TEST REPORT

Applicant Name :	Astera LED-Technology GmbH
Address :	Stahlgruberring 36, Munich,81829 Germany
Report Number :	SZNS220601-24201E-RF-00
FCC ID:	X55FP6

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	HydraPanel
Model No.:	FP6
Multiple Model(s) No.:	N/A
Trade Mark:	ASTERA
Date Received:	2022/06/01
Report Date:	2022/07/14

Test Result:	Pass*

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

Prepared and Checked By:

Audy Yu
EMC Engineer

Approved By:

Robert 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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TABLE OF CONTENTS

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Frequency Range	917-922.2MHz
Maximum conducted Peak output power	9.83dBm
Modulation Technique	GFSK
Antenna Specification*	PCB antenna, -1.2dBi (provided by the applicant)
Voltage Range	DC 10.8V from battery or DC 24.0V from adapter
Sample serial number	SZNS220601-24201E-RF-S1 for Conducted and Radiated Emissions SZNS220601-24201E-RF-S2 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition
Adapter information	Model: PA1050-240IB200 Input: AC 100-240V, 50/60Hz, 1.8A Output: DC 24.0V, 2.0A, 48.0W Max

Objective

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

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, 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 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 Frequency		$0.082*10^{-7}$
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.66dB
	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
	26.5GHz - 40GHz	4.72dB
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 an 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**	/	/

Channel 0, 26, 52 was tested

EUT Exercise Software

“AsteraApp_9.96”* exercise software was used and the power level is default*. The software and power level was provided by applicant

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

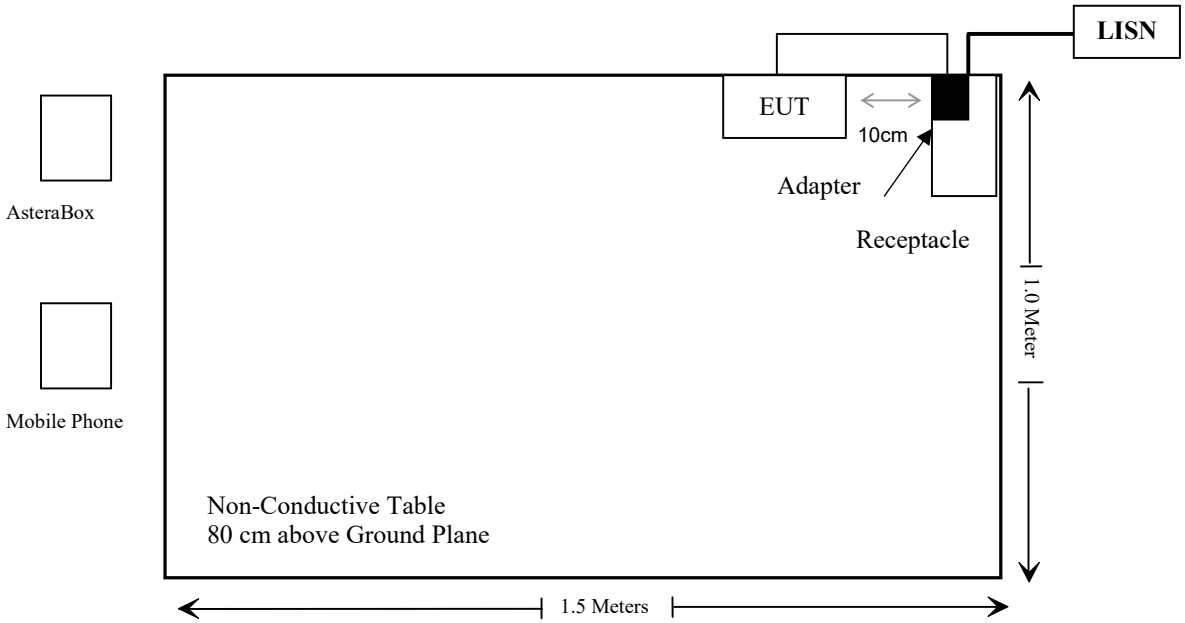
Manufacturer	Description	Model	Serial Number
ASTERA	AsteraBox	ART7-U	025-0918819
Nubia	Mobile Phone	NX549J	Unknown

External I/O Cable

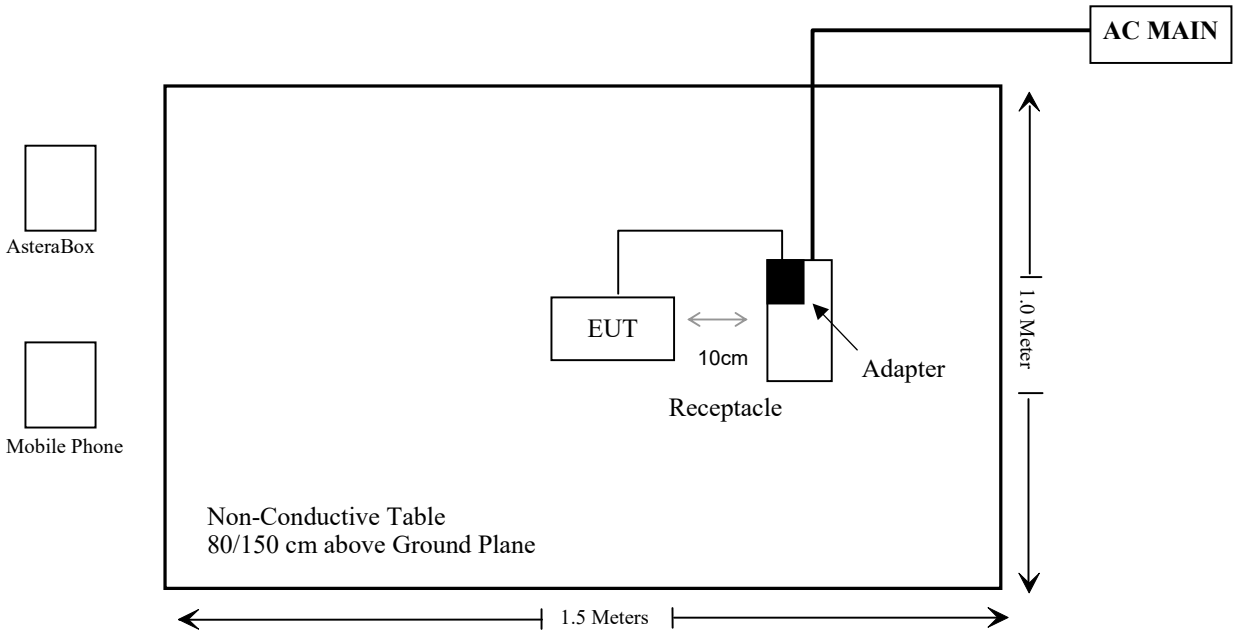
Cable Description	Length (m)	From/Port	To
Un-shielding Un-Detachable USB Cable	1.5	EUT	Adapter

Block Diagram of Test Setup

For conducted emission



For radiate emission



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (3) & §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)	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	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 Emissions 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
Radiated Emission Test Software: e3 19821b (V9)					
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

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
SPECTRUM ANALYZER	Rohde & Schwarz	FSU26	200982	2021/07/06	2022/07/05
SPECTRUM ANALYZER	Rohde & Schwarz	FSU26	200982	2022/07/06	2023/07/05
WEINSCHEL	3dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Unknown	RF Cable	Unknown	Unknown	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) & §1.1307 (b) (3) & §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

For multiple RF sources: Multiple RF sources are exempt if:

in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation:

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

Result

Mode	Frequency (MHz)	Tune up conducted power	Antenna Gain		ERP		Evaluation Distance (m)	ERP Limit (W)
		(dBm)	(dBi)	(dBd)	(dBm)	(W)		
UHF	917-922.2	10.0	-1.2	-3.35	6.65	0.005	0.2	0.470
BT	2402-2480	9.0	3.4	1.25	10.3	0.011	0.2	0.768
BLE	2402-2480	7.0	3.4	1.25	8.3	0.007	0.2	0.768
Wi-Fi	2412-2462	27.0	3.4	1.25	28.3	0.668	0.2	0.768

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.
2. EUT contain a BT/Wi-Fi module ESP32-WROVER-E, FCC ID: 2AC7Z-ESP32WROVERE
3. 0dBd=2.15dBi
4. The UHF can transmit with BT/Wi-Fi at same time, the BT and Wi-Fi cannot transmit simultaneously

Simultaneous transmitting consideration (worst case):

The ratio=$MPE_{Wi\text{-}Fi}$/limit+MPE_{UHF}/limit=0.668/0.758+0.010/0.470=0.903＜1.0, so simultaneous exposure is compliant.

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

Antenna Connector Construction

The EUT has one internal Antenna arrangement for UHF, which was permanently attached and the antenna gain is -1.2dBi, fulfill the requirement of this section. Please refer to the EUT photos.

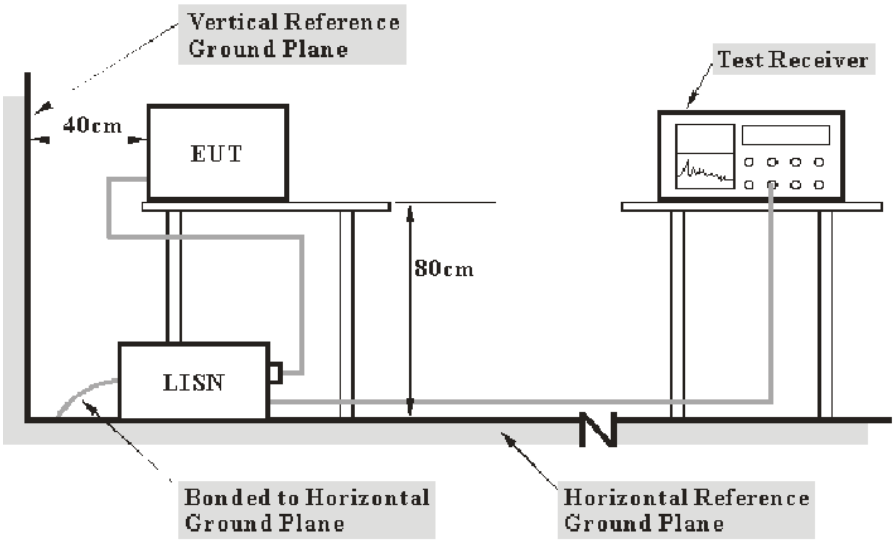
Result: Compliance.

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.

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, a over limit of -7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Over Limit = level – Limit
Level= reading level+ Transd Factor

Test Data

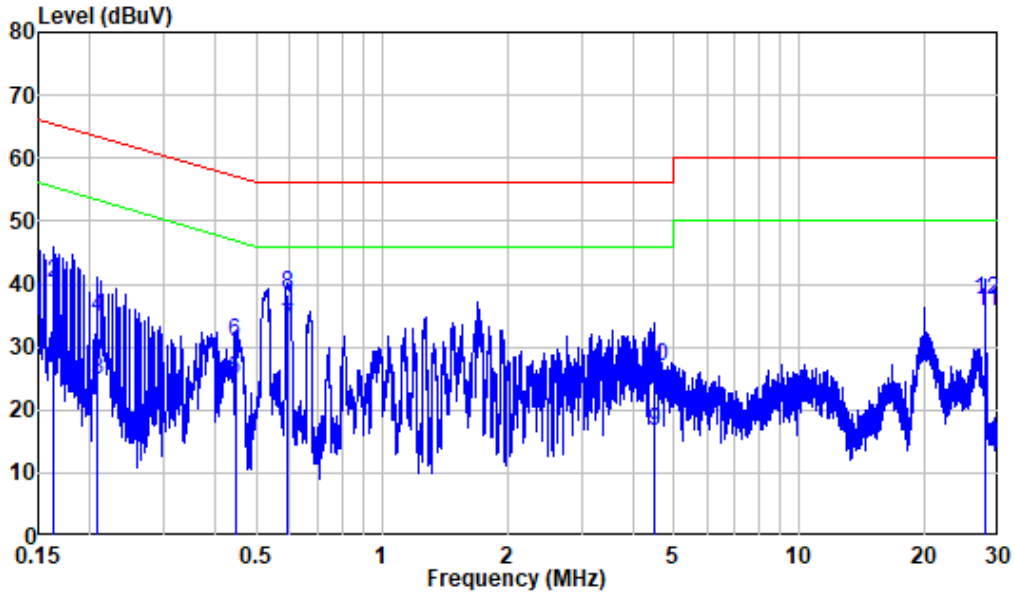
Environmental Conditions

Temperature:	23 ℃
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by Jason Liu on 2022-06-20.

EUT operation mode: Transmitting (the worst case for low channel)

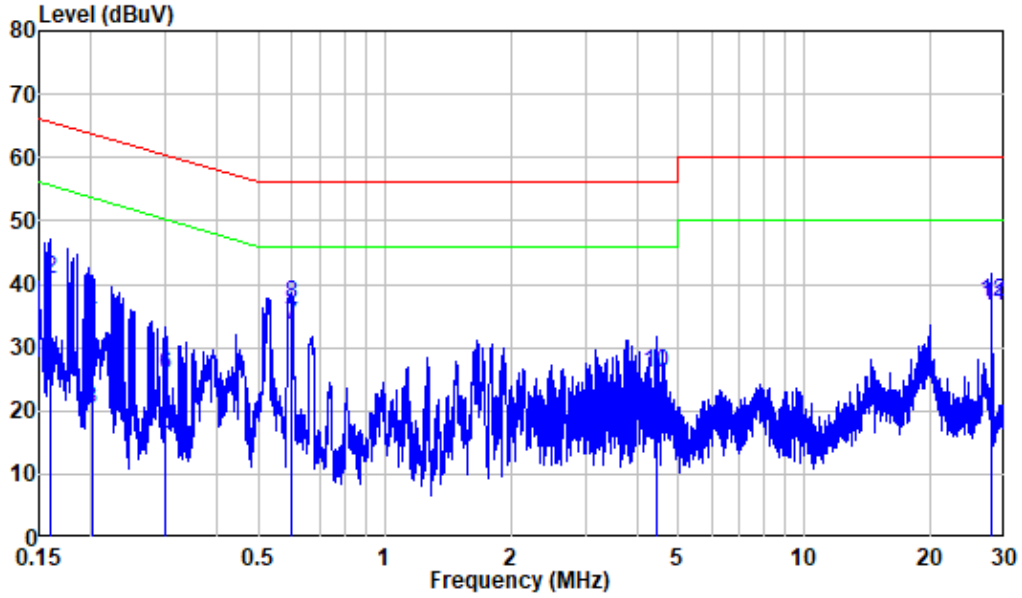
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Mode : Working + UHF
Model : FP6
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.163	9.80	15.66	25.46	55.32	-29.86	Average
2	0.163	9.80	30.47	40.27	65.32	-25.05	QP
3	0.207	9.80	14.85	24.65	53.32	-28.67	Average
4	0.207	9.80	25.06	34.86	63.32	-28.46	QP
5	0.444	9.80	14.82	24.62	46.98	-22.36	Average
6	0.444	9.80	20.85	30.65	56.98	-26.33	QP
7	0.592	9.81	23.50	33.31	46.00	-12.69	Average
8	0.592	9.81	28.43	38.24	56.00	-17.76	QP
9	4.487	9.84	6.90	16.74	46.00	-29.26	Average
10	4.487	9.84	17.14	26.98	56.00	-29.02	QP
11	28.003	10.08	25.45	35.53	50.00	-14.47	Average
12	28.003	10.08	27.24	37.32	60.00	-22.68	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
Condition: Neutral
Mode : Working + UHF
Model : FP6
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.160	9.80	15.30	25.10	55.48	-30.38	Average
2	0.160	9.80	30.83	40.63	65.48	-24.85	QP
3	0.200	9.80	10.45	20.25	53.60	-33.35	Average
4	0.200	9.80	25.63	35.43	63.60	-28.17	QP
5	0.300	9.80	6.65	16.45	50.25	-33.80	Average
6	0.300	9.80	15.87	25.67	60.25	-34.58	QP
7	0.601	9.81	23.73	33.54	46.00	-12.46	Average
8	0.601	9.81	26.94	36.75	56.00	-19.25	QP
9	4.425	9.86	5.73	15.59	46.00	-30.41	Average
10	4.425	9.86	16.12	25.98	56.00	-30.02	QP
11	28.003	10.18	26.28	36.46	50.00	-13.54	Average
12	28.003	10.18	27.04	37.22	60.00	-22.78	QP

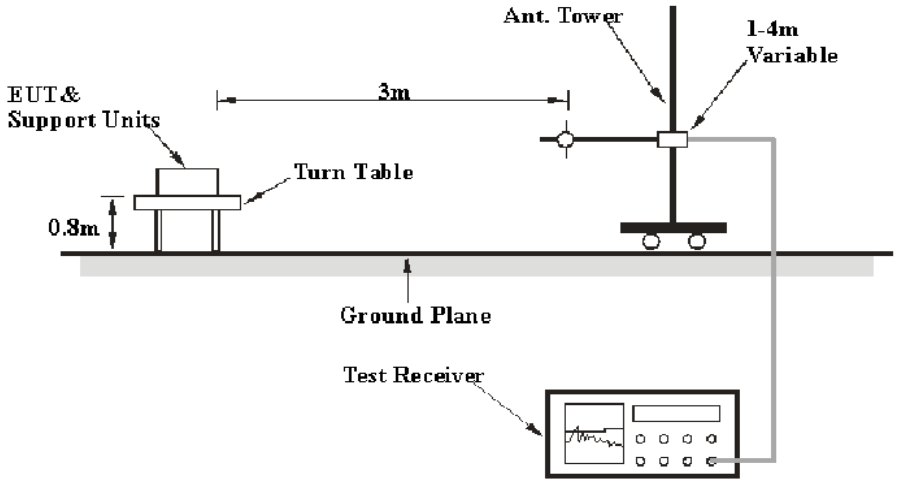
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

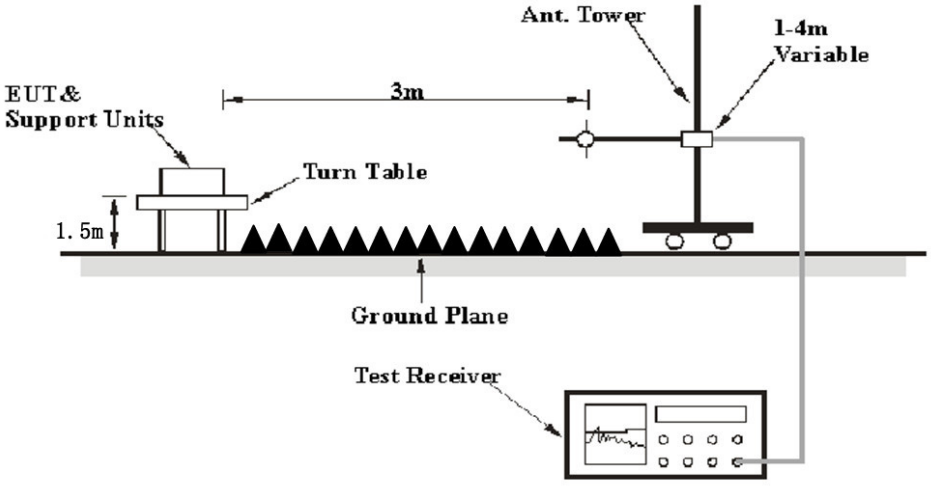
FCC §15.205; §15.209; §15.247(d)

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

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 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 overlimit/margin of -7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin/Over Limit = Corrected Amplitude/Level-Limit
Corrected Amplitude/Level = Reading + Corrected Factor

Test Data

Environmental Conditions

Temperature:	24~25.1 ℃
Relative Humidity:	54~61 %
ATM Pressure:	101.0 kPa

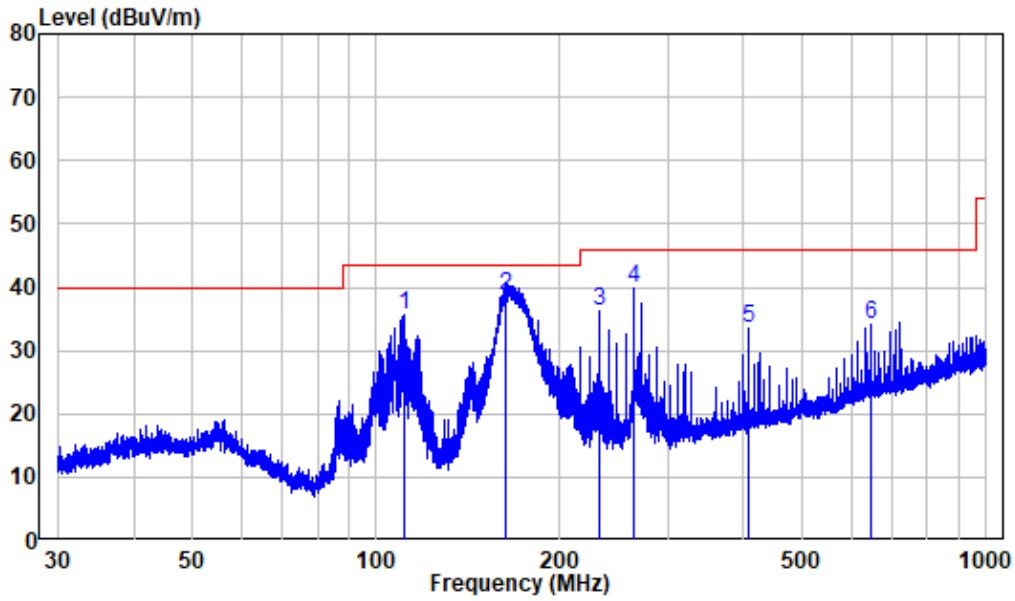
The testing was performed by Level Li on 2022-07-01 for below 1GHz, Level Li and Zeki Ma on 2022-06-01 and 2022-06-15 for above 1GHz.

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

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

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

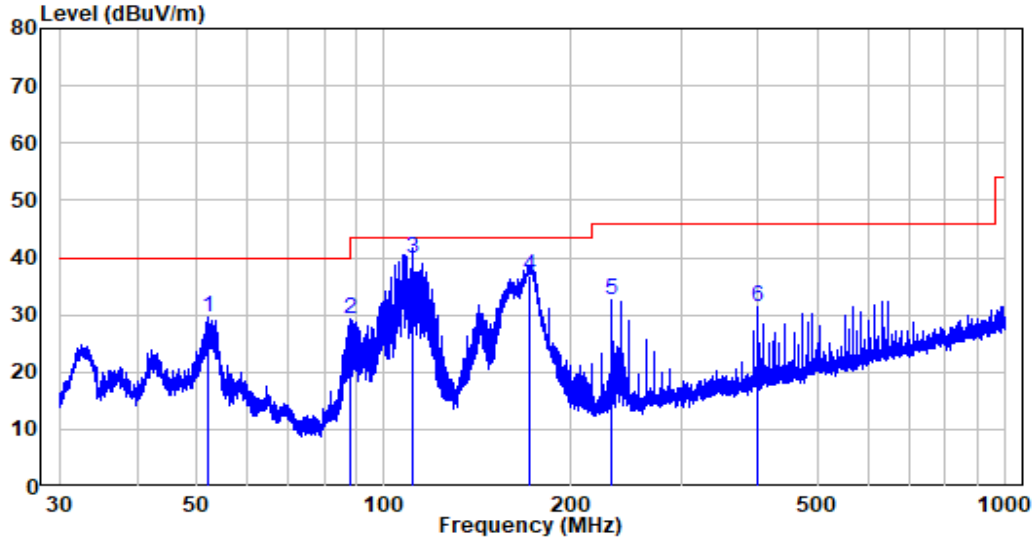
Horizontal:



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220601-24201E-RF
Test Mode: TX

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	111.445	-12.16	47.70	35.54	43.50	-7.96	Peak
2	162.611	-14.29	53.05	38.76	43.50	-4.74	QP
3	232.023	-11.05	47.22	36.17	46.00	-9.83	Peak
4	264.050	-10.48	50.33	39.85	46.00	-6.15	Peak
5	408.051	-6.49	40.07	33.58	46.00	-12.42	Peak
6	648.237	-1.79	35.78	33.99	46.00	-12.01	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS220601-24201E-RF
Test Mode: TX

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	52.231	-10.02	39.70	29.68	40.00	-10.32	Peak
2	88.265	-14.49	43.66	29.17	43.50	-14.33	Peak
3	110.763	-12.06	51.86	39.80	43.50	-3.70	QP
4	171.167	-13.46	50.23	36.77	43.50	-6.73	QP
5	232.023	-11.05	43.53	32.48	46.00	-13.52	Peak
6	400.081	-6.73	38.27	31.54	46.00	-14.46	Peak

Above 1GHz:

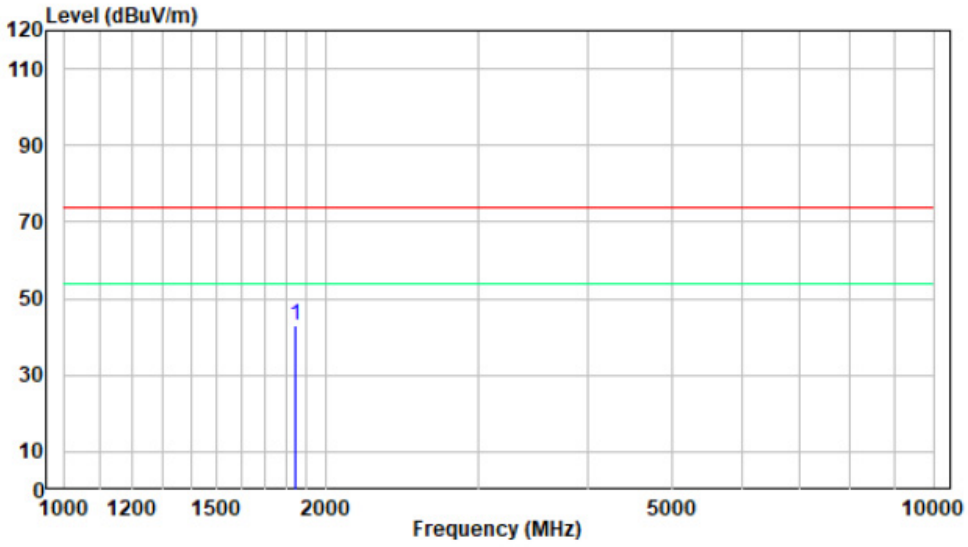
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
Low Channel									
1834	50.42	PK	66	1.6	H	-8.50	41.92	74	-32.08
1834	51.74	PK	215	2	V	-8.50	43.24	74	-30.76
Middle Channel									
1839.2	50.68	PK	337	1.8	H	-8.46	42.22	74	-31.78
1839.2	50.71	PK	66	2.3	V	-8.46	42.25	74	-31.75
High Channel									
1844.4	51.52	PK	94	1.1	H	-8.41	43.11	74	-30.89
1844.4	52.28	PK	168	2.1	V	-8.41	43.87	74	-30.13

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 or in noise floor was not recorded.
The test result of peak was less than the limit of average, so just peak value were recorded.

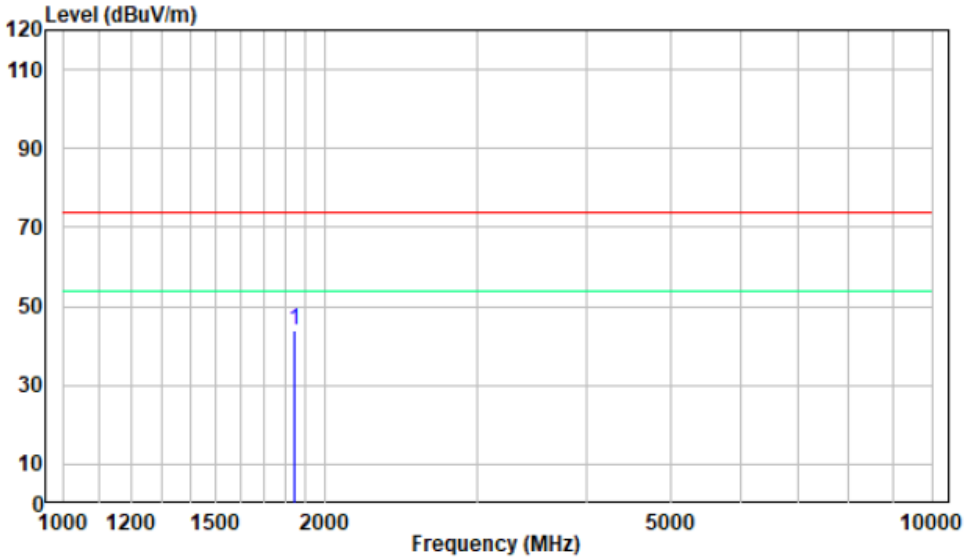
1-10GHz

Pre-scan for High Channel

Horizontal:



Vertical:



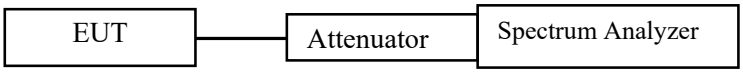
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

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:	27.7 ℃
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

The testing was performed by Audy Yu on 2022-07-14.

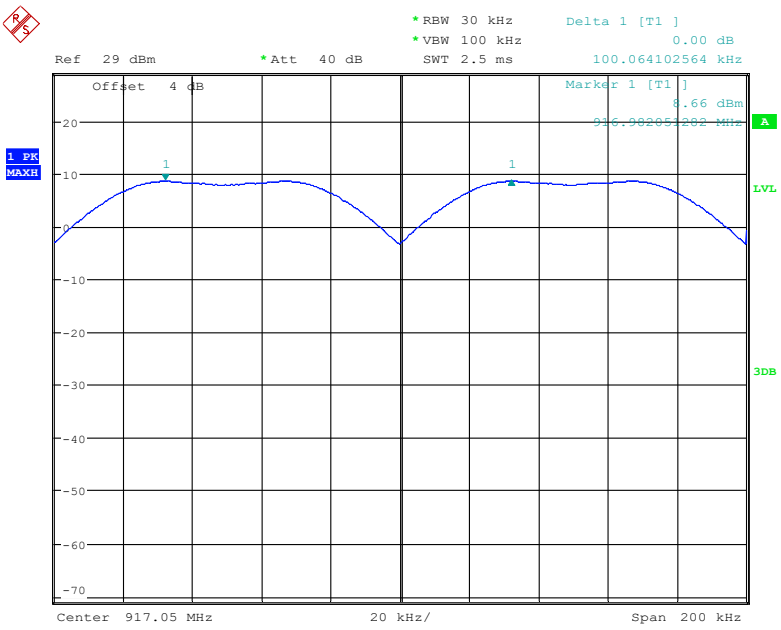
EUT operation mode: Transmitting

Test Result: Compliant.

Channel	Channel Separation (MHz)	20 dB Emission Bandwidth (MHz)	Limit	Result
Low	0.100	0.069	≥20 dB Emission Bandwidth	Compliance
Middle	0.100	0.067	≥20 dB Emission Bandwidth	Compliance
High	0.100	0.069	≥20 dB Emission Bandwidth	Compliance

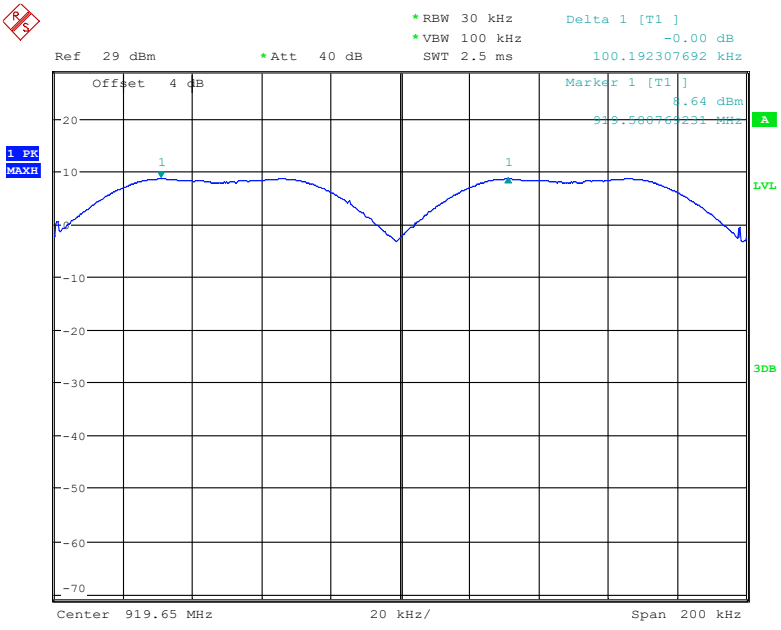
Please refer to the below plots:

Low Channel



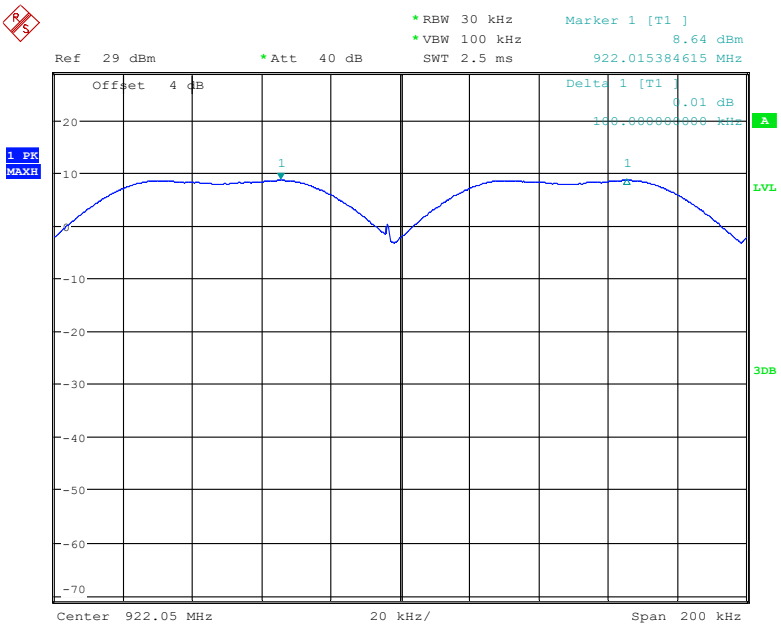
Date: 14.JUL.2022 16:18:42

Middle Channel



Date: 14.JUL.2022 16:21:20

High Channel



Date: 14.JUL.2022 16:20:13

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

Applicable Standard

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

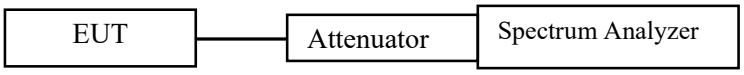
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

• The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.

• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data

Environmental Conditions

Temperature:	27.7 ℃
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

The testing was performed by Audy Yu on 2022-07-01.

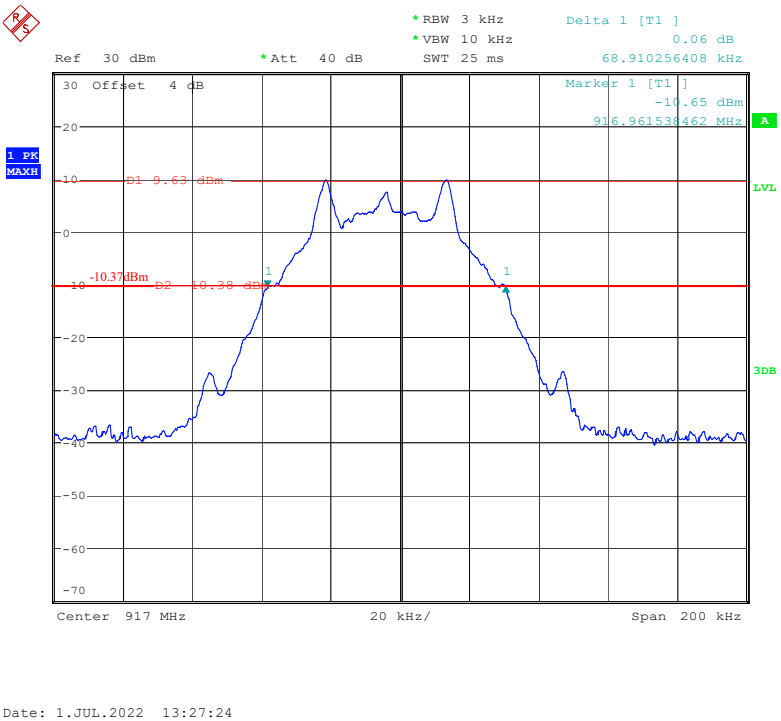
EUT operation mode: Transmitting

Test Result: Compliant.

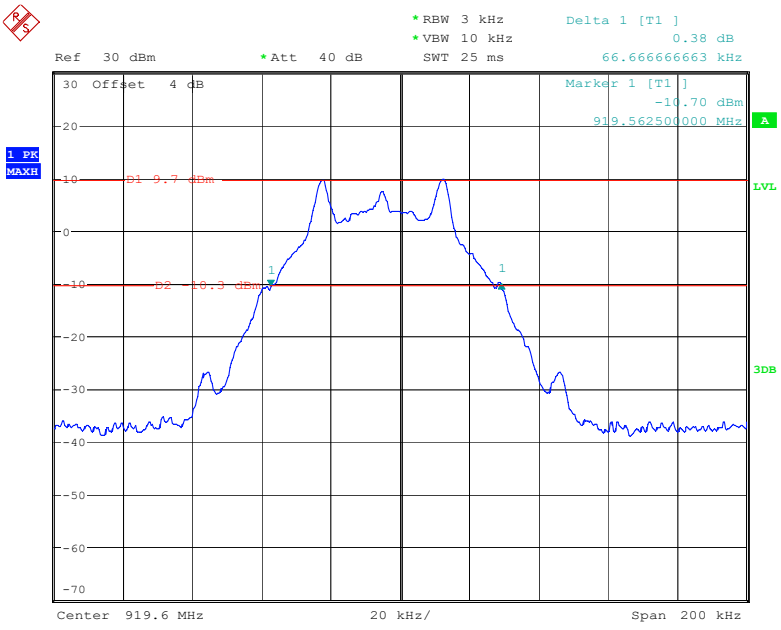
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)	Limit (kHz)
GFSK	Low	917	0.069	250
	Middle	919.6	0.067	250
	High	922.2	0.069	250

Please refer to the below plots:

Low Channel

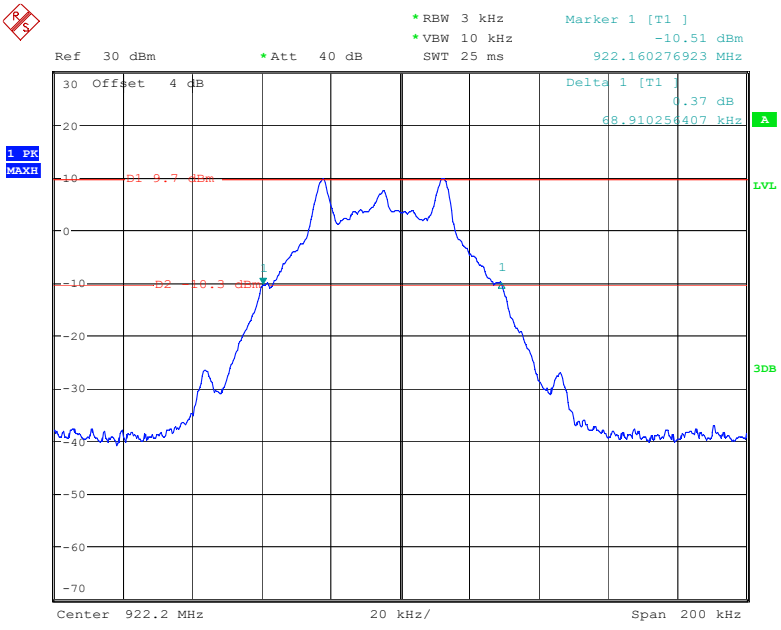


Middle Channel



Date: 1.JUL.2022 13:33:55

High Channel



Date: 1.JUL.2022 13:50:12

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

Applicable Standard

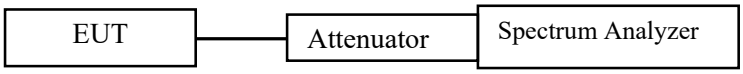
For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period;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

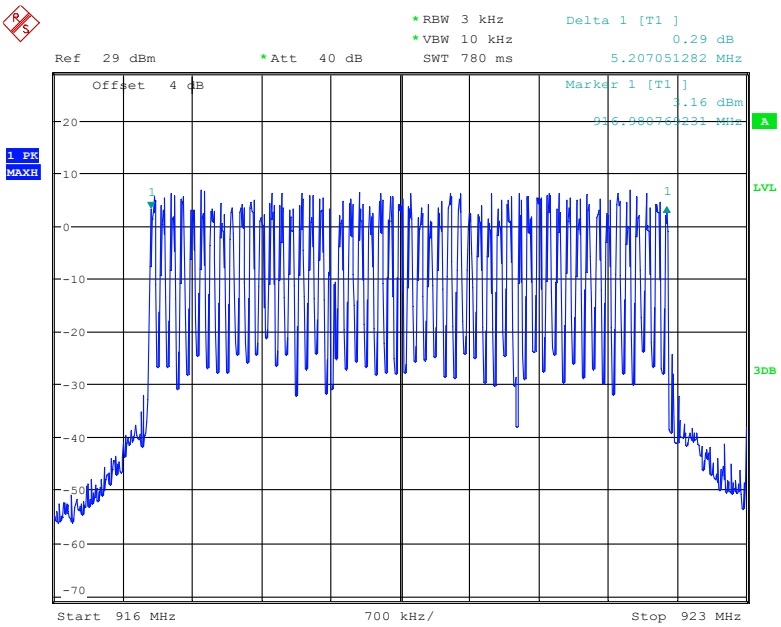
Temperature:	27.7 ℃
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

The testing was performed by Audy Yu on 2022-07-14

EUT operation mode: Transmitting

Test Result: Compliant.

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



Date: 14.JUL.2022 16:28:33

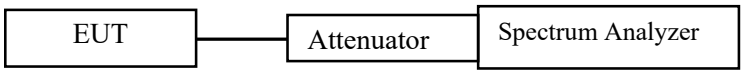
FCC §15.247(a) (1) (i) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

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. The EUT was worked in channel hopping.
2. Set the RBW to: 10kHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses



Test Data

Environmental Conditions

Temperature:	27.7 ℃
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

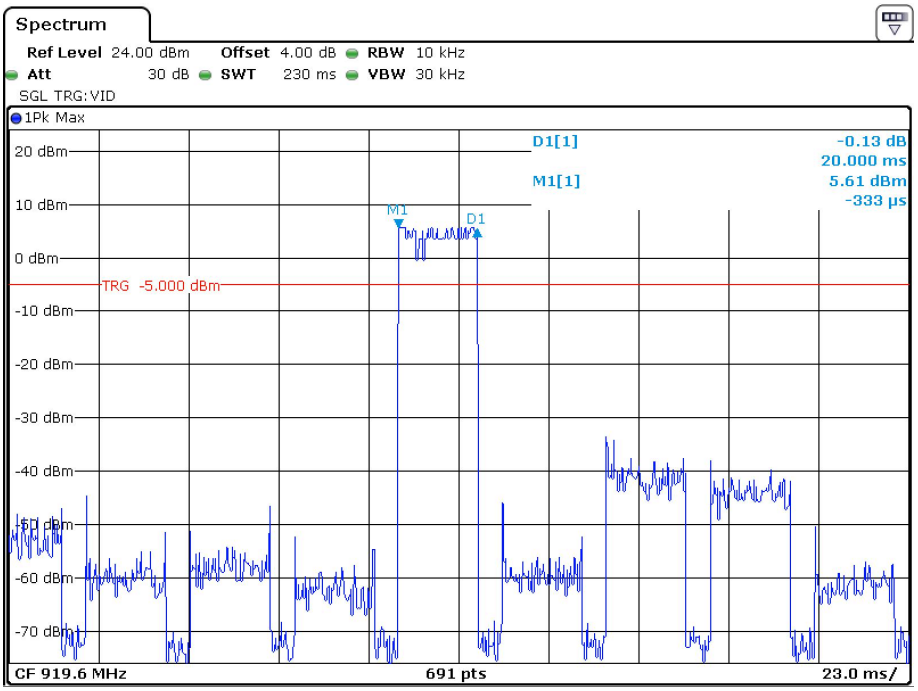
The testing was performed by Audy Yu on 2022-07-01 and 2022-07-02.

EUT operation mode: Transmitting

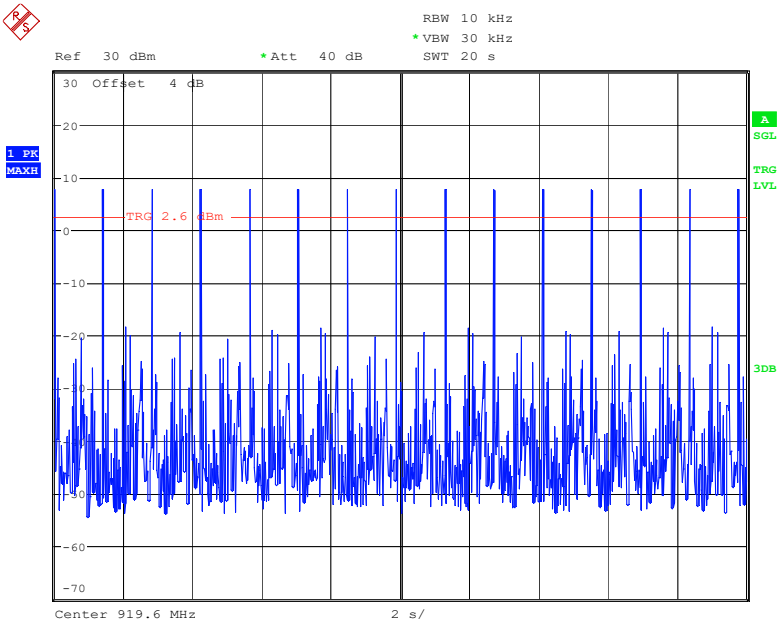
Test Result: Compliant.

Frequency (MHz)	Pulse Time (ms)	Total hops	Period Time (s)	Result (ms)	Limit (ms)	Result
919.6	20	15	20	300	<400	Pass

Note : Result= Pulse Time *Total hops



Date: 2.JUL.2022 13:45:53



Date: 1.JUL.2022 14:10:56

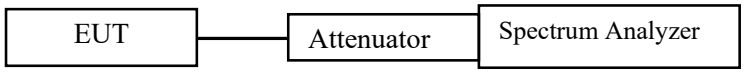
FCC §15.247(b) (2) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to §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 Data

Environmental Conditions

Temperature:	27.7 ℃
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

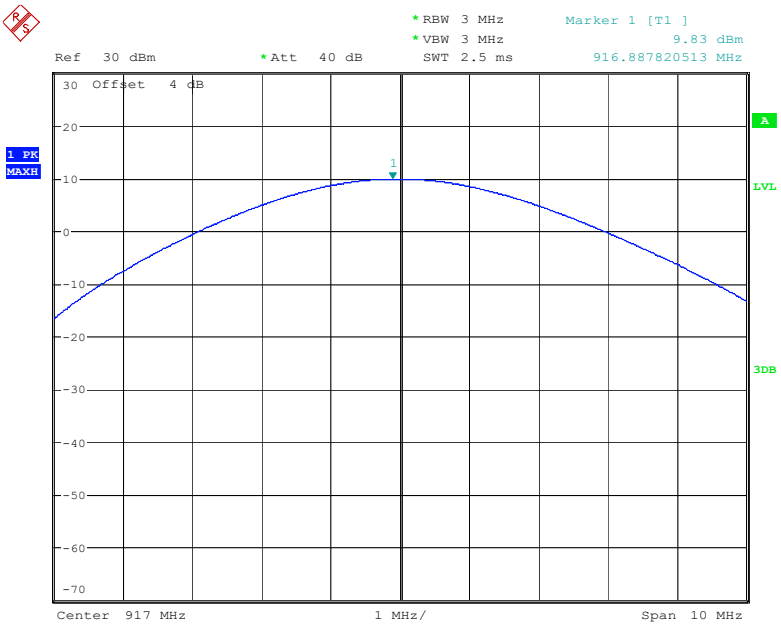
The testing was performed by Audy Yu on 2022-07-01.

EUT operation mode: Transmitting

Test Result: Compliant.

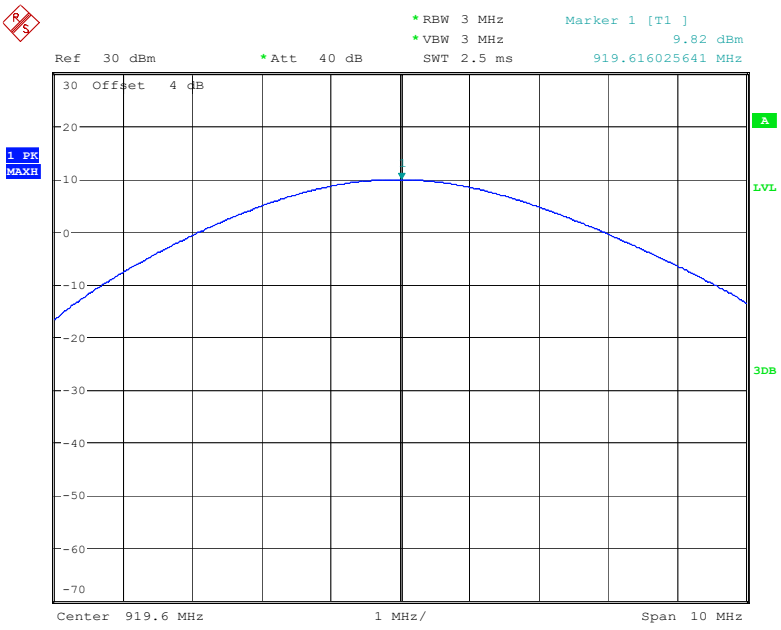
Channel	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)
Low	917	9.83	30
Middle	919.6	9.82	30
High	922.2	9.79	30

Low channel



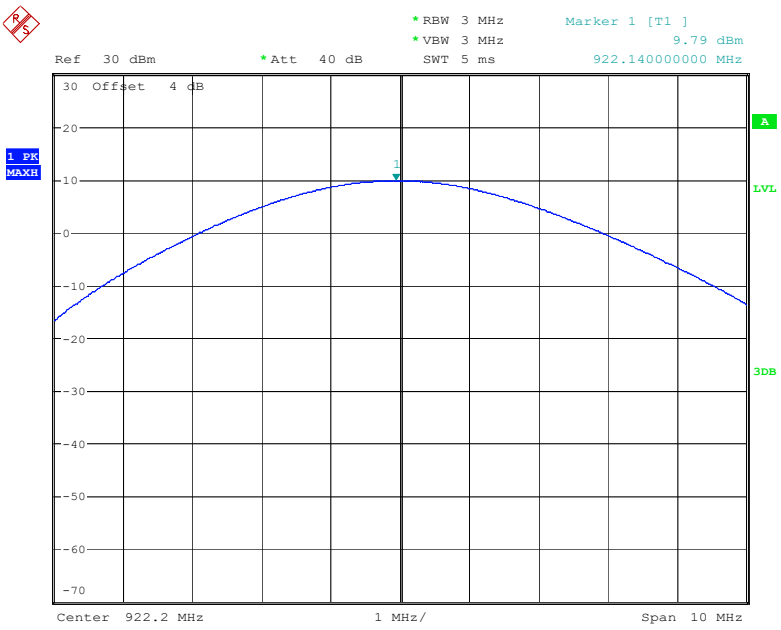
Date: 1.JUL.2022 13:23:48

Middle channel



Date: 1.JUL.2022 13:32:15

High channel



Date: 1.JUL.2022 13:47:32

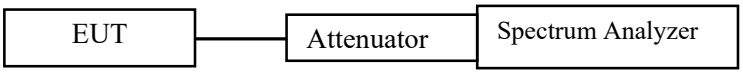
FCC §15.247(d) - BAND EDGES TESTING

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. 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 of spectrum analyzer to 100 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:	27.7 ℃
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

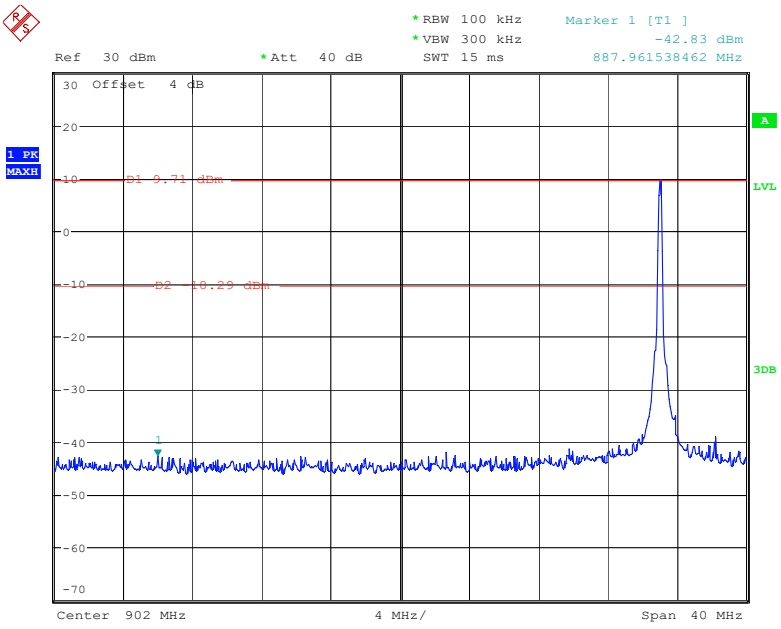
The testing was performed by Audy Yu on 2022-07-01.

EUT operation mode: Transmitting

Test Result: Compliant.

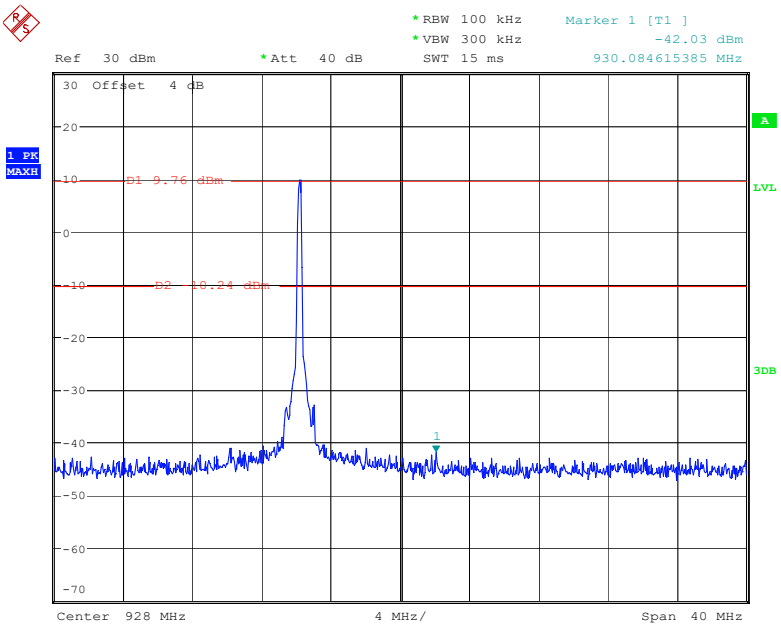
Conducted Band Edge Result:

Low



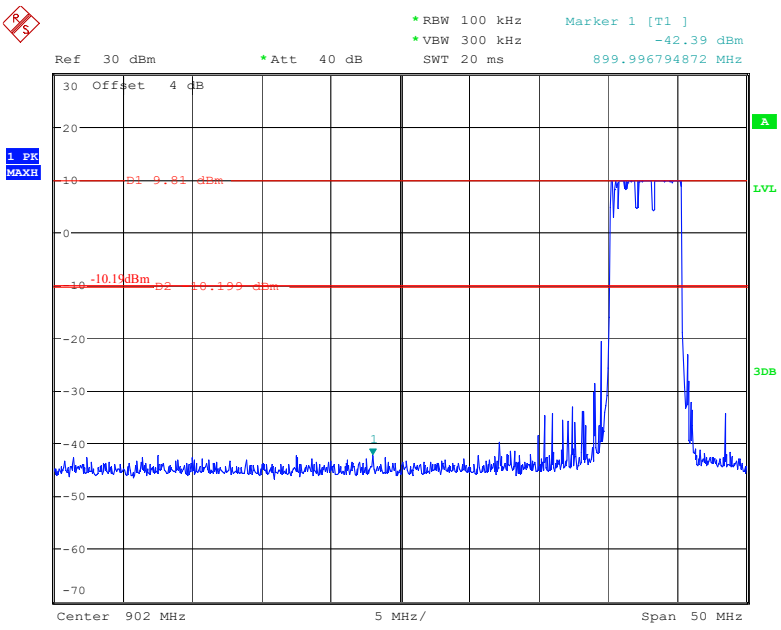
Date: 1.JUL.2022 13:29:18

High



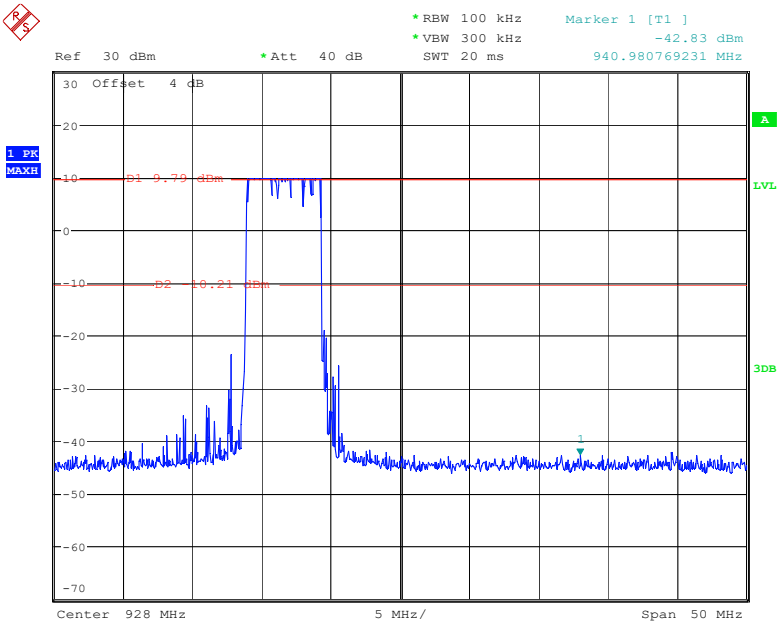
Date: 1.JUL.2022 13:52:43

Low_Hop



Date: 1.JUL.2022 14:06:12

High_Hop



Date: 1.JUL.2022 14:08:45

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