TEST REPORT

Applicant Name :	Fanvil Technology Co., LTD.
Address :	10/F Block A, Dualshine Global Science Innovation Honglang North 2nd Road, Bao'an District, Shenzhen, 518101, China
Report Number :	SZNS220429-17654E-RF-00A
FCC ID:	2APPZ-X5UV2

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type:	IP Phone
Model No.:	X5U V2
Multiple Model(s) No.:	X5U (Please refer to DOS for Model difference)
Trade Mark:	Fanvil
Date Received:	2022/04/29
Report Date:	2022/06/14

Test Result:	Pass*

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

Prepared and Checked By:

Ting Lü

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.
This report cannot be reproduced except in full, without prior written approval of the Company. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

TABLE OF CONTENTS

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Frequency Range	Bluetooth: 2402~2480MHz
Maximum conducted Peak output power	Bluetooth: 5.77dBm
Modulation Technique	Bluetooth: GFSK, π/4-DQPSK, 8DPSK
Antenna Specification*	2.7 dBi (provided by the applicant)
Voltage Range	DC 5V from Adapter or DC 48V from POE
Sample serial number	SZNS220429-17654E-RF-S2 (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.

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.

EUT Exercise Software

"MP Tool"* exercise software was used, and the power level is Default *. The software and power level was provided by the manufacturer.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

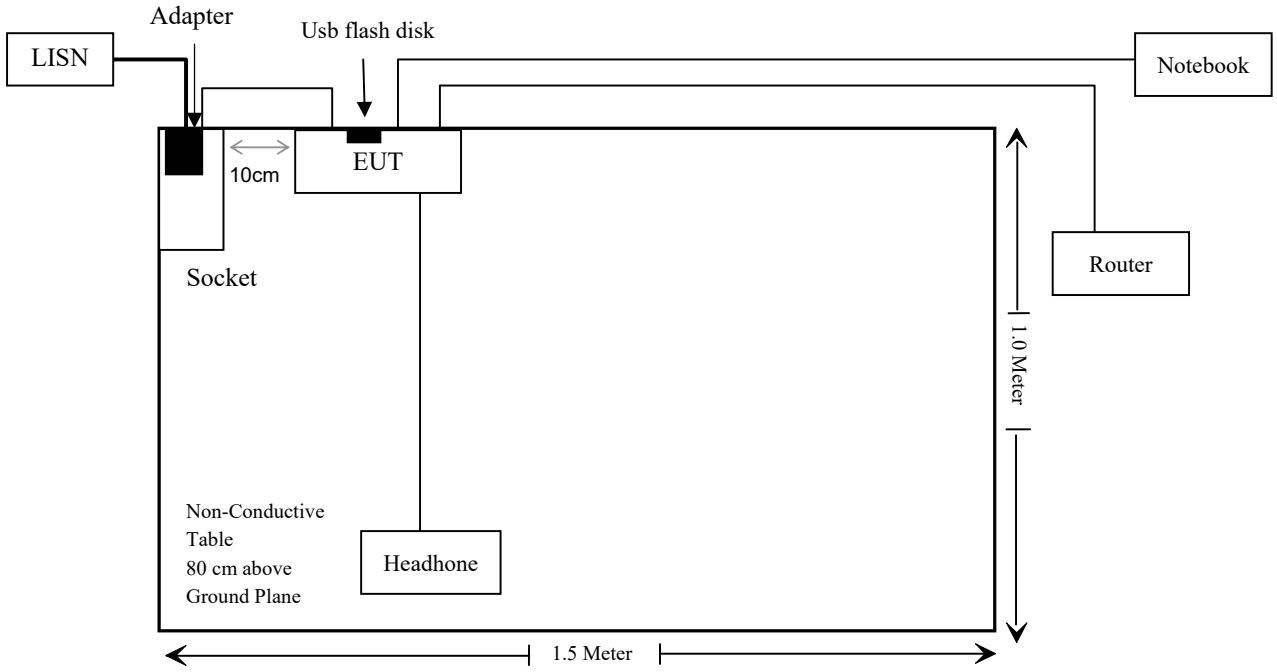
Manufacturer	Description	Model	Serial Number
DELL	NoteBook	Latitude E4710	PC201911252059
HUAWEI	Router	WS5100	A4933FEF1D01
TECNO	Adapter	U050TSA	AH07015321906
Xilang	Earphone	Unknown	Earphone
GOSPELL	POE Adapter	G0720-480-050	212701319
Sandisk	USB flash disk	Unknown	USB flash disk

External I/O Cable

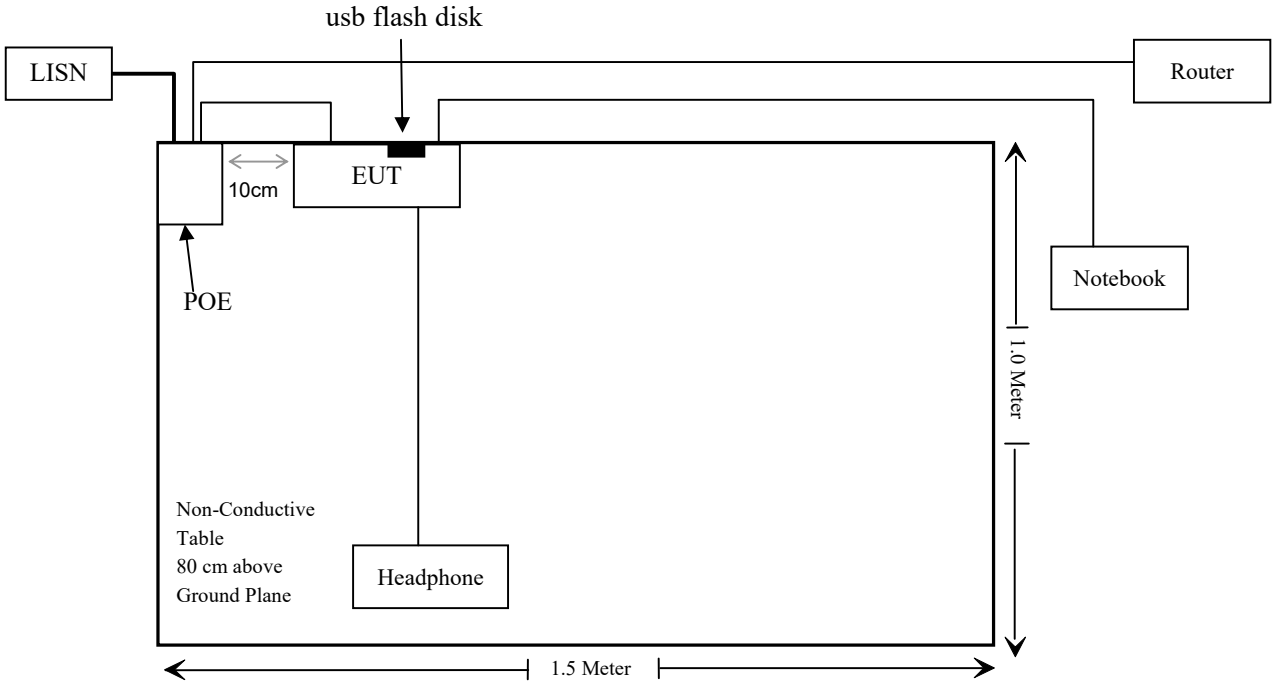
Cable Description	Length (m)	From/Port	To
Un-shielding Detachable RJ45 Cable	8.0	EUT	Notebook
Unshielded detachable AC cable	1.0	LISN	POE
Un-shielded detachable RJ45 Cable	8.0	EUT	Router
Un-shielded detachable RJ11 Cable	1.2	EUT	Earphone
Unshielded detachable DC cable	1.2	EUT	Adapter
Un-shielded detachable RJ45 Cable	8.0	Router	POE
Un-shielded detachable RJ45 Cable	0.8	EUT	POE

Block Diagram of Test Setup

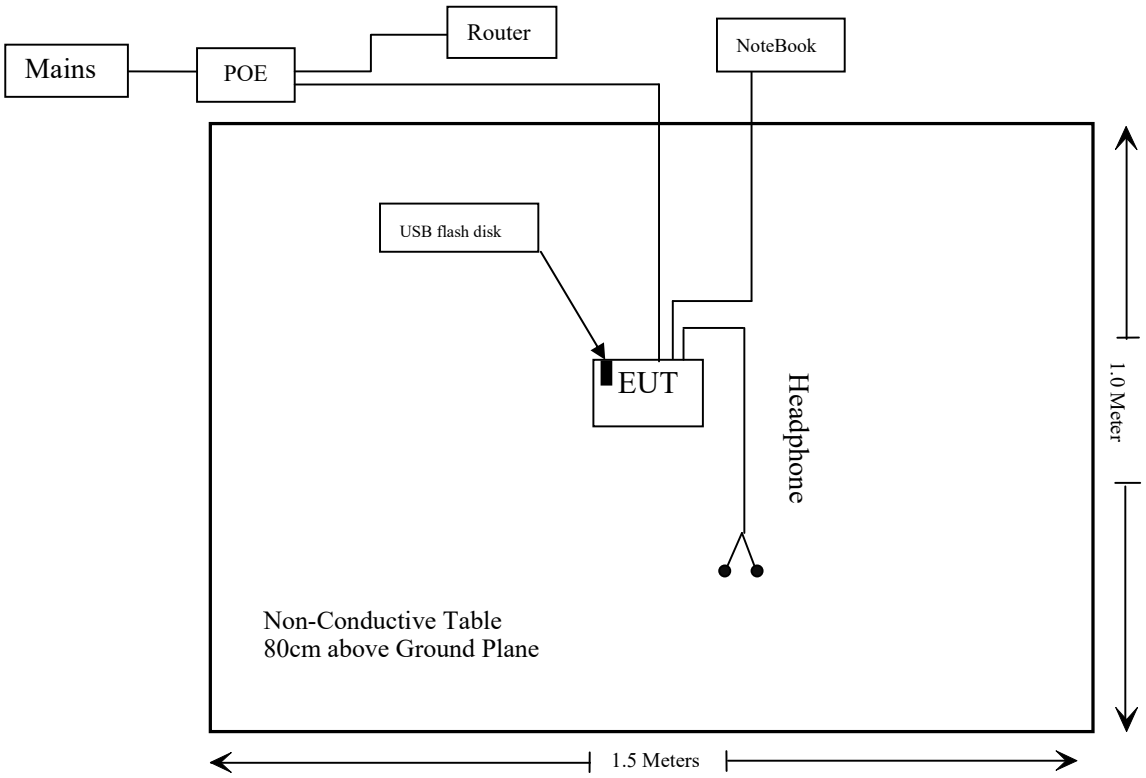
For conducted emission (Adapter power supply):



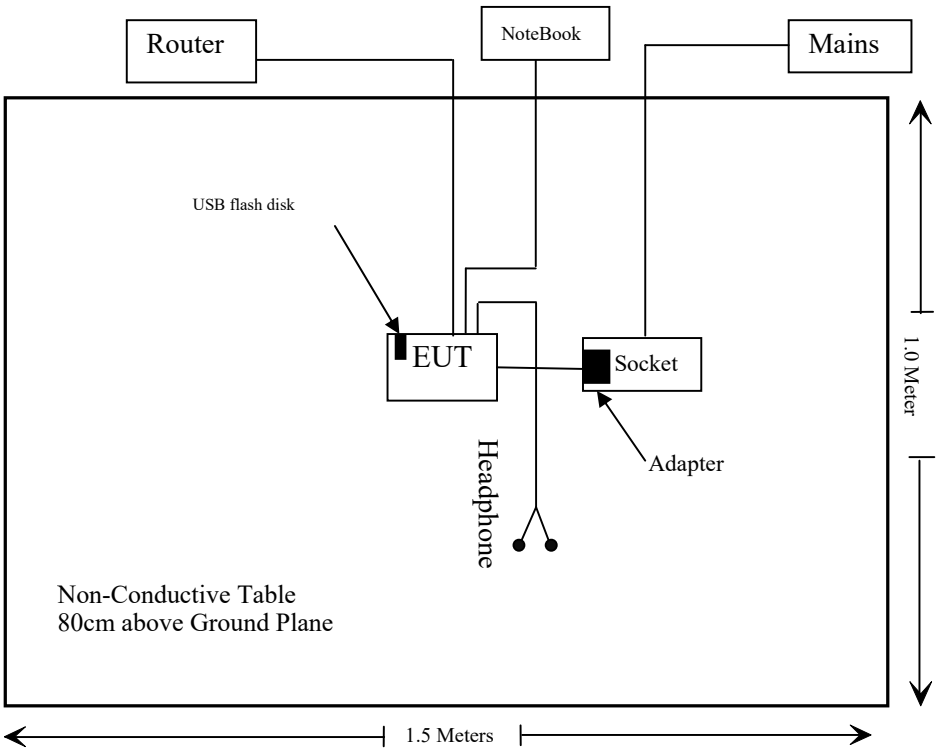
For conducted emission (POE power supply):



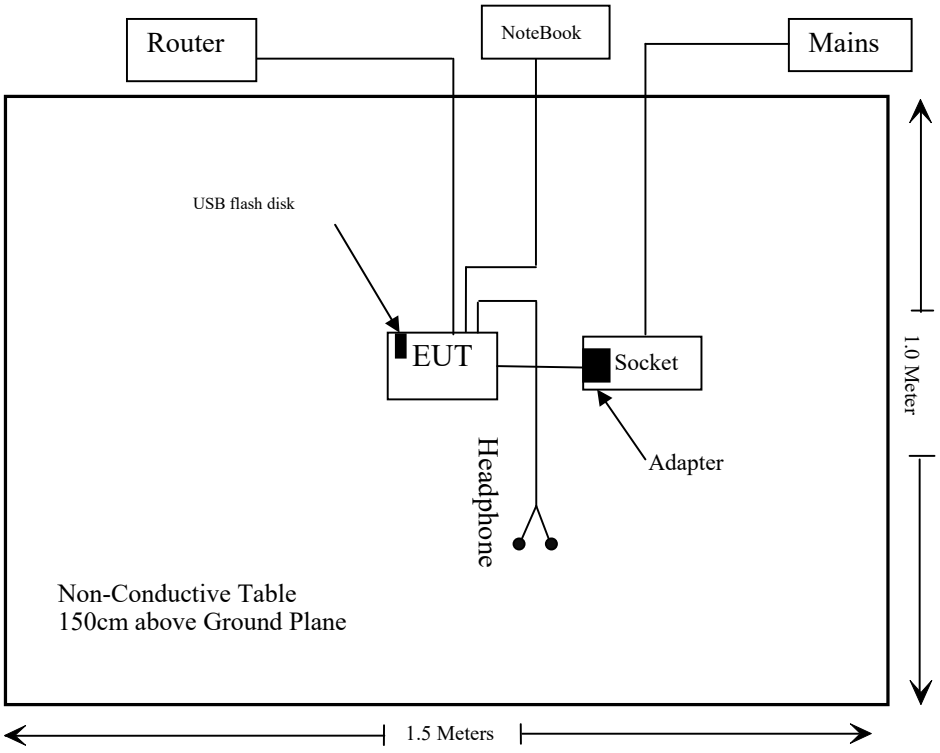
For radiated emission below 1 GHz (POE power supply):



For radiated emission below 1 GHz (Adapter power supply):



For radiated emission above 1 GHz:



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)	Channel Separation Test	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliant
§15.247(b)(1)	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
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2021/11/11	2022/11/10
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	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
Unknown	RF Coaxial Cable	No.15	N600	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.16	N650	2021/12/14	2022/12/13
Wainwright	High Pass Filter	WHKX3.6/18G-10SS	5	2021/12/14	2022/12/13

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101948	2021/12/13	2022/12/12
HP	6dB Attenuator	8493B	2708A 04769	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) & §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	2.7	1.86	6.0	3.98	20	0.0015	1

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

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, which was permanently attached and the antenna gain is 2.7 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

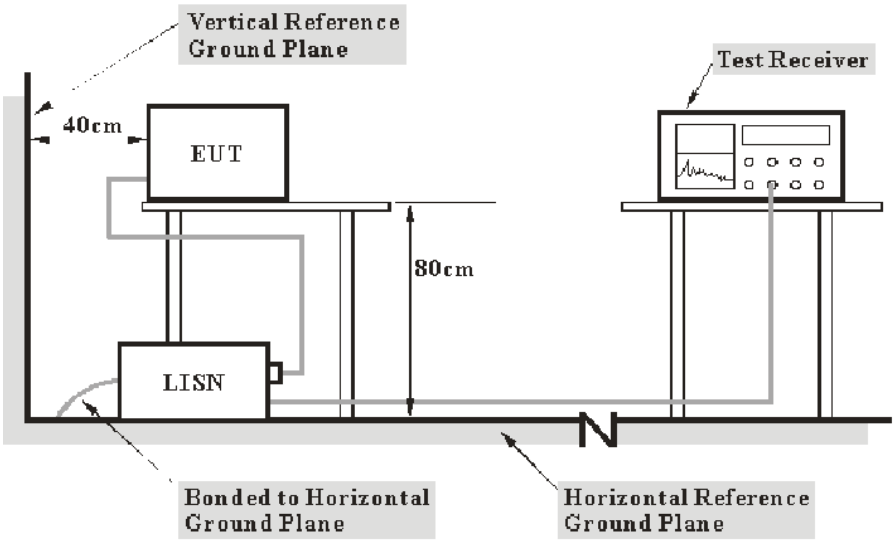
Result: Compliance.

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.

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

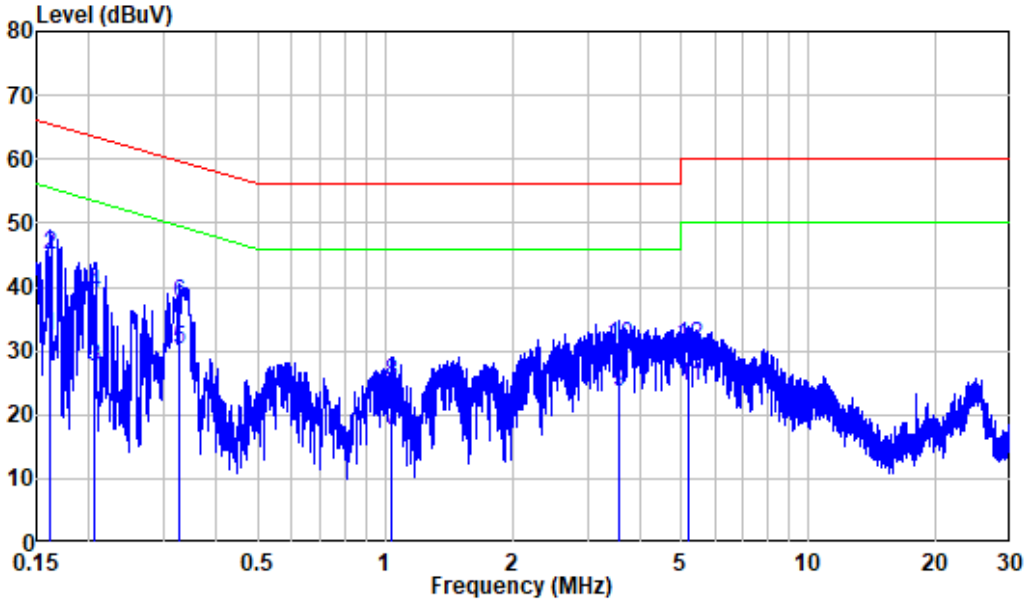
Temperature:	23 ℃
Relative Humidity:	52 %
ATM Pressure:	101.0 kPa

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

EUT operation mode: Transmitting (the worst case for 8DPSK Mode, High channel)

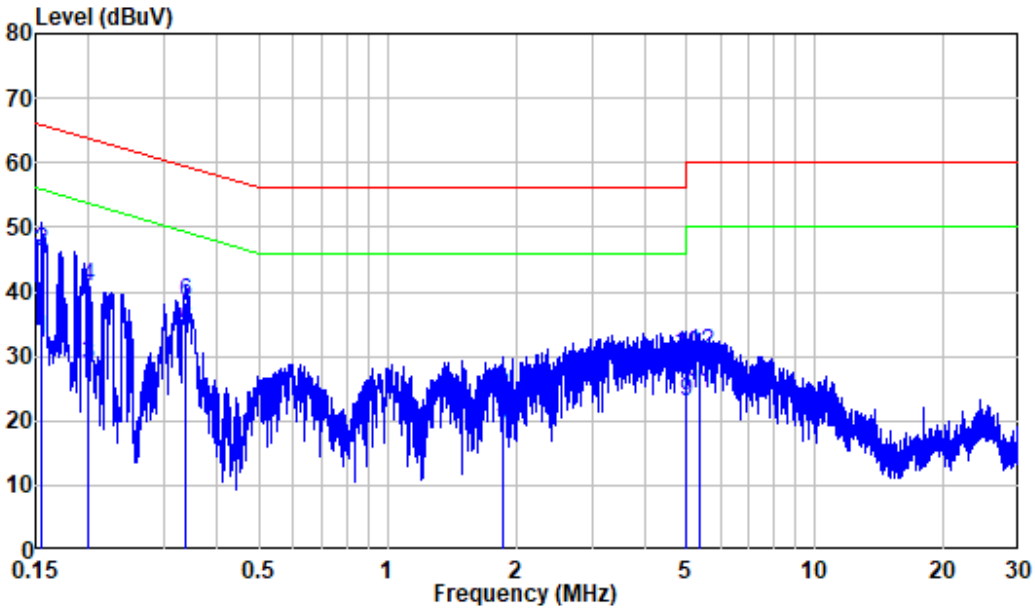
POE:

AC 120V/60 Hz, Line



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.162	9.80	22.63	32.43	55.38	-22.95	Average
2	0.162	9.80	35.18	44.98	65.38	-20.40	QP
3	0.205	9.80	17.77	27.57	53.39	-25.82	Average
4	0.205	9.80	29.14	38.94	63.39	-24.45	QP
5	0.325	9.80	20.45	30.25	49.57	-19.32	Average
6	0.325	9.80	27.78	37.58	59.57	-21.99	QP
7	1.039	9.81	7.75	17.56	46.00	-28.44	Average
8	1.039	9.81	15.10	24.91	56.00	-31.09	QP
9	3.582	9.84	13.60	23.44	46.00	-22.56	Average
10	3.582	9.84	21.04	30.88	56.00	-25.12	QP
11	5.225	9.85	14.74	24.59	50.00	-25.41	Average
12	5.225	9.85	21.00	30.85	60.00	-29.15	QP

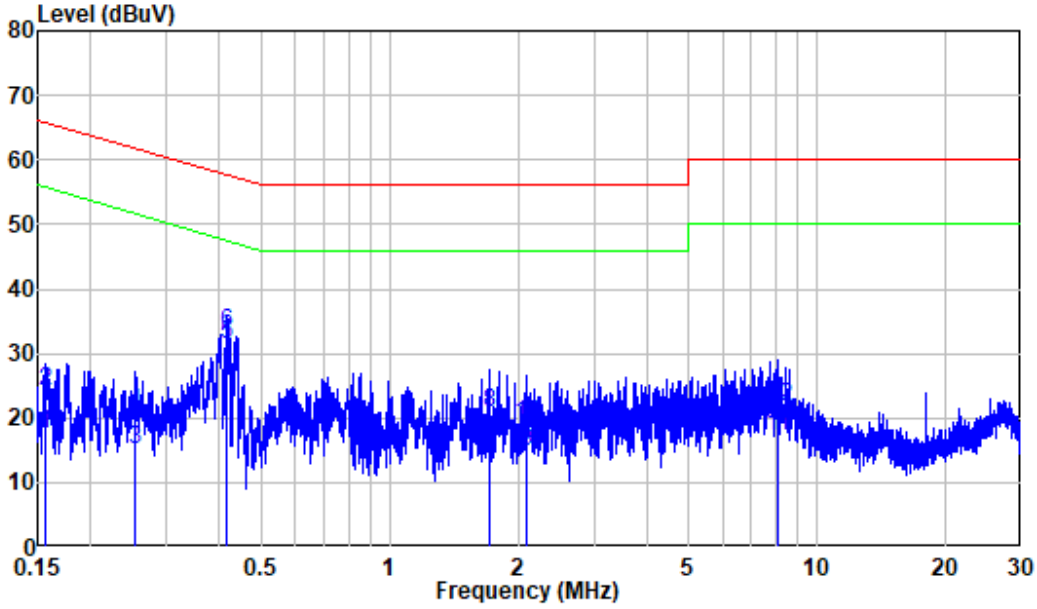
AC 120V/60 Hz, Neutral



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.155	9.80	22.89	32.69	55.72	-23.03	Average
2	0.155	9.80	36.38	46.18	65.72	-19.54	QP
3	0.200	9.80	18.76	28.56	53.61	-25.05	Average
4	0.200	9.80	30.82	40.62	63.61	-22.99	QP
5	0.337	9.80	23.87	33.67	49.27	-15.60	Average
6	0.337	9.80	28.55	38.35	59.27	-20.92	QP
7	1.862	9.82	8.16	17.98	46.00	-28.02	Average
8	1.862	9.82	14.14	23.96	56.00	-32.04	QP
9	4.985	9.89	13.20	23.09	46.00	-22.91	Average
10	4.985	9.89	20.24	30.13	56.00	-25.87	QP
11	5.362	9.90	14.28	24.18	50.00	-25.82	Average
12	5.362	9.90	20.49	30.39	60.00	-29.61	QP

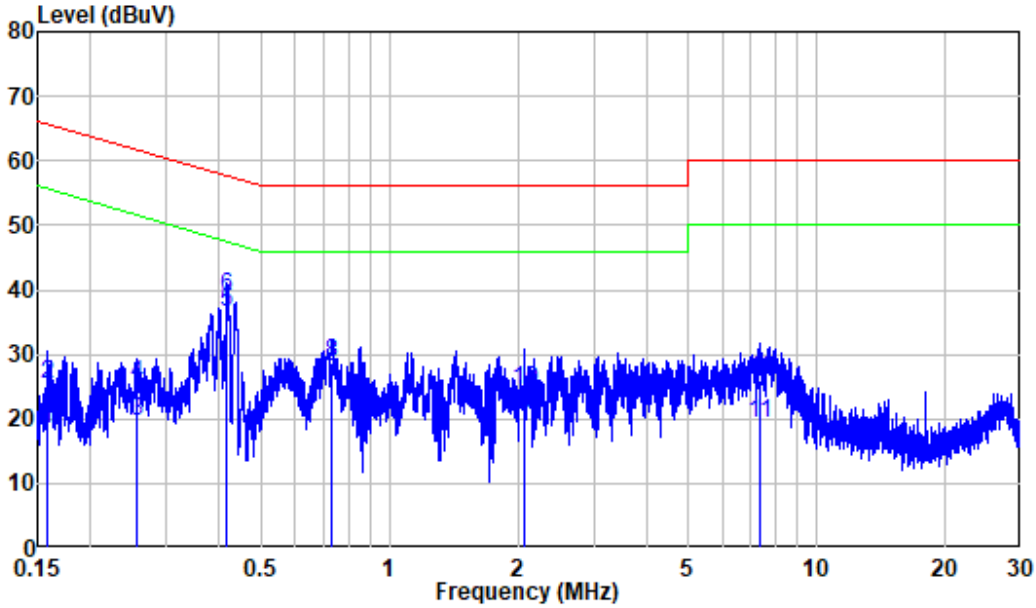
Adapter:

AC 120V/60 Hz, Line



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.157	9.80	7.71	17.51	55.62	-38.11	Average
2	0.157	9.80	14.44	24.24	65.62	-41.38	QP
3	0.254	9.80	5.34	15.14	51.61	-36.47	Average
4	0.254	9.80	11.02	20.82	61.61	-40.79	QP
5	0.416	9.80	21.63	31.43	47.53	-16.10	Average
6	0.416	9.80	23.43	33.23	57.53	-24.30	QP
7	1.706	9.82	6.51	16.33	46.00	-29.67	Average
8	1.706	9.82	11.10	20.92	56.00	-35.08	QP
9	2.084	9.82	4.89	14.71	46.00	-31.29	Average
10	2.084	9.82	9.19	19.01	56.00	-36.99	QP
11	8.095	9.88	7.22	17.10	50.00	-32.90	Average
12	8.095	9.88	11.97	21.85	60.00	-38.15	QP

AC 120V/60 Hz, Neutral



	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.158	9.80	8.70	18.50	55.58	-37.08	Average
2	0.158	9.80	15.64	25.44	65.58	-40.14	QP
3	0.255	9.80	9.93	19.73	51.59	-31.86	Average
4	0.255	9.80	15.47	25.27	61.59	-36.32	QP
5	0.417	9.80	26.80	36.60	47.51	-10.91	Average
6	0.417	9.80	29.06	38.86	57.51	-18.65	QP
7	0.734	9.81	15.77	25.58	46.00	-20.42	Average
8	0.734	9.81	18.89	28.70	56.00	-27.30	QP
9	2.075	9.82	10.70	20.52	46.00	-25.48	Average
10	2.075	9.82	14.65	24.47	56.00	-31.53	QP
11	7.334	9.97	9.46	19.43	50.00	-30.57	Average
12	7.334	9.97	16.13	26.10	60.00	-33.90	QP

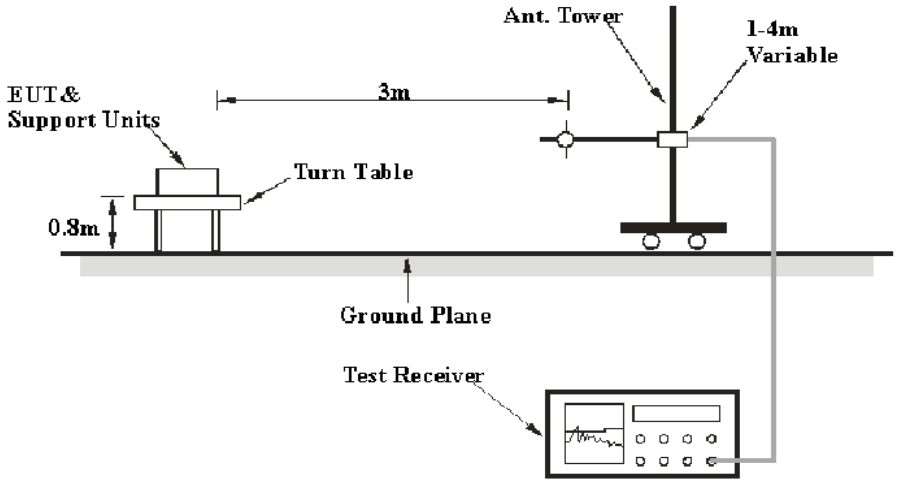
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

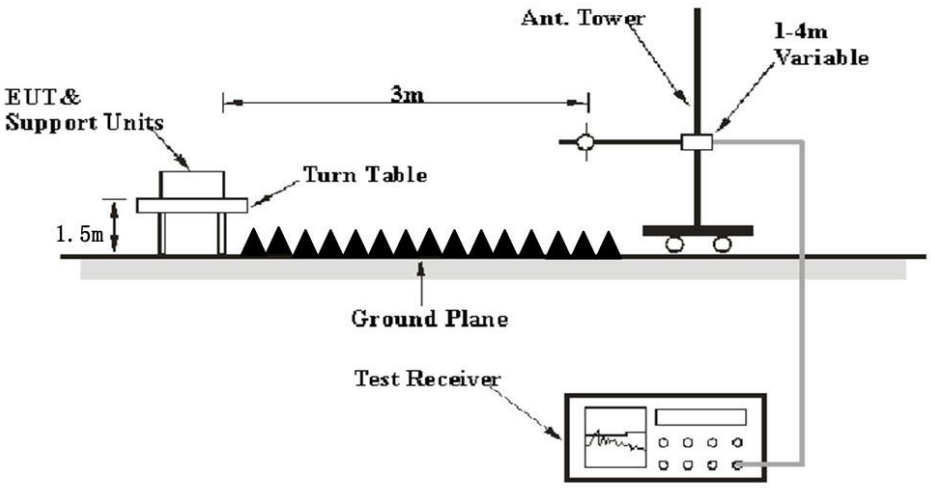
FCC §15.205; §15.209; §15.247(d)

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:	25.1~29 ℃
Relative Humidity:	54~68 %
ATM Pressure:	101.0 kPa

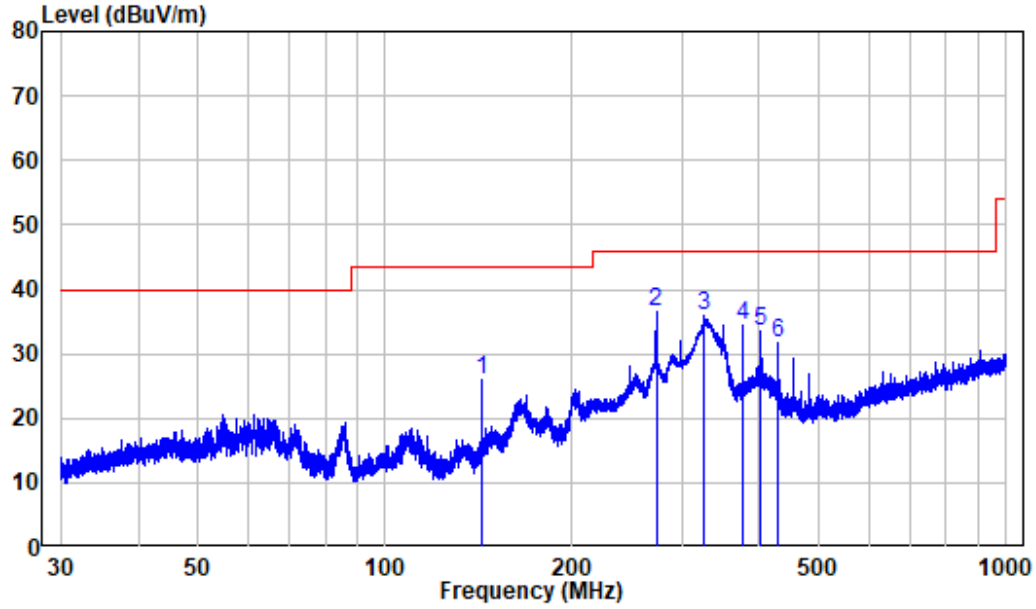
The testing was performed by Leo on 2022-06-06 for below 1GHz, and Leo from 2022-05-26 to 2022-06-07 for above 1GHz.

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 8DPSK Mode, High channel)*

POE:

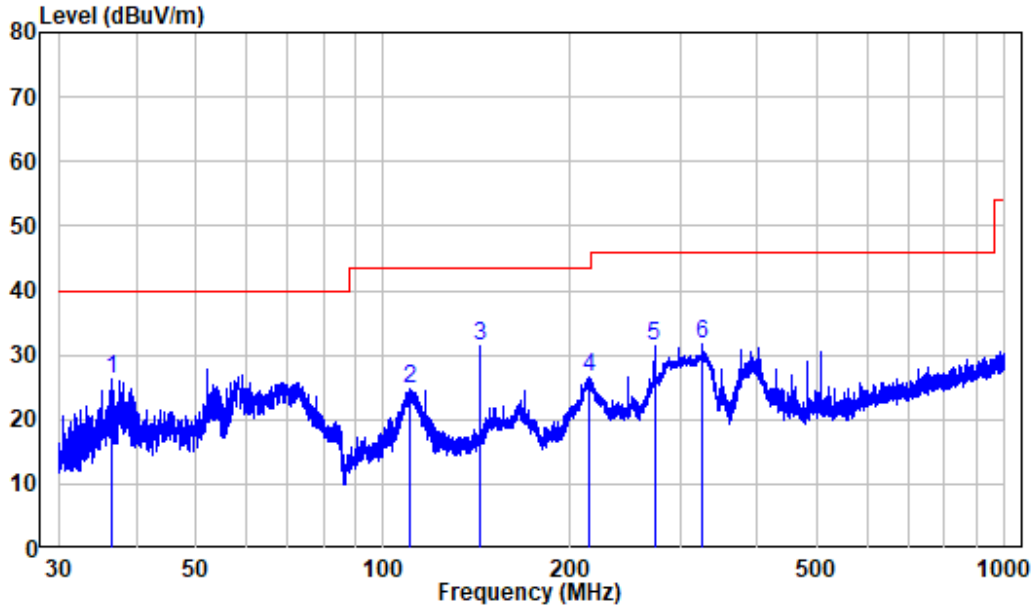
Horizontal:



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220429-17654E-RF
Test Mode: BT
Note : POE

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	143.012	-15.52	41.42	25.90	43.50	-17.60	Peak
2	272.995	-10.04	46.53	36.49	46.00	-9.51	Peak
3	325.026	-8.27	44.18	35.91	46.00	-10.09	Peak
4	377.094	-7.22	41.53	34.31	46.00	-11.69	Peak
5	403.073	-6.73	40.22	33.49	46.00	-12.51	Peak
6	429.146	-5.80	37.46	31.66	46.00	-14.34	Peak

Vertical

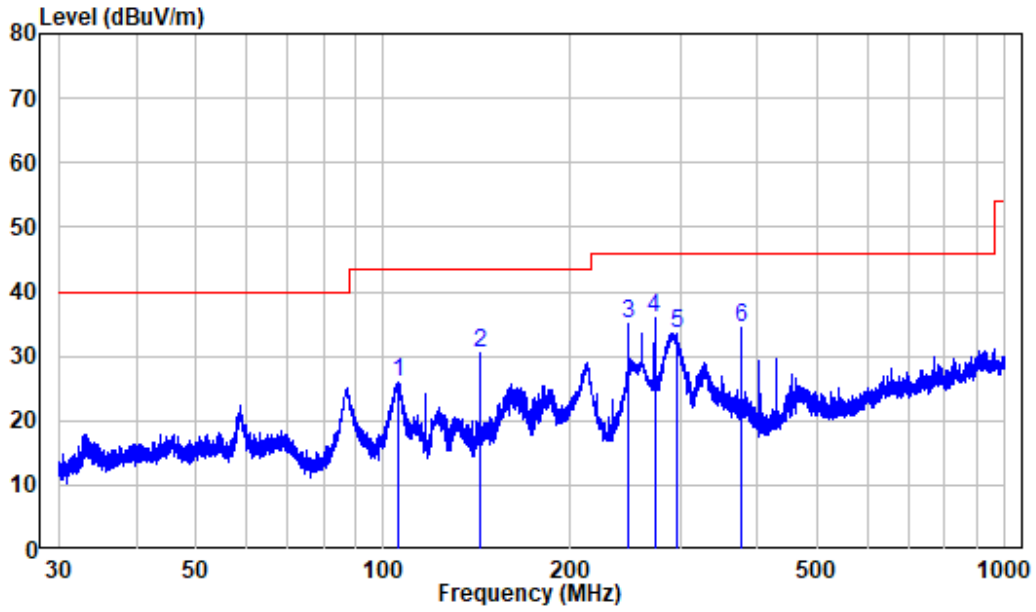


Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS220429-17654E-RF
Test Mode: BT
Note : POE

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	36.589	-11.09	37.48	26.39	40.00	-13.61	Peak
2	110.037	-11.97	36.59	24.62	43.50	-18.88	Peak
3	143.012	-15.52	46.87	31.35	43.50	-12.15	Peak
4	214.232	-11.71	38.38	26.67	43.50	-16.83	Peak
5	272.995	-10.04	41.46	31.42	46.00	-14.58	Peak
6	325.026	-8.27	39.83	31.56	46.00	-14.44	Peak

Adapter:

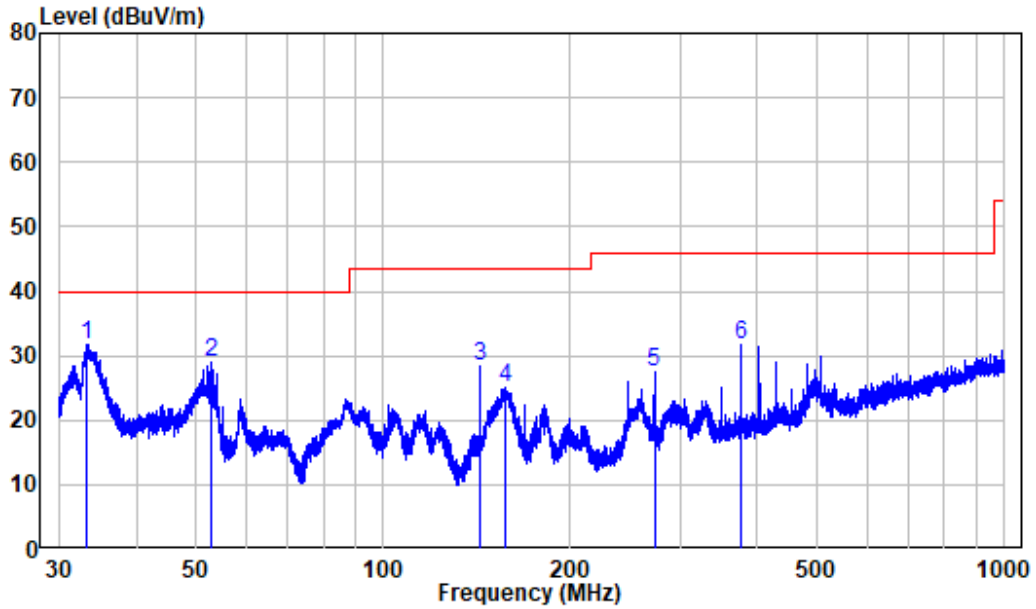
Horizontal:



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220429-17654E-RF
Test Mode: BT
Note : Adpter

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	105.457	-11.88	37.96	26.08	43.50	-17.42	Peak
2	143.012	-15.52	45.88	30.36	43.50	-13.14	Peak
3	247.031	-10.65	45.65	35.00	46.00	-11.00	Peak
4	272.995	-10.04	46.09	36.05	46.00	-9.95	Peak
5	296.184	-9.26	42.92	33.66	46.00	-12.34	Peak
6	377.094	-7.22	41.70	34.48	46.00	-11.52	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS220429-17654E-RF
Test Mode: BT
Note : Adpter

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	33.372	-11.95	43.78	31.83	40.00	-8.17	Peak
2	52.644	-10.10	39.16	29.06	40.00	-10.94	Peak
3	143.012	-15.52	43.99	28.47	43.50	-15.03	Peak
4	156.939	-14.68	39.87	25.19	43.50	-18.31	Peak
5	272.995	-10.04	37.65	27.61	46.00	-18.39	Peak
6	377.094	-7.22	38.85	31.63	46.00	-14.37	Peak

Above 1GHz: *(the worst case is 8DPSK Mode, adapter)*

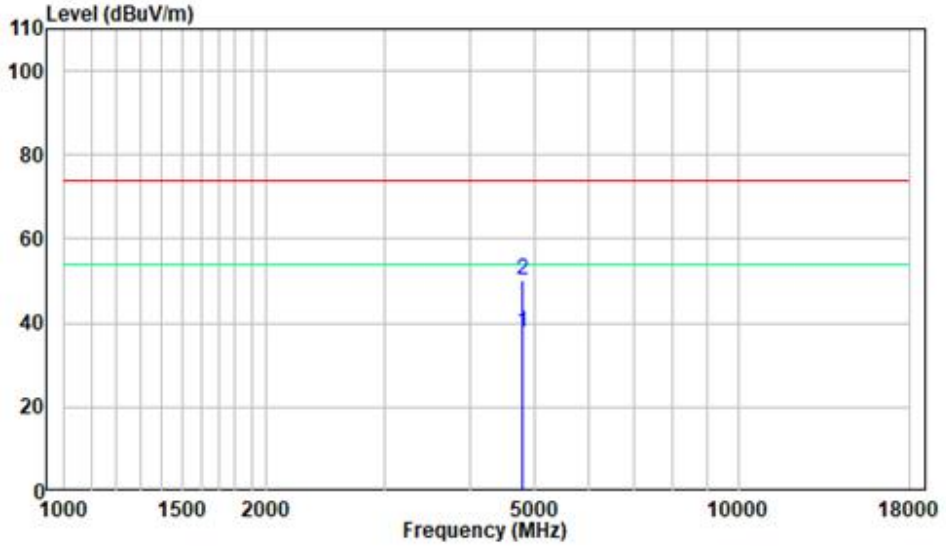
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
Low Channel 2402 MHz									
2310	67.06	PK	285	2.3	H	-7.24	59.82	74	-14.18
2310	54.92	AV	285	2.3	H	-7.24	47.68	54	-6.32
2310	67.00	PK	339	2.4	V	-7.24	59.76	74	-14.24
2310	55.17	AV	339	2.4	V	-7.24	47.93	54	-6.07
2390	68.37	PK	340	1.6	H	-7.22	61.15	74	-12.85
2390	56.42	AV	340	1.6	H	-7.22	49.20	54	-4.80
2390	68.00	PK	60	1.8	V	-7.22	60.78	74	-13.22
2390	56.16	AV	60	1.8	V	-7.22	48.94	54	-5.06
4804	53.88	PK	56	2.1	H	-3.51	50.37	74	-23.63
4804	54.86	PK	356	2.4	V	-3.51	51.35	74	-22.65
Middle Channel 2441MHz									
4882	53.92	PK	192	1.1	H	-3.37	50.55	74	-23.45
4882	53.90	PK	136	1.1	V	-3.37	50.53	74	-23.47
High Channel 2480MHz									
2483.5	68.45	PK	231	1.6	H	-7.20	61.25	74	-12.75
2483.5	56.16	AV	231	1.6	H	-7.20	48.96	54	-5.04
2483.5	68.92	PK	209	2.5	V	-7.20	61.72	74	-12.28
2483.5	56.90	AV	209	2.5	V	-7.20	49.7	54	-4.30
2500	68.62	PK	93	1.1	H	-7.18	61.44	74	-12.56
2500	56.99	AV	93	1.1	H	-7.18	49.81	54	-4.19
2500	68.83	PK	210	2	V	-7.18	61.65	74	-12.35
2500	56.47	AV	210	2	V	-7.18	49.29	54	-4.71
4960	52.80	PK	201	1.8	H	-3.01	49.79	74	-24.21
4960	52.77	PK	333	2.2	V	-3.01	49.76	74	-24.24

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.

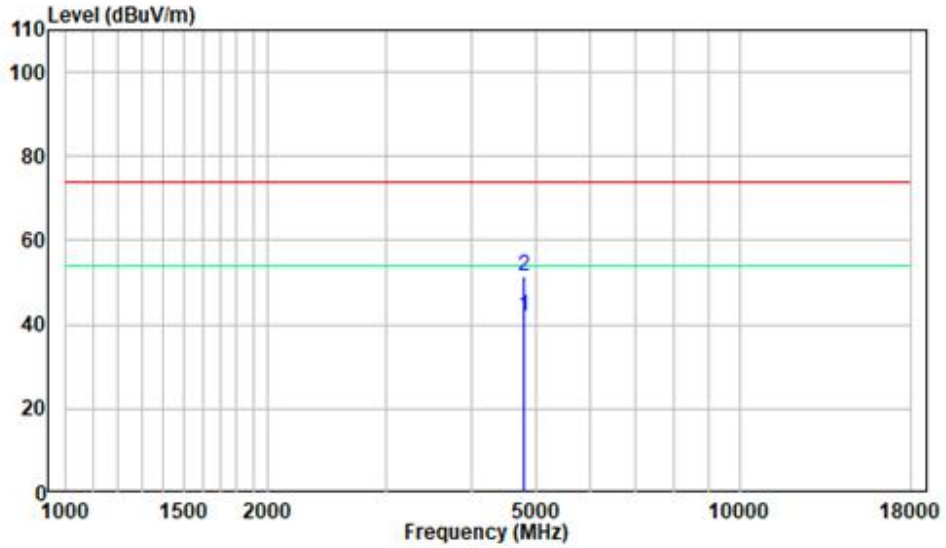
1-18GHz

Pre-scan for Low Channel

Horizontal:



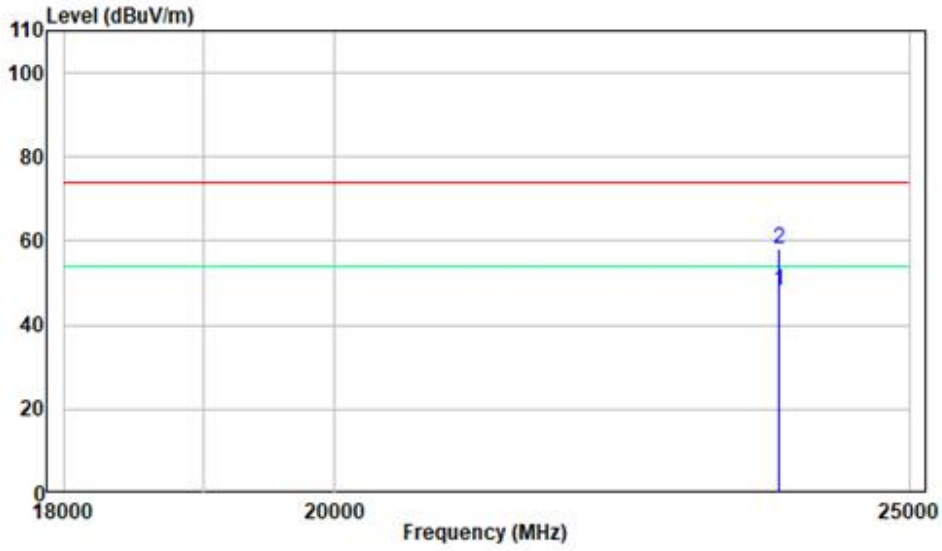
Vertical:



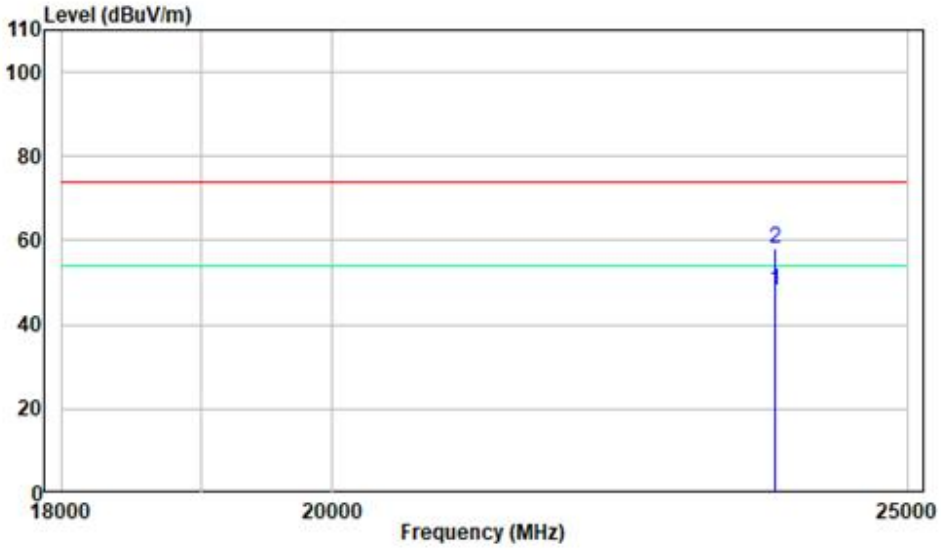
18-25GHz

Pre-scan for Low Channel

Horizontal:



Vertical:



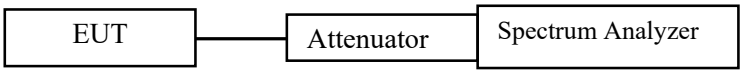
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. 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:	28.1 ℃
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lu on 2022-05-30.

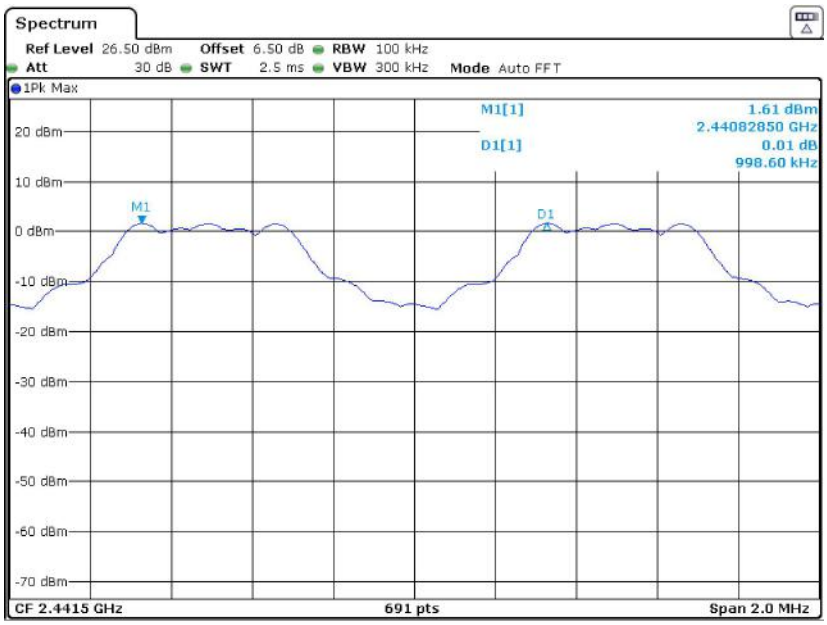
EUT operation mode: Transmitting

Test Result: Compliant.

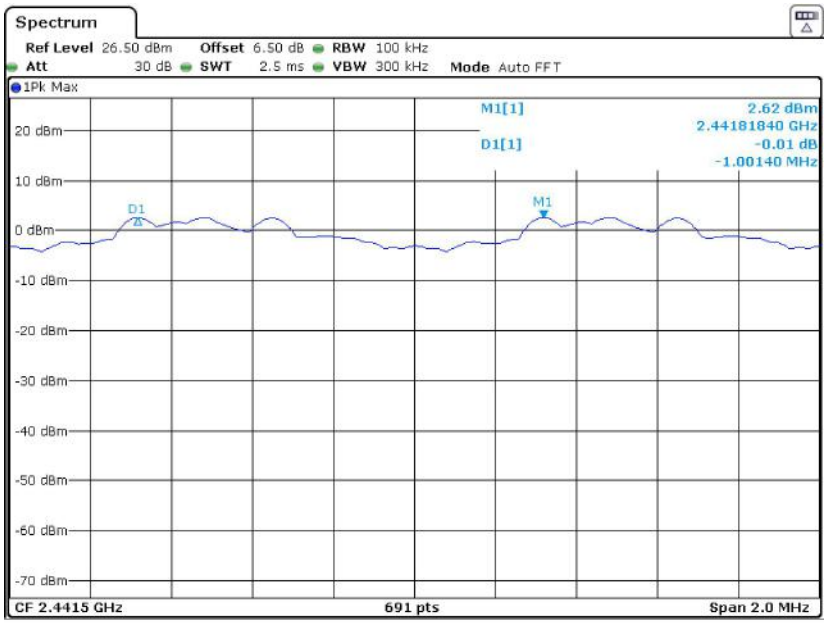
Test Mode	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit	Result
BDR(GFSK)					
Hopping	0.999	1.033	0.689	> two-thirds of the 20 dB bandwidth	Compliance
EDR(π/4-DQPSK)					
Hopping	1.001	1.221	0.814	> two-thirds of the 20 dB bandwidth	Compliance
EDR(8DPSK)					
Hopping	0.999	1.230	0.820	> two-thirds of the 20 dB bandwidth	Compliance

Please refer to the below plots:

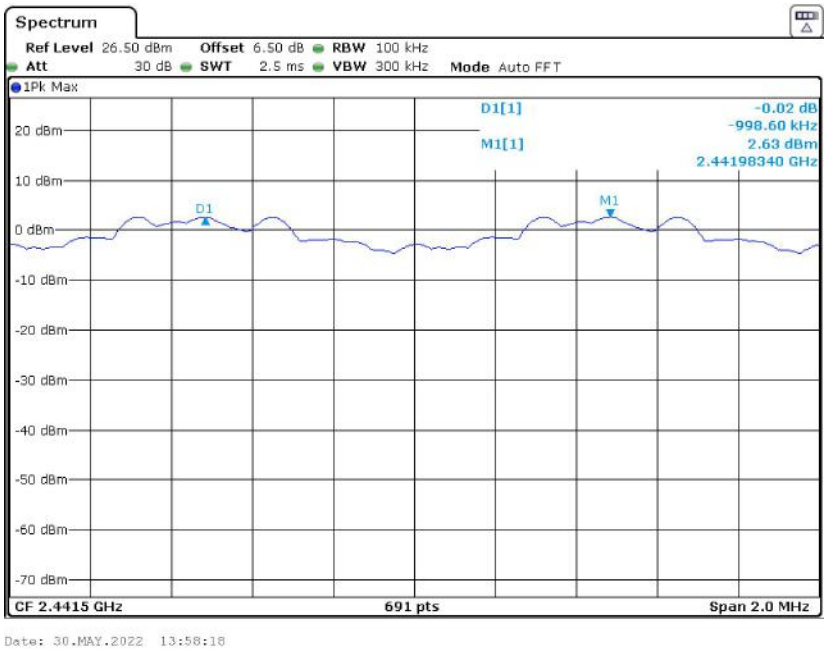
DH1_Hop



2DH1_Hop



3DH1_Hop


Spectrum
Ref Level 26.50 dBm Offset 6.50 dB RBW 100 kHz
Att 30 dB SWT 2.5 ms VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] -0.02 dB
-998.60 kHz
M1[1] 2.63 dBm
2.44198340 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
D1
M1
CF 2.4415 GHz
691 pts
Span 2.0 MHz
Date: 30.MAY.2022 13:58:16

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

Applicable Standard

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

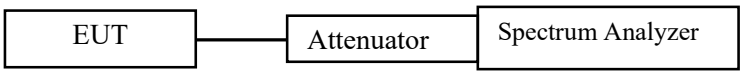
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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:	28.1 ℃
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lu on 2022-05-30.

EUT operation mode: Transmitting

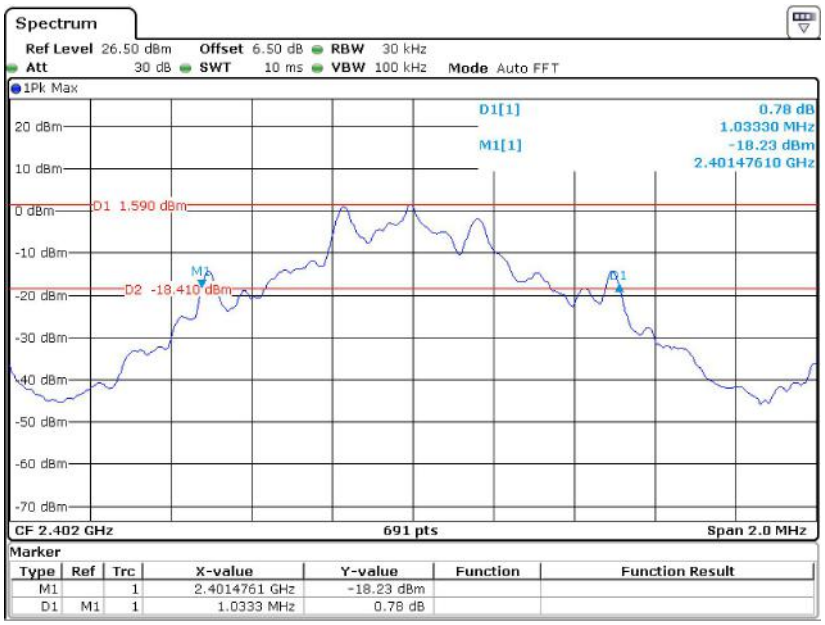
Test Result: Compliant.

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	1.033
	Middle	2441	1.033
	High	2480	1.033
EDR (π/4-DQPSK)	Low	2402	1.219
	Middle	2441	1.219
	High	2480	1.221
EDR (8DPSK)	Low	2402	1.230
	Middle	2441	1.230
	High	2480	1.230

Please refer to the below plots:

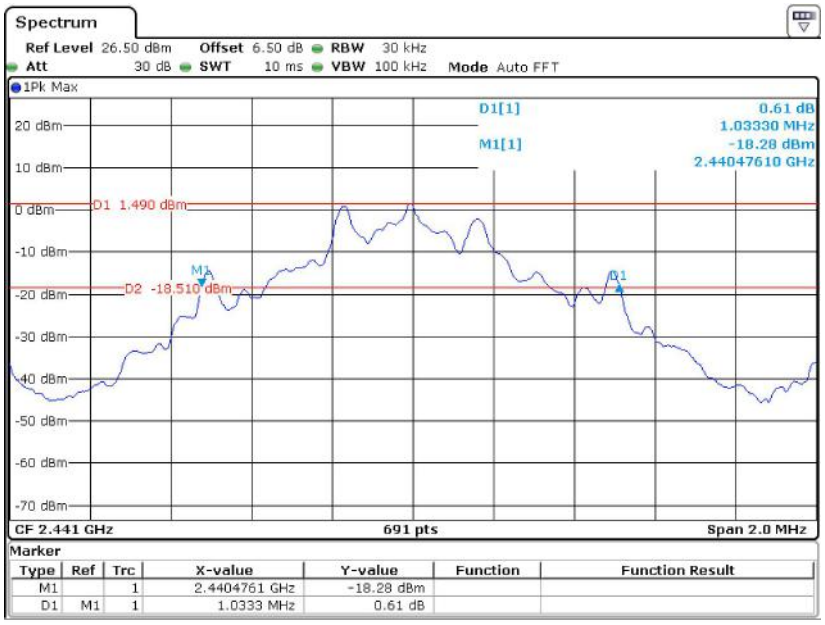
20 dB EMISSION BANDWIDTH

DH1_2402MHz



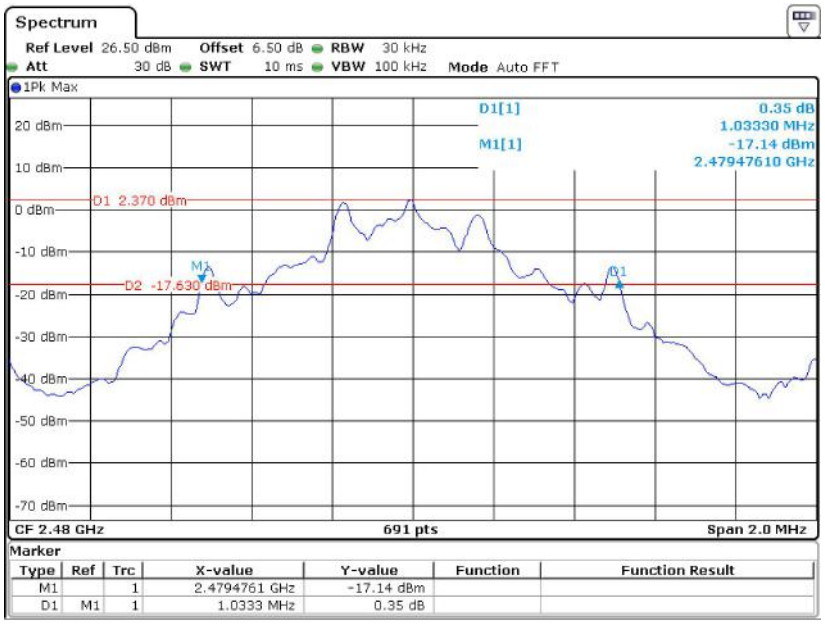
Date: 30.MAY.2022 14:49:01

DH1_2441MHz



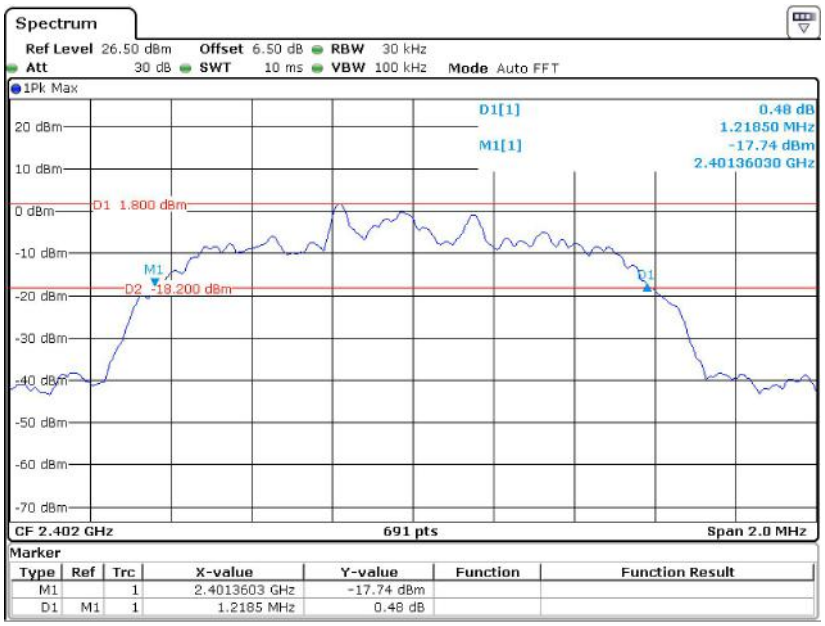
Date: 30.MAY.2022 15:03:36

DH1_2480MHz



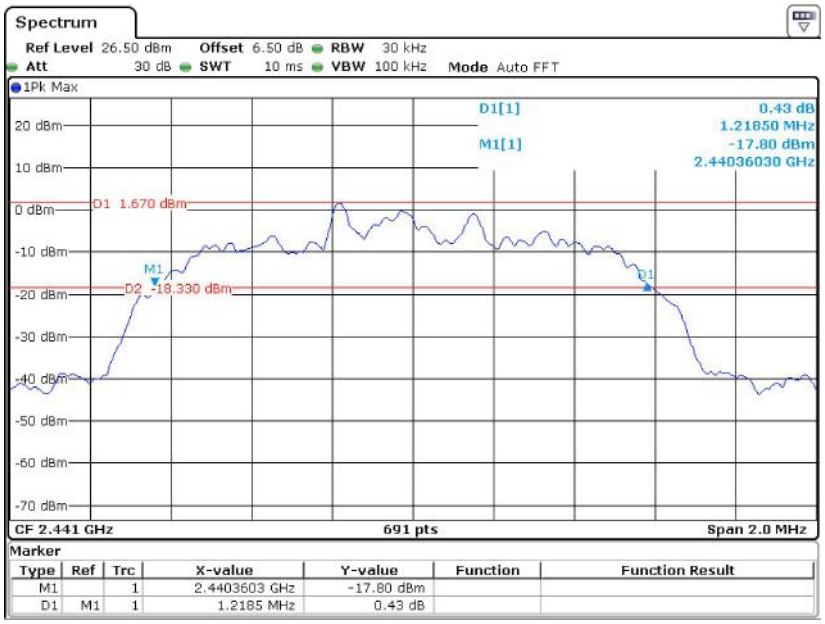
Date: 30.MAY.2022 14:47:27

2DH1_2402MHz



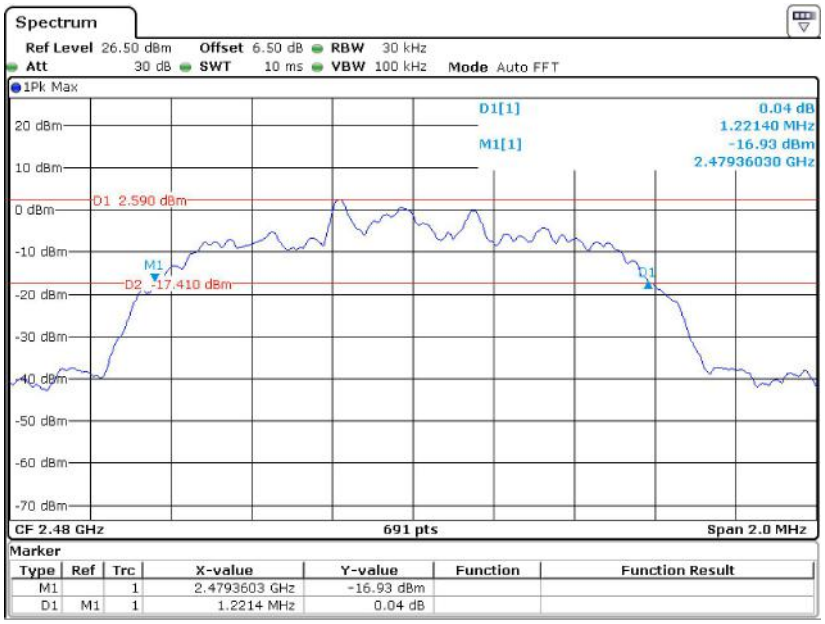
Date: 30.MAY.2022 14:53:11

2DH1_2441MHz



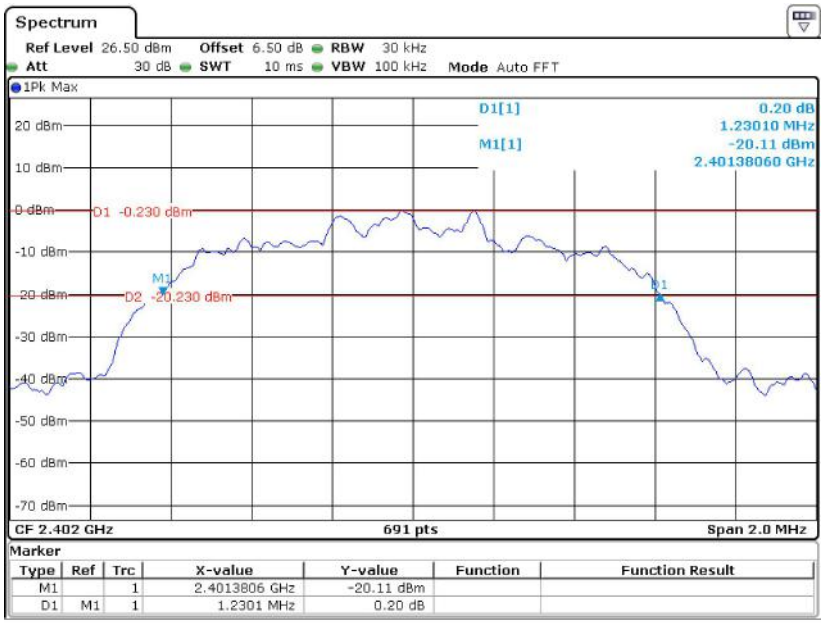
Date: 30.MAY.2022 14:56:47

2DH1_2480MHz



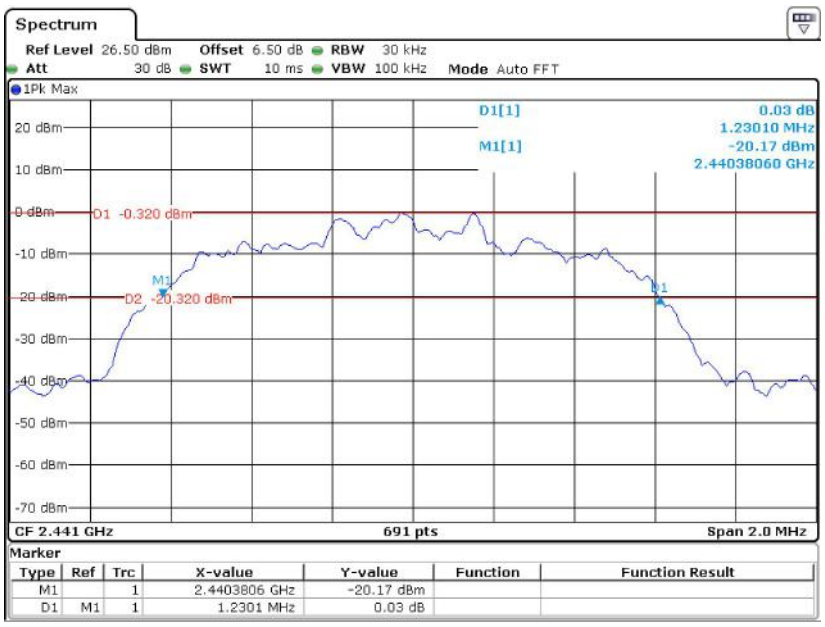
Date: 30.MAY.2022 14:55:23

3DH1_2402MHz



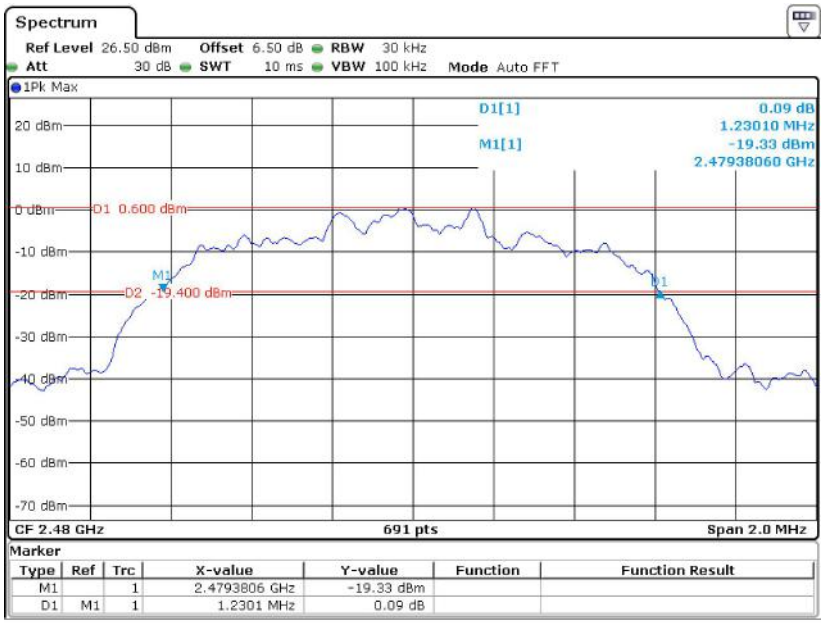
Date: 30.MAY.2022 15:01:03

3DH1_2441MHz



Date: 30.MAY.2022 14:58:50

3DH1_2480MHz



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

Applicable Standard

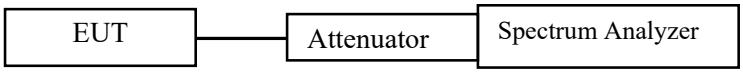
Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that
a minimum of 15 channels are used.

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:	28.1 ℃
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

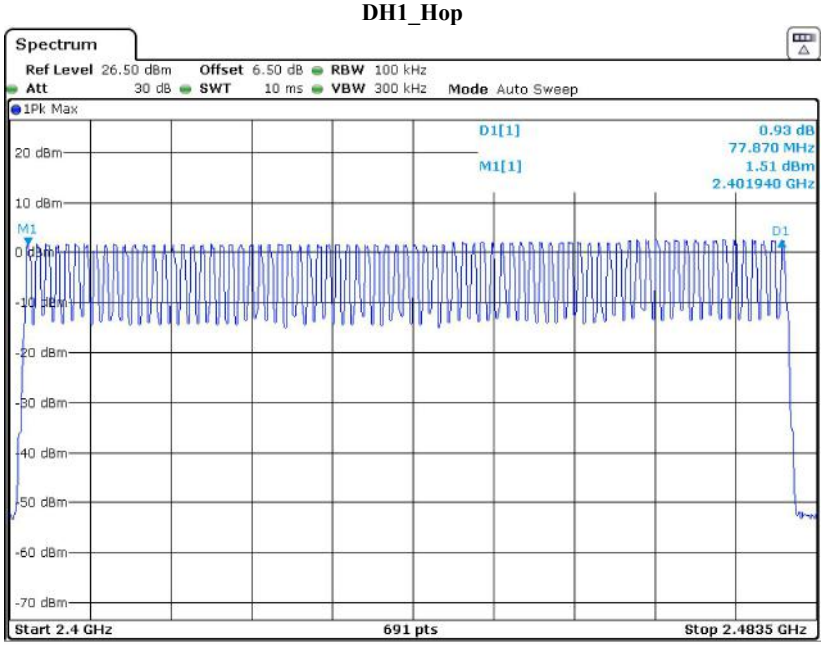
The testing was performed by Ting Lu on 2022-05-30.

EUT operation mode: Transmitting

Test Result: Compliant.

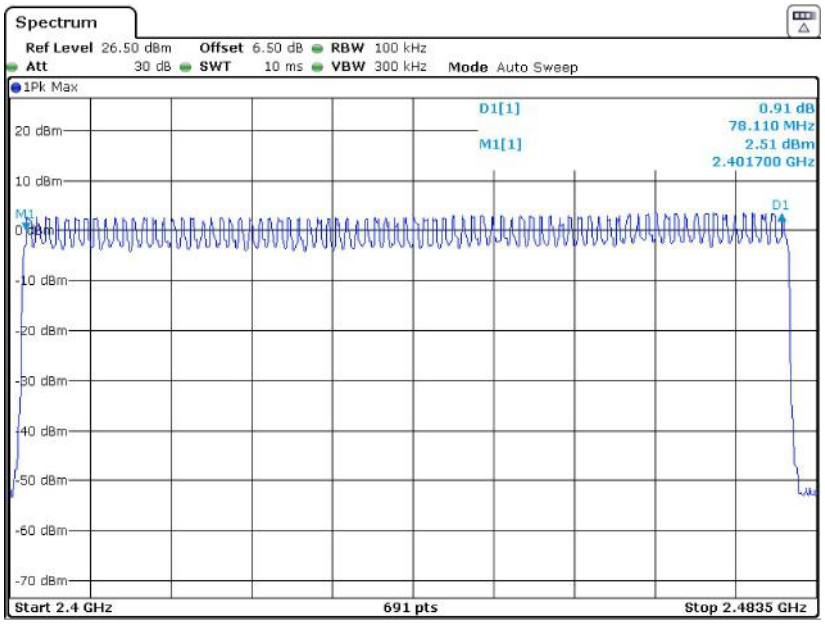
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥15
EDR (π/4-DQPSK)	2400-2483.5	79	≥15
EDR (8DPSK)	2400-2483.5	79	≥15

DH1_Hop



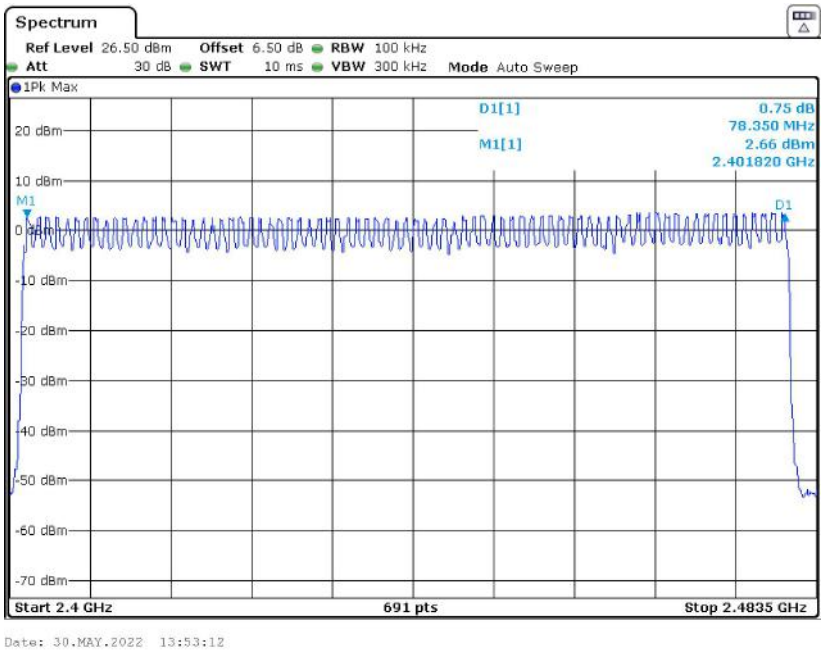
Date: 30.MAY.2022 13:55:44

2DH1_Hop



Date: 30.MAY.2022 13:50:31

3DH1_Hop


Spectrum
Ref Level 26.50 dBm Offset 6.50 dB RBW 100 kHz
Att 30 dB SWT 10 ms VBW 300 kHz Mode Auto Sweep
1Pk Max
D1[1] 0.75 dB
78.350 MHz
M1[1] 2.66 dBm
2.401820 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
D1
Start 2.4 GHz
691 pts
Stop 2.4835 GHz
Date: 30.MAY.2022 13:53:12

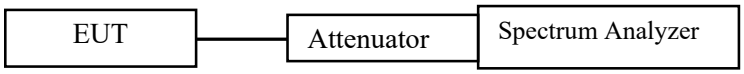
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
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:	28.1 ℃
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lu on 2022-05-30 and 2022-06-14.

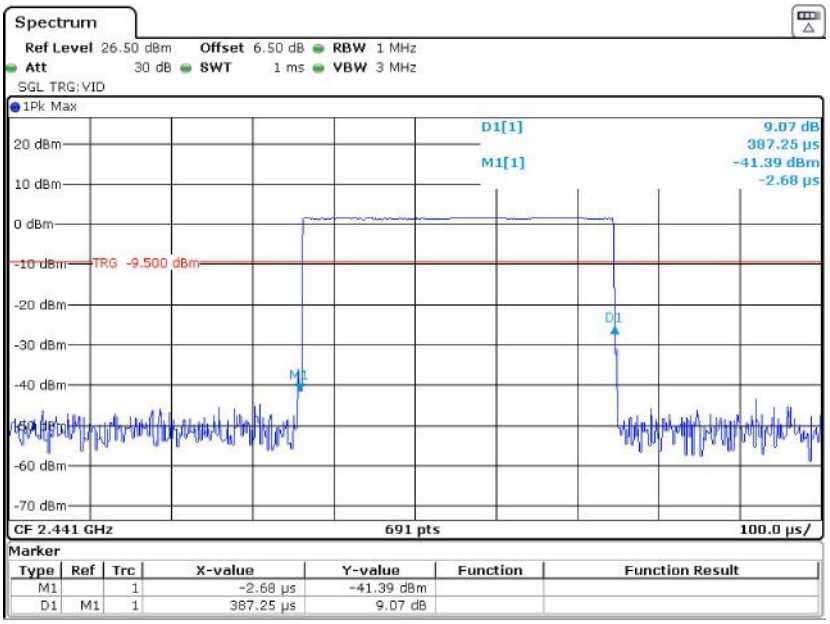
EUT operation mode: Transmitting

Test Result: Compliant.

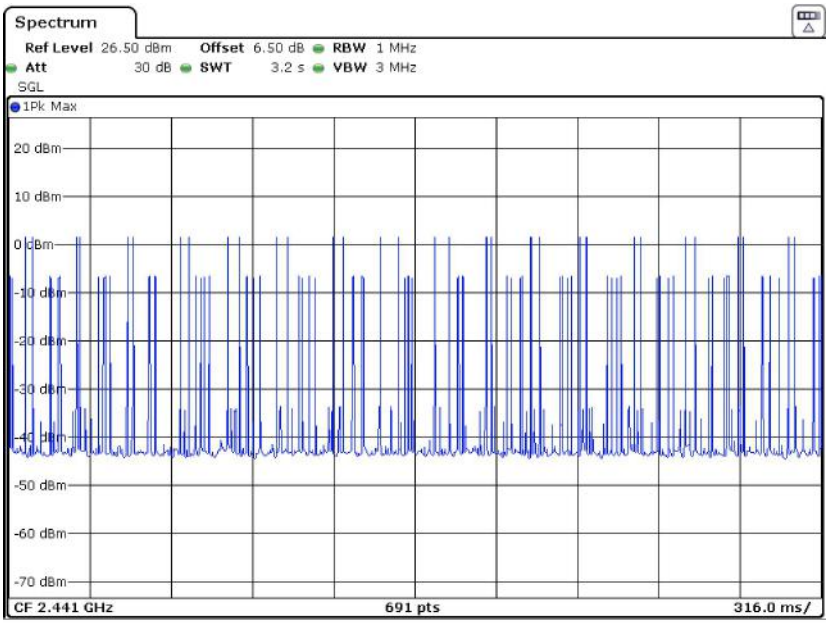
Test Mode	Channel	Pulse Time [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Hop	0.387	320	0.124	<=0.4	PASS
DH3	Hop	1.661	130	0.216	<=0.4	PASS
DH5	Hop	2.929	110	0.322	<=0.4	PASS
2DH1	Hop	0.397	320	0.127	<=0.4	PASS
2DH3	Hop	1.667	160	0.267	<=0.4	PASS
2DH5	Hop	2.937	120	0.352	<=0.4	PASS
3DH1	Hop	0.397	320	0.127	<=0.4	PASS
3DH3	Hop	1.672	170	0.284	<=0.4	PASS
3DH5	Hop	2.937	120	0.352	<=0.4	PASS

Note 1: A period time=0.4*79=31.6(S), Result= Pulse Time *Total hops
Note 2: Total hops=Hopping Number in 3.16s*10
Note 3: Hopping Number in 3.16s=Total of highest signals in 3.16s (Second high signals were other channel)

DH1_Hop

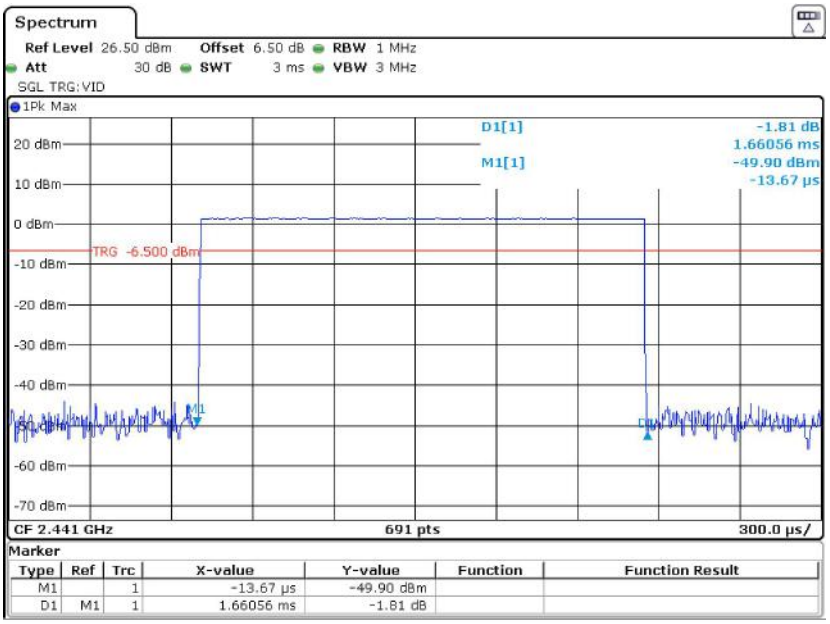


Date: 30.MAY.2022 14:35:54

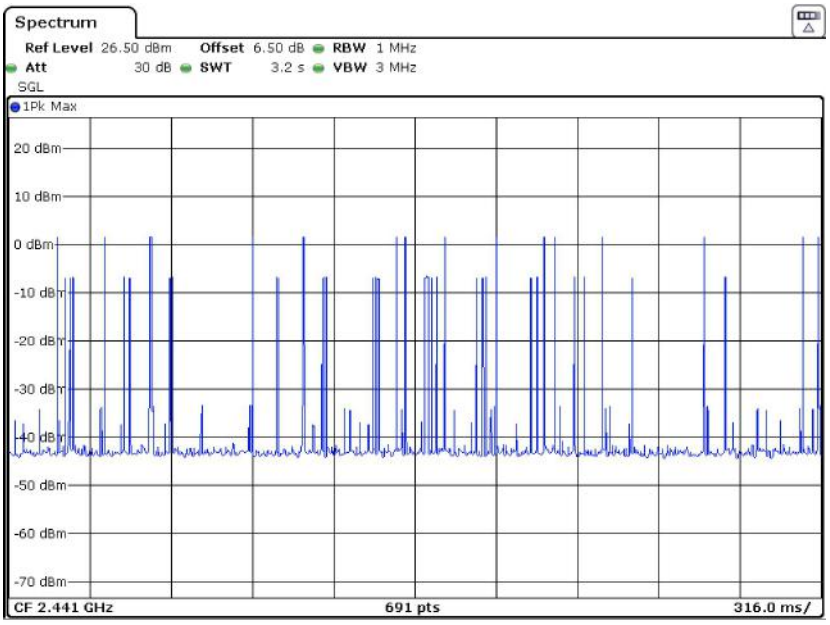


Date: 30.MAY.2022 14:11:40

DH3_ Hop

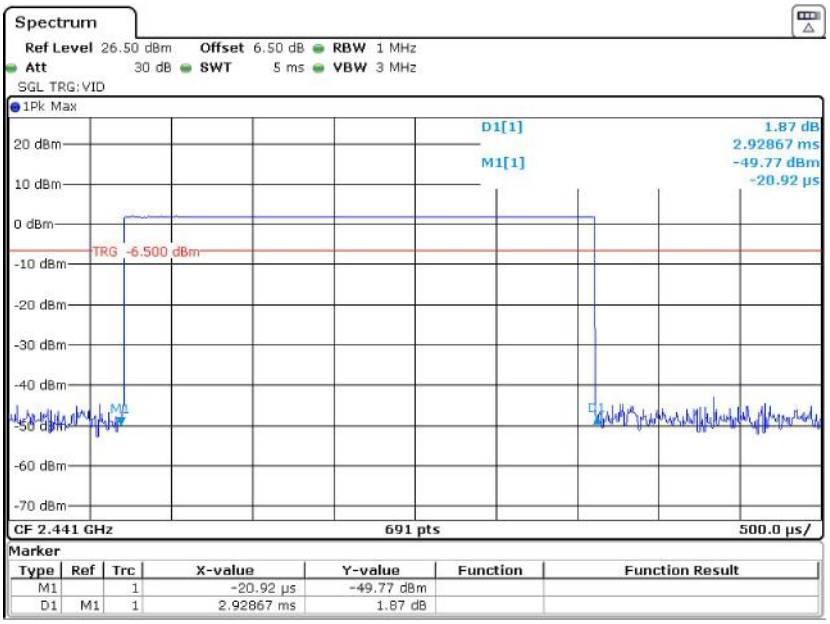


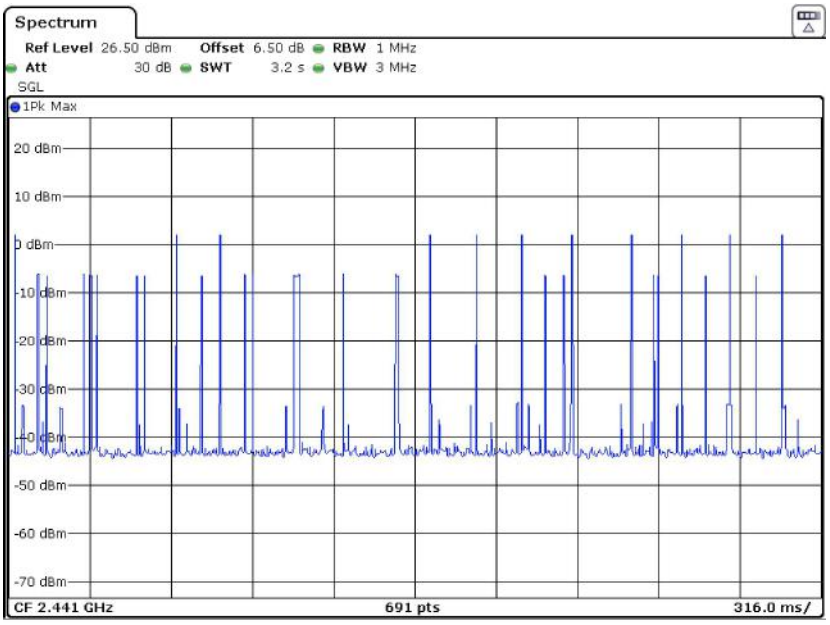
Date: 30.MAY.2022 14:40:05



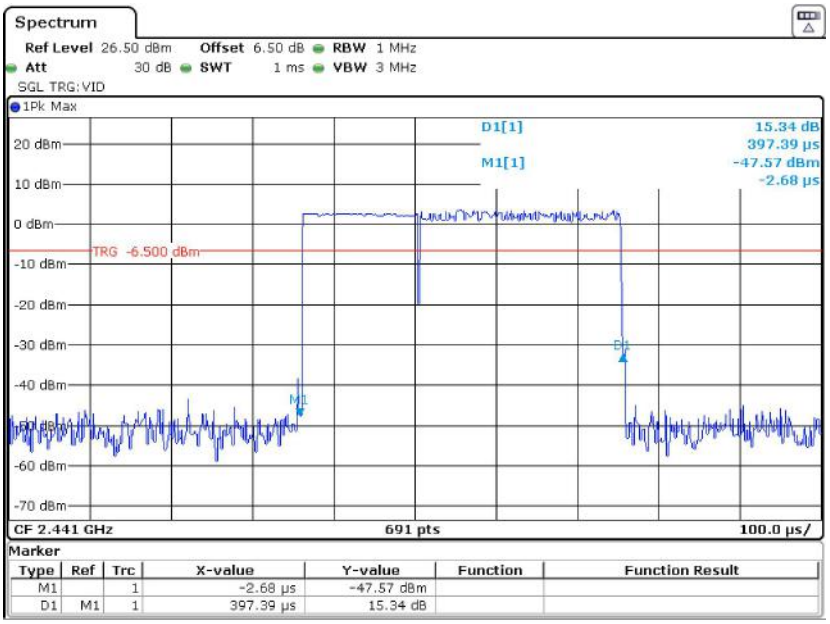
Date: 30.MAY.2022 14:12:09

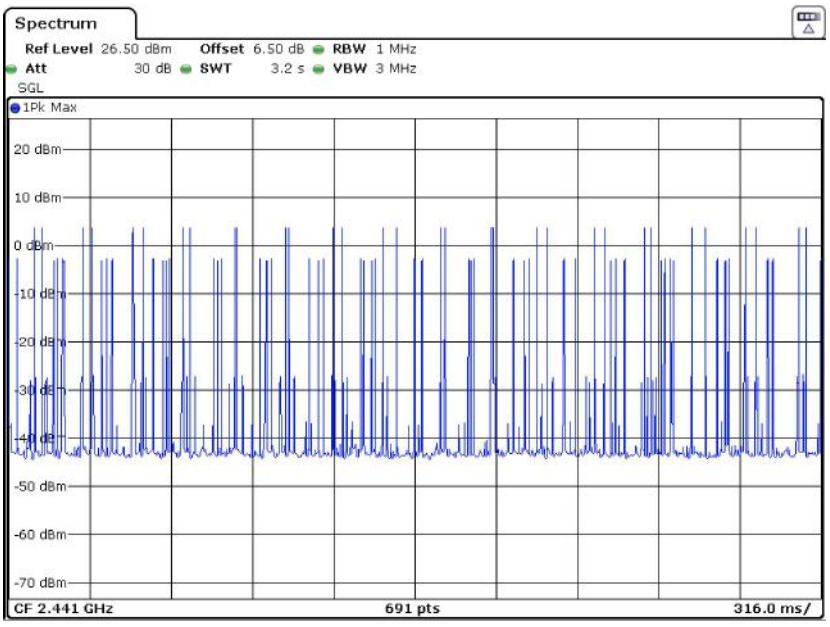
DH5_ Hop


Spectrum
Ref Level 26.50 dBm Offset 6.50 dB RBW 1 MHz
Att 30 dB SWT 5 ms VBW 3 MHz
SGL TRG:VID
1Pk Max
D1[1] 1.87 dB
2.92867 ms
M1[1] -49.77 dBm
-20.92 µs
20 dBm
10 dBm
0 dBm
TRG -6.500 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.441 GHz
691 pts
500.0 µs/
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 -20.92 µs -49.77 dBm
D1 M1 1 2.92867 ms 1.87 dB
Date: 30.MAY.2022 14:41:02

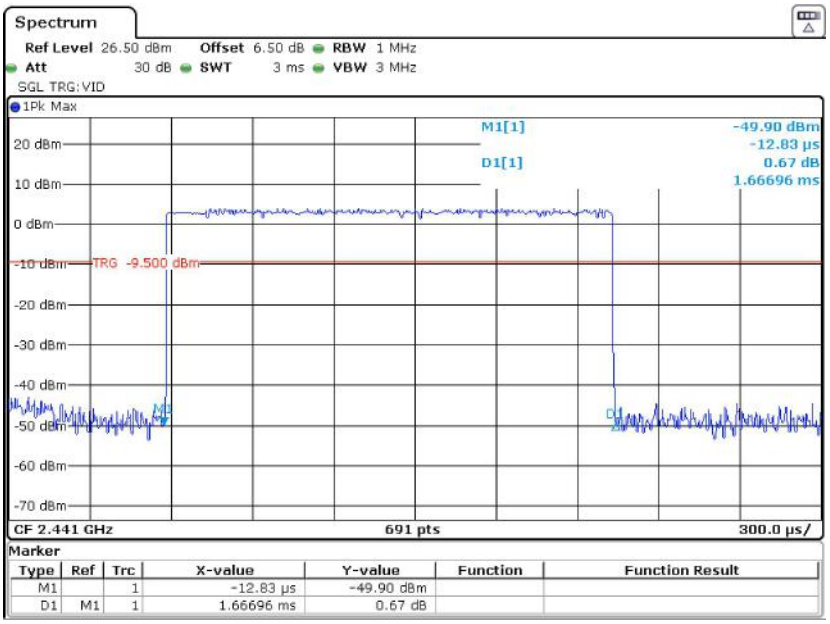

Spectrum
Ref Level 26.50 dBm Offset 6.50 dB RBW 1 MHz
Att 30 dB SWT 3.2 s VBW 3 MHz
SGL
1Pk Max
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.441 GHz
691 pts
316.0 ms/
Date: 30.MAY.2022 14:12:34

2DH1_Hop

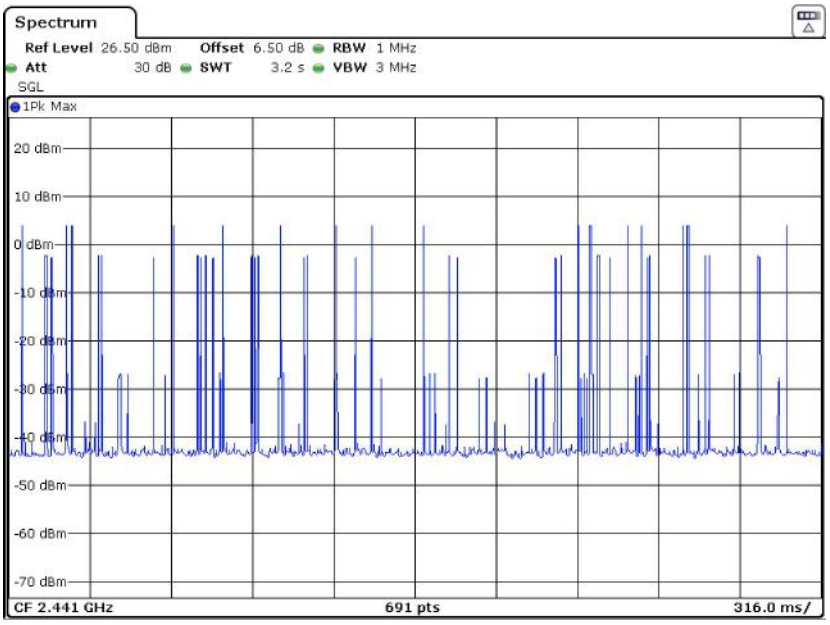

Spectrum
Ref Level 26.50 dBm Offset 6.50 dB RBW 1 MHz
Att 30 dB SWT 1 ms VBW 3 MHz
SGL TRG:VID
1Pk Max
D1[1] 15.34 dB
397.39 µs
M1[1] -47.57 dBm
-2.68 µs
20 dBm
10 dBm
0 dBm
TRG -6.500 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.441 GHz
691 pts
100.0 µs/
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 -2.68 µs -47.57 dBm
D1 M1 1 397.39 µs 15.34 dB
Date: 30.MAY.2022 14:37:45


Spectrum
Ref Level 26.50 dBm Offset 6.50 dB RBW 1 MHz
Att 30 dB SWT 3.2 s VBW 3 MHz
SGL
1Pk Max
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.441 GHz
691 pts
316.0 ms/
Date: 30.MAY.2022 14:09:33

2DH3_ Hop

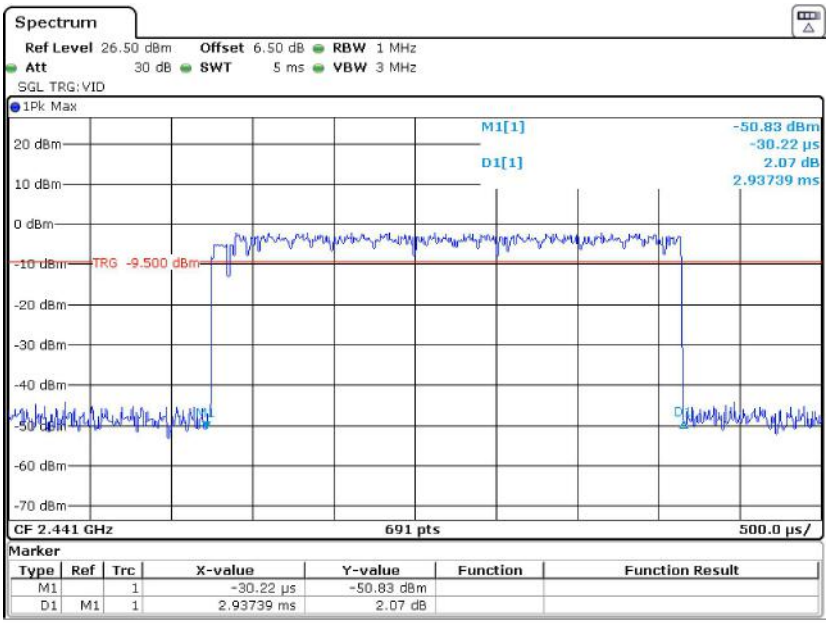


Date: 30.MAY.2022 14:30:18

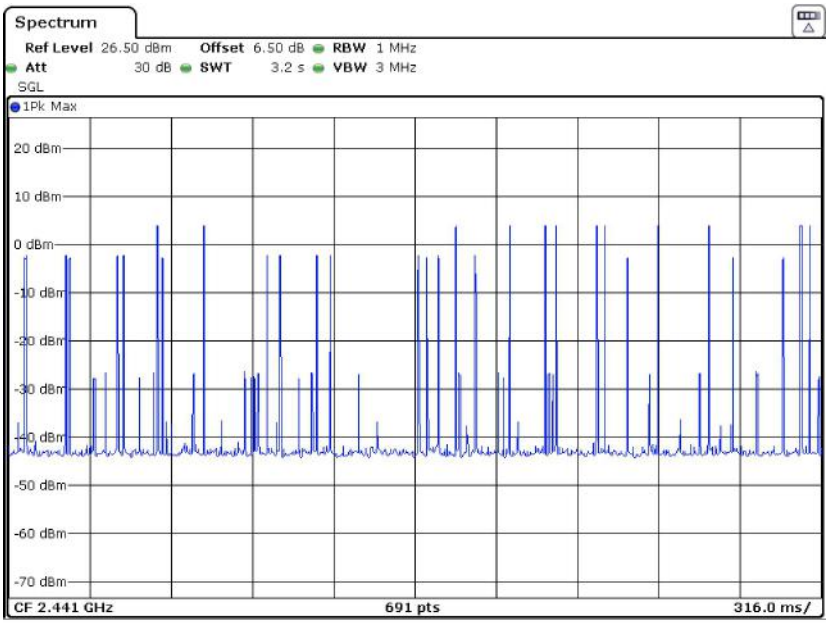


Date: 30.MAY.2022 14:13:13

2DH5_ Hop

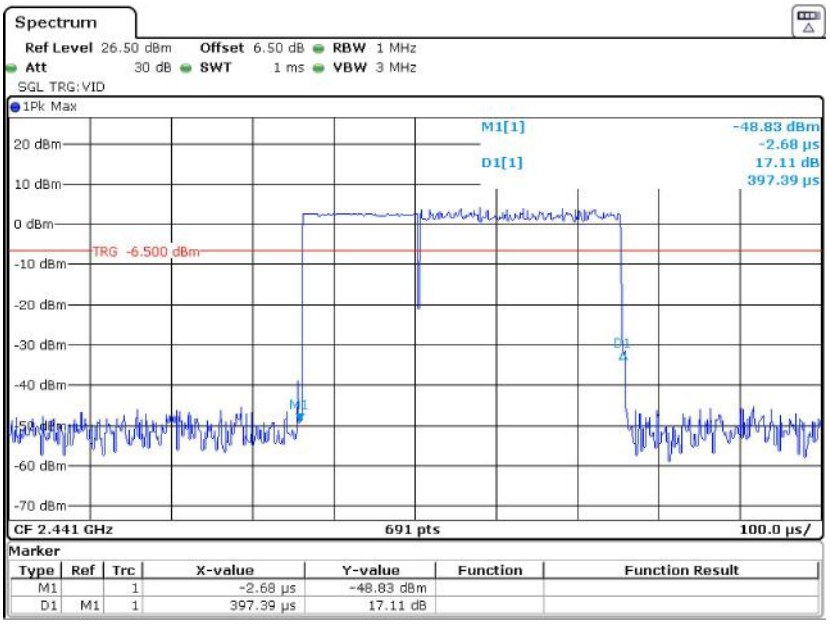


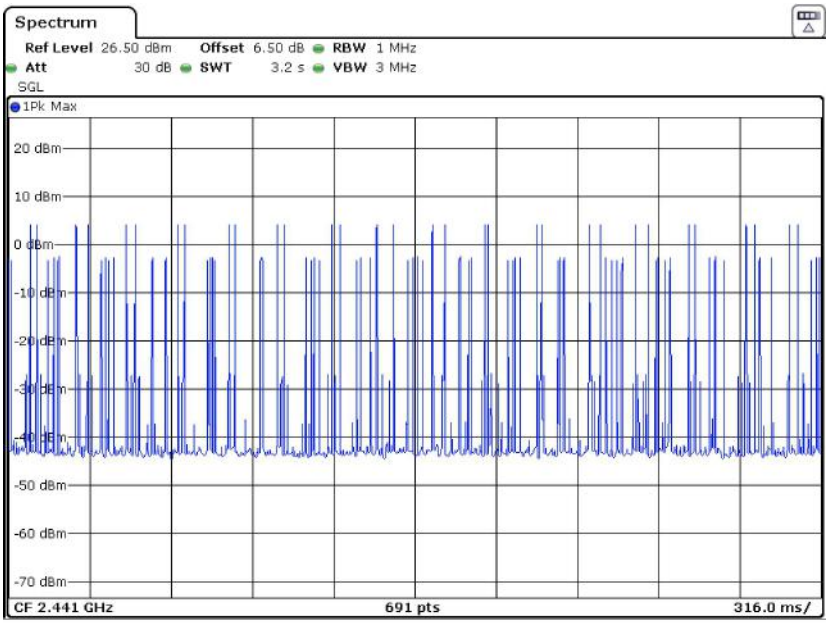
Date: 30.MAY.2022 14:27:12



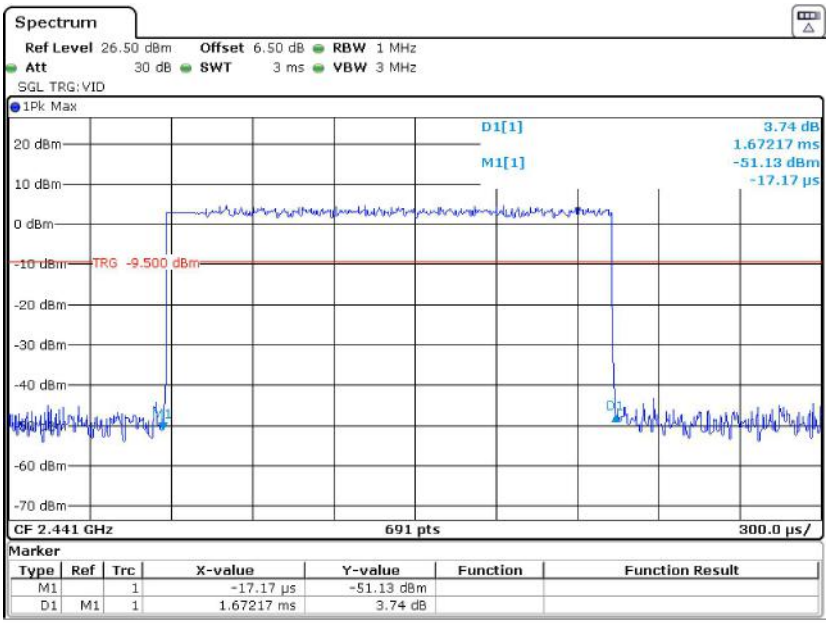
Date: 30.MAY.2022 14:13:35

3DH1_Hop

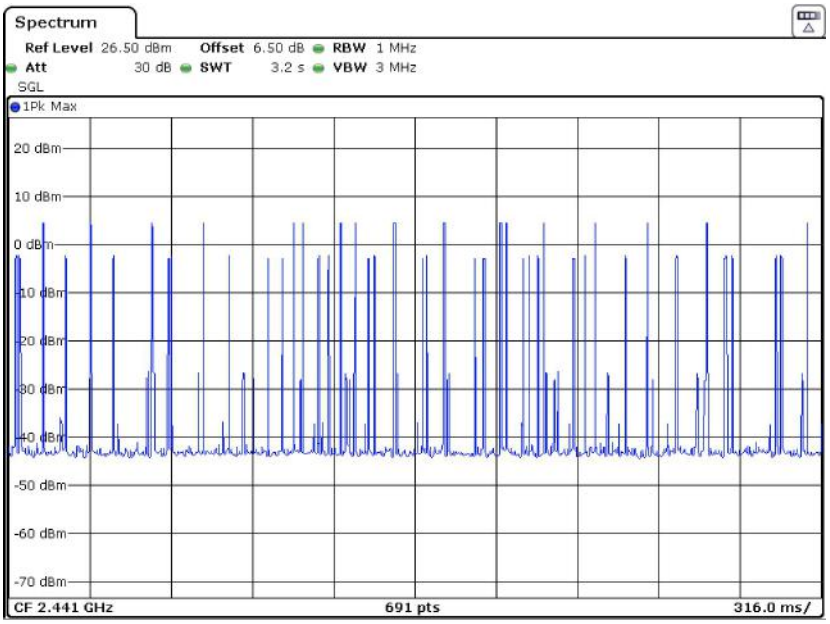

Spectrum
Ref Level 26.50 dBm Offset 6.50 dB RBW 1 MHz
Att 30 dB SWT 1 ms VBW 3 MHz
SGL TRG:VID
1Pk Max
M1[1] -48.83 dBm
-2.68 µs
D1[1] 17.11 dB
397.39 µs
TRG -6.500 dBm
CF 2.441 GHz
691 pts
100.0 µs/
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 -2.68 µs -48.83 dBm
D1 M1 1 397.39 µs 17.11 dB
Date: 30.MAY.2022 14:38:28


Spectrum
Ref Level 26.50 dBm Offset 6.50 dB RBW 1 MHz
Att 30 dB SWT 3.2 s VBW 3 MHz
SGL
1Pk Max
CF 2.441 GHz
691 pts
316.0 ms/
Date: 30.MAY.2022 14:10:00

3DH3_ Hop

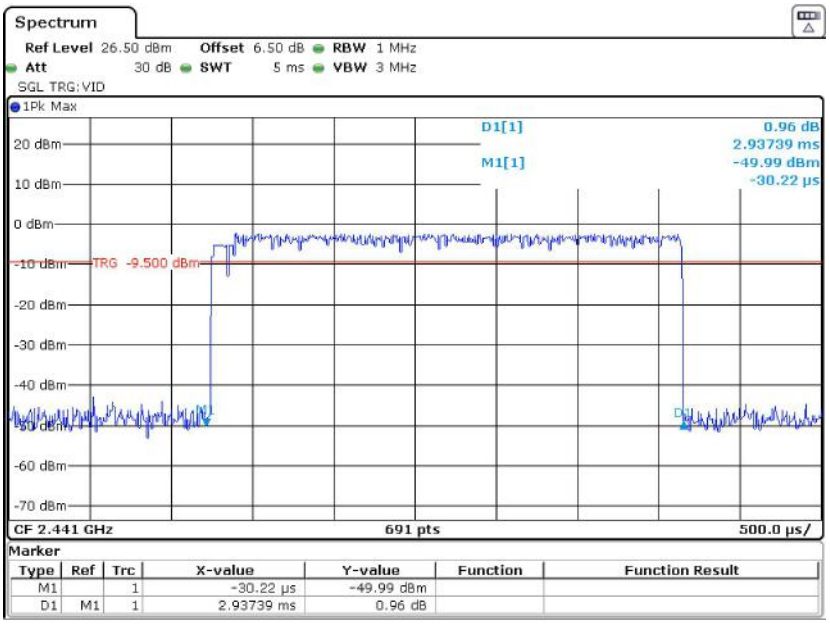


Date: 30.MAY.2022 14:28:59

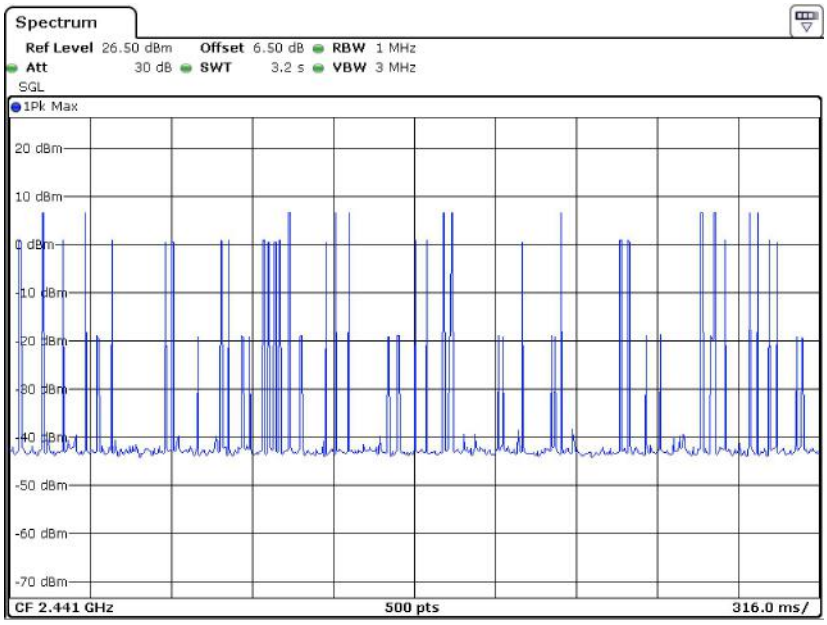


Date: 30.MAY.2022 14:14:26

3DH5_ Hop



Date: 30.MAY.2022 14:25:49



Date: 14.JUN.2022 09:46:05

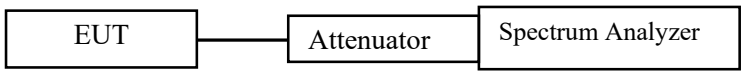
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

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:	28.1 ℃
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

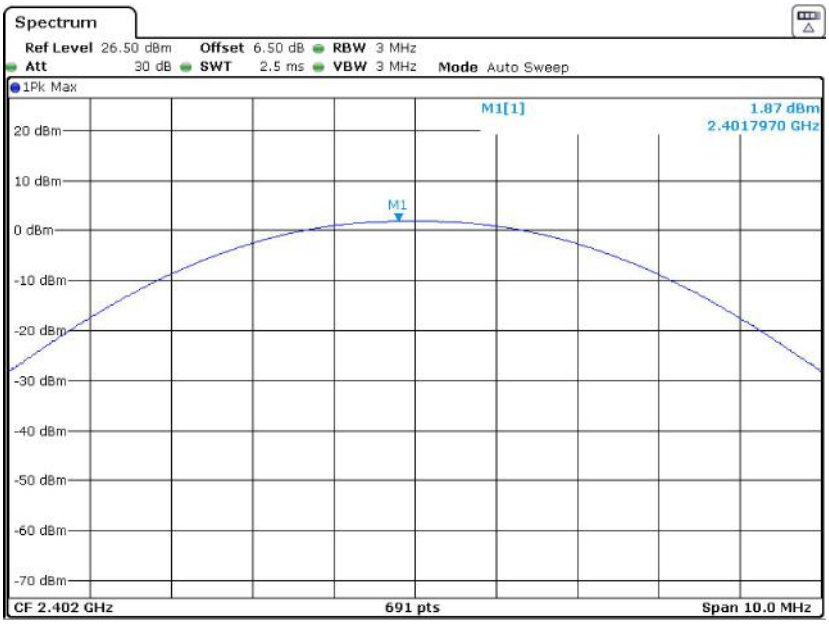
The testing was performed by Ting Lu on 2022-05-30.

EUT operation mode: Transmitting

Test Result: Compliant.

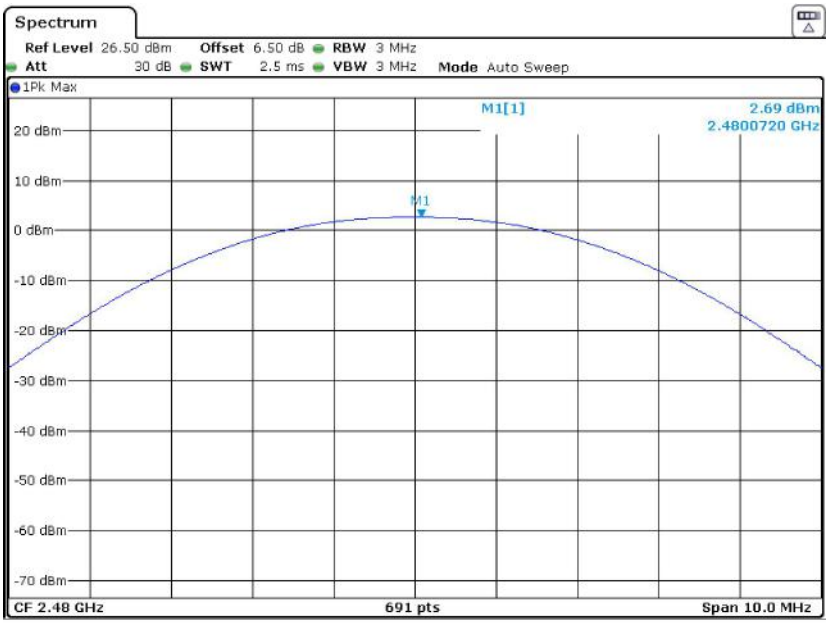
Mode	Channel	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)
BDR (GFSK)	Low	2402	1.87	21
	Middle	2441	1.76	21
	High	2480	2.69	21
EDR (π/4-DQPSK)	Low	2402	4.38	21
	Middle	2441	4.29	21
	High	2480	5.19	21
EDR (8DPSK)	Low	2402	4.93	21
	Middle	2441	4.83	21
	High	2480	5.77	21

DH1_2402MHz

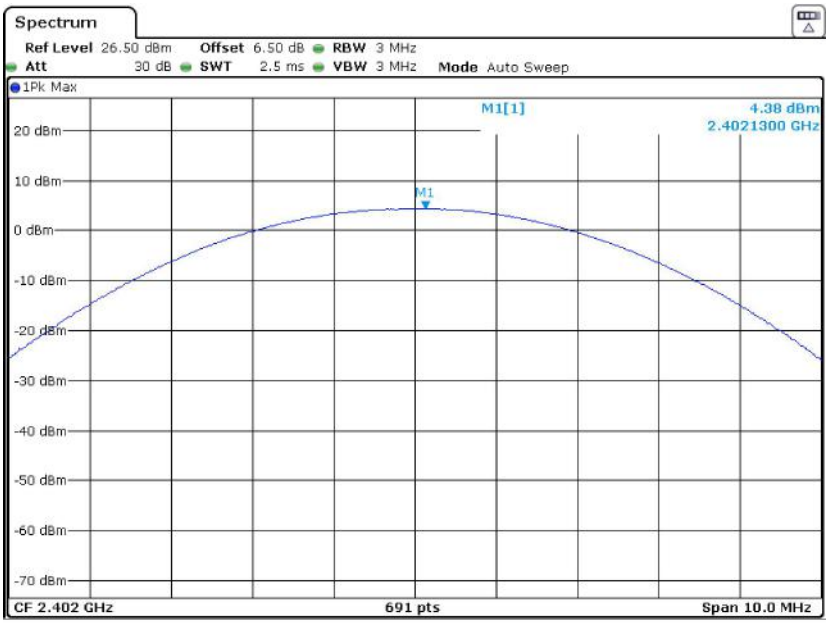


DH1_2441MHz

DH1_2480MHz

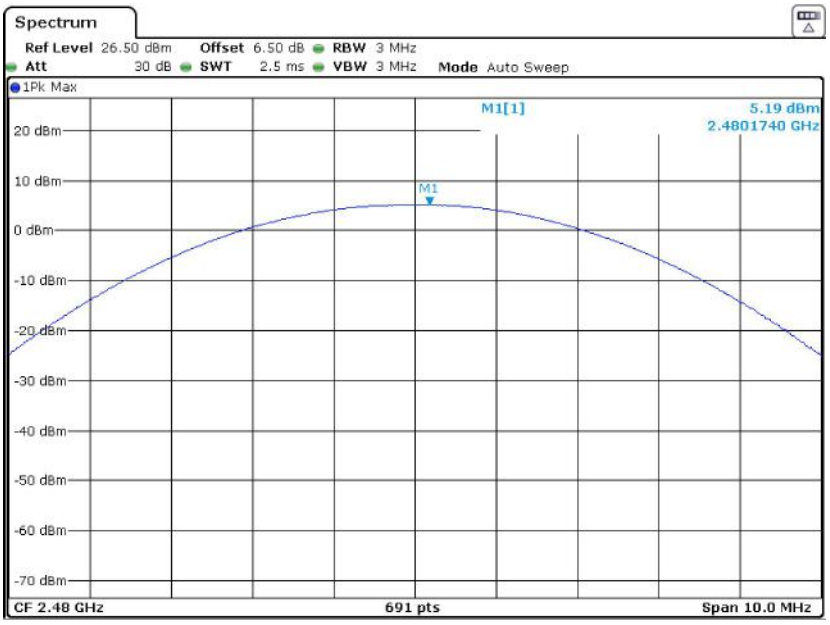


2DH1_2402MHz

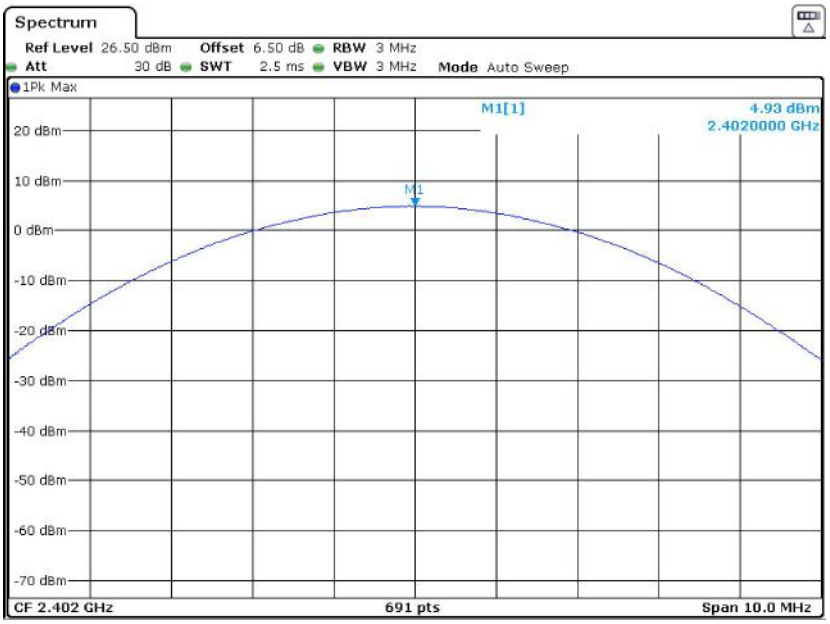


2DH1_2441MHz

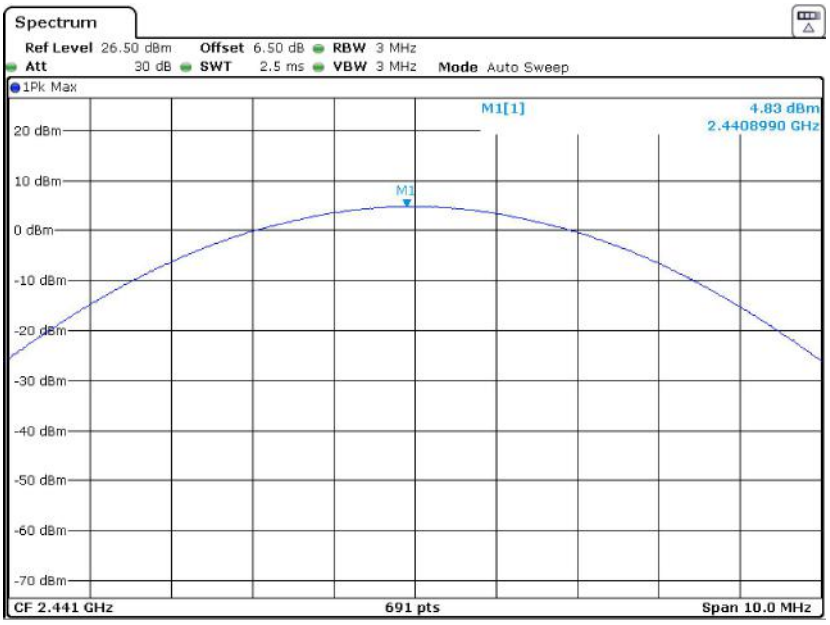
2DH1_2480MHz



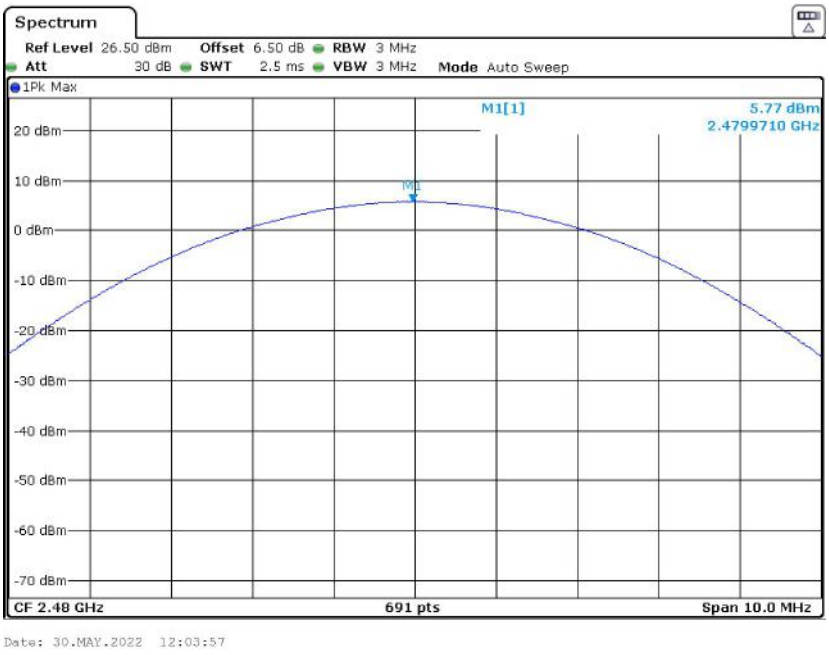
3DH1_2402MHz



3DH1_2441MHz



3DH1_2480MHz



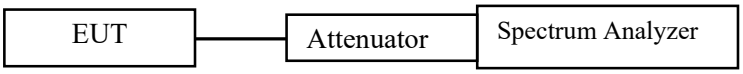
FCC §15.247(d) - BAND EDGES TESTING

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:	28.1 ℃
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

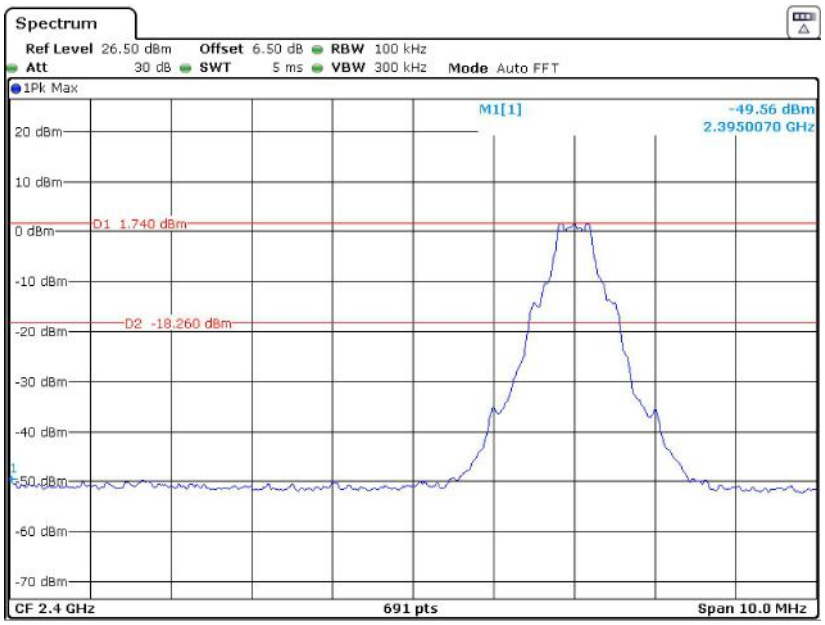
The testing was performed by Ting Lu on 2022-05-30.

EUT operation mode: Transmitting

Test Result: Compliant.

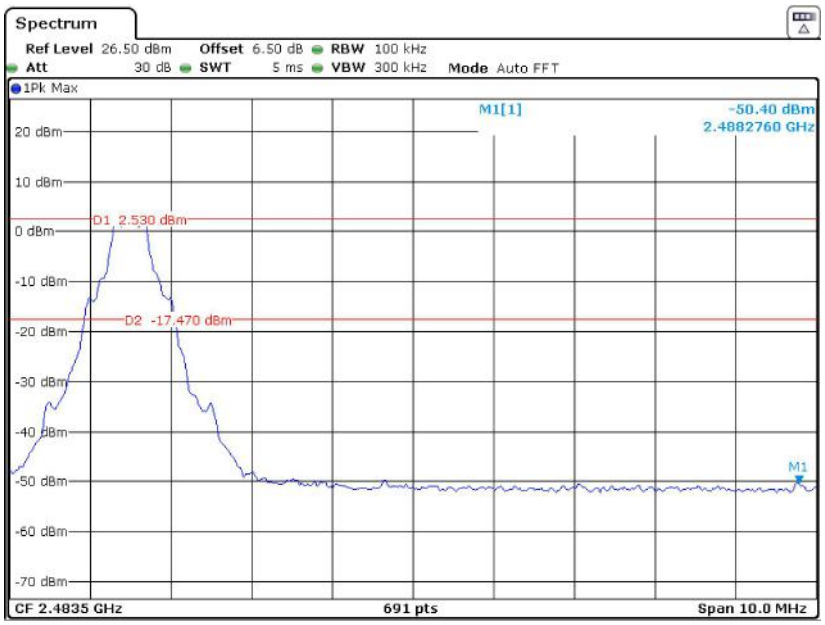
Conducted Band Edge Result:

DH1_Low_2402MHz



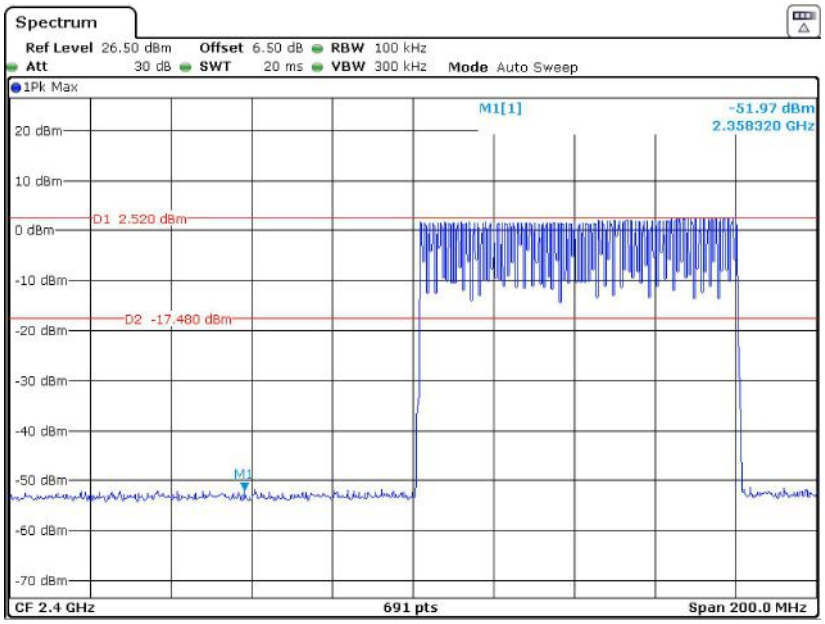
Date: 30.MAY.2022 13:08:09

DH1_High_2480MHz

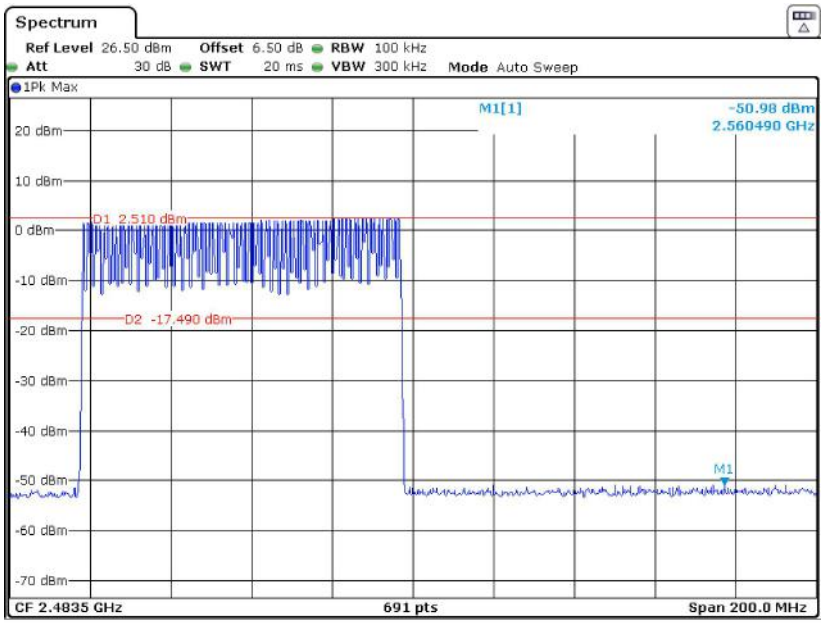


Date: 30.MAY.2022 13:26:53

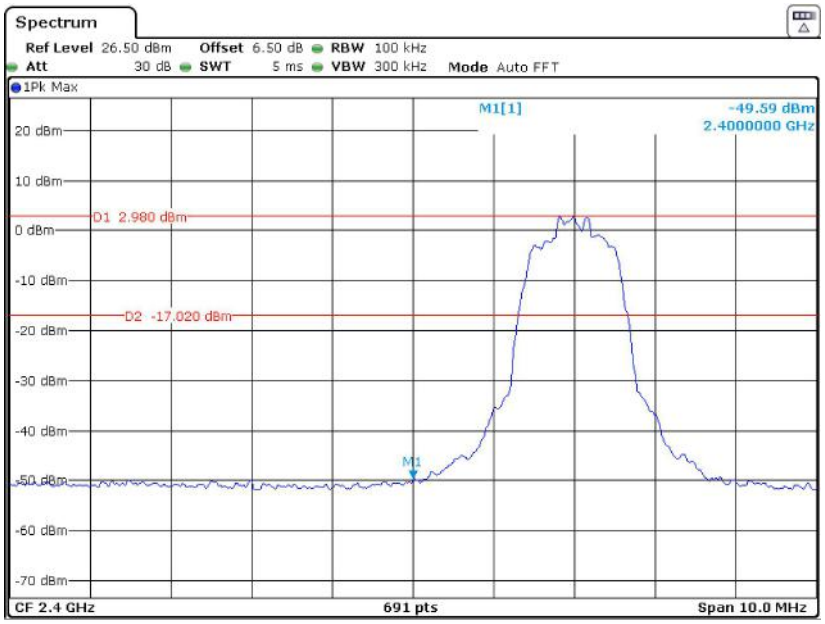
DH1_Low_Hop_2402MHz



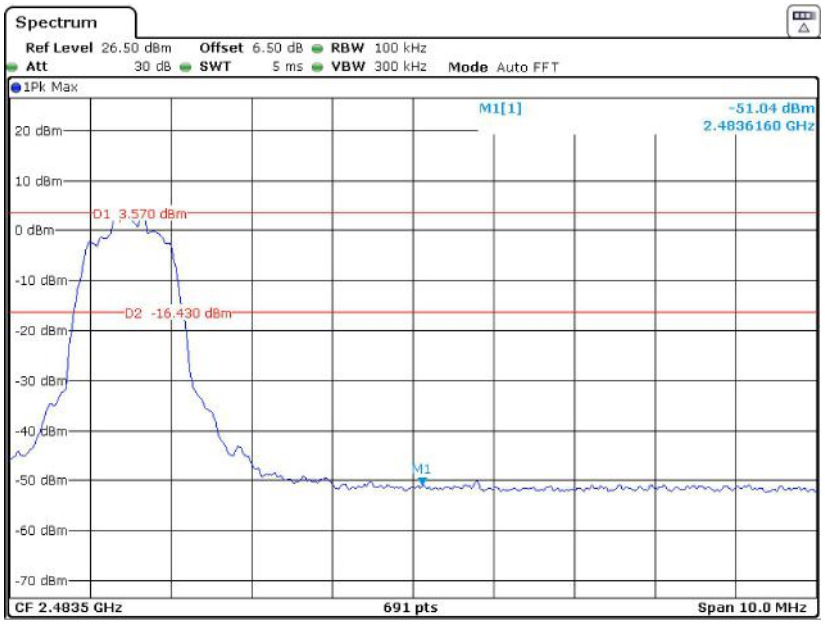
DH1_High_Hop_2480MHz



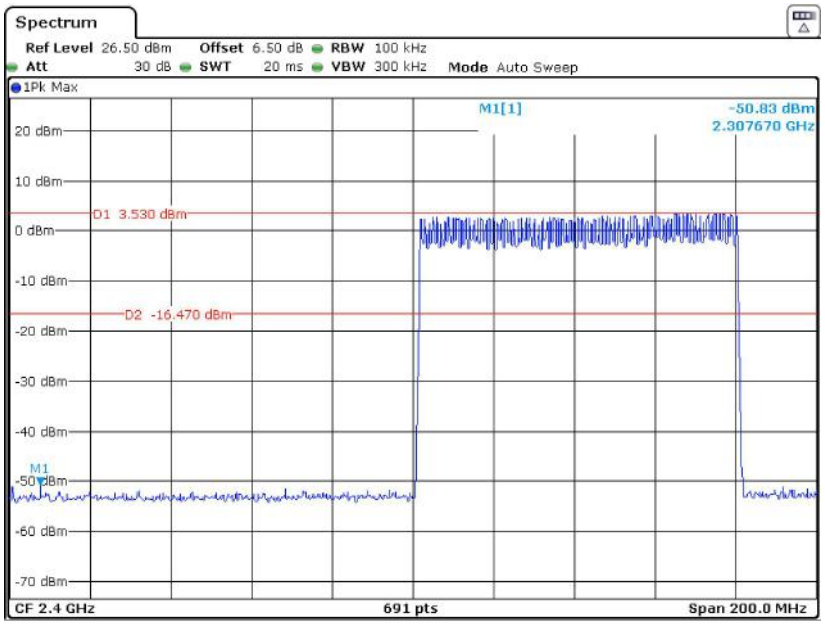
2DH1_Low_2402MHz



2DH1_High_2480MHz

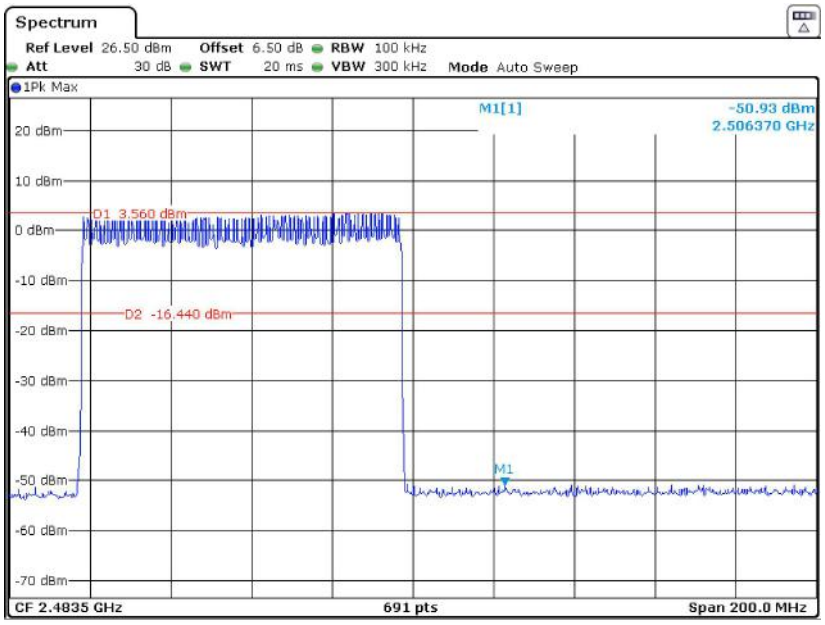


2DH1_Low_Hop_2402MHz



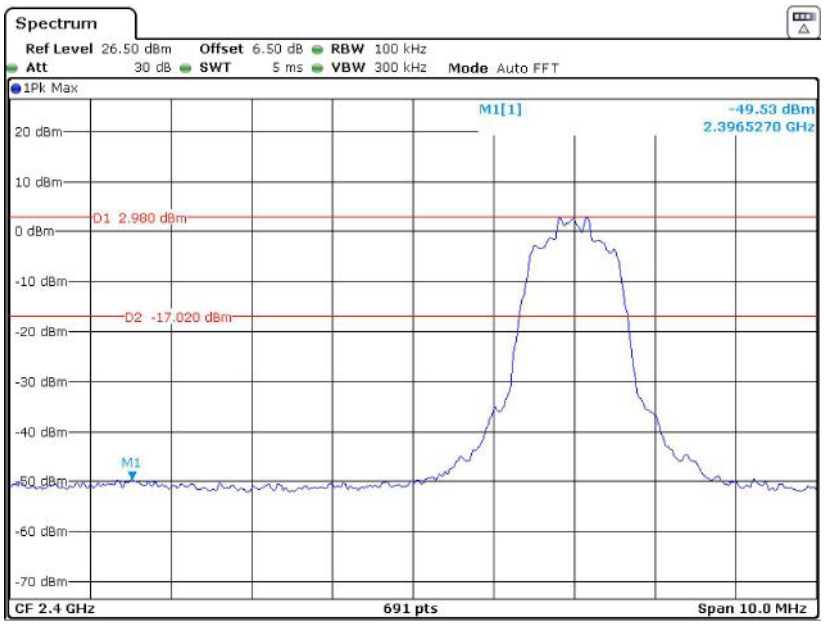
Date: 30.MAY.2022 13:37:02

2DH1_High_Hop_2480MHz

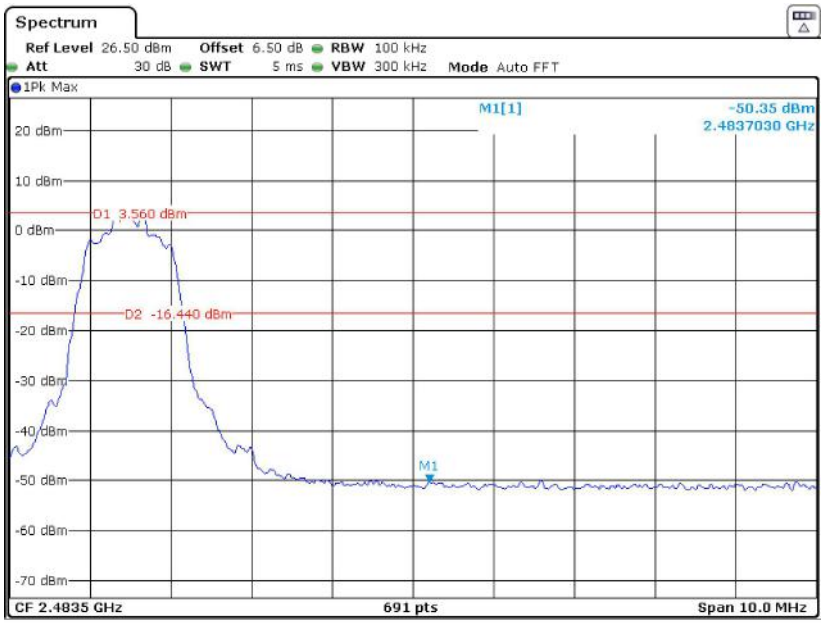


Date: 30.MAY.2022 13:46:21

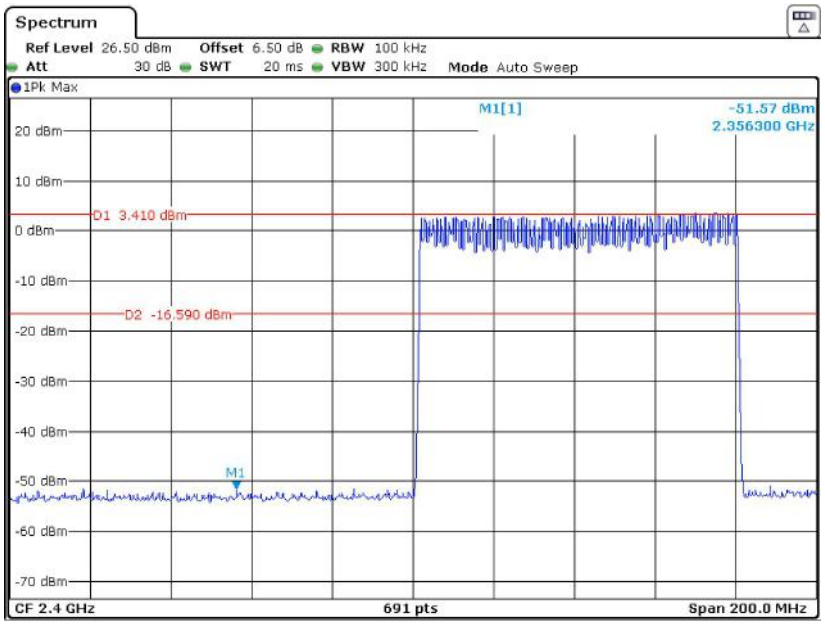
3DH1_Low_2402MHz



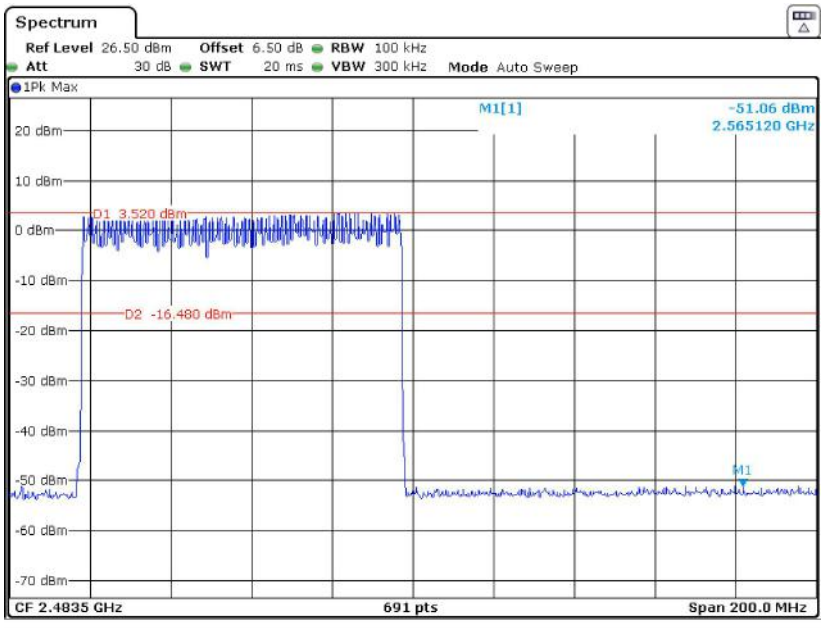
3DH1_High_2480MHz



3DH1_Low_Hop_2402MHz



3DH1_High_Hop_2480MHz



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