TEST REPORT

Applicant Name :	SHENZHEN MOCLOUD TECHNOLOGY CO., LTD.
Address :	Rm 1401-02, Huatong Bldg., Ganli 2nd Road, Jihua Town, Longgang Dist., Shenzhen, China
Report Number :	RA230329-15458E-RF
FCC ID:	2AXUU-ZS-VIBIN-SPKR

Test Standard (s)
FCC PART 15.247

Sample Description

Product Type:	Bluetooth Speaker
Model No.:	ZS-VIBIN-SPKR
Trade Mark:	N/A
Date Received:	2023-03-29
Date of Test:	2023-04-02 to 2023-04-26
Report Date:	2023-04-26

Test Result:	Pass*

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

Prepared and Checked By:

Dave Liang
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.

TABLE OF CONTENTS

DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	RA230329-15458E-RF	Original Report	2023-04-26

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product Type	Bluetooth Speaker
Tested Model	ZS-VIBIN-SPKR
Frequency Range	Bluetooth:2402~2480MHz
Maximum Conducted Peak Output Power	5.21dBm
Modulation Technique	BDR(GFSK)/EDR(π/4-DQPSK)/EDR(8DPSK)
Antenna Specification*	Internal Antenna: 1.08443 dBi(provided by the applicant)
Voltage Range	DC5V from USB port or 3.7V from battery
Sample number	RA230329-15458E-RF-S1(CE&RE) RA230329-15458E-RF-S2(RF Conducted Test) (Assigned by ATC, Shenzhen)
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.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF Frequency		$0.082*10^{-7}$
RF output power, conducted		0.71dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.92dB
Emissions, Radiated	30MHz - 1GHz	5.08dB
	1GHz - 18GHz	4.96dB
	18GHz - 26.5GHz	5.16dB
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 Floor 1, KuMaKe Building, Dongzhou Community, Guangming Street, Guangming District, Shenzhen, Guangdong, 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 4297.01

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 30241.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

Software “bt_tool_v1.1.0 *” was used during testing and the power level was 7*.

Special Accessories

N/A.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

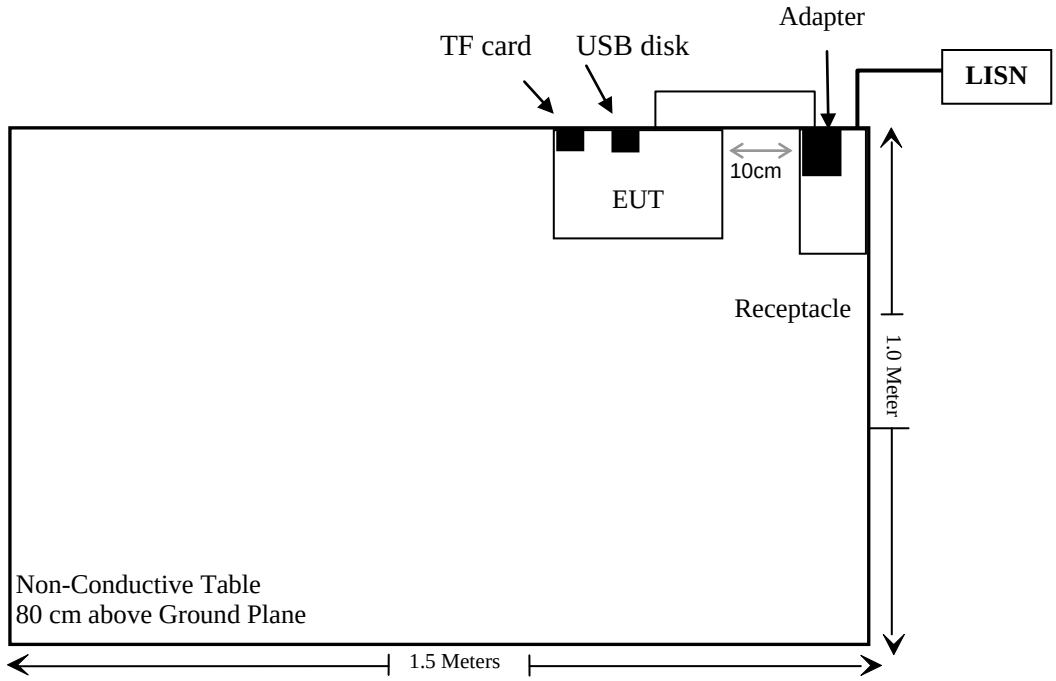
Manufacturer	Description	Model	Serial Number
Unknown	Adapter	KA06E-0501000US	Unknown
Unknown	USB flash disk	Unknown	Unknown
Unknown	TF card	Unknown	Unknown

External I/O Cable

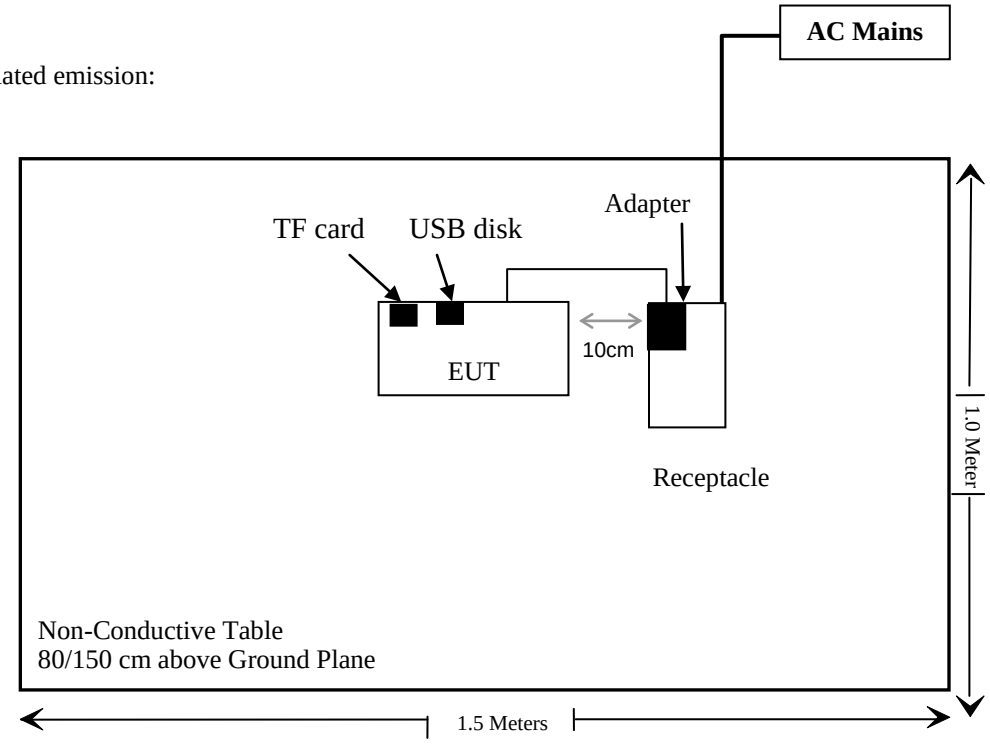
Cable Description	Length(m)	From/Port	To
USB Cable	1.0	EUT	Adapter

Block Diagram of Test Setup

For conducted emission:



For radiated emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1307 (b)	RF Exposure	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 & 99% Occupied 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 Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100784	2022/11/25	2023/11/24
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2022/11/25	2023/11/24
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2022/12/07	2023/12/06
Unknown	RF Coaxial Cable	No.17	N0350	2022/11/25	2023/11/24
Conducted Emission Test Software: e3 191218 (V9)					
Radiated Emissions Test					
Rohde & Schwarz	Test Receiver	ESR	102725	2022/11/25	2023/11/24
Rohde & Schwarz	Spectrum Analyzer	FSV40	101949	2022/11/25	2023/11/24
SONOMA INSTRUMENT	Amplifier	310 N	186131	2022/11/08	2023/11/07
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2022/11/08	2023/11/07
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2022/11/08	2023/11/07
Schwarzbeck	Bilog Antenna	VULB9163	9163-194	2023/02/14	2026/02/13
Schwarzbeck	Horn Antenna	BBHA9120D	837	2023/02/22	2026/02/21
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2022/12/26	2025/12/25
Unknown	RF Coaxial Cable	No.10	N050	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.11	N1000	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.12	N040	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.13	N300	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.14	N800	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.15	N600	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.16	N650	2022/11/25	2023/11/24
Wainwright	High Pass Filter	WHKX3.6/18G-10SS	5	2022/11/25	2023/11/24
Wainwright	Band Reject Filter	WRCG2400/2485-2375/2510-60/11SS	10	2022/11/25	2023/11/24
Radiated Emission Test Software: e3 191218 (V9)					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2022/11/25	2023/11/24
Rohde & Schwarz	Open Switch and Control Unit	OSP120 + OSP-B157	101244 + 100866	2022/11/25	2023/11/24
WEINSCHEL	10dB Attenuator	5324	AU 3842	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.33	RF-03	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 §1.1307 (b)-RF EXPOSURE

Applicable Standard

According to FCC §1.1307(b), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D04 Interim General RF Exposure Guidance v01, clause 2.1.4 –MPE-Based Exemption:

An alternative to the SAR-based exemption is provided in § 1.1307(b)(3)(i)(C), for a much wider frequency range, from 300 kHz to 100 GHz, applicable for separation distances greater or equal to $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. The MPE-based test exemption condition is in terms of ERP, defined as the product of the maximum antenna gain and the delivered maximum time-averaged power. For this case, a RF source is an RF exempt device if its ERP (watts) is no more than a frequency-dependent value, as detailed tabular form in Appendix B. These limits have been derived based on the basic specifications on Maximum Permissible Exposure (MPE) considered for the FCC rules in § 1.1310(e)(1).

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

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

f = frequency in MHz;
R = minimum separation distance from the body of a nearby person (appropriate units, e.g., m);

Test result

For worst case:

Mode	Frequency Range (MHz)	Tune-up Output Power		Antenna Gain		ERP		Evaluation Distance (cm)	MPE-Based Exemption Threshold (mW)
		(dBm)	(mW)	(dBi)	(dBd)	(dBm)	(mW)		
BT	2402-2480	5.5	3.55	1.08443	-1.06557	4.43443	2.7762	20	768

Note 1: The tune-up power was declared by the applicant.
Note 2: 0dBd=2.15dBi.

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

Result: Compliant.

FCC §15.203-ANTENNA REQUIREMENT

Applicable Standard

According to 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 1.08443dBi, fulfill the requirement of this section. Please refer to the EUT photos.

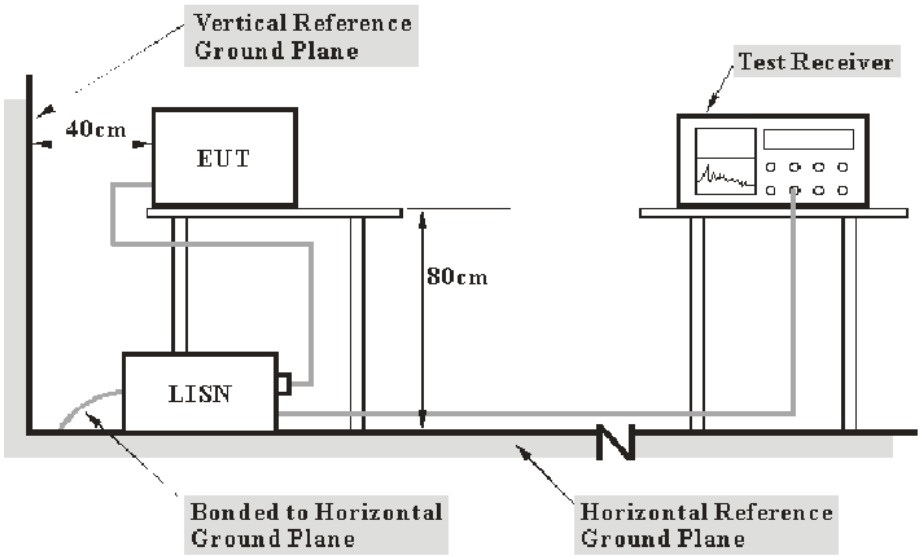
Result: Compliant.

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.

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.

Factor & Margin Calculation

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

Factor = LISN VDF + Cable Loss

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

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

Test Data

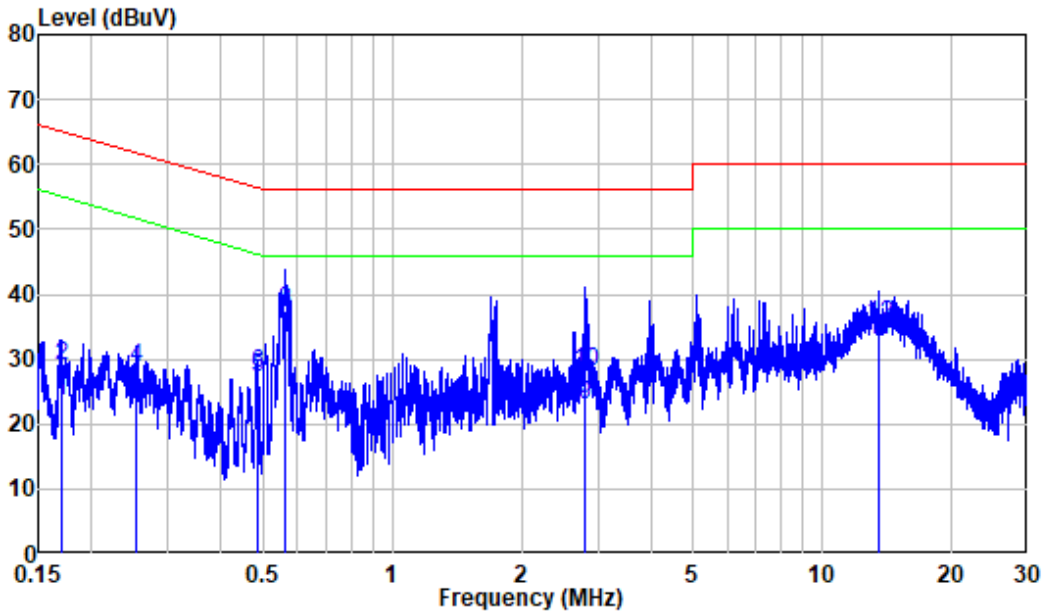
Environmental Conditions

Temperature:	23℃
Relative Humidity:	50%
ATM Pressure:	101kPa

The testing was performed by Lipa Wu on 2023-04-03.

EUT operation mode: Charging+ BT Transmitting (worst case 8DPSK high channel)

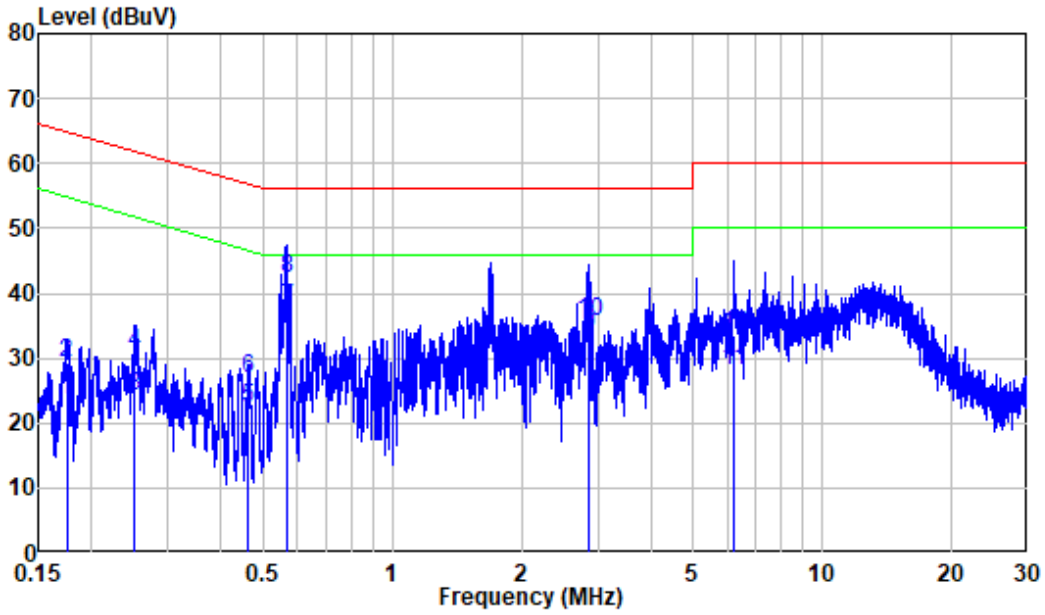
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Job No. : RA230329-15458E-RF
Mode : Charging+BT Transmitting
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.170	10.12	13.47	23.59	54.97	-31.38	Average
2	0.170	10.12	18.99	29.11	64.97	-35.86	QP
3	0.253	10.20	12.94	23.14	51.67	-28.53	Average
4	0.253	10.20	18.48	28.68	61.67	-32.99	QP
5	0.486	10.27	16.85	27.12	46.24	-19.12	Average
6	0.486	10.27	17.45	27.72	56.24	-28.52	QP
7	0.564	10.31	22.92	33.23	46.00	-12.77	Average
8	0.564	10.31	27.01	37.32	56.00	-18.68	QP
9	2.800	10.42	12.44	22.86	46.00	-23.14	Average
10	2.800	10.42	17.80	28.22	56.00	-27.78	QP
11	13.515	10.41	22.51	32.92	50.00	-17.08	Average
12	13.515	10.41	24.79	35.20	60.00	-24.80	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
Condition: Neutral
Job No. : RA230329-15458E-RF
Mode : Charging+BT Transmitting
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.175	9.68	13.94	23.62	54.73	-31.11	Average
2	0.175	9.68	19.52	29.20	64.73	-35.53	QP
3	0.252	9.70	14.48	24.18	51.69	-27.51	Average
4	0.252	9.70	21.09	30.79	61.69	-30.90	QP
5	0.462	9.76	12.43	22.19	46.65	-24.46	Average
6	0.462	9.76	17.00	26.76	56.65	-29.89	QP
7	0.567	9.77	27.96	37.73	46.00	-8.27	Average
8	0.567	9.77	32.49	42.26	56.00	-13.74	QP
9	2.848	9.82	23.57	33.39	46.00	-12.61	Average
10	2.848	9.82	25.78	35.60	56.00	-20.40	QP
11	6.223	9.89	18.22	28.11	50.00	-21.89	Average
12	6.223	9.89	23.68	33.57	60.00	-26.43	QP

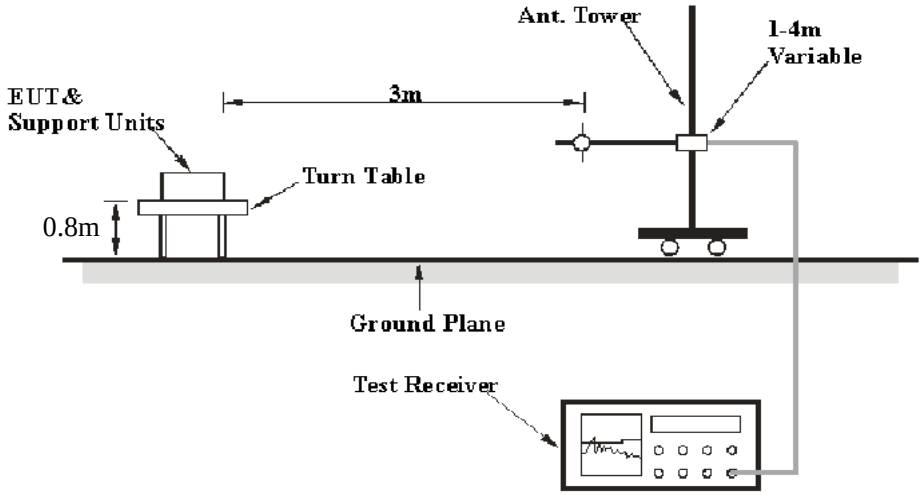
FCC §15.205, §15.209 & §15.247(d)-RADIATED EMISSIONS

Applicable Standard

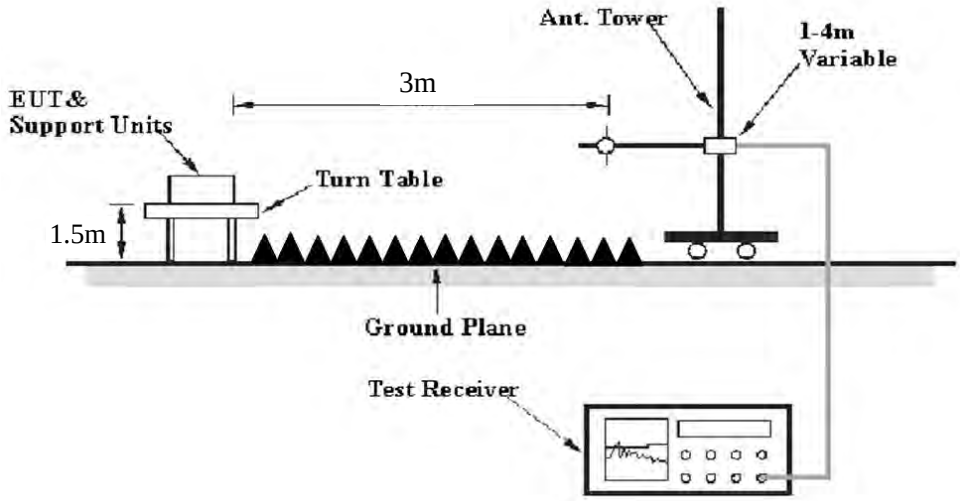
FCC §15.205; §15.209; §15.247(d)

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	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

For average measurement:

Use the duty cycle factor correction factor method per 15.35(c).
Duty cycle=On time/100milliseconds, On time=N1*L1+N2*L2+…Nn-1*Ln-1+Nn*Ln,
Where N1 is number of type 1 pulses, L1 is length of type 1 pulse, etc.
Average Emission Level=Peak Emission Level+20*log(Duty cycle)

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.

If the maximized peak measured value complies with the limit, then it is unnecessary to perform an QP/Average measurement

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

Test Data

Environmental Conditions

Temperature:	24℃
Relative Humidity:	56-57%
ATM Pressure:	101.0kPa

The testing was performed by Jimi Zheng from 2023-04-02 to 2023-04-06.

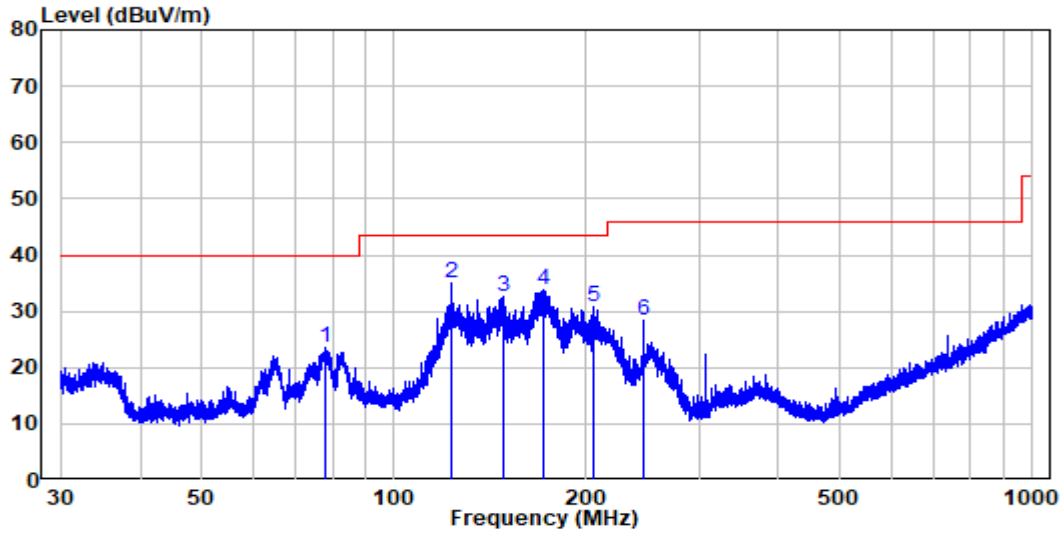
EUT operation mode: Charging+ BT Transmitting

(Scan with GFSK, π/4-DQPSK, 8DPSK mode at X axis, Y axis, Z axis, the worst case is 8DPSK Mode at Y axis)

Below 1GHz:

Worst case for 8DPSK, High Channel:

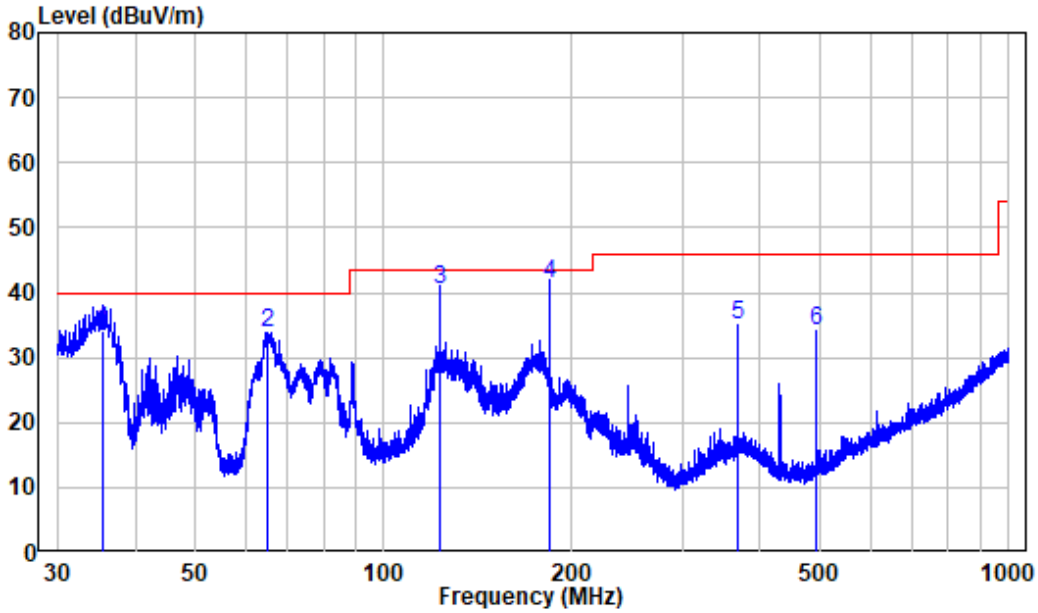
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230329-15458E-RF
Test Mode: Charging+BT Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	77.797	-13.31	36.86	23.55	40.00	-16.45	Peak
2	122.834	-10.92	46.00	35.08	43.50	-8.42	Peak
3	148.246	-10.38	43.02	32.64	43.50	-10.86	Peak
4	171.242	-10.28	44.21	33.93	43.50	-9.57	Peak
5	205.315	-10.75	41.53	30.78	43.50	-12.72	Peak
6	245.735	-12.23	40.61	28.38	46.00	-17.62	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : RA230329-15458E-RF
Test Mode: Charging+BT Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	35.406	-14.47	48.51	34.04	40.00	-5.96	QP
2	65.229	-13.76	47.67	33.91	40.00	-6.09	Peak
3	122.942	-10.92	51.50	40.58	43.50	-2.92	QP
4	184.409	-10.29	51.70	41.41	43.50	-2.09	QP
5	368.758	-11.27	46.33	35.06	46.00	-10.94	Peak
6	491.821	-14.10	48.25	34.15	46.00	-11.85	Peak

Above 1GHz (worst case for 8DPSK):

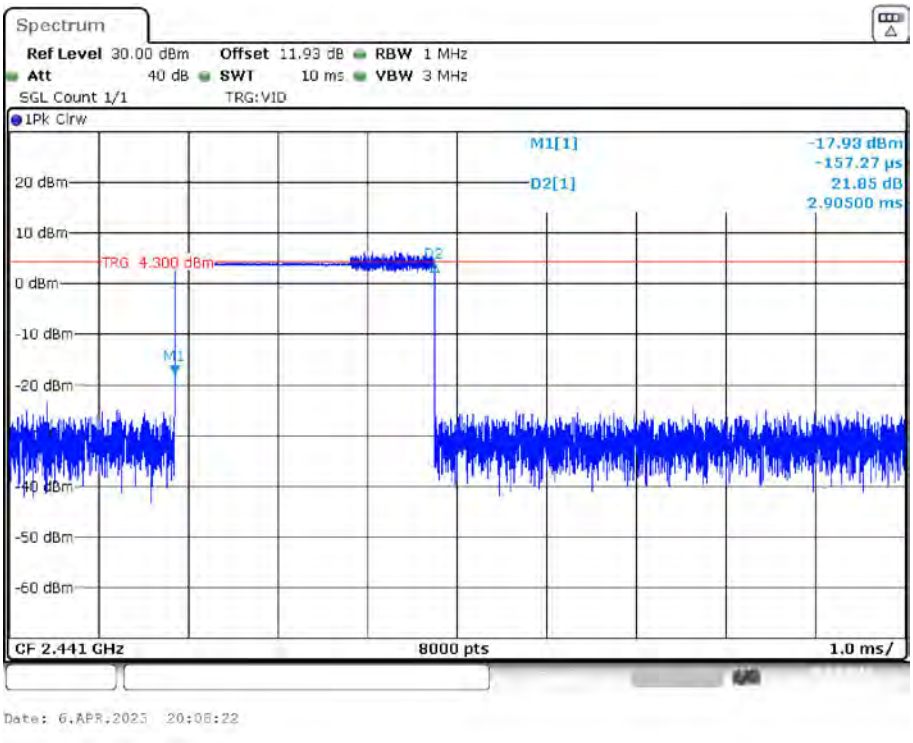
Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/Ave		Height (m)	Polar (H/V)				
Low Channel									
2310	43.55	PK	273	1.4	H	-7.23	36.32	74	-37.68
2310	45.55	PK	34	1.7	V	-7.23	38.32	74	-35.68
2390	47.98	PK	90	1.0	H	-7.21	40.77	74	-33.23
2390	47.41	PK	184	2.1	V	-7.21	40.2	74	-33.80
4804	67.82	PK	273	1.4	H	-3.52	64.30	74	-9.70
4804	59.37	PK	90	1.0	V	-3.52	55.85	74	-18.15
Middle Channel									
4882	67.63	PK	104	1.3	H	-3.37	64.26	74	-9.74
4882	58.80	PK	103	1.3	V	-3.37	55.43	74	-18.57
High Channel									
2483.5	57.40	PK	34	1.3	H	-7.2	50.2	74	-23.80
2483.5	51.36	PK	38	2.0	V	-7.2	44.16	74	-29.84
2500	46.39	PK	263	1.9	H	-7.18	39.21	74	-34.79
2500	43.54	PK	184	1.1	V	-7.18	36.36	74	-37.64
4960	67.58	PK	34	1.3	H	-3.01	64.57	74	-9.43
4960	62.99	PK	263	1.9	V	-3.01	59.98	74	-14.02

Field Strength of Average						
Frequency (MHz)	Peak Measurement @3m (dBμV/m)	Polar (H/V)	Duty Cycle Correction Factor (dB)	Corrected Ampitude (dBμV/m)	FCC Part 15.247	
					Limit (dBμV/m)	Margin (dB)
Low Channel						
4804	64.30	H	-24.7	39.60	54	-14.40
4804	55.85	V	-24.7	31.15	54	-22.85
Middle Channel						
4882	64.26	H	-24.7	39.56	54	-14.44
4882	55.43	V	-24.7	30.73	54	-23.27
High Channel						
4960	64.57	H	-24.7	39.87	54	-14.13
4960	59.98	V	-24.7	35.28	54	-18.72

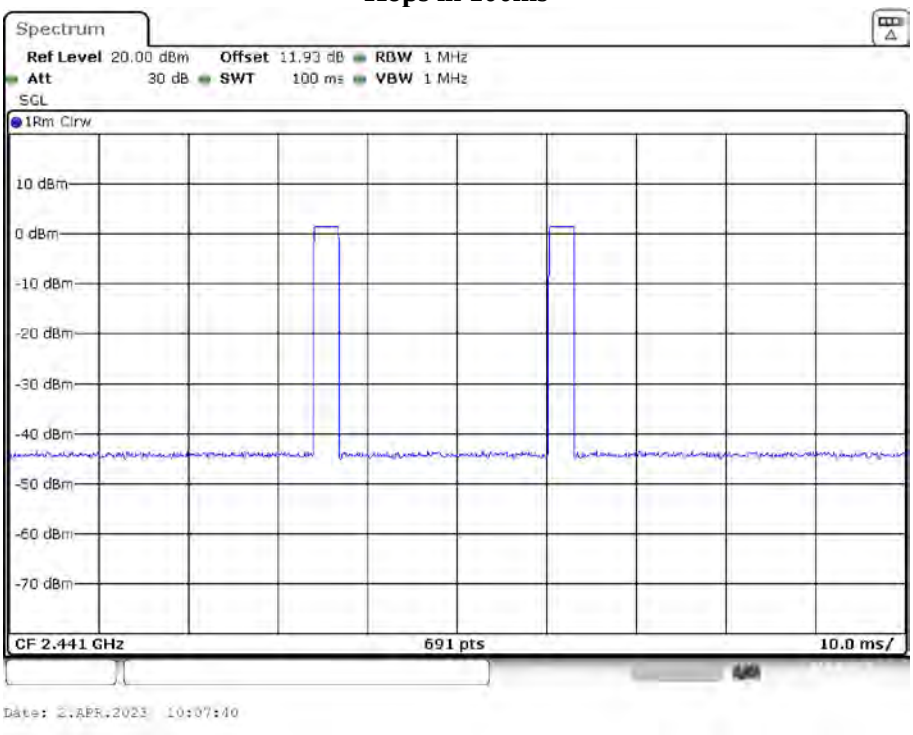
Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Factor + Reading
Margin = Corrected Amplitude – Limit
Average level= Peak level+ Duty Cycle Corrected Factor
The other spurious emission which is in the noise floor level was not recorded.
For above 1GHz, when the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

The worst case duty cycle as below:
Duty cycle = Ton/100ms = (2.91*2)/100=0.0582
Duty Cycle Corrected Factor = 20*lg (Duty cycle) = 20*lg(0.0582) = -24.7

Pulse time



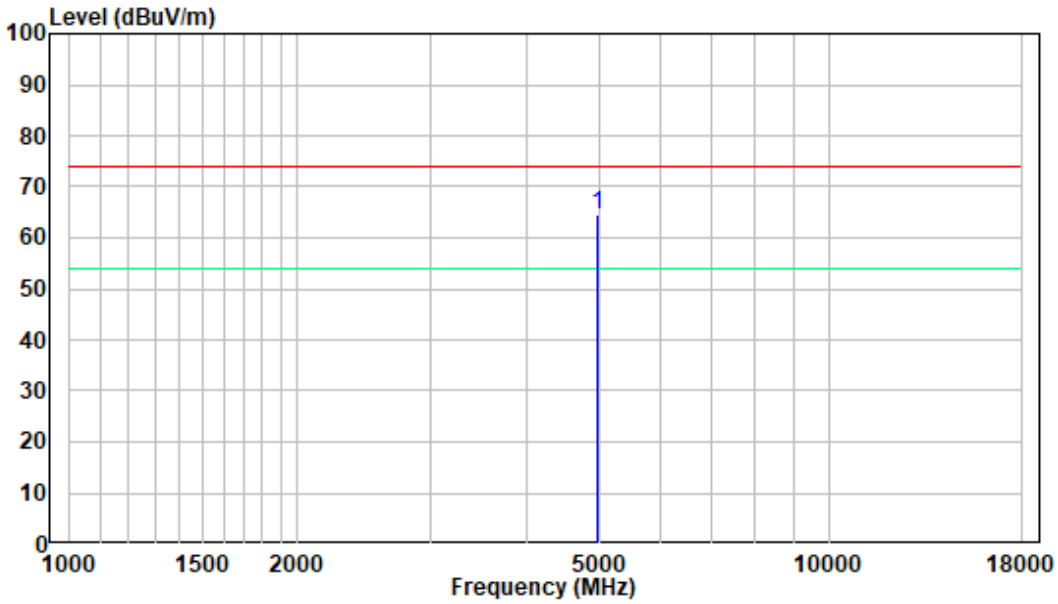
Hops in 100ms



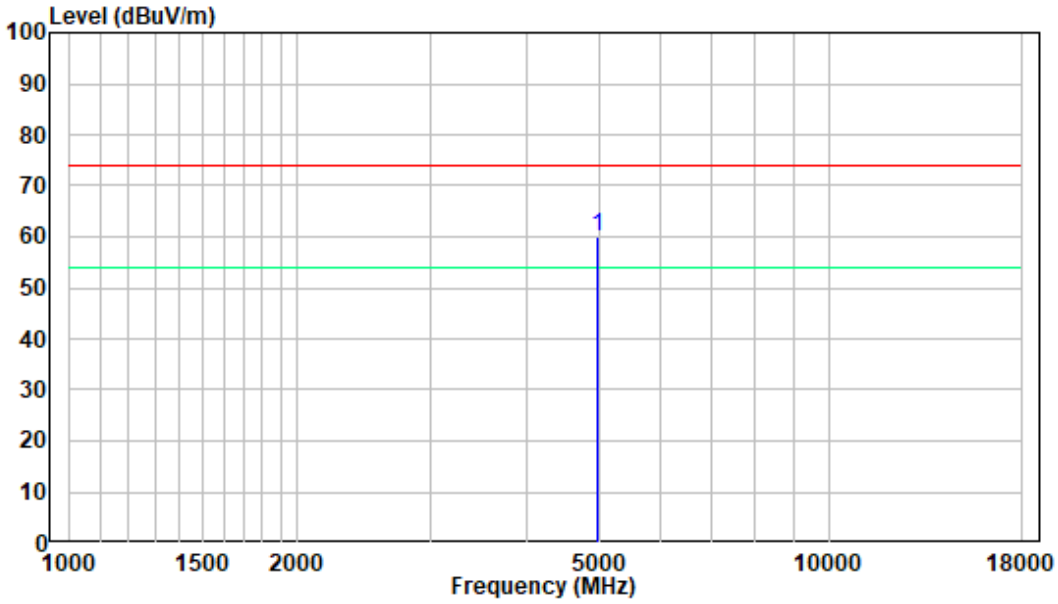
1 GHz - 18 GHz: (Pre-Scan plots)

Worst case for 8DPSK, High Channel:

Horizontal



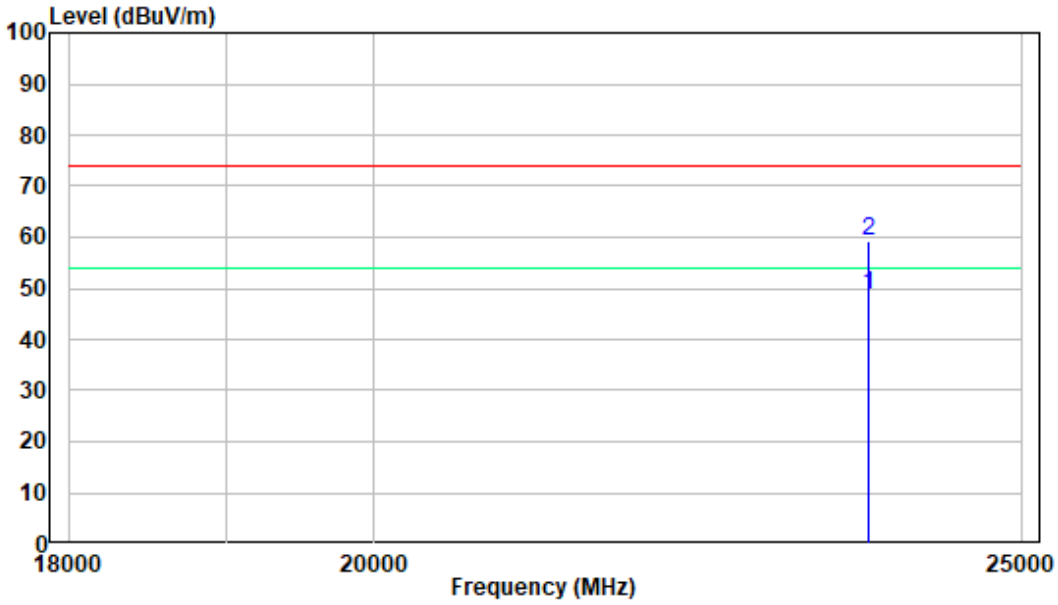
Vertical



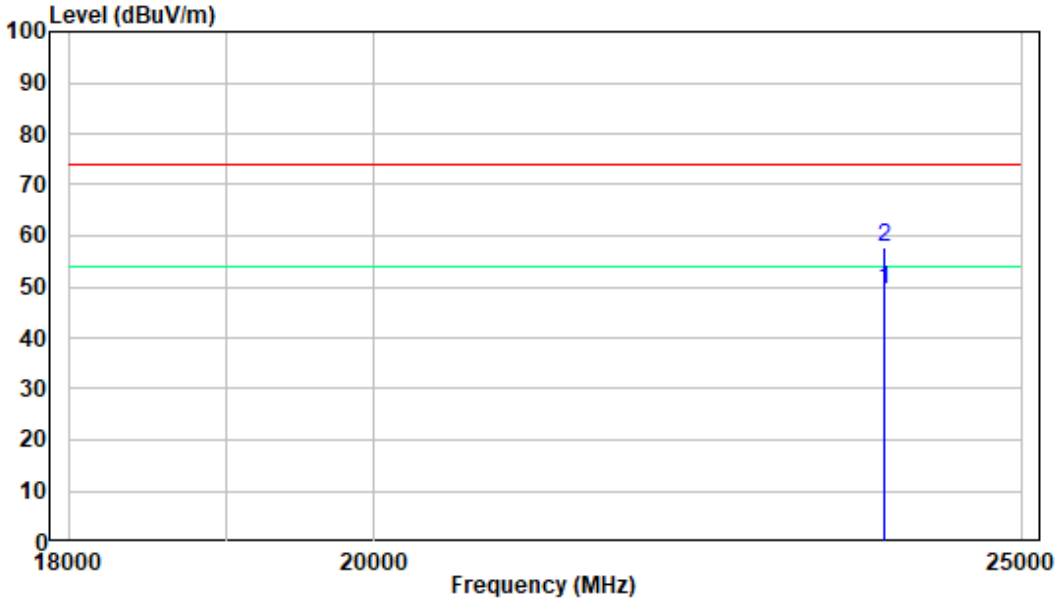
18-25GHz: (Pre-Scan plots)

Worst case for 8DPSK, High Channel:

Horizontal



Vertical



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

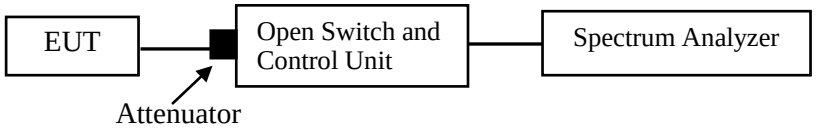
Applicable Standard

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Test Procedure

According to ANSI C63.10-2013, section 7.8.2

1. Set the EUT in TX 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:	24℃
Relative Humidity:	48%
ATM Pressure:	101kPa

The testing was performed by Dave Liang on 2023-04-26.

EUT operation mode: Transmitting

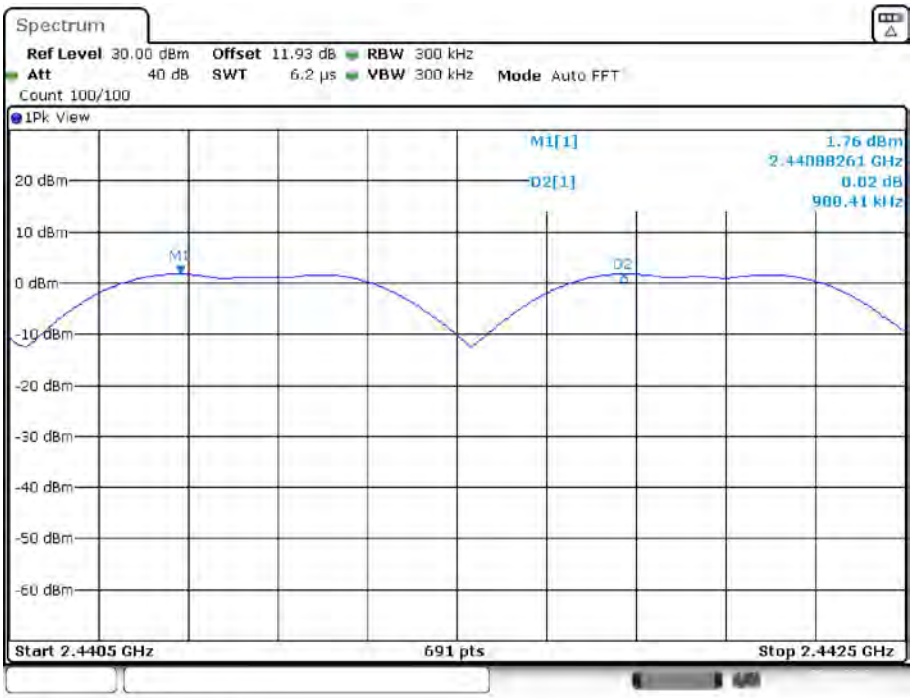
Test Result: Compliant.

Test Mode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop	0.988	≥0.512	PASS
2DH5	Ant1	Hop	0.997	≥0.756	PASS
3DH5	Ant1	Hop	1	≥0.860	PASS

Note: The limit = (2/3) * 20dB bandwidth

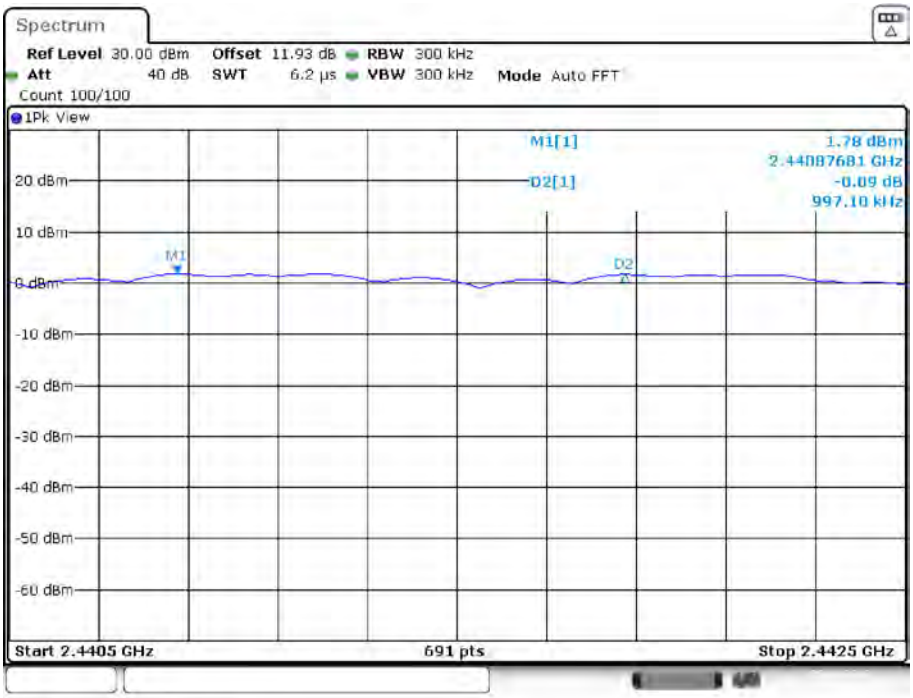
Please refer to the below plots:

DH5_Ant1_Hop



Date: 26.APR.2023 11:06:18

2DH5_Ant1_Hop



Date: 26.APR.2023 11:46:16

3DH5_Ant1_Hop

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

According to ANSI C63.10-2013, section 7.8.7 and section 6.9.2

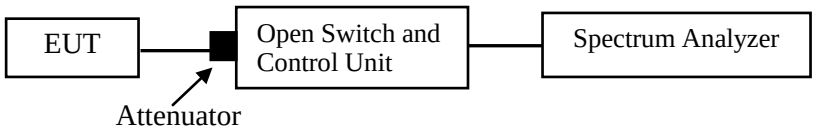
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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 TX 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:	24℃
Relative Humidity:	48%
ATM Pressure:	101kPa

The testing was performed by Dave Liang on 2023-04-26.

.

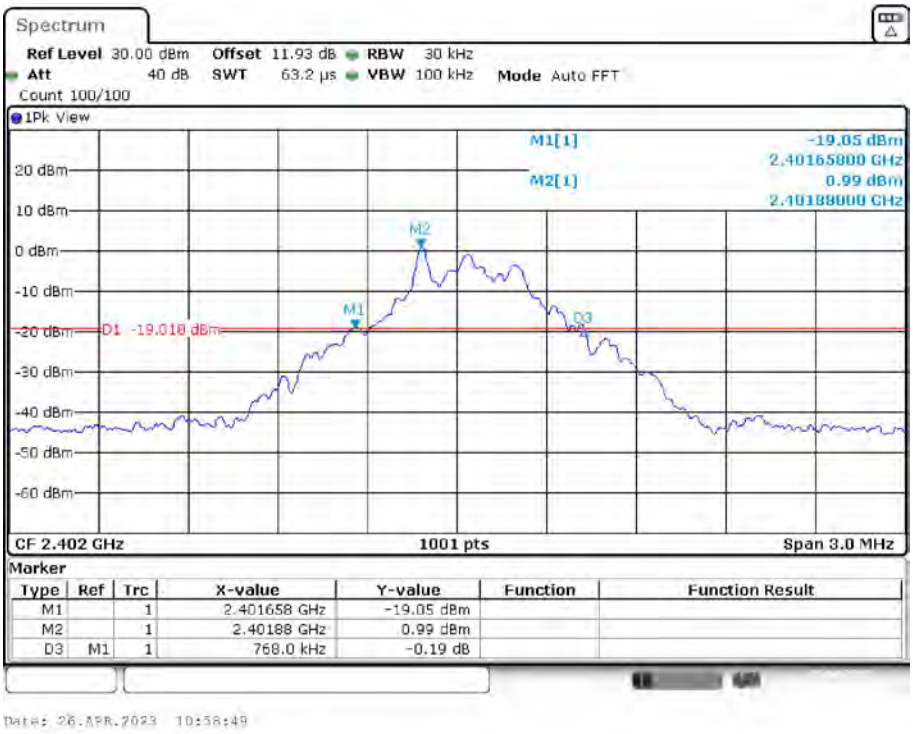
EUT operation mode: Transmitting

Test Result: Compliant.

Test Mode	Antenna	Channel	20db EBW[MHz]	OCB [MHz]	Verdict
DH5	Ant1	2402	0.768	0.776	PASS
		2441	0.720	0.773	PASS
		2480	0.720	0.776	PASS
2DH5	Ant1	2402	1.131	1.088	PASS
		2441	1.119	1.088	PASS
		2480	1.134	1.088	PASS
3DH5	Ant1	2402	1.272	1.190	PASS
		2441	1.251	1.190	PASS
		2480	1.290	1.187	PASS

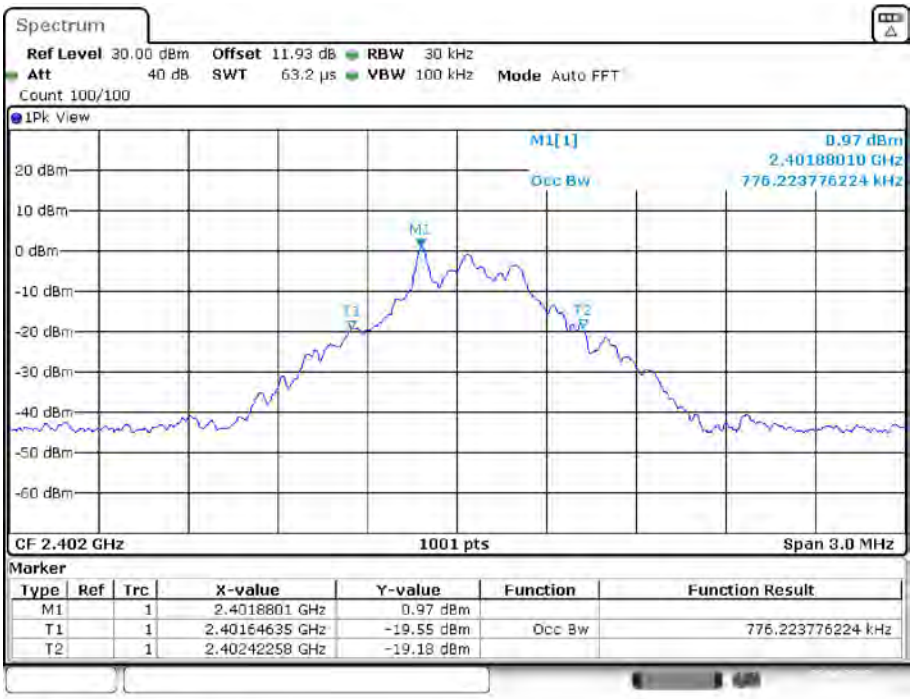
Please refer to the below plots:

20 dB EMISSION BANDWIDTH_DH5_Ant1_2402



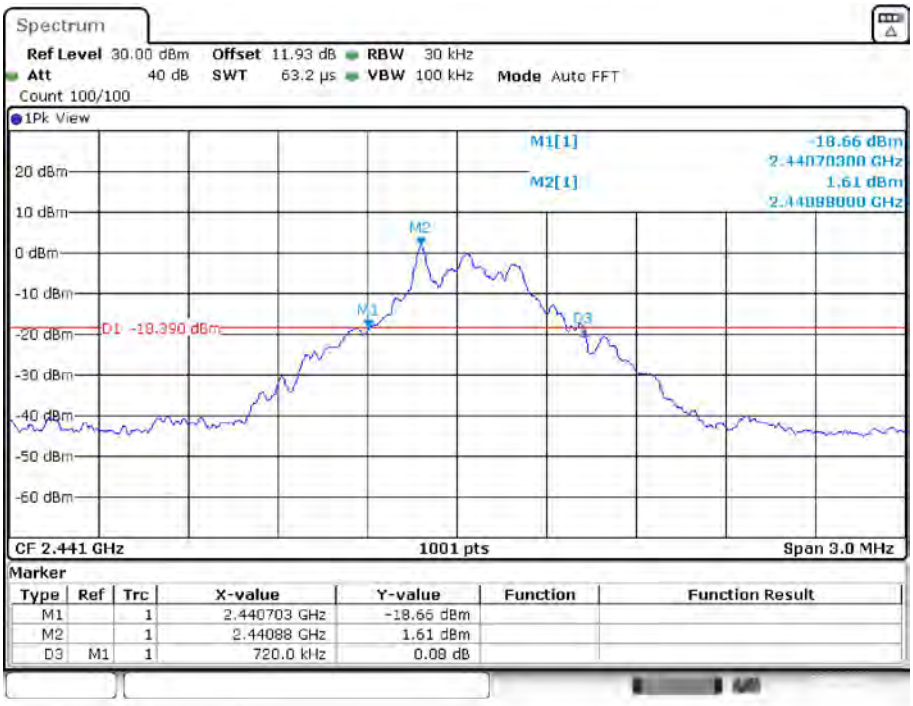
Date: 26.APR.2023 10:58:49

99% OCCUPIED BANDWIDTH_DH5 _Ant1_2402

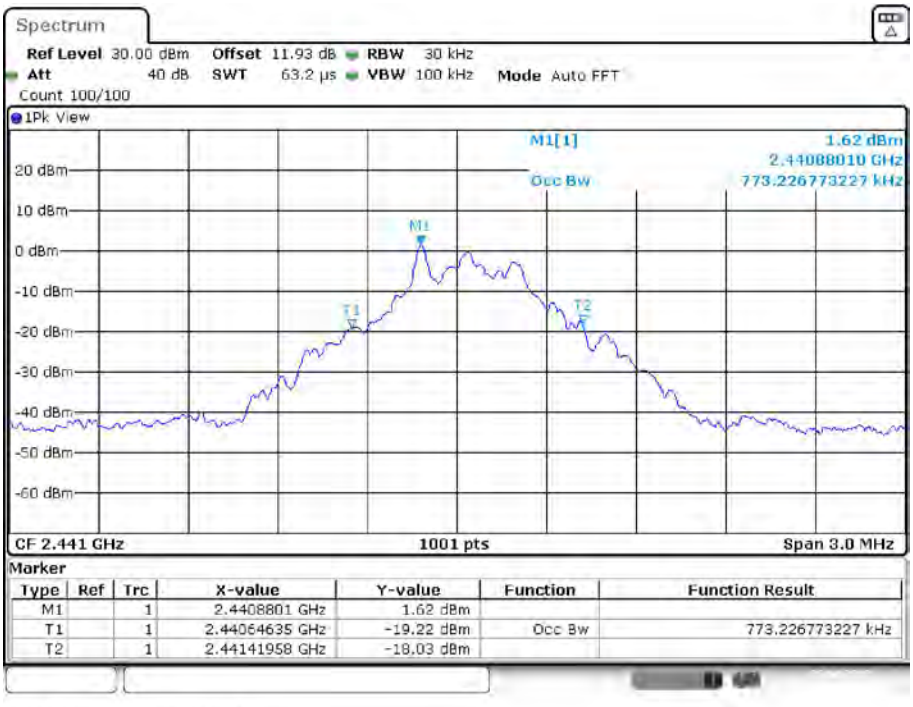


Date: 26.APR.2023 10:58:55

20 dB EMISSION BANDWIDTH_DH5 _Ant1_2441



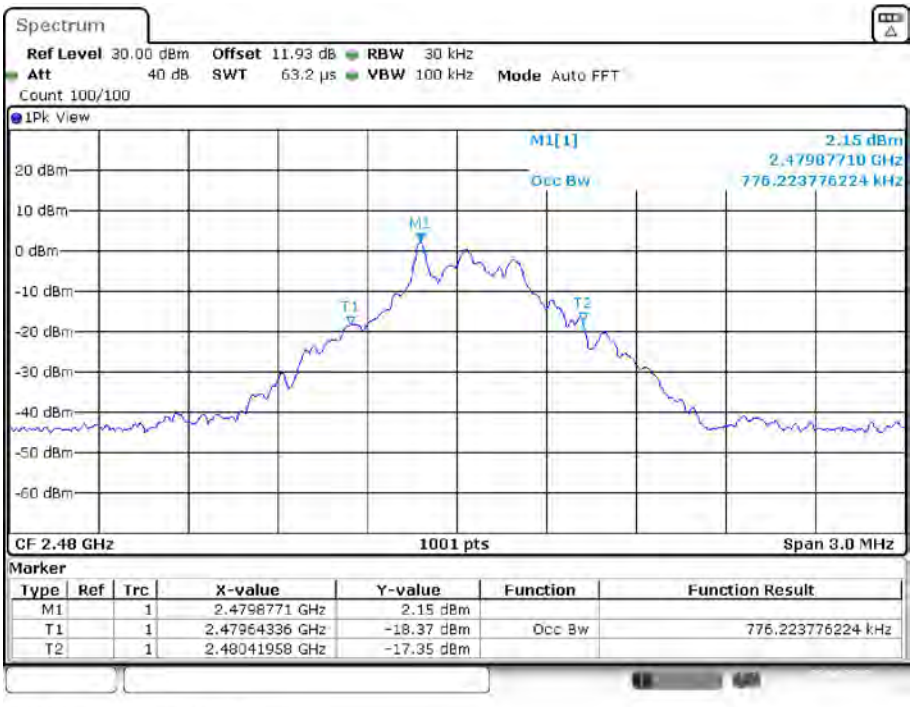
99% OCCUPIED BANDWIDTH_DH5 _Ant1_2441



20 dB EMISSION BANDWIDTH_DH5 _Ant1_2480

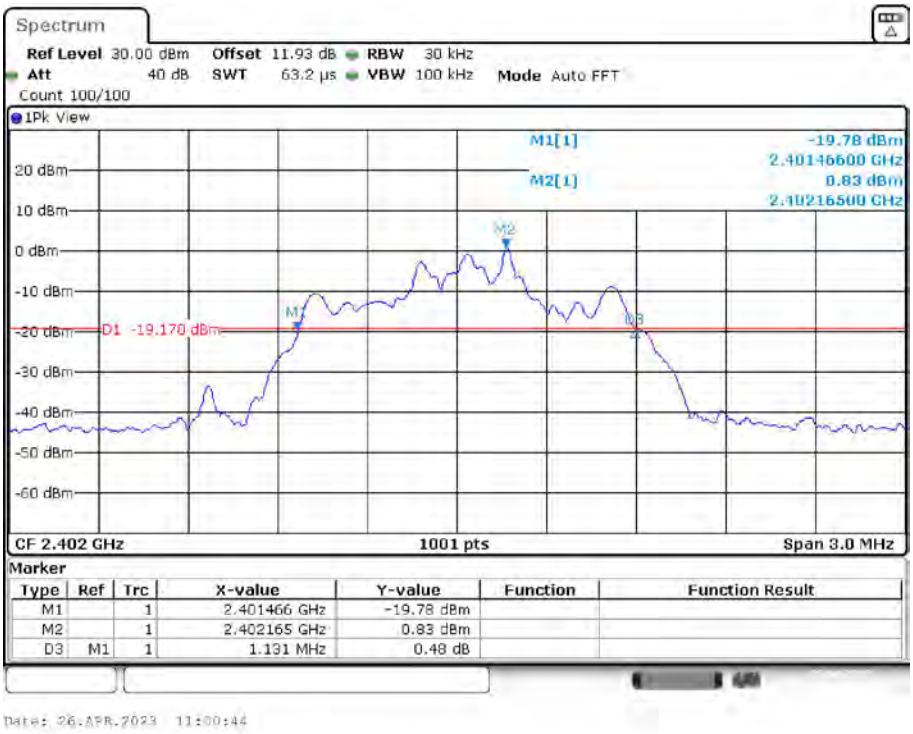
Date: 26.APR.2023 11:00:01

99% OCCUPIED BANDWIDTH_DH5 _Ant1_2480

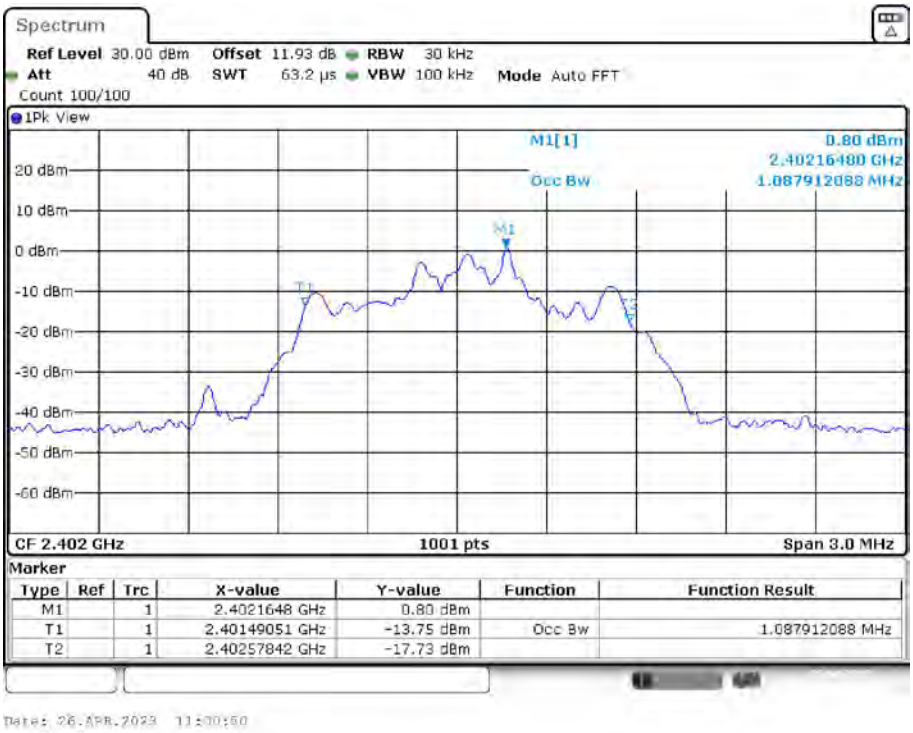


Date: 26.APR.2023 11:00:06

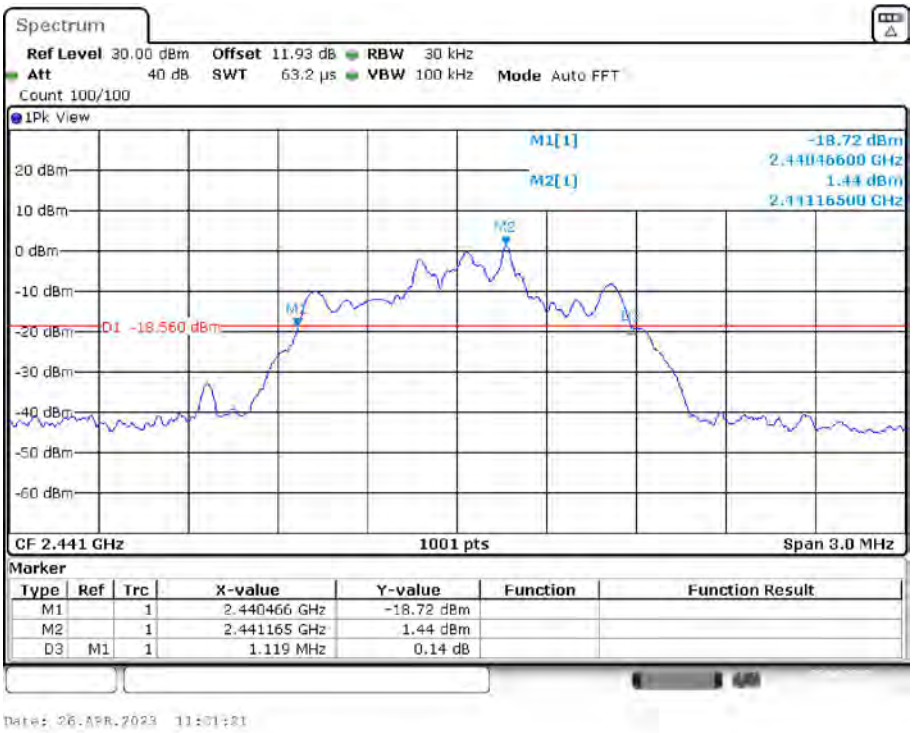
20 dB EMISSION BANDWIDTH_2DH5 _Ant1_2402



99% OCCUPIED BANDWIDTH_2DH5 _Ant1_2402

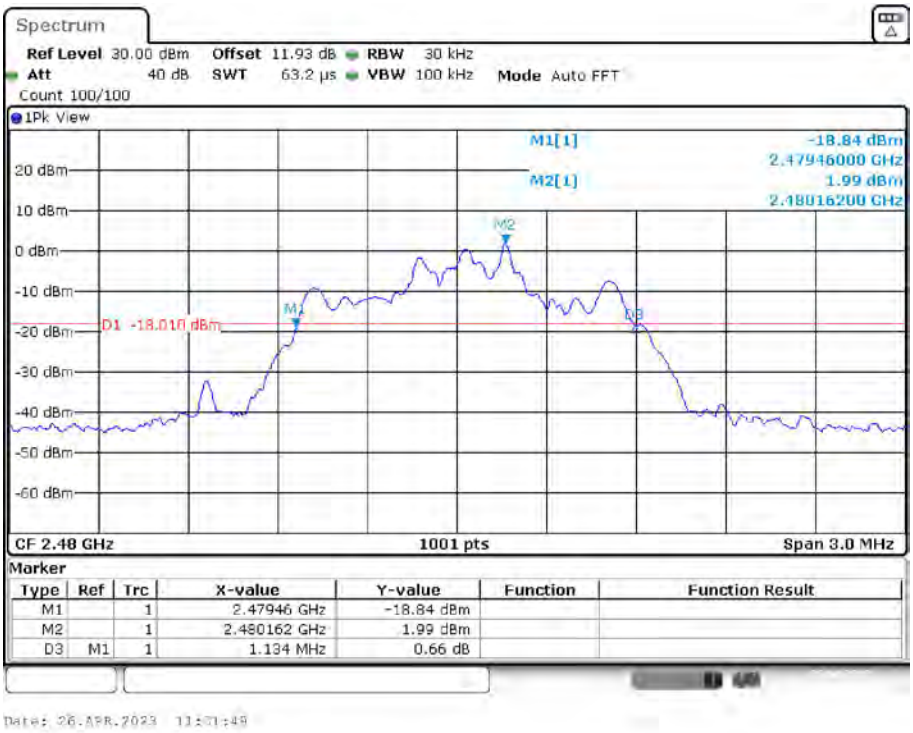


20 dB EMISSION BANDWIDTH_2DH5 _Ant1_2441

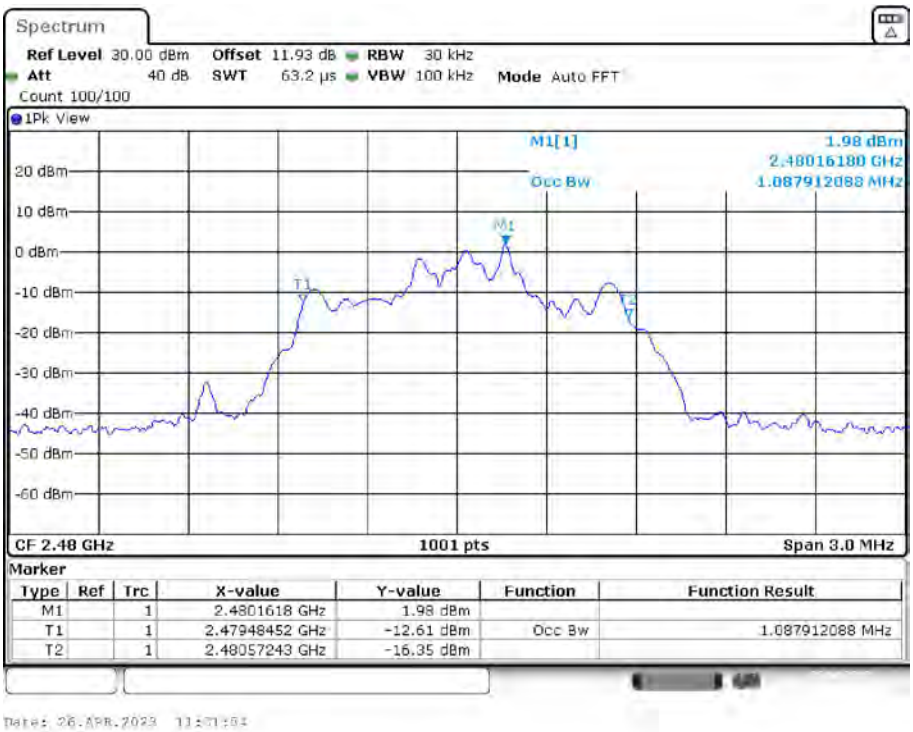


99% OCCUPIED BANDWIDTH_2DH5 _Ant1_2441

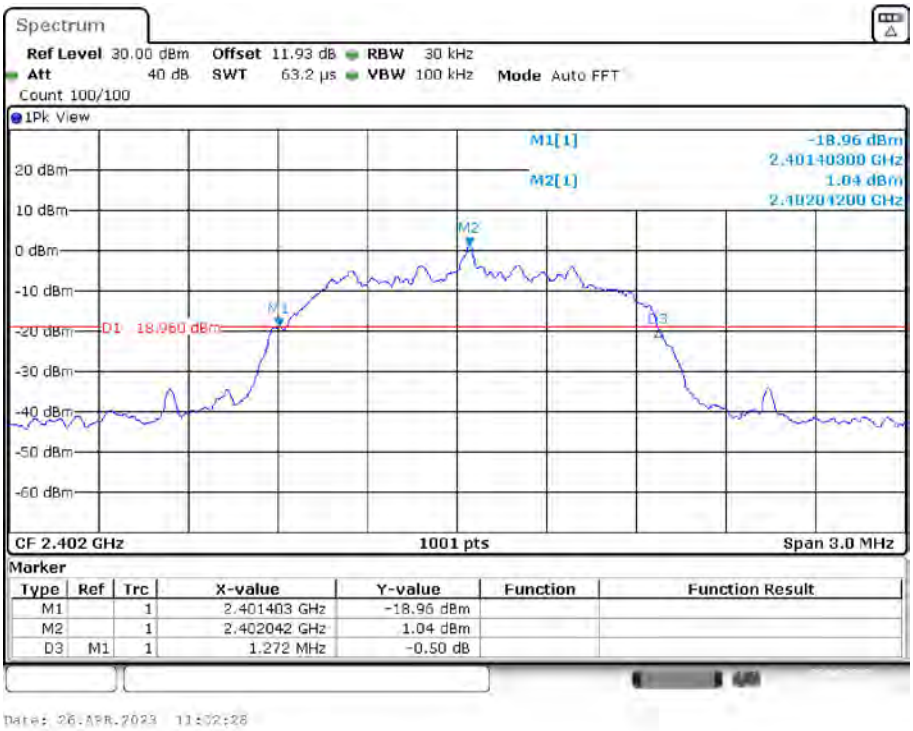
20 dB EMISSION BANDWIDTH _2DH5_Ant1_2480



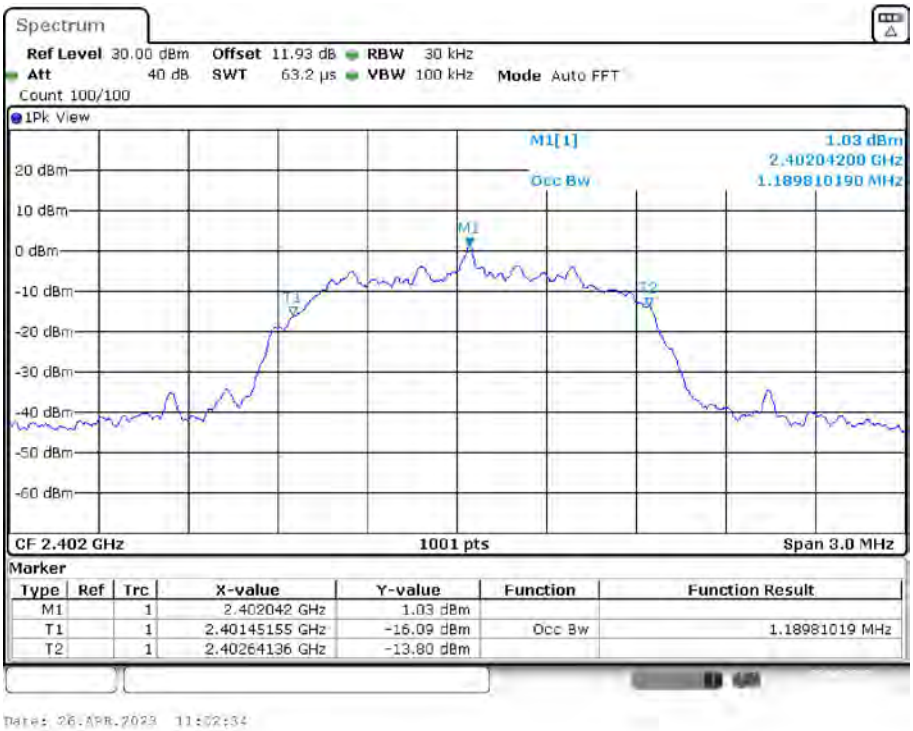
99% OCCUPIED BANDWIDTH _2DH5_Ant1_2480



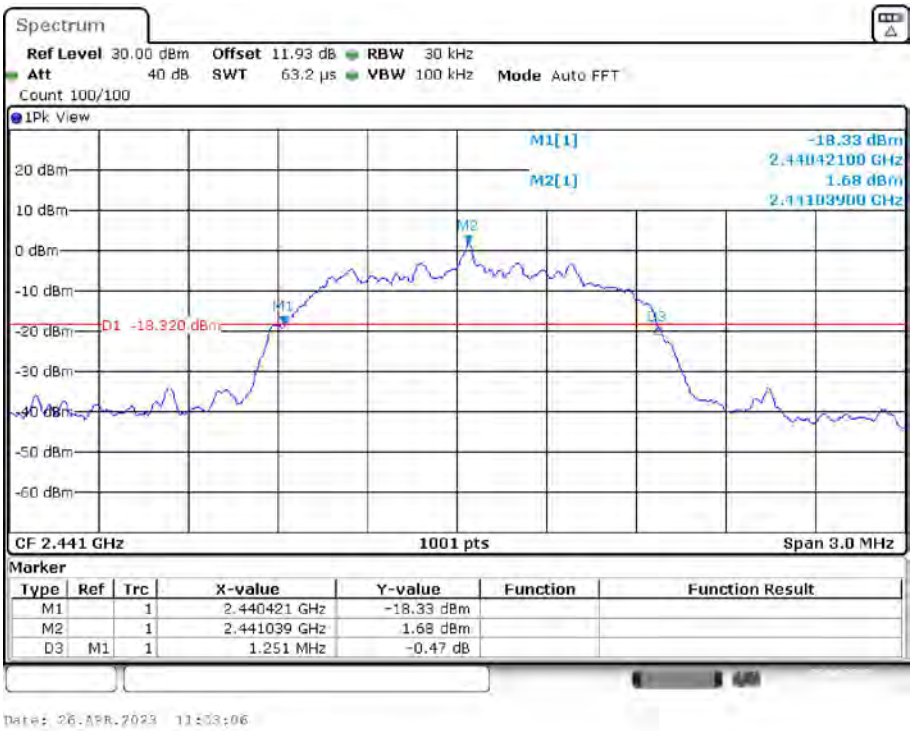
20 dB EMISSION BANDWIDTH _3DH5_Ant1_2402



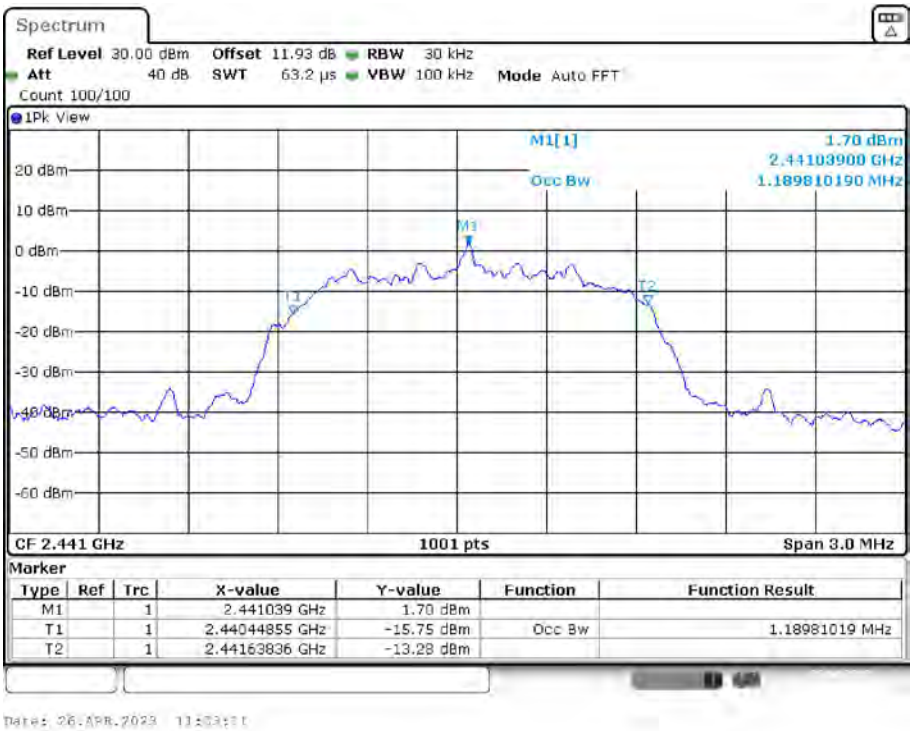
99% OCCUPIED BANDWIDTH _3DH5_Ant1_2402



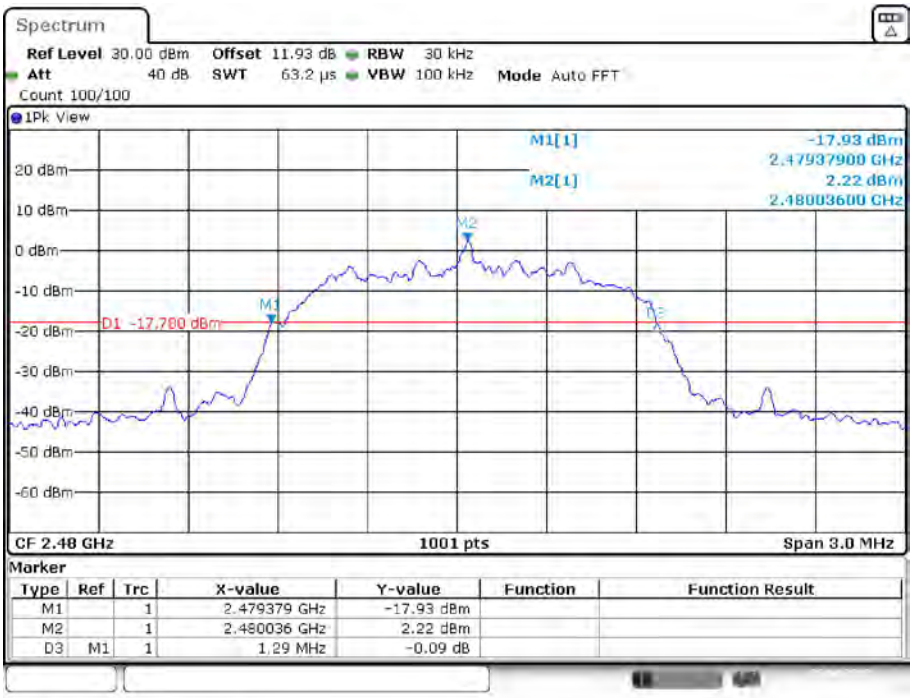
20 dB EMISSION BANDWIDTH _3DH5_Ant1_2441



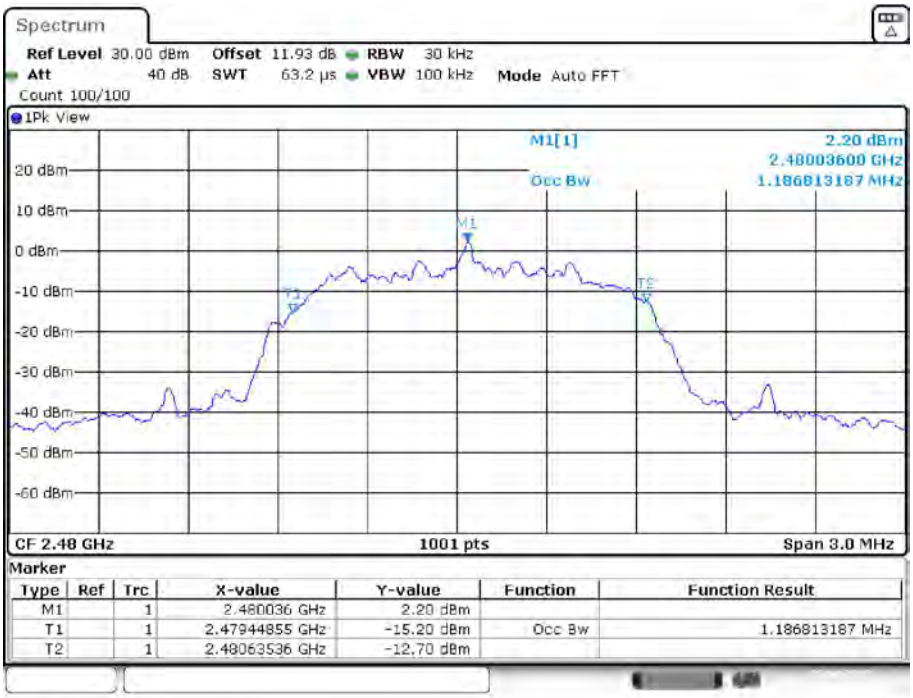
99% OCCUPIED BANDWIDTH _3DH5_Ant1_2441



20 dB EMISSION BANDWIDTH _3DH5_Ant1_2480



99% OCCUPIED BANDWIDTH _3DH5_Ant1_2480



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.

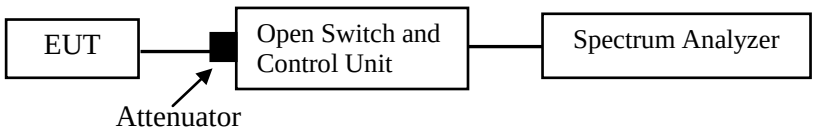
Test Procedure

According to ANSI C63.10-2013, section 7.8.3

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℃
Relative Humidity:	48%
ATM Pressure:	101kPa

The testing was performed by Dave Liang on 2023-04-26.

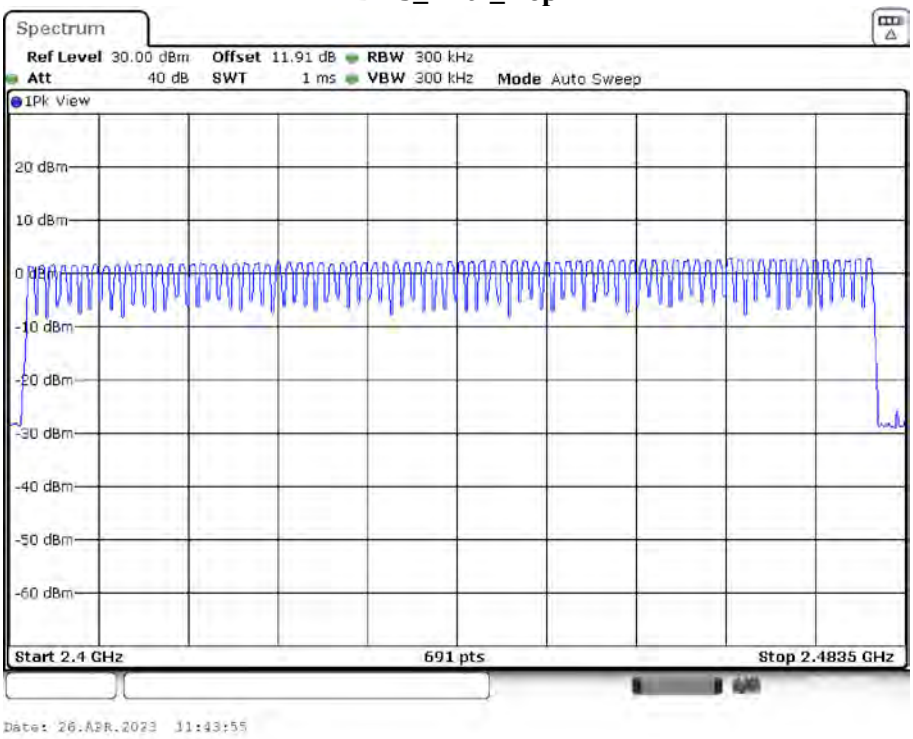
EUT operation mode: Transmitting

Test Result: Compliant.

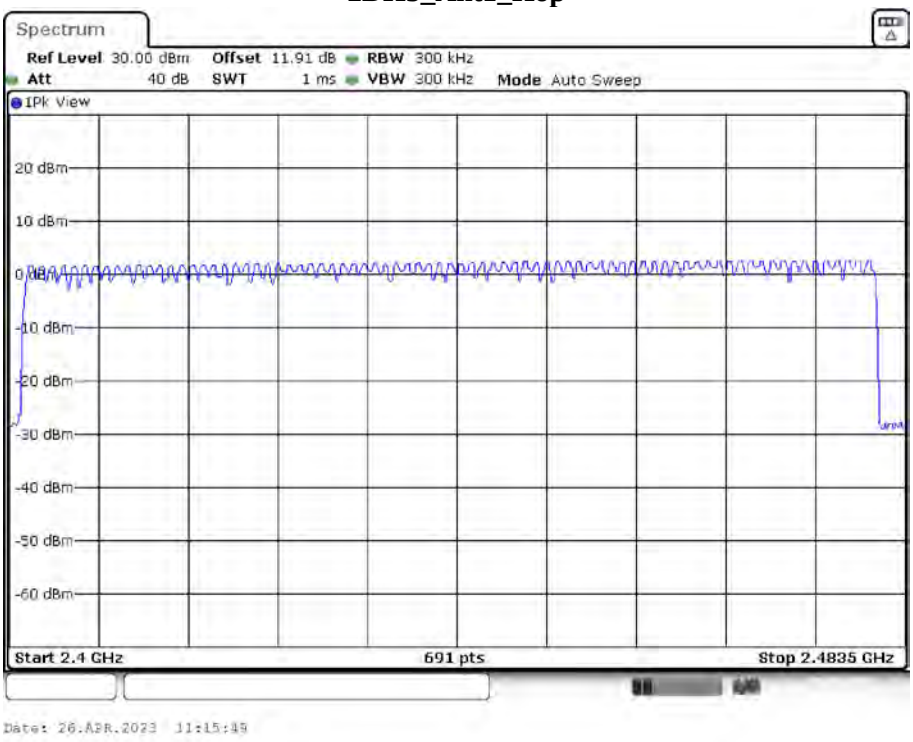
Test Mode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH5	Ant1	Hop	79	>=15	PASS
2DH5	Ant1	Hop	79	>=15	PASS
3DH5	Ant1	Hop	79	>=15	PASS

Please refer to the below plots:

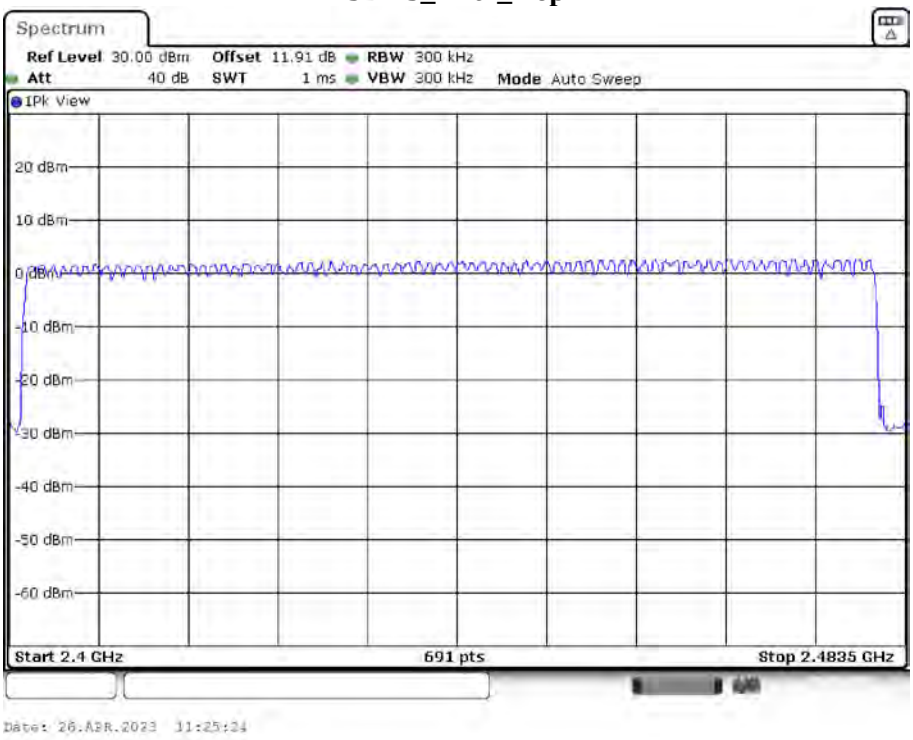
DH5_Ant1_Hop



2DH5_Ant1_Hop



3DH5_Ant1_Hop



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

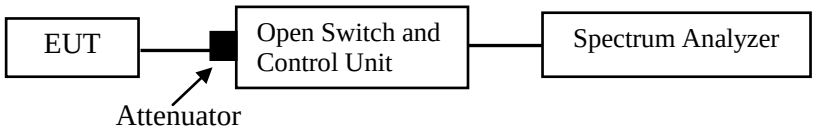
Applicable Standard

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

According to ANSI C63.10-2013, section 7.8.4

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:	24℃
Relative Humidity:	48%
ATM Pressure:	101kPa

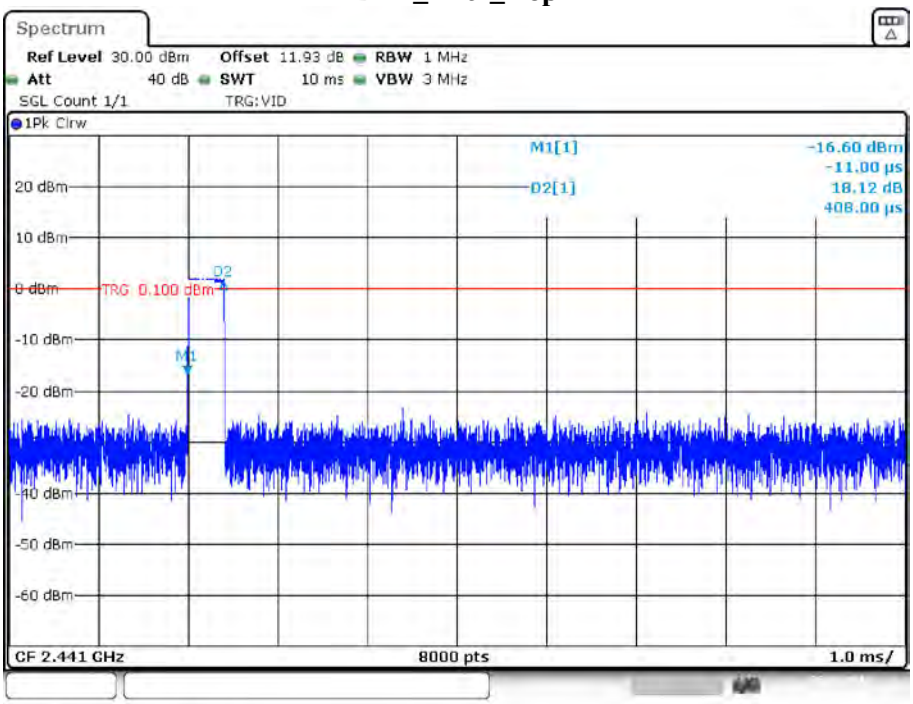
The testing was performed by Dave Liang on 2023-04-26.
EUT operation mode: Transmitting

Test Result: Compliant.

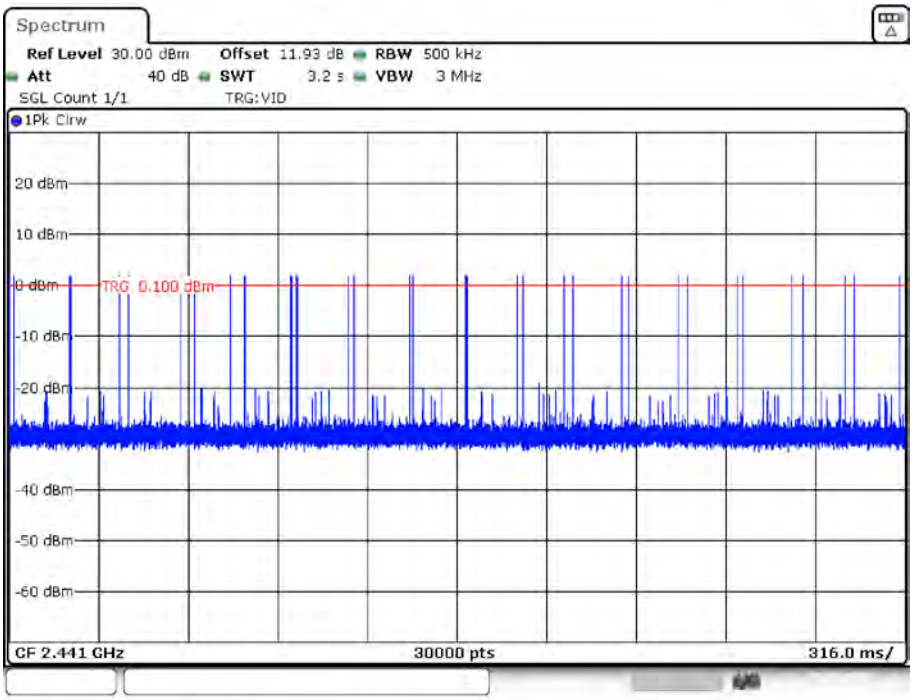
Test Mode	Antenna	Channel	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.408	330	0.135	<=0.4	PASS
DH3	Ant1	Hop	1.656	220	0.364	<=0.4	PASS
DH5	Ant1	Hop	2.895	100	0.29	<=0.4	PASS
2DH1	Ant1	Hop	0.418	320	0.134	<=0.4	PASS
2DH3	Ant1	Hop	1.661	190	0.316	<=0.4	PASS
2DH5	Ant1	Hop	2.903	110	0.319	<=0.4	PASS
3DH1	Ant1	Hop	0.420	320	0.134	<=0.4	PASS
3DH3	Ant1	Hop	1.663	160	0.266	<=0.4	PASS
3DH5	Ant1	Hop	2.907	60	0.174	<=0.4	PASS

Note 1: A period time=0.4*79=31.6(s), Result=Burst Width*Total Hops
Note 2: Total Hops =Hopping Number in 3.16s*10
Note 3: Hoping Number in 3.16s=Total of highest signals in 3.16s (Second high signals were other channel)
Please refer to the below plots:

DH1_Ant1_Hop

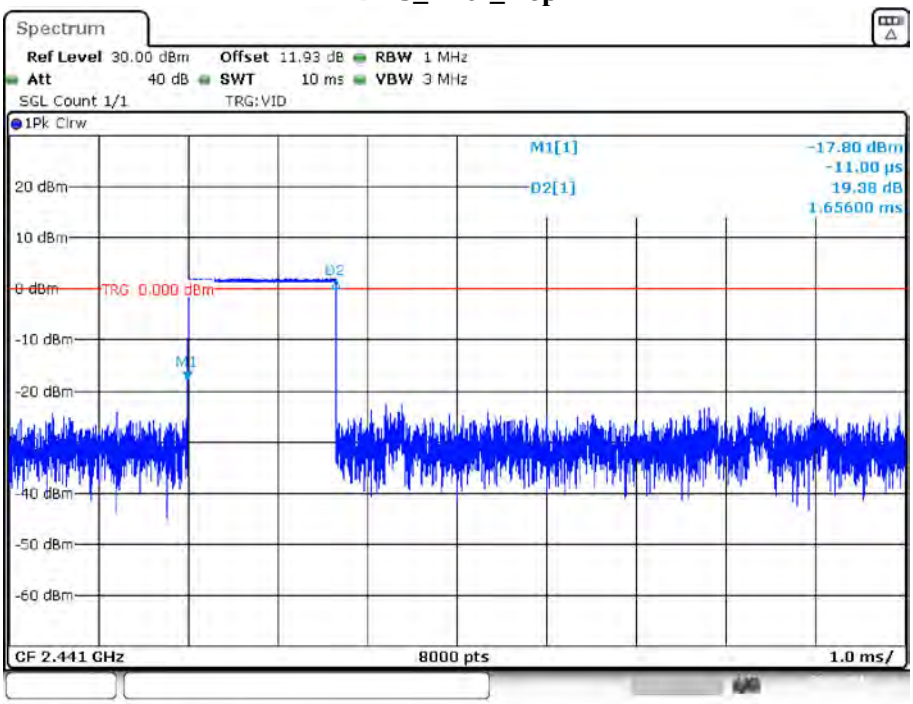


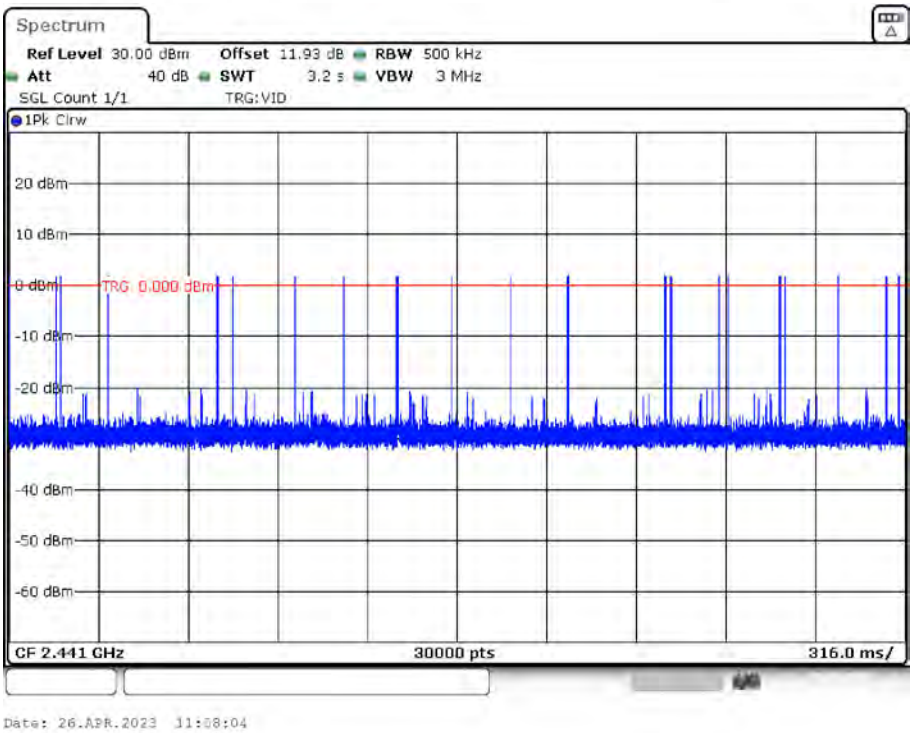
Date: 26.APR.2023 11:07:22



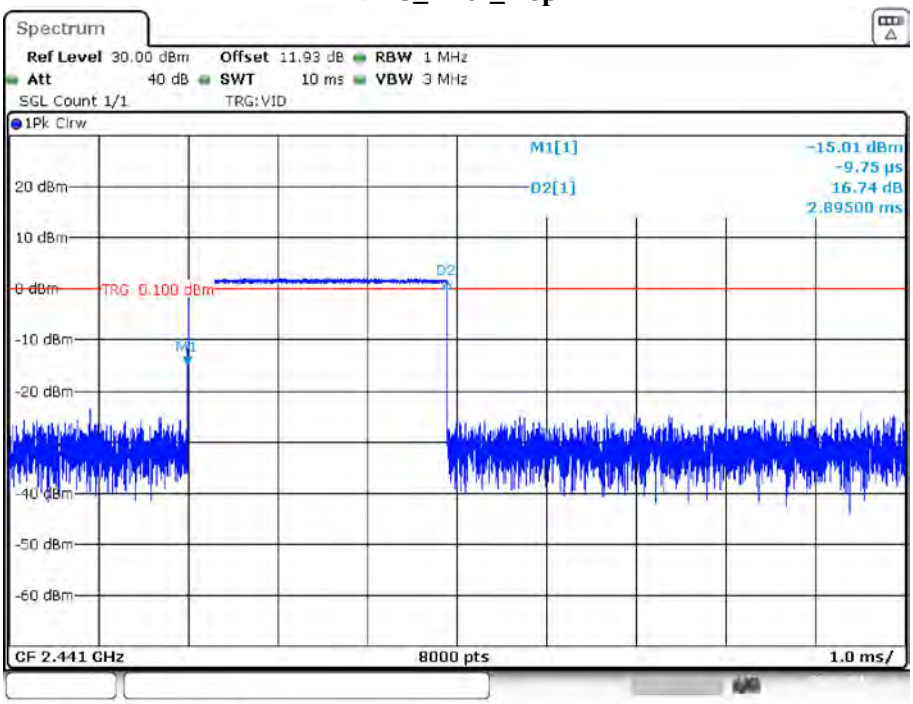
Date: 26.APR.2023 11:07:27

DH3_Ant1_Hop

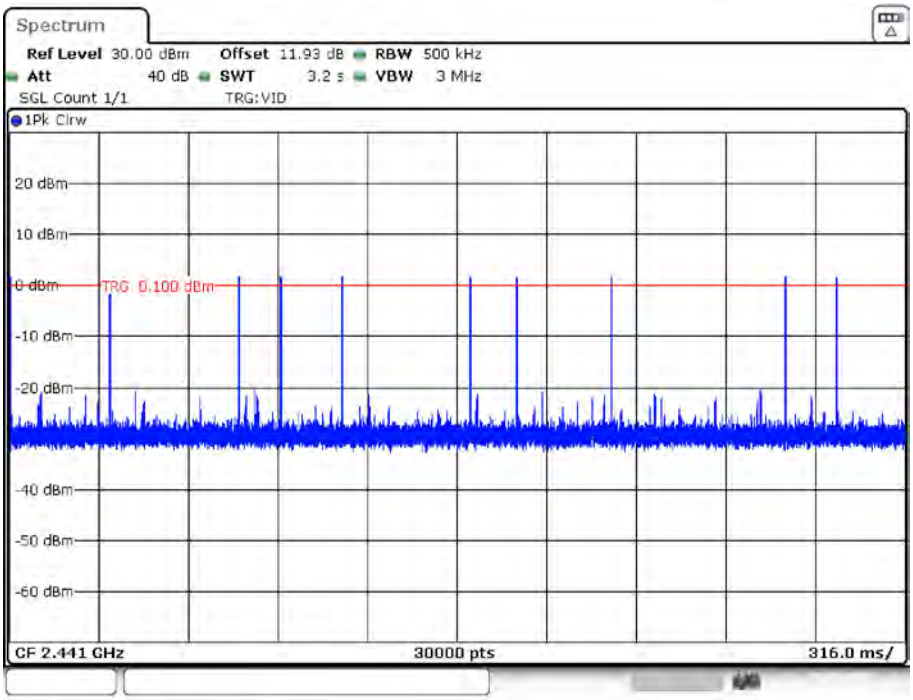

Spectrum
Ref Level 30.00 dBm Offset 11.93 dB RBW 1 MHz
Att 40 dB SWT 10 ms VBW 3 MHz
SGL Count 1/1 TRG:VID
1Pk Clrw
M1[1] -17.80 dBm
-11.00 µs
D2[1] 19.38 dB
1.65600 ms
20 dBm
10 dBm
0 dBm
TRG 0.000 dBm
-10 dBm
-20 dBm
-40 dBm
-50 dBm
-60 dBm
D2
M1
CF 2.441 GHz
8000 pts
1.0 ms/
Date: 26.APR.2023 11:07:59


Spectrum
Ref Level 30.00 dBm Offset 11.93 dB RBW 500 kHz
Att 40 dB SWT 3.2 s VBW 3 MHz
SGL Count 1/1 TRG:VID
1Pk Clrw
20 dBm
10 dBm
0 dBm
TRG 0.000 dBm
-10 dBm
-20 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
30000 pts
316.0 ms/
Date: 26.APR.2023 11:08:04

DH5_Ant1_Hop

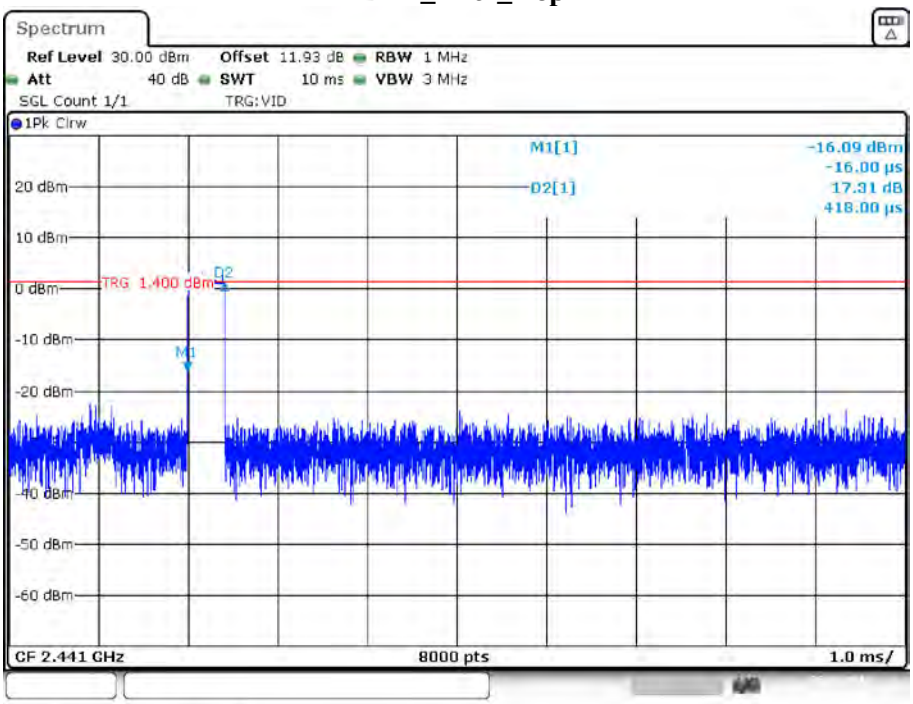


Date: 26.APR.2023 11:44:09

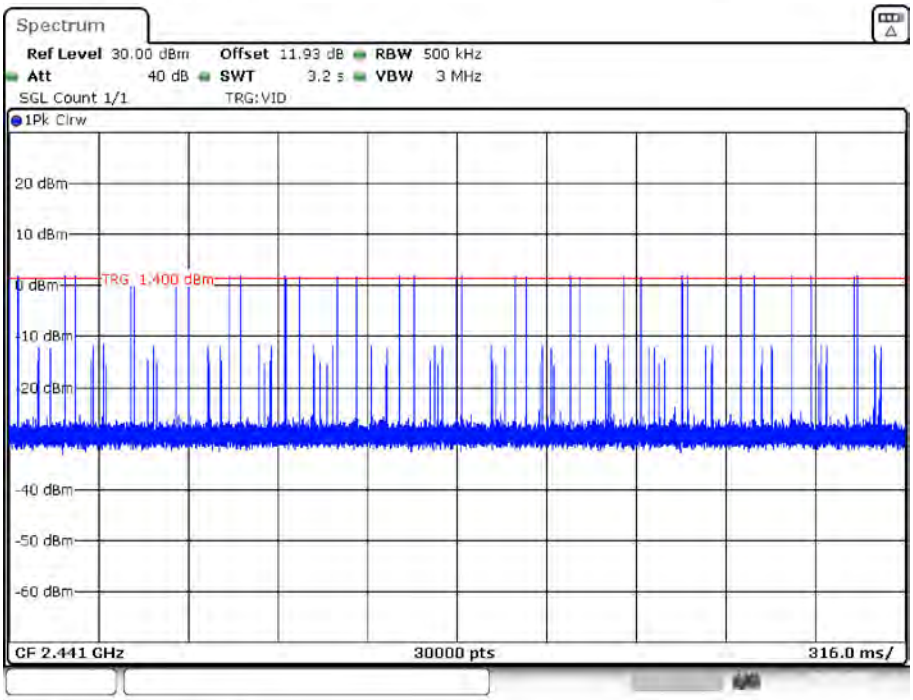


Date: 26.APR.2023 11:44:14

2DH1_Ant1_Hop

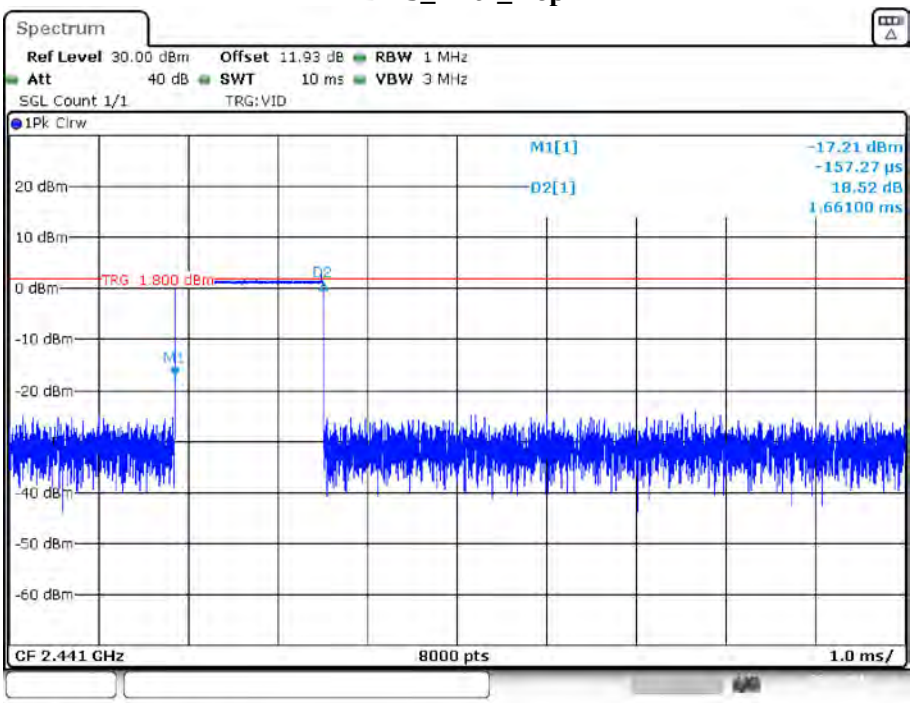


Date: 26.APR.2023 11:16:40



Date: 26.APR.2023 11:16:46

2DH3_Ant1_Hop



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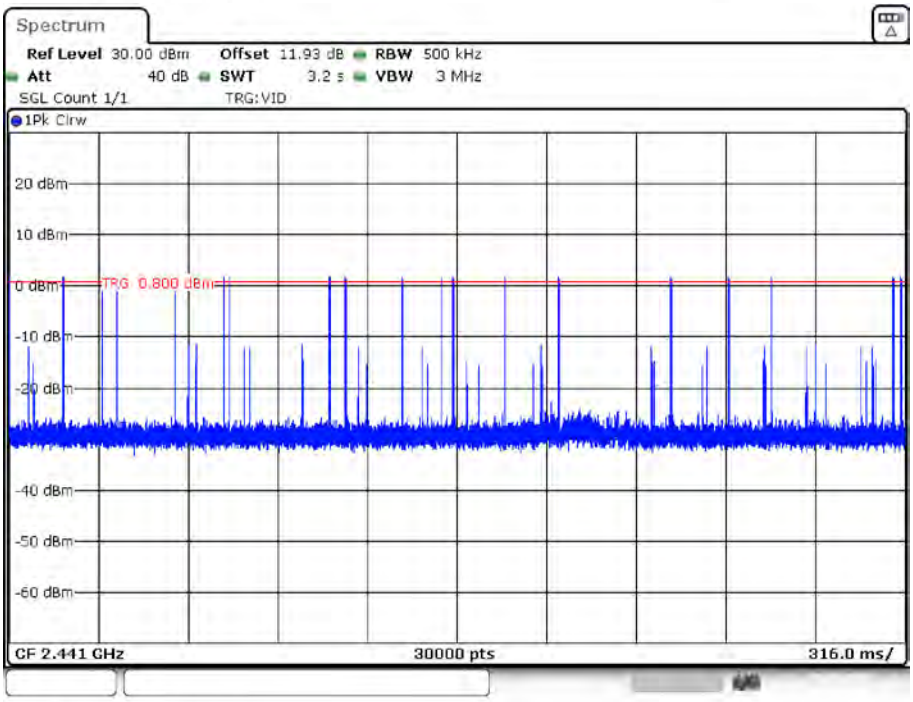
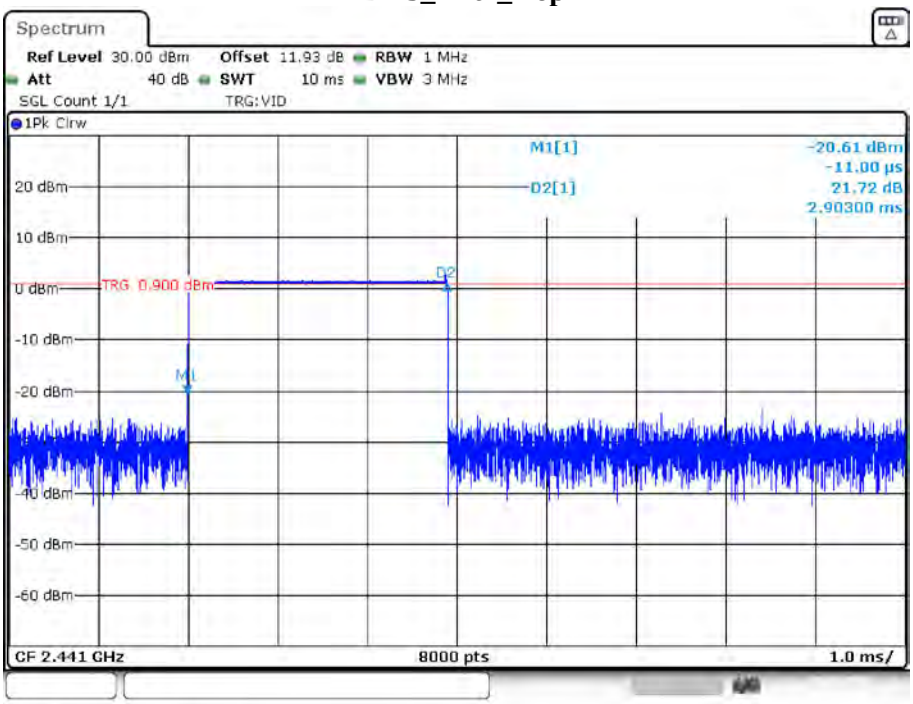
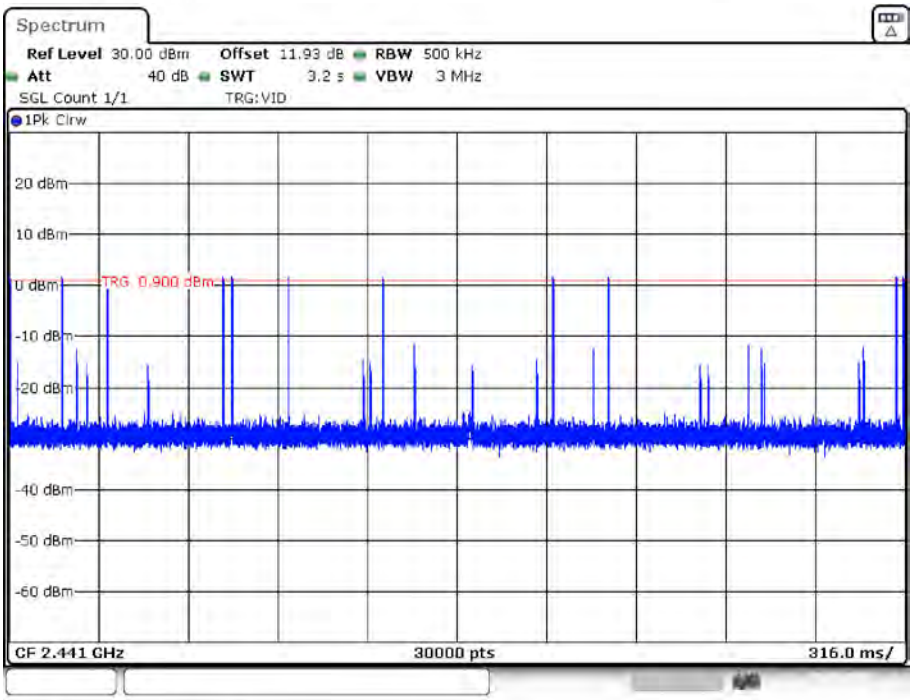


Date: 26.APR.2023 11:17:23

2DH5_Ant1_Hop

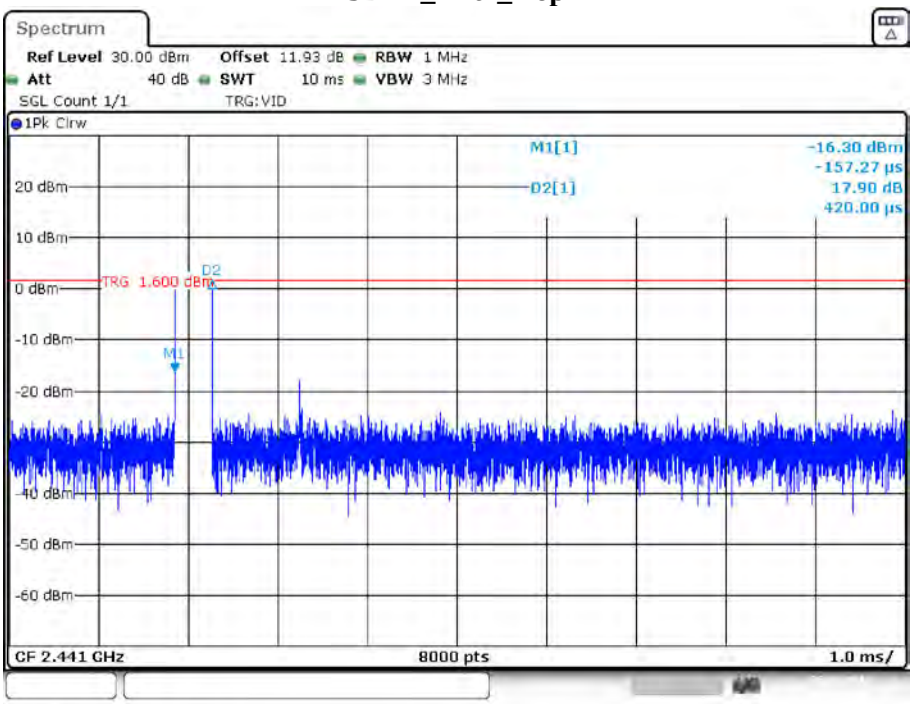


Date: 26.APR.2023 11:16:03

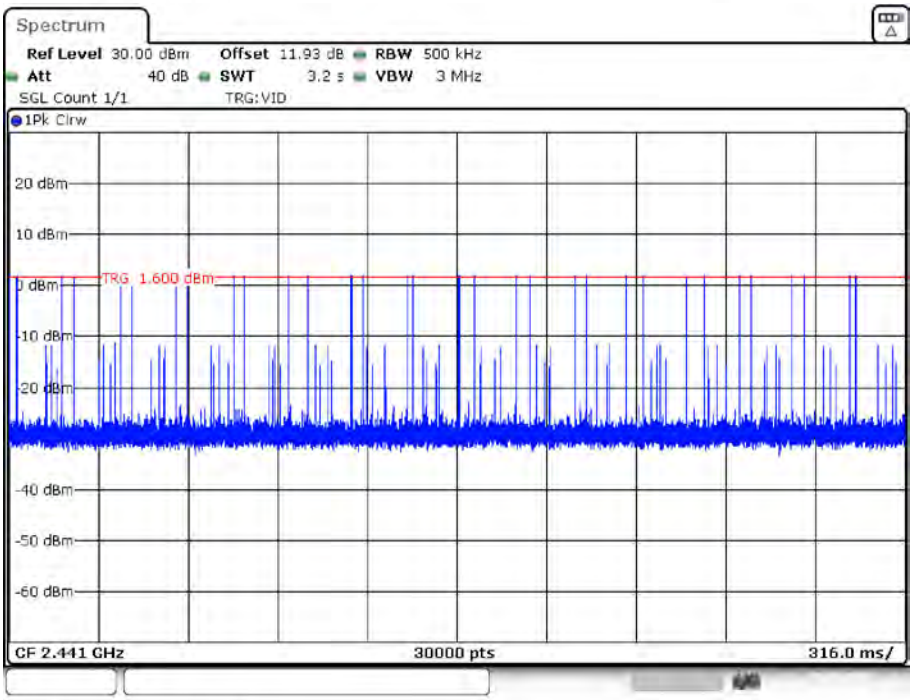


Date: 26.APR.2023 11:16:08

3DH1_Ant1_Hop



Date: 26.APR.2023 11:26:18



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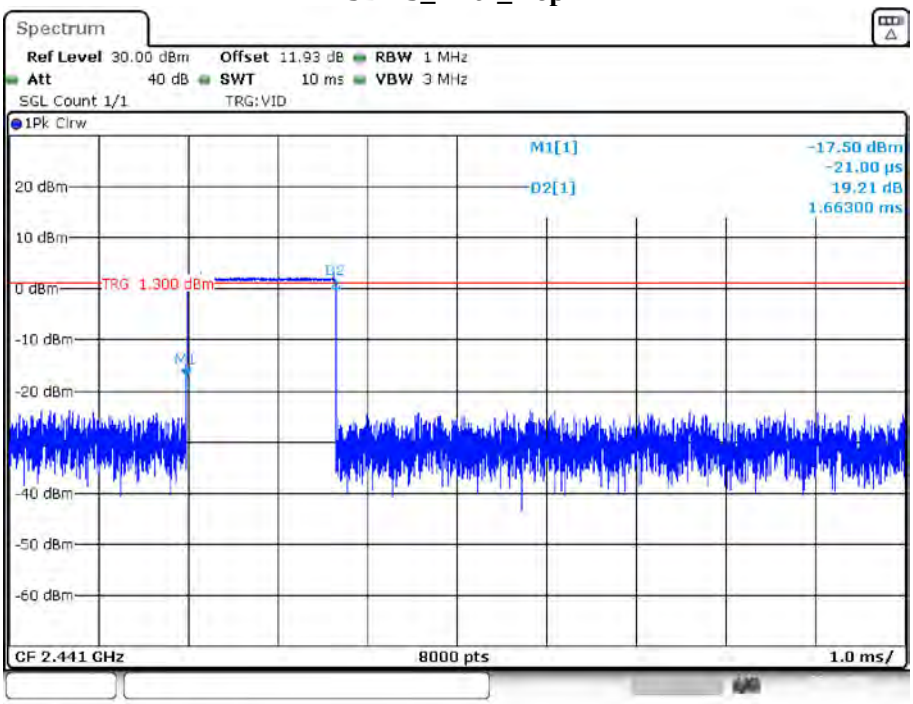
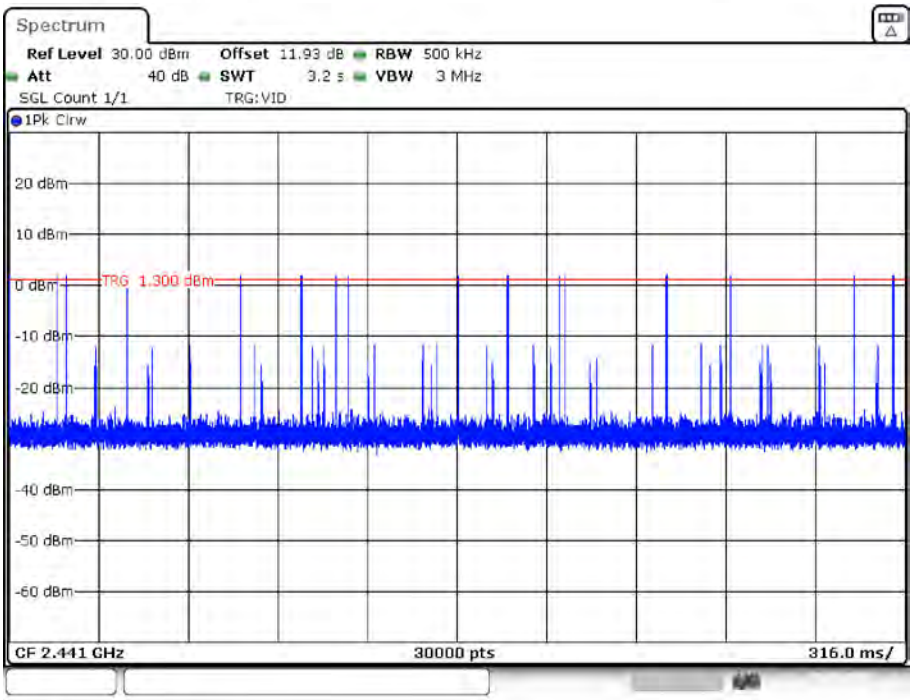
3DH3_Ant1_Hop

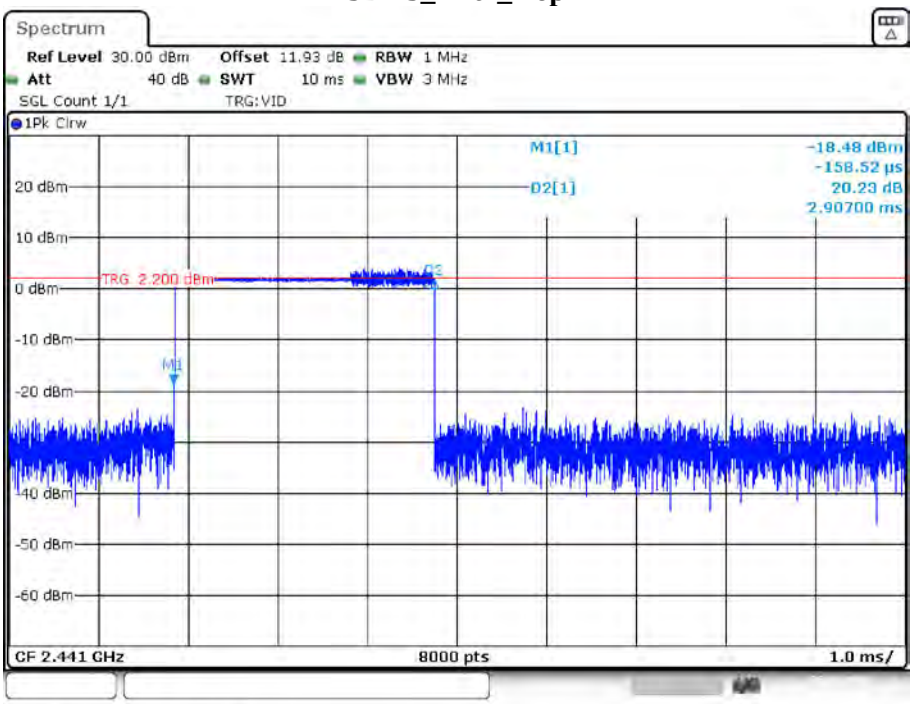


Date: 26.APR.2023 11:26:54

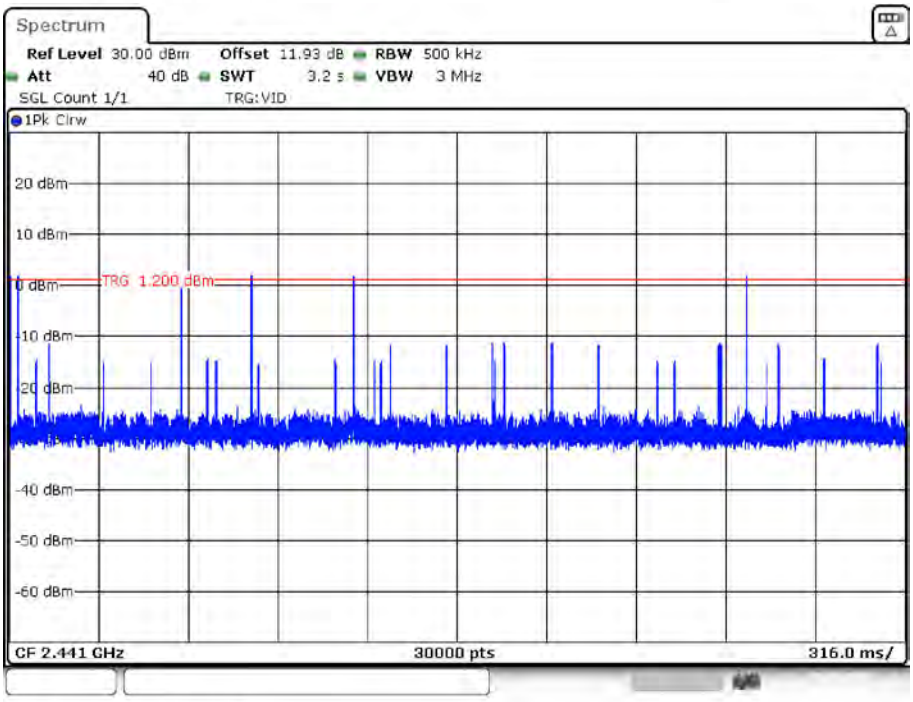


Date: 26.APR.2023 11:26:59

3DH5_Ant1_Hop



Date: 26.APR.2023 11:25:38



Date: 26.APR.2023 11:25:49

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

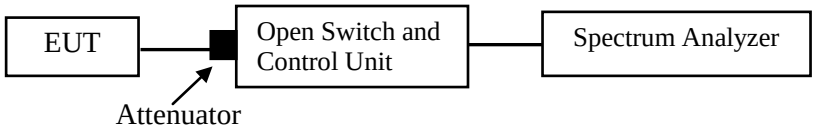
Applicable Standard

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

According to ANSI C63.10-2013, section 7.8.5

1. Place the EUT on a bench and set in TX 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:	24℃
Relative Humidity:	48%
ATM Pressure:	101kPa

The testing was performed by Dave Liang on 2023-04-26.

EUT operation mode: Transmitting

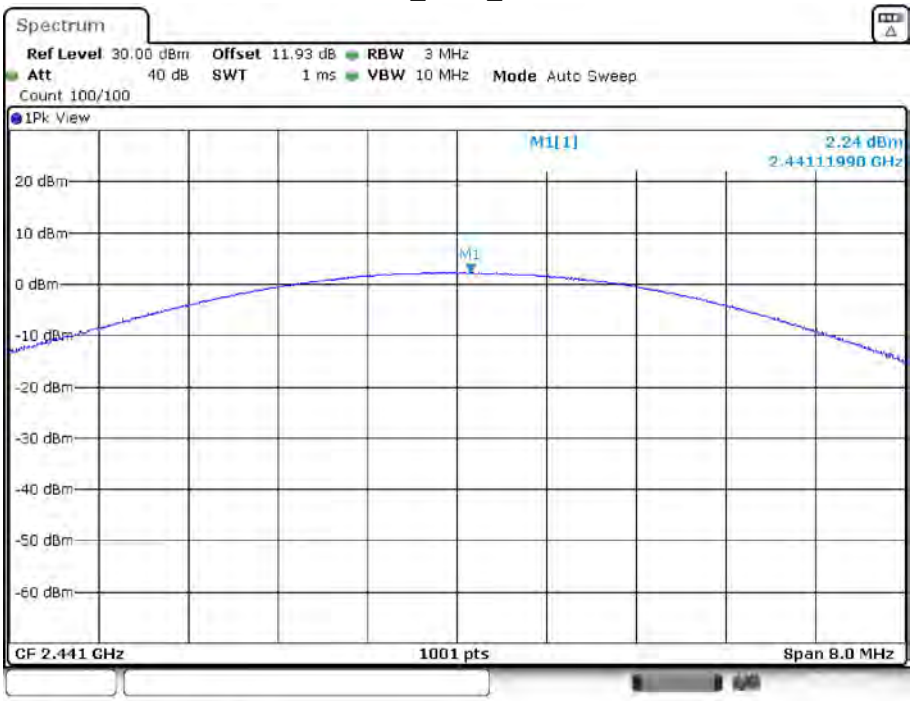
Test Result: Compliant.

Test Mode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH5	Ant1	2402	1.60	≤ 20.97	PASS
		2441	2.24	≤ 20.97	PASS
		2480	2.66	≤ 20.97	PASS
2DH5	Ant1	2402	3.34	≤ 20.97	PASS
		2441	4.02	≤ 20.97	PASS
		2480	4.58	≤ 20.97	PASS
3DH5	Ant1	2402	4.18	≤ 20.97	PASS
		2441	4.70	≤ 20.97	PASS
		2480	**5.21**	≤ 20.97	PASS

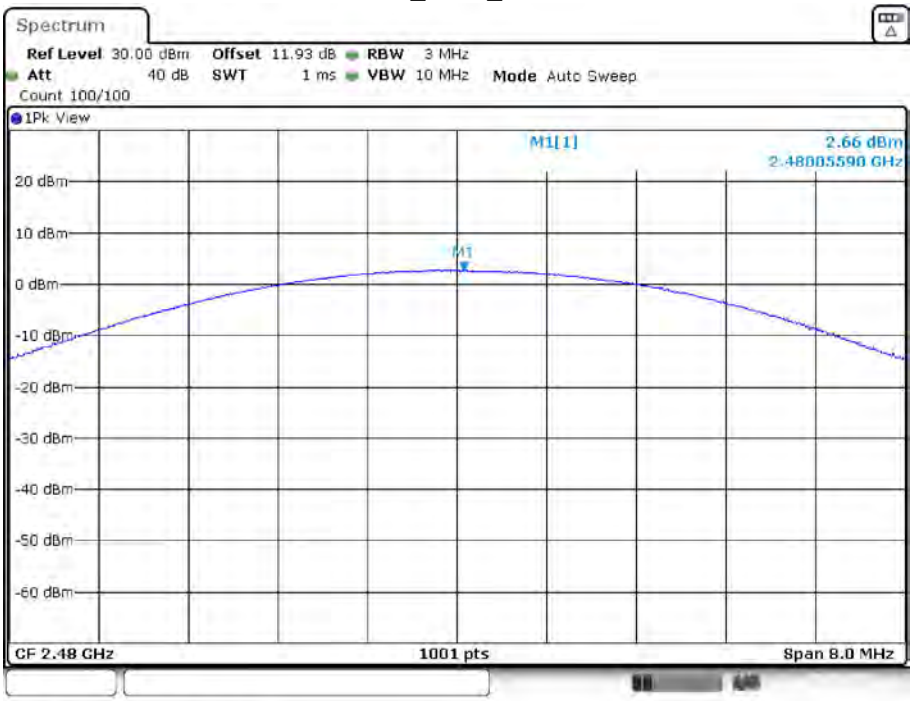
Please refer to the below plots:

DH5_Ant1_2402

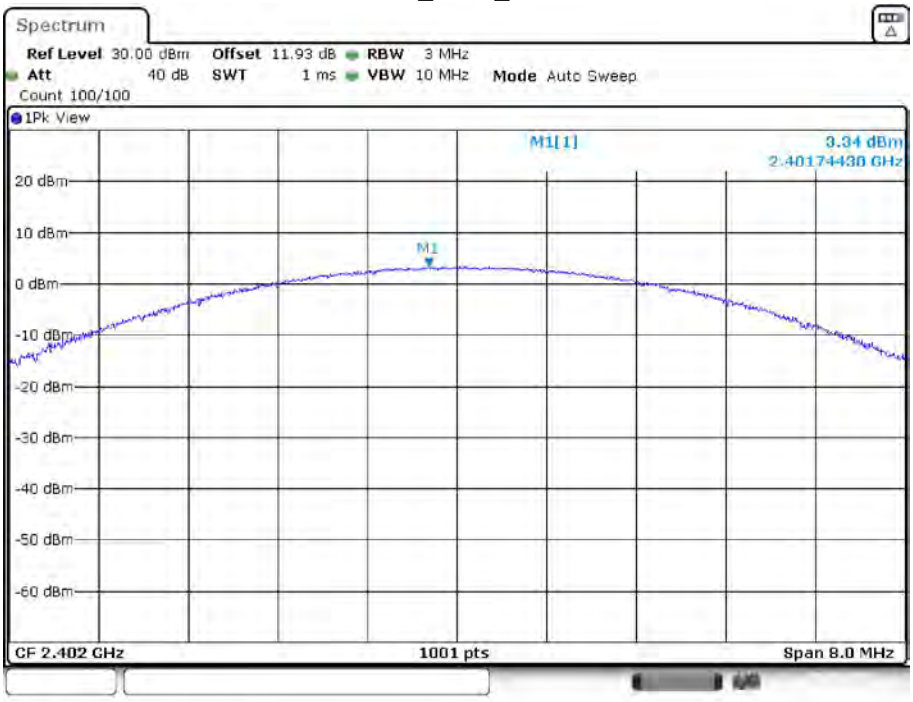
DH5_Ant1_2441



DH5_Ant1_2480

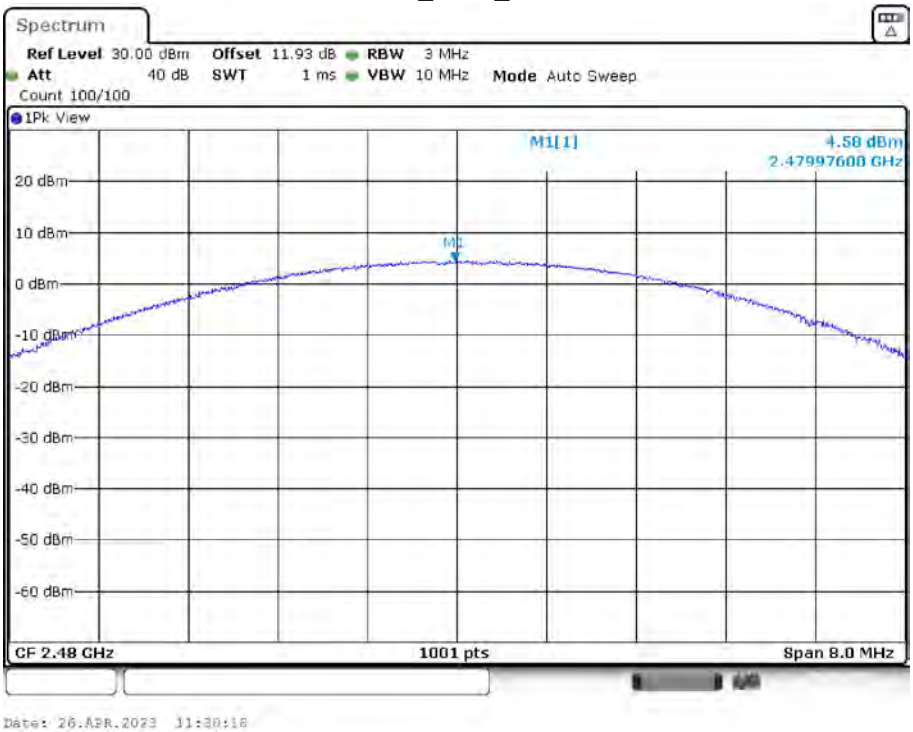


2DH5_Ant1_2402

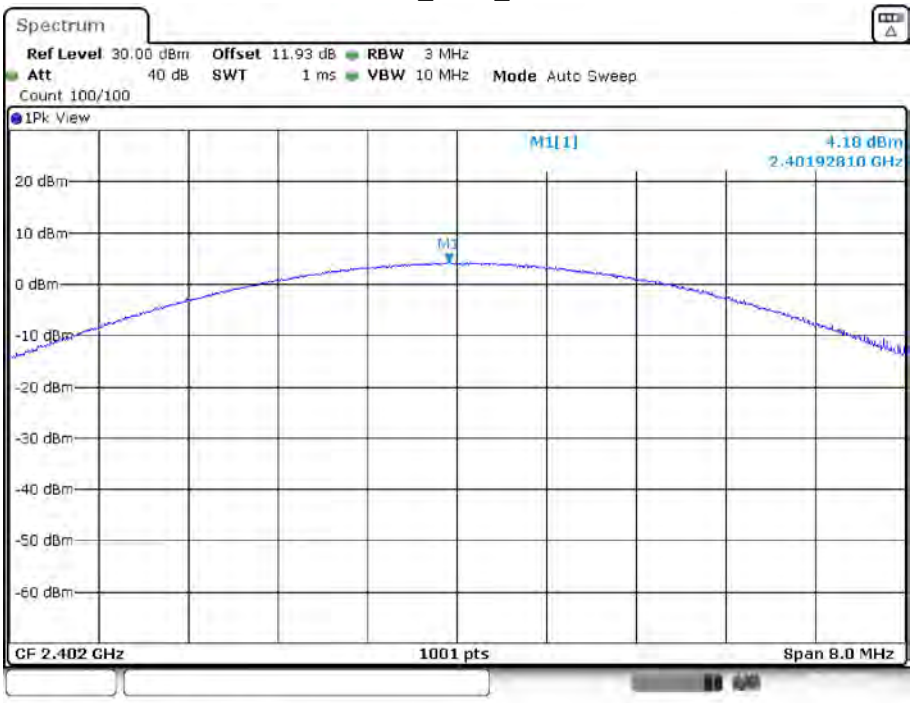


2DH5_Ant1_2441

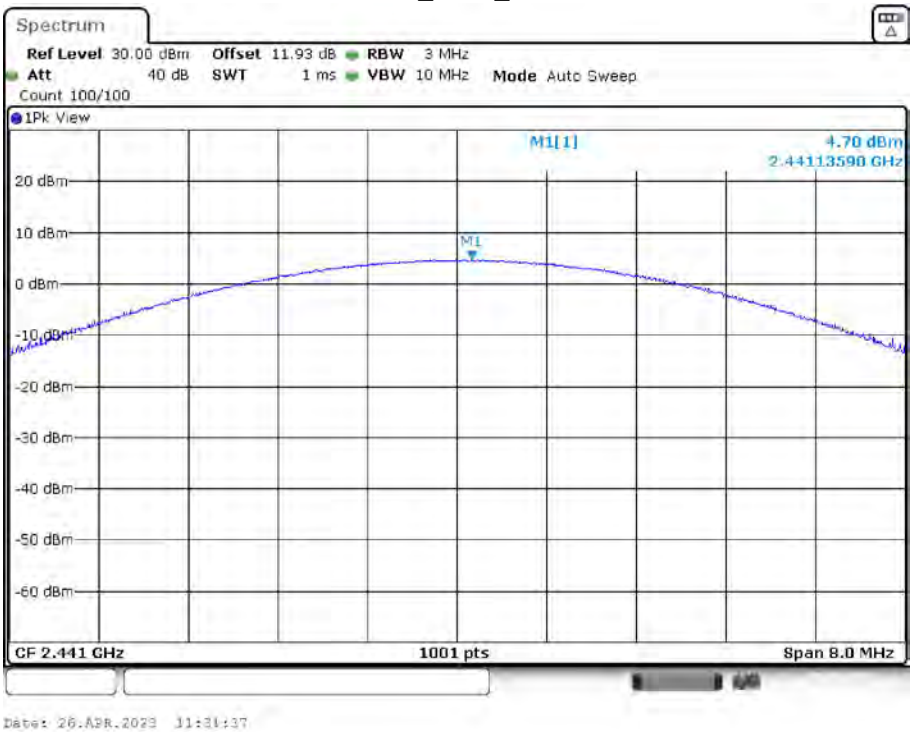
2DH5_Ant1_2480



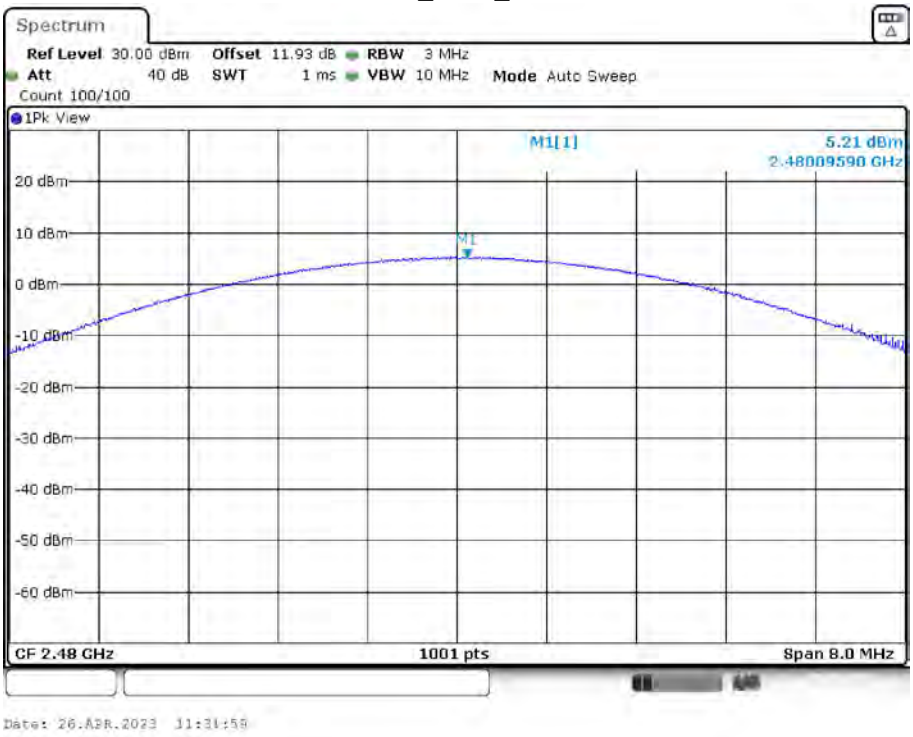
3DH5_Ant1_2402



3DH5_Ant1_2441



3DH5_Ant1_2480



FCC §15.247(d)-BAND EDGES TESTING

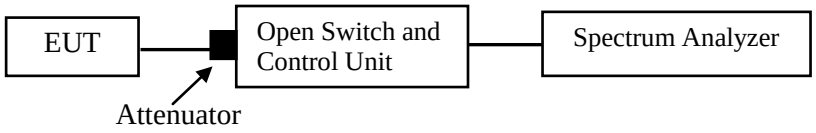
Applicable Standard

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

According to ANSI C63.10-2013, section 7.8.6 and section 6.10

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 TX 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:	24℃
Relative Humidity:	48%
ATM Pressure:	101kPa

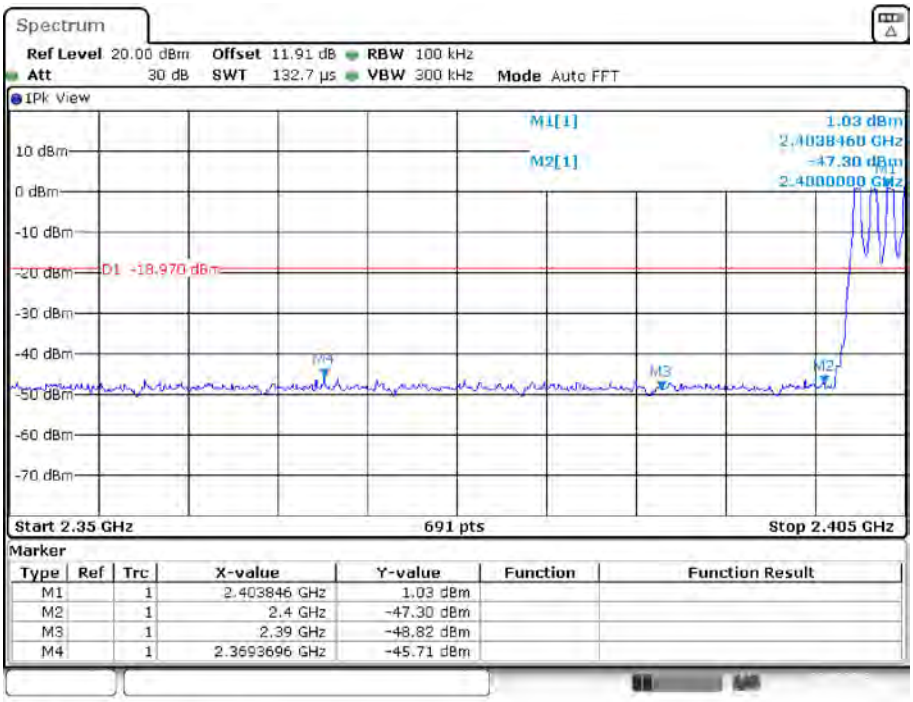
The testing was performed by Brian Li on 2023-04-15.

EUT operation mode: Transmitting

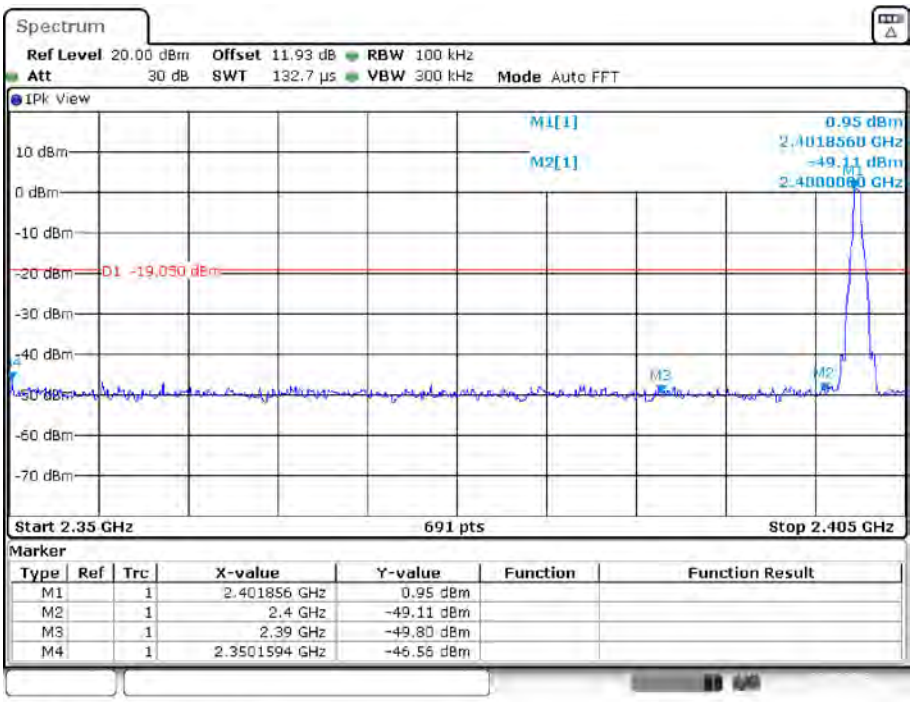
Test Result: Compliant

Please refer to the below plots:

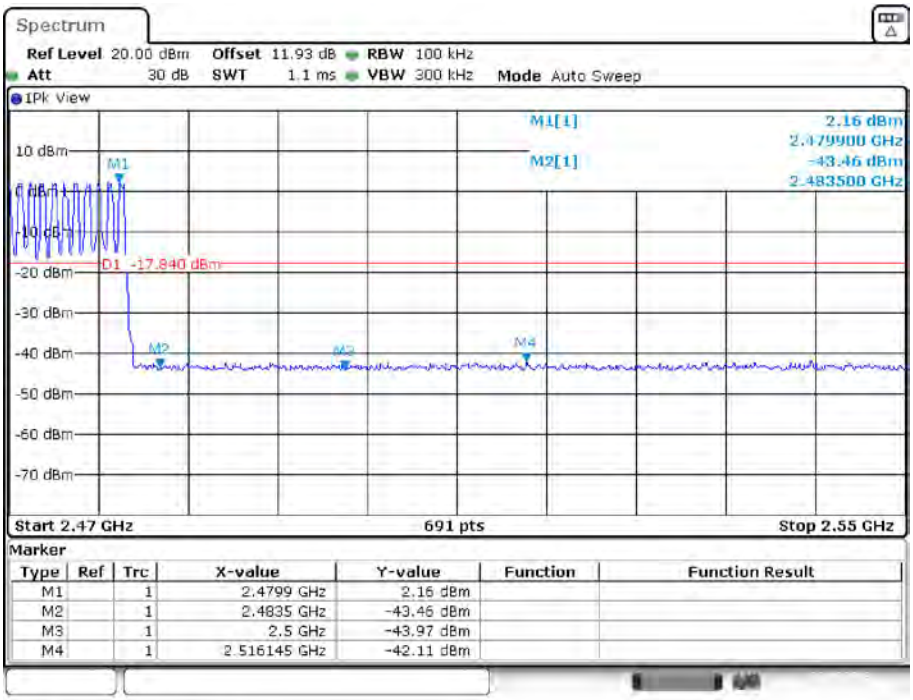
DH5: Band Edge-Left Side
Hopping



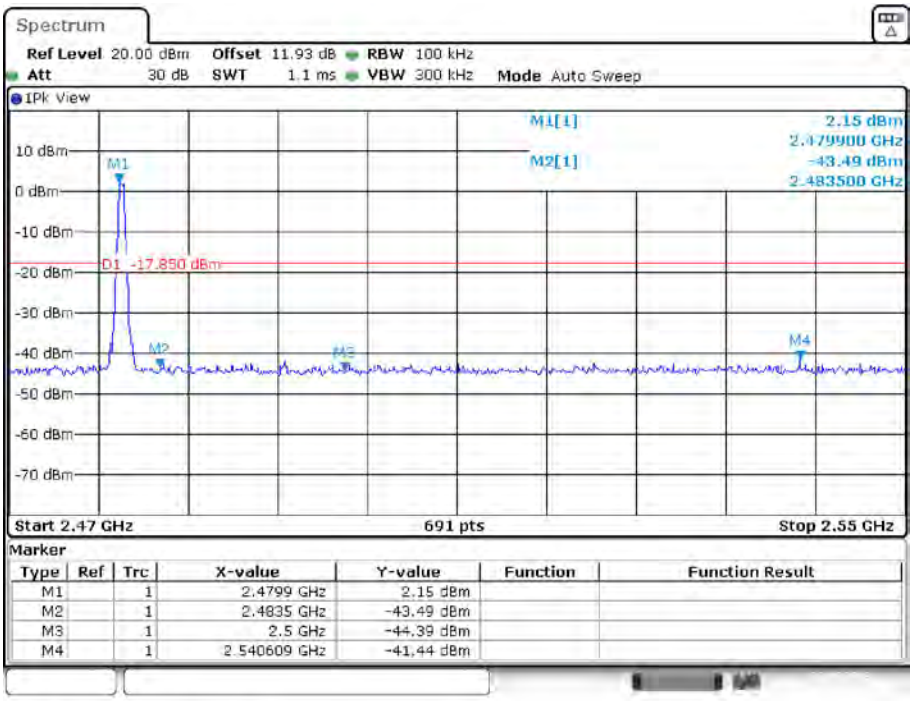
Single



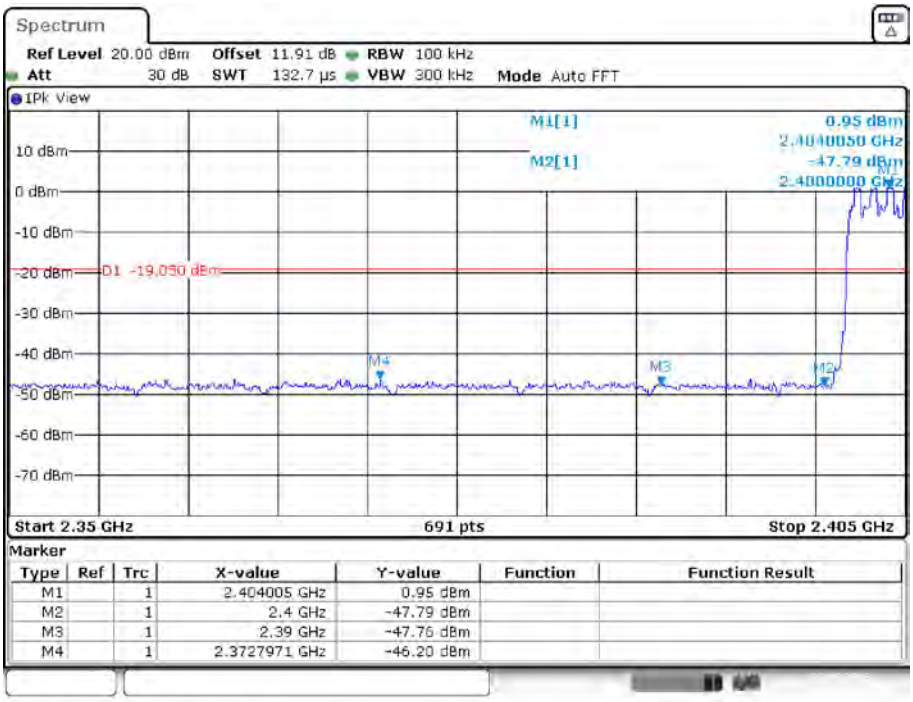
DH5: Band Edge- Right Side
Hopping



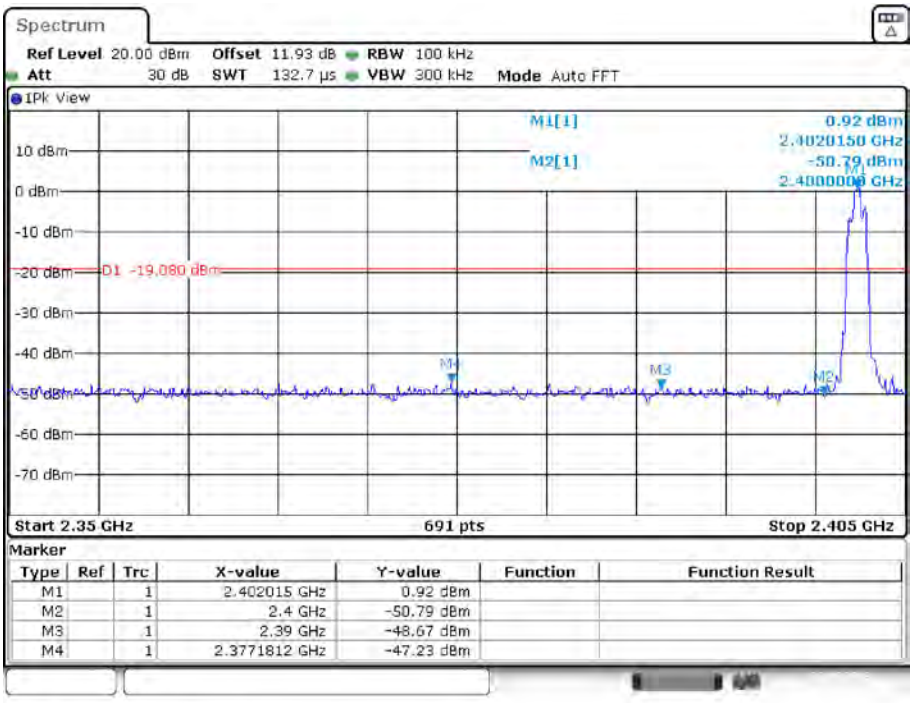
Single



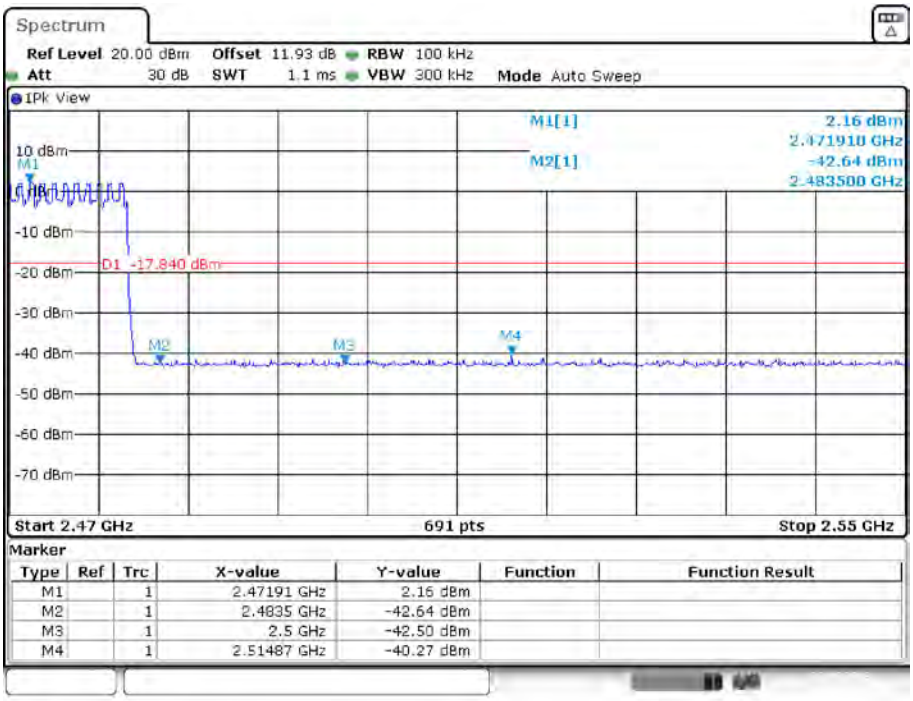
2DH5: Band Edge-Left Side
Hopping



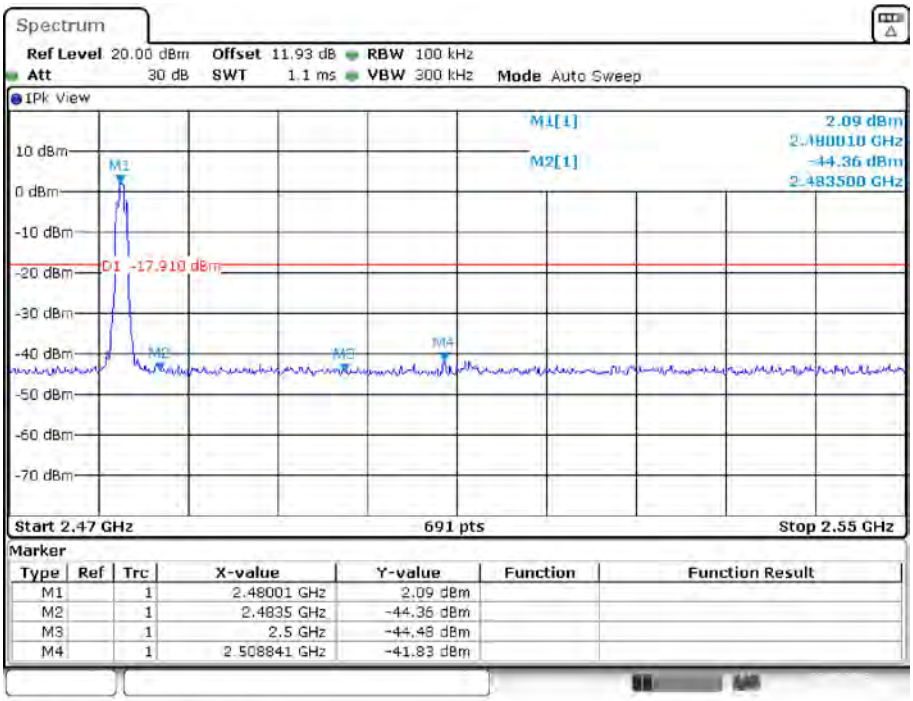
Single



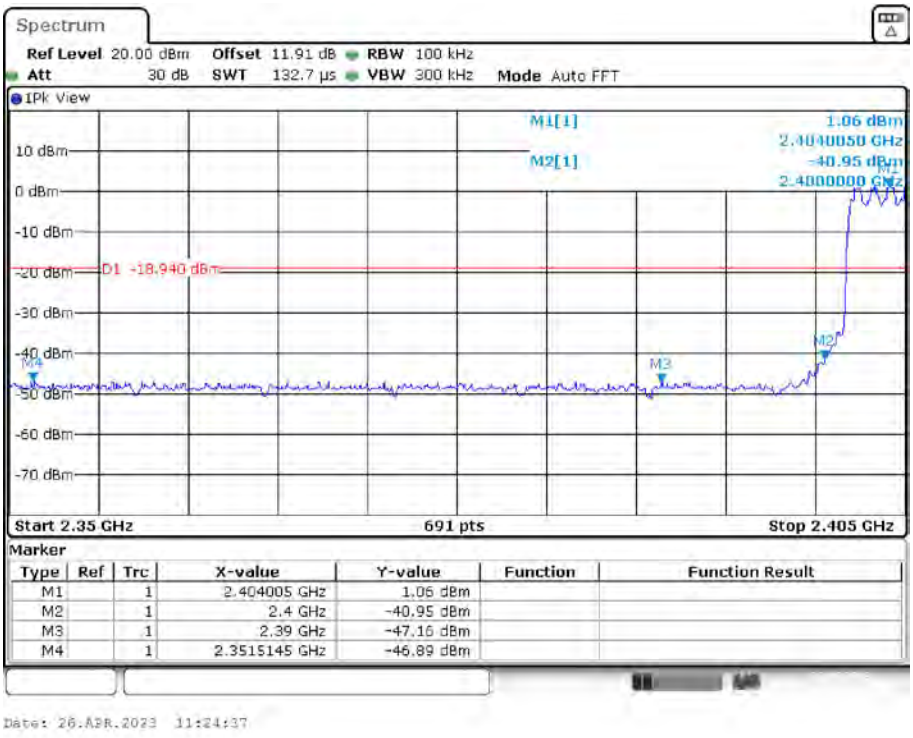
2DH5: Band Edge- Right Side
Hopping



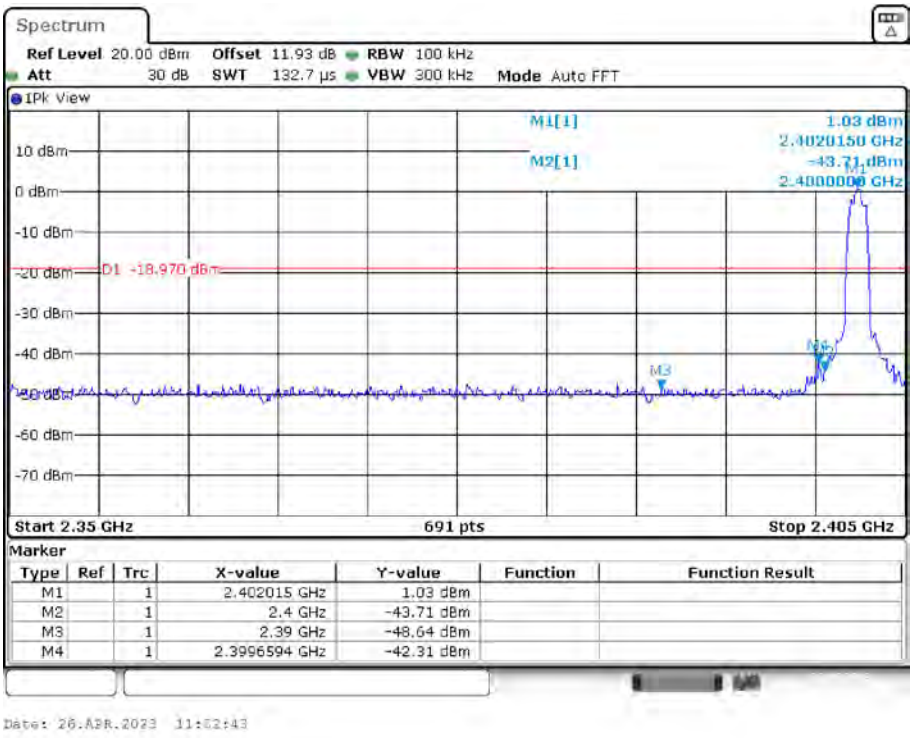
Single



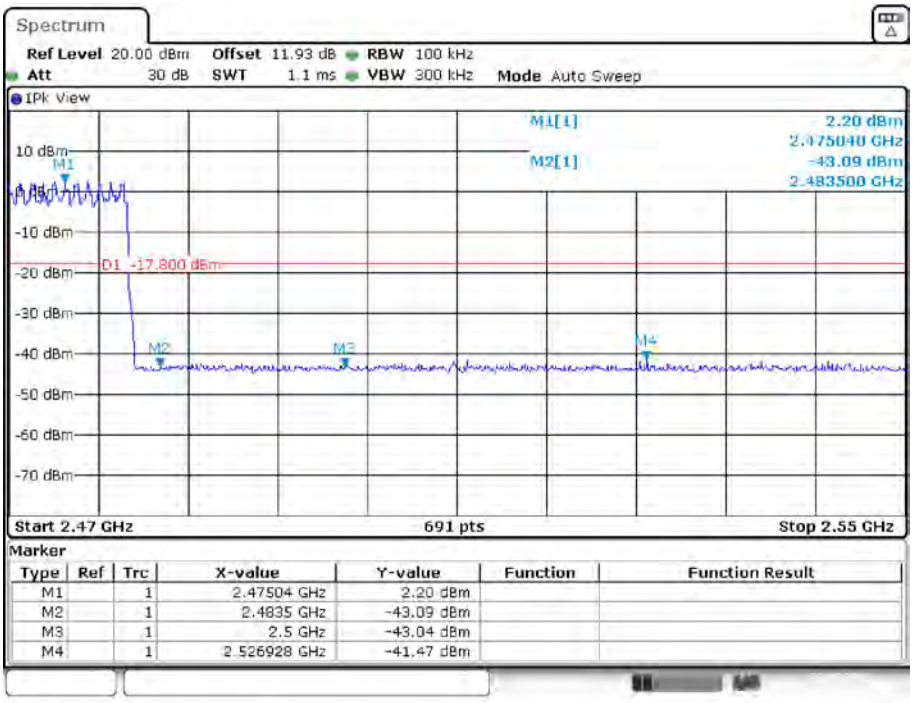
3DH5: Band Edge-Left Side
Hopping



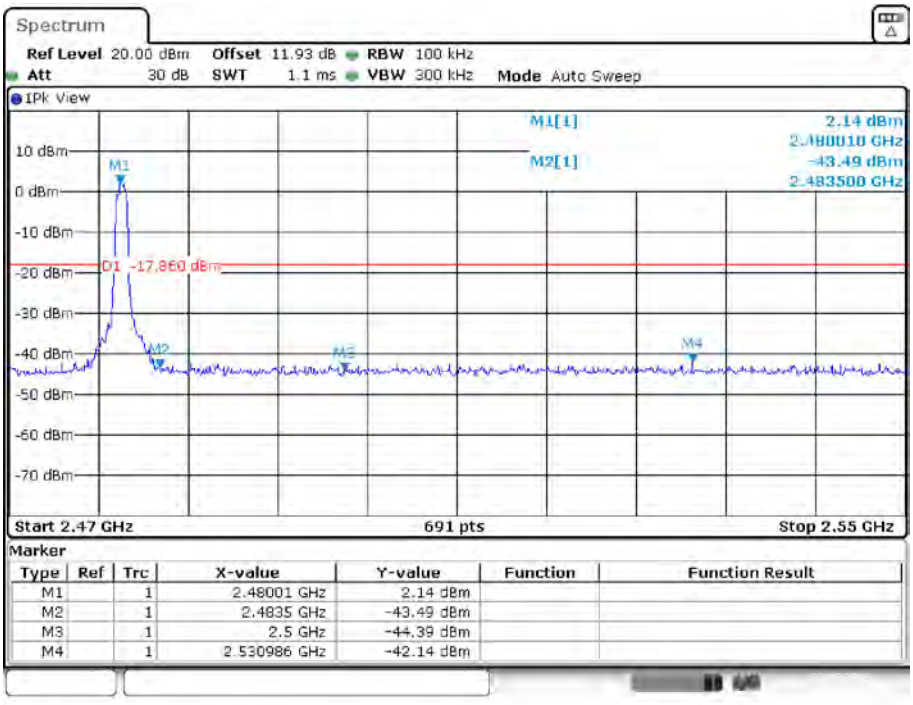
Single



3DH5: Band Edge- Right Side
Hopping



Single



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