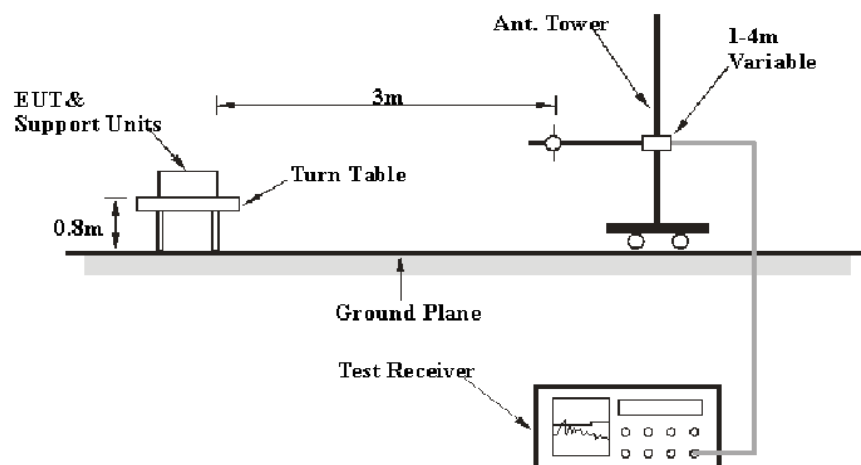
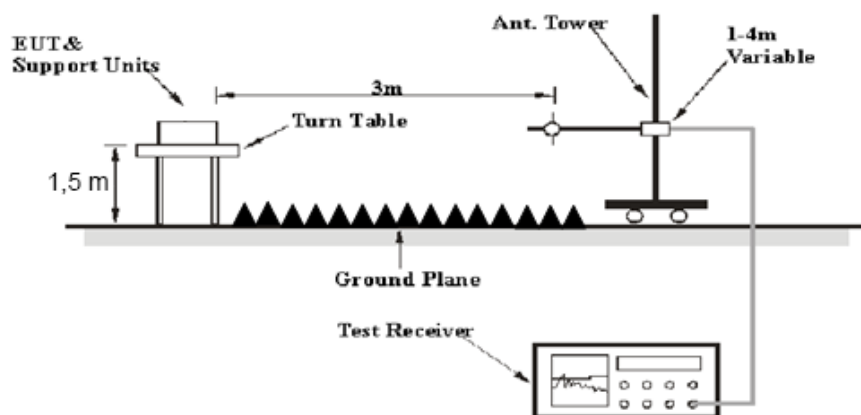
The EUT has one internal antenna arrangement, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	input impedance (Ohm)	Antenna Gain
internal	50	1.04 dBi

Result: Compliance.

FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS**Applicable Standard**

FCC §15.247 (d); §15.209; §15.205

EUT Setup**Below 1GHz:****Above 1GHz:**

The radiated emission below 1GHz tests were performed in the 3 meters chamber test site A, above 1GHz tests were performed in the 3 meters chamber test site B, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 10 GHz.

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

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	AV

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.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiation Below 1GHz					
R&S	EMI Test Receiver	ESR3	102453	2019-06-26	2020-06-26
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Sunol Sciences	Antenna	JB3	A060611-1	2017-11-10	2020-11-10
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-1400-01	2019-05-06	2020-05-06
HP	Amplifier	8447D	2727A05902	2019-09-05	2020-09-05
Radiation Above 1GHz					
Agilent	Spectrum Analyzer	E4440A	SG43360054	2019-05-09	2020-05-09
ETS-Lindgren	Horn Antenna	3115	000 527 35	2018-10-12	2021-10-12
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
MICRO-COAX	Coaxial Cable	UFA147-1-2362-100100	64639 231029-001	2019-02-24	2020-02-24
Mini-Circuit	Amplifier	ZVA-213-S+	54201245	2019-09-05	2020-09-05

*** 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).

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 Data

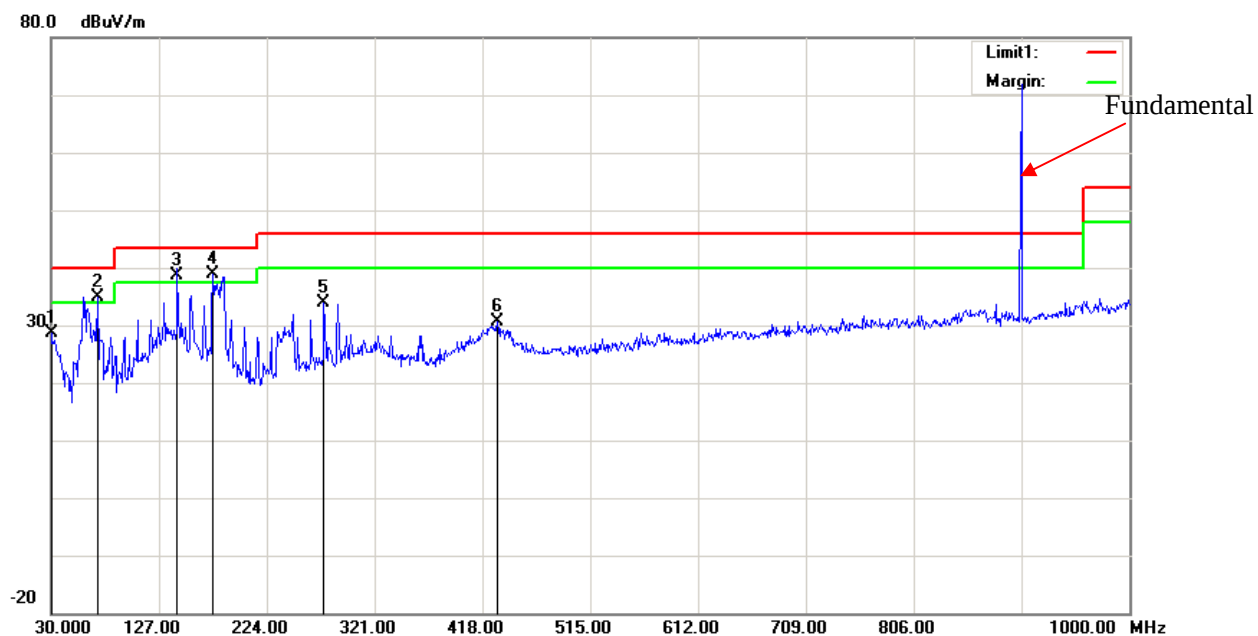
Environmental Conditions

Test Items	Radiation Below 1GHz	Radiation Above 1GHz
Temperature:	24.3°C	25°C
Relative Humidity:	39%	44%
ATM Pressure:	102.5 kPa	100.9 kPa
Tester:	Davy Wang	Lucy Lu
Test Date:	2019-12-26	2020-01-07

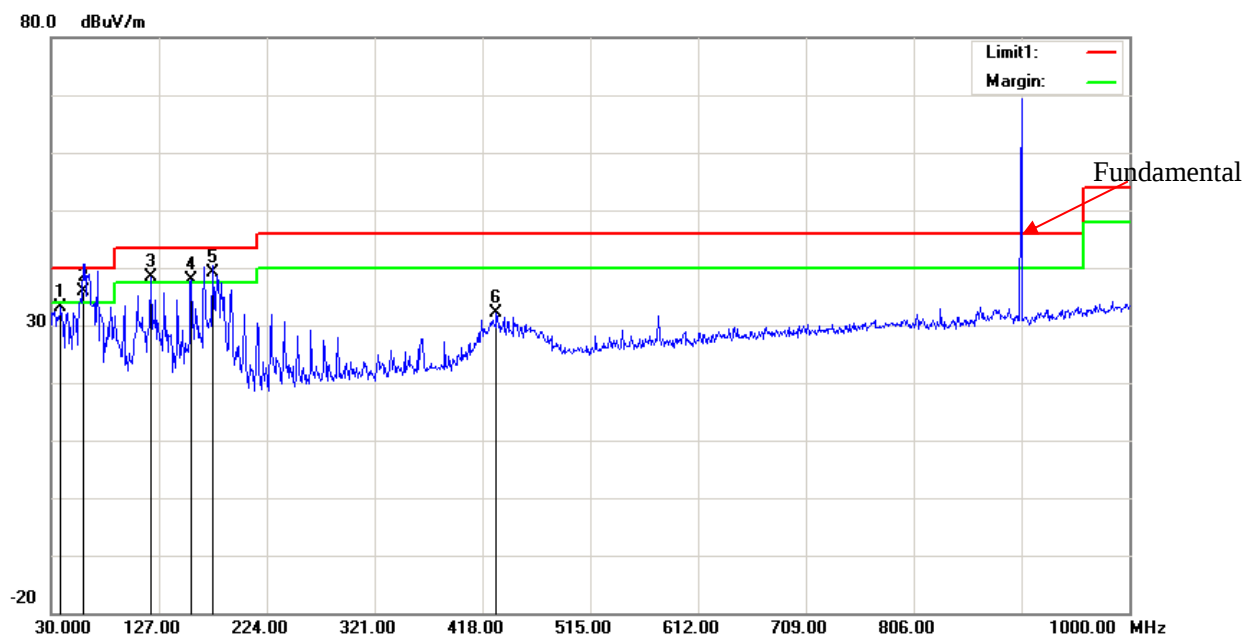
Test Mode: Transmitting

30MHz-1GHz

Horizontal:



Frequency (MHz)	Receiver Reading (dBμV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
30.0000	27.02	peak	1.72	28.74	40.00	11.26
71.7100	45.97	peak	-11.06	34.91	40.00	5.09
143.4900	44.70	QP	-5.95	38.75	43.50	4.75
175.5000	45.70	peak	-6.88	38.82	43.50	4.68
275.4100	37.89	peak	-4.13	33.76	46.00	12.24
431.5800	31.98	peak	-1.26	30.72	46.00	15.28

Vertical:

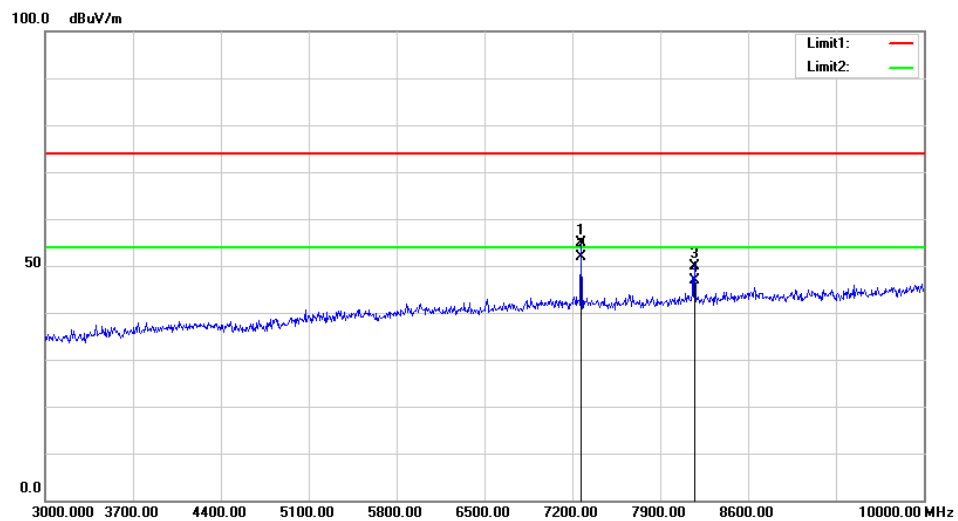
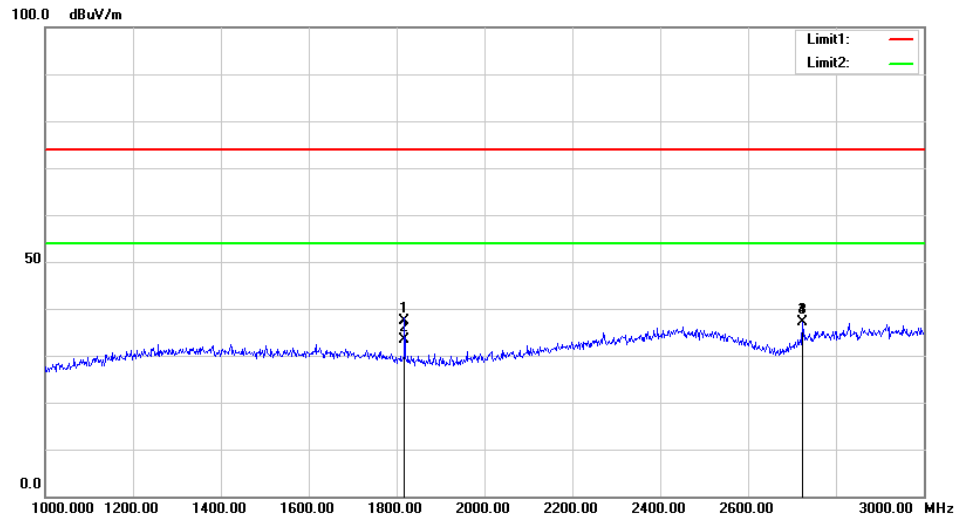
Frequency (MHz)	Receiver Reading (dBμV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
38.7300	38.20	peak	-4.95	33.25	40.00	6.75
59.1000	48.00	QP	-12.18	35.82	40.00	4.18
120.2100	43.23	peak	-4.83	38.40	43.50	5.10
156.1000	43.68	peak	-5.83	37.85	43.50	5.65
175.5000	46.12	QP	-6.88	39.24	43.50	4.26
430.6100	33.40	peak	-1.27	32.13	46.00	13.87

2) Fundamental, Bandedge, and above 1GHz:

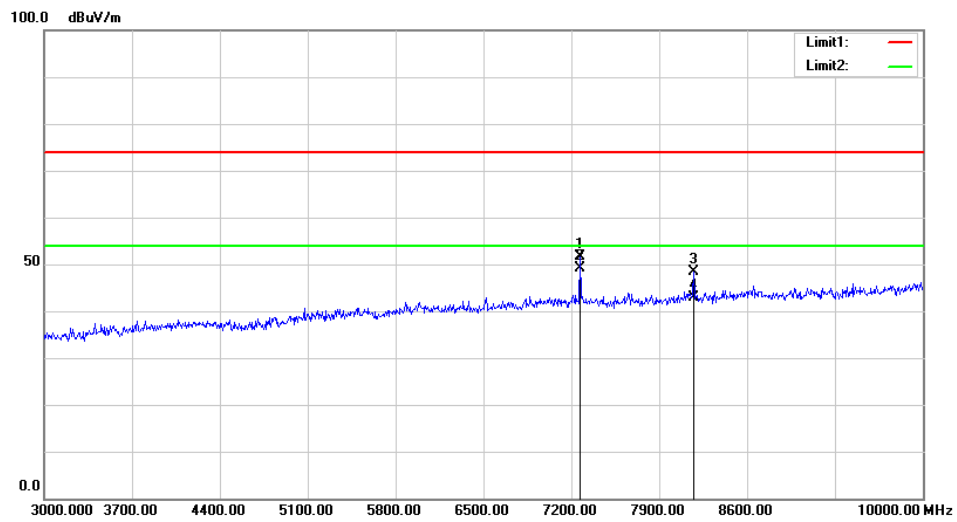
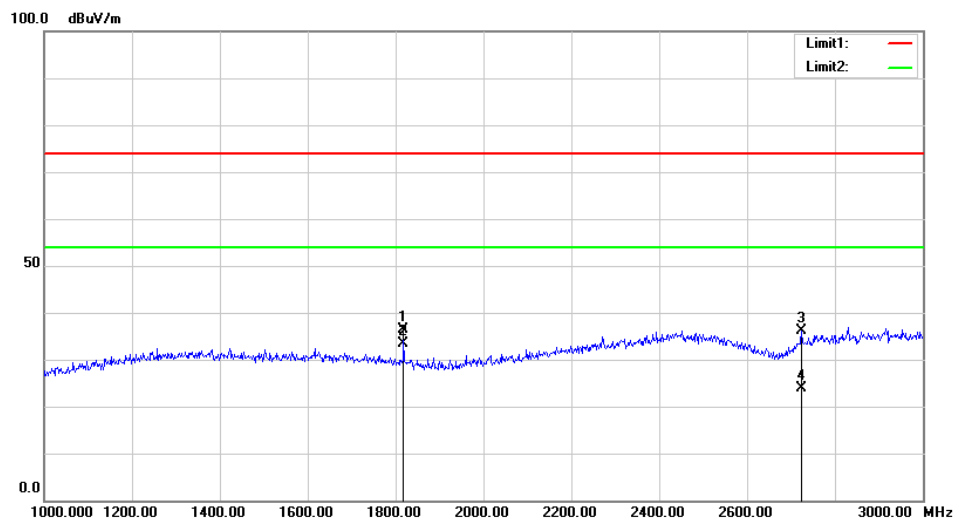
Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 902.3 MHz									
902.30	75.70	QP	H	22.35	4.29	0.00	102.34	N/A	N/A
902.30	72.50	QP	V	22.35	4.29	0.00	99.14	N/A	N/A
902.00	18.10	QP	H	22.34	4.29	0.00	44.73	46.00	1.27
1804.60	46.65	PK	H	26.48	1.66	25.80	48.99	74.00	25.01
1804.60	44.77	AV	H	26.48	1.66	25.80	47.11	54.00	6.89
2706.90	37.10	PK	H	29.04	1.88	26.11	41.91	74.00	32.09
2706.90	26.78	AV	H	29.04	1.88	26.11	31.59	54.00	22.41
3609.20	35.16	PK	H	31.54	2.41	25.95	43.16	74.00	30.84
3609.20	22.78	AV	H	31.54	2.41	25.95	30.78	54.00	23.22
7218.40	41.56	PK	H	35.77	4.80	25.62	56.51	74.00	17.49
7218.40	38.42	AV	H	35.77	4.80	25.62	53.37	54.00	0.63
8120.70	39.66	PK	H	36.94	4.86	26.05	55.41	74.00	18.59
8120.70	30.82	AV	H	36.94	4.86	26.05	46.57	54.00	7.43
Middle Channel: 908.5 MHz									
908.50	75.40	QP	H	22.40	4.23	0.00	102.03	N/A	N/A
908.50	73.90	QP	V	22.40	4.23	0.00	100.53	N/A	N/A
1817.00	41.92	PK	H	26.53	1.66	25.85	44.26	74.00	29.74
1817.00	37.65	AV	H	26.53	1.66	25.85	39.99	54.00	14.01
2725.50	36.87	PK	H	29.11	1.89	26.10	41.77	74.00	32.23
2725.50	25.93	AV	H	29.11	1.89	26.10	30.83	54.00	23.17
3634.00	35.28	PK	H	31.59	2.45	25.94	43.38	74.00	30.62
3634.00	22.54	AV	H	31.59	2.45	25.94	30.64	54.00	23.36
7268.00	42.84	PK	H	35.90	4.71	25.67	57.78	74.00	16.22
7268.00	38.76	AV	H	35.90	4.71	25.67	53.70	54.00	0.30
8176.50	37.98	PK	H	37.01	4.90	26.05	53.84	74.00	20.16
8176.50	31.05	AV	H	37.01	4.90	26.05	46.91	54.00	7.09
High Channel: 914.9 MHz									
914.90	75.20	QP	H	22.40	4.21	0.00	101.81	N/A	N/A
914.90	73.30	QP	V	22.40	4.21	0.00	99.91	N/A	N/A
928.00	18.11	QP	H	22.56	4.34	0.00	45.01	46.00	0.99
1829.80	39.53	PK	H	26.59	1.66	25.91	41.87	74.00	32.13
1829.80	35.29	AV	H	26.59	1.66	25.91	37.63	54.00	16.37
2744.70	35.78	PK	H	29.18	1.91	26.10	40.77	74.00	33.23
2744.70	24.92	AV	H	29.18	1.91	26.10	29.91	54.00	24.09
3659.60	35.40	PK	H	31.65	2.50	25.93	43.62	74.00	30.38
3659.60	22.45	AV	H	31.65	2.50	25.93	30.67	54.00	23.34
7319.20	42.03	PK	H	36.03	4.62	25.72	56.96	74.00	17.04
7319.20	38.35	AV	H	36.03	4.62	25.72	53.28	54.00	0.72
8234.10	37.48	PK	H	37.08	4.95	26.06	53.45	74.00	20.55
8234.10	30.76	AV	H	37.08	4.95	26.06	46.73	54.00	7.27

Worst Plots(Middle channel)

Horizontal



Vertical



FCC §15.247(a) (1) - CHANNEL SEPARATION TEST**Applicable Standard**

According to FCC §15.247(a) (1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.50 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-09-12	2020-09-12
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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 Procedure

1. Set the EUT in transmitting mode, spectrum Bandwidth was set at 3 kHz, maxhold the channel.
2. Set the adjacent channel of the EUT maxhold another trace.
3. Measure the channel separation.

Test Data**Environmental Conditions**

Temperature:	23.9 °C
Relative Humidity:	54 %
ATM Pressure:	102.0 kPa

* The testing was performed by Severn Zhu on 2019-12-30.

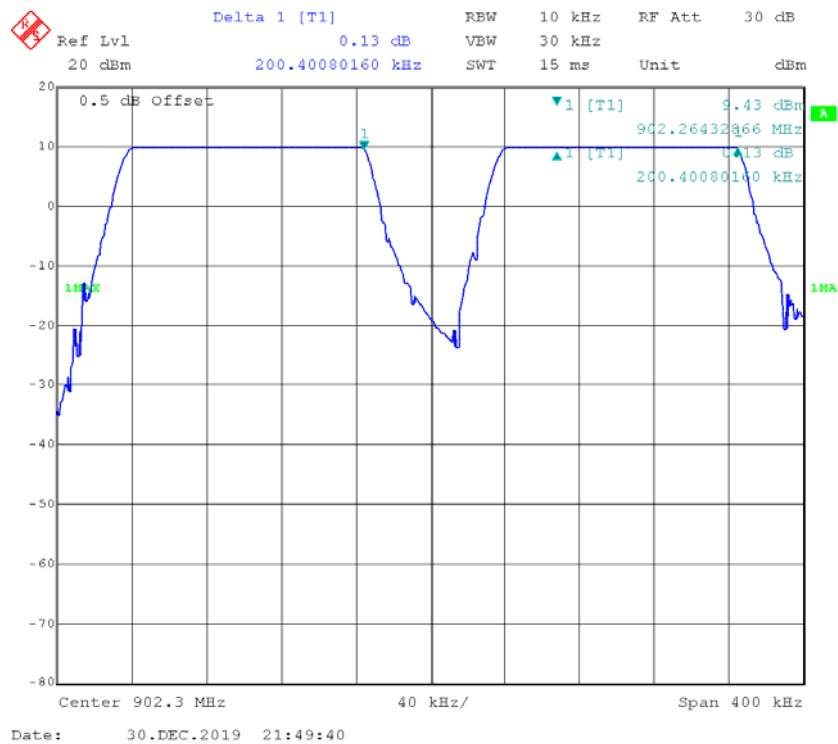
Test Result: Compliance.

Please refer to following tables and plots

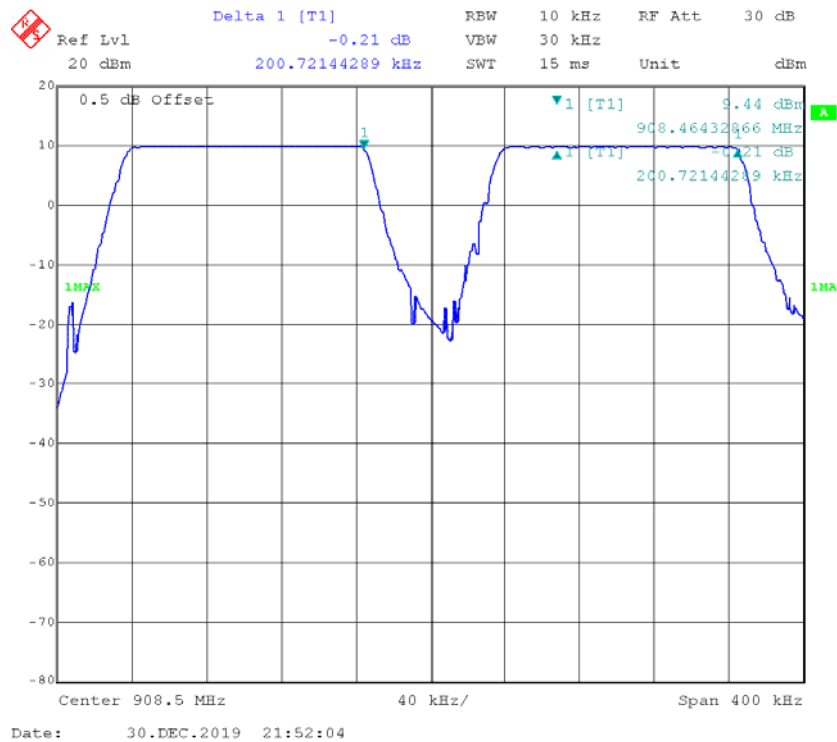
Test Mode: Transmitting

Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
Low	902.3	0.200	≥ 0.141
Middle	908.5	0.201	≥ 0.143
High	914.9	0.200	≥ 0.141

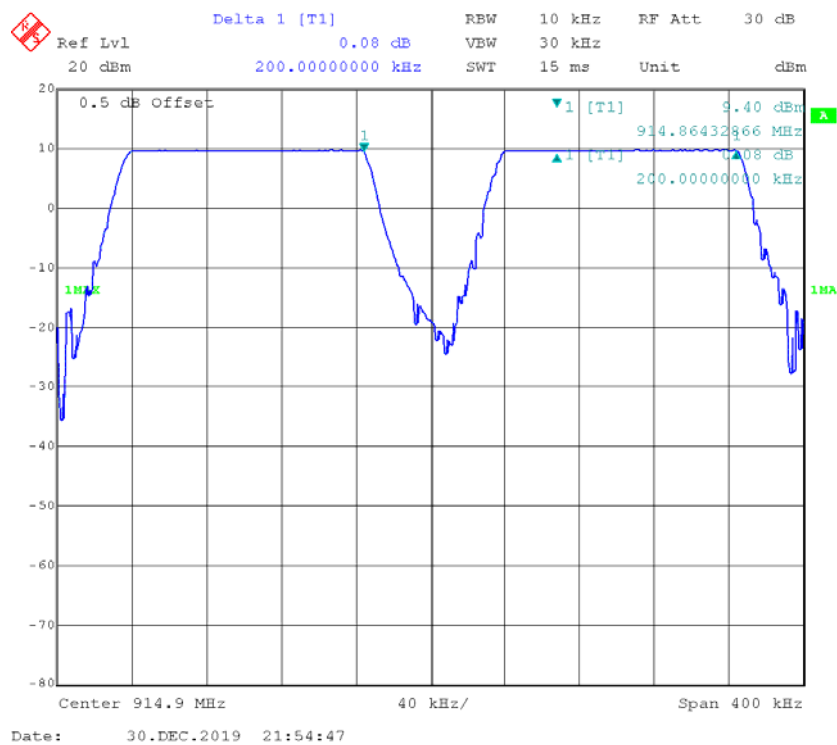
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (1) – 20 dB BANDWIDTH TESTING

Applicable Standard

According to FCC §15.247(a) (1) (i)

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

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 on the test table without connection to measurement instrument. Turn on the EUT. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-09-12	2020-09-12
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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:	23.9 °C
Relative Humidity:	54 %
ATM Pressure:	102.0 kPa

* The testing was performed by Severn Zhu on 2019-12-30.

Test Result: Compliance.

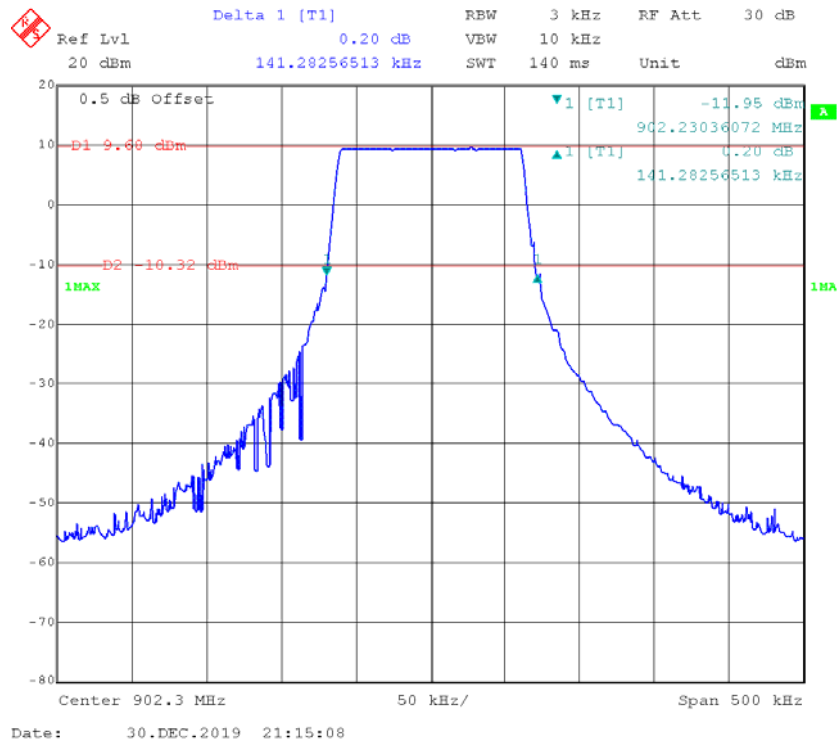
Please refer to following tables and plots

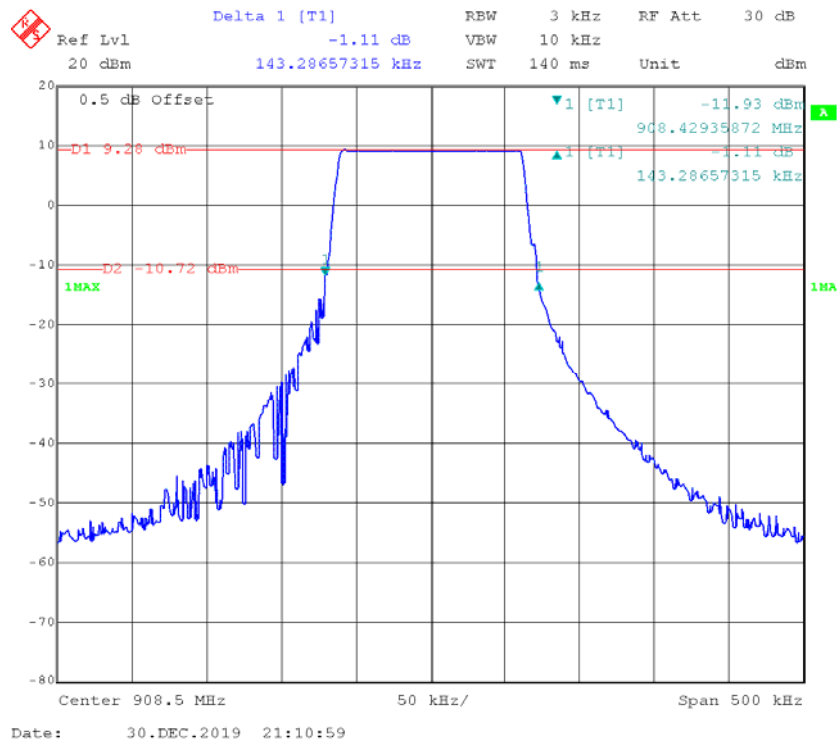
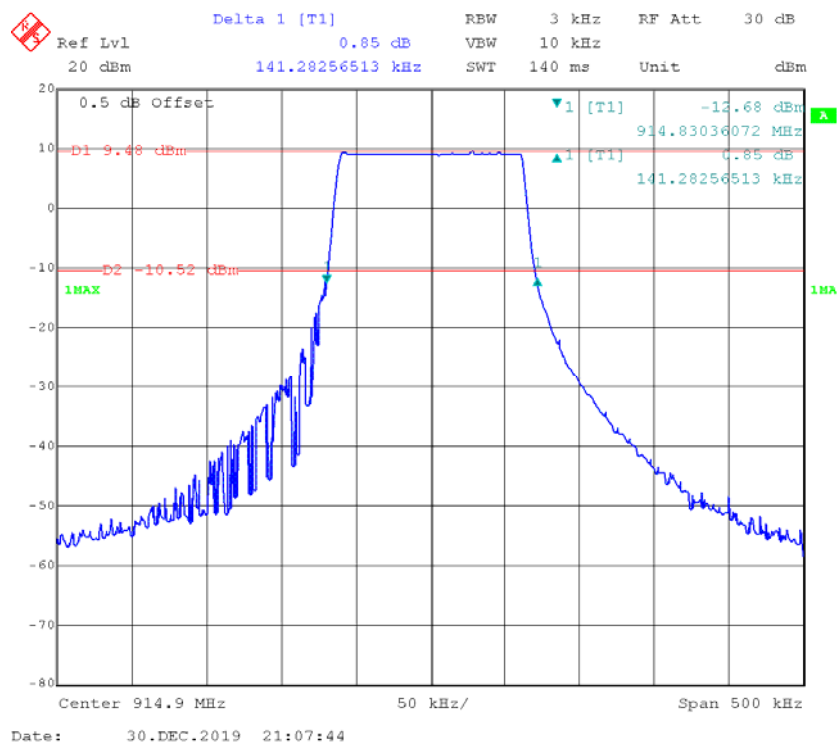
Test Mode: Transmitting

Channel	Frequency (MHz)	20 dB Bandwidth (MHz)
Low	902.3	0.141
Middle	908.5	0.143
High	914.9	0.141

20dB Bandwidth:

Low Channel



Middle Channel**High Channel**

FCC §15.247(a) (1) (i) - QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

According to FCC §15.247(a) (1) (i)

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the Max-Hold function record the Quantity of the channel.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-09-12	2020-09-12
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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:	23.9 °C
Relative Humidity:	54 %
ATM Pressure:	102.0 kPa

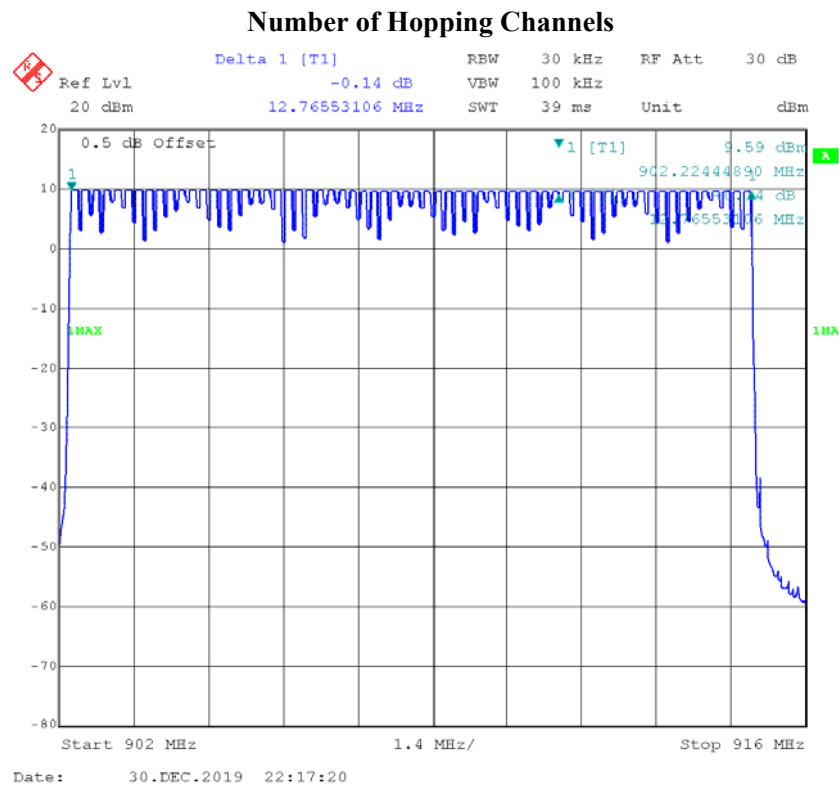
* The testing was performed by Severn Zhu on 2019-12-30.

Test Result: Compliance.

Please refer to following tables and plots

Test Mode: Transmitting

Frequency Range (MHz)	Number of Hopping Channel	Limit
902-928	64	≥ 50



FCC §15.247(a) (1) (i) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

According to FCC §15.247(a) (1) (i)

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure

The EUT was worked in channel hopping; the time of single pulses was tested.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-09-12	2020-09-12
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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

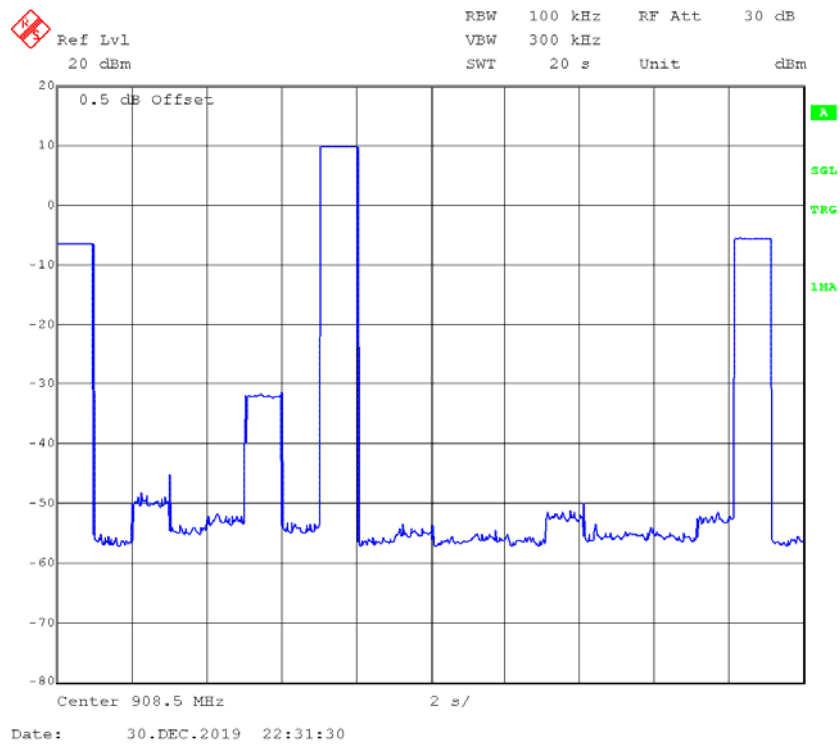
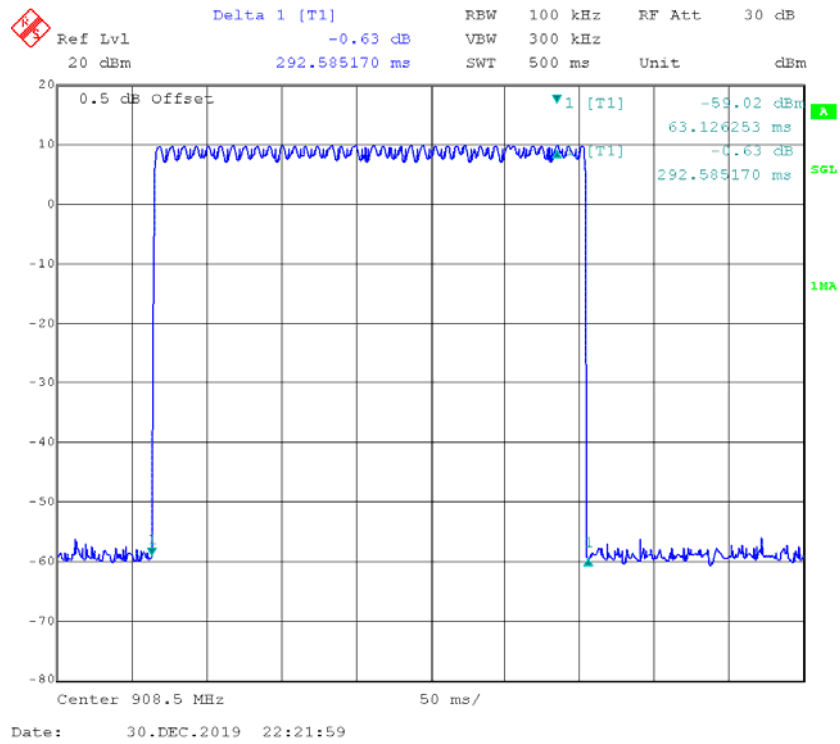
Temperature:	23.9 °C
Relative Humidity:	54 %
ATM Pressure:	102.0 kPa

* The testing was performed by Severn Zhu on 2019-12-30.

Test Mode: Transmitting

Channel	Frequency (MHz)	Pulse Width (ms)	Real Observed Period(s)	Hopping number in Observed Period	Dwell Time (s)	Limit (s)	Result
Middle	908.5	292.585	20	1	0.293	0.4	Compliance
Note: Dwell time=Pulse width × hopping number per channel in Observed Period Observed Period=20s							

Middle Channel



FCC §15.247(b) (2) - PEAK OUTPUT POWER MEASUREMENT**Applicable Standard**

According to FCC §15.247(b)

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-09-12	2020-09-12
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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:	23.9 °C
Relative Humidity:	54 %
ATM Pressure:	102.0 kPa

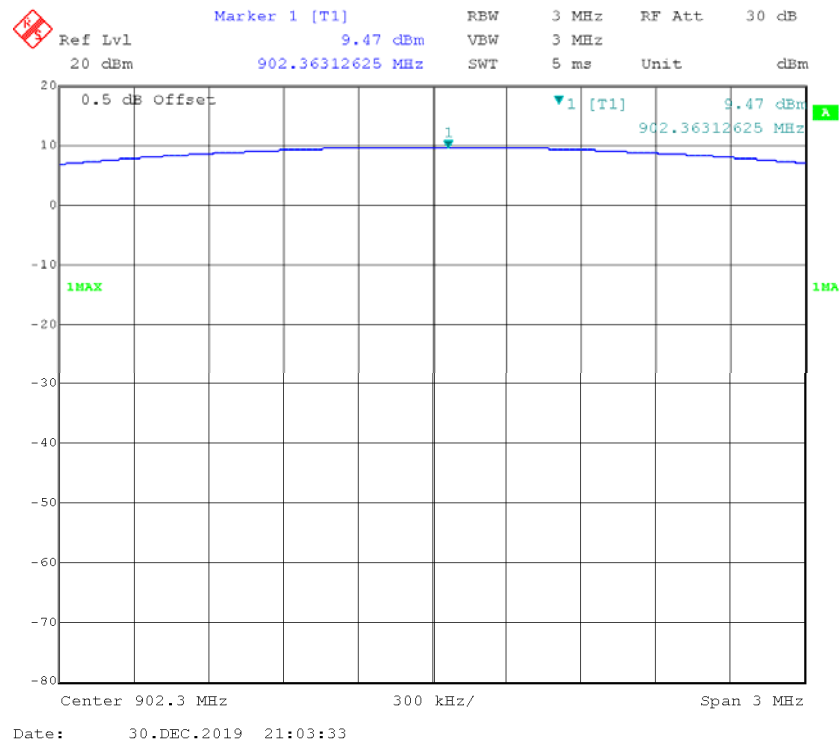
* The testing was performed by Severn Zhu on 2019-12-30.

Test Result: Compliance.

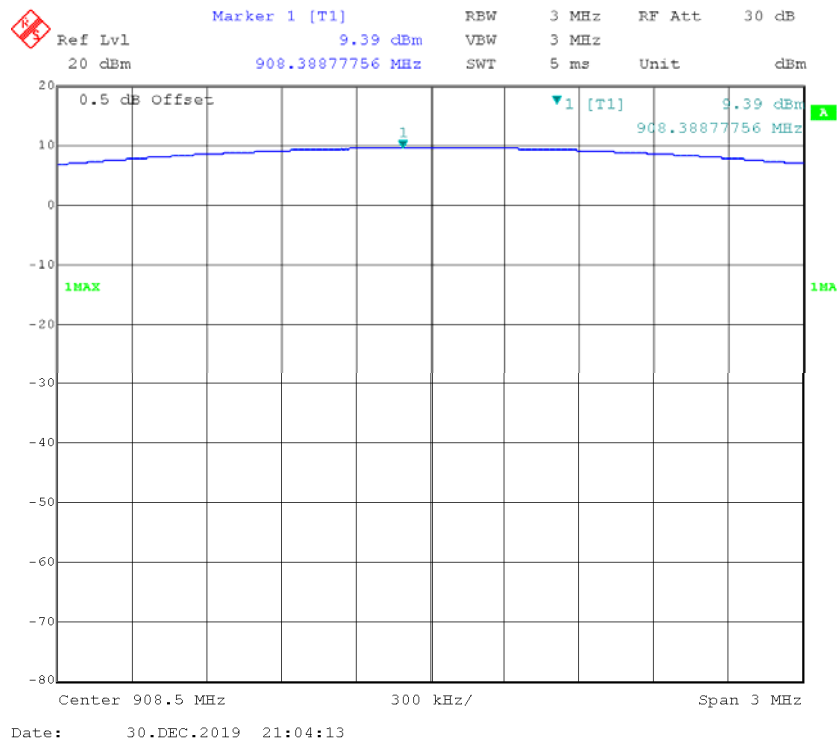
Test Mode: Transmitting

Channel	Frequency (MHz)	Peak Conducted Output power (dBm)	Peak Conducted Output power Limit (dBm)
Low	902.3	9.47	30
Middle	908.5	9.39	30
High	914.9	9.39	30

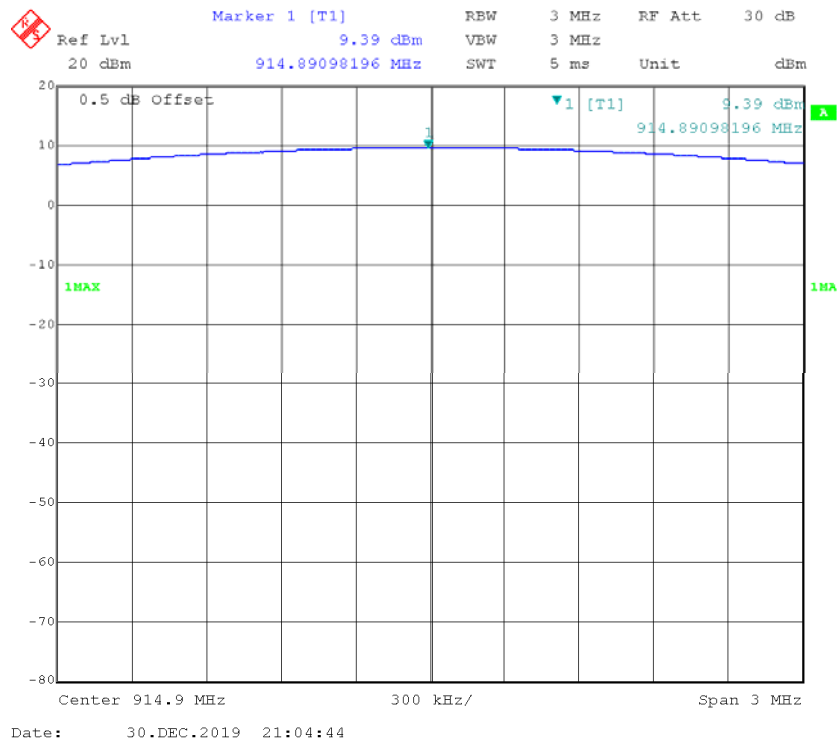
Note: The data above was tested in conducted mode.

Low Channel

Middle Channel



High Channel



FCC §15.247(d) - BAND EDGES TESTING

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)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW/ VBW of spectrum analyzer to 100/300 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
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2019-09-12	2020-09-12
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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

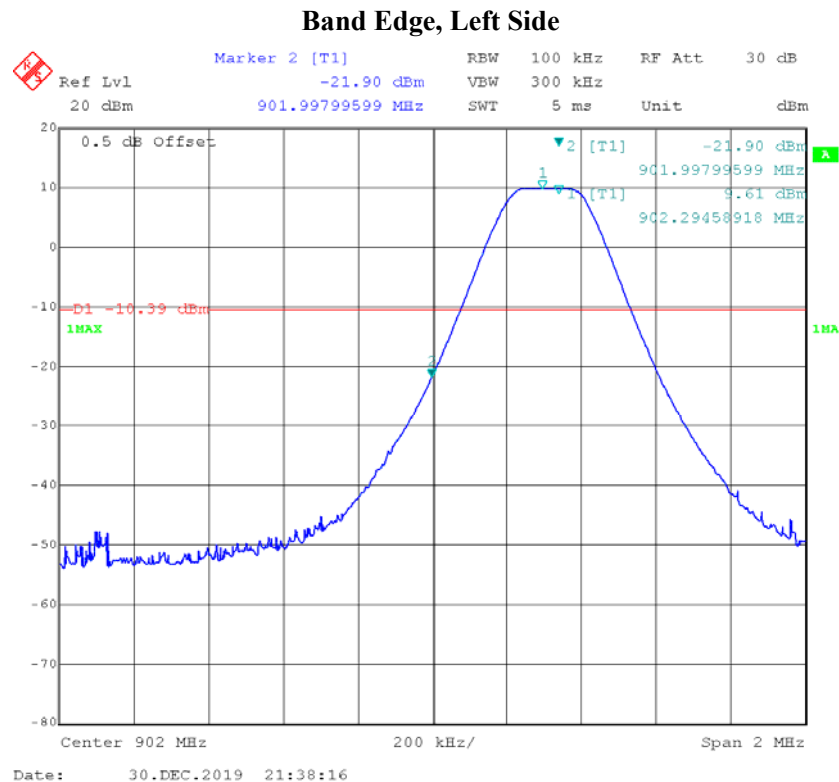
Environmental Conditions

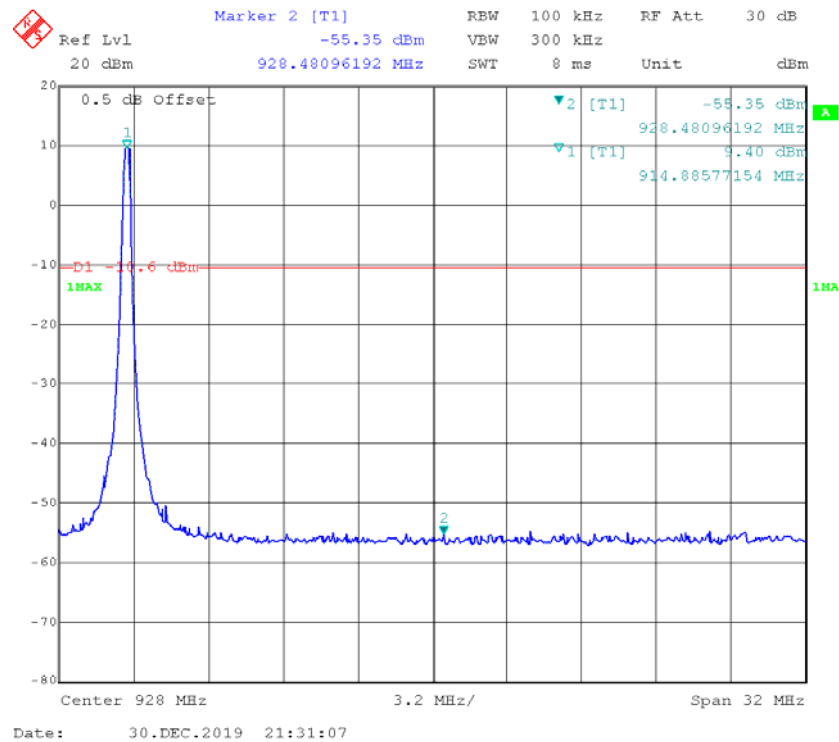
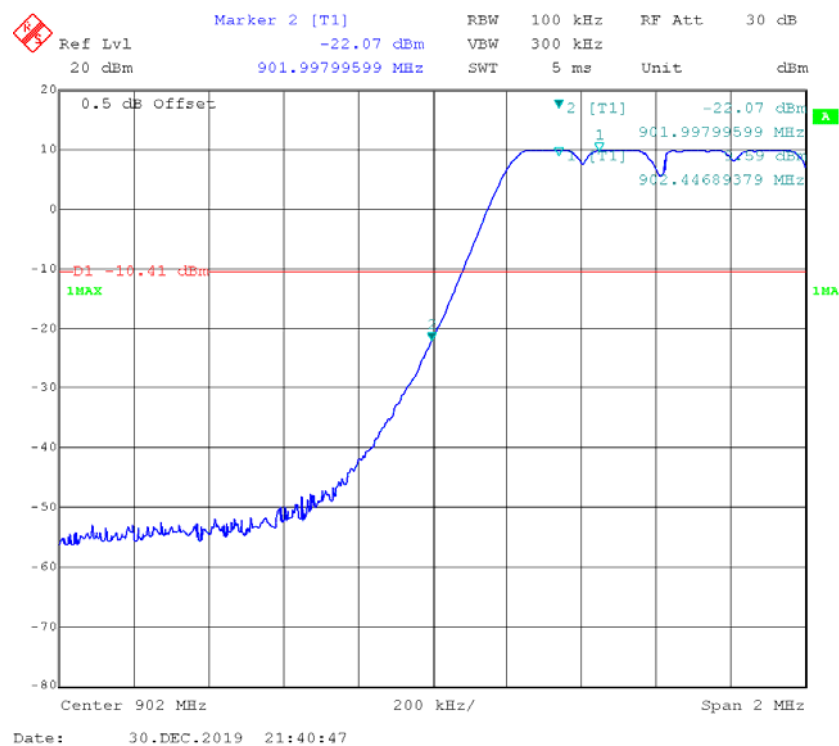
Temperature:	23.9 °C
Relative Humidity:	54 %
ATM Pressure:	102.0 kPa

* The testing was performed by Severn Zhu on 2019-12-30.

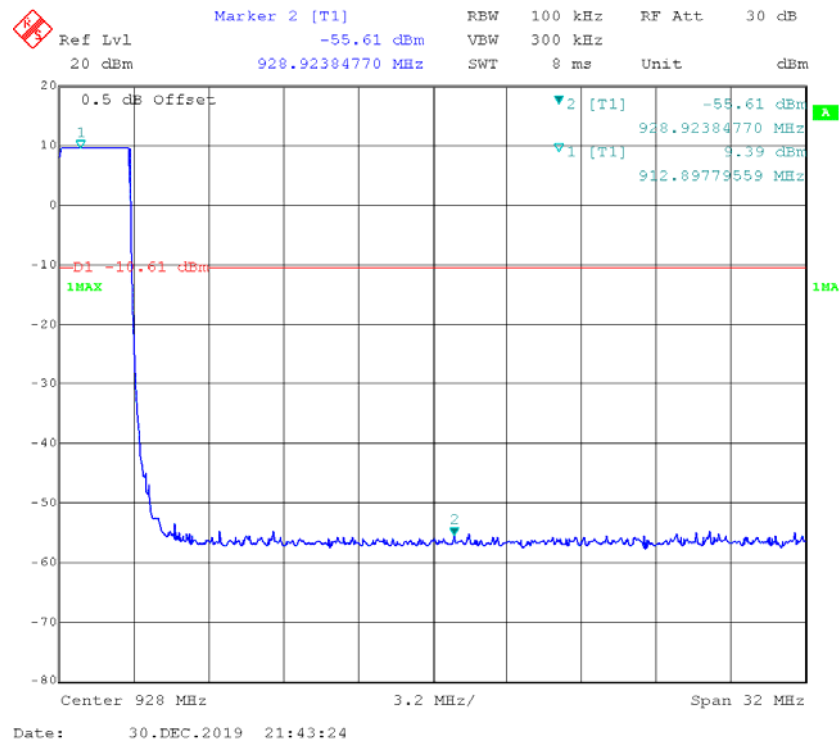
Test Result: Compliance

Single mode:



Band Edge, Right Side*Hopping mode:***Band Edge, Left Side**

Band Edge, Right Side



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