

TEST REPORT

Applicant Name : Shanghai XiXun Electronic Co., Ltd.
Address : NO.302,Floor 3,Building31, Lane 1555, West Jinshajiang Road, JiaDing District, Shanghai ,China
Report Number : SH1220110-01295E-RF-00A
FCC ID: 2AQNML20

Test Standard (s)
FCC PART 15.247

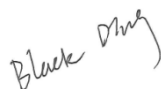
Sample Description

Product Type: LCD Control Card
Test Model: L20
Date Received: 2022-01-10
Date of Test: 2022-04-25 to 2022-05-12
Report Date: 2022-05-13

Test Result:	Pass*
--------------	-------

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

Prepared and Checked By:



Black Ding
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.

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.

Shenzhen Accurate Technology Co., Ltd.

1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China

Tel: +86 755-26503290

Fax: +86 755-26503396

Web: www.atc-lab.com

TABLE OF CONTENTS

GENERAL INFORMATION	4
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT)	4
OBJECTIVE	4
TEST METHODOLOGY	4
MEASUREMENT UNCERTAINTY	5
TEST FACILITY	5
SYSTEM TEST CONFIGURATION	6
DESCRIPTION OF TEST CONFIGURATION	6
EUT EXERCISE SOFTWARE	6
SPECIAL ACCESSORIES	6
EQUIPMENT MODIFICATIONS	6
SUPPORT EQUIPMENT LIST AND DETAILS	6
BLOCK DIAGRAM OF TEST SETUP	7
SUMMARY OF TEST RESULTS	9
TEST EQUIPMENT LIST	10
FCC §1.1307(b) – RF EXPOSURE	11
APPLICABLE STANDARD	11
TEST RESULT	13
FCC §15.203 – ANTENNA REQUIREMENT	14
APPLICABLE STANDARD	14
ANTENNA CONNECTOR CONSTRUCTION	14
FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS	15
APPLICABLE STANDARD	15
EUT SETUP	15
EMI TEST RECEIVER SETUP	15
TEST PROCEDURE	16
FACTOR & MARGIN CALCULATION	16
TEST DATA	16
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS	19
APPLICABLE STANDARD	19
EUT SETUP	19
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP	20
TEST PROCEDURE	20
FACTOR & MARGIN CALCULATION	20
TEST DATA	20
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST	28
APPLICABLE STANDARD	28
TEST PROCEDURE	28
TEST DATA	28
FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH	31
APPLICABLE STANDARD	31
TEST PROCEDURE	31
TEST DATA	32
FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST	42

APPLICABLE STANDARD	42
TEST PROCEDURE	42
TEST DATA	42
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....	45
APPLICABLE STANDARD	45
TEST PROCEDURE	45
TEST DATA	45
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT.....	55
APPLICABLE STANDARD	55
TEST PROCEDURE	55
TEST DATA	55
FCC §15.247(d) - BAND EDGES TESTING	61
APPLICABLE STANDARD	61
TEST PROCEDURE	61
TEST DATA	61

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	LCD Control Card
Tested Model	L20
Frequency Range	2402~2480MHz
Maximum conducted Peak output power	1.86dBm
Modulation Technique	BDR(GFSK)/EDR($\pi/4$ -DQPSK)/EDR(8DPSK)
Antenna Specification*	Antenna gain: 5.0dBi(provided by the applicant)
Voltage Range	DC 12V from adapter.
Sample number	SH1220110-01295E-RF-S1
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 output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
Temperature		1°C
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 (ISED), 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

Software “adb instruction into signaling mode, connect CMW500 test”* was used during testing and the power level was Default Power level default *.

Special Accessories

N/A.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

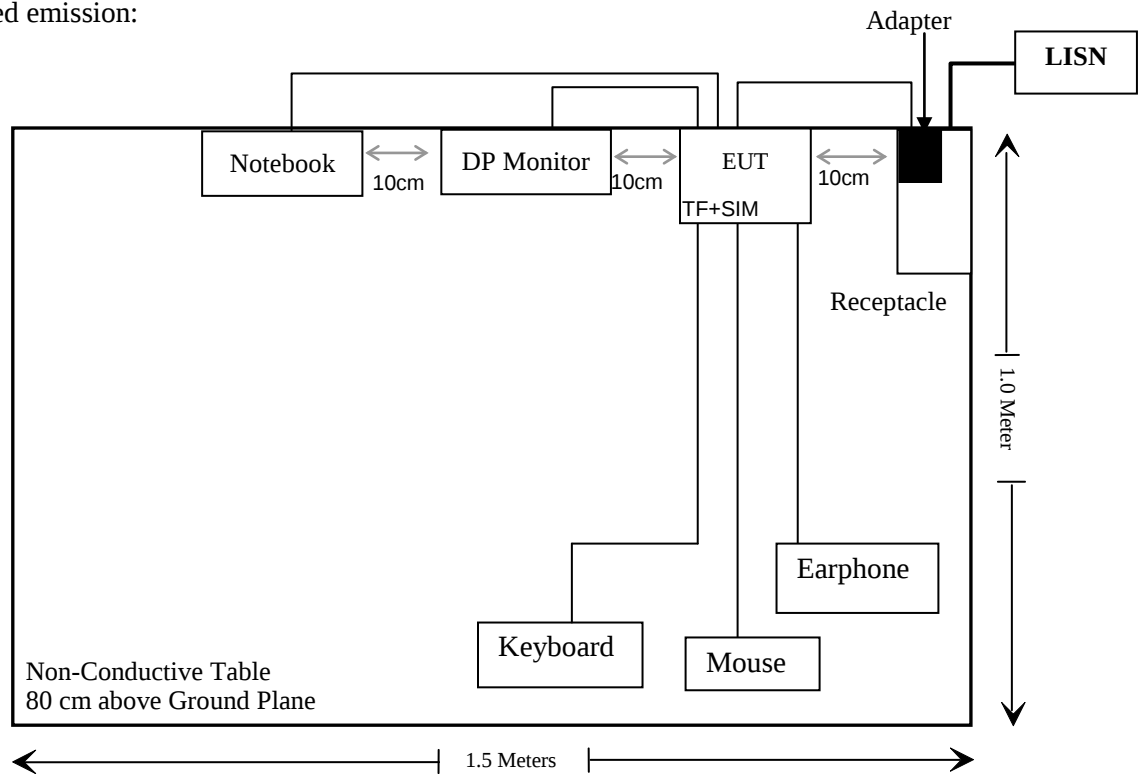
Manufacturer	Description	Model	Serial Number
SHENZHEN FRECOM ELECTRONICS CO.,LTD.	Adapter	F18W8-120150SPAUY	E257831
Unknown	Earphone	Unknown	Unknown
PHILIPS	DP Monitor	275M7C	Unknown
Lenovo	Notebook	T430	Unknown
DELL	Keyboard	L100	CN0RH66658985C018C
DELL	Mouse	MOC5UG	Unknown
Kingston	TF card	SDCS2/32GB	Unknown

External I/O Cable

Cable Description	Length (m)	From/Port	To
Un-shielding Detachable DC Cable	1.0	EUT	Adapter
Shielding Detachable HDMI Cable	1.5	EUT	DP Monitor
Un-shielding Detachable Earphone Cable	1.0	EUT	Earphone
Un-shielding Detachable RJ45 Cable	1.0	EUT	Notebook
Unshielded Detachable USB Cable	1.5	EUT	Mouse
Unshielded Detachable USB Cable	1.5	EUT	Keyboard

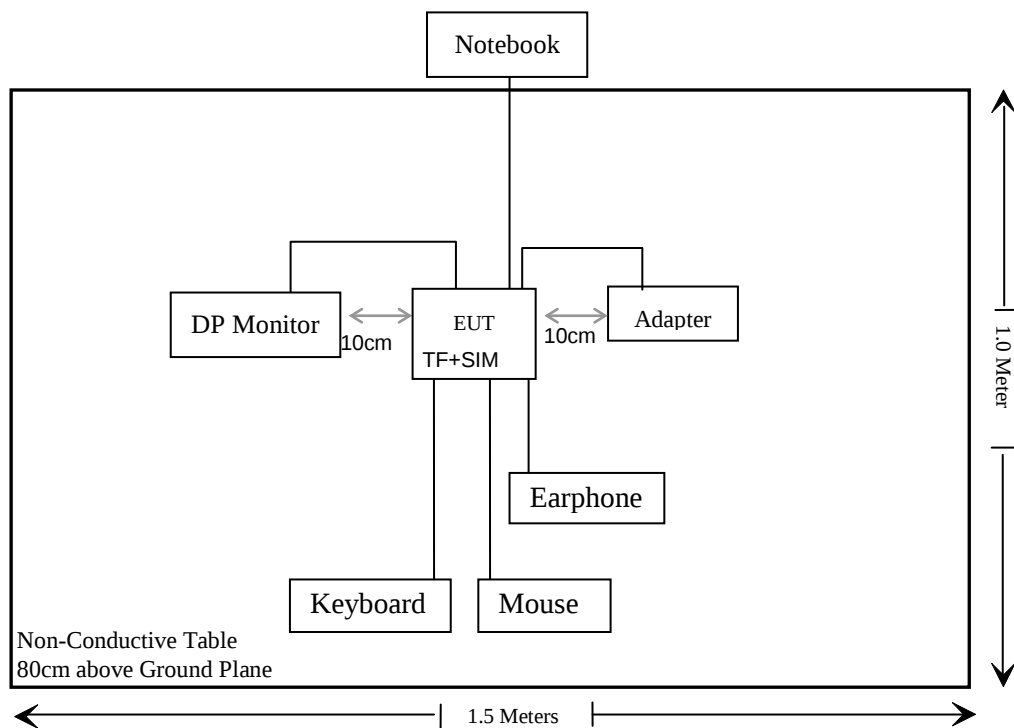
Block Diagram of Test Setup

For conducted emission:

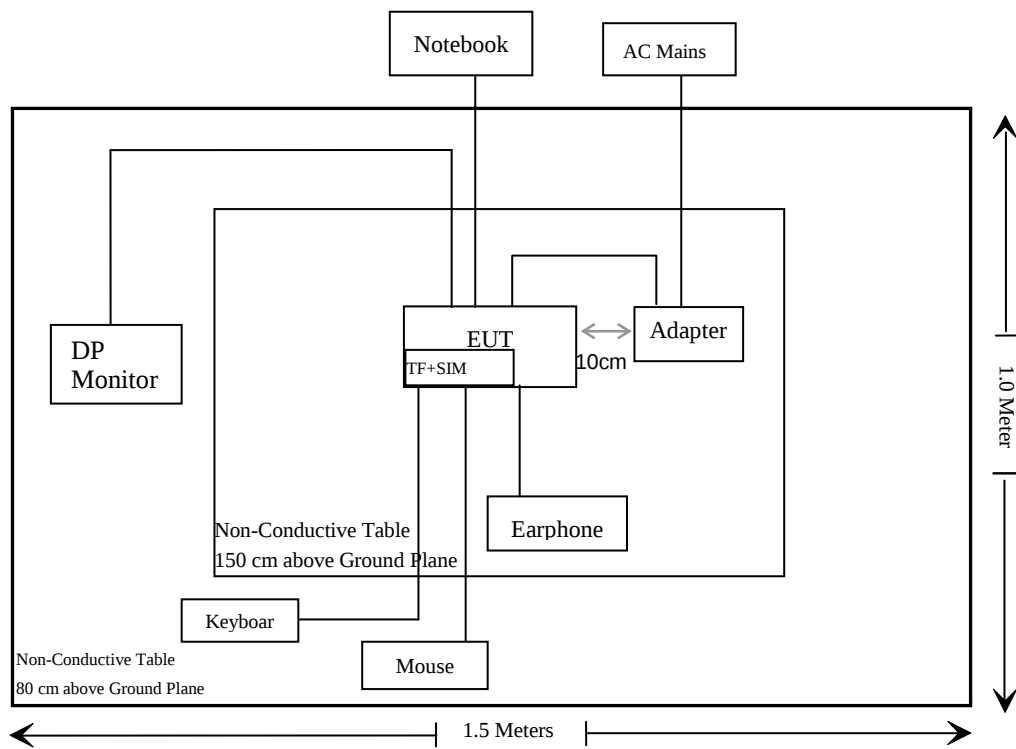


For radiated emission:

Below 1GHz:



Above 1GHz:



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 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-184055 36-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
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2021/12/14	2022/12/13
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
Radiated Emission Test Software: e3 19821b (V9)					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2021/12/13	2022/12/12
Rohde & Schwarz	Open Switch and Control Unit	OSP120 + OSP-B157	101244 + 100866	2021/12/13	2022/12/12
WEINSCHTEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.31	RF-01	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 2.1.3.1-SAR-Based Exemption:

A more comprehensive exemption, considering a variable power threshold that depends on both the separation distance and power, is provided in § 1.1307(b)(3)(i)(B). This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with test separation distances between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.

Accordingly, a RF source is considered an RF exempt device if its available maximum time-averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold. This exemption threshold was derived based on general population 1-g SAR requirements and is detailed in Appendix C.

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}}(d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

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

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

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

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) of this section for P_{th}, including existing exempt transmitters and those being added.

b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) of this section for Threshold ERP, including existing exempt transmitters and those being added.

c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance including existing evaluated transmitters.

P_i = the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).

P_{th,i} = the exemption threshold power (P_{th}) according to paragraph (b)(3)(i)(B) of this section for fixed, mobile, or portable RF source i.

ERP_j = the ERP of fixed, mobile, or portable RF source j.

ERP_{th,j} = exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least λ/2π according to the applicable formula of paragraph (b)(3)(i)(C) of this section.

Evaluated_k = the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.

Exposure Limit_k = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from § 1.1310 of this chapter.

Test Result

For worst case:

Mode	Frequency	Maximum Tune-up Conducted Power	Antenna Gain		ERP		Distance	SAR-Based Exclusion Threshold P_{th}	SAR-Based Exclusion
	MHz	dBm	dBi	dBd	dBm	mW	(mm)	mW	
BT	2402-2480	2	5	2.85	4.85	3.05	200	3060	Yes
2.4G Wi-Fi	2412-2462	16.5	5	2.85	19.35	86.10	200	3060	Yes
WCDMA B2	1850-1910	25	4	1.85	26.85	484.17	200	3060	Yes
WCDMA B4	1710-1755	25	4	1.85	26.85	484.17	200	3060	Yes
WCDMA B5	824-849	25	4	1.85	26.85	484.17	200	1681	Yes
LTE B2	1850-1910	25	4	1.85	26.85	484.17	200	3060	Yes
LTE B4	1710-1755	25	4	1.85	26.85	484.17	200	3060	Yes
LTE B5	824-849	25	4	1.85	26.85	484.17	200	1681	Yes
LTE B12	699-716	25	4	1.85	26.85	484.17	200	1426	Yes
LTE B13	777-787	25	4	1.85	26.85	484.17	200	1585	Yes
LTE B14	788-798	25	4	1.85	26.85	484.17	200	1607	Yes
LTE B66	1710-1780	25	4	1.85	26.85	484.17	200	3060	Yes
LTE B71	663-698	25	4	1.85	26.85	484.17	200	1352	Yes

Note 1: The tune-up power was declared by the applicant.

Note 2: 0dBd=2.15dBi.

Note 3: The BT and Wi-Fi can't transmit at the same time.

Note 4: The BT or Wi-Fi can transmit at the same time with the WWAN.

Note 5: Please refer to the FCC ID: XMR201808EC25AF about the power for the LTE module

Simultaneous transmitting consideration (worst case):

The ratio= $EEPE_{2.4G\ Wi-Fi} / \text{limit} + EPE_{LTE\ B71} / \text{limit} = 86.10/3060 + 484.17/1352 = 0.386 < 1.0$

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 external antenna arrangement, which was used a unique coupling and the antenna gain is 5dBi, fulfill the requirement of this section. Please refer to the EUT photos.

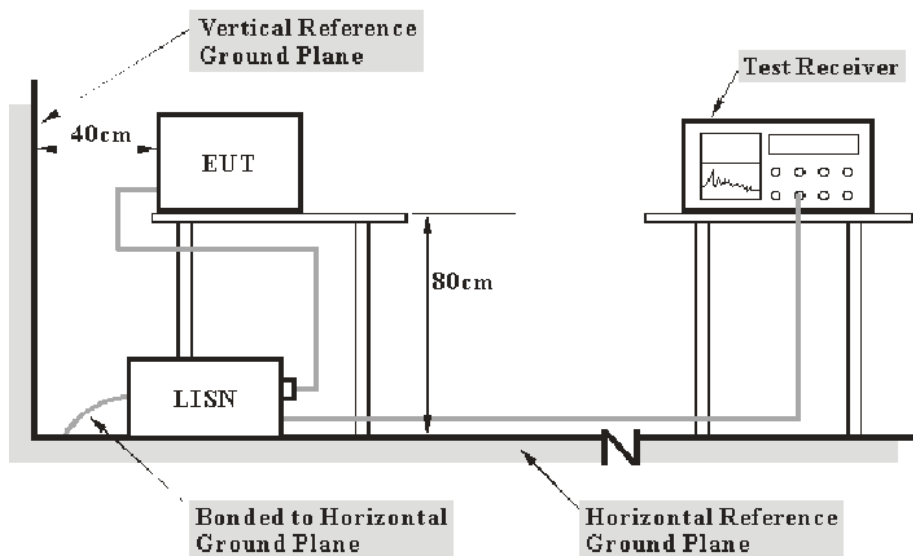
Result: Compliant.

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:

$$\text{Factor} = \text{LISN VDF} + \text{Cable Loss}$$

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:

$$\begin{aligned}\text{Over Limit} &= \text{Level} - \text{Limit} \\ \text{Level} &= \text{Read Level} + \text{Factor}\end{aligned}$$

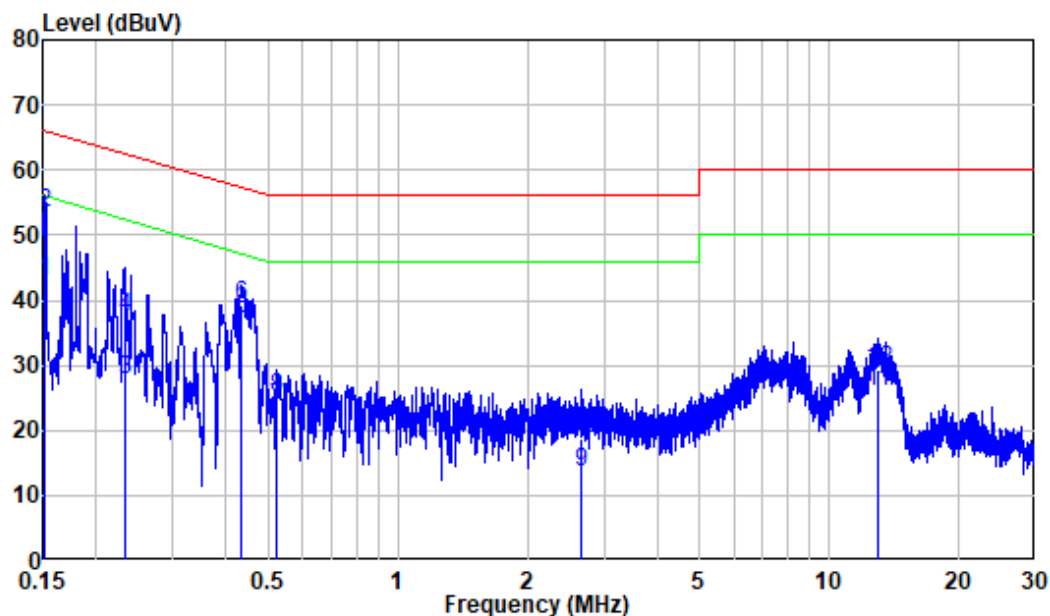
Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	47 %
ATM Pressure:	101.1 kPa

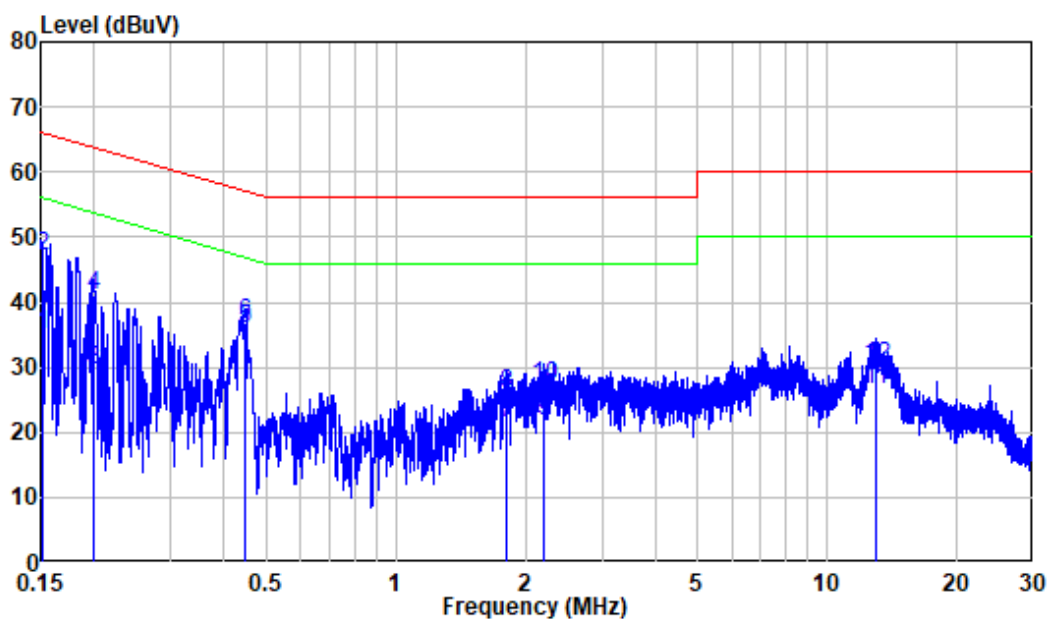
The testing was performed by Caro Hu on 2022-04-25.

EUT operation mode: BT transmitting

AC 120V/60 Hz, Line

Site : Shielding Room
 Condition: Line
 Job No. : SH1220110-01295E-RF
 Mode : BT Transmitting
 Model : L20
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit	Over	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.152	9.80	33.20	43.00	55.88	-12.88	Average
2	0.152	9.80	43.73	53.53	65.88	-12.35	QP
3	0.233	9.80	17.89	27.69	52.36	-24.67	Average
4	0.233	9.80	27.66	37.46	62.36	-24.90	QP
5	0.434	9.80	27.36	37.16	47.18	-10.02	Average
6	0.434	9.80	29.33	39.13	57.18	-18.05	QP
7	0.522	9.81	13.89	23.70	46.00	-22.30	Average
8	0.522	9.81	15.20	25.01	56.00	-30.99	QP
9	2.661	9.83	3.77	13.60	46.00	-32.40	Average
10	2.661	9.83	8.75	18.58	56.00	-37.42	QP
11	12.954	9.93	16.00	25.93	50.00	-24.07	Average
12	12.954	9.93	19.50	29.43	60.00	-30.57	QP

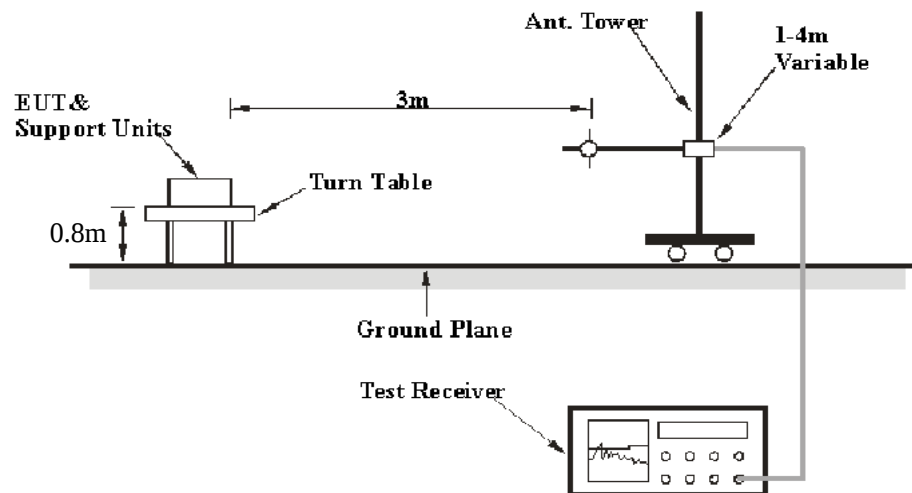
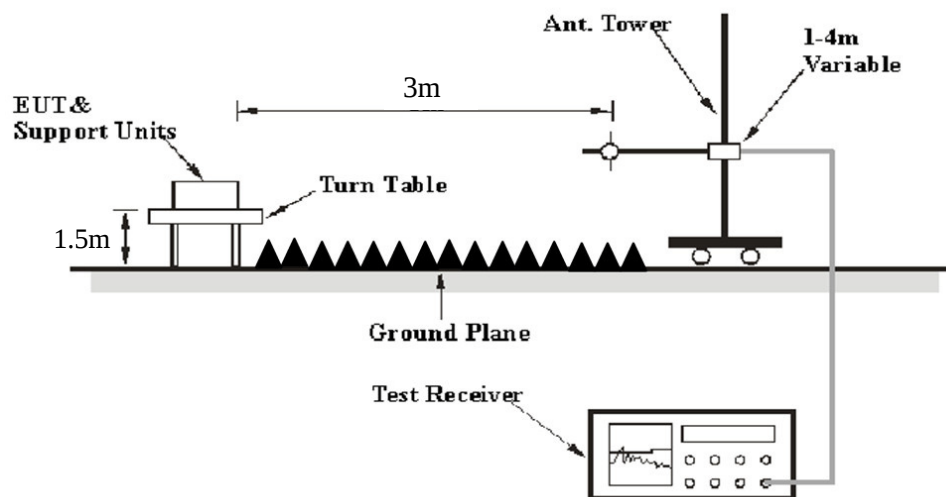
AC 120V/60 Hz, Neutral

Site : Shielding Room
 Condition: Neutral
 Job No. : SH1220110-01295E-RF
 Mode : BT Transmitting
 Model : L20
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.151	9.80	25.22	35.02	55.93	-20.91	Average
2	0.151	9.80	37.36	47.16	65.93	-18.77	QP
3	0.200	9.80	19.83	29.63	53.62	-23.99	Average
4	0.200	9.80	31.40	41.20	63.62	-22.42	QP
5	0.445	9.80	26.08	35.88	46.96	-11.08	Average
6	0.445	9.80	26.98	36.78	56.96	-20.18	QP
7	1.811	9.82	11.73	21.55	46.00	-24.45	Average
8	1.811	9.82	16.24	26.06	56.00	-29.94	QP
9	2.201	9.82	11.85	21.67	46.00	-24.33	Average
10	2.201	9.82	17.27	27.09	56.00	-28.91	QP
11	12.920	10.03	16.43	26.46	50.00	-23.54	Average
12	12.920	10.03	20.01	30.04	60.00	-29.96	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
	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.

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:

$$\text{Factor} = \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\begin{aligned} \text{Over Limit/Margin} &= \text{Level} / \text{Corrected Amplitude} - \text{Limit} \\ \text{Level} / \text{Corrected Amplitude} &= \text{Read Level} + \text{Factor} \end{aligned}$$

Test Data

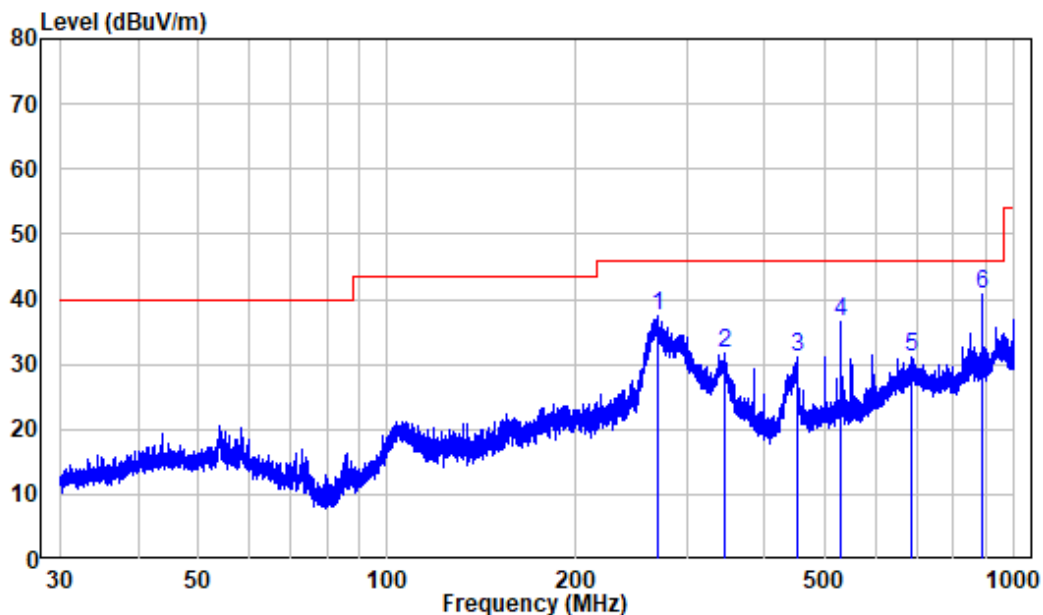
Environmental Conditions

Temperature:	23 °C
Relative Humidity:	58 %
ATM Pressure:	101.2 kPa

The testing was performed by Nick Fang on 2022-04-25.

EUT operation mode: BT Transmitting

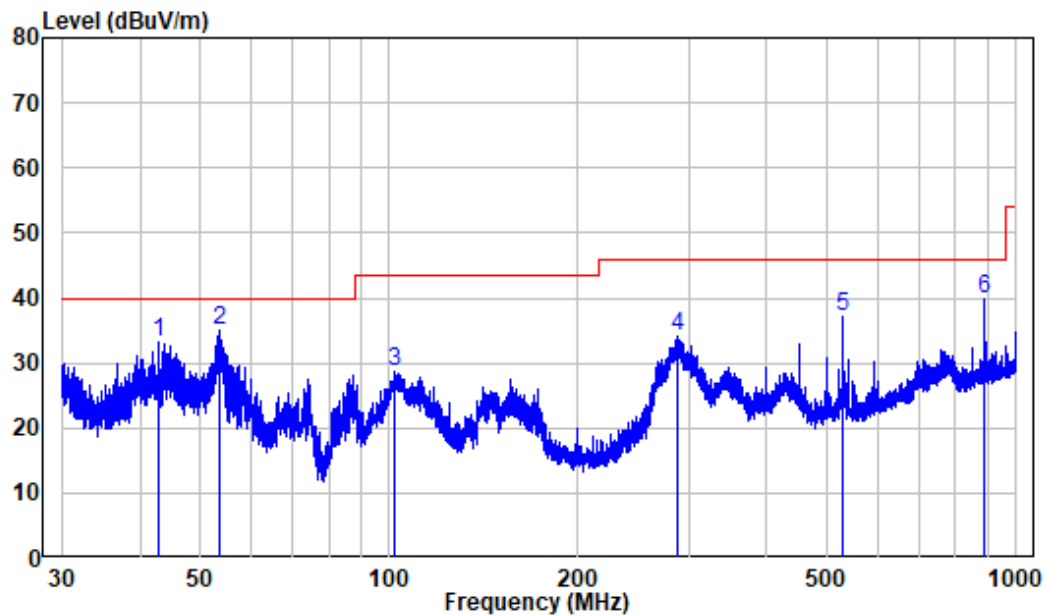
(Scan with GFSK, $\pi/4$ -DQPSK, 8DPSK mode at X axis, Y axis, Z axis, the worst case is 8DPSK Mode at Y axis)

Below 1GHz: 8DPSK High Channel**Horizontal**

Site : chamber
Condition: 3m HORIZONTAL
Job NO. : SH1220110-01295E-RF
MODE : BT Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	269.310	-10.26	47.65	37.39	46.00	-8.61	Peak
2	345.898	-7.23	39.01	31.78	46.00	-14.22	Peak
3	450.147	-5.62	36.60	30.98	46.00	-15.02	Peak
4	528.014	-4.48	40.94	36.46	46.00	-9.54	Peak
5	686.850	-1.51	32.63	31.12	46.00	-14.88	Peak
6	891.118	0.94	39.88	40.82	46.00	-5.18	QP

Vertical

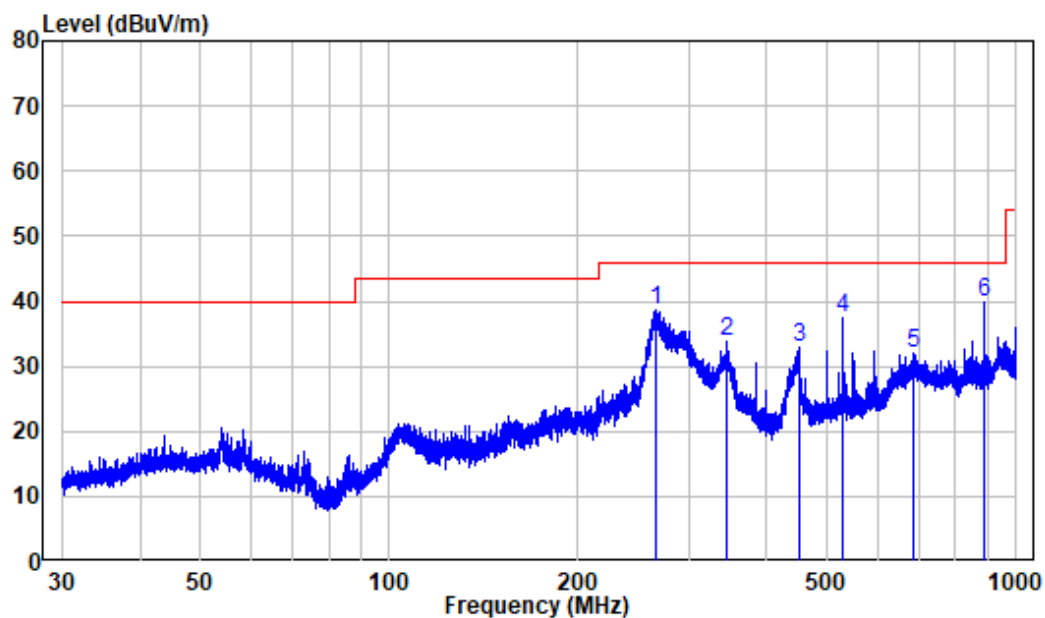


Site : chamber
 Condition: 3m VERTICAL
 Job NO. : SH1220110-01295E-RF
 MODE : BT Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	42.731	-9.97	43.13	33.16	40.00	-6.84	Peak
2	53.435	-10.25	45.36	35.11	40.00	-4.89	Peak
3	101.867	-11.58	40.31	28.73	43.50	-14.77	Peak
4	289.002	-9.33	43.43	34.10	46.00	-11.90	Peak
5	528.246	-4.49	41.49	37.00	46.00	-9.00	Peak
6	891.118	0.94	38.96	39.90	46.00	-6.10	Peak

Co-location:

Horizontal



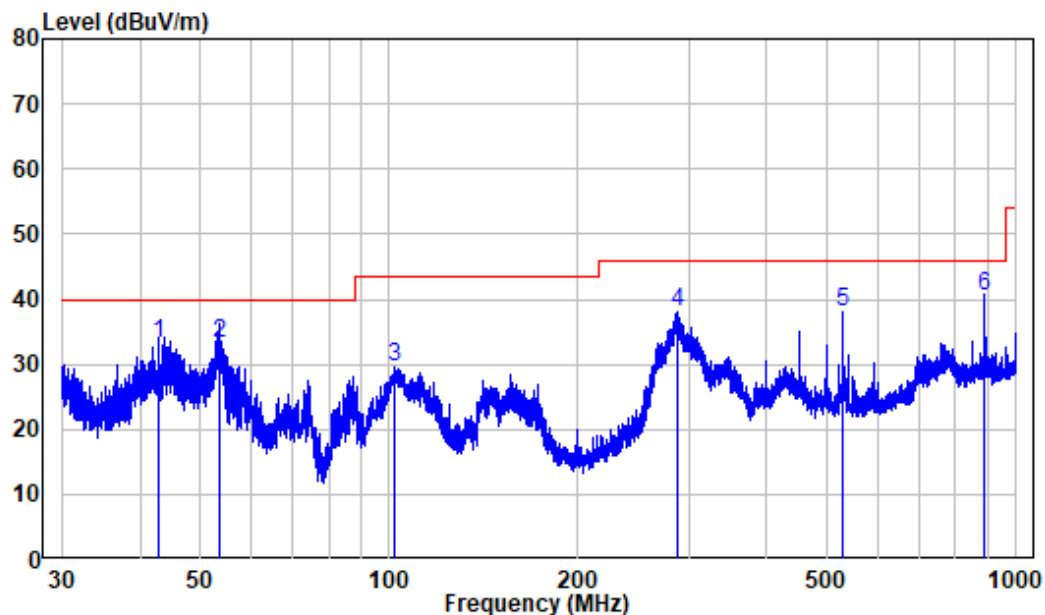
Site : chamber

Condition: 3m HORIZONTAL

Job NO. : SH1220110-01295E-RF

MODE : BT Transmitting + LTE Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	266.142	-10.40	49.18	38.78	46.00	-7.22	Peak
2	345.898	-7.23	41.01	33.78	46.00	-12.22	Peak
3	450.147	-5.62	38.60	32.98	46.00	-13.02	Peak
4	528.014	-4.48	41.94	37.46	46.00	-8.54	Peak
5	686.850	-1.51	33.63	32.12	46.00	-13.88	Peak
6	891.118	0.94	38.88	39.82	46.00	-6.18	Peak

Vertical

Site : chamber

Condition: 3m VERTICAL

Job NO. : SH1220110-01295E-RF

MODE : BT Transmitting + LTE Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	42.731	-9.97	43.13	33.16	40.00	-6.84	QP
2	53.435	-10.25	43.36	33.11	40.00	-6.89	QP
3	101.867	-11.58	41.31	29.73	43.50	-13.77	Peak
4	289.002	-9.33	47.43	38.10	46.00	-7.90	Peak
5	528.246	-4.49	42.49	38.00	46.00	-8.00	Peak
6	891.118	0.94	39.51	40.45	46.00	-5.55	QP

Above 1GHz (worst case for 8DPSK):

Frequency (MHz)	Receiver		Turntable Angle	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/AV	Degree	Height	Polar				
				(m)	(H/V)				
Low Channel									
2310	43.88	PK	5	1.6	H	-7.23	36.65	74	-37.35
2310	44.2	PK	344	1.9	V	-7.23	36.97	74	-37.03
2390	42.7	PK	96	2.1	H	-7.21	35.49	74	-38.51
2390	46.62	PK	204	1.4	V	-7.21	39.41	74	-34.59
4804	45.07	PK	312	2.0	H	-3.52	41.55	74	-32.45
4804	44.67	PK	113	1.8	V	-3.52	41.15	74	-32.85
Middle Channel									
4882	44.48	PK	310	1.5	H	-3.37	41.11	74	-32.89
4882	43.81	PK	262	1.6	V	-3.37	40.44	74	-33.56
High Channel									
2483.5	51.37	PK	254	2.0	H	-7.2	44.17	74	-29.83
2483.5	46.03	PK	352	1.7	V	-7.2	38.83	74	-35.17
2500	48.7	PK	127	1.8	H	-7.18	41.52	74	-32.48
2500	45.89	PK	74	1.7	V	-7.18	38.71	74	-35.29
4960	44.57	PK	233	1.5	H	-3.01	41.56	74	-32.44
4960	44.5	PK	100	1.6	V	-3.01	41.49	74	-32.51

Co-location (Worst case for 8DPSK and LTE Band 2)

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/AV		Height (m)	Polar (H/V)				
5426.76	50.82	PK	293	2.3	H	-1.79	49.03	74	-24.97
5561.82	50.27	PK	238	2.4	V	-1.31	48.96	74	-25.04

Note:

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

Absolute Level (Corrected Amplitude) = Factor + Reading

Margin = Absolute Level (Corrected Amplitude) – Limit

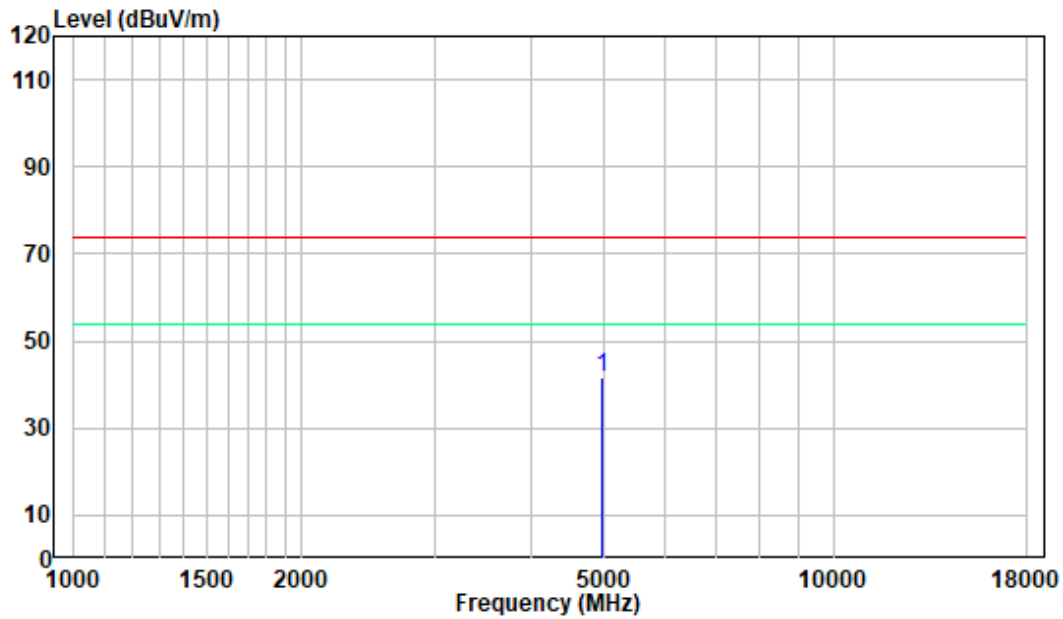
The other spurious emission which is in the noise floor level was not recorded.

For above 1GHz, the test result of peak was 20dB below to the limit of peak, which can be compliant to the average limit, so just peak value was recorded.

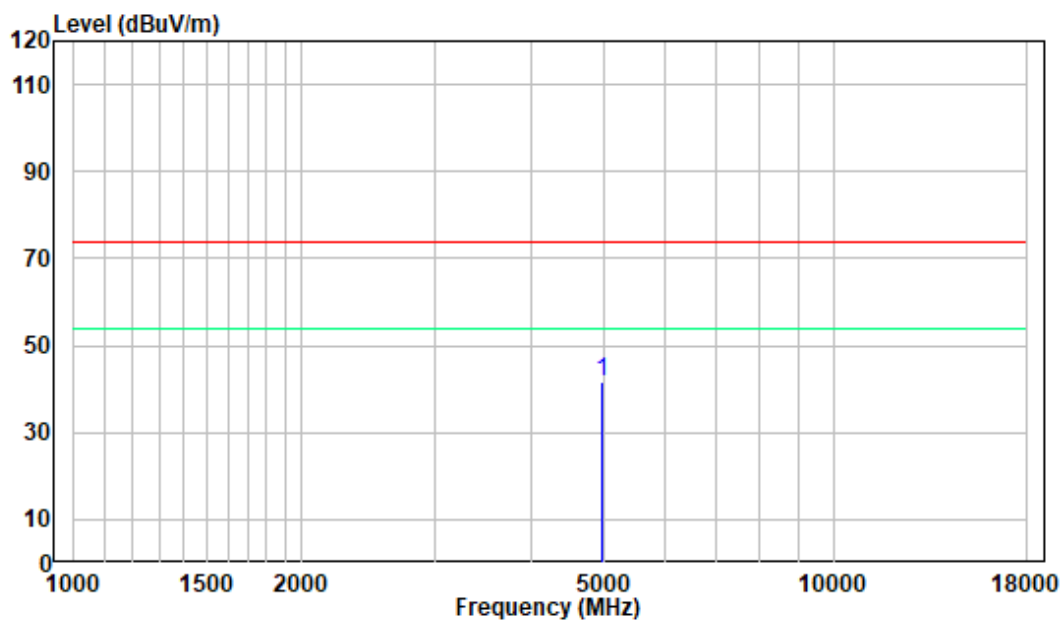
1 GHz - 18 GHz: (Pre-Scan plots)

Worst case for 8DPSK High Channel:

Horizontal



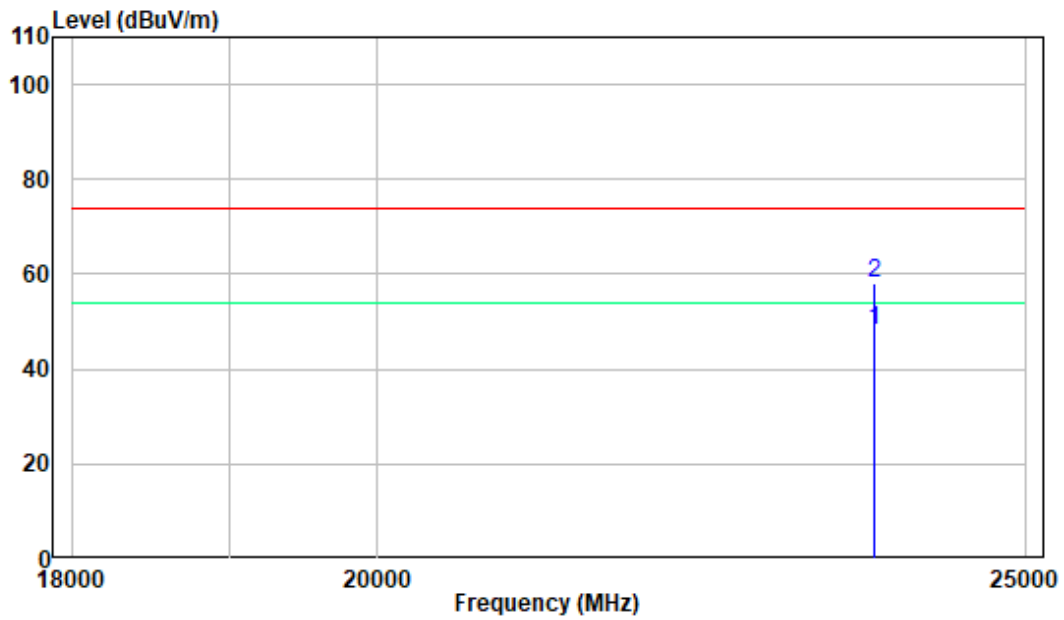
Vertical



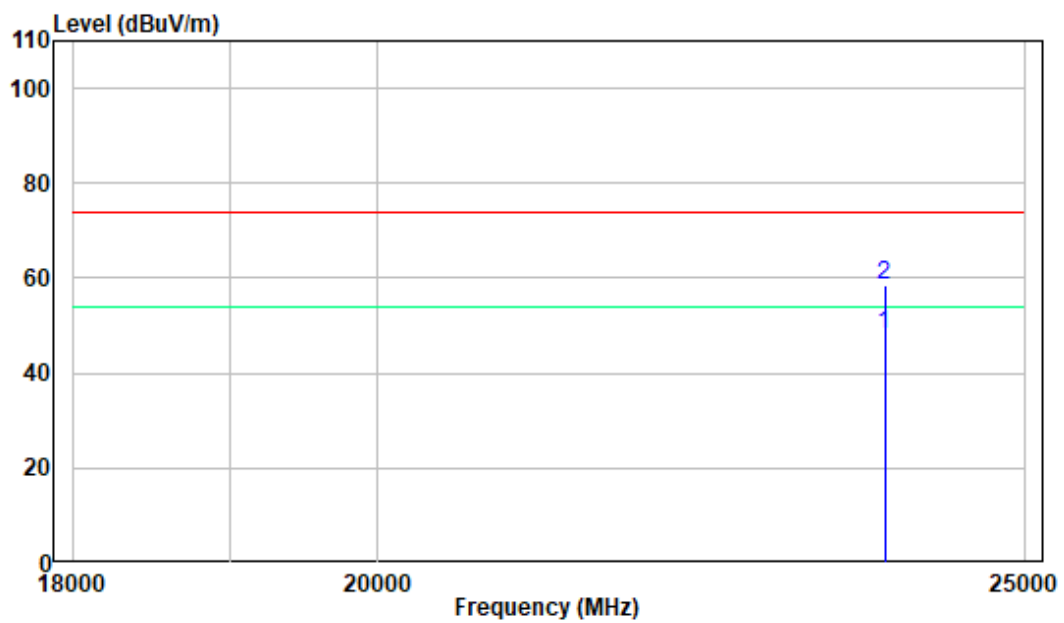
18-25GHz: (Pre-Scan plots)

Worst case for 8DPSK High Channel:

Horizontal



Vertical



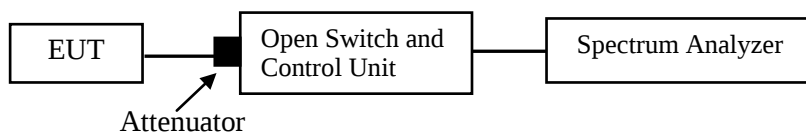
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. 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:	23°C
Relative Humidity:	59 %
ATM Pressure:	101.0 kPa

The testing was performed by Leo Li on 2022-05-12.

EUT operation mode: Transmitting

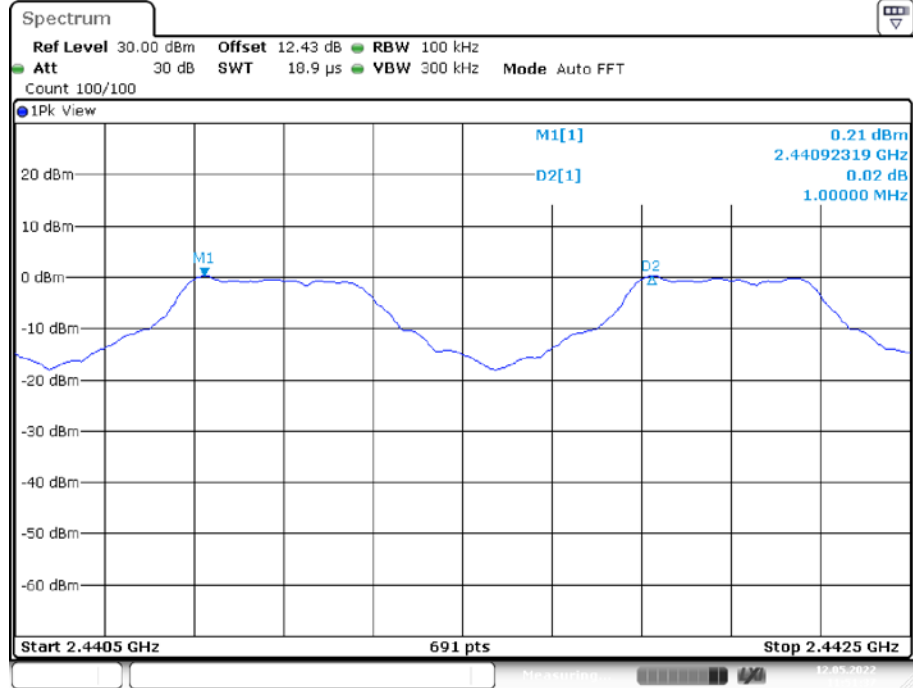
Test Result: Compliant.

TestMode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	1	≥ 0.588	PASS
2DH1	Ant1	Hop	1.003	≥ 0.834	PASS
3DH1	Ant1	Hop	1.003	≥ 0.812	PASS

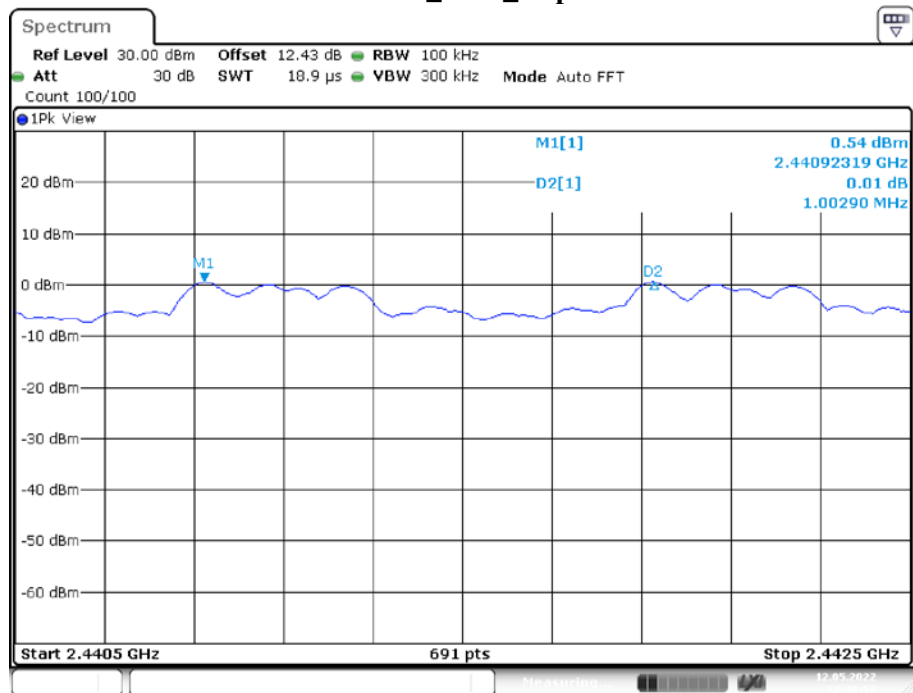
Note: The limit = $(2/3) * 20\text{dB bandwidth}$

Please refer to the below plots:

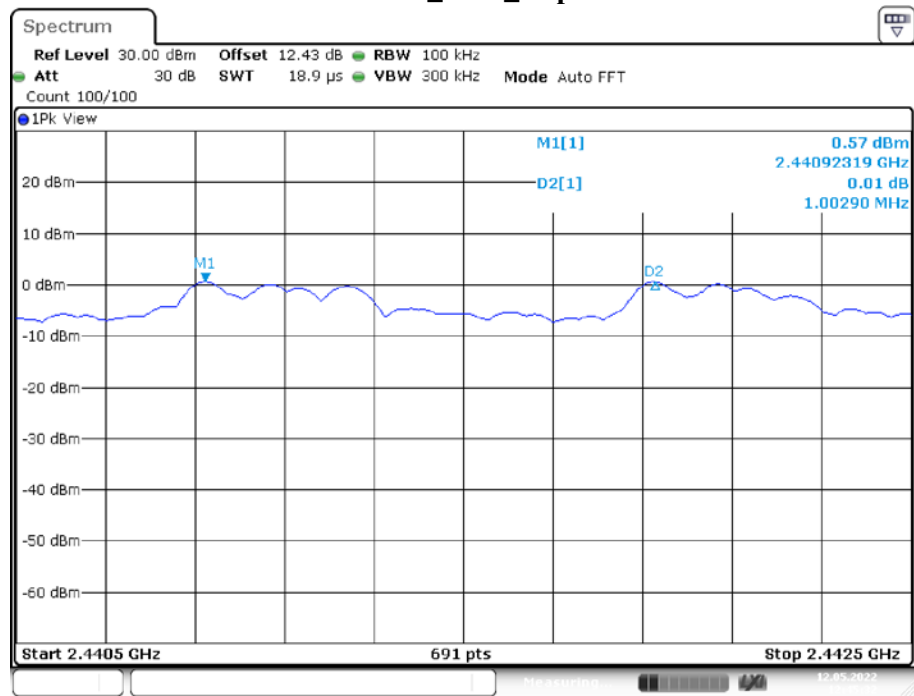
DH1_Ant1_Hop



2DH1_Ant1_Hop



3DH1_Ant1_Hop



Date: 12.MAY.2022 12:45:33

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.

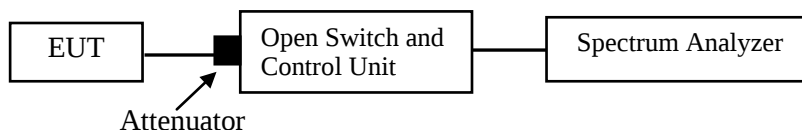
Test Procedure

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data**Environmental Conditions**

Temperature:	23°C
Relative Humidity:	59 %
ATM Pressure:	101.0kPa

The testing was performed by Leo Li on 2022-05-12.

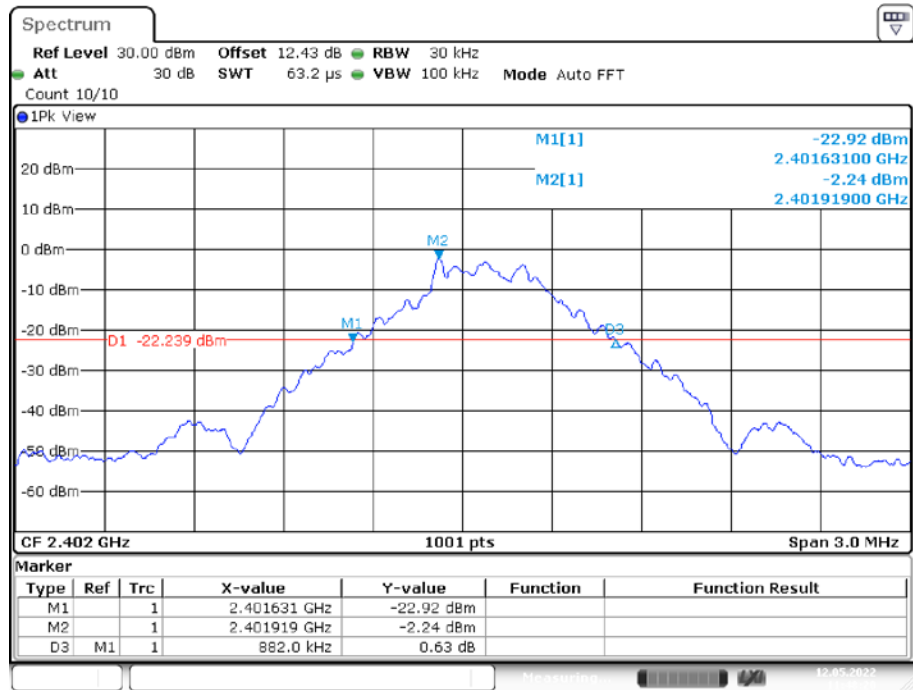
EUT operation mode: Transmitting

Test Result: Compliant.

TestMode	Antenna	Channel	20db EBW[MHz]	99% OCCUPIED BANDWIDTH[MHz]	Verdict
DH1	Ant1	2402	0.882	0.827	PASS
		2441	0.882	0.824	PASS
		2480	0.882	0.827	PASS
2DH1	Ant1	2402	1.251	1.166	PASS
		2441	1.248	1.166	PASS
		2480	1.248	1.169	PASS
3DH1	Ant1	2402	1.218	1.154	PASS
		2441	1.218	1.154	PASS
		2480	1.218	1.154	PASS

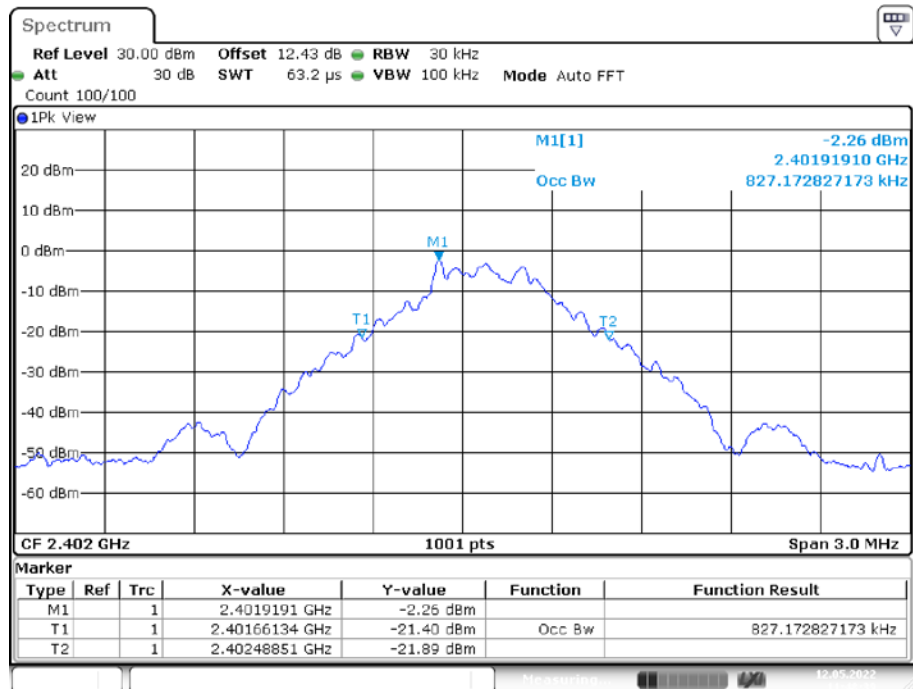
Please refer to the below plots:

20 dB EMISSION BANDWIDTH_DH1_Ant1_2402



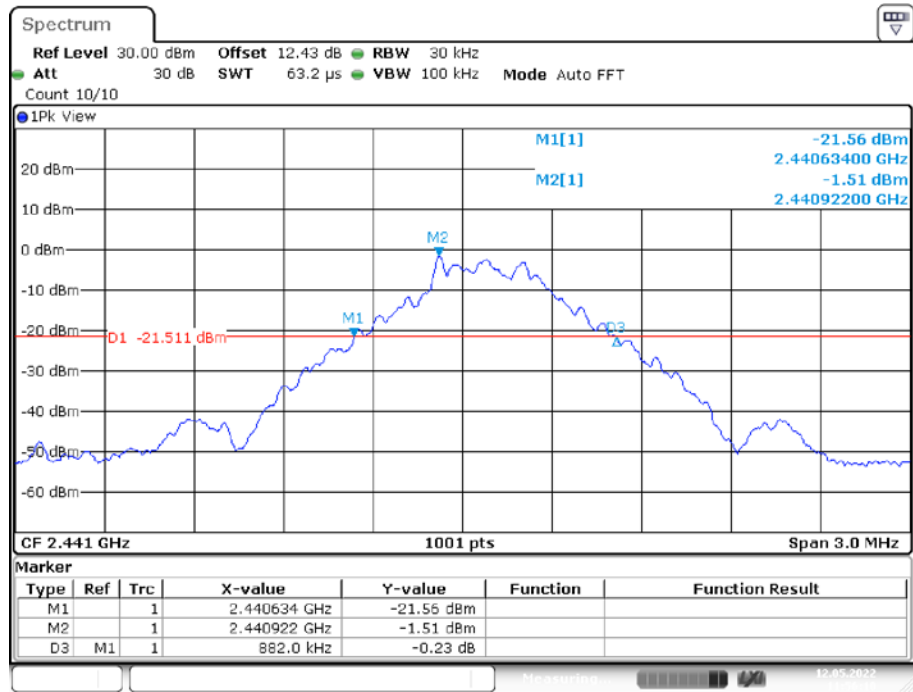
Date: 12.MAY.2022 11:48:21

99% OCCUPIED BANDWIDTH_DH1_Ant1_2402



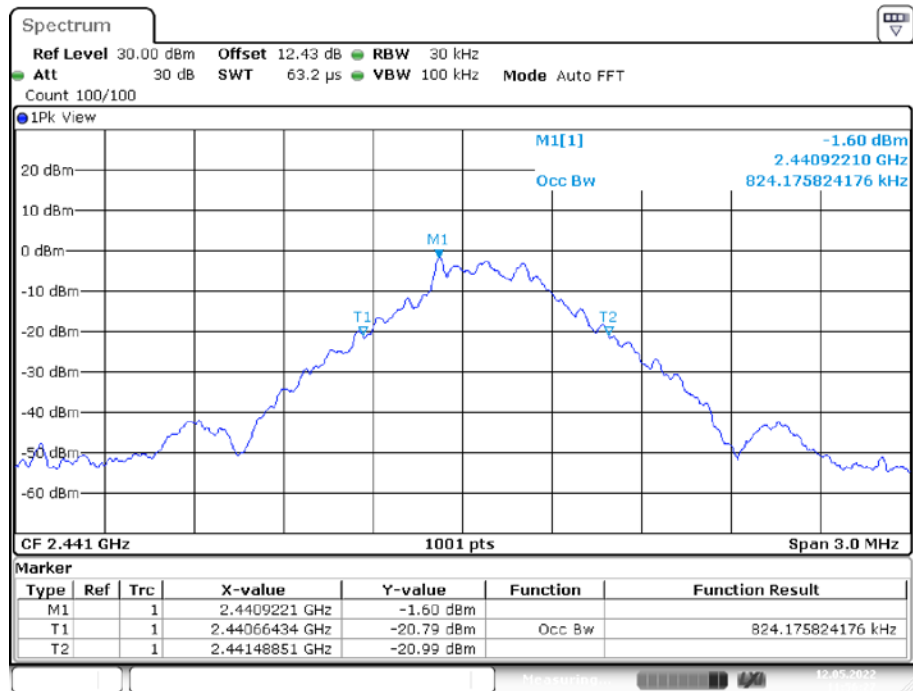
Date: 12.MAY.2022 11:48:40

20 dB EMISSION BANDWIDTH_DH1_Ant1_2441



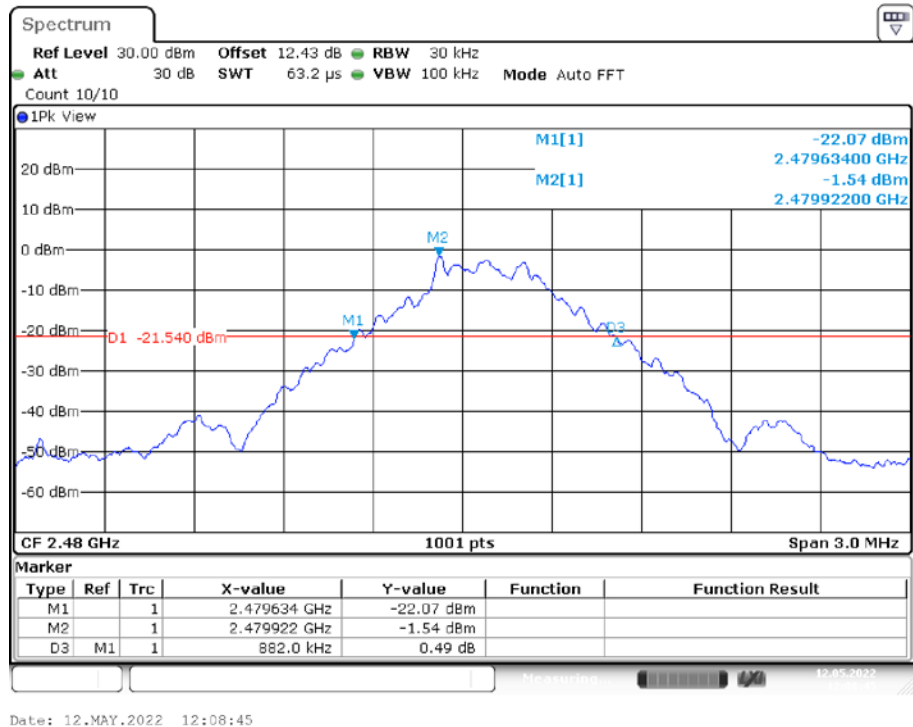
Date: 12.MAY.2022 11:56:10

99% OCCUPIED BANDWIDTH_DH1_Ant1_2441

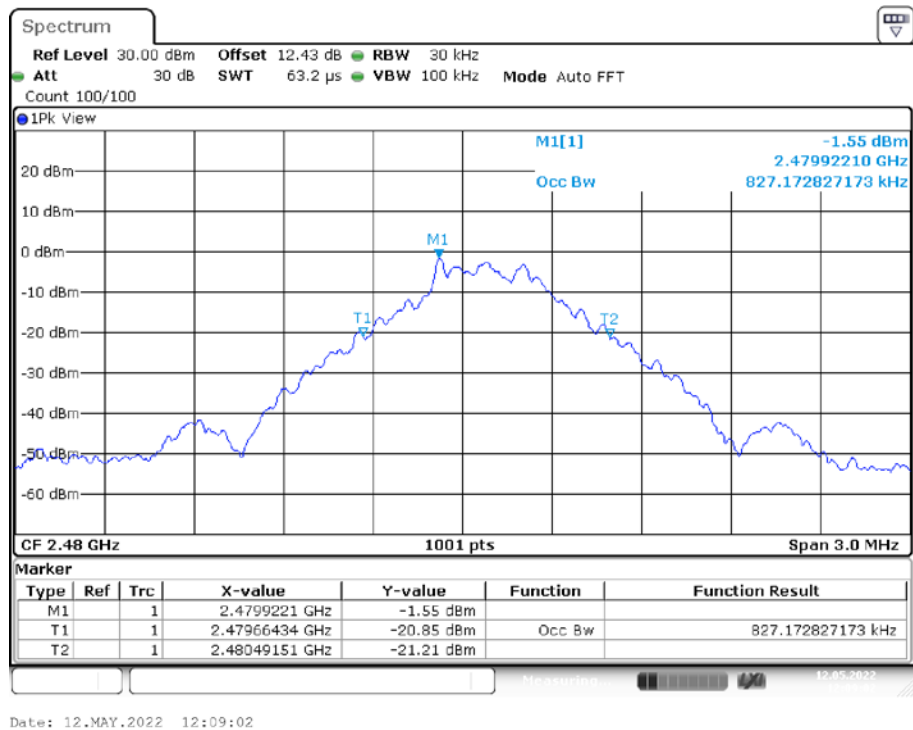


Date: 12.MAY.2022 11:56:28

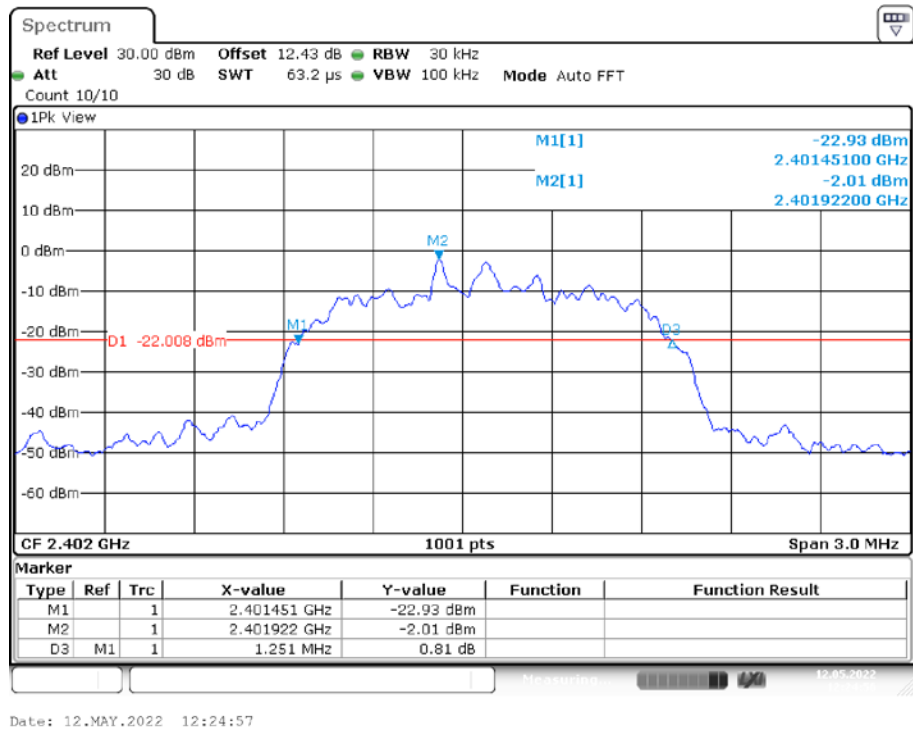
20 dB EMISSION BANDWIDTH_DH1 _Ant1_2480



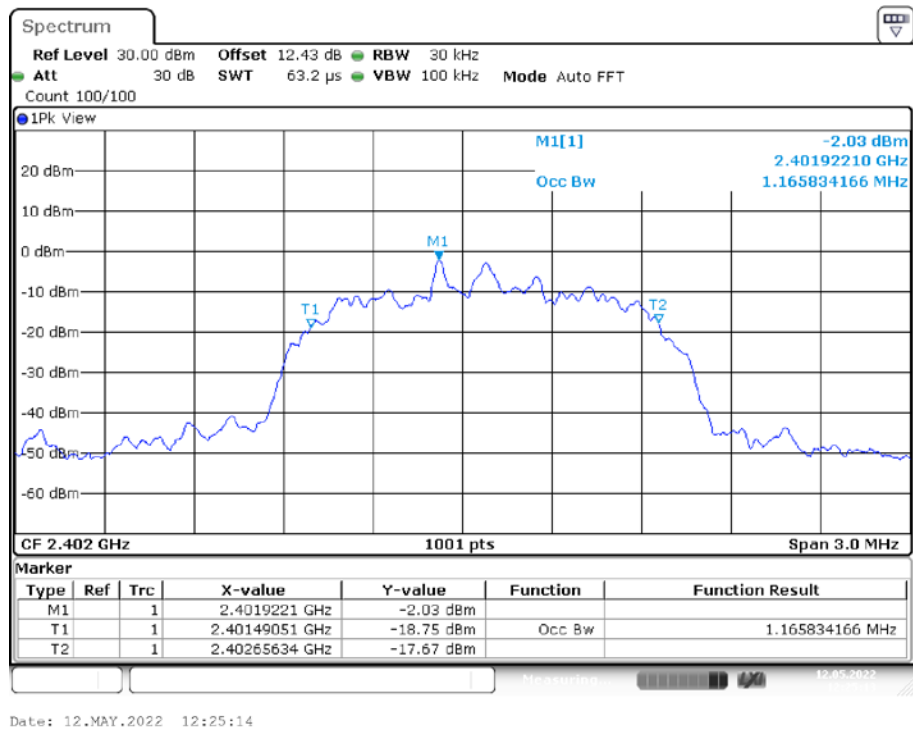
99% OCCUPIED BANDWIDTH_DH1 _Ant1_2480



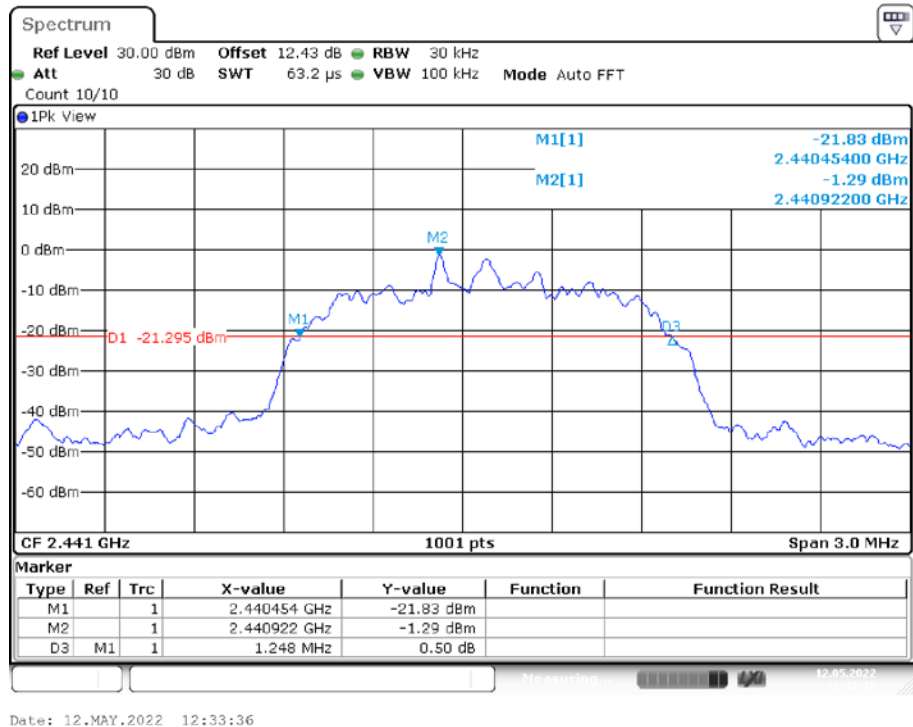
20 dB EMISSION BANDWIDTH_2DH1_Ant1_2402



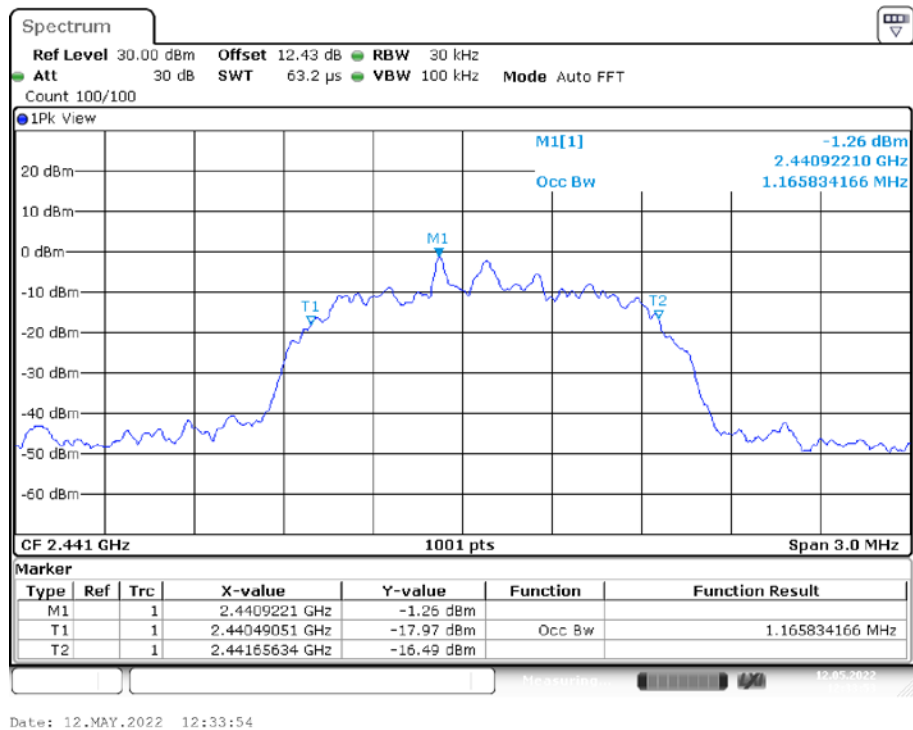
99% OCCUPIED BANDWIDTH_2DH1_Ant1_2402



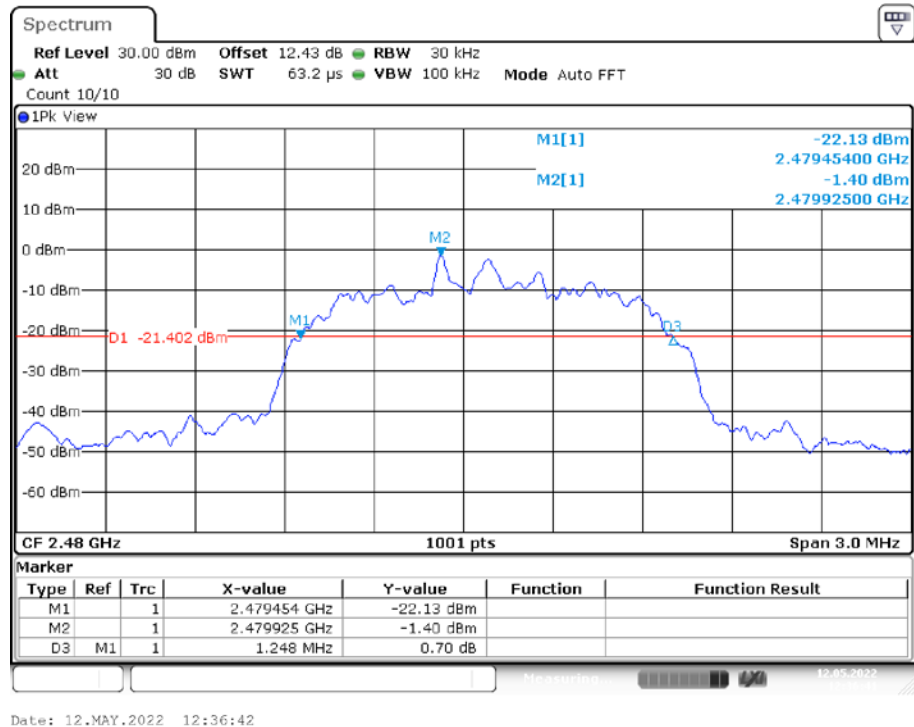
20 dB EMISSION BANDWIDTH_2DH1_Ant1_2441



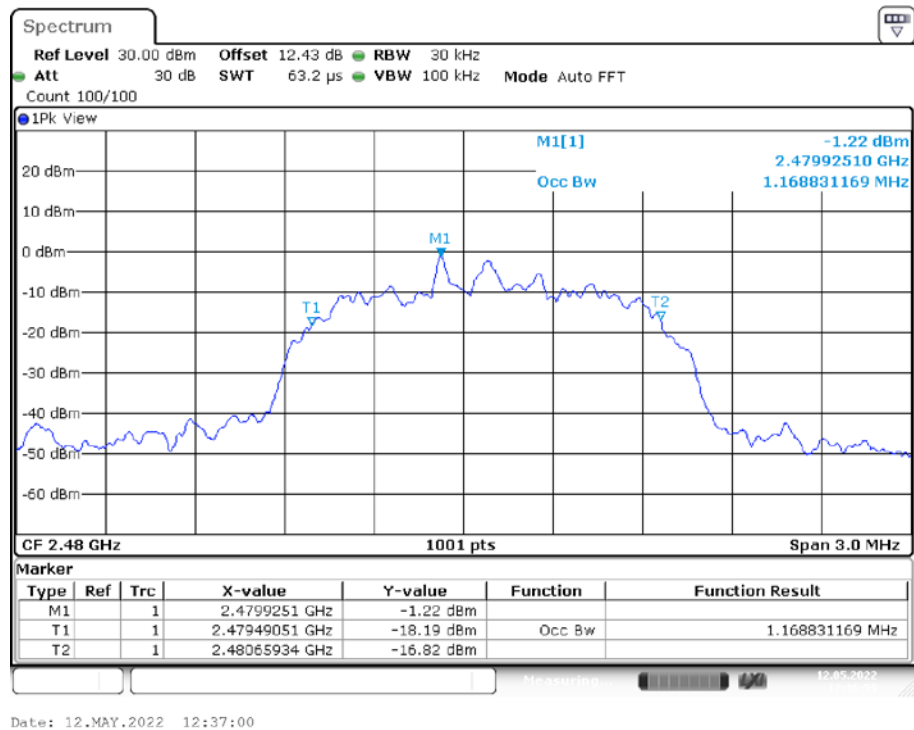
99% OCCUPIED BANDWIDTH_2DH1_Ant1_2441



20 dB EMISSION BANDWIDTH _2DH1_Ant1_2480



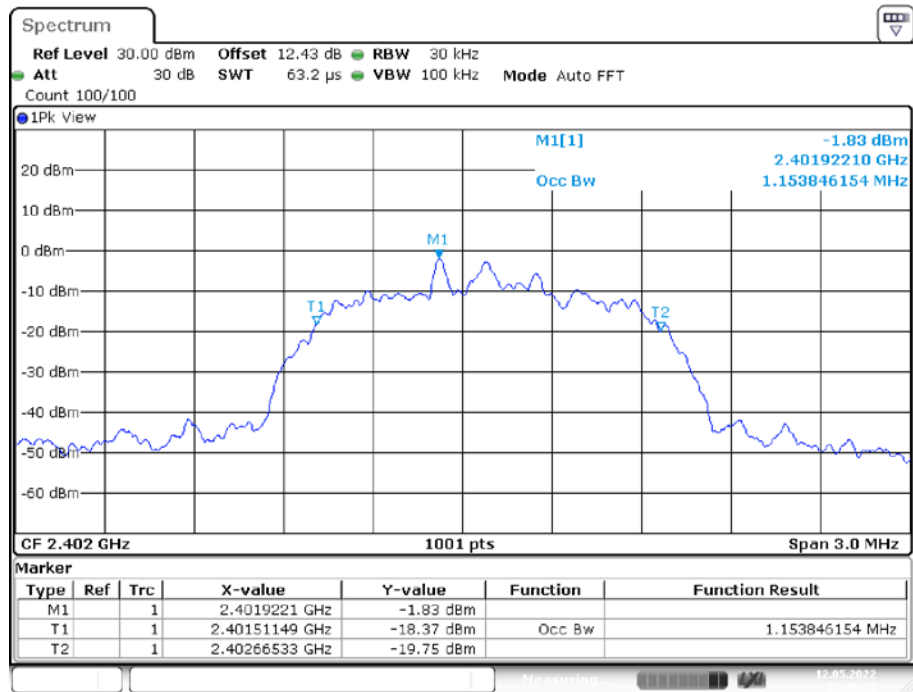
99% OCCUPIED BANDWIDTH _2DH1_Ant1_2480



20 dB EMISSION BANDWIDTH_3DH1_Ant1_2402



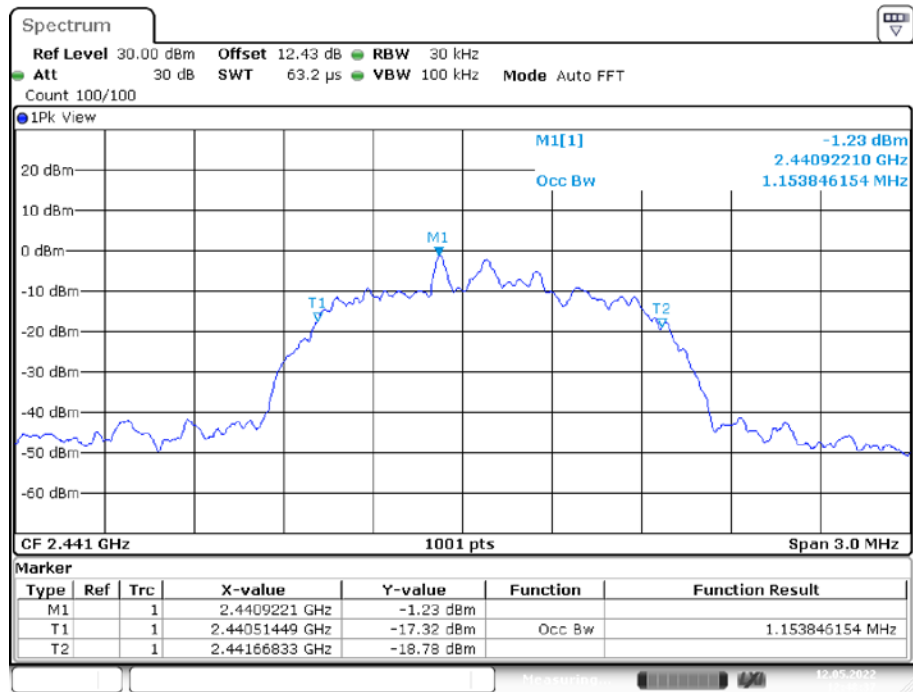
99% OCCUPIED BANDWIDTH_3DH1_Ant1_2402



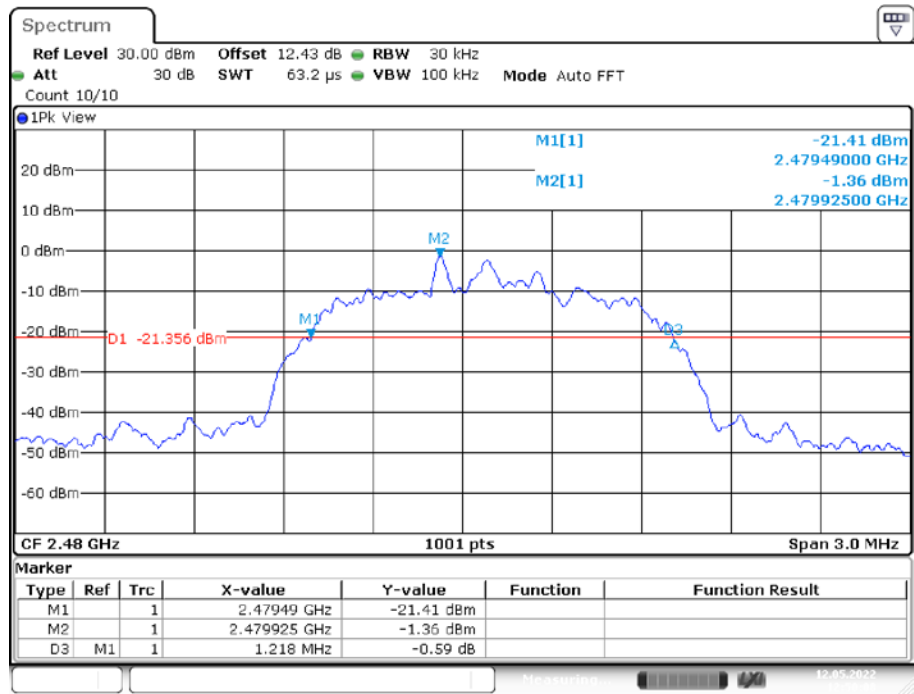
20 dB EMISSION BANDWIDTH_3DH1_Ant1_2441



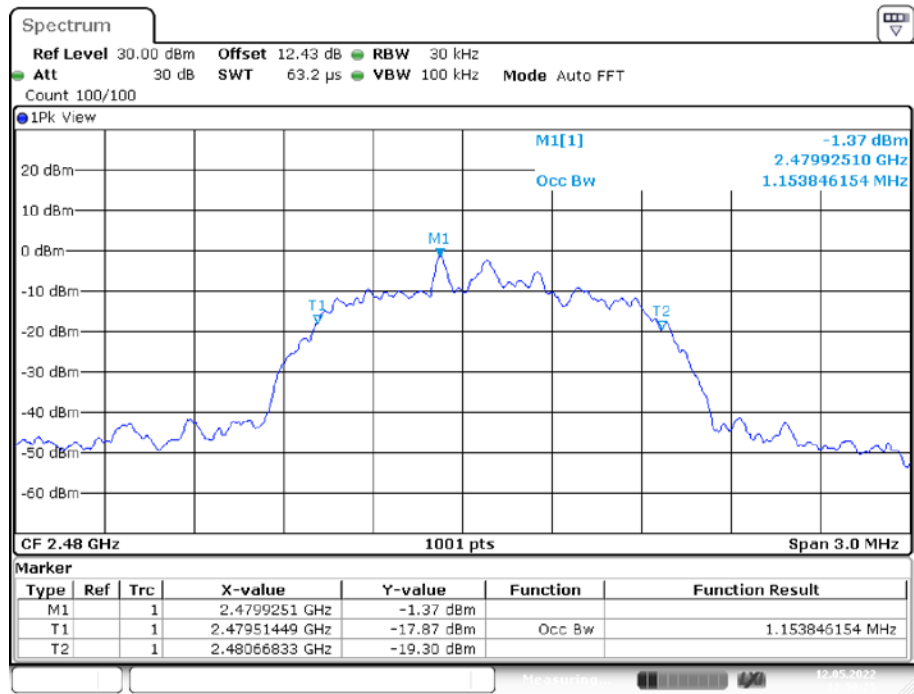
99% OCCUPIED BANDWIDTH_3DH1_Ant1_2441



20 dB EMISSION BANDWIDTH_3DH1_Ant1_2480



99% OCCUPIED BANDWIDTH_3DH1_Ant1_2480



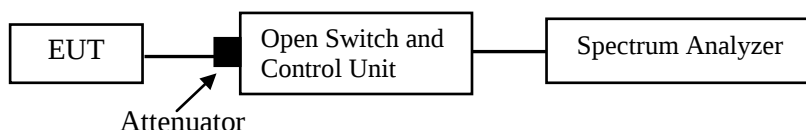
FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST

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

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:	23°C
Relative Humidity:	59 %
ATM Pressure:	101.0 kPa

The testing was performed by Leo Li on 2022-05-12.

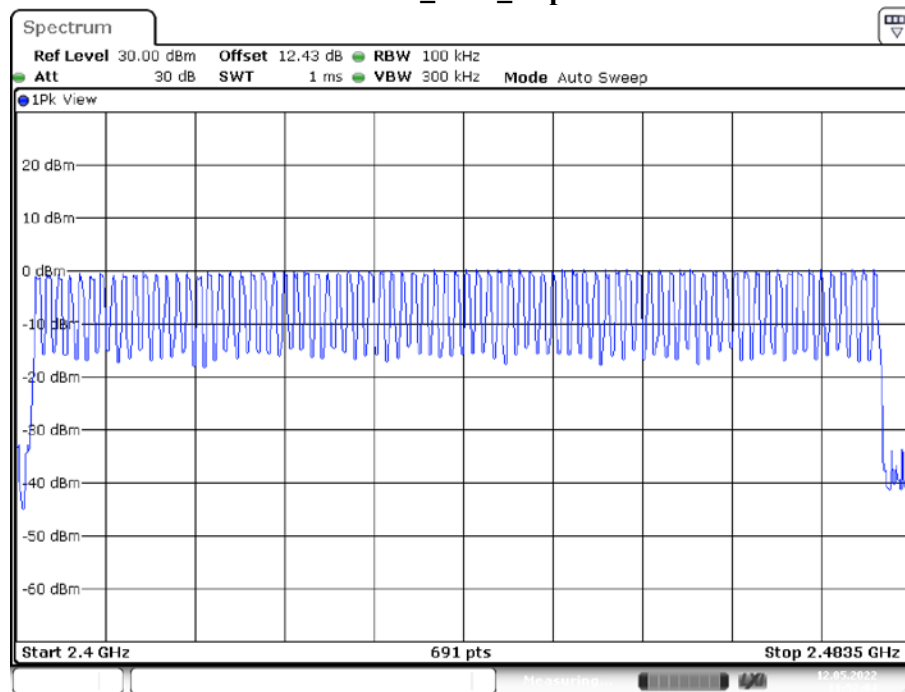
EUT operation mode: Transmitting

Test Result: Compliant.

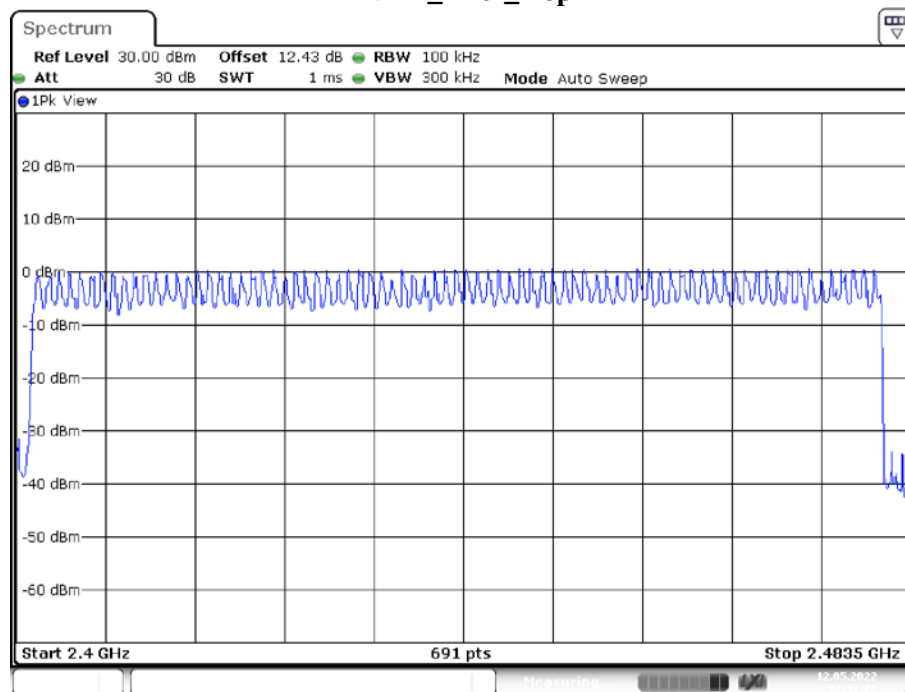
TestMode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Hop	79	>=15	PASS
2DH1	Ant1	Hop	79	>=15	PASS
3DH1	Ant1	Hop	79	>=15	PASS

Please refer to the below plots:

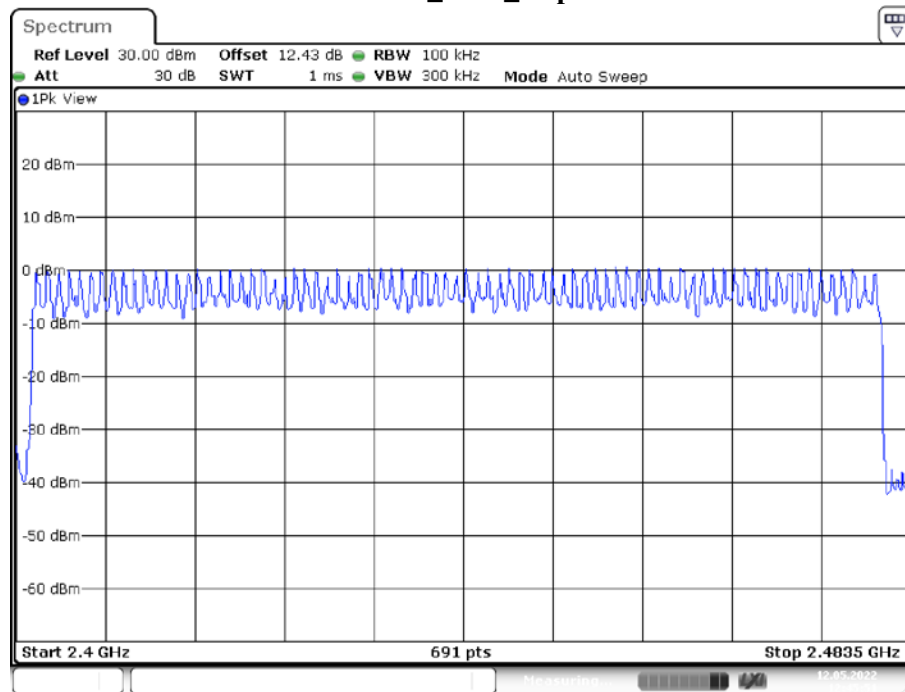
DH1_Ant1_Hop



2DH1_Ant1_Hop



3DH1_Ant1_Hop



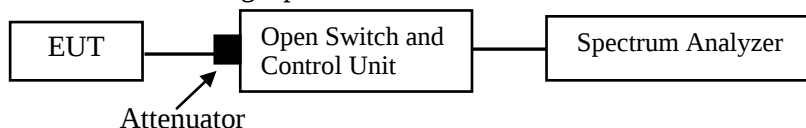
Date: 12.MAY.2022 12:45:52

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 $\geq 3 \times$ RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

**Test Data****Environmental Conditions**

Temperature:	23°C
Relative Humidity:	59 %
ATM Pressure:	101.0 kPa

The testing was performed by Leo Li on 2022-05-12.

EUT operation mode: Transmitting

Test Result: Compliant.

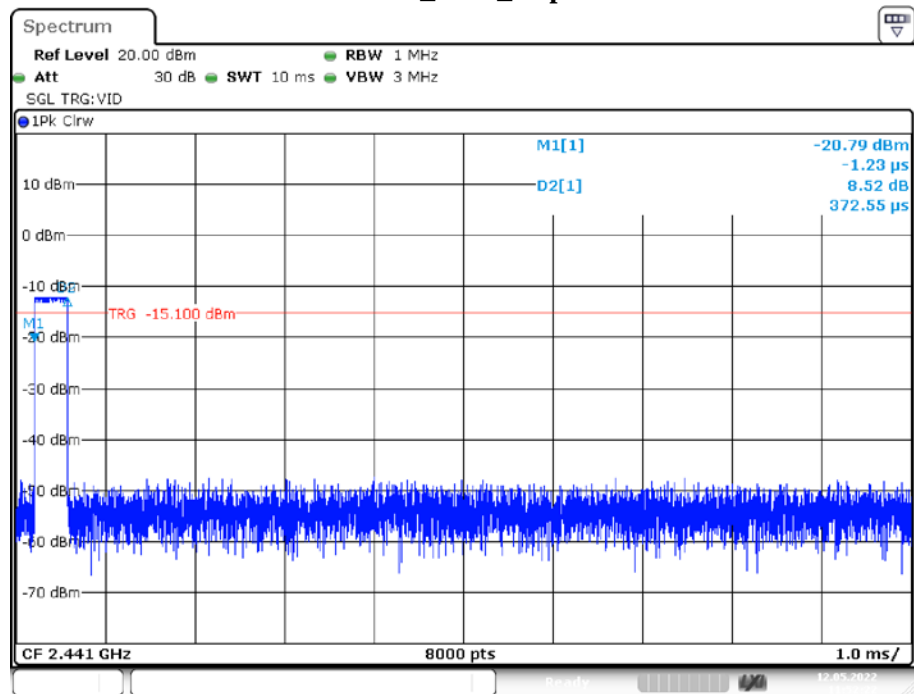
TestMode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.37	320	0.119	≤ 0.4	PASS
DH3	Ant1	Hop	1.62	150	0.243	≤ 0.4	PASS
DH5	Ant1	Hop	2.86	110	0.315	≤ 0.4	PASS
2DH1	Ant1	Hop	0.38	330	0.126	≤ 0.4	PASS
2DH3	Ant1	Hop	1.63	150	0.244	≤ 0.4	PASS
2DH5	Ant1	Hop	2.87	110	0.315	≤ 0.4	PASS
3DH1	Ant1	Hop	0.38	320	0.123	≤ 0.4	PASS
3DH3	Ant1	Hop	1.63	150	0.244	≤ 0.4	PASS
3DH5	Ant1	Hop	2.87	110	0.316	≤ 0.4	PASS

Note 1: A period time = $0.4 \times 79 = 31.6(s)$, Result = Burst Width * Total Hops

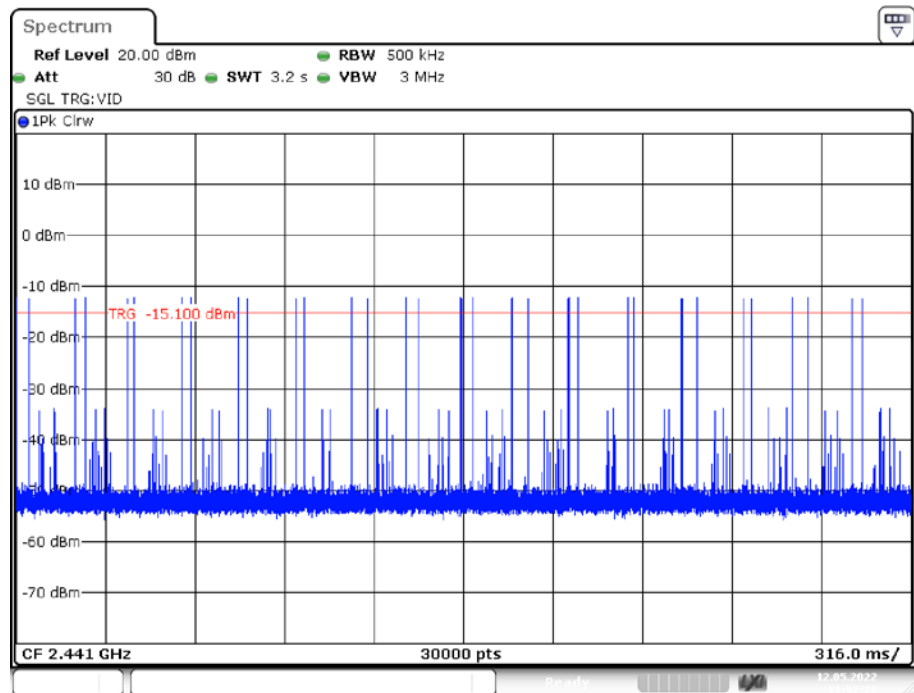
Note 2: Total Hops = Hopping Number in $3.16s \times 10$

Note 3: Hopping Number in 3.16s = Total of highest signals in 3.16s (Second high signals were other channel)

DH1_Ant1_Hop

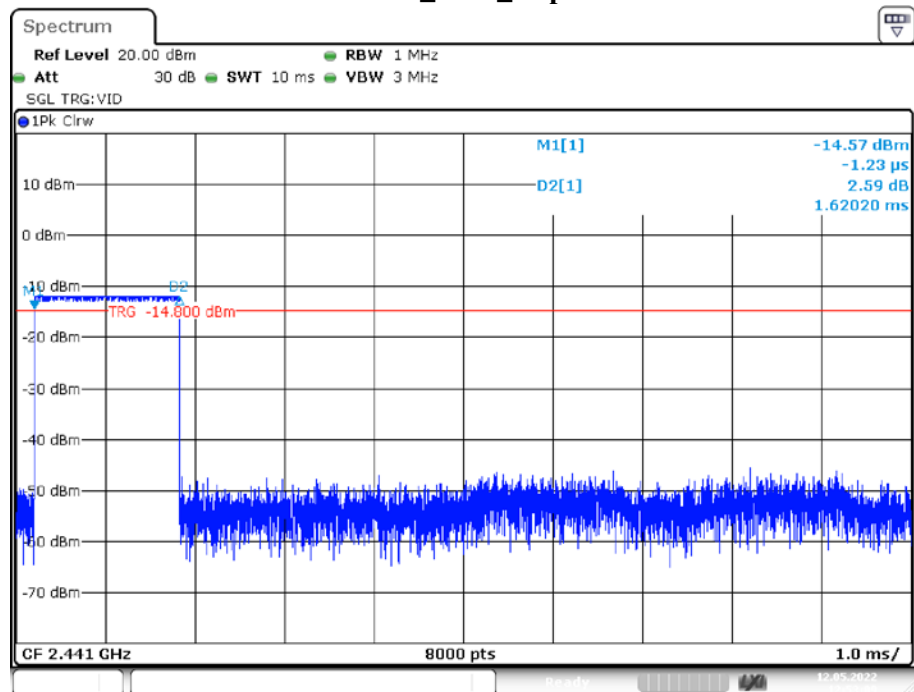


Date: 12.MAY.2022 11:52:23

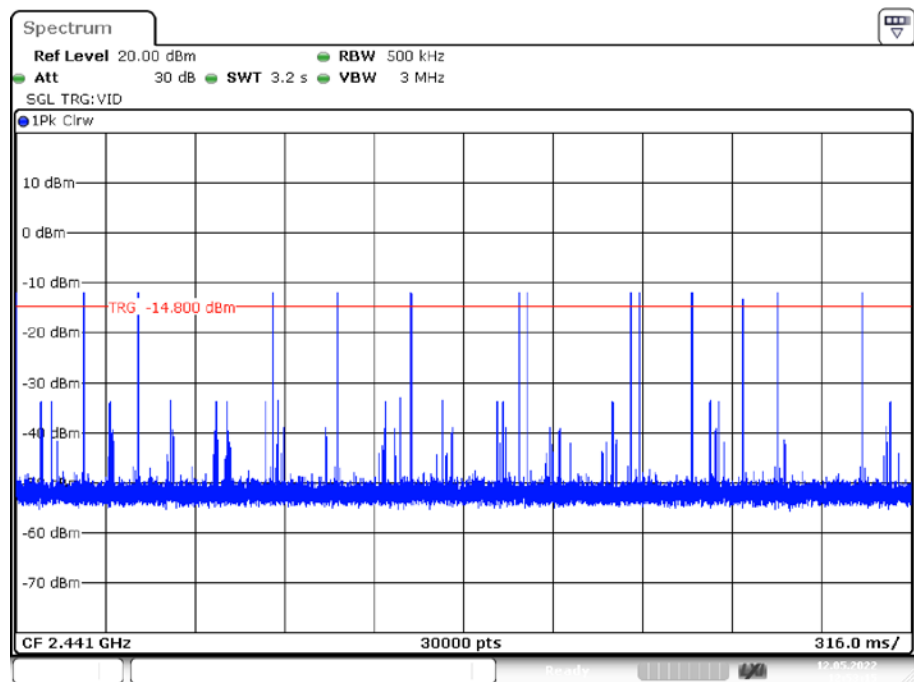


Date: 12.MAY.2022 11:52:28

DH3_Ant1_Hop

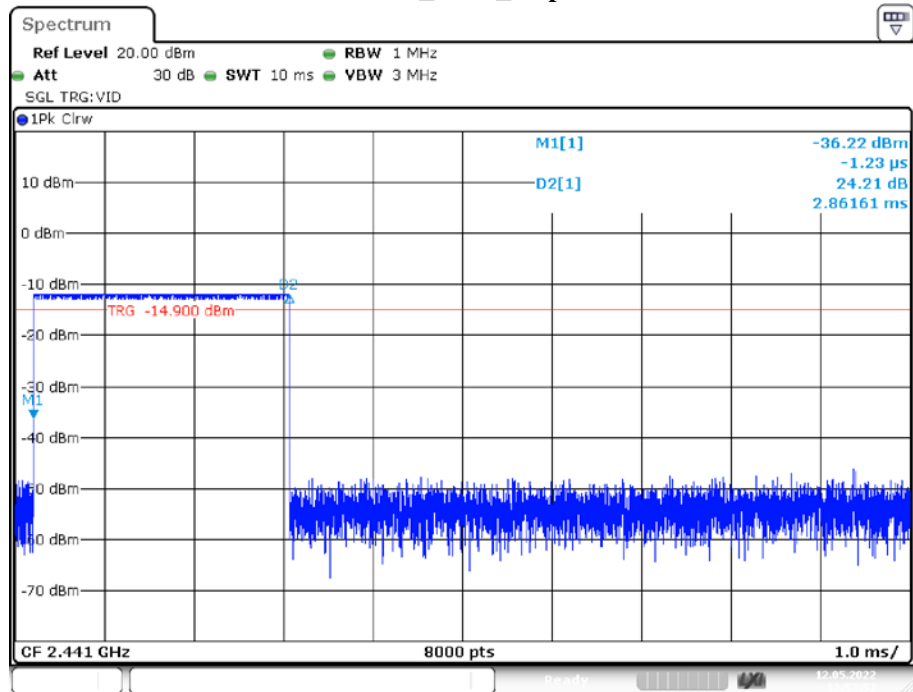


Date: 12.MAY.2022 12:53:10

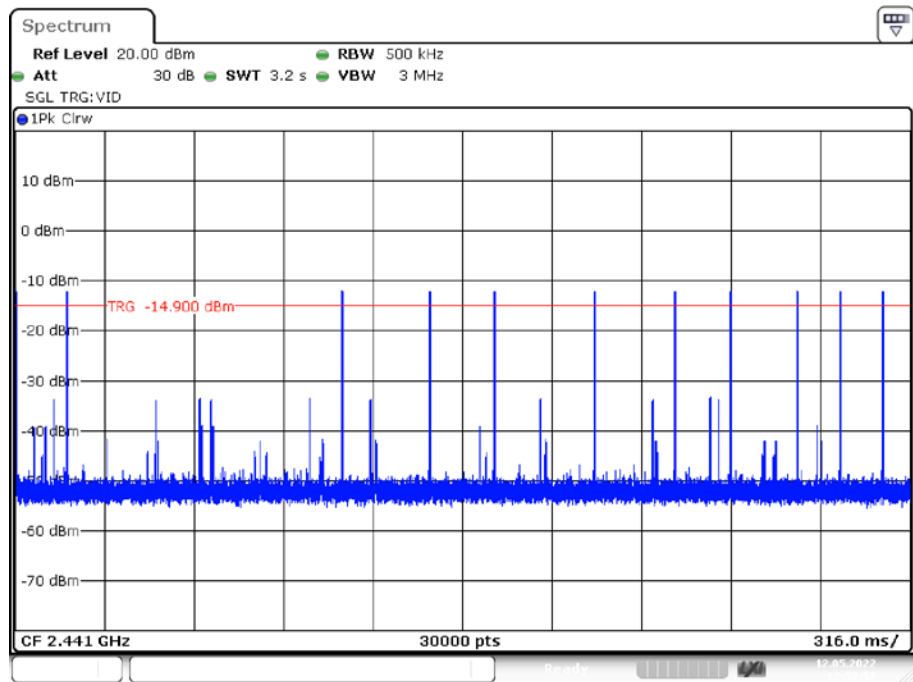


Date: 12.MAY.2022 12:53:16

DH5_Ant1_Hop

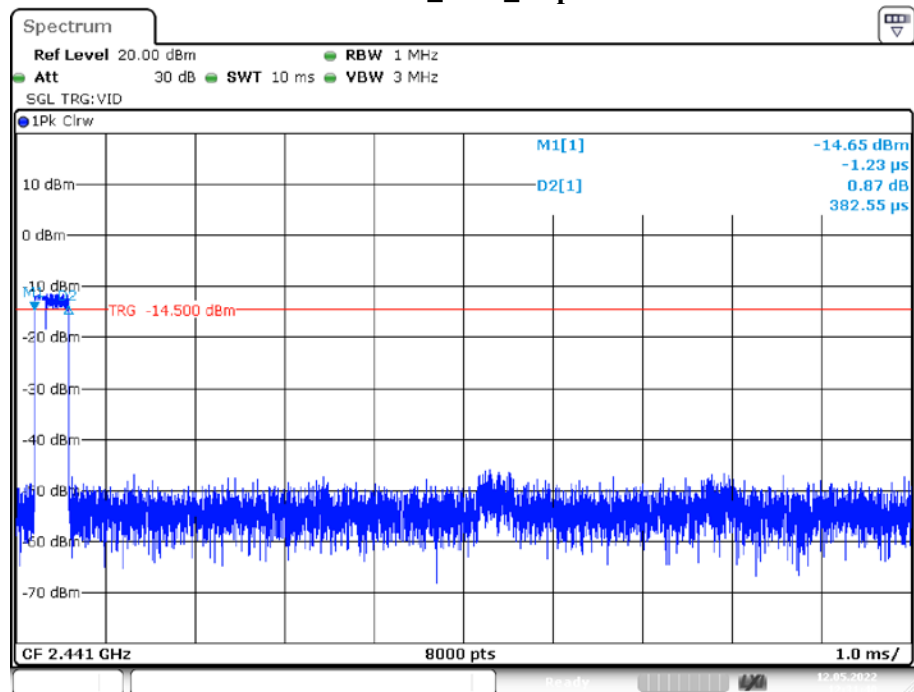


Date: 12.MAY.2022 12:53:52

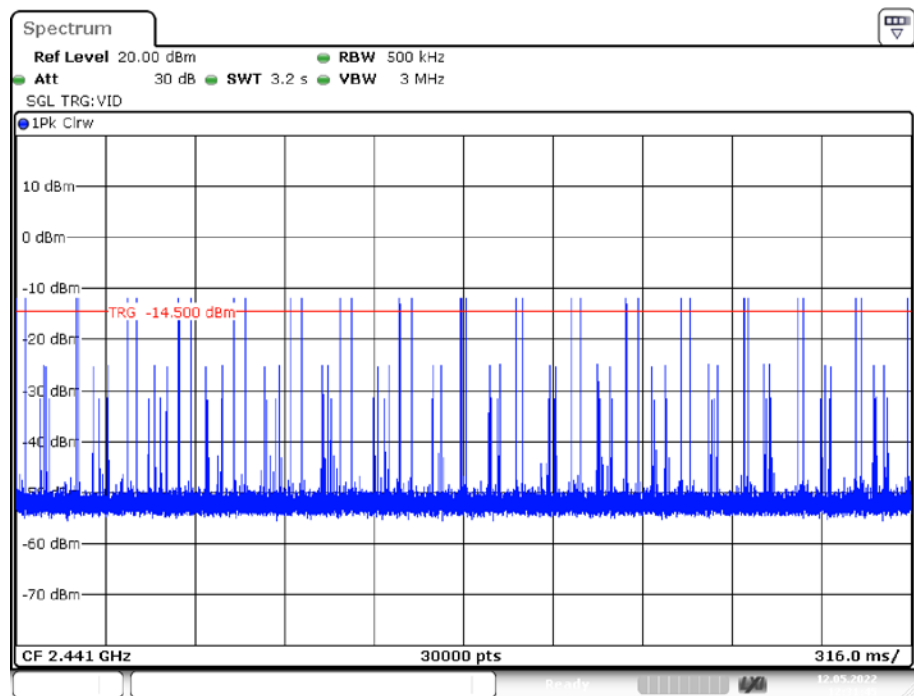


Date: 12.MAY.2022 12:53:58

2DH1_Ant1_Hop

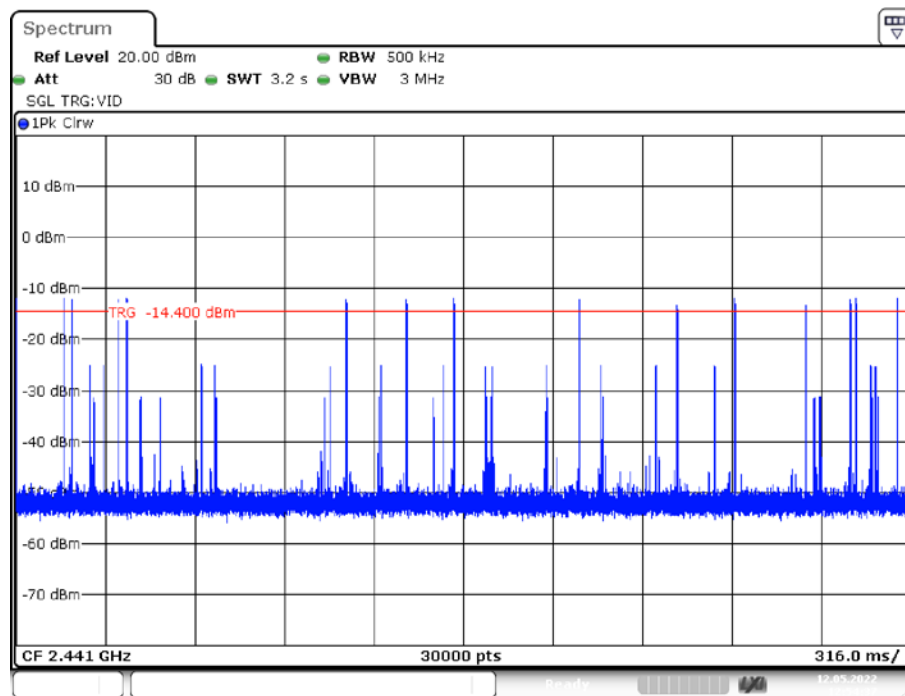
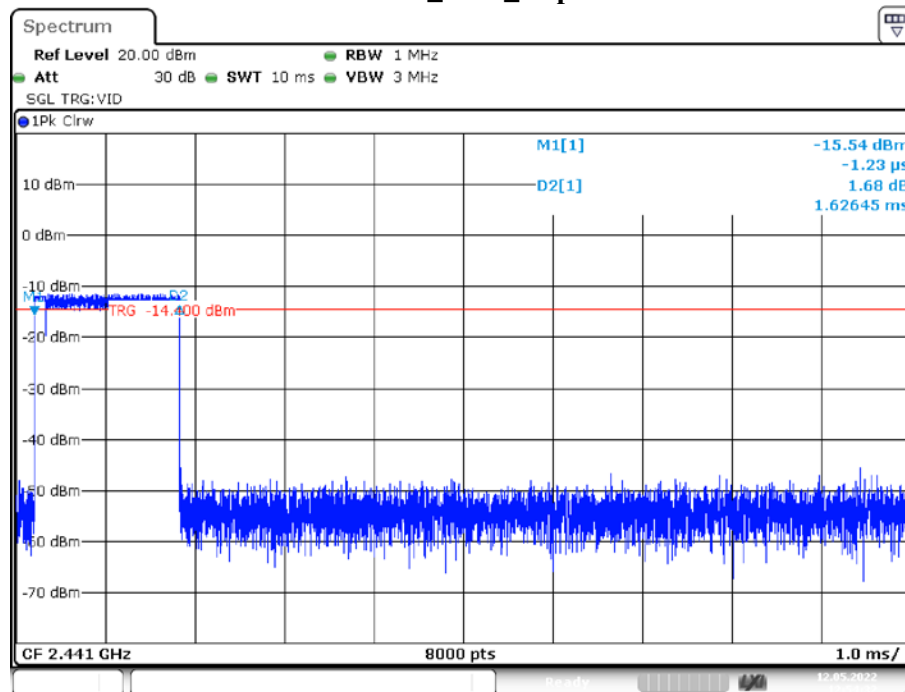


Date: 12.MAY.2022 12:31:41

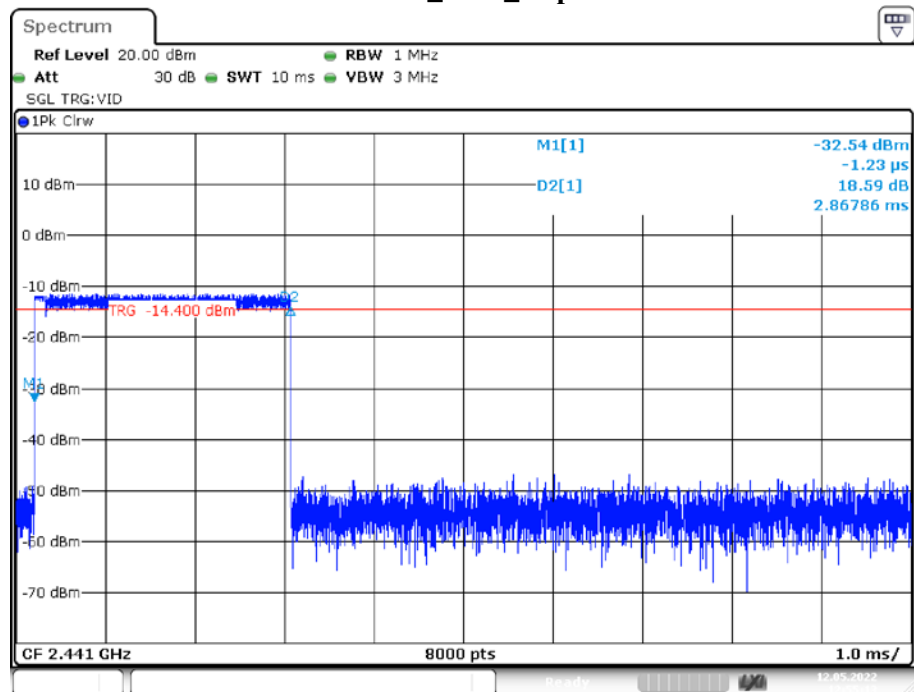


Date: 12.MAY.2022 12:31:46

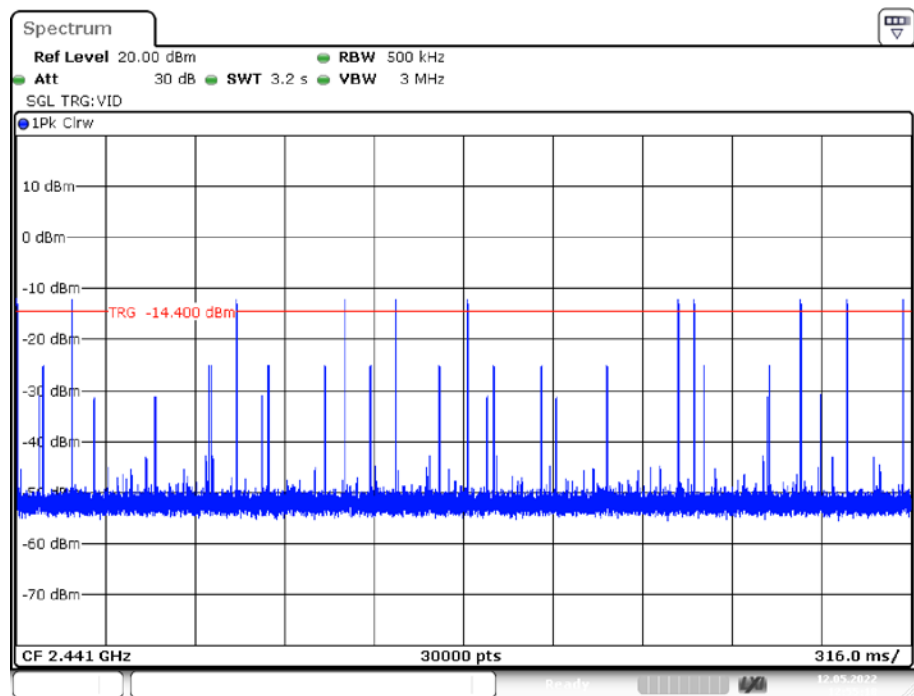
2DH3_Ant1_Hop



2DH5_Ant1_Hop

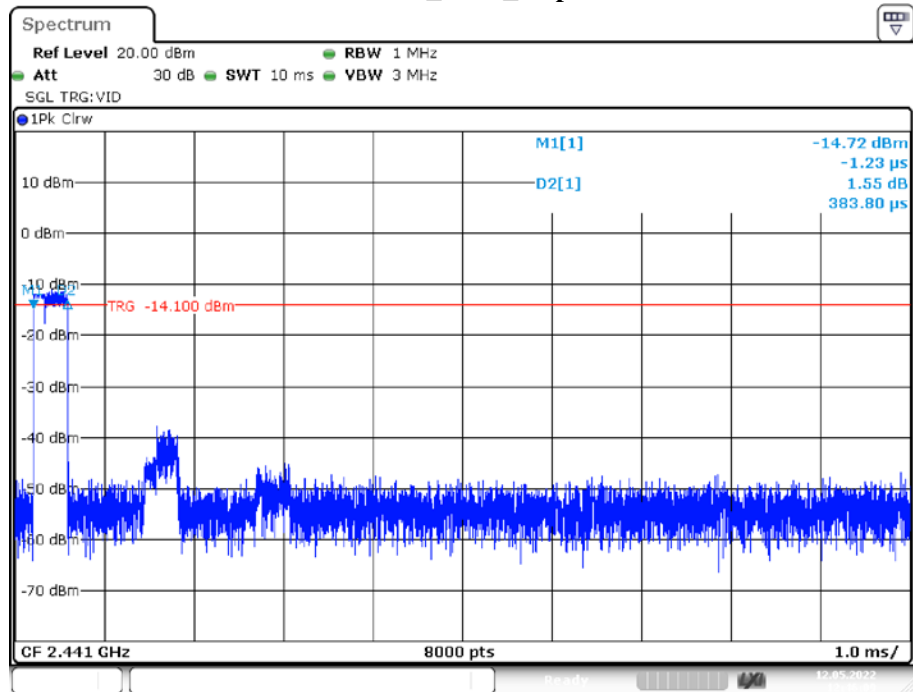


Date: 12.MAY.2022 12:55:13

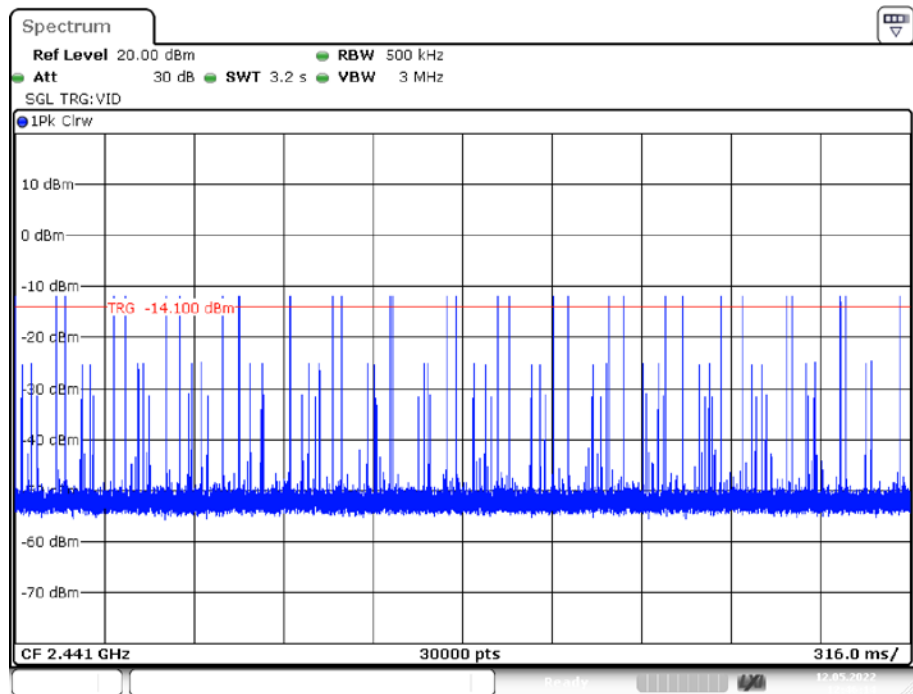


Date: 12.MAY.2022 12:55:19

3DH1_Ant1_Hop

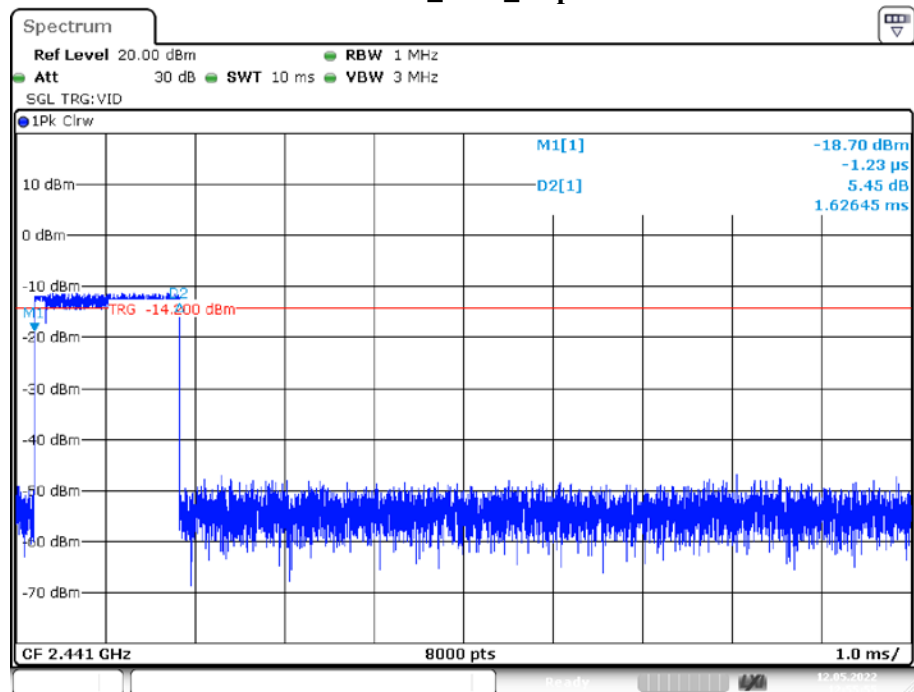


Date: 12.MAY.2022 12:46:10

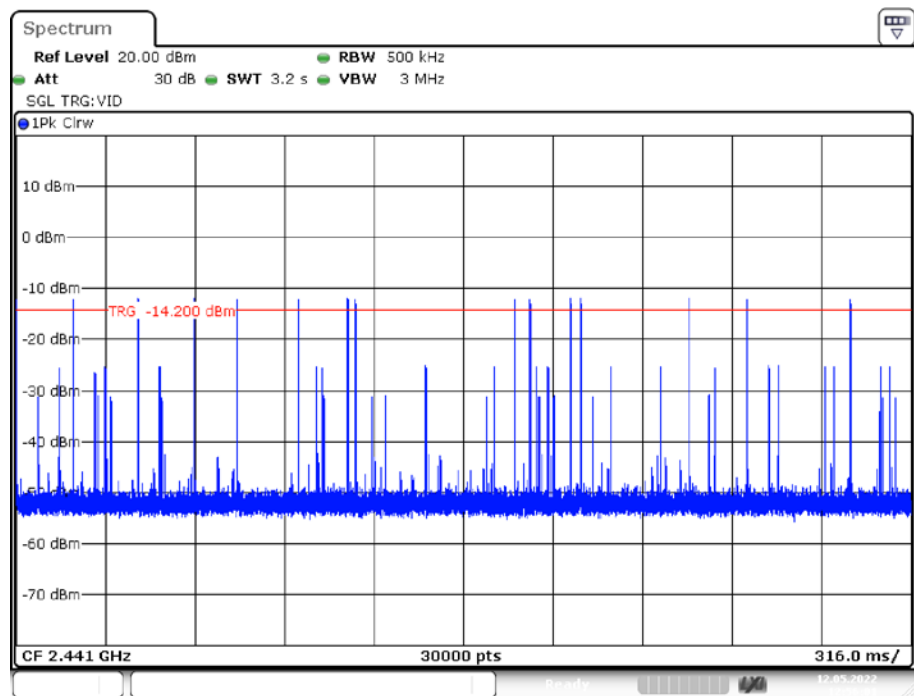


Date: 12.MAY.2022 12:46:15

3DH3_Ant1_Hop

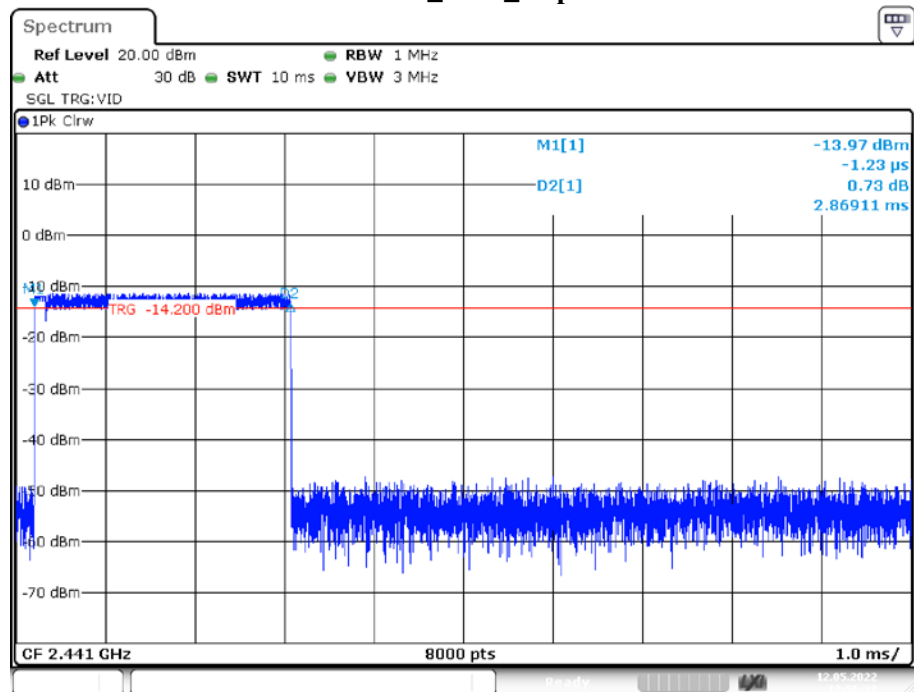


Date: 12.MAY.2022 12:55:56

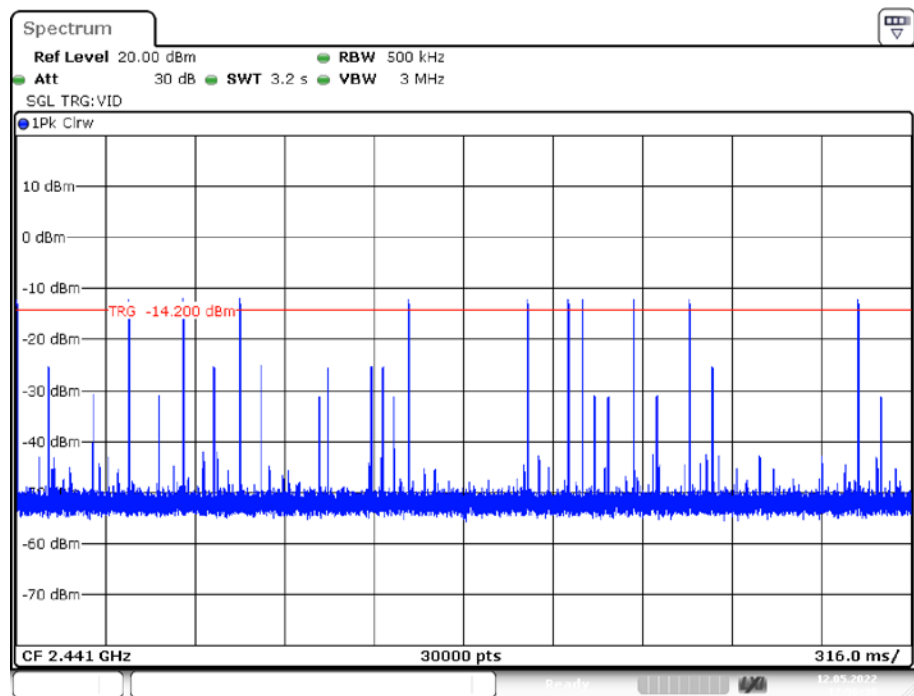


Date: 12.MAY.2022 12:56:01

3DH5_Ant1_Hop



Date: 12.MAY.2022 12:56:33



Date: 12.MAY.2022 12:56:38

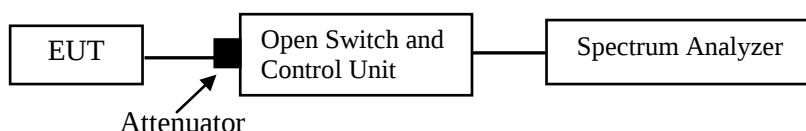
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

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:	23°C
Relative Humidity:	59 %
ATM Pressure:	101.0kPa

The testing was performed by Leo Li on 2022-05-12.

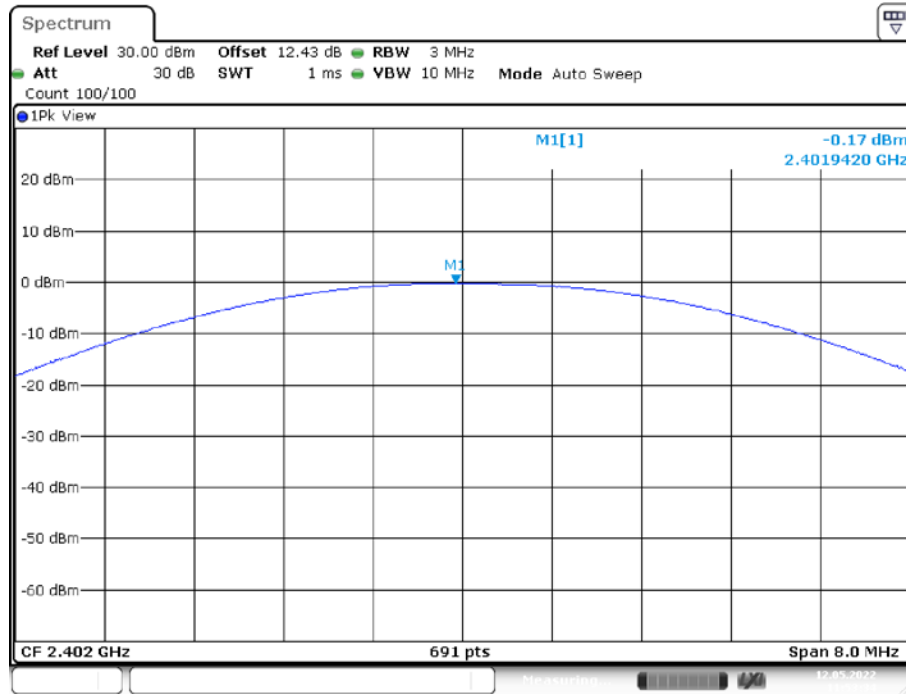
EUT operation mode: Transmitting

Test Result: Compliant.

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH1	Ant1	2402	-0.17	<=20.97	PASS
		2441	0.43	<=20.97	PASS
		2480	0.53	<=20.97	PASS
2DH1	Ant1	2402	0.93	<=20.97	PASS
		2441	1.32	<=20.97	PASS
		2480	1.46	<=20.97	PASS
3DH1	Ant1	2402	1.46	<=20.97	PASS
		2441	1.8	<=20.97	PASS
		2480	1.86	<=20.97	PASS

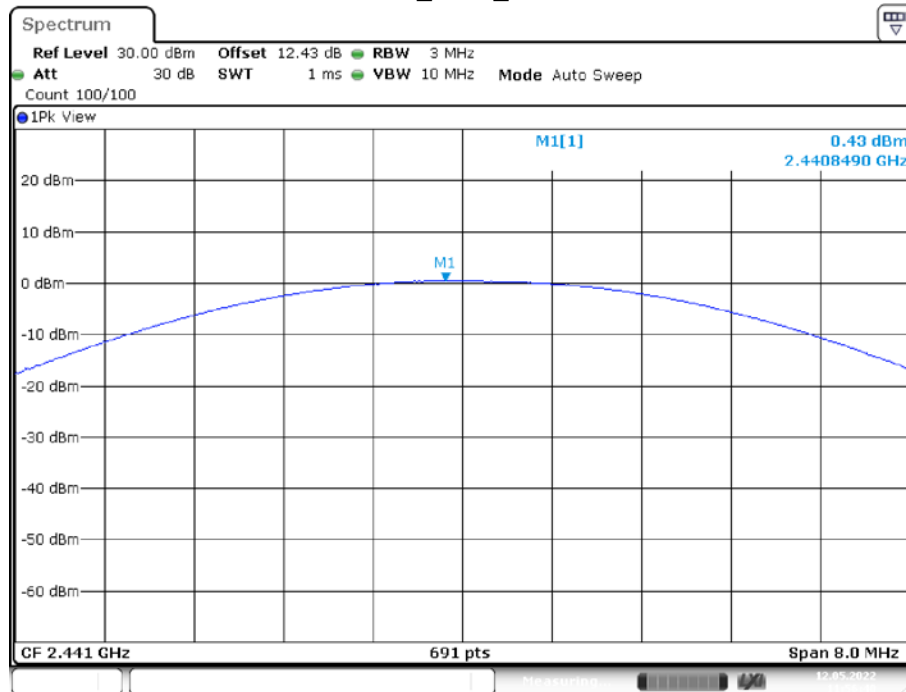
Please refer to the below plots:

DH1_Ant1_2402



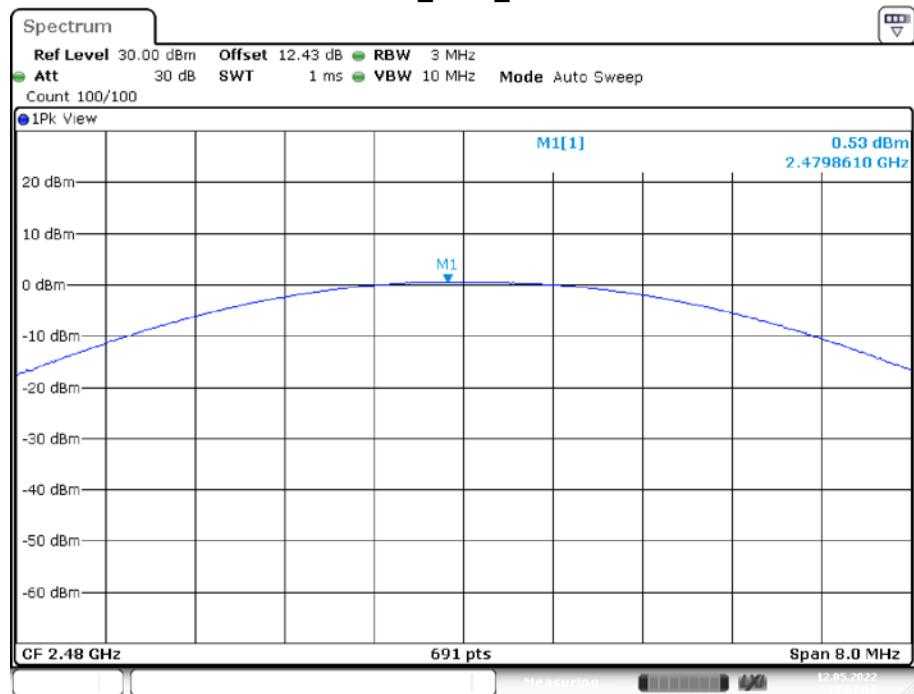
Date: 12.MAY.2022 11:53:35

DH1_Ant1_2441



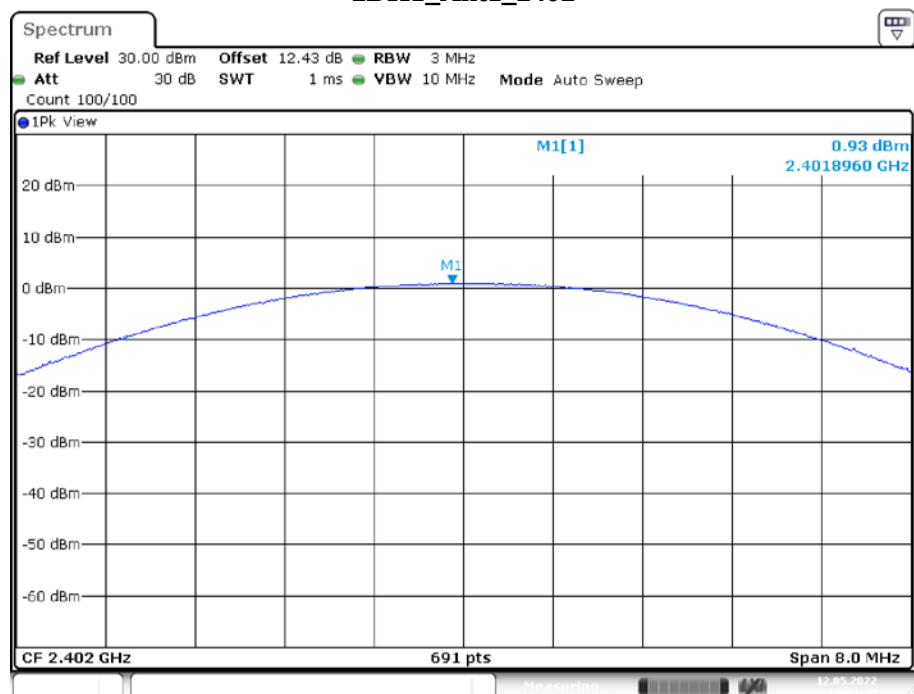
Date: 12.MAY.2022 11:56:41

DH1_Ant1_2480



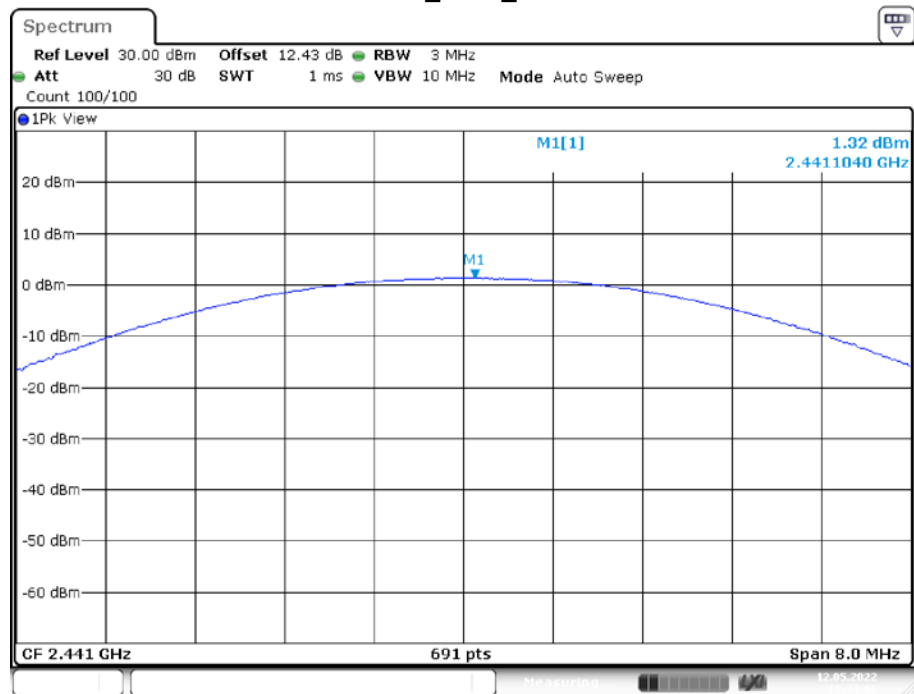
Date: 12.MAY.2022 12:07:13

2DH1_Ant1_2402



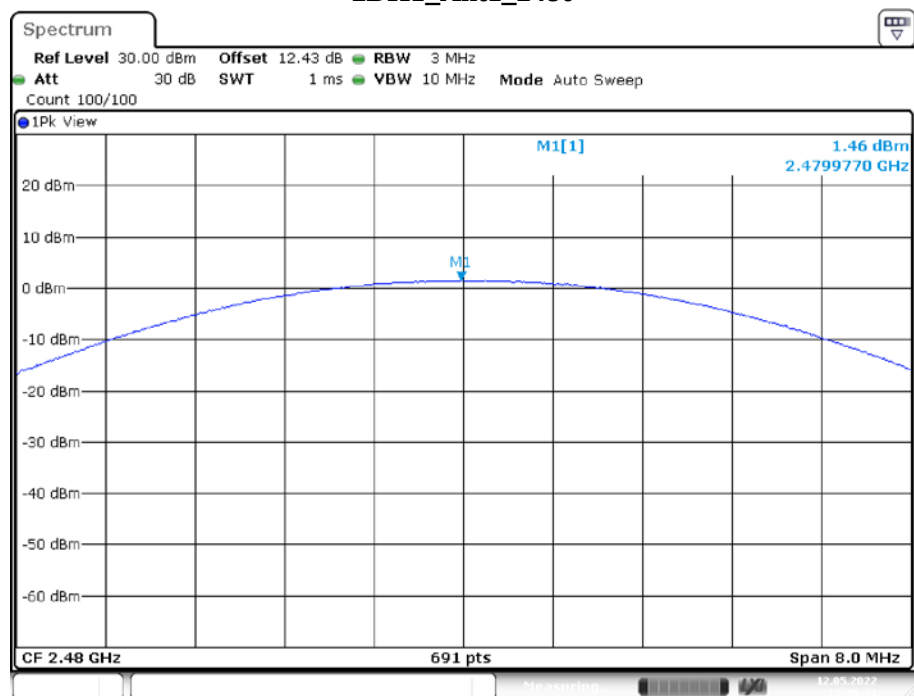
Date: 12.MAY.2022 12:32:21

2DH1_Ant1_2441



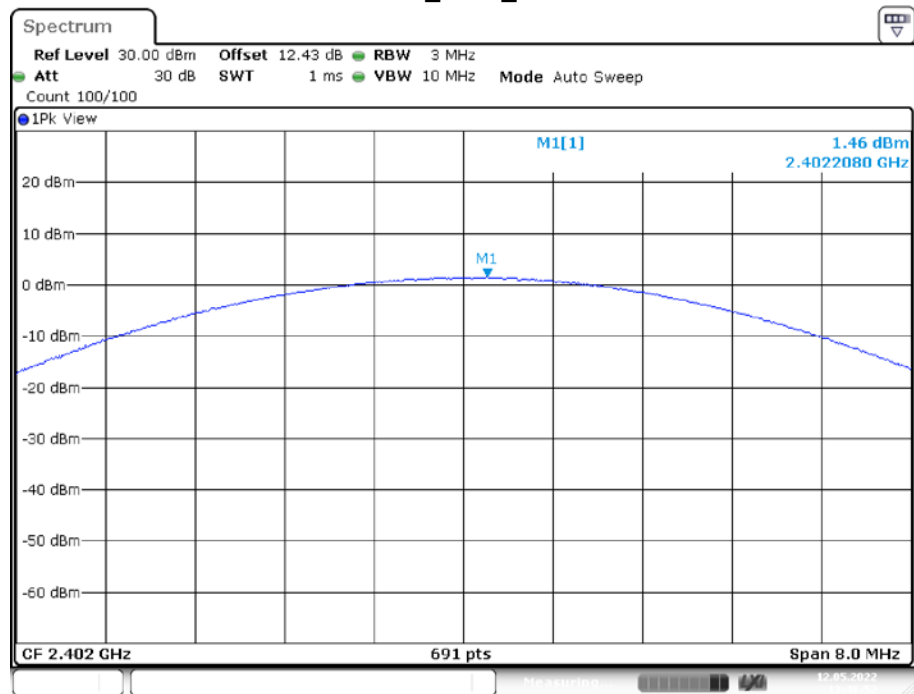
Date: 12.MAY.2022 12:34:07

2DH1_Ant1_2480



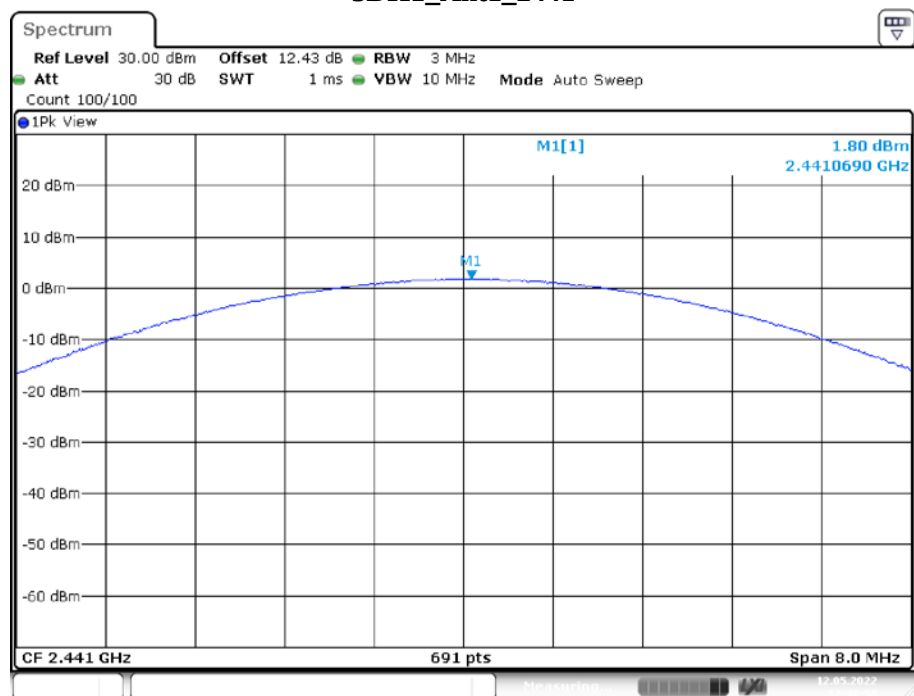
Date: 12.MAY.2022 12:38:12

3DH1_Ant1_2402



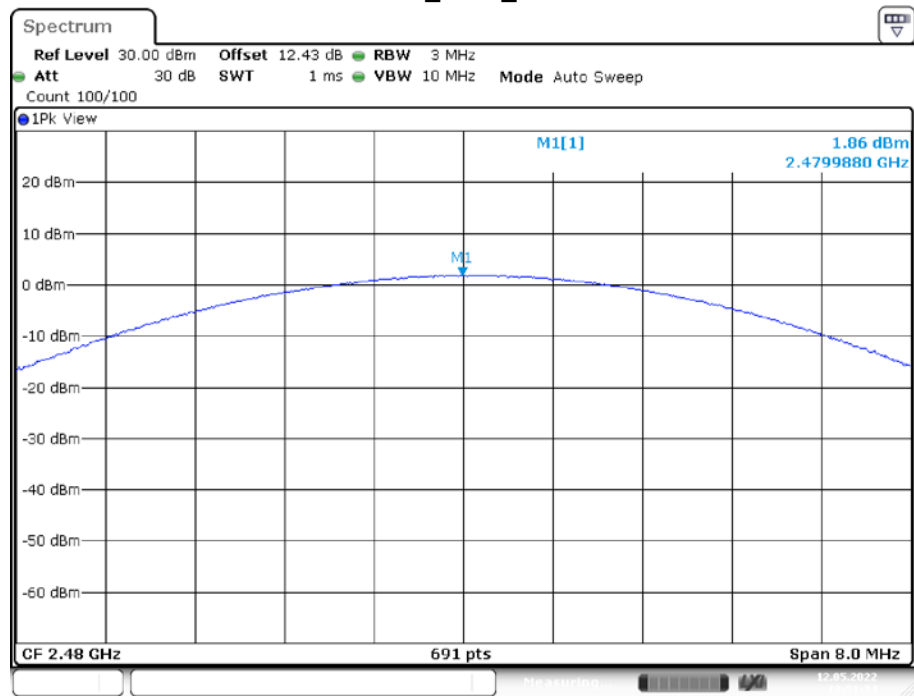
Date: 12.MAY.2022 12:46:52

3DH1_Ant1_2441



Date: 12.MAY.2022 12:48:50

3DH1_Ant1_2480



Date: 12.MAY.2022 12:51:34

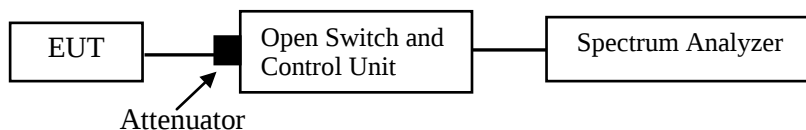
FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	23°C
Relative Humidity:	59 %
ATM Pressure:	101.0 kPa

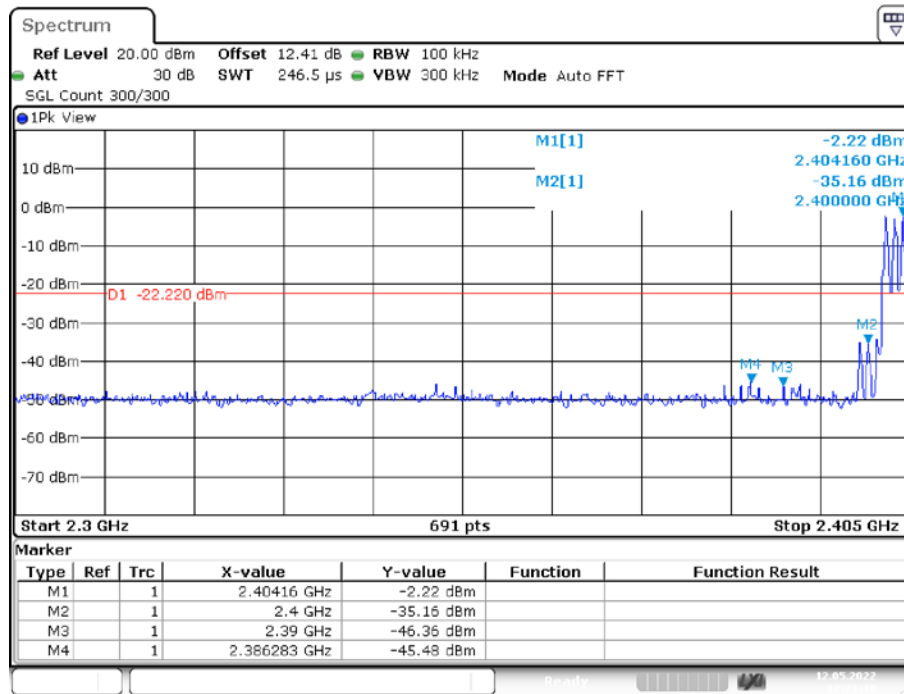
The testing was performed by Leo Li on 2022-05-12.

EUT operation mode: Transmitting

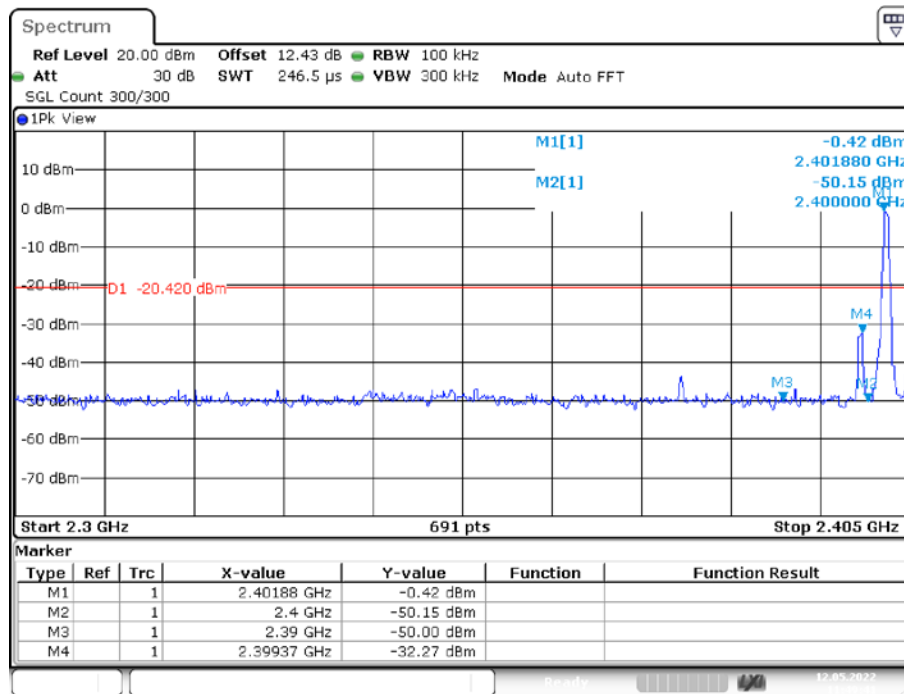
Test Result: Compliant

Please refer to the below plots:

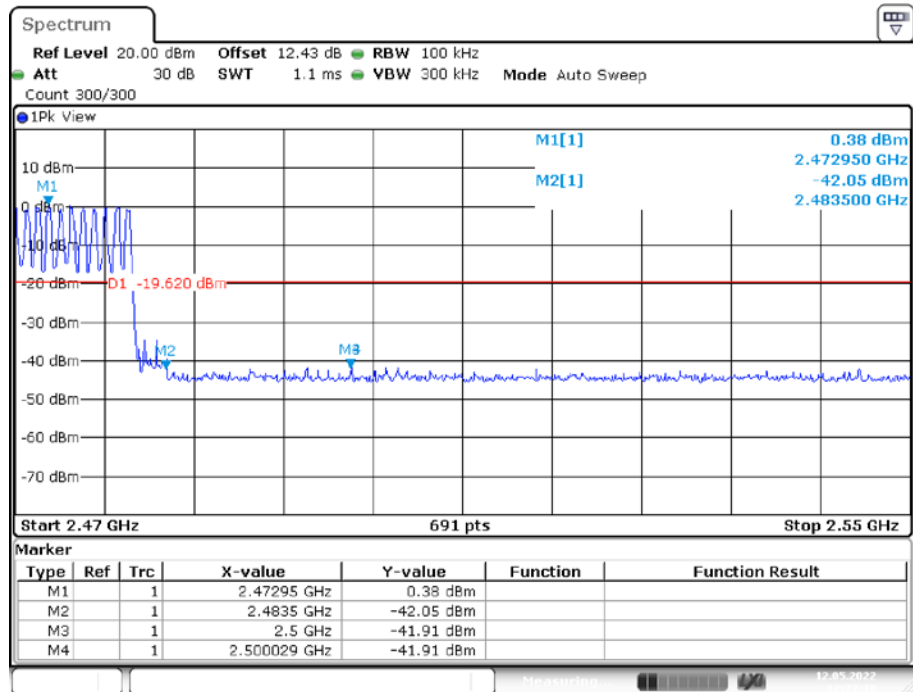
DH1: Band Edge-Left Side Hopping



Single

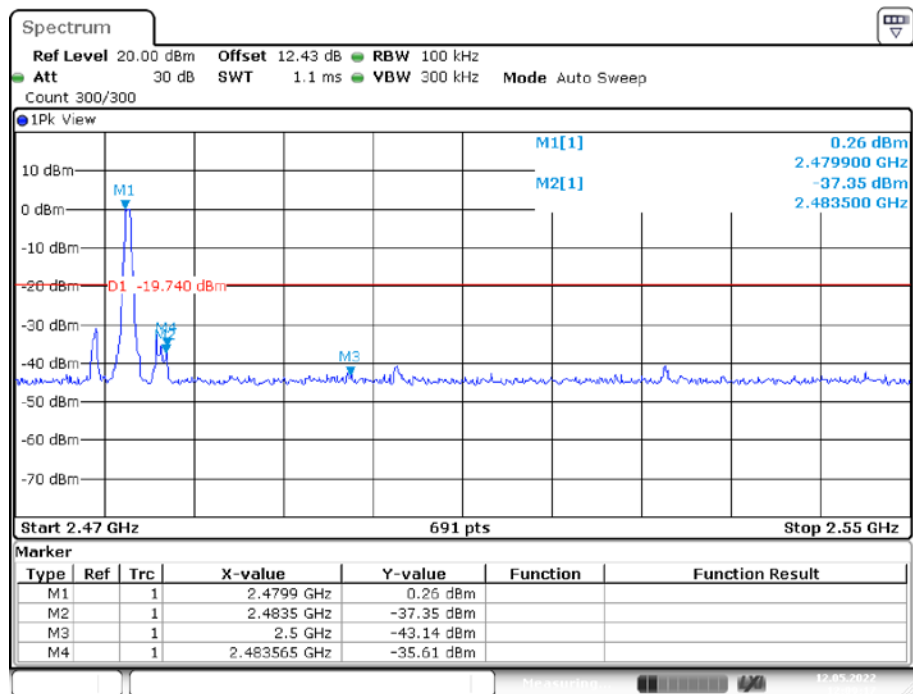


DH1: Band Edge- Right Side Hopping



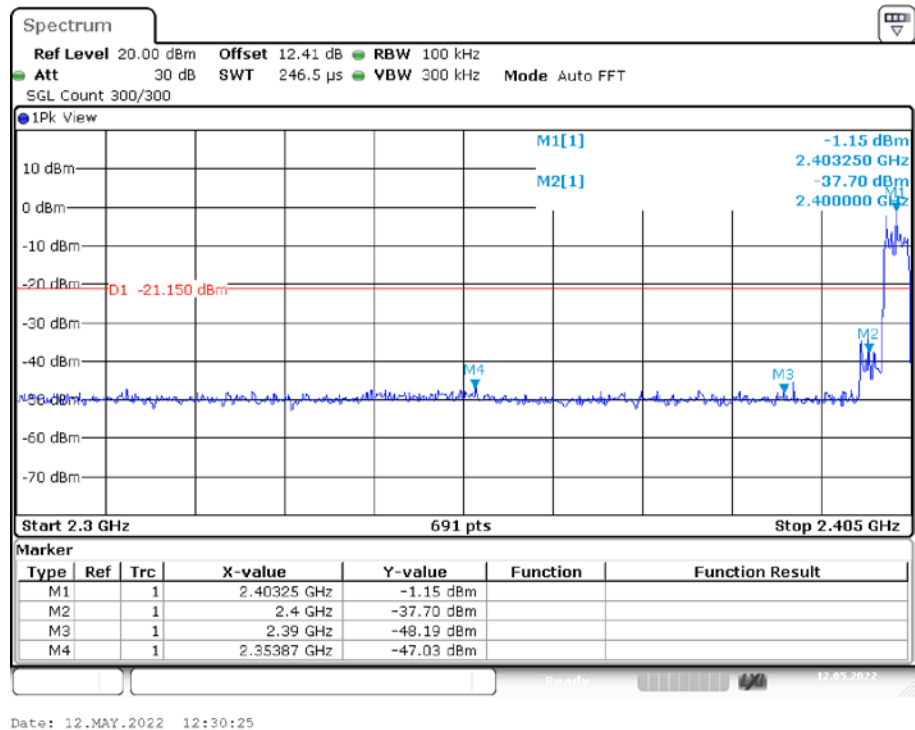
Date: 12.MAY.2022 12:22:11

Single

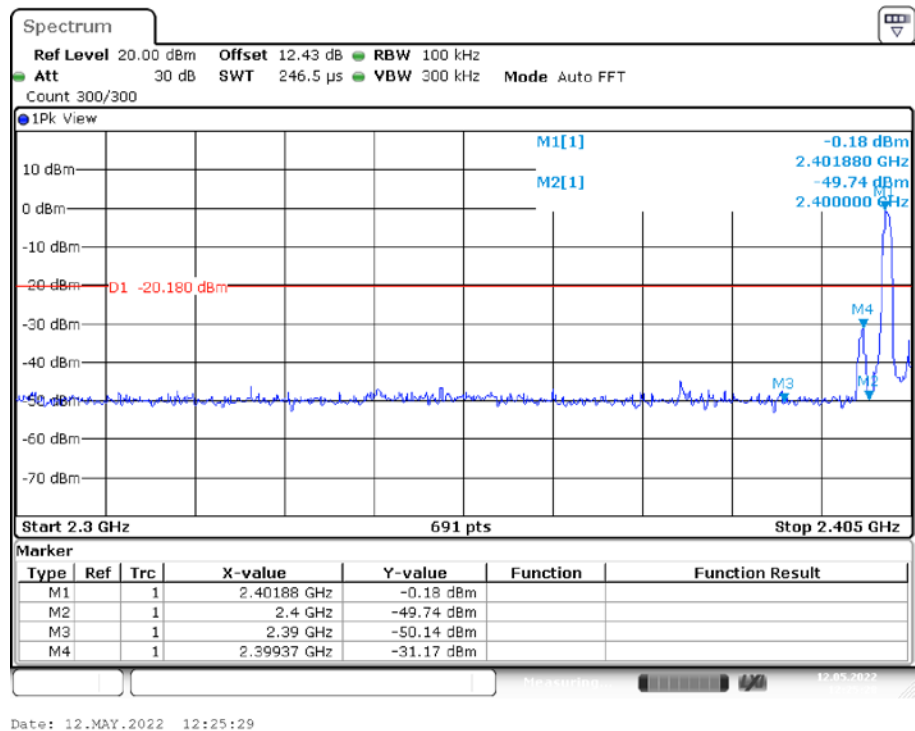


Date: 12.MAY.2022 12:09:17

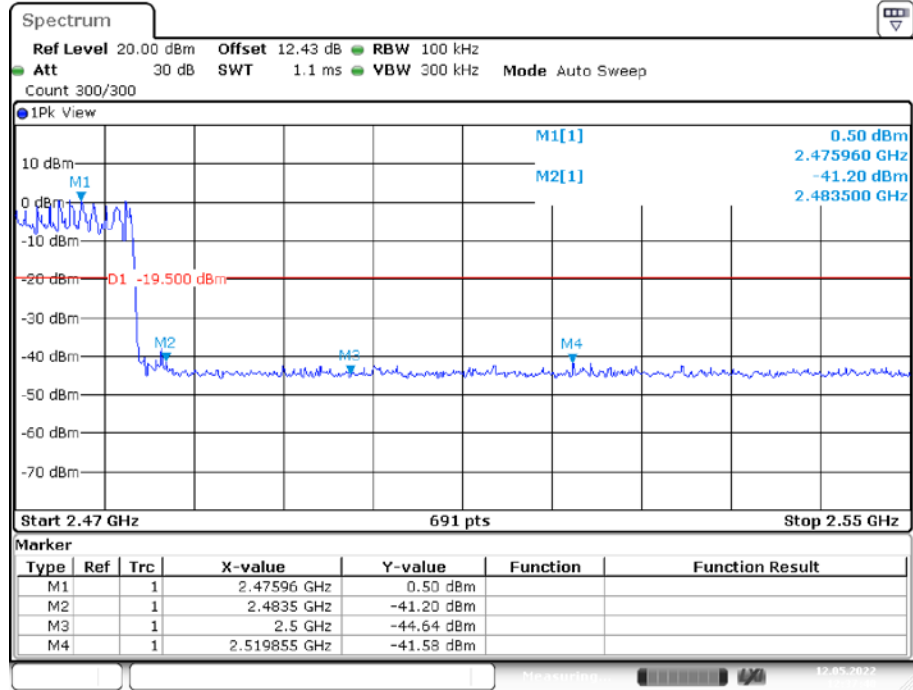
2DH1: Band Edge-Left Side
Hopping



Single

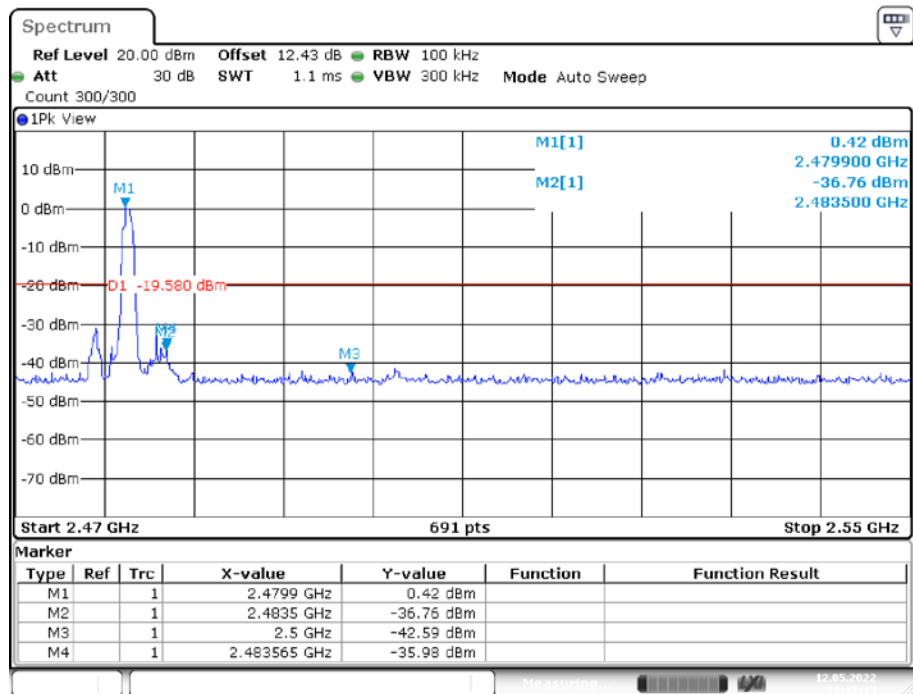


2DH1: Band Edge- Right Side Hopping



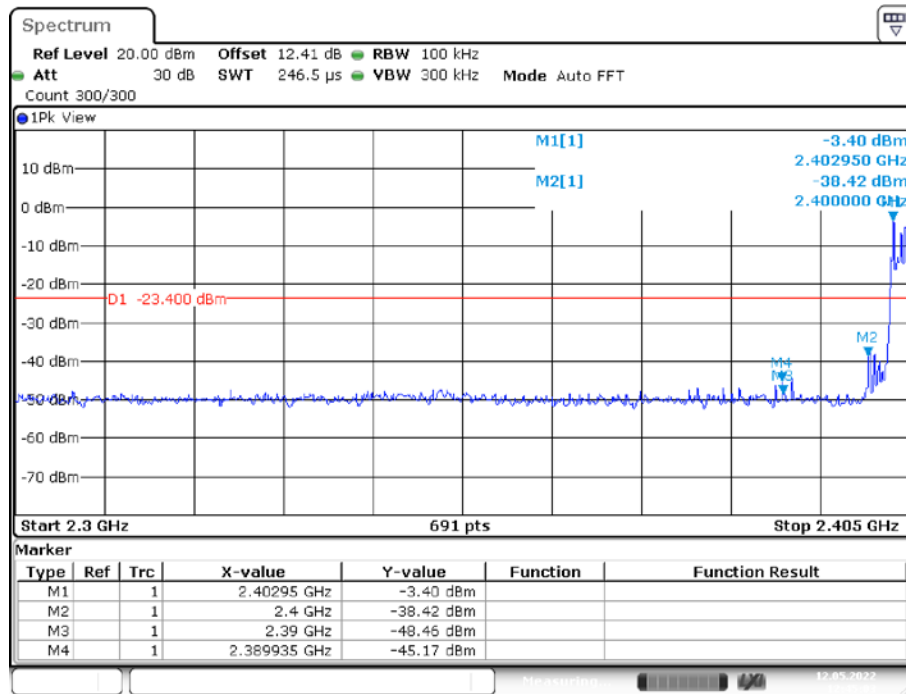
Date: 12.MAY.2022 12:37:41

Single

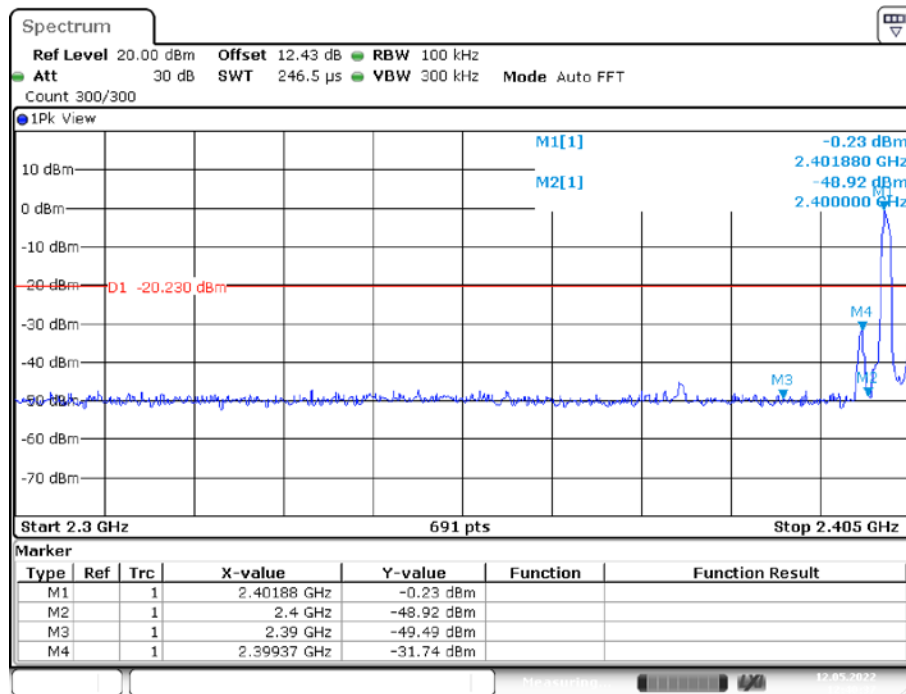


Date: 12.MAY.2022 12:37:15

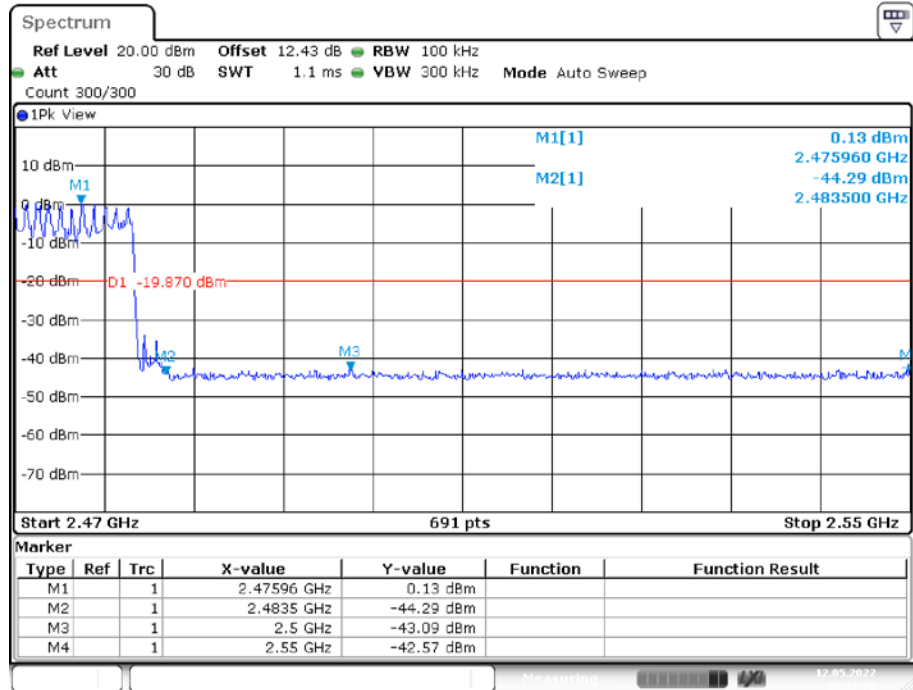
3DH1: Band Edge-Left Side Hopping



Single

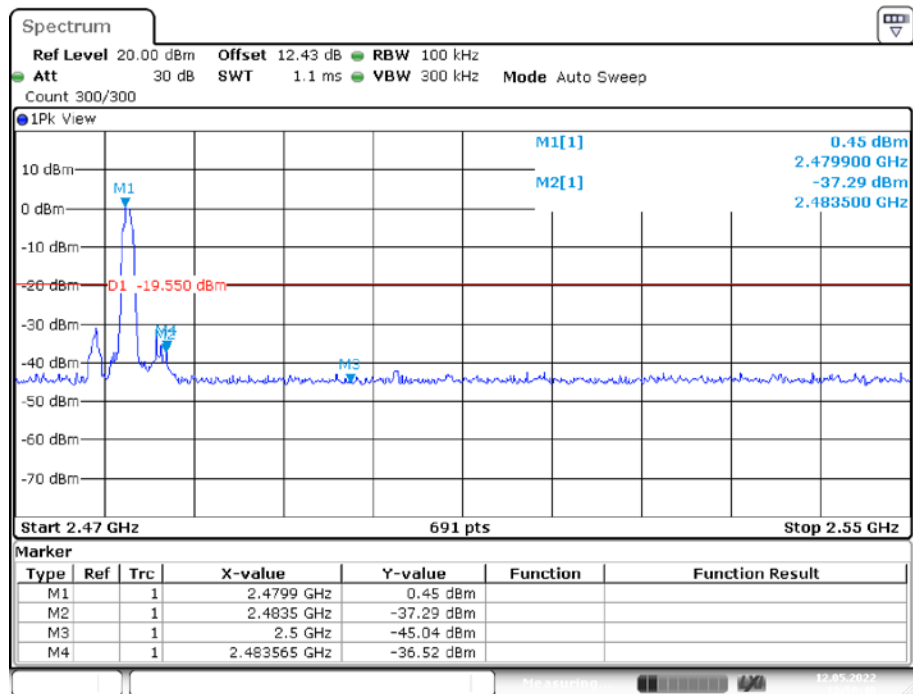


3DH1: Band Edge- Right Side Hopping



Date: 12.MAY.2022 12:57:53

Single



Date: 12.MAY.2022 12:50:41

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