TEST REPORT

Applicant Name :	Hangzhou Roombanker Technology Co., Ltd.
Address :	A#801 Wantong center, Hangzhou, China
Report Number :	SH1220303-07083E-00B
FCC ID:	2AUXBDSGW-210B

Test Standard (s)
FCC PART 15.247

Sample Description

Product Name:	HNT Indoor Hotspot Miner
Model No.:	DSGW-210B
Date Received:	2022-03-03
Date of Test:	2022-03-07 to 2022-03-28
Report Date:	2022-03-30

Test Result:	Pass*

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

Prepared and Checked By:

Ting Lü
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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TABLE OF CONTENTS

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	HNT Indoor Hotspot Miner
Tested Model No.	DSGW-210B
Frequency Range	902.3-914.9MHz
Maximum conducted Peak output power	22.10 dBm
Modulation Technique	LoRa/Chirp Spread Spectrum
Antenna Specification*	Monopole Antenna: 2.44 dBi (provided by the applicant)
Voltage Range	DC 5.0V from adapter
Sample serial number	SH1220303-07083E-RF-S1 (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 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.

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.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		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.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016.

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.
The frequencies is F(MHz)=902.3+0.2*n (0<=n<=63). The lowest, middle, highest channel numbers of the EUT used and tested in this report are below:

Channel	Frequency (MHz)
0	902.3
32	908.7
63	914.9

EUT Exercise Software

Software “putty” was used to test and the power level is 8.

.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

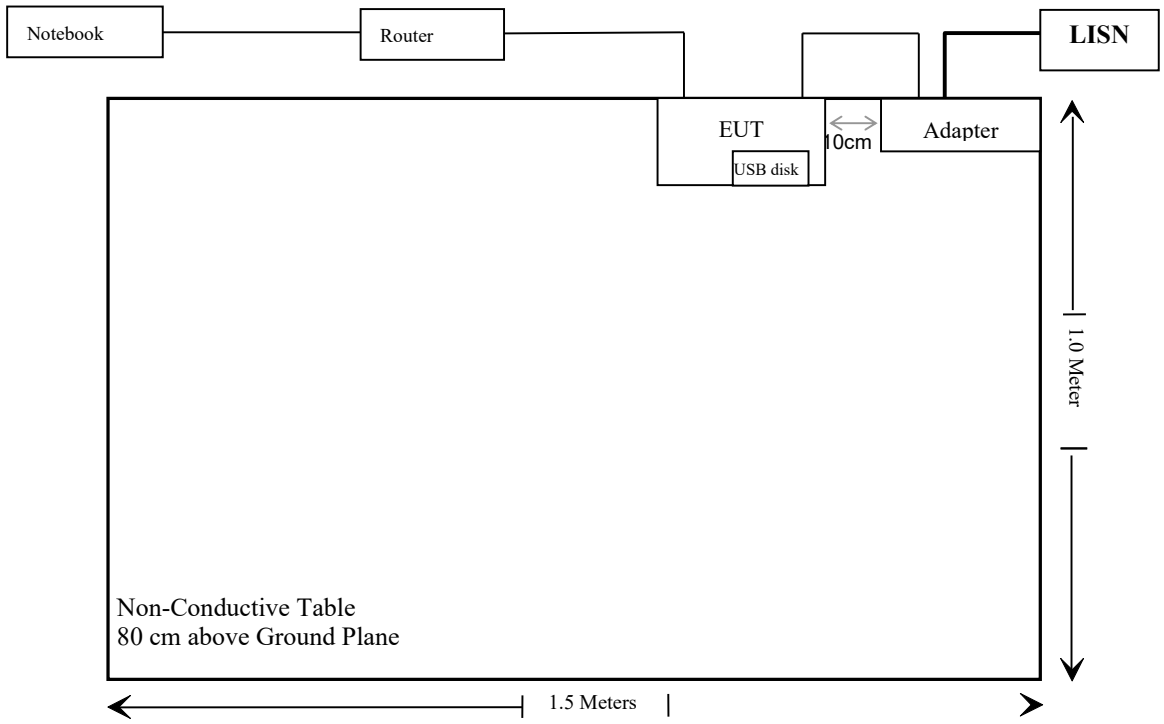
Manufacturer	Description	Model	Serial Number
Lenovo	Notebook	T430	Unknown
HUAWEI	Wireless ADSL Router	WS5100	Unknown
SanDisk	USB Disk	Unknown	Unknown
HUAWEI	Adapter	HW-100400C00CA38L1K1 810009	Unknown

External I/O Cable

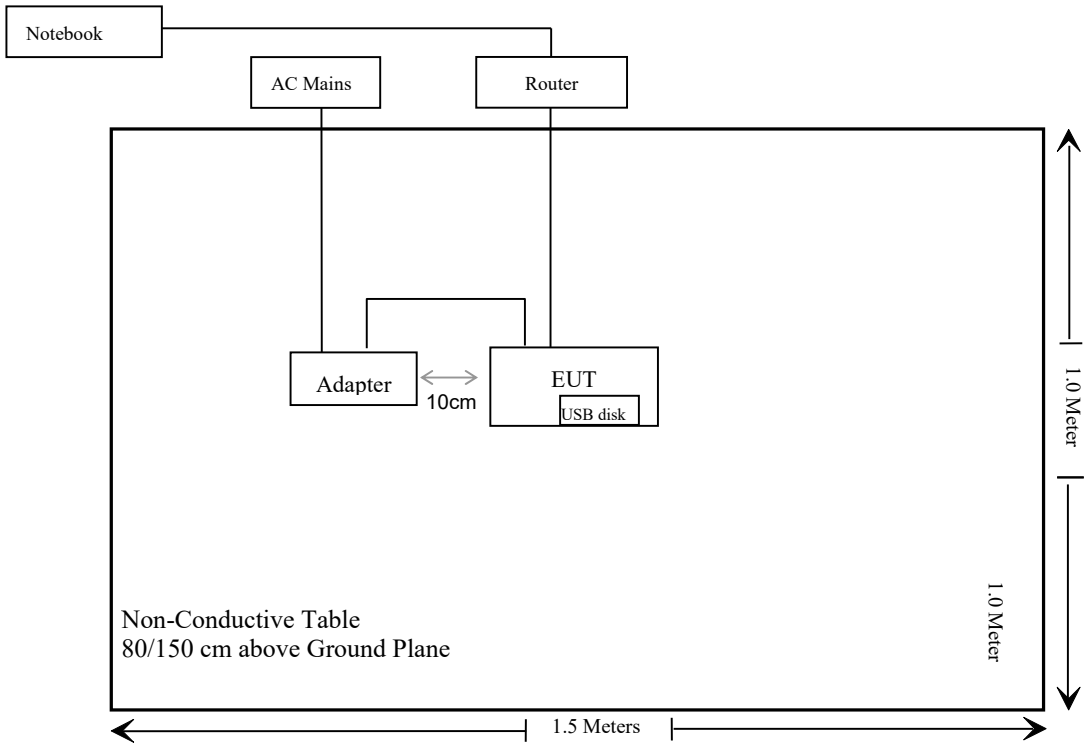
Cable Description	Length (m)	From Port	To
Power Cable	1.0	EUT	Adapter
Network cable	5.0	EUT	Router
Network cable	1.0	Notebook	Router

Block Diagram of Test Setup

For conducted emission:



For radiated emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC §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) (i)	20 dB Emission Bandwidth & 99% Occupied Bandwidth	Compliant
§15.247(a)(1)	Channel Separation Test	Compliant
§15.247(f)	Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)(i)	Quantity of hopping channel Test	Compliant
§15.247(b)(3)	Maximum conducted(average) output power	Compliant
§15.247(d)	Band edges	Compliant
§15.247(f)	Power Spectral Density of hybrid systems	Compliant

Note: the EUT is hybrid systems.

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
Unknown	Band Reject Filter	MSF880-915 MS-1149	201706003	2021/12/14	2022/12/13
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
Radiated Emission Test Software: e3 19821b (V9)					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2021/12/13	2022/12/12
WEINSCHEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Roombanker	RF Cable	Roombanker C01	C01	Each Time	N/A

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.

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/cm^2)
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)

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)			
2402-2480	3.87	2.44	6.5	4.47	20	0.0022	1
2412-2462	3.19	2.09	23	199.53	20	0.083	1
902.3-914.9	2.44	1.75	22.5	177.83	20	0.0619	0.6
923.3-927.5	2.44	1.75	27	501.19	20	0.1745	0.61

Note: 1. The tune up conducted power was declared by the applicant.
2. The BLE and Wi-Fi and Lora can transmit at the same time.

$$\sum_i \frac{S_i}{S_{Limit,i}}$$ =0.083/1+0.1745/0.61+0.0022/1=0.3713 < 1

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

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 a unique antenna port arrangement for LoRa, which was employed the antenna maximum gain is 2.44 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Type	Antenna Gain	Impedance
Monopole	2.44 dBi	50 Ω

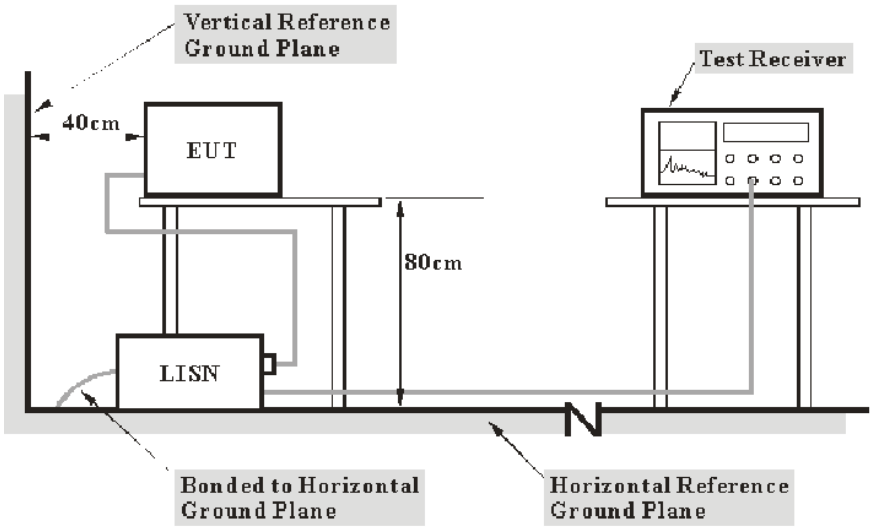
Result: Compliant.

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.

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	RBW	VBW
150 kHz – 30 MHz	9 kHz	30 kHz

Test Procedure

During the conducted emission test, the DC Source 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 margin of -7dB 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 Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

Test Data

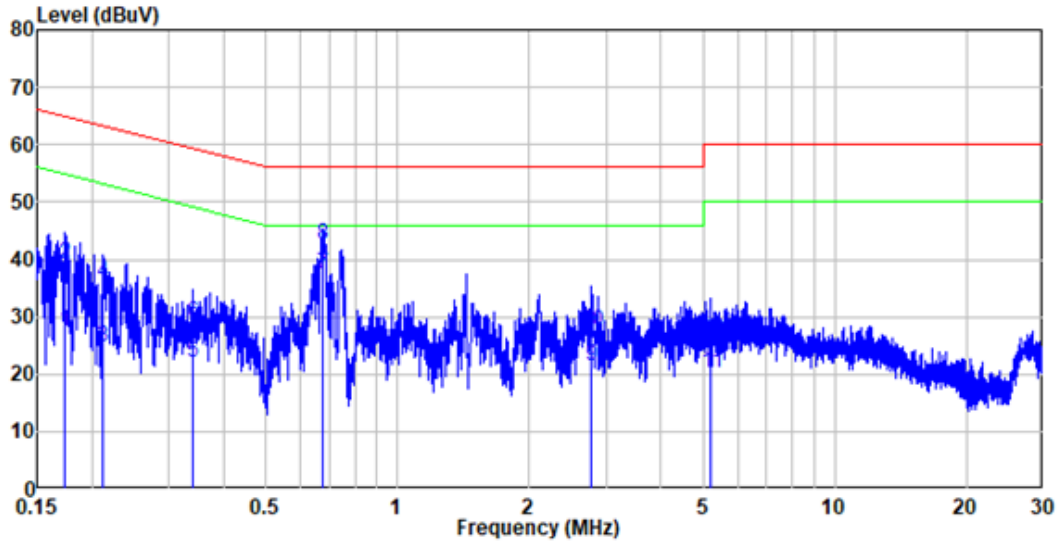
Environmental Conditions

Temperature:	23 ℃
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2022-03-08.

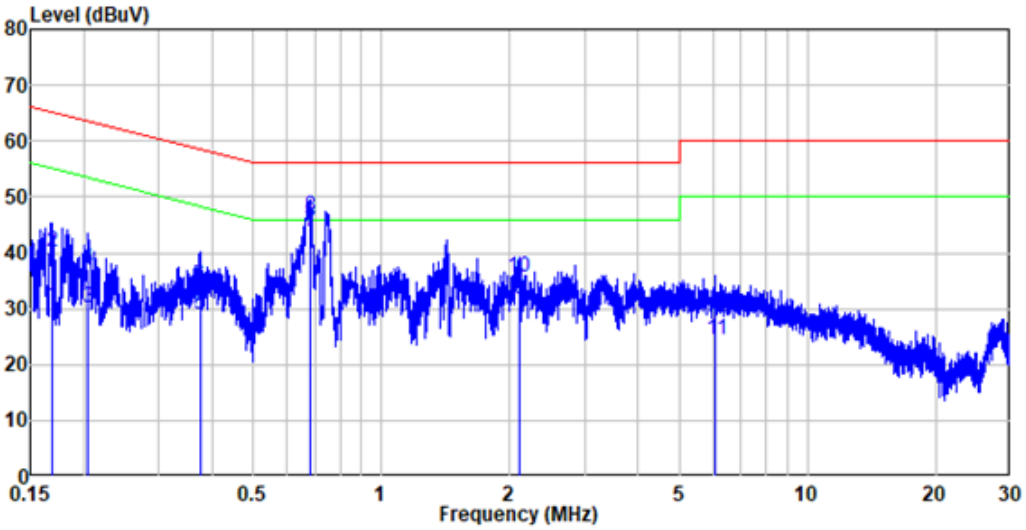
EUT operation mode: Transmitting in middle channel (worst case)

AC 120V/60 Hz, Line



No.	Frequency	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.173	9.80	17.71	27.51	54.80	-27.29	Average
2	0.173	9.80	29.30	39.10	64.80	-25.70	QP
3	0.213	9.80	14.96	24.76	53.08	-28.32	Average
4	0.213	9.80	26.12	35.92	63.08	-27.16	QP
5	0.341	9.80	12.24	22.04	49.18	-27.14	Average
6	0.341	9.80	19.24	29.04	59.18	-30.14	QP
7	0.678	9.81	27.52	37.33	46.00	-8.67	Average
8	0.678	9.81	32.82	42.63	56.00	-13.37	QP
9	2.778	9.83	11.70	21.53	46.00	-24.47	Average
10	2.778	9.83	17.63	27.46	56.00	-28.54	QP
11	5.232	9.85	10.51	20.36	50.00	-29.64	Average
12	5.232	9.85	16.05	25.90	60.00	-34.10	QP

AC 120V/60 Hz, Neutral



No.	Frequency	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.168	9.80	20.75	30.55	55.05	-24.50	Average
2	0.168	9.80	30.33	40.13	65.05	-24.92	QP
3	0.205	9.80	20.26	30.06	53.40	-23.34	Average
4	0.205	9.80	27.24	37.04	63.40	-26.36	QP
5	0.375	9.80	19.18	28.98	48.39	-19.41	Average
6	0.375	9.80	24.25	34.05	58.39	-24.34	QP
7	0.683	9.81	33.93	43.74	46.00	-2.26	Average
8	0.683	9.81	36.72	46.53	56.00	-9.47	QP
9	2.103	9.82	22.01	31.83	46.00	-14.17	Average
10	2.103	9.82	25.84	35.66	56.00	-20.34	QP
11	6.105	9.94	14.64	24.58	50.00	-25.42	Average
12	6.105	9.94	18.50	28.44	60.00	-31.56	QP

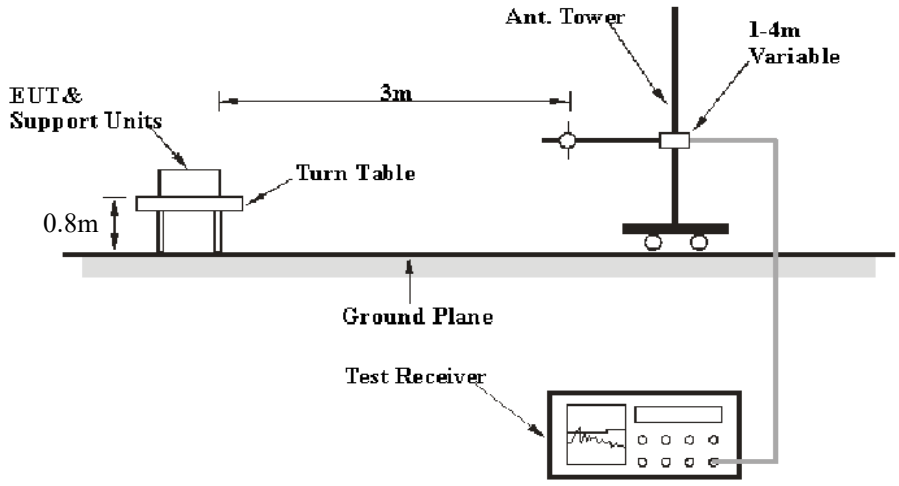
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

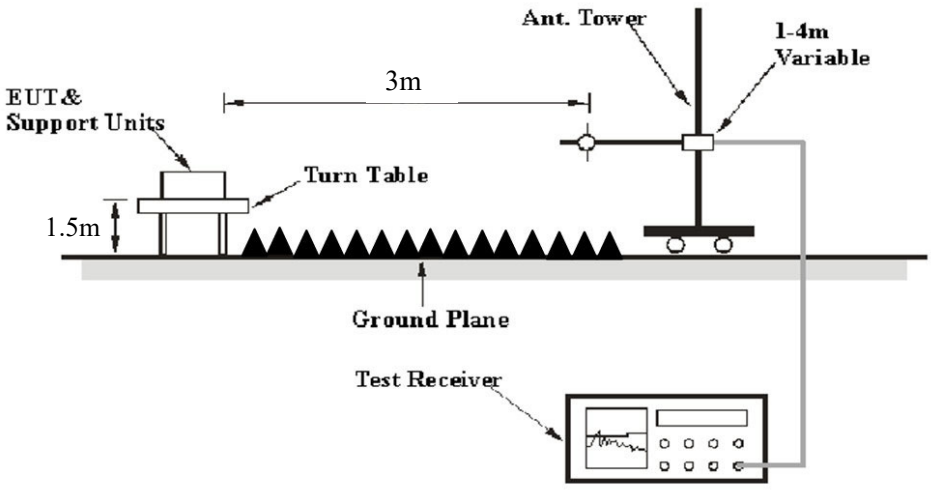
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, 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	VBW	Measurement
30 MHz – 1000 MHz	100 kHz	300 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.

Factor & Margin Calculation

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

Factor/Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain

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

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

Test Data

Environmental Conditions

Temperature:	23℃
Relative Humidity:	51%
ATM Pressure:	101.7kPa

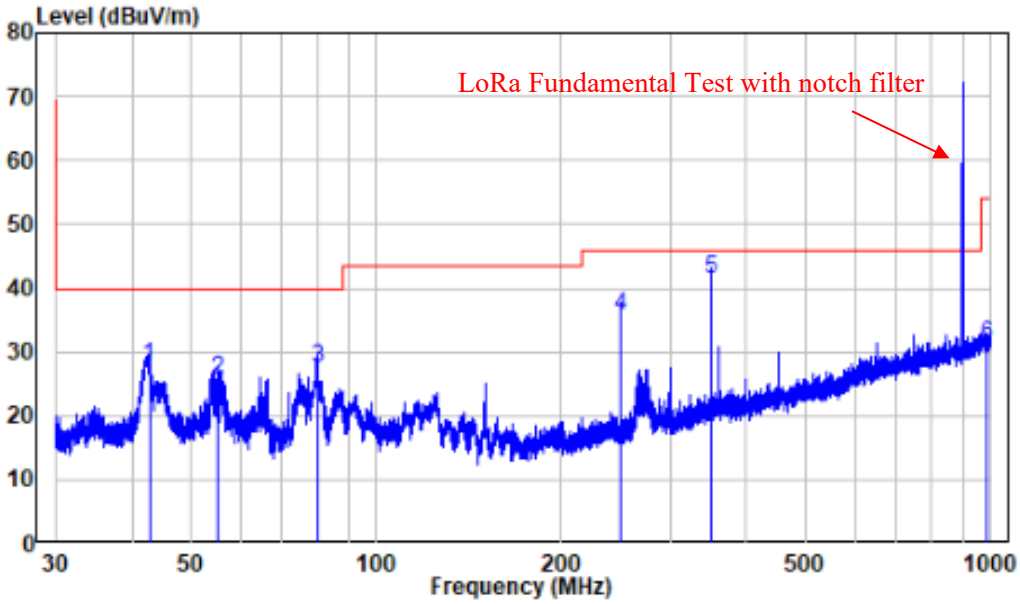
The testing was performed by Paul Liu on 2022-03-08.

EUT operation mode: Transmitting in middle channel (worst case)

30MHz-1GHz:

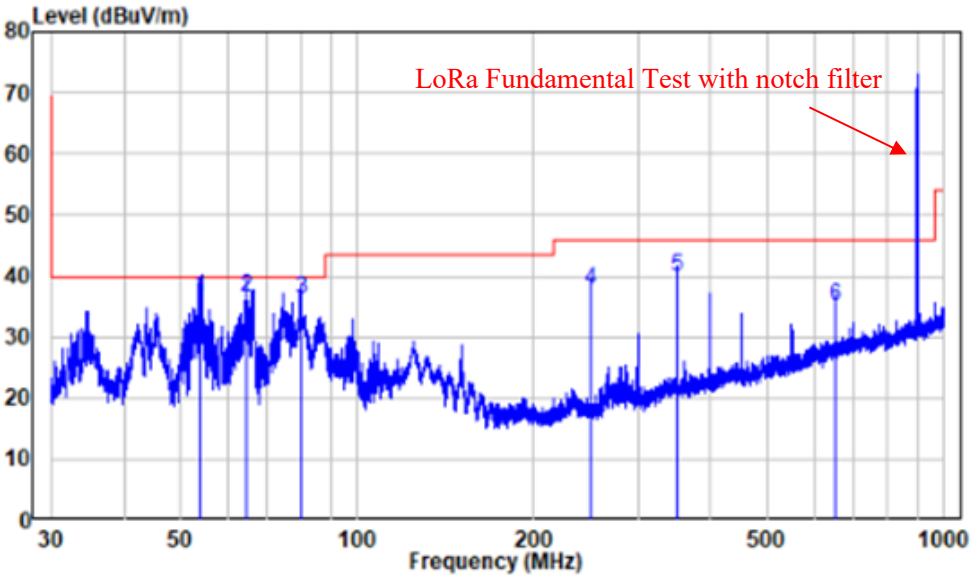
*Pre-scan in the X, Y and Z axes of orientation, the worst case **in X-axis of orientation** was recorded*

Horizontal



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	42.675	-9.98	37.64	27.66	40.00	-12.34	QP
2	55.293	-10.26	35.94	25.68	40.00	-14.32	QP
3	80.010	-16.79	44.40	27.61	40.00	-12.39	QP
4	249.972	-10.74	46.47	35.73	46.00	-10.27	QP
5	350.016	-7.31	48.54	41.23	46.00	-4.77	QP
6	986.937	2.76	28.22	30.98	54.00	-23.02	QP

Vertical



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	53.858	-10.32	46.76	36.44	40.00	-3.56	QP
2	64.773	-12.43	48.89	36.46	40.00	-3.54	QP
3	80.010	-16.79	53.10	36.31	40.00	-3.69	QP
4	249.972	-10.74	48.43	37.69	46.00	-8.31	QP
5	350.016	-7.31	47.04	39.73	46.00	-6.27	QP
6	650.229	-1.72	36.72	35.00	46.00	-11.00	QP

1-10GHz (worst case):

Frequency (MHz)	Receiver		Turntable Angle	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PeaK/OP/AV	Degree	Height (m)	Polar (H/V)				
Low Channel									
1804.60	49.03	PK	160	1.7	H	-8.73	40.30	74	-33.70
1804.60	48.93	PK	335	2.2	V	-8.73	40.20	74	-33.80
Middle Channel									
1817.40	48.22	PK	255	1.8	H	-8.63	39.59	74	-34.41
1817.40	47.74	PK	58	2.2	V	-8.63	39.11	74	-34.89
High Channel									
1829.80	47.47	PK	312	2.1	H	-8.53	38.94	74	-35.06
1829.80	47.04	PK	112	1.9	V	-8.53	38.51	74	-35.49

Bandedge Emissions Test:

Frequency (MHz)	Receiver		Turntable Angle	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PeaK/OP/AV	Degree	Height (m)	Polar (H/V)				
Low Channel									
902.30	120.52	PK	160	1.2	H	1.37	121.89	--	--
902.30	110.94	PK	324	1.1	V	1.37	112.31	--	--
902.00	83.57	PK	189	1.2	H	1.37	84.94	101.89	-16.95
902.00	73.90	PK	258	1.1	V	1.37	75.27	92.31	-17.04
High Channel									
914.90	119.61	PK	118	1.2	H	1.50	121.11	--	--
914.90	110.18	PK	210	1	V	1.50	111.68	--	--
928.00	31.94	PK	312	1.2	H	1.62	33.56	101.11	-67.55
928.00	31.65	PK	336	1	V	1.62	33.27	91.68	-58.41

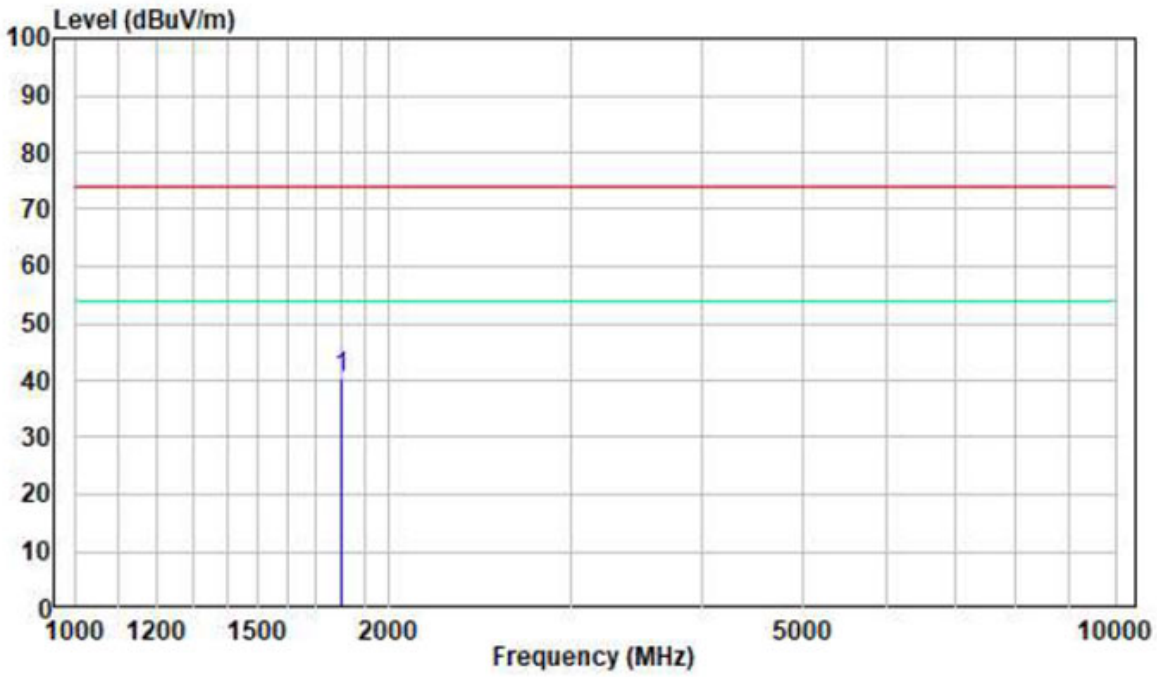
Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Absolute Level (Corrected Amplitude) = Factor + Reading
Margin = Absolute Level - Limit
The other spurious emission which is in the noise floor level was not recorded.
For above 1GHz, the test result of peak was 20dB below to the limit of peak, which can be compliant to the average limit, so just peak value was recorded.

1-10 GHz: (Pre-Scan plots for Worst case)

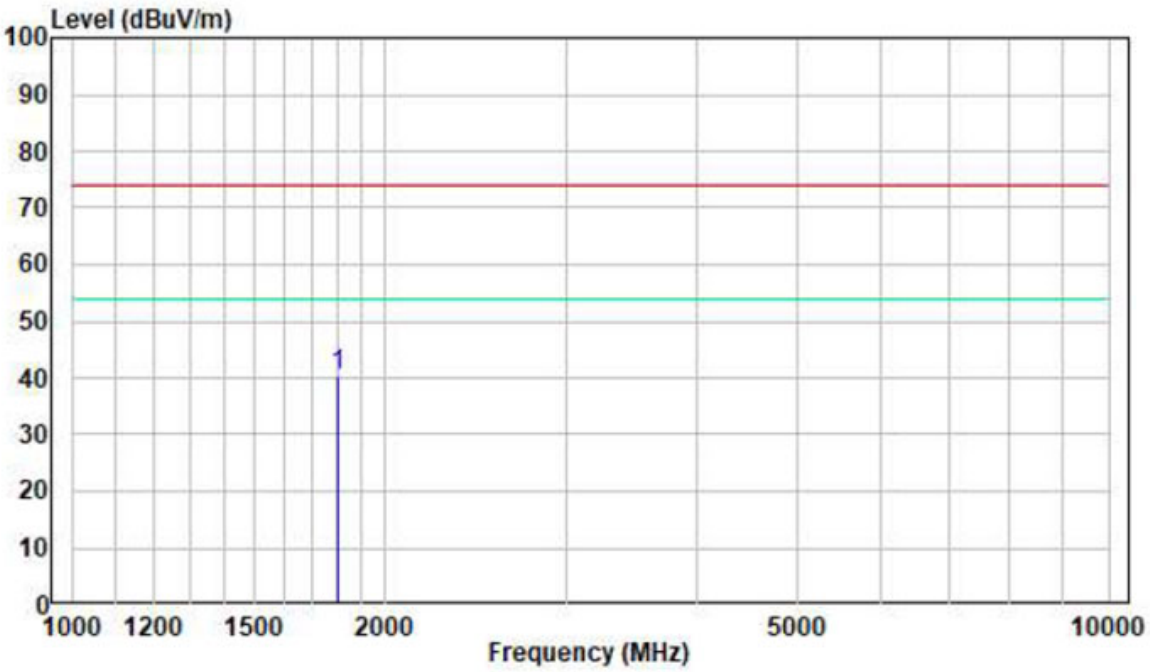
*Pre-scan in the X, Y and Z axes of orientation, the worst case **X-axis of orientation** was recorded.*

Low Channel

Horizontal



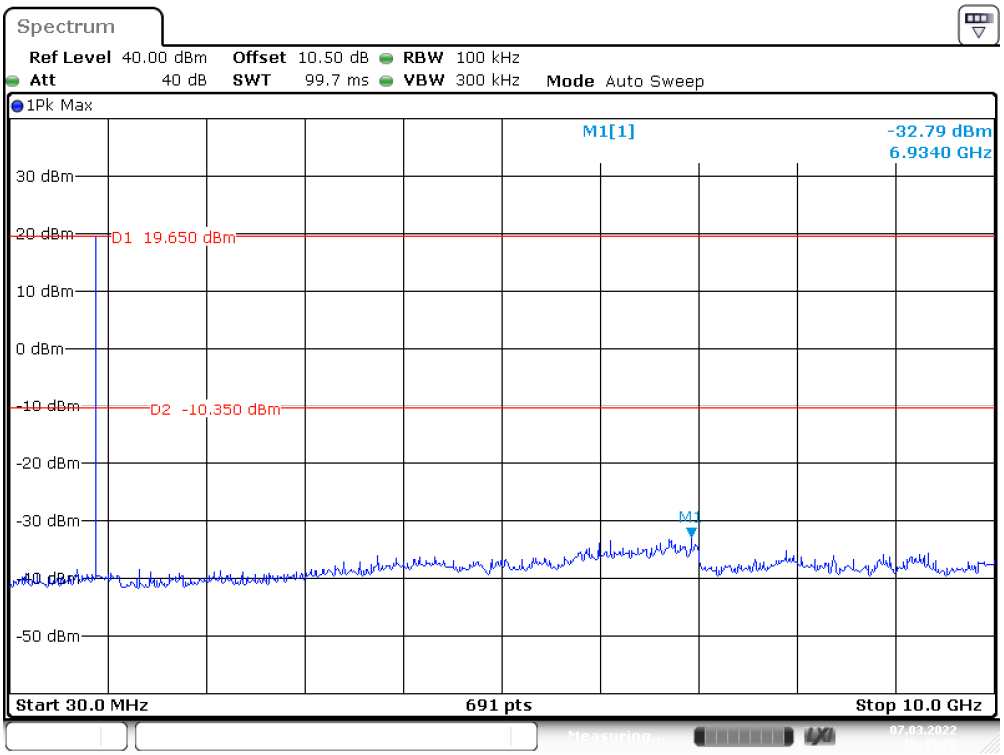
Vertical


Level (dBuV/m)
100
90
80
70
60
50
40
30
20
10
0
1
1000
1200
1500
2000
5000
10000
Frequency (MHz)

Conducted spurious emissions:

Low Channel:

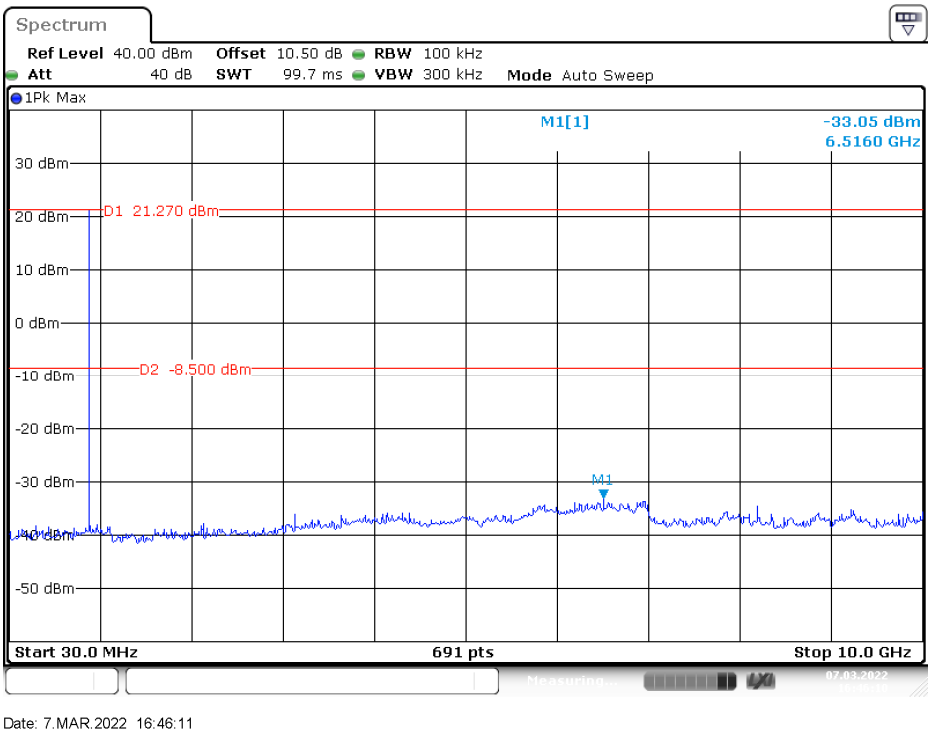
30 MHz-10 GHz:



Date: 7.MAR.2022 16:45:28

Middle Channel:

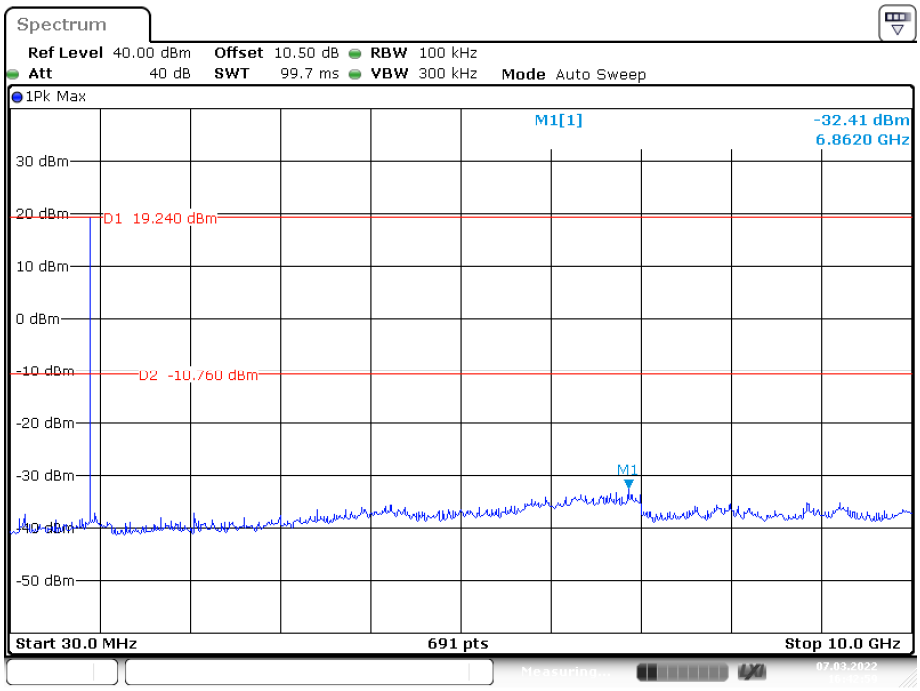
30 MHz-10 GHz:



Date: 7.MAR.2022 16:46:11

High Channel:

30 MHz-10 GHz:



Date: 7.MAR.2022 16:42:59

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.

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	23 ℃
Relative Humidity:	52 %
ATM Pressure:	102.0 kPa

The testing was performed by Paul Liu on 2022-03-07.

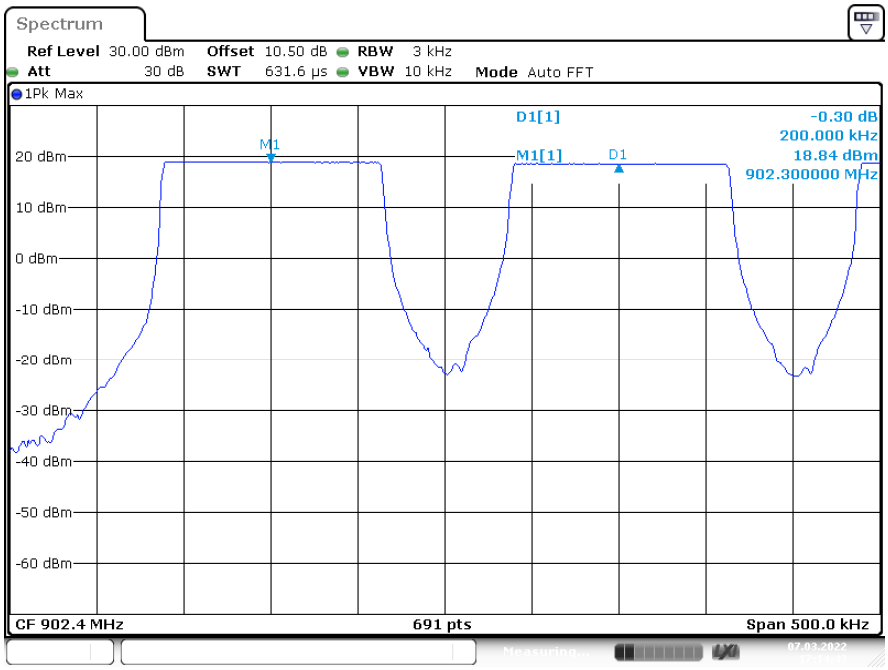
EUT operation mode: Transmitting

Test Result: Compliant.

Channel	Frequency [MHz]	Channel Separation [MHz]	Limit[MHz]	Verdict
Low	902.3	0.200	>=0.136	PASS
Adjacent	902.5			
Middle	908.7	0.200	>=0.138	PASS
Adjacent	908.9			
High	914.9	0.200	>=0.140	PASS
Adjacent	914.7			

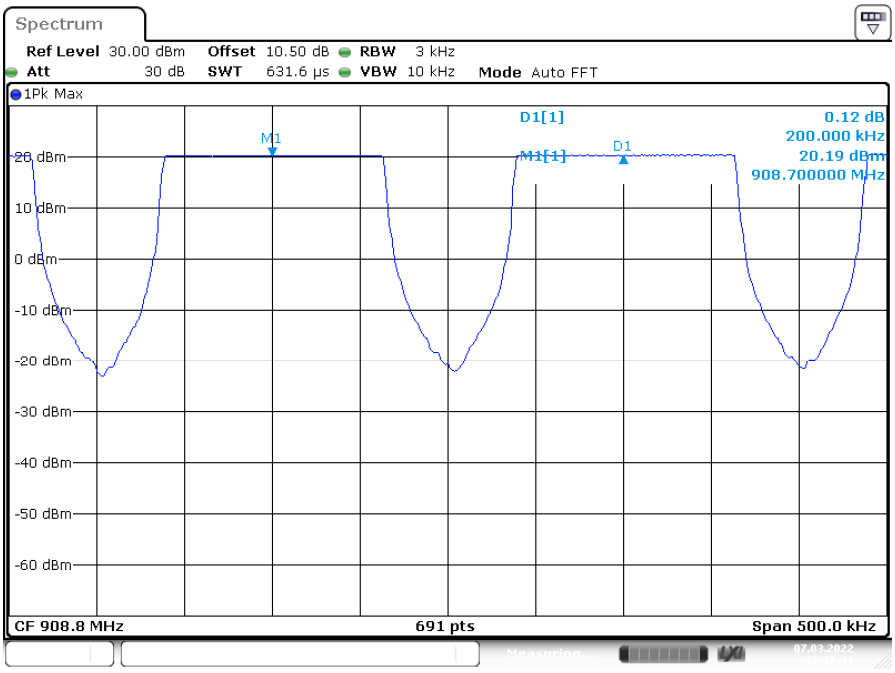
Please refer to the below plots:

902.3 MHz - 902.5 MHz



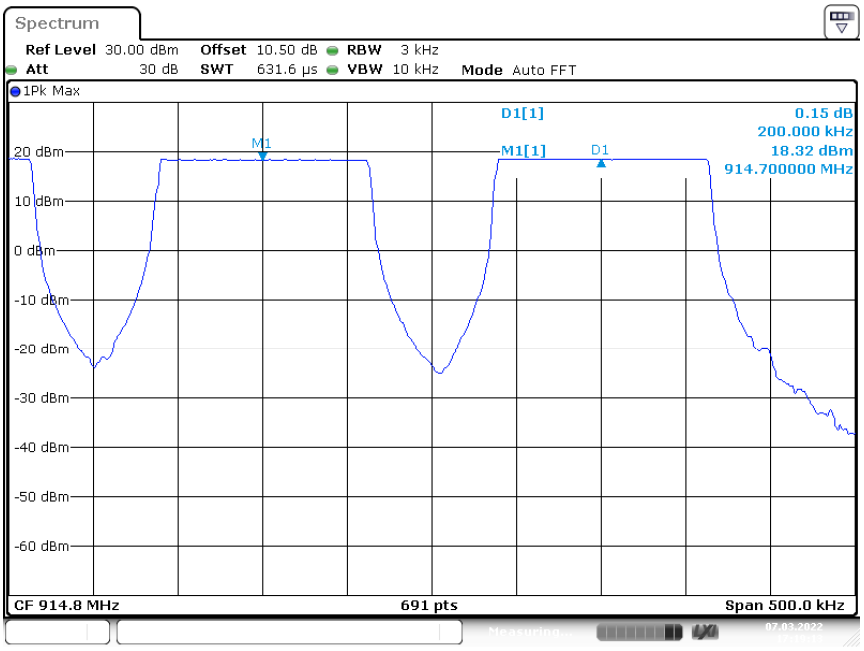
Date: 7.MAR.2022 17:14:43

908.7 MHz - 908.9MHz



Date: 7.MAR.2022 17:17:41

914.7MHz - 914.9 MHz



Date: 7.MAR.2022 17:19:13

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED 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

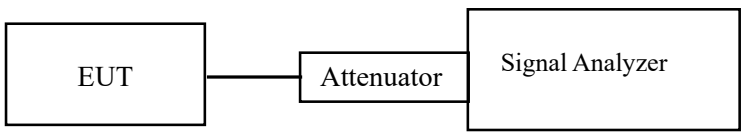
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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:	23 ℃
Relative Humidity:	51 %
ATM Pressure:	102.0 kPa

The testing was performed by Paul Liu on 2022-03-07.

EUT operation mode: Transmitting

Test Result: Compliant.

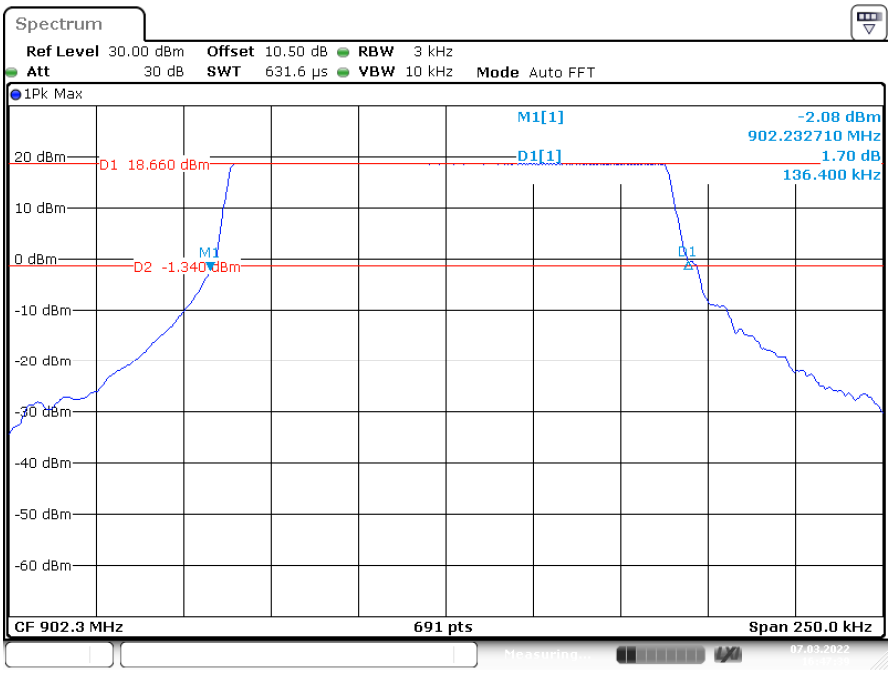
Channel	20db EBW [MHz]	Limit [MHz]	Verdict
Low	0.136	<=0.25	PASS
Middle	0.138	<=0.25	PASS
High	0.140	<=0.25	PASS

Channel	99% OBW [MHz]	Limit [MHz]	Verdict
Low	0.126	---	PASS
Middle	0.126	---	PASS
High	0.126	---	PASS

Please refer to the below plots:

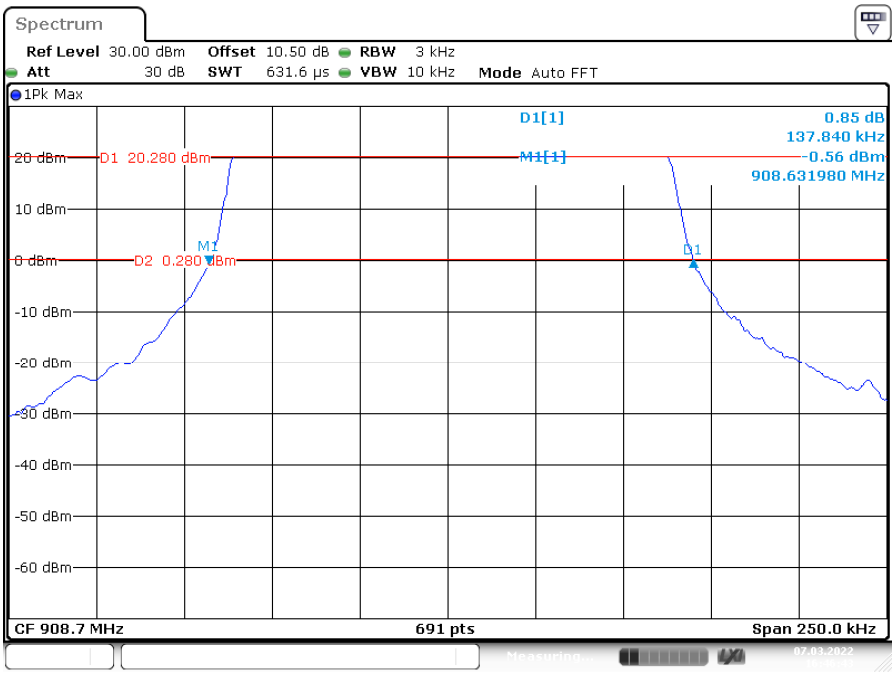
20 dB EMISSION BANDWIDTH

Low Channel: 902.3 MHz



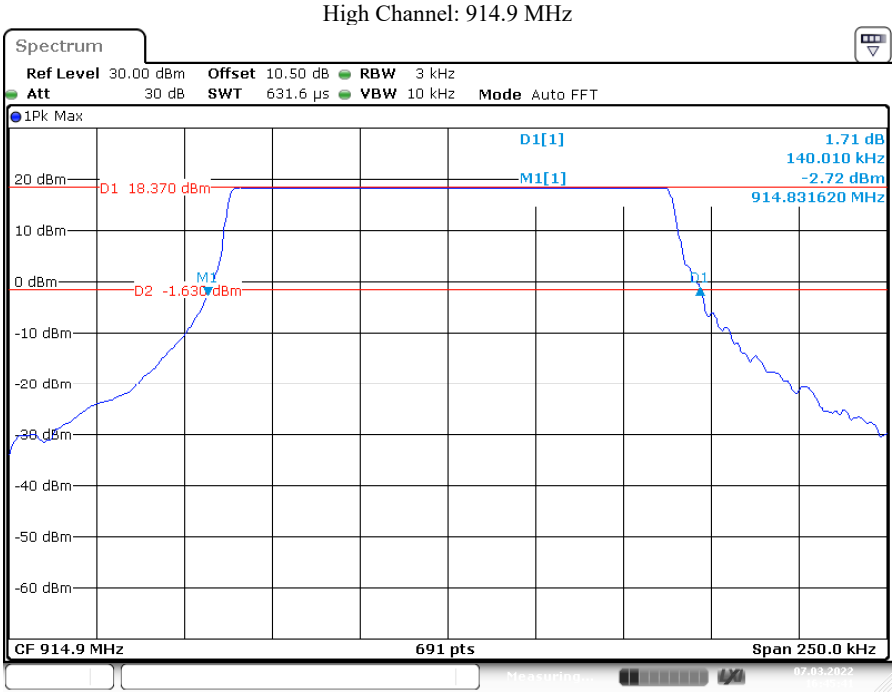
Date: 7.MAR.2022 16:47:40

Middle Channel: 908.7 MHz



Date: 7.MAR.2022 16:46:42

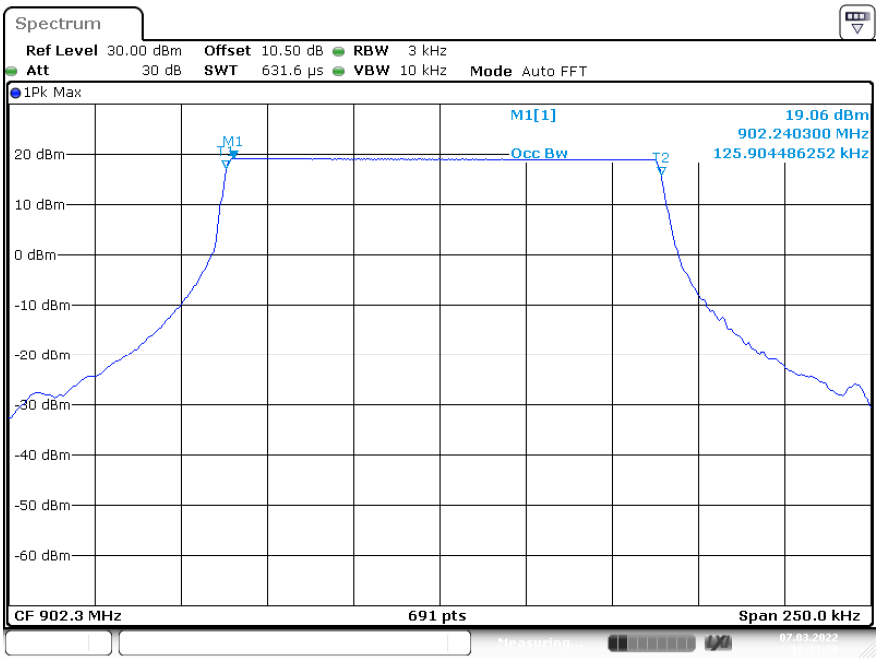
High Channel: 914.9 MHz



Date: 7.MAR.2022 16:45:41

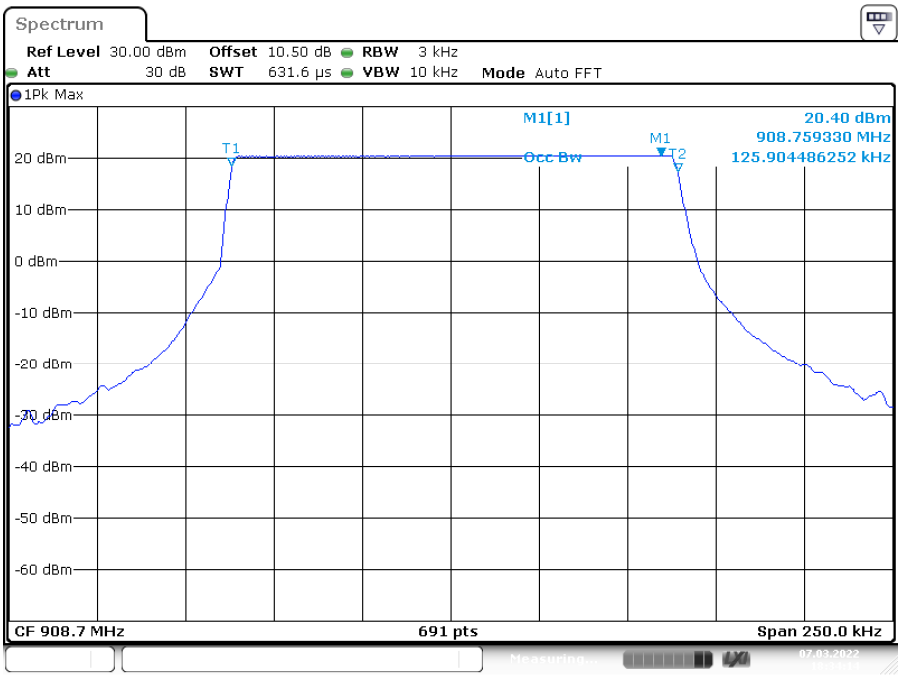
99% OCCUPIED BANDWIDTH

Low Channel: 902.3 MHz



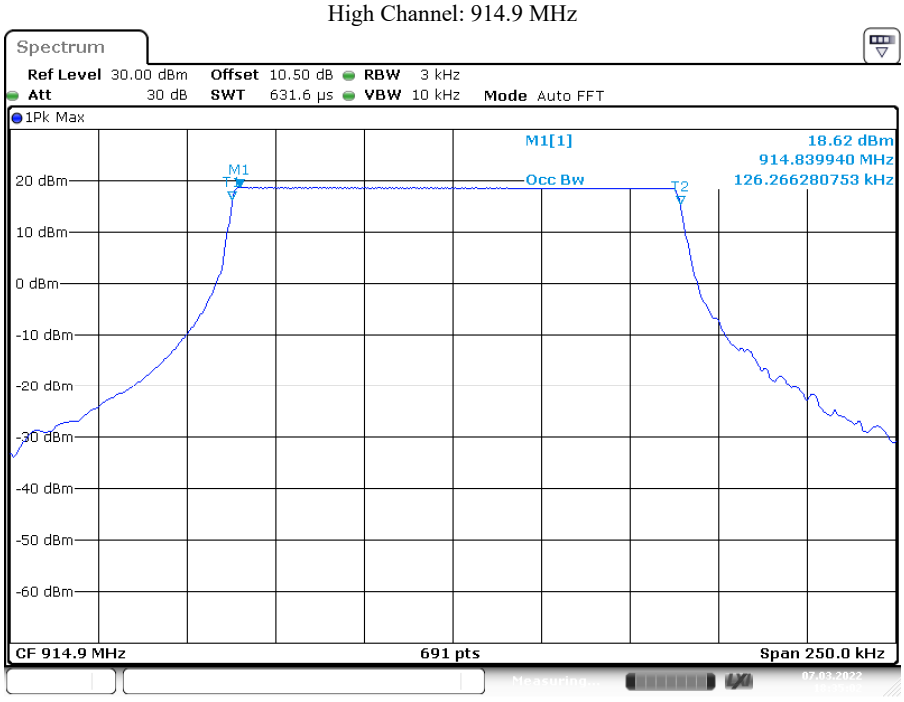
Date: 7.MAR.2022 18:33:30

Middle Channel: 908.7 MHz



Date: 7.MAR.2022 18:34:14

High Channel: 914.9 MHz



Date: 7.MAR.2022 18:35:02

FCC §15.247(a) (1) (iii)-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:	24.5 ℃
Relative Humidity:	53 %
ATM Pressure:	102.0 kPa

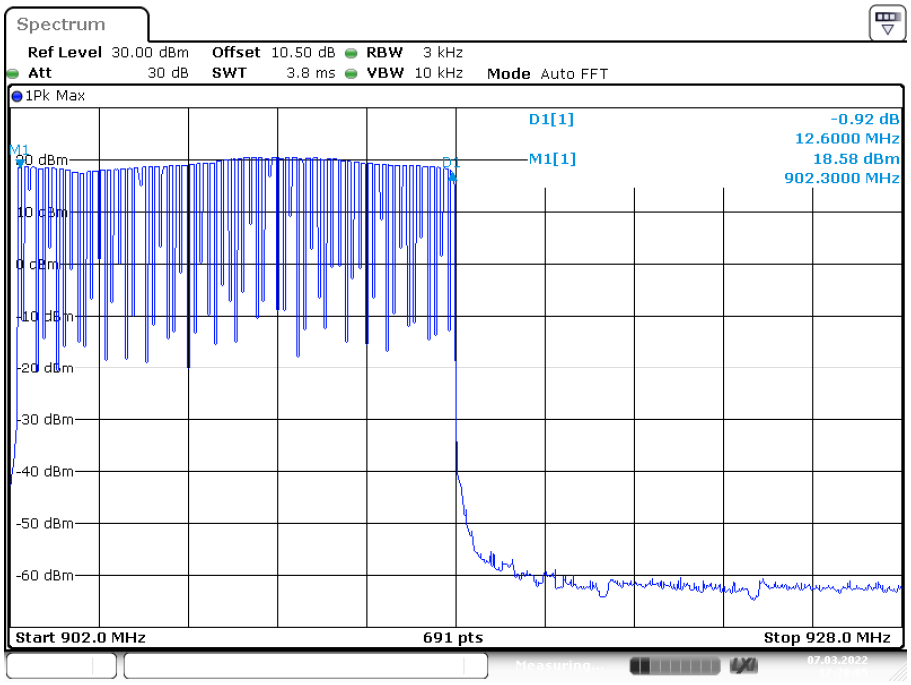
The testing was performed by Paul Liu on 2022-03-07.

EUT operation mode: Transmitting

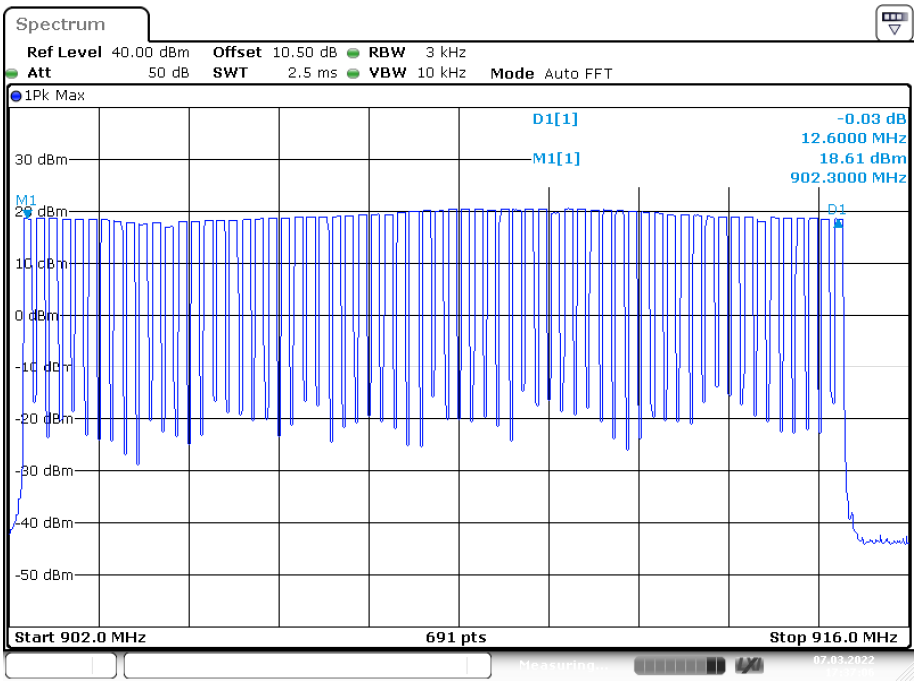
Test Result: Compliant.

Frequency Range [MHz]	Result [Num]	Verdict
902~928MHz	64	PASS

902-928 MHz



Date: 7.MAR.2022 17:28:05



Date: 7.MAR.2022 17:37:07

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

Applicable Standard

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

1. The EUT was worked in channel hopping.
2. Set the RBW to: 500 kHz.
3. Set the VBW ≥ 4×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:	23 ℃ ~ 25℃
Relative Humidity:	49 % ~ 51 %
ATM Pressure:	101.0 kPa ~ 102.0 kPa

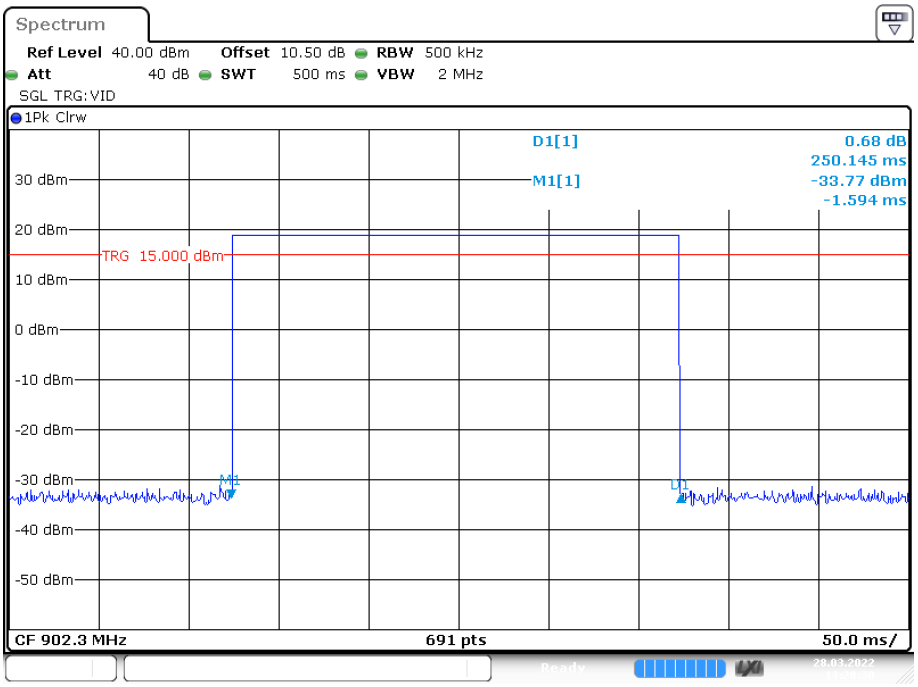
The testing was performed by Paul Liu on 2022-03-28.

EUT operation mode: Transmitting

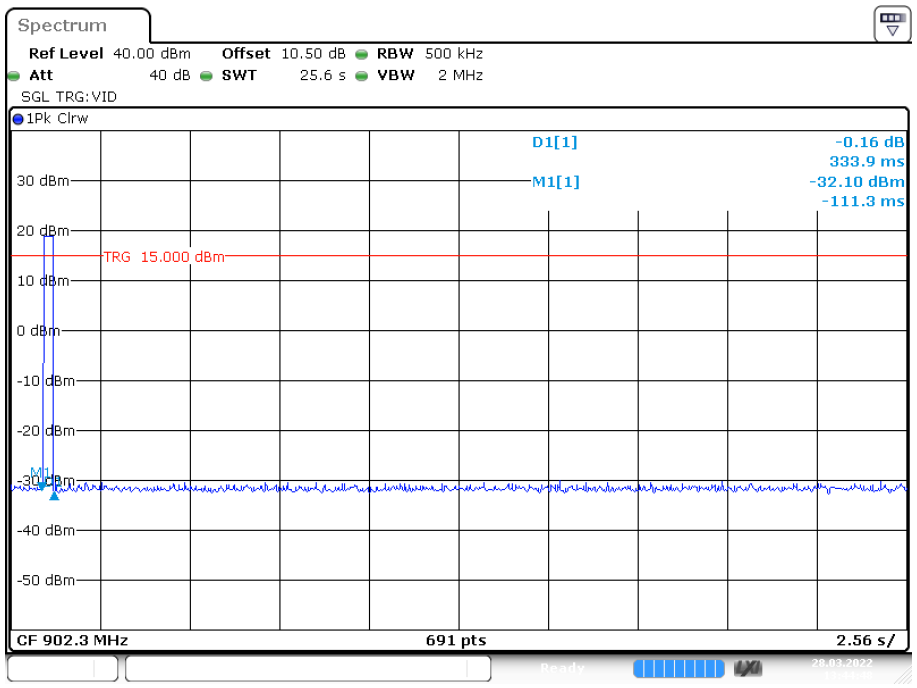
Test Result: Compliant.

Channel	Dwell Time [s]	Limit [s]	Verdict
Low	0.250	<=0.4	PASS
Middle	0.250	<=0.4	PASS
High	0.251	<=0.4	PASS

Low Channel: 902.3 MHz

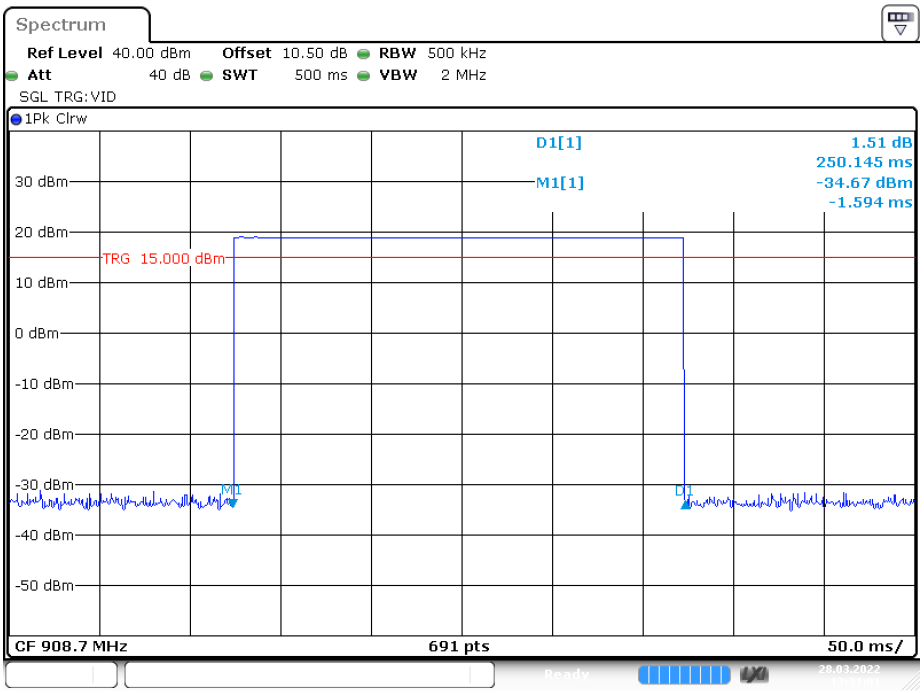


Date: 28.MAR.2022 13:28:31

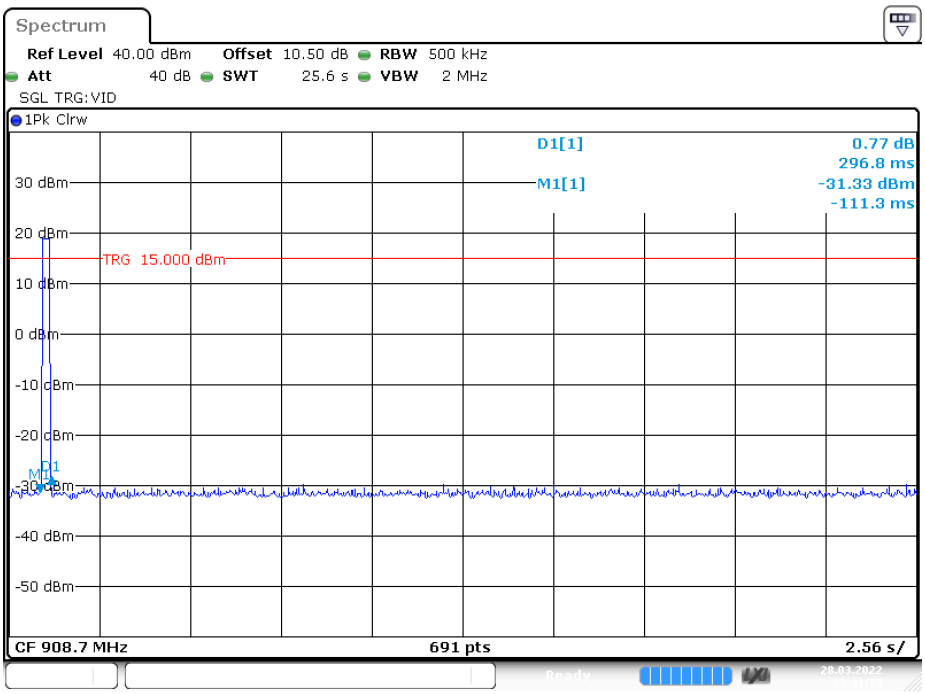


Date: 28.MAR.2022 13:44:48

Middle Channel: 908.7 MHz

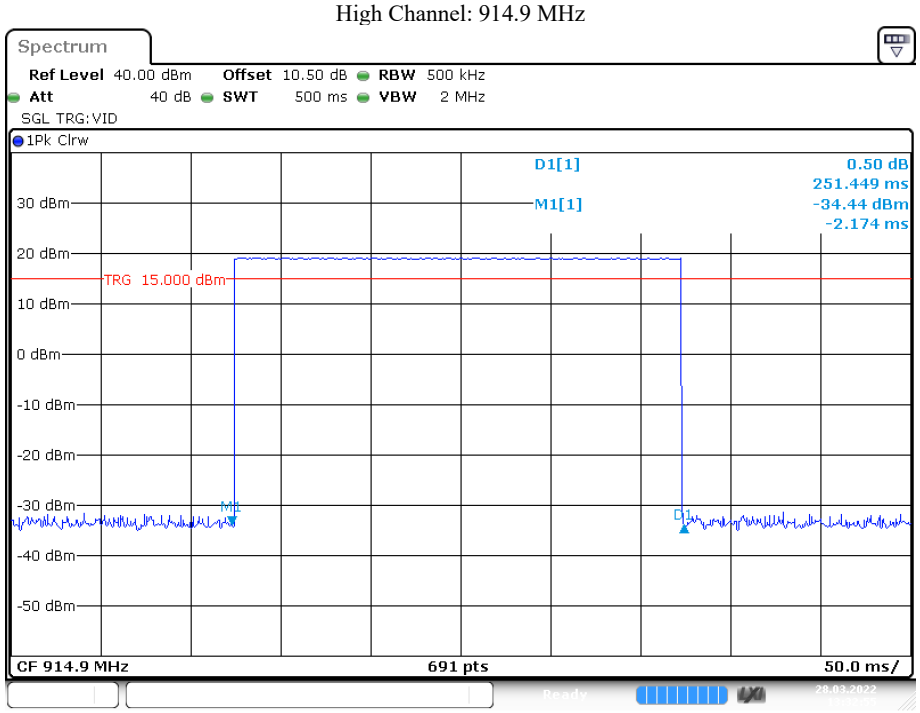


Date: 28.MAR.2022 13:31:02

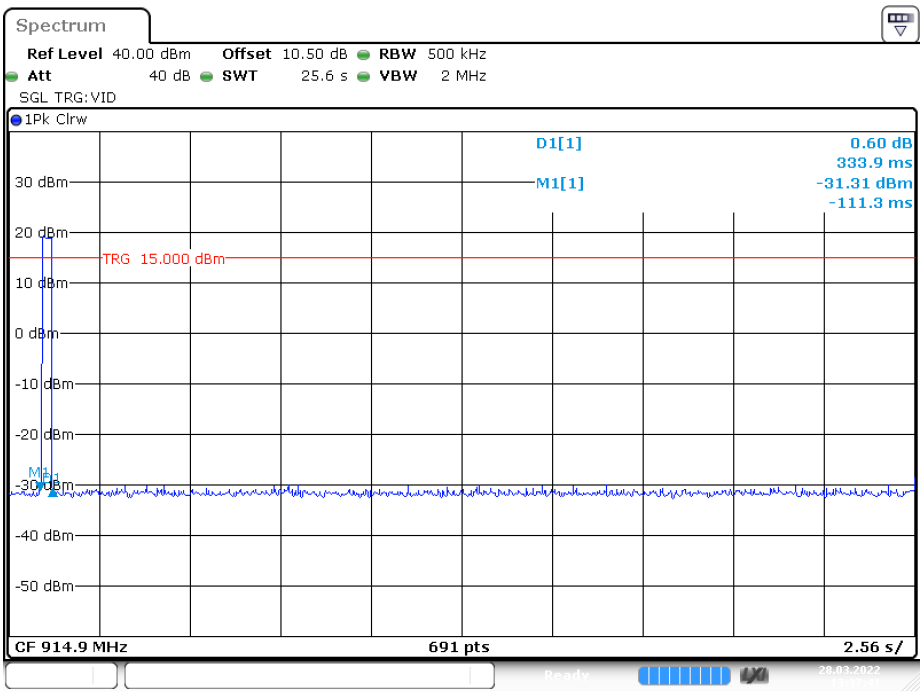


Date: 28.MAR.2022 13:41:36

High Channel: 914.9 MHz



Date: 28.MAR.2022 13:32:55



Date: 28.MAR.2022 13:37:41

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

Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, Compliant 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

a) Set span to at least 1.5 times the OBW.
b) Set RBW = 1% to 5% of the OBW, not to exceed 1 MHz.
c) Set VBW ≥ [3 × RBW].
d) Number of points in sweep ≥ [2 × span / RBW]. (This gives bin-to-bin spacing ≤ RBW / 2, so that narrowband signals are not lost between frequency bins.)
e) Manually set sweep time ≥ [10 × (number of points in sweep) × (transmission symbol period)], but not less than the automatic default sweep time.
f) Set detector = RMS (power averaging).
g) The EUT shall be operated at ≥98% duty cycle or sweep triggering/signal gating shall be employed such that the sweep time is less than or equal to the transmission duration *T*.
h) Perform a single sweep.
i) Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, then sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

Test Data

Environmental Conditions

Temperature:	23.5 ℃
Relative Humidity:	49%
ATM Pressure:	102.0 kPa

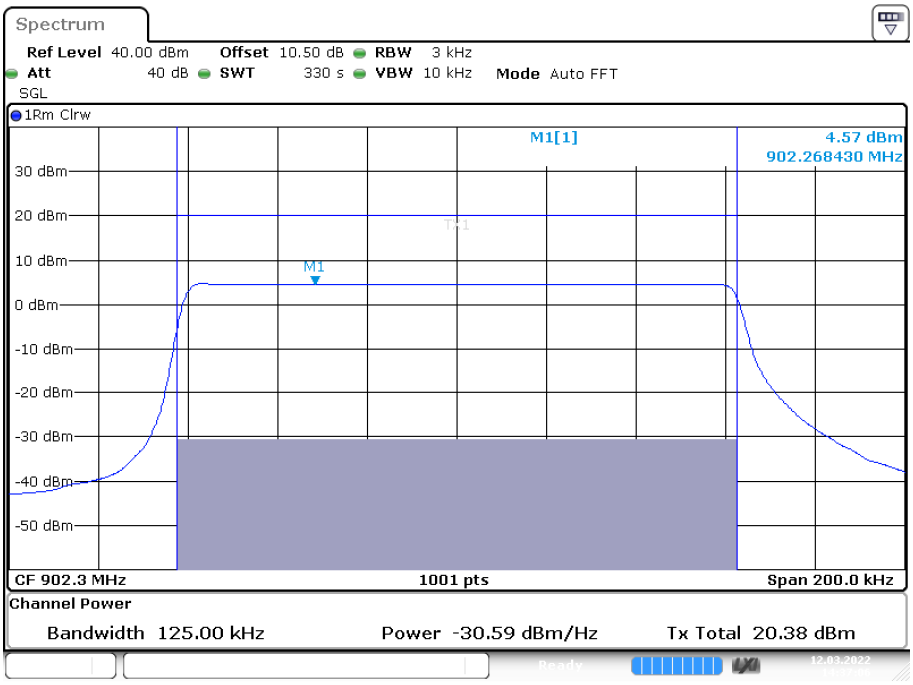
The testing was performed by Paul Liu on 2022-03-12.

EUT operation mode: Transmitting

Test Result: Compliant.

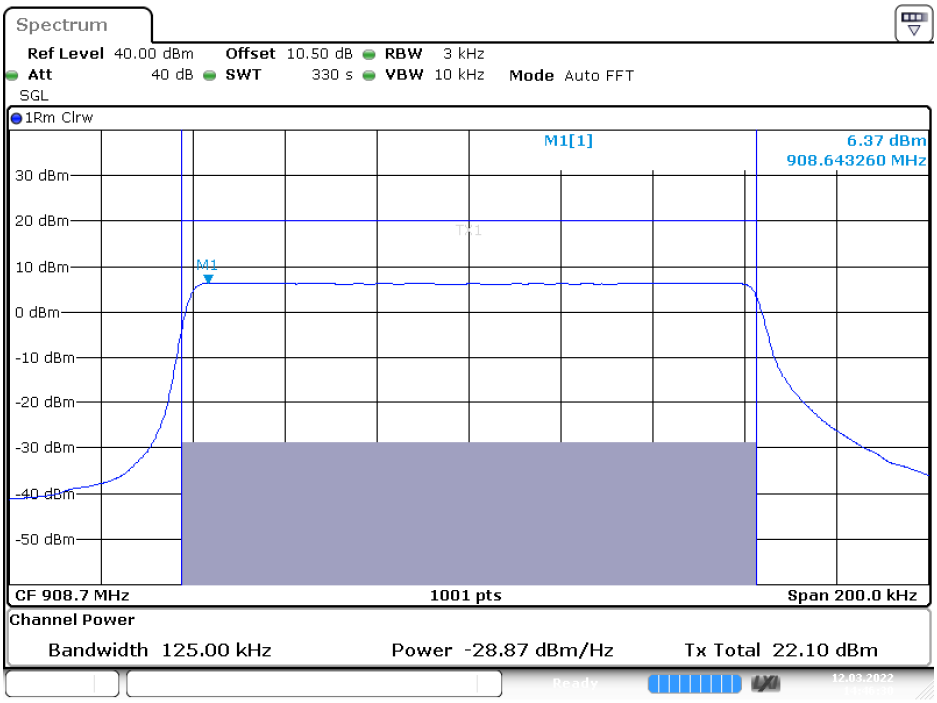
Channel	Result [dBm]	Limit [dBm]	Verdict
Low	20.38	<=30	PASS
Middle	22.10	<=30	PASS
High	20.23	<=30	PASS

Low Channel: 902.3 MHz



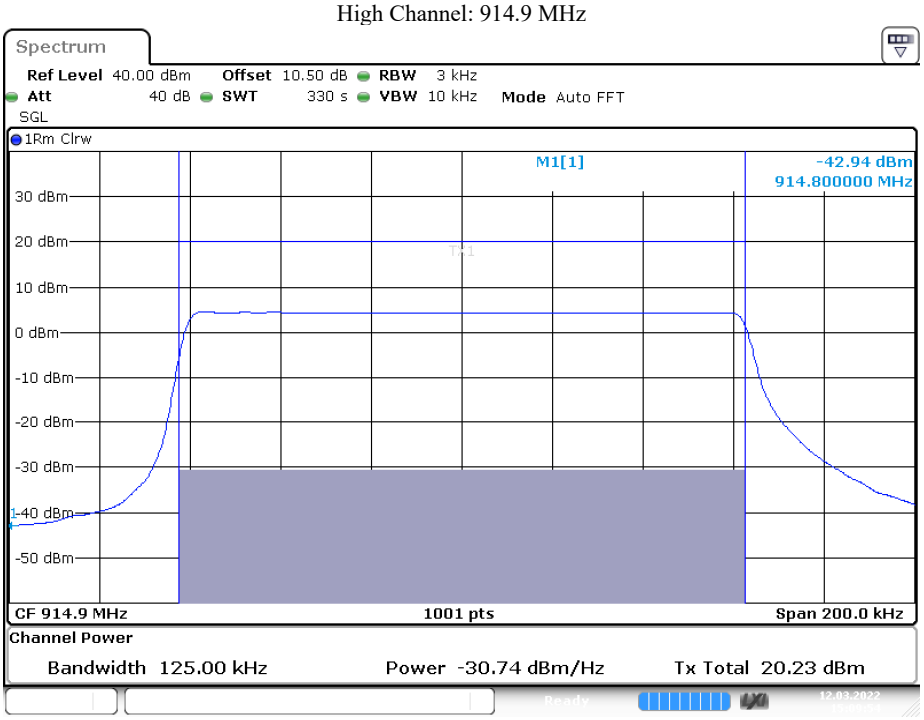
Date: 12.MAR.2022 14:37:07

Middle Channel: 908.7 MHz



Date: 12.MAR.2022 14:46:31

High Channel: 914.9 MHz



Date: 12.MAR.2022 15:09:54

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:	23.8 ℃
Relative Humidity:	51 %
ATM Pressure:	102.0 kPa

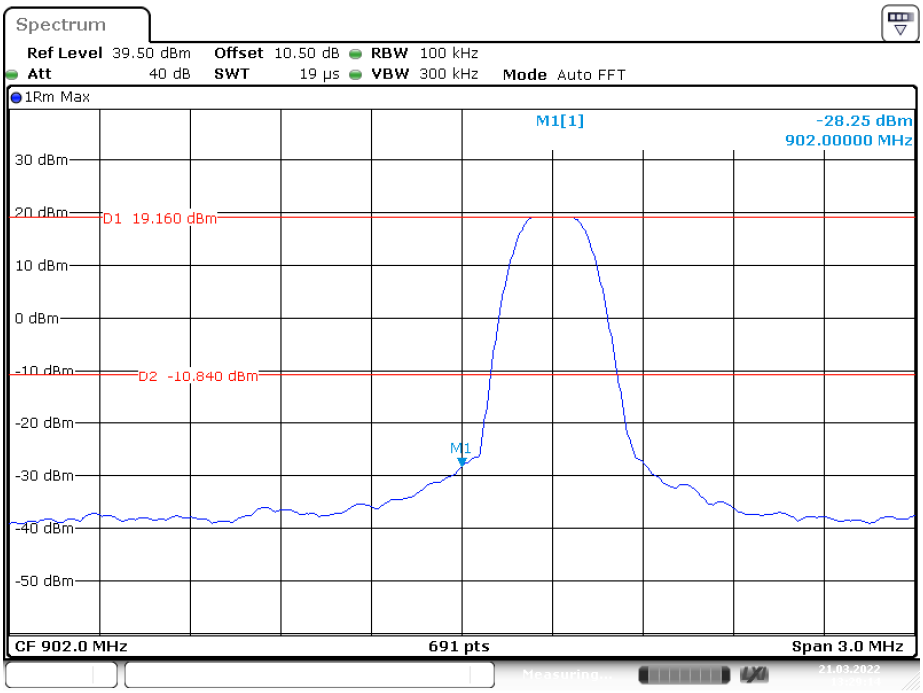
The testing was performed by Paul Liu on 2022-03-21

EUT operation mode: Transmitting

Test Result: Compliant.

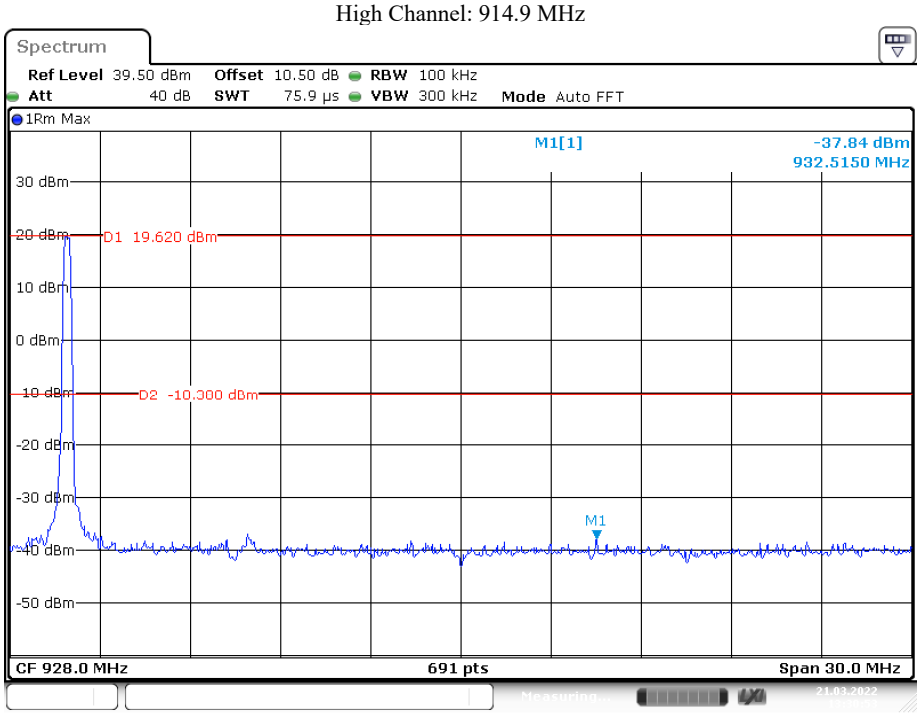
Conducted Band Edge Result:

Low Channel: 902.3 MHz



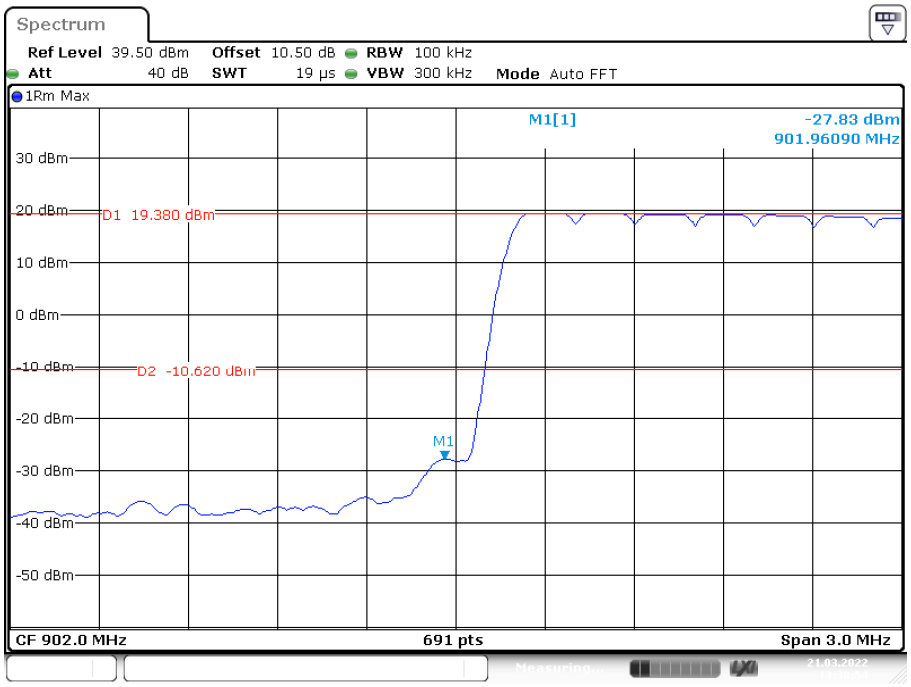
Date: 21.MAR.2022 13:29:15

High Channel: 914.9 MHz



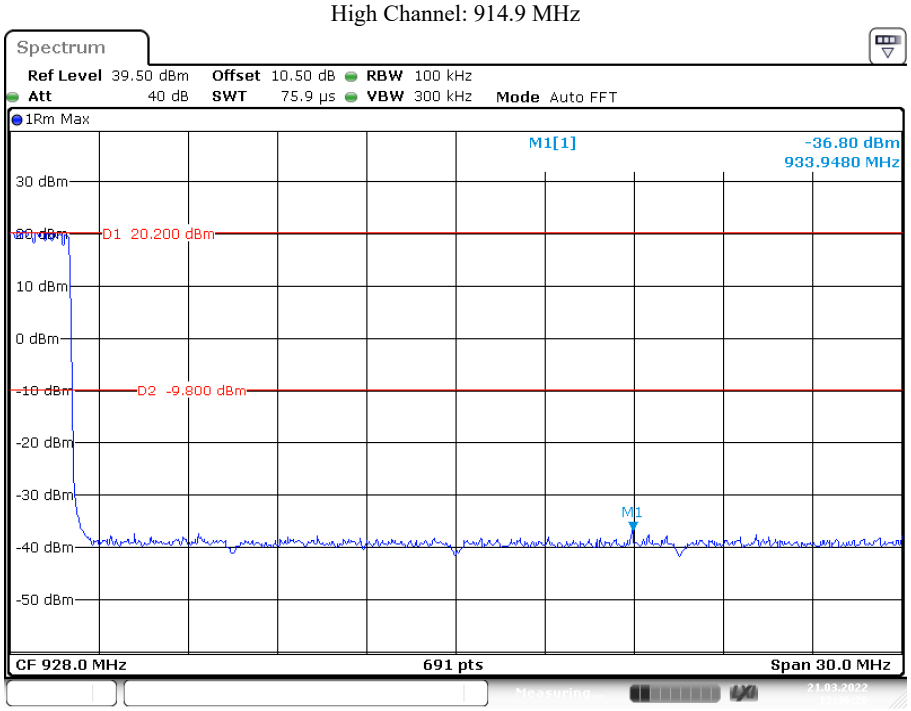
Date: 21.MAR.2022 13:30:52

Low Channel: 902.3 MHz



Date: 21.MAR.2022 13:38:54

High Channel: 914.9 MHz



Date: 21.MAR.2022 13:46:26

FCC §15.247(f) - POWER SPECTRAL DENSITY OF HYBRID SYSTEMS

Applicable Standard

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

a) Set instrument center frequency to DTS channel center frequency.
b) Set span to at least 1.5 times the OBW.
c) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set VBW ≥ [3 × RBW].
e) Detector = power averaging (rms)
f) Ensure that the number of measurement points in the sweep ≥ [2 × span / RBW].
g) Manually set the sweep time to: ≥ [10 × (number of measurement points in sweep) × (transmission symbol period)], but no less than the auto sweep time.
h) Perform the measurement over a single sweep.
i) Use the peak marker function to determine the maximum amplitude level.
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).

Test Data

Environmental Conditions

Temperature:	24.2 ℃
Relative Humidity:	49 %
ATM Pressure:	101.2 kPa

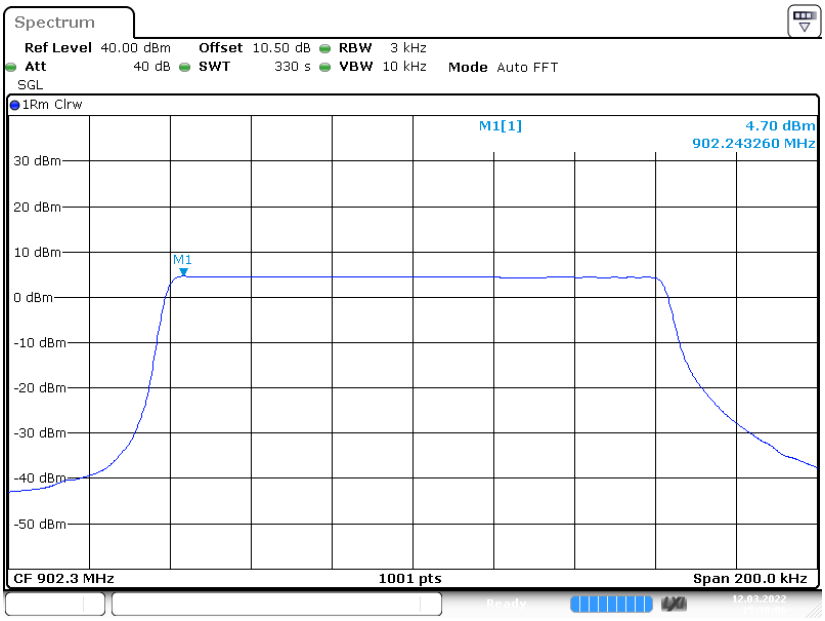
The testing was performed by *Paul Liu* on 2022-03-12.

EUT operation mode: Transmitting

Test Result: Compliant.

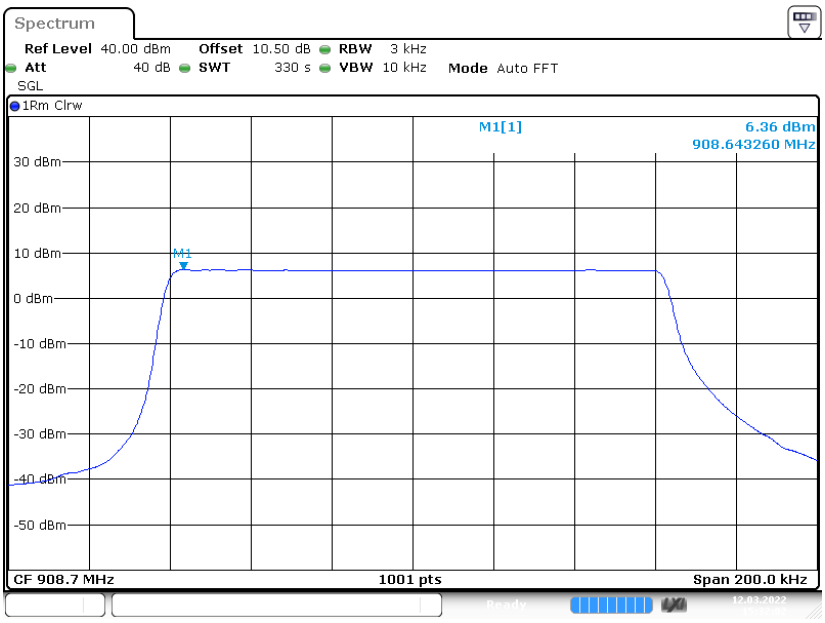
Channel	Result [dBm/3kHz]	Limit [dBm/3kHz]	Verdict
Low	4.70	<=8	PASS
Middle	6.36	<=8	PASS
High	4.52	<=8	PASS

Low Channel: 902.3 MHz



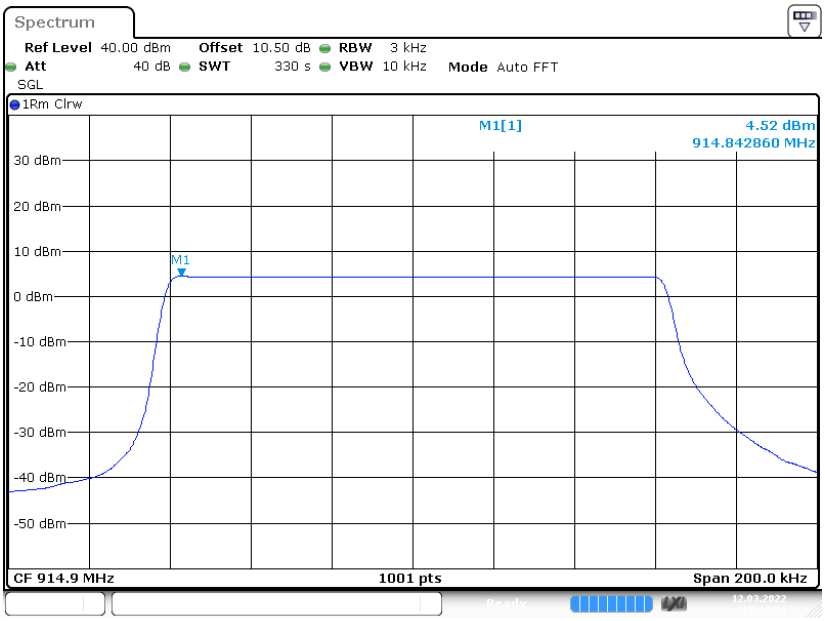
Date: 12.MAR.2022 15:39:06

Middle Channel: 908.7 MHz



Date: 12.MAR.2022 15:32:03

High Channel: 914.9 MHz



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