TEST REPORT

Applicant Name :	Dragino Technology Co., Limited.
Address :	Room 202,BaoChengTai industrial park,No.8 CaiYun, LongCheng Street, LongGang District,Shenzhen,China
Report Number :	SZNS220819-37799E-RF-00A
FCC ID:	ZHZLA66

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	LoRaWAN IoT Module
Model No.:	LA66 LoRaWAN Module
Multiple Model(s) No.:	N/A
Trade Mark:	DRAGINO
Date Received:	2022/08/19
Report Date:	2022/10/31

Test Result:	Pass*

* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Roger Ling
EMC Engineer

Approved By:

Candy Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★ ".
Shenzhen Accurate Technology Co., Ltd. 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 an asterisk '*'. Customer model name, addresses, names, trademarks etc. are not considered data.
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Frequency Range	902.3-914.9MHz
Maximum Conducted Peak Output Power	7.32dBm
Technique	Hybrid System
Antenna Specification	2dBi (provide by applicant)
Voltage Range	DC 3.3V
Sample serial number	SZNS220819-37799E-RF-S1 for Radiated Emissions SZNS220819-37799E-RF-S2 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted 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.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Line Conducted emission		2.72dB
Emissions, Radiated	30MHz – 1GHz	4.28dB
	1GHz – 18GHz	4.98dB
	18GHz – 26.5GHz	5.06dB
Temperature		1℃
Humidity		6%
Supply voltages		0.4%

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

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. 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.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in engineering mode.

Channel list:

Channel	Freq.(MHz)	Channel	Freq.(MHz)	Channel	Freq.(MHz)	Channel	Freq.(MHz)
0	902.3	16	905.5	32	908.7	48	911.9
1	902.5	17	905.7	33	908.9	49	912.1
2	902.7	18	905.9	34	909.1	50	912.3
3	902.9	19	906.1	35	909.3	51	912.5
4	903.1	20	906.3	36	909.5	52	912.7
5	903.3	21	906.5	37	909.7	53	912.9
6	903.5	22	906.7	38	909.9	54	913.1
7	903.7	23	906.9	39	910.1	55	913.3
8	903.9	24	907.1	40	910.3	56	913.5
9	904.1	25	907.3	41	910.5	57	913.7
10	904.3	26	907.5	42	910.7	58	913.9
11	904.5	27	907.7	43	910.9	59	914.1
12	904.7	28	907.9	44	911.1	60	914.3
13	904.9	29	908.1	45	911.3	61	914.5
14	905.1	30	908.3	46	911.5	62	914.7
15	905.3	31	908.5	47	911.7	63	914.9

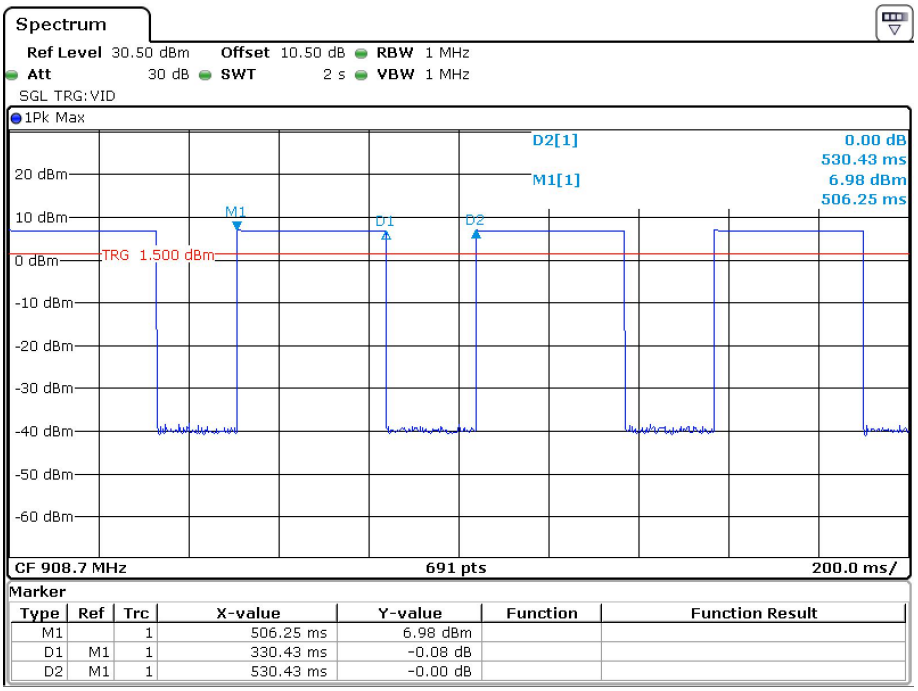
EUT was test with channel 0/32/63

EUT Exercise Software

“serial_port_utility.exe”* software was used to the EUT tested and power level is 12. The software and power level was provided by the applicant.

Duty cycle

Mode	T_{on} (ms)	T_{on+off} (ms)	Duty Cycle (%)
Hybrid System	330.43	530.43	62.29



Equipment Modifications

No modification was made to the EUT tested.

Special Accessories

No special accessory.

Support Equipment List and Details

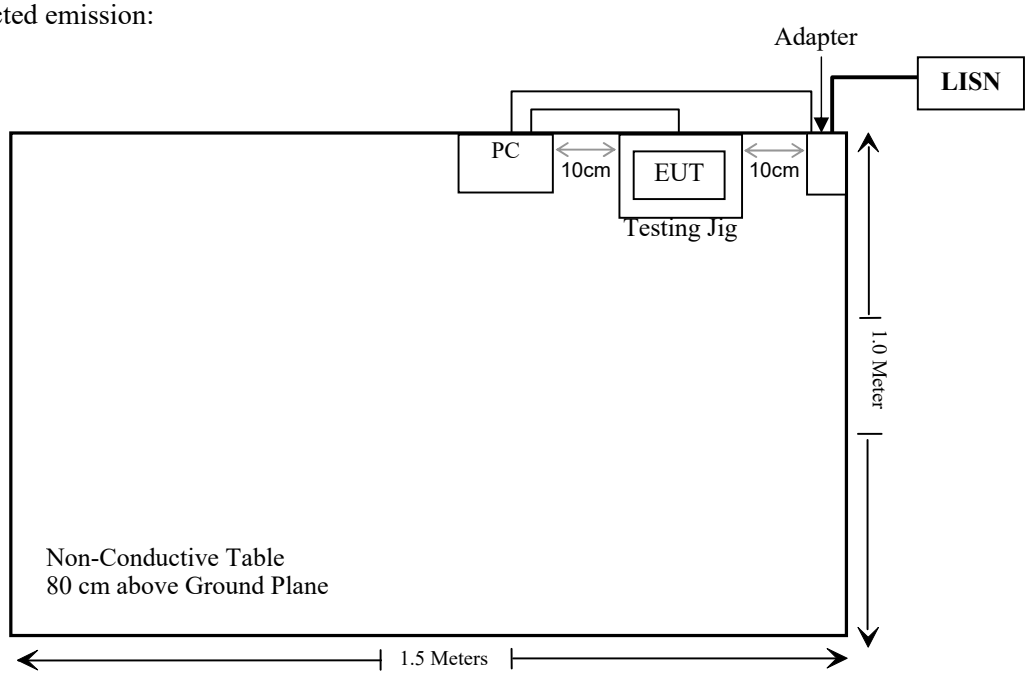
Manufacturer	Description	Model	Serial Number
DELL	PC	Latitude	11429208685
DELL	Adapter	DA130PE1-00	CN-0JU012-68219-18B-JEYY-A04
Dragino	Testing Jig	LA66 LoRaWAN Shield	Unkonwn

External I/O Cable

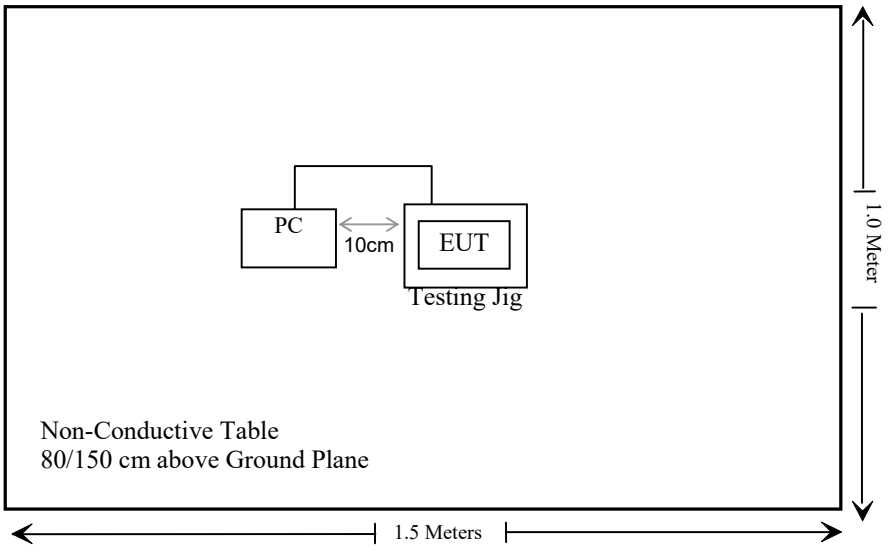
Cable Description	Length (m)	From/Port	To
Un-shielding Detachable AC Cable	1.5	Adapter	LISN
Un-shielding Un-Detachable DC Cable	1.5	Adapter	PC
Shielding Detachable USB Cable	1.0	PC	Testing Jig

Block Diagram of Test Setup

For conducted emission:



For radiated emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §2.1091	Maximum Permissible Exposure(MPE)	Compliant
§15.203	Antenna Requirement	Compliant
§15.207(a)	AC Line Conducted Emissions	Compliant
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliant
§15.247(a)(1)	20 dB Emission Bandwidth	Compliant
§15.247(a)(1)(i)	Channel Separation Test	Compliant
§15.247(f)	Time of Occupancy (Dwell Time)	Compliant
§15.247(b)(3)	Peak Output Power Measurement	Compliant
§15.247(d)	Band edges	Compliant
§15.247(f)	Power Spectral Density	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	EMI Test Receiver	ESCI	100784	2021/12/13	2022/12/12
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2021/12/13	2022/12/12
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2021/12/13	2022/12/12
Unknown	RF Coaxial Cable	No.17	N0350	2021/12/14	2022/12/13
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emission Test					
Rohde& Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2021/12/13	2022/12/12
SONOMA INSTRUMENT	Amplifier	310 N	186131	2021/11/09	2022/11/08
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2021/11/09	2022/11/08
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Unknown	RF Coaxial Cable	No.10	N050	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.11	N1000	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.12	N040	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.13	N300	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.14	N800	2021/12/14	2022/12/13
CD	High Pass Filter	HPM-1.2/18G-60	110	2021/12/14	2022/12/13
Radiated Emission Test Software: e3 19821b (V9)					
RF Conducted Test					
Rohde & Schwarz	Open Switch and ControlUnit	OSP120 + OSP-B157	101244 + 100866	2021/12/13	2022/12/12
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101948	2021/12/13	2022/12/12
WEINSCHEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.31	RF-01	Each time	

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

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

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

According to KDB 447498 D04 Interim General RF Exposure Guidance

MPE-Based Exemption:

General frequency and separation-distance dependent MPE-based effective radiated power(ERP) thresholds are in Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemptionfrom further evaluation from 300 kHz through 100 GHz.

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 R^2.
1.34-30	3,450 R^2/f^2.
30-300	3.83 R^2.
300-1,500	0.0128 R^2f.
1,500-100,000	19.2R^2.

Ris the minimum separation distance in meters
f = frequency in MHz

Result

Mode	Frequency (MHz)	Tune up conducted power	Antenna Gain		ERP		Evaluation Distance (m)	ERP Limit (W)
		(dBm)	(dBi)	(dBd)	(dBm)	(W)		
Hybrid System	902.3-914.9	7.5	2.0	-0.15	7.35	0.005	0.2	0.462

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.
2. 0dBd=2.15dBi

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliant.

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.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.
And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has one external antenna with unique antenna connector, the antenna gain is 2.0dBi, fulfill the requirement of this section. Please refer to the EUT photos.

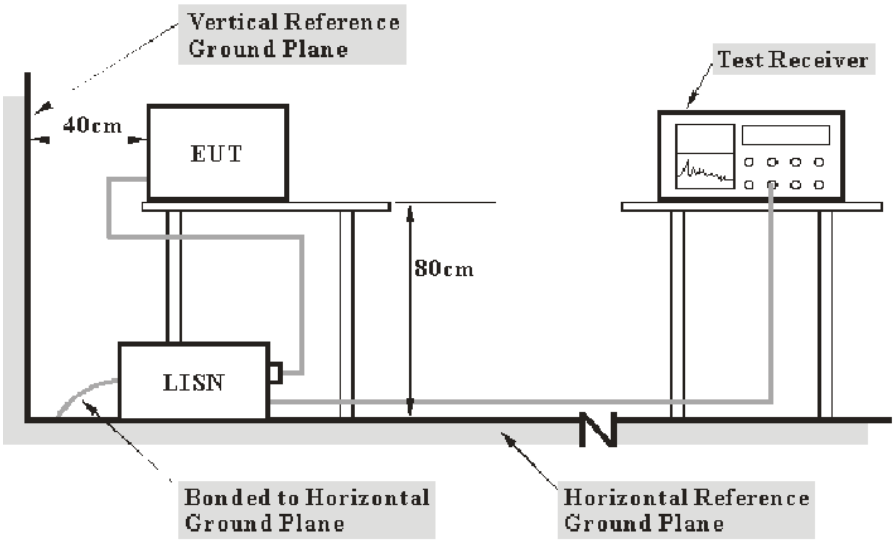
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207

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 limits.

The spacing between the peripherals was 10 cm.

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 device was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Transd Factor & Margin Calculation

The Transd factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Transd Factor = LISN VDF + Cable Loss

The "**Over limit**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an Over limit of -7 dB means the emission is 7 dB below the limit. The equation for calculation is as follows:

Over Limit = Level – Limit
Level = Read Level + Factor

Test Data

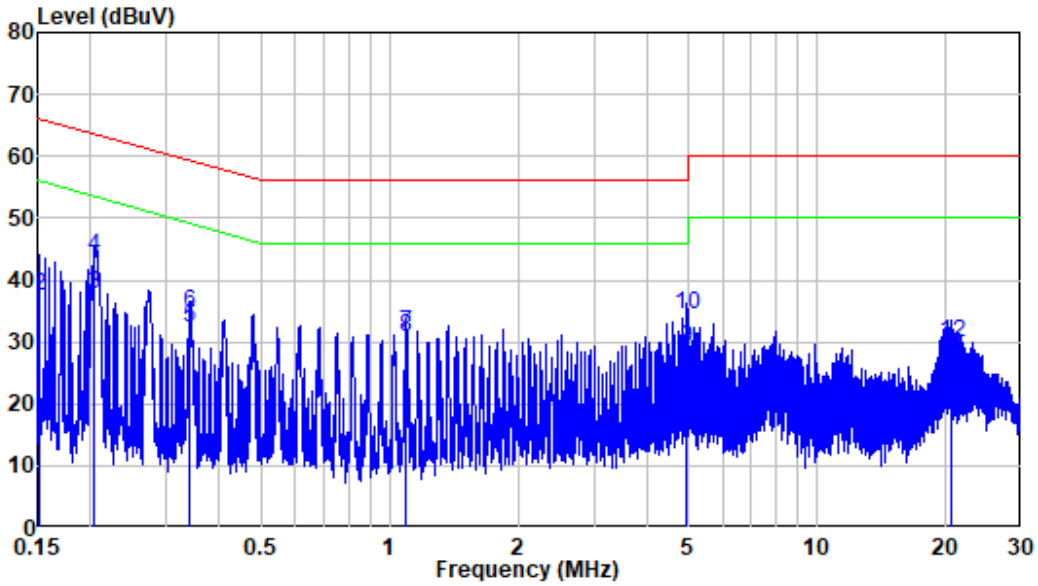
Environmental Conditions

Temperature:	23 ℃
Relative Humidity:	41%
ATM Pressure:	101.0 kPa

The testing was performed by Jason on 2022-10-25.

EUT operation mode: Transmitting (worst case is Middle channel)

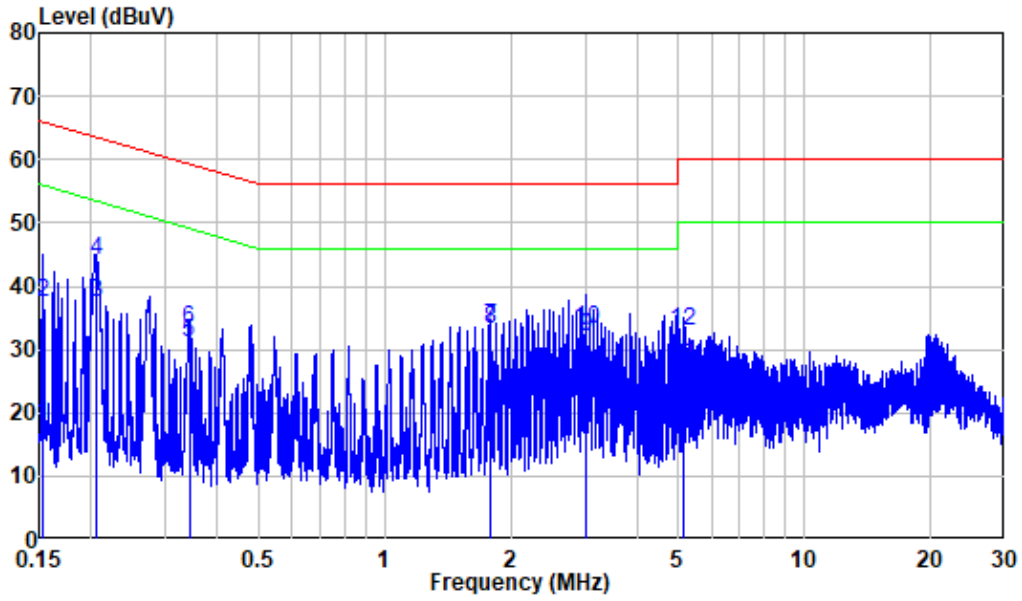
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Job No. : SZNS220819-37799E-RF
Mode : Hybrid system
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.151	9.80	7.37	17.17	55.94	-38.77	Average
2	0.151	9.80	27.75	37.55	65.94	-28.39	QP
3	0.204	9.80	27.94	37.74	53.46	-15.72	Average
4	0.204	9.80	33.83	43.63	63.46	-19.83	QP
5	0.342	9.80	22.45	32.25	49.16	-16.91	Average
6	0.342	9.80	24.89	34.69	59.16	-24.47	QP
7	1.094	9.81	21.55	31.36	46.00	-14.64	Average
8	1.094	9.81	21.11	30.92	56.00	-25.08	QP
9	4.919	9.85	19.24	29.09	46.00	-16.91	Average
10	4.919	9.85	24.42	34.27	56.00	-21.73	QP
11	20.499	10.00	17.70	27.70	50.00	-22.30	Average
12	20.499	10.00	19.97	29.97	60.00	-30.03	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
Condition: Neutral
Job No. : SZNS220819-37799E-RF
Mode : Hybrid system
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.153	9.80	8.32	18.12	55.85	-37.73	Average
2	0.153	9.80	27.74	37.54	65.85	-28.31	QP
3	0.205	9.80	27.53	37.33	53.41	-16.08	Average
4	0.205	9.80	34.23	44.03	63.41	-19.38	QP
5	0.342	9.80	21.25	31.05	49.16	-18.11	Average
6	0.342	9.80	23.45	33.25	59.16	-25.91	QP
7	1.776	9.82	23.64	33.46	46.00	-12.54	Average
8	1.776	9.82	23.24	33.06	56.00	-22.94	QP
9	3.007	9.83	22.19	32.02	46.00	-13.98	Average
10	3.007	9.83	23.24	33.07	56.00	-22.93	QP
11	5.125	9.89	17.77	27.66	50.00	-22.34	Average
12	5.125	9.89	22.90	32.79	60.00	-27.21	QP

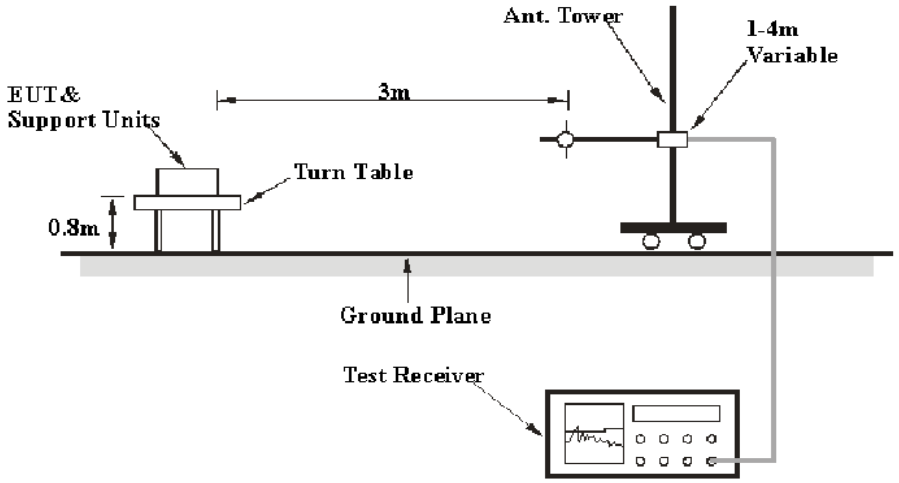
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

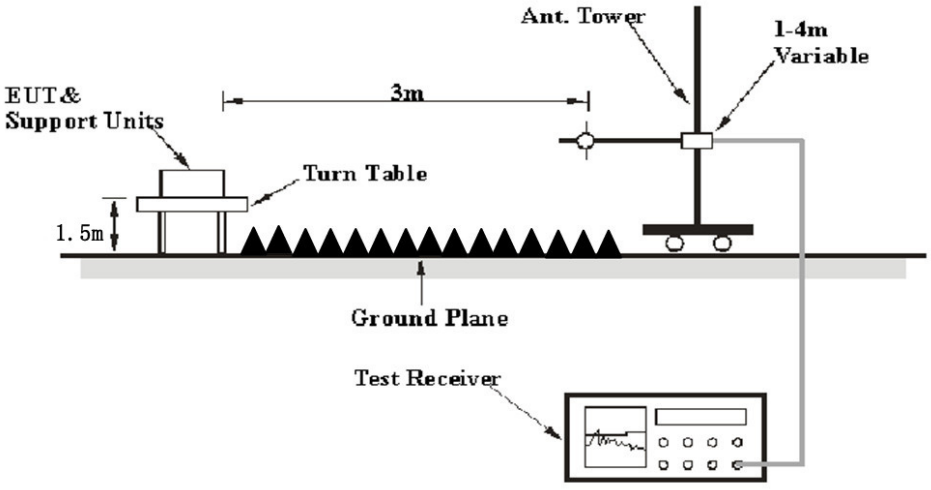
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

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	Measurements
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	Ave.

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 Factor & Margin Calculation

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

Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain

The "**Over Limit or Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a over limit/margin of -7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Over Limit/Margin = Level/Corrected Amplitude – Limit
Level/Corrected Amplitude= Read Level + Corrected Factor

Test Data

Environmental Conditions

Temperature:	25~26.8℃
Relative Humidity:	52~60 %
ATM Pressure:	101.0 kPa

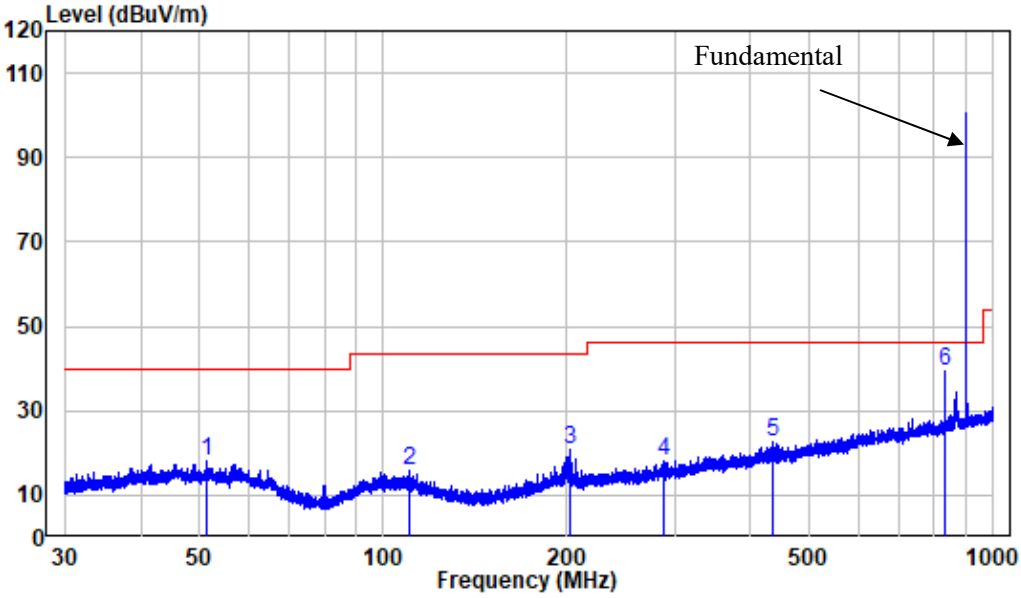
The testing was performed by Level Li on 2022-09-22 for below 1G and on 2022-08-29 for above 1G.

EUT operation mode: Transmitting (Pre-scan in the X,Y and Z axes of orientation, the worst case of orientation was recorded)

30MHz - 1GHz: *(worst case is Middle channel)*

Note: When the test result of peak was less than the limit of QP more than 6dB, just peak value were recorded.

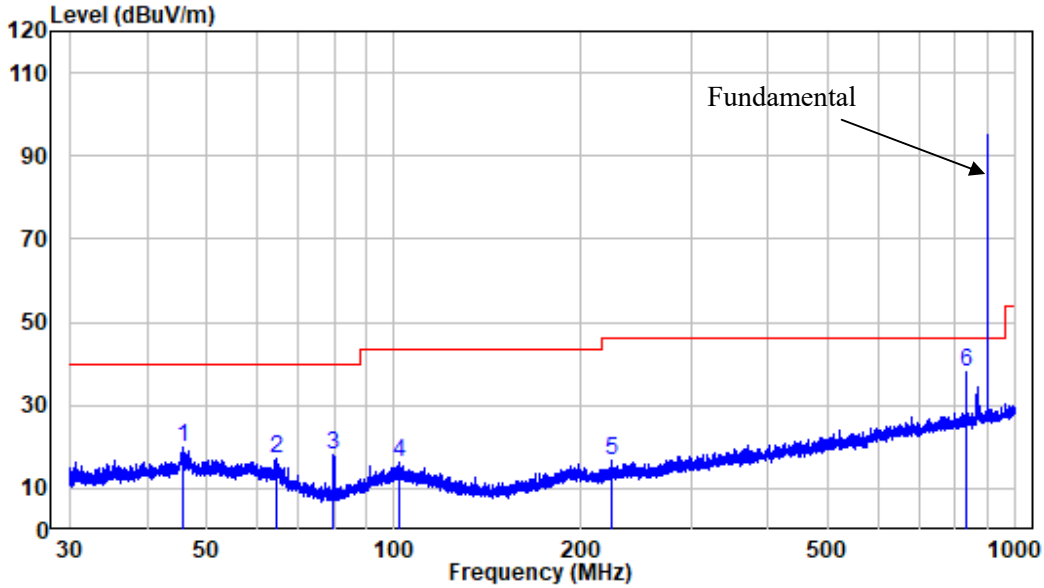
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220819-37799E-RF
Test Mode: Hybrid system

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	51.458	-9.95	28.02	18.07	40.00	-21.93	Peak
2	110.569	-12.05	27.87	15.82	43.50	-27.68	Peak
3	202.278	-11.60	32.52	20.92	43.50	-22.58	Peak
4	289.129	-9.33	27.43	18.10	46.00	-27.90	Peak
5	436.354	-5.69	28.26	22.57	46.00	-23.43	Peak
6	833.317	0.14	39.09	39.23	46.00	-6.77	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS220819-37799E-RF
Test Mode: Hybrid system

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	45.735	-9.98	29.74	19.76	40.00	-20.24	Peak
2	64.801	-12.44	29.46	17.02	40.00	-22.98	Peak
3	79.975	-16.79	34.75	17.96	40.00	-22.04	Peak
4	101.957	-11.57	27.89	16.32	43.50	-27.18	Peak
5	223.733	-11.29	28.15	16.86	46.00	-29.14	Peak
6	834.048	0.17	37.97	38.14	46.00	-7.86	Peak

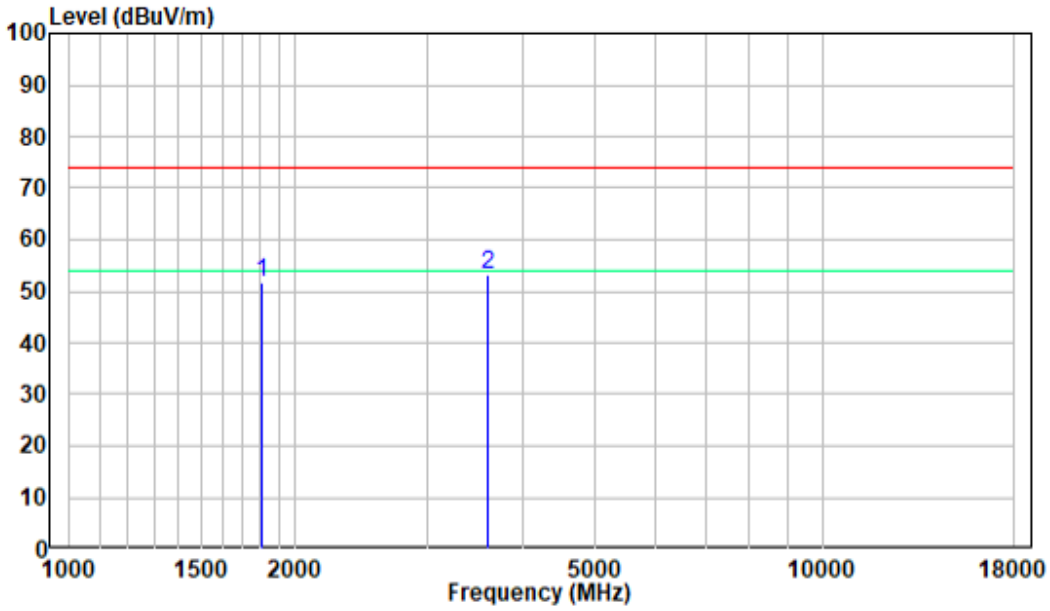
Above 1 GHz:

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
Low Channel(902.3MHz)									
1804.6	60.40	PK	110	1.9	H	-8.73	51.67	74	-22.33
1804.6	57.89	PK	334	1.5	V	-8.73	49.16	74	-24.84
3609.2	59.10	PK	303	1.1	H	-5.93	53.17	74	-20.83
3609.2	61.58	PK	139	2.4	V	-5.93	55.65	74	-18.35
3609.2	56.62	AV	139	2.4	V	-5.93	50.69	54	-3.31
Middle Channel(908.7MHz)									
1817.4	59.37	PK	303	2.1	H	-8.63	50.74	74	-23.26
1817.4	56.80	PK	253	2.4	V	-8.63	48.17	74	-25.83
3634.8	58.68	PK	146	2.1	H	-5.88	52.80	74	-21.20
3634.8	59.97	PK	106	1.9	V	-5.88	54.09	74	-19.91
3634.8	55.98	AV	154	1.4	V	-5.88	50.10	54	-3.90
High Channel(914.9MHz)									
1829.8	57.83	PK	194	1.5	H	-8.53	49.30	74	-24.70
1829.8	56.29	PK	171	1.9	V	-8.53	47.76	74	-26.24
3659.6	59.41	PK	165	2.0	H	-5.83	53.58	74	-20.42
3659.6	60.25	PK	277	2.4	V	-5.83	54.42	74	-19.58
3659.6	56.19	AV	277	2.4	V	-5.83	50.36	54	-3.64

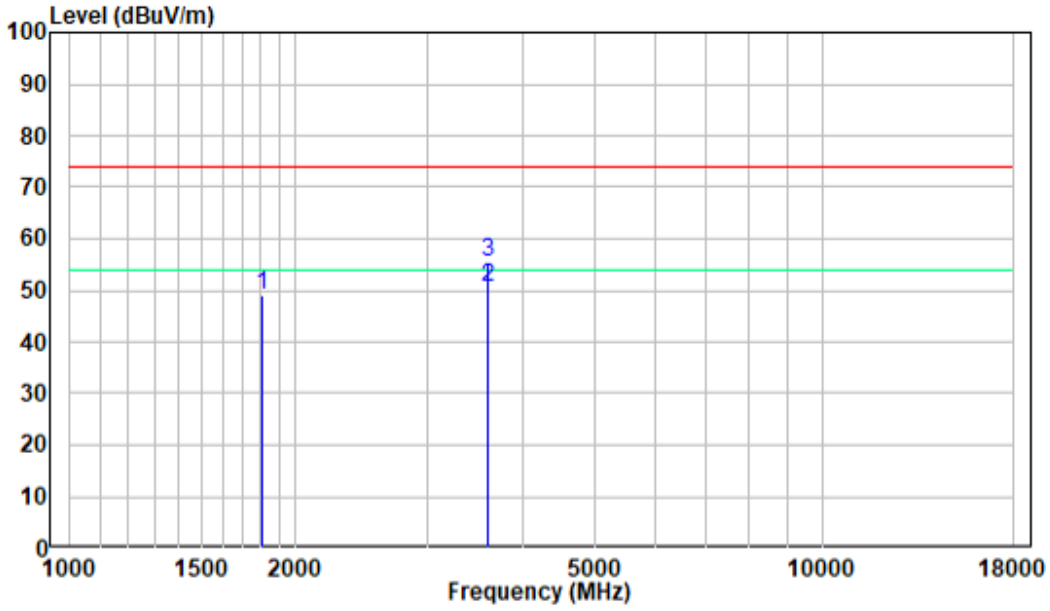
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Corrected. Amplitude - Limit
The other spurious emission which is 20dB to the limit was not recorded.
The test result of peak was less than the limit of average, so just peak value were recorded.

Pre-scan with Low channel

Horizontal



Vertical



FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW.

Test Procedure

c. Set the EUT in transmitting mode, maxhold the channel.
d. Set the adjacent channel of the EUT and maxhold another trace.
e. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	29.1℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

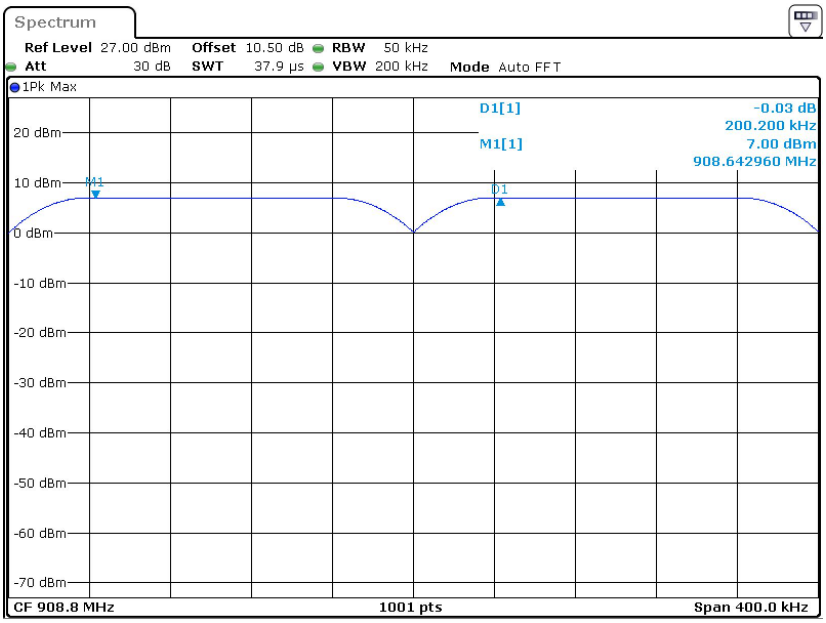
The testing was performed by Cat Kang on 2022-09-08.

EUT operation mode: Transmitting

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

Test Mode	Frequency [MHz]	Frequency Separation [MHz]	20dB Bandwidth [MHz]	Verdict
Hybrid System	Hop	0.200	0.140	Pass

Note: Limit ≥ 20 dB bandwidth



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FCC §15.247(a) (1) (i)– 20 dB EMISSION BANDWIDTH

Applicable Standard

According to §15.247(a) (1) (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

f. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
g. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. 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.
h. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
i. Repeat above procedures until all frequencies measured were complete.

Test Data

Environmental Conditions

Temperature:	29.1℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

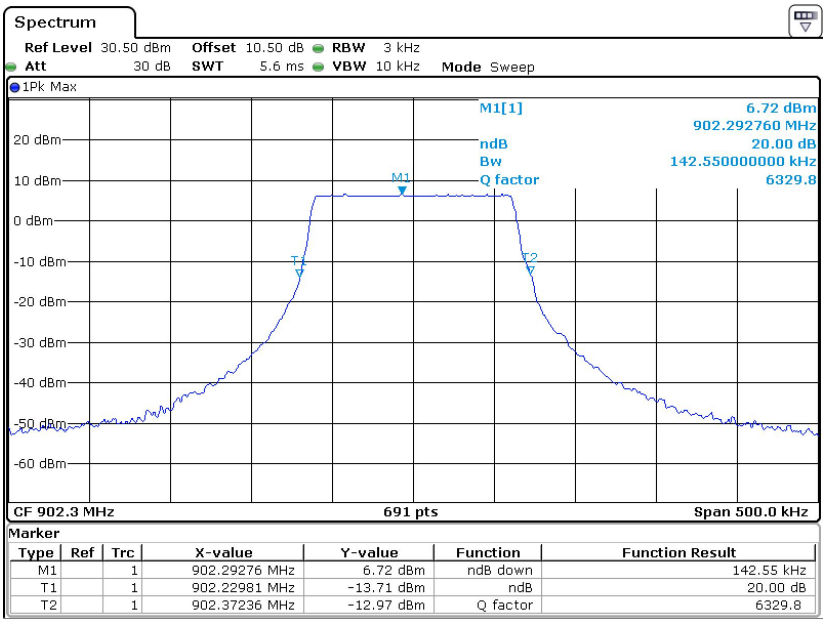
The testing was performed by Cat Kang on 2022-09-08.

EUT operation mode: Transmitting

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

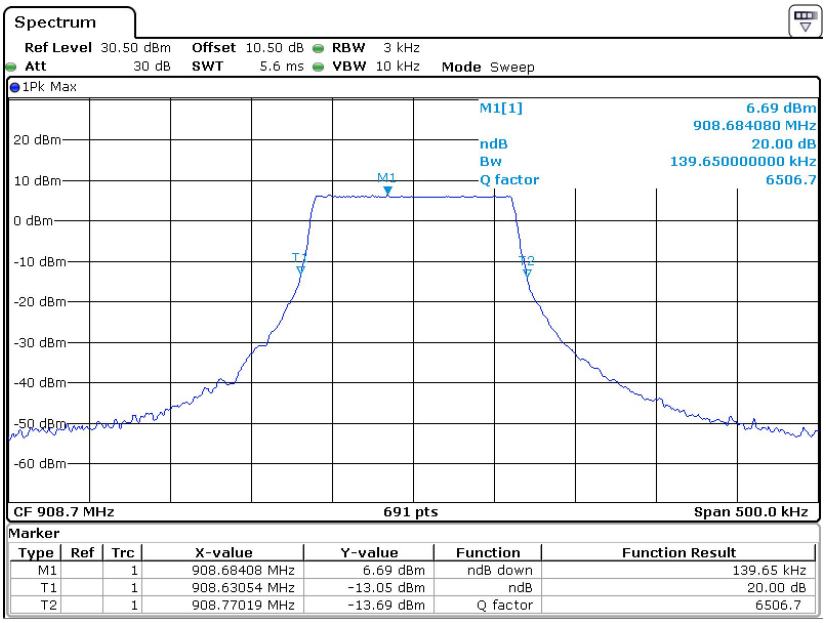
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
Hybrid System	Low	902.3	0.143
	Middle	908.7	0.140
	High	914.9	0.141

Low Channel



Date: 8.SEP.2022 14:00:59

Middle Channel



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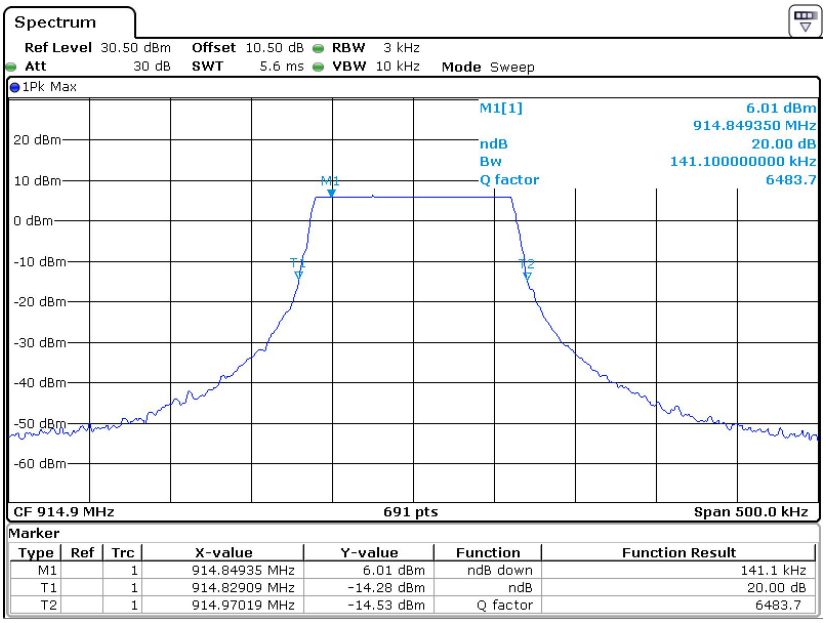
High Channel



FCC §15.247(f) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
a) Span: Zero span, centered on a hopping channel.
b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) =
(number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

Test Data

Environmental Conditions

Temperature:	29.1℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-12-27 and 2022-02-17.

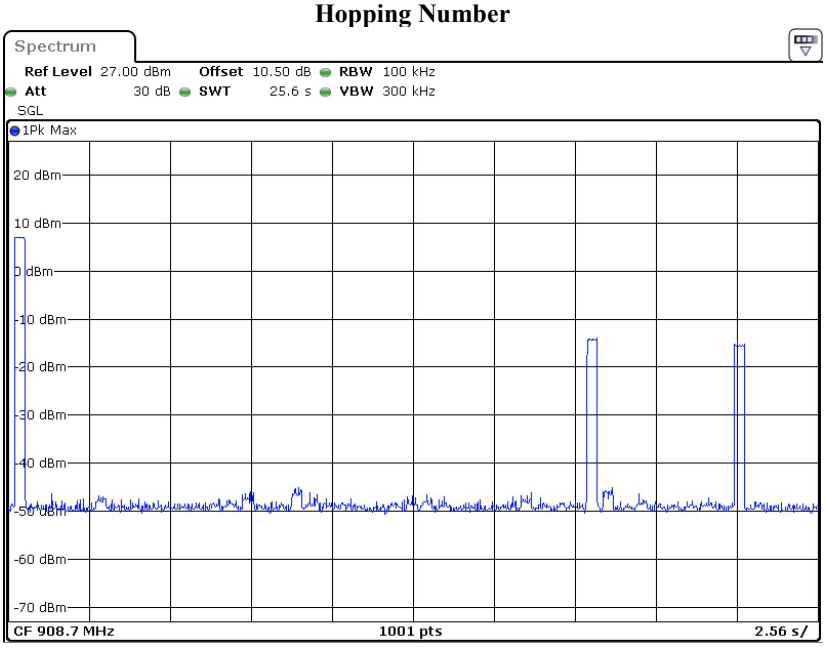
EUT operation mode: Transmitting

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

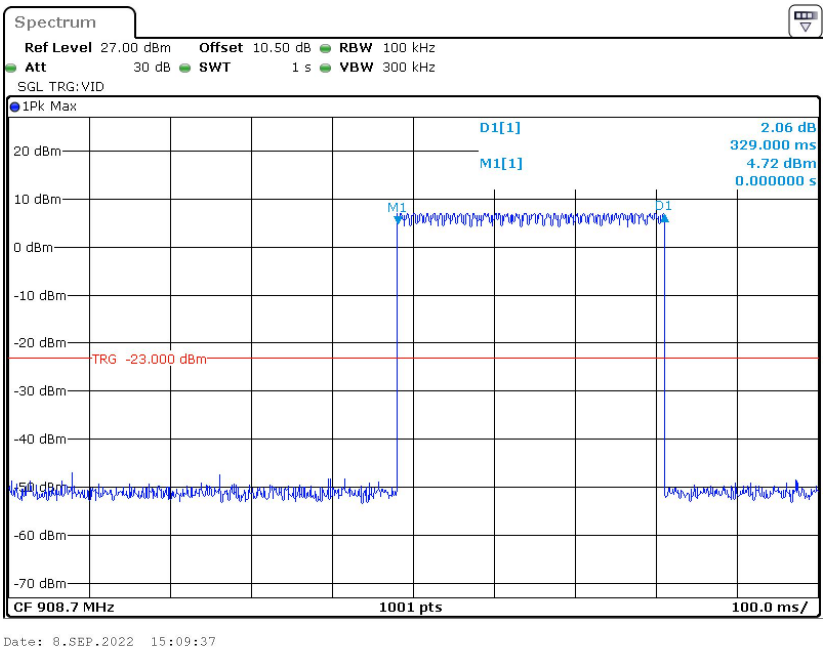
Mode	Pulse Time (ms)	Hopping Number	Period Time (s)	Total of Dwell Time(ms)	Limit (ms)	Result
Hopping	329	1	25.6	329	400	Pass

Note: A period time=0.4*64=25.6(s), Total of Dwell Time= Pluse Time*Hopping Number

Hopping Number



Pulse Time


Spectrum
Ref Level 27.00 dBm Offset 10.50 dB RBW 100 kHz
Att 30 dB SWT 1 s VBW 300 kHz
SGL TRG:VID
1Pk Max
D1[1] 2.06 dB
329.000 ms
M1[1] 4.72 dBm
0.000000 s
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
TRG -23.000 dBm
M1
D1
CF 908.7 MHz
1001 pts
100.0 ms/
Date: 8.SEP.2022 15:09:37

FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

Applicable Standard

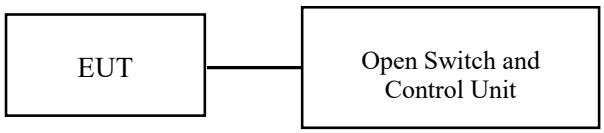
(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined 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.

Test Procedure

j. Place the EUT on a bench and set it in transmitting mode.

k. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.

l. Add a correction factor to the display.



Note: the Open Switch and Control Unit has a built-in power sensor.

Test Data

Environmental Conditions

Temperature:	29.1℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

The testing was performed by Cat Kang on 2022-09-08.

Test Result: Compliance. Please refer to following table.

EUT operation mode: Transmitting

Test Mode	Frequency (MHZ)	Max Peak Output Power (dBm)	Limit[dBm]	Verdict
Hybrid System	902.3	7.32	<=30	PASS
	908.7	7.03		PASS
	914.9	7.12		PASS

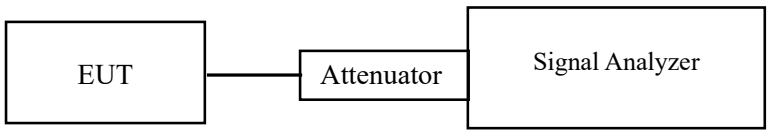
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

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

m. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
n. 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.
o. 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.
p. 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.
q. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	29.1℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

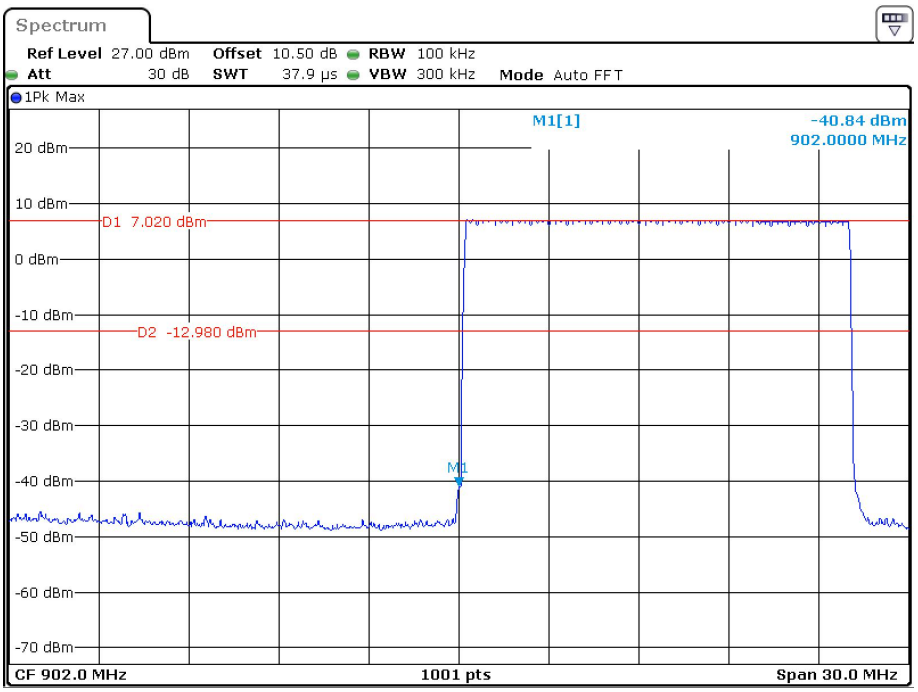
The testing was performed by Cat Kang on 2022-09-08.

Test Result: Compliance. Please refer to following plots.

EUT operation mode: Transmitting

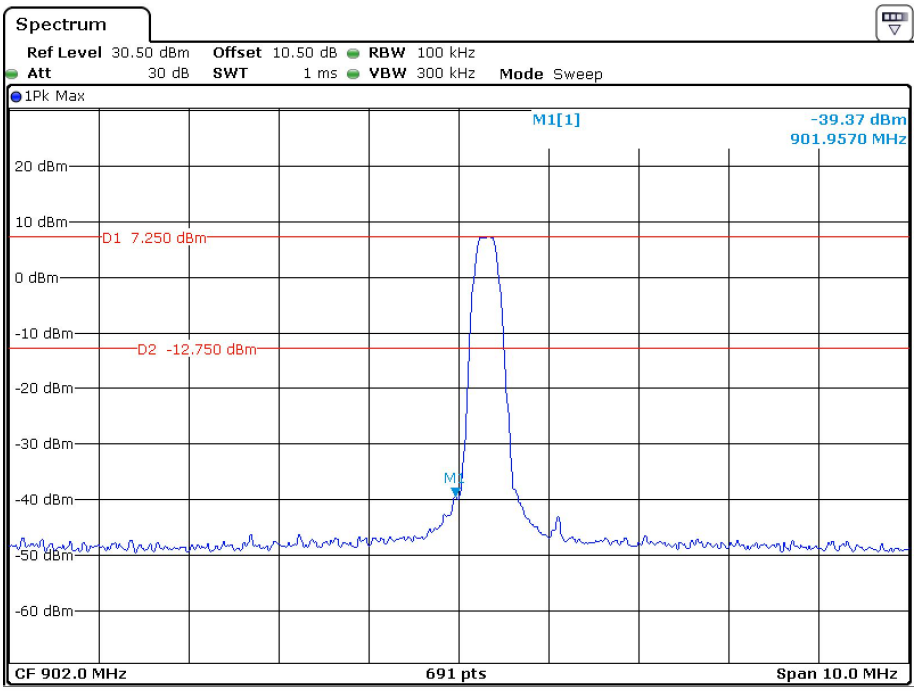
Left side

Hopping



Date: 8.SEP.2022 15:22:20

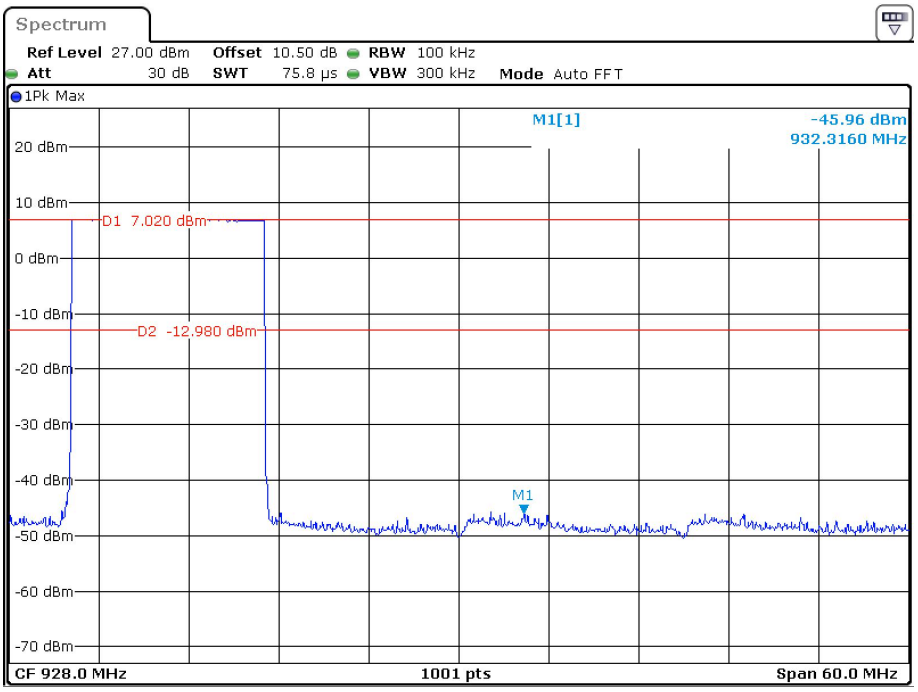
Single



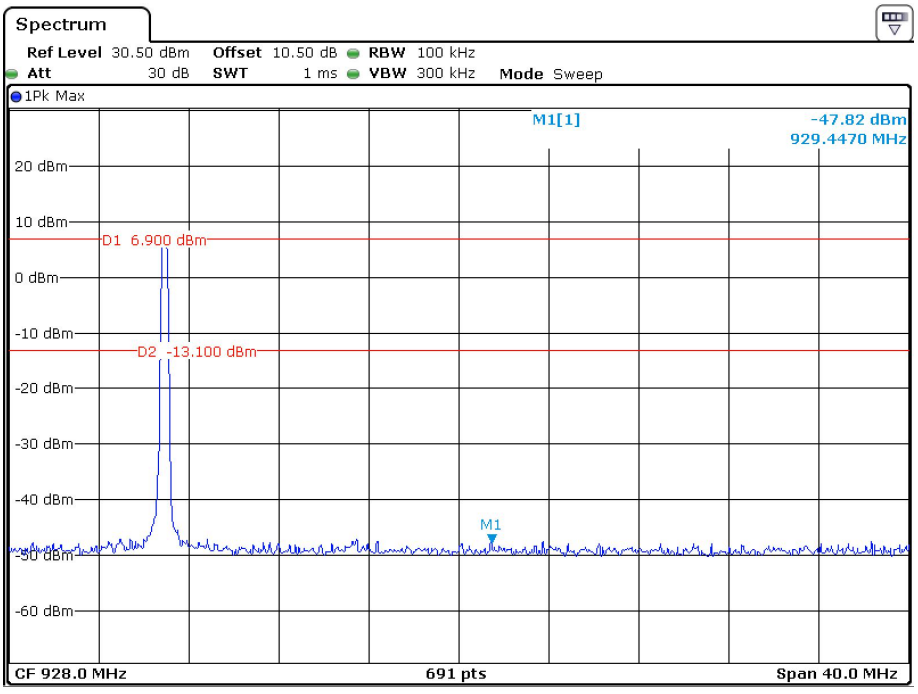
Date: 8.SEP.2022 14:05:58

Right side

Hopping



Single



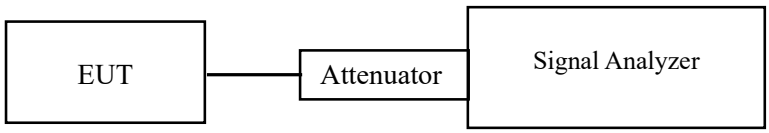
FCC §15.247(f) - POWER SPECTRAL DENSITY

Applicable Standard

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure

r. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
s. Set the RBW to: 3kHz≤ RBW≤100 kHz.
t. Set the VBW ≥ 3×RBW.
u. Set the span to 1.5 times the DTS bandwidth.
v. Detector = peak.
w. Sweep time = auto couple.
x. Trace mode = max hold.
y. Allow trace to fully stabilize.
z. Use the peak marker function to determine the maximum amplitude level within the RBW.
aa. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test Data

Environmental Conditions

Temperature:	29.1℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

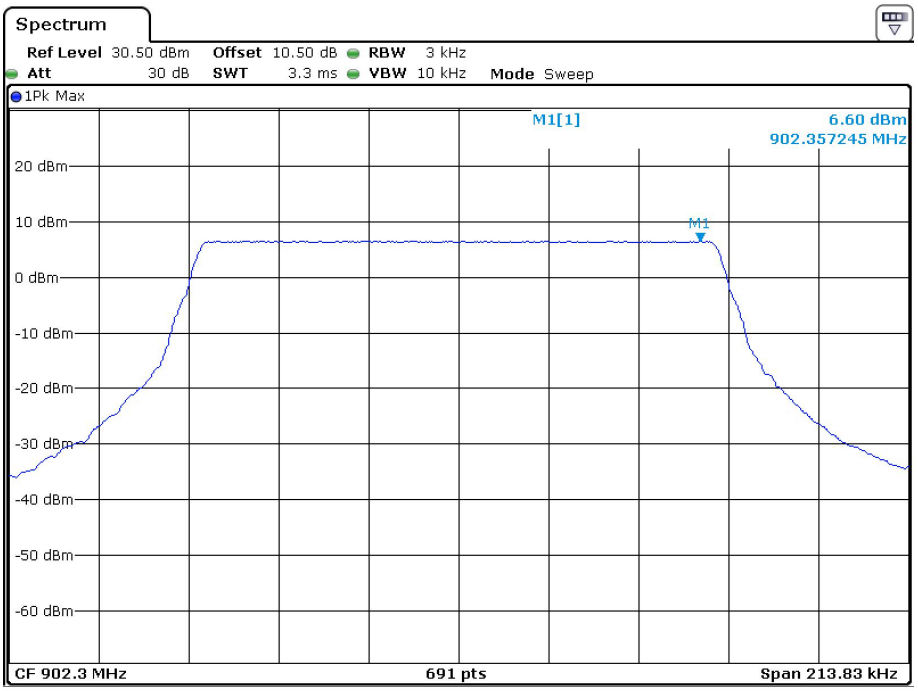
The testing was performed by Cat Kang on 2022-09-08.

EUT operation mode: Transmitting

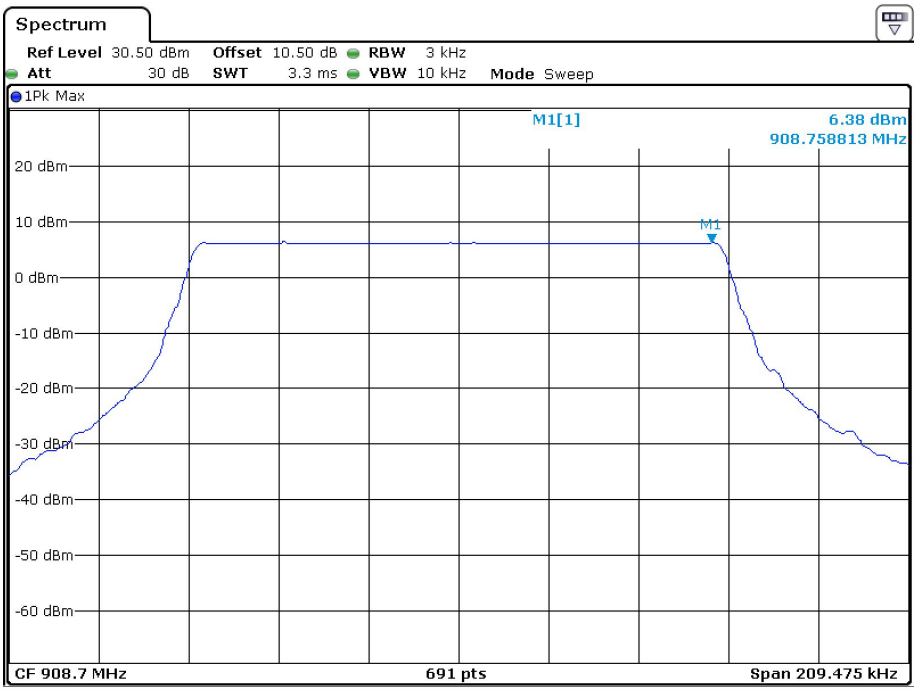
Test Result: Pass

Test Mode	Frequency (MHz)	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
Hybrid System	902.3	6.60	<=8	PASS
	908.7	6.38		PASS
	914.9	6.50		PASS

Power Spectral Density, Low Channel



Power Spectral Density, Middle Channel



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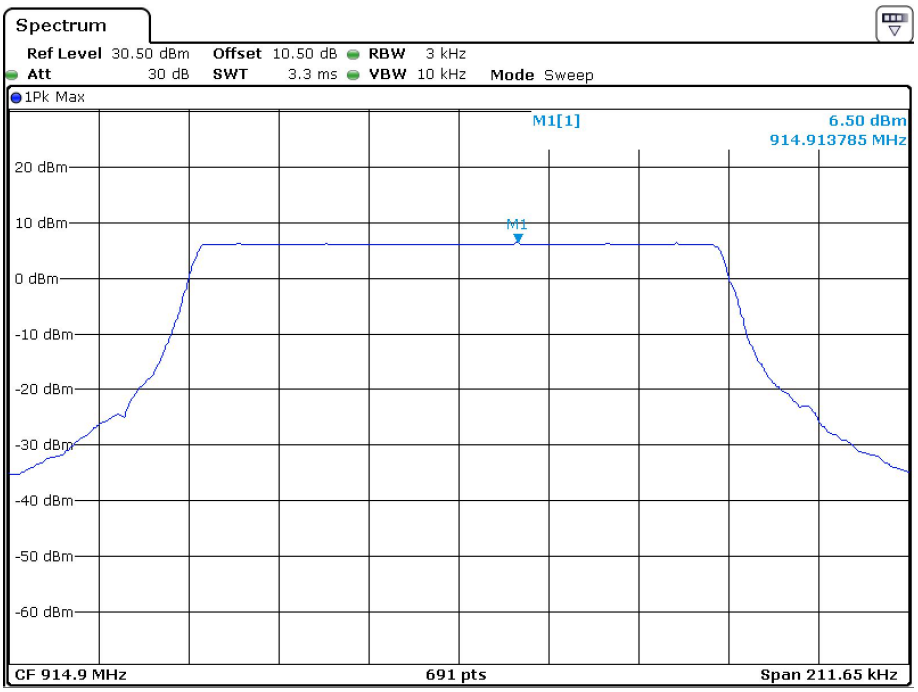
Power Spectral Density, High Channel



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