



TESTING LABORATORY
CERTIFICATE # 4821.01



FCC PART 15.247

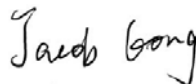
TEST REPORT

For

Astera LED-Technology GmbH

Stahlgruberring 36, Munich, Germany 81829

FCC ID: X55PB15

Report Type: Original Report	Product Type: Pixel Brick
Report Number: SZ4210722-30587E-RF-00	
Report Date: 2021-09-02	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Pixel Brick
Tested Model	PB15
Frequency Range	917~922.2MHz
Transmit Power	8.83dBm
Modulation Technique	GFSK
Antenna Specification	PCB Antenna, 2 dBi (It is provided by the applicant)
Voltage Range	DC18.0V from battery or DC 24.0V from adapter
Date of Test	2021-08-06 to 2021-08-12
Sample serial number	SZ4210722-30587E-RF-S1(Assigned by BACL, Shenzhen)
Received date	2021-07-22
Sample/EUT Status	Good condition
Adapter information	Model: PA1050-240IB200 Input: 100-240V,50/60Hz, 1.8A Output: 24.0V,2.0A,48.0W Max

Objective

This 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.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). 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		$\pm 5\%$
RF output power, conducted		$\pm 0.73\text{dB}$
Unwanted Emission, conducted		$\pm 1.95\text{dB}$
Radiated Emissions	Below 1GHz	$\pm 4.75\text{dB}$
	Above 1GHz	$\pm 4.88\text{dB}$
Temperature		$\pm 1^\circ\text{C}$
Supply voltages		$\pm 0.4\%$

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 Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 5F(B-West) , 6F, 7F, the 3rd Phase of Wan Li Industrial Building D, Shihua Rd, FuTian Free Trade Zone, Shenzhen, 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.: 342867, the FCC Designation No.: CN1221.

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

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0023.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in engineering mode.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	917.00	27	919.70
1	917.10	28	919.80
2	917.20	29	919.90
3	917.30	30	920.00
4	917.40	31	920.10
5	917.50	32	920.20
6	917.60	33	920.30
7	917.70	34	920.40
8	917.80	35	920.50
9	917.90	36	920.60
10	918.00	37	920.70
11	918.10	38	920.80
12	918.20	39	920.90
13	918.30	40	921.00
14	918.40	41	921.10
15	918.50	42	921.20
16	918.60	43	921.30
17	918.70	44	921.40
18	918.80	45	921.50
19	918.90	46	921.60
20	919.00	47	921.70
21	919.10	48	921.80
22	919.20	49	921.90
23	919.30	50	922.00
24	919.40	51	922.10
25	919.50	52	922.20
26	919.60		

EUT was test on channel 0, 26, 52.

EUT Exercise Software

“AsterApp_9.96” software was used for the test and the power level is default. The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

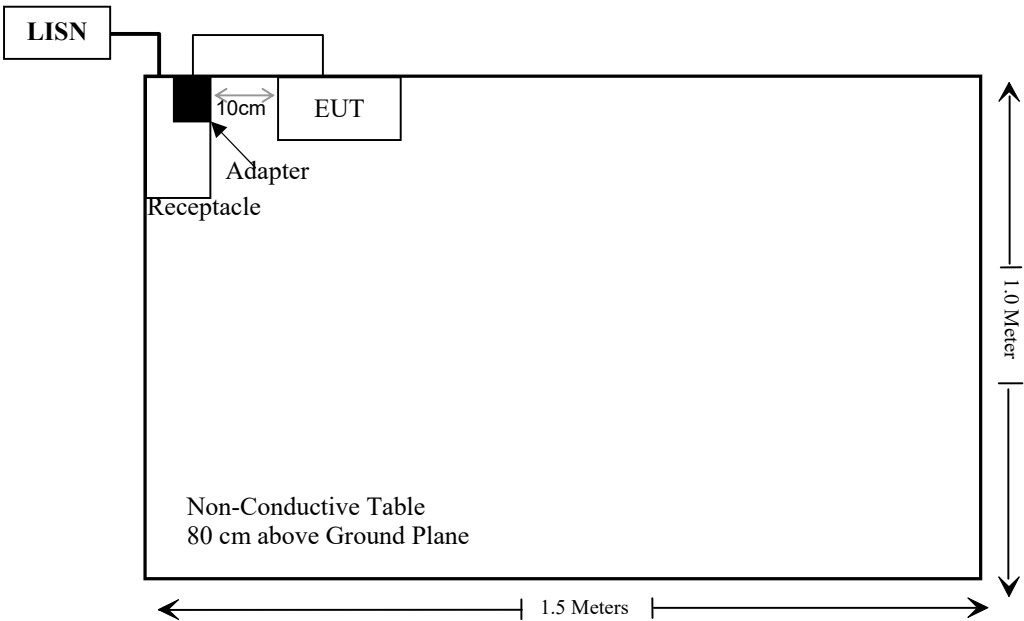
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Un-Detachable USB Cable	1.5	Adapter	EUT

Block Diagram of Test Setup

For conducted 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(a)(1)(i)	Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)(i)	Quantity of hopping channel Test	Compliant
§15.247(b)(2)	Peak Output Power Measurement	Compliant
§15.247(d)	Band edges	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2021/07/07	2022/07/06
Rohde & Schwarz	LISN	ENV216	101613	2021/07/07	2022/07/06
Rohde & Schwarz	Transient Limitor	ESH3Z2	DE25985	2020/11/29	2021/11/28
Unknown	CE Cable	CE Cable	UF A210B-1-0720-504504	2020/11/29	2021/11/28
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2021/07/06	2022/07/05
Sonoma instrument	Pre-amplifier	310 N	186238	2021/08/03	2022/08/02
Sunol Sciences	Broadband Antenna	JB1	A040904-2	2020/12/22	2023/12/21
Unknown	Cable 2	RF Cable 2	F-03-EM197	2020/11/29	2021/11/28
Unknown	Cable	Chamber Cable 4	EC-007	2021/08/03	2022/08/02
Rohde & Schwarz	Auto test software	EMC 32	V9.10.00	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2021/07/06	2022/07/05
COM-POWER	Pre-amplifier	PA-122	181919	2020/11/29	2021/11/28
Sunol Sciences	Horn Antenna	3115	9107-3694	2021/01/15	2024/01/14
Insulted Wire Inc.	RF Cable	SPS-2503-3150	02222010	2020/11/29	2021/11/28
Unknown	RF Cable	W1101-EQ1 OUT	F-19-EM005	2020/11/29	2021/11/28
Unknown	High Pass filter	1.3GHz	101120	2021/04/20	2022/04/20
RF Conducted Test					
Rohde & Schwarz	SPECTRUM ANALYZER	FSU26	200120	2021/04/02	2022/04/01
WEINSCHL	3dB Attenuator	Unknown	F-03-EM121	2020/11/29	2021/11/28

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) 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.

Limits for General Population/Uncontrolled Exposure

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

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = 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)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Mode	Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
UHF	917~922.2	2.0	1.58	9.0	7.94	20	0.0025	0.61
BT	2402-2480	3.4	2.19	9.0	7.94	20	0.0035	1.0
BLE	2402-2480	3.4	2.19	7.0	5.01	20	0.0022	1.0
Wi-Fi	2412-2462	3.4	2.19	27.0	501.19	20	0.2183	1.0

Note: 1. EUT contains a certified BT/Wi-Fi module (FCC ID: 2AC7Z-ESP32WROVERE), the tune-up power of BT/BLE/Wi-Fi was refer to the module report.
 2. the UHF and BT/BLE/Wi-Fi can transmit at the same time, the BT/BLE/Wi-Fi cannot transmit at the same time

Simultaneous transmitting consideration:

The ratio= $MPE_{Wi-Fi}/limit + MPE_{UHF}/limit = 0.2183/1 + 0.0025/0.61 = 0.2224 < 1.0$

So simultaneous exposure comply with the limit.

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

Result: Compliance

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 an internal antenna arrangement, which was permanently attached and the antenna gain is 2.0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

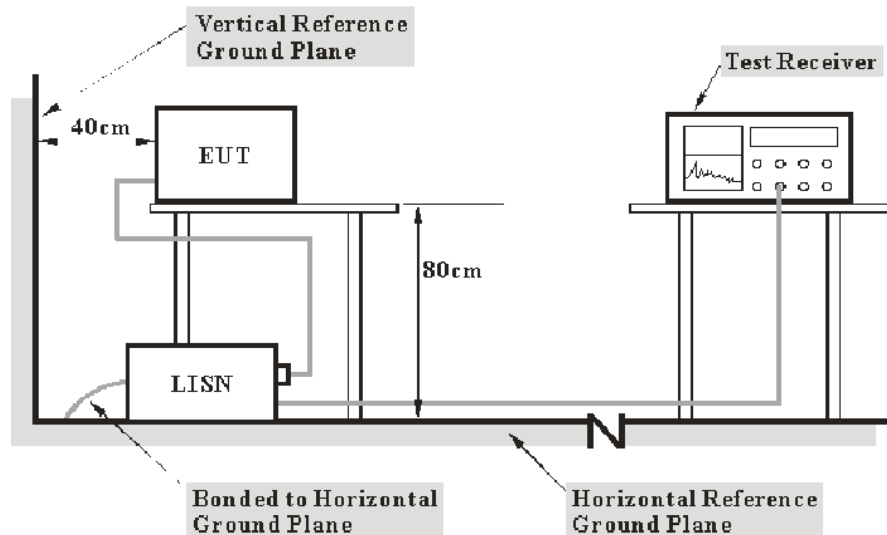
Result: Compliance.

FCC §15.207 (a)– AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

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 measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

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 adapter 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.

Corrected Factor & Margin Calculation

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

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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

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

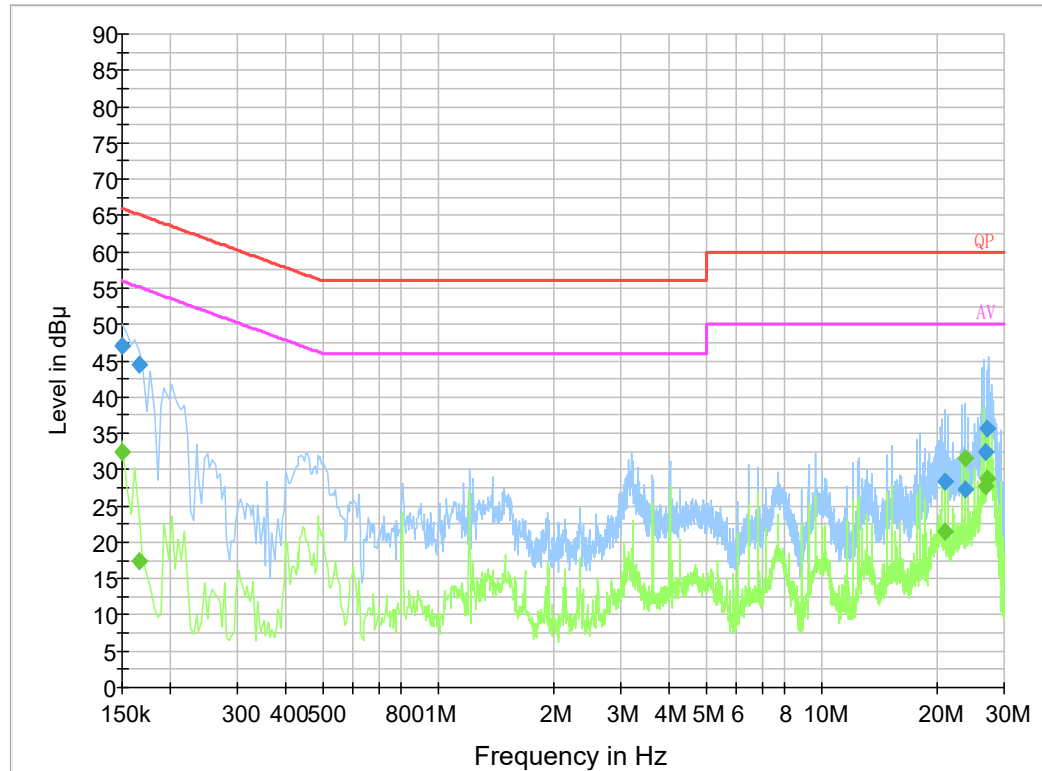
Test Data

Environmental Conditions

Temperature:	25°C
Relative Humidity:	70 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2021-08-06.

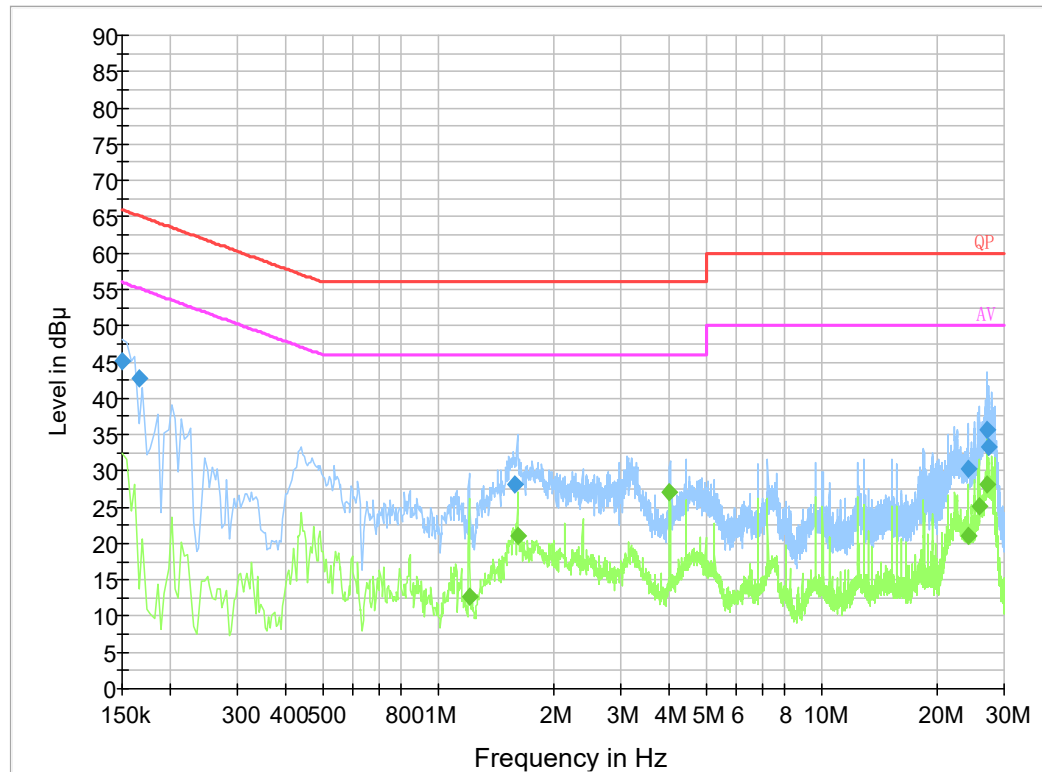
EUT operation mode: Transmitting

AC 120V/60 Hz, Line**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	47.0	9.000	L1	19.8	19.0	66.0
0.165500	44.5	9.000	L1	19.9	20.6	65.2
20.951330	28.3	9.000	L1	20.5	31.7	60.0
23.793090	27.4	9.000	L1	20.3	32.6	60.0
26.738850	32.4	9.000	L1	20.2	27.6	60.0
27.040050	35.6	9.000	L1	20.2	24.4	60.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	32.4	9.000	L1	19.8	23.6	56.0
0.165500	17.3	9.000	L1	19.9	37.9	55.2
20.951330	21.4	9.000	L1	20.5	28.6	50.0
23.793090	31.5	9.000	L1	20.3	18.5	50.0
26.738850	27.7	9.000	L1	20.2	22.3	50.0
27.040050	28.7	9.000	L1	20.2	21.3	50.0

AC 120V/60 Hz, Neutral**Final Result 1**

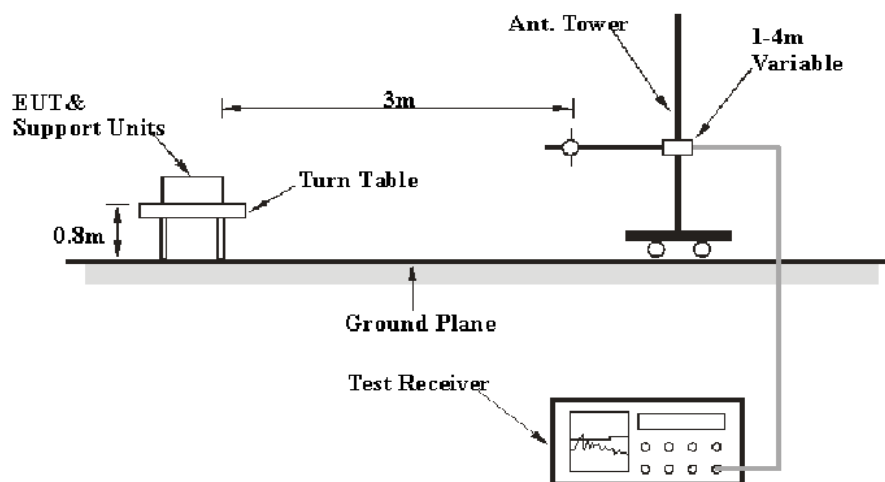
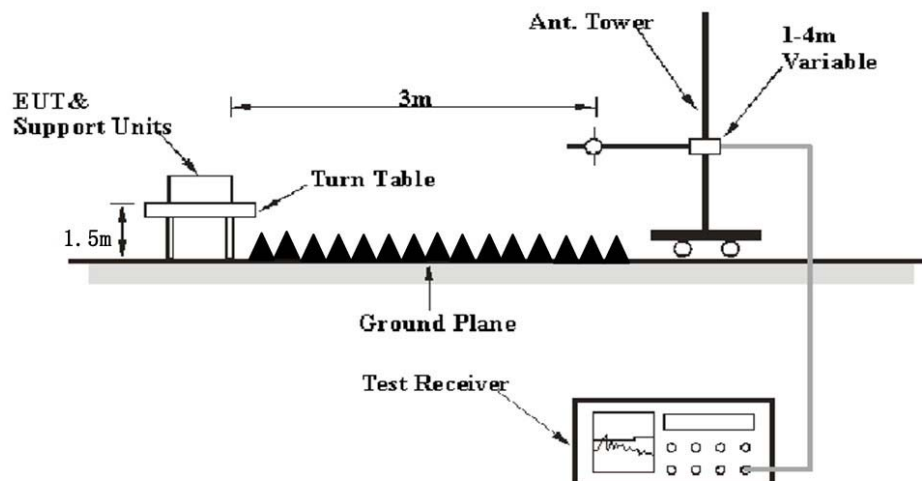
Frequency (MHz)	QuasiPeak (dB µ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB µ V)
0.150000	45.2	9.000	N	19.8	20.8	66.0
0.165500	42.6	9.000	N	19.8	22.5	65.2
1.593850	28.1	9.000	N	19.8	27.9	56.0
24.231450	30.2	9.000	N	20.3	29.8	60.0
27.012970	35.6	9.000	N	20.2	24.4	60.0
27.254410	33.2	9.000	N	20.2	26.8	60.0

Final Result 2

Frequency (MHz)	Average (dB µ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB µ V)
1.206000	12.6	9.000	N	19.8	33.4	46.0
1.614000	21.0	9.000	N	19.8	25.0	46.0
4.026000	27.0	9.000	N	19.9	19.0	46.0
24.166000	21.1	9.000	N	20.3	28.9	50.0
25.858000	25.2	9.000	N	20.2	24.8	50.0
27.002000	28.1	9.000	N	20.2	21.9	50.0

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

FCC §15.205; §15.209; §15.247(d)

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

The radiated emission tests were performed in the 3 meters, 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

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	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Average

Test Procedure

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

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and 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:

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

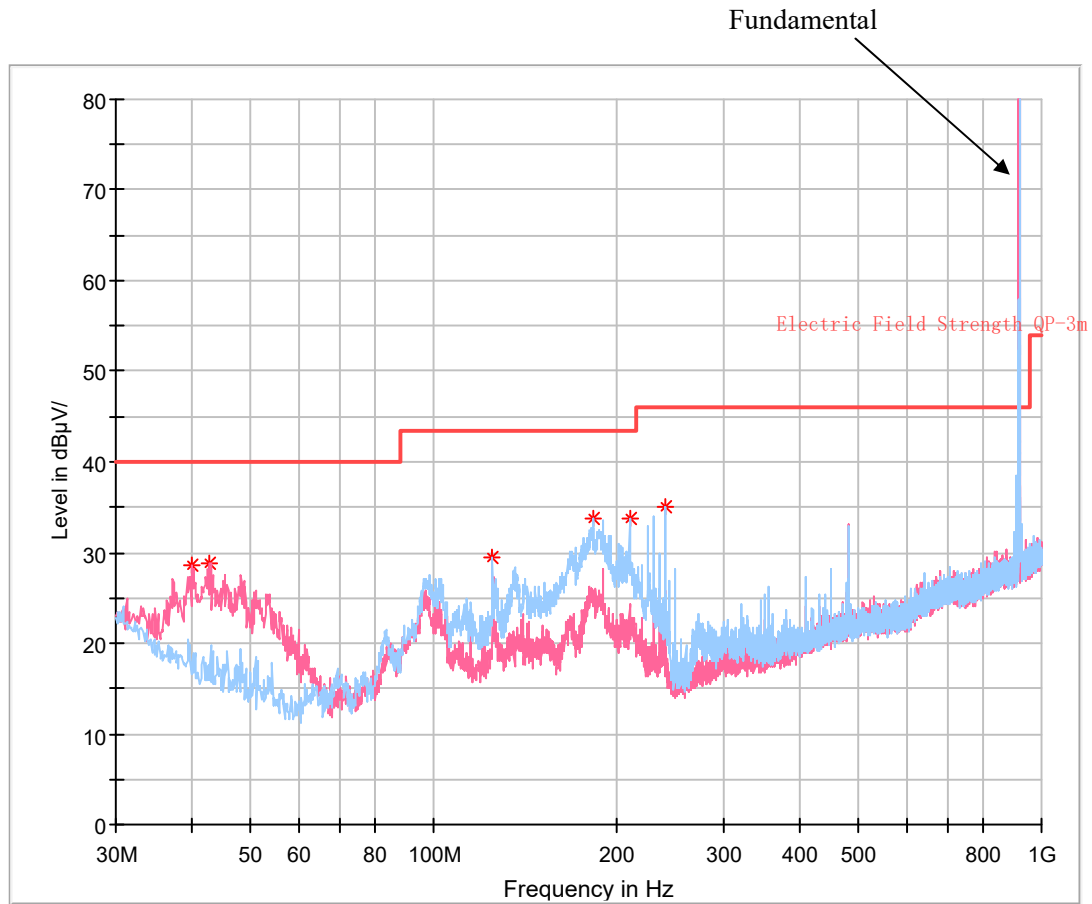
Test Data

Environmental Conditions

Temperature:	25.8~26 °C
Relative Humidity:	51~56 %
ATM Pressure:	101 kPa

The testing was performed by Cloud Qiu on 2021-08-06 for below 1GHz and Dio Ding on 2021-08-11 for above 1GHz.

EUT operation mode: Transmitting

30 MHz~1 GHz:**Critical_Freqs**

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.063750	28.51	40.00	11.49	100.0	V	38.0	-10.4
42.852500	28.84	40.00	11.16	100.0	V	38.0	-12.4
125.060000	29.37	43.50	14.13	200.0	H	247.0	-10.3
183.138750	33.69	43.50	9.81	100.0	H	61.0	-12.2
209.935000	33.77	43.50	9.73	200.0	H	289.0	-11.2
240.005000	35.05	46.00	10.95	100.0	H	301.0	-11.7

1 GHz - 10 GHz:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/Ave.)		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (917MHz)									
1834.00	54.35	PK	244	1.1	H	-1.55	52.80	74	21.20
1834.00	50.7	Ave.	244	1.1	H	-1.55	49.15	54	4.85
2751.00	46.16	PK	310	2.5	H	1.42	47.58	74	26.42
2751.00	38.04	Ave.	310	2.5	H	1.42	39.46	54	14.54
3668.00	49.54	PK	226	1.4	H	3.06	52.60	74	21.40
3668.00	44.89	Ave.	226	1.4	H	3.06	47.95	54	6.05
Middle Channel(916.6MHz)									
1839.20	54.76	PK	75	1.7	H	-1.55	53.21	74	20.79
1839.20	52.01	Ave.	75	1.7	H	-1.55	50.46	54	3.54
2758.80	47.68	PK	322	1.0	H	1.42	49.10	74	24.90
2758.80	35.27	Ave.	322	1.0	H	1.42	36.69	54	17.31
3678.40	48.51	PK	12	1.8	H	3.06	51.57	74	22.43
3678.40	43.02	Ave.	12	1.8	H	3.06	46.08	54	7.92
High Channel (922.2 MHz)									
1844.40	54.35	PK	212	1.2	H	-1.55	52.80	74	21.20
1844.40	52.05	Ave.	212	1.2	H	-1.55	50.50	54	3.50
2766.60	47.51	PK	242	1.6	H	1.42	48.93	74	25.07
2766.60	38.51	Ave.	242	1.6	H	1.42	39.93	54	14.07
3688.80	47.85	PK	305	1.1	H	3.16	51.01	74	22.99
3688.80	42.42	Ave.	305	1.1	H	3.16	45.58	54	8.42

Note:

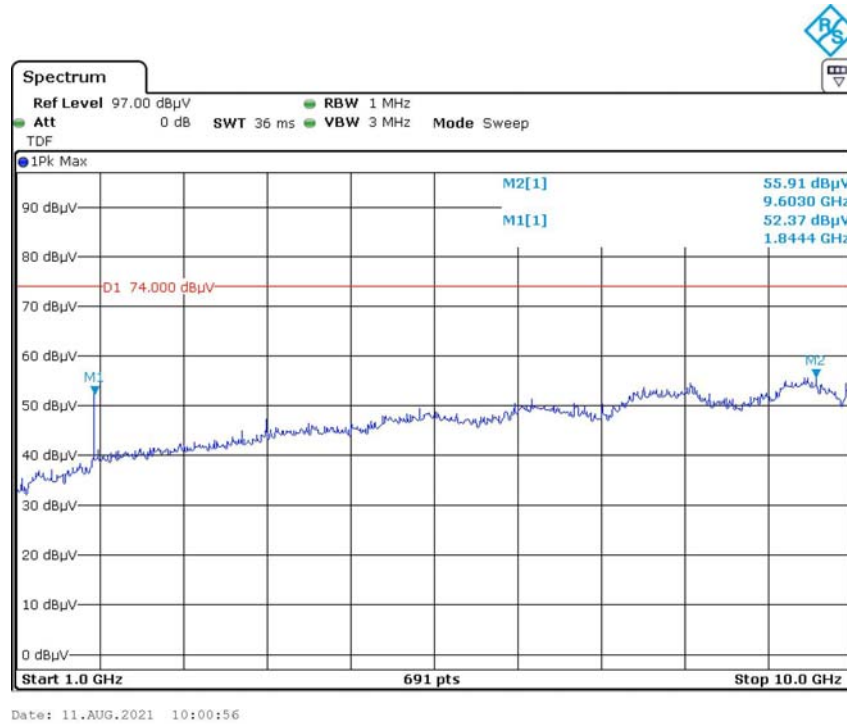
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

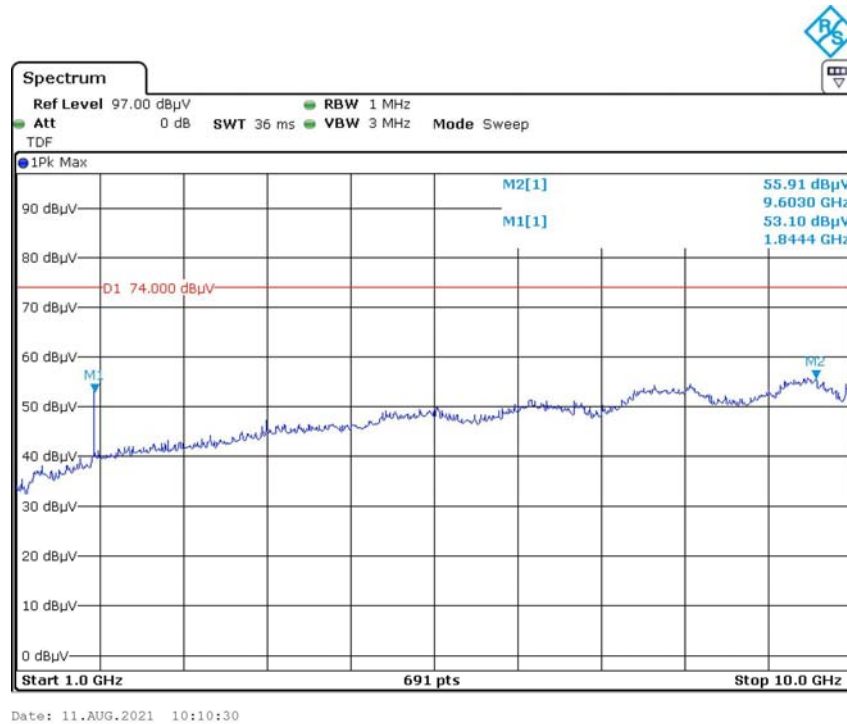
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

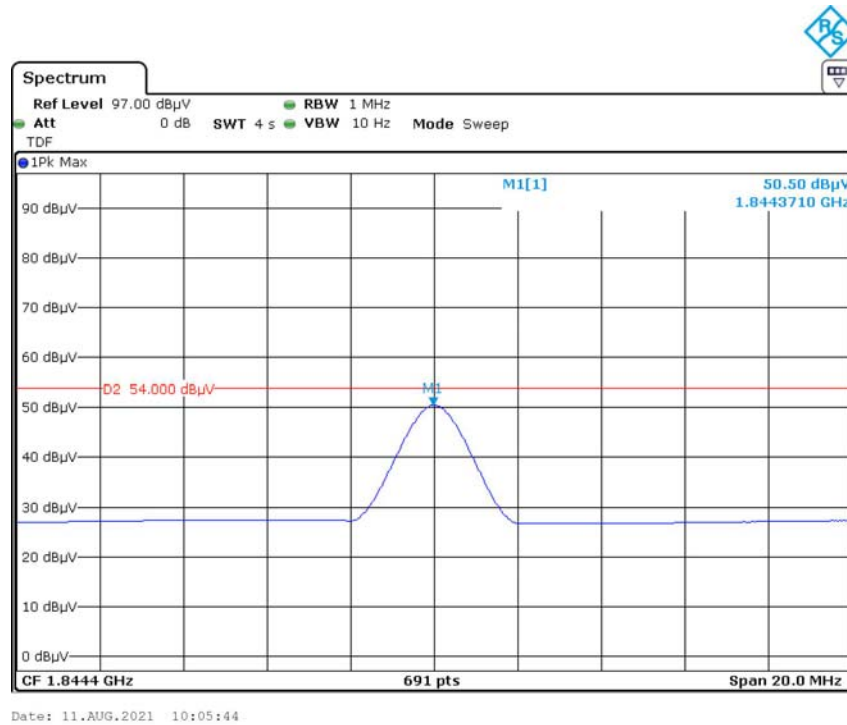
Pre-scan with High channel for Peak Horizontal



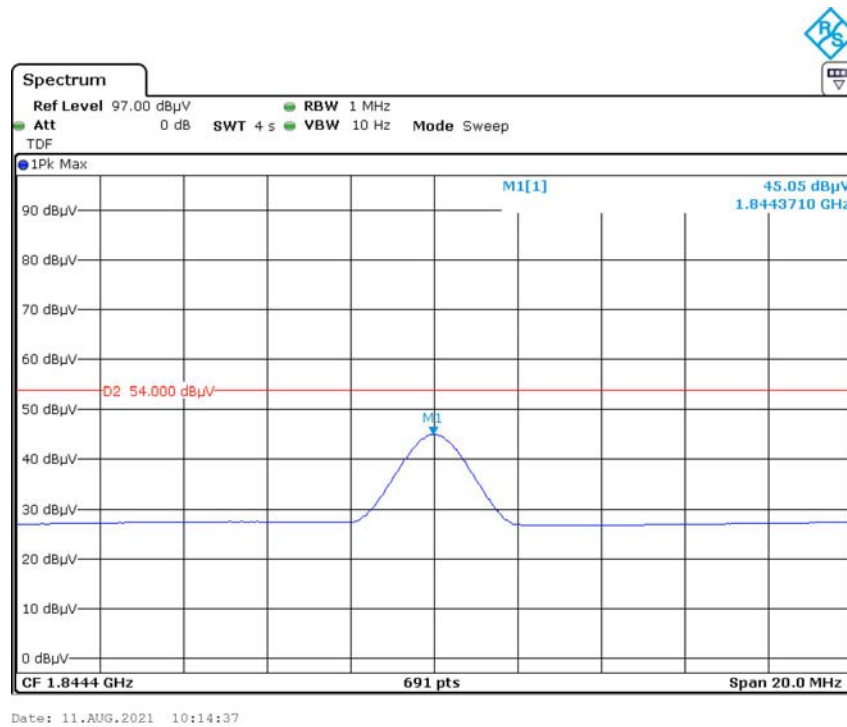
Vertical



Average Horizontal



Vertical



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

Applicable Standard

Frequency hopping systems shall have hopping 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

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	29.4 °C
Relative Humidity:	53 %
ATM Pressure:	110.0 kPa

The testing was performed by Pedro Yun on 2021-08-12.

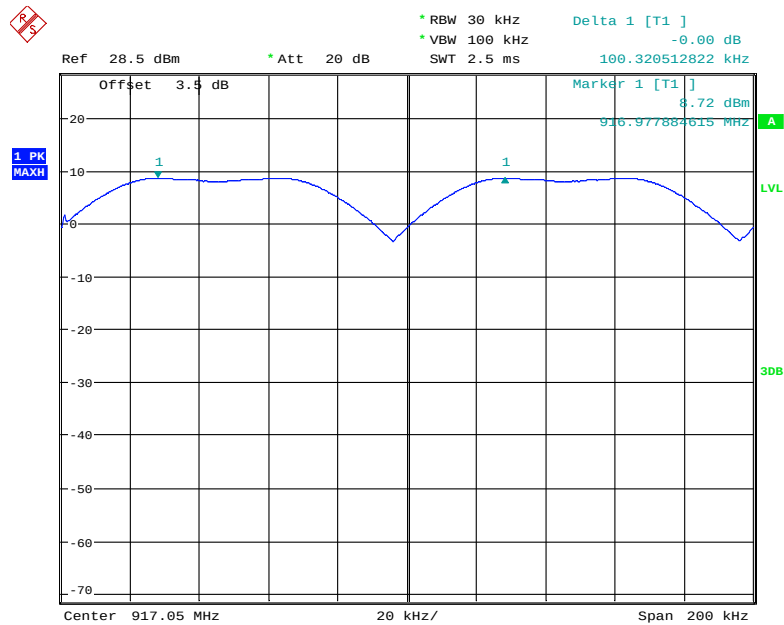
EUT operation mode: Transmitting

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

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	20dB Bandwidth (MHz)	Result
GFSK	Low	917	0.100	0.068	Pass
	Adjacent	917.1			
	Middle	919.6	0.100	0.068	Pass
	Adjacent	919.7			
	High	922.1	0.997	0.069	Pass
	Adjacent	922.2			

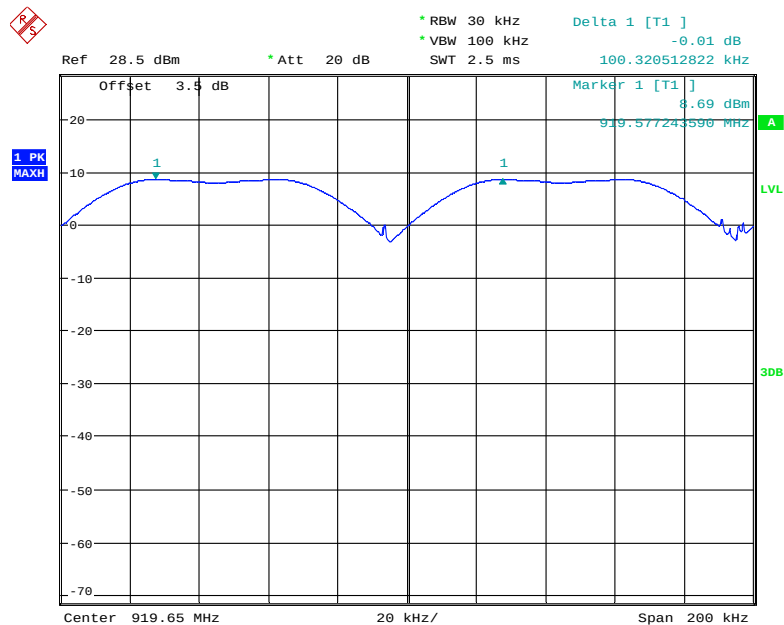
Limit: ≥ 20 dB bandwidth

Low Channel



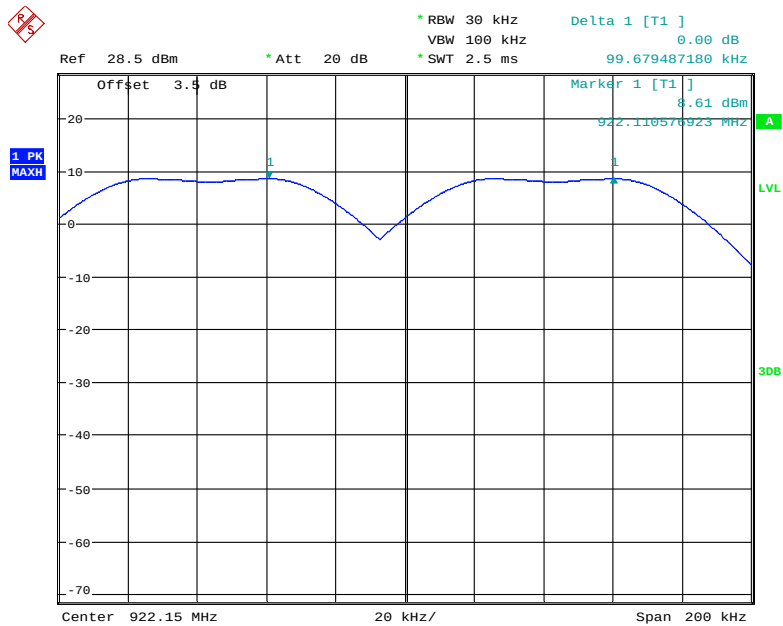
Date: 12.AUG.2021 22:03:24

Middle Channel



Date: 12.AUG.2021 22:05:52

High Channel



Date: 12.AUG.2021 22:01:29

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

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 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.
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.
4. Repeat above procedures until all frequencies measured were complete.

Test Data

Environmental Conditions

Temperature:	29.4 °C
Relative Humidity:	53 %
ATM Pressure:	110.0 kPa

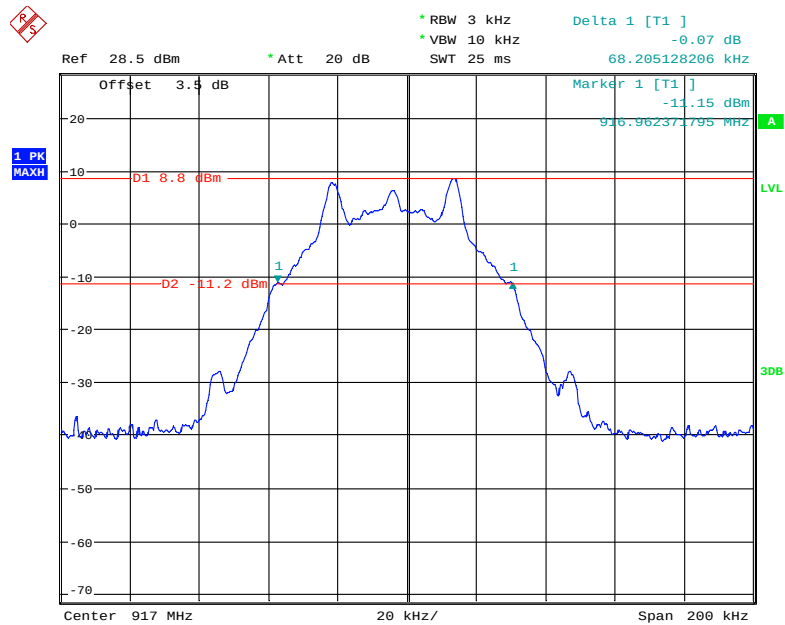
The testing was performed by Pedro Yun on 2021-08-12.

EUT operation mode: Transmitting

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

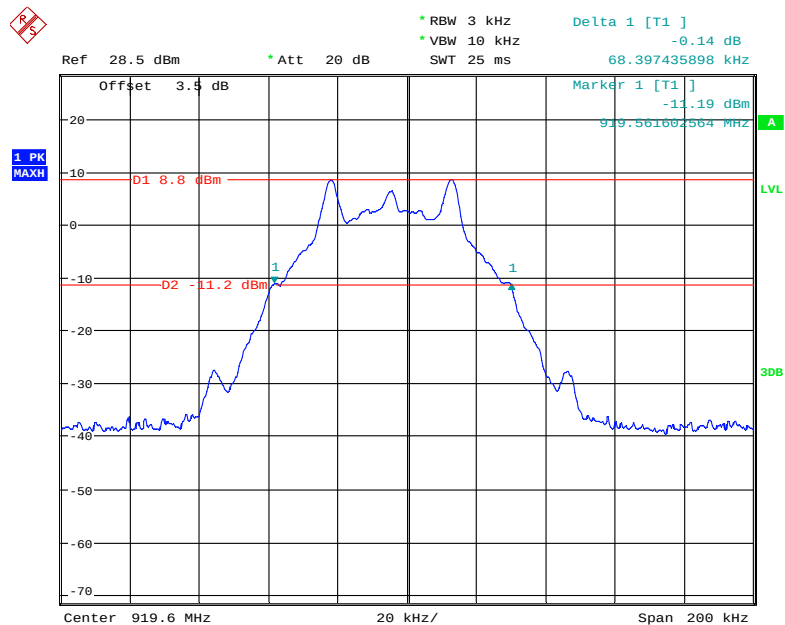
Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)	Limit (MHz)
Low	917.0	0.068	<0.25
Middle	919.6	0.068	<0.25
High	922.2	0.069	<0.25

Low Channel



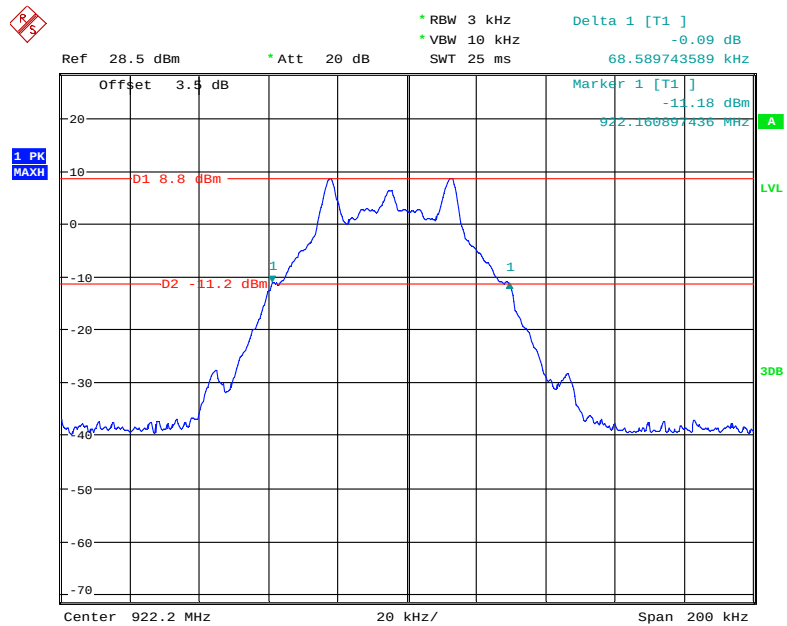
Date: 12.AUG.2021 21:48:16

Middle Channel



Date: 12.AUG.2021 21:45:55

High Channel



Date: 12.AUG.2021 21:36:38

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

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 Data**Environmental Conditions**

Temperature:	29.4 °C
Relative Humidity:	53 %
ATM Pressure:	110.0 kPa

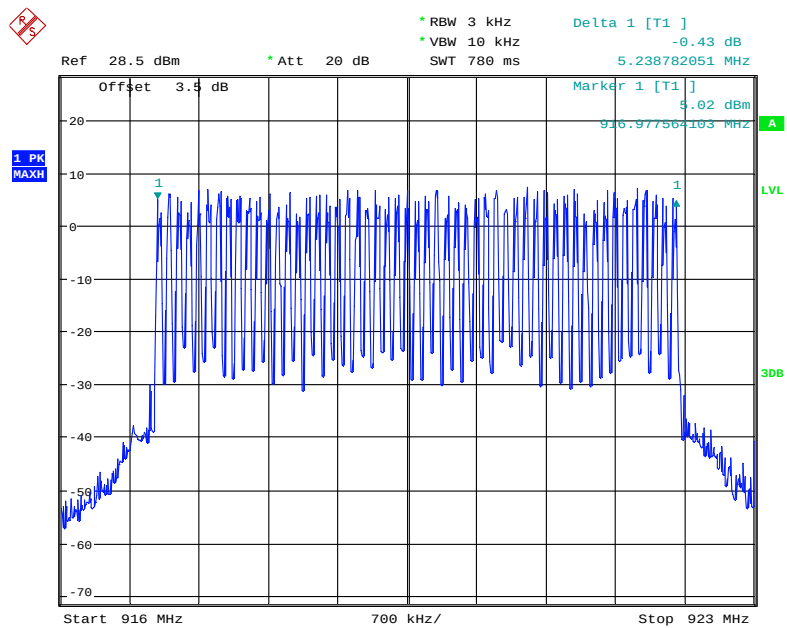
The testing was performed by Pedro Yun on 2021-08-12.

EUT operation mode: Transmitting

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

Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
Hopping	902-928	53	≥50

Number of Hopping Channels



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

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

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 $\leq$ channel spacing and where possible RBW should be set $\gg 1 / T$, 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:

$$\begin{aligned} & \text{(Number of hops in the period specified in the requirements)} = \\ & \text{(number of hops on spectrum analyzer)} \times (\text{period specified in the requirements} / \text{analyzer sweep time}) \end{aligned}$$

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:	29.4 °C
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

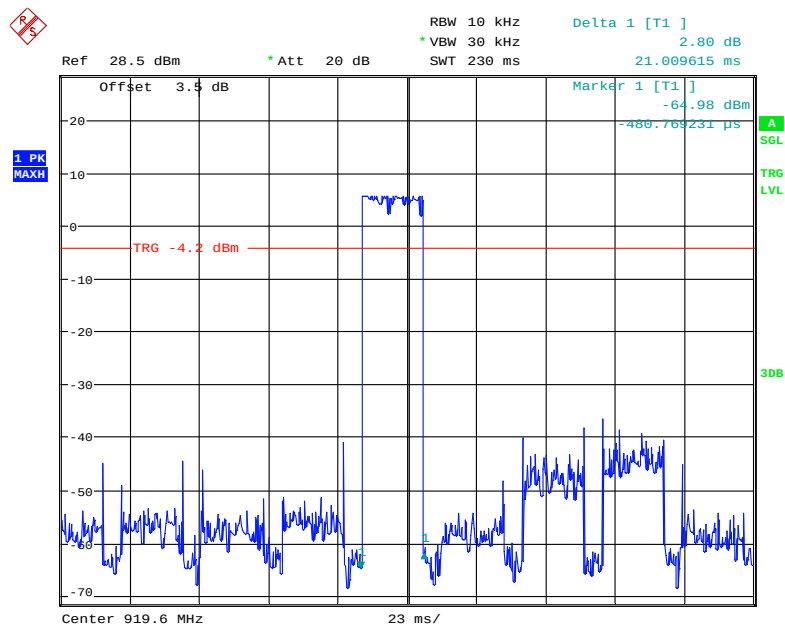
The testing was performed by Pedro Yun on 2021-08-12.

EUT operation mode: Transmitting

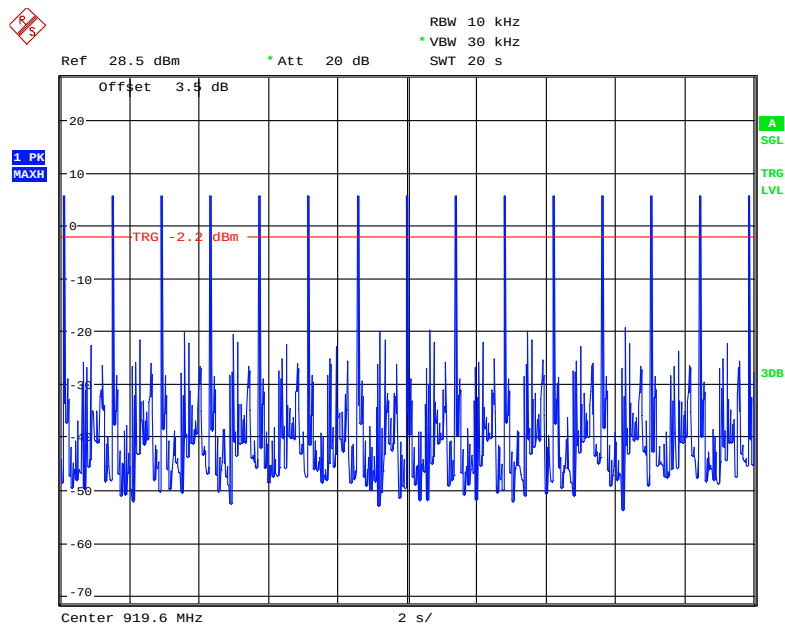
Test Result: Compliance. Please refer to following table and plots.

Frequency (MHz)	Pulse Time (ms)	Hopping Number	Period Time (s)	Total of Dwell (ms)	Limit (ms)	Result
919.6	21.01	15	20	315.15	<400	Pass

Pulse time



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Date: 12.AUG.2021 22:24:01

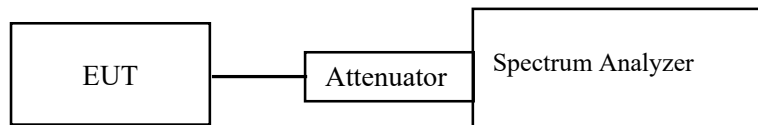
FCC §15.247(b) (2) - MAXIMUM CONDUCTED OUTPUT POWER

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 it 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 Data

Environmental Conditions

Temperature:	29.4 °C
Relative Humidity:	53 %
ATM Pressure:	110.0 kPa

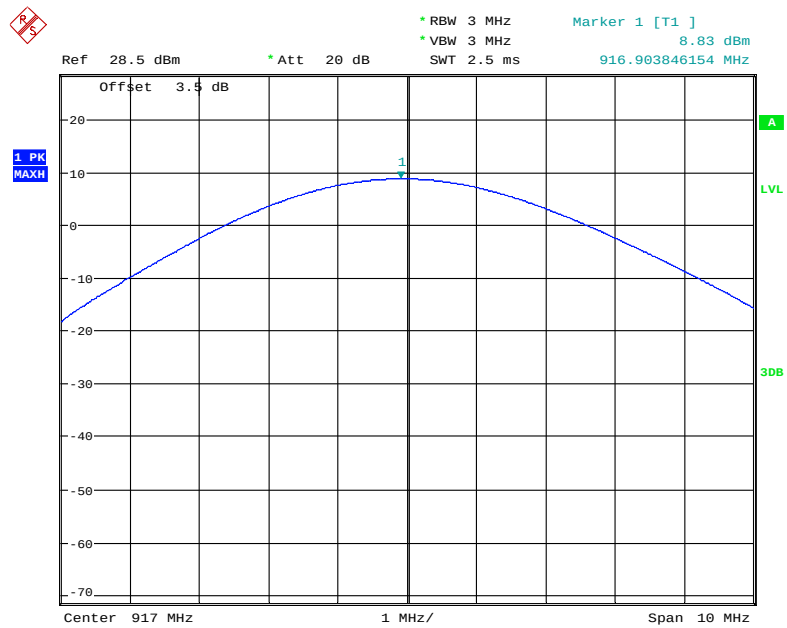
The testing was performed by Pedro Yun on 2021-08-12.

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

EUT operation mode: Transmitting

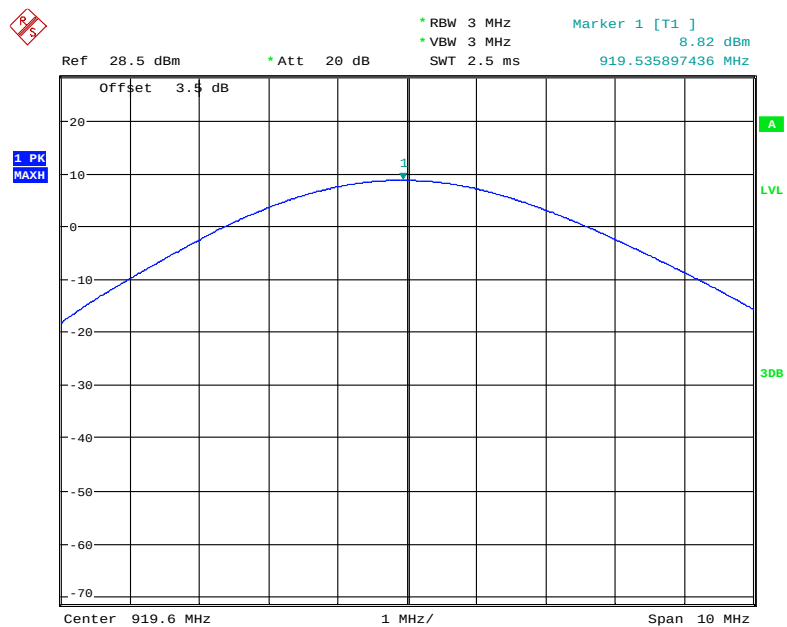
Mode	Channel	Frequency (MHz)	Reading power (dBm)	Limit (dBm)
GFSK	Low	917.0	8.83	30
	Middle	919.6	8.82	30
	High	922.2	8.78	30

Low Channel



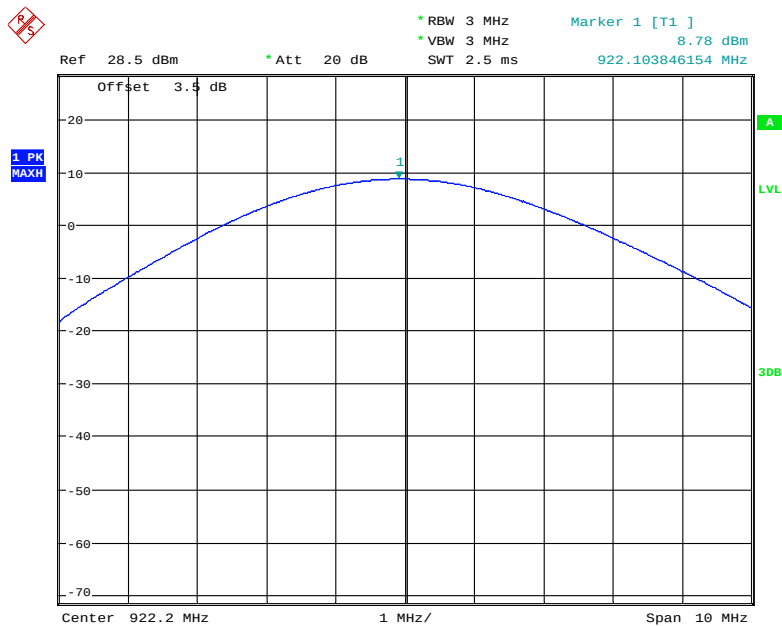
Date: 12.AUG.2021 21:31:05

Middle Channel



Date: 12.AUG.2021 21:32:39

High Channel



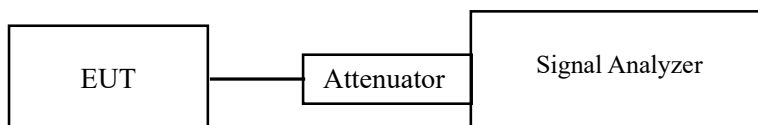
Date: 12.AUG.2021 21:33:37

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

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 Data****Environmental Conditions**

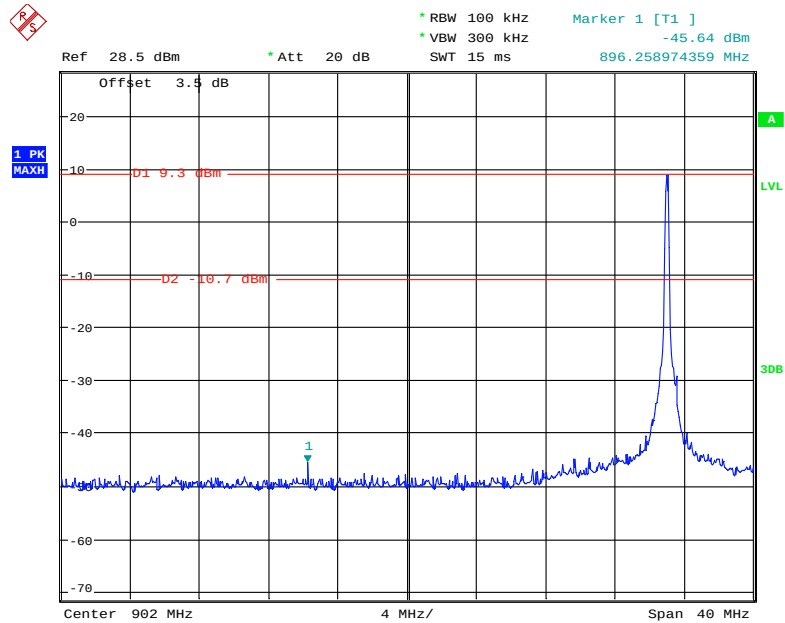
Temperature:	29.4 °C
Relative Humidity:	53 %
ATM Pressure:	110.0 kPa

The testing was performed by Pedro Yun on 2021-08-12.

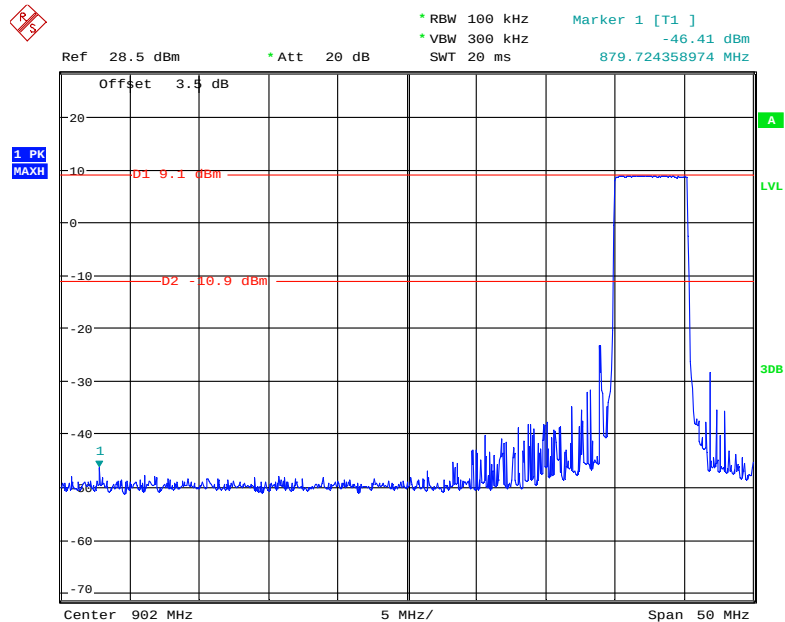
Test Result: Compliance. Please refer to following table and plots.

EUT operation mode: Transmitting

Band Edge, Left Side

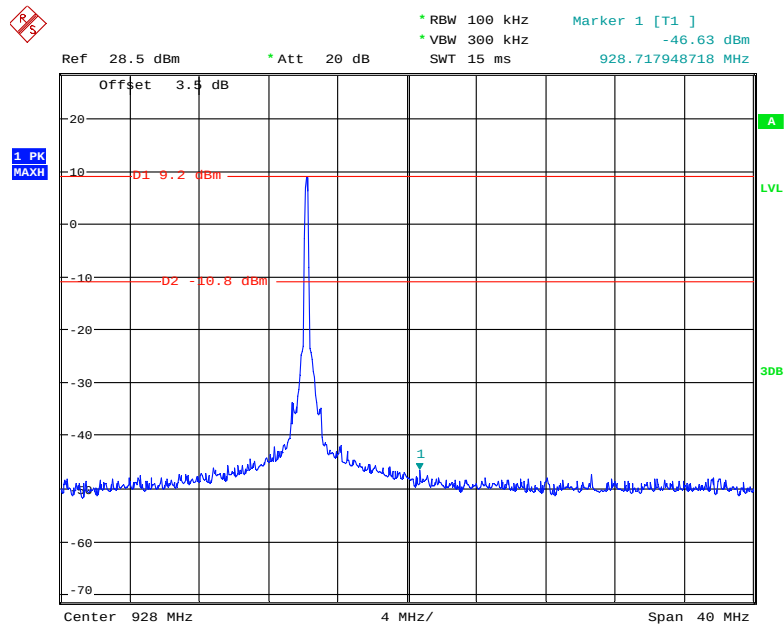


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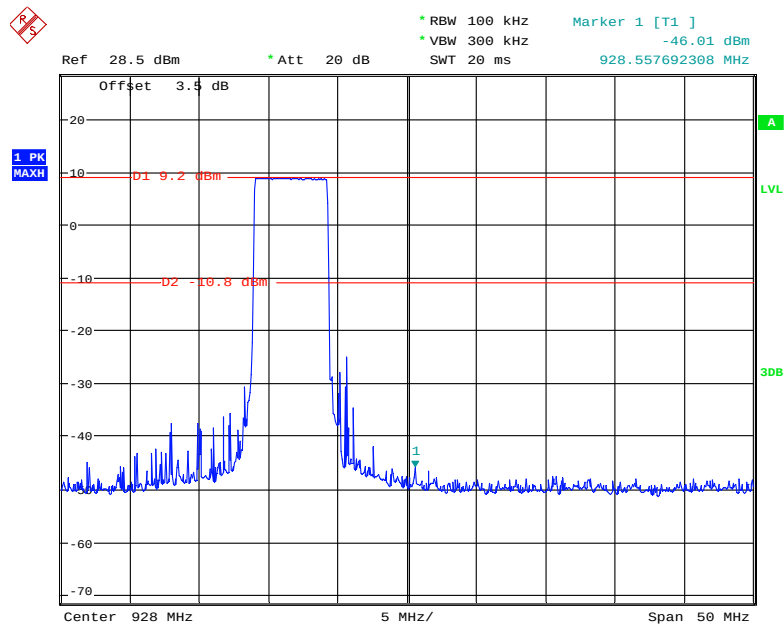


Date: 12.AUG.2021 21:58:48

Band Edge, Right Side



Date: 12.AUG.2021 21:53:10



Date: 12.AUG.2021 21:54:27

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