TEST REPORT

Applicant Name :	ARICH INTERNATIONAL INC
Address :	360 SUMMERVIEW CT SAN RAMON CA 94583-4463, SAN RAMON, California, United States 945834463
Report Number :	SZNS2220914-41668E-RF-00A
FCC ID:	2ADZTDRAGONFLY

Test Standard (s)
FCC PART 15.247

Sample Description

Product Type:	Dragonfly
Model No.:	HULK-10
Trade Name	TUNAI
Date Received:	2022-09-14
Date of Test:	2022-09-21 to 2022-11-23
Report Date:	2022-11-28

Test Result:	Pass*

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

Prepared and Checked By:

Roger.Ling

Roger.Ling
EMC Engineer

Approved By:

Candy.Li

Candy Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★".
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Dragonfly
Tested Model	HULK-10
Frequency Range	2402~2480MHz
Maximum conducted Peak output power	4.27dBm
Modulation Technique	BDR(GFSK)/EDR(π/4-DQPSK)/EDR(8DPSK)
Antenna Specification*	Internal Antenna:3.2dBi(provided by the applicant)
Voltage Range	DC 5V from USB port
Sample number	SZNS2220914-41668E-RF-S1 (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, 15.209 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		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.66dB
	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
	26.5GHz - 40GHz	4.72dB
Temperature		1℃
Humidity		6%
Supply voltages		0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189.

Accredited by American Association for Laboratory Accreditation (A2LA). The Certificate Number is 4297.01

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016. 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 "Xshell7.0.0063"* was used during testing and the power level was16*.

Special Accessories

N/A.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

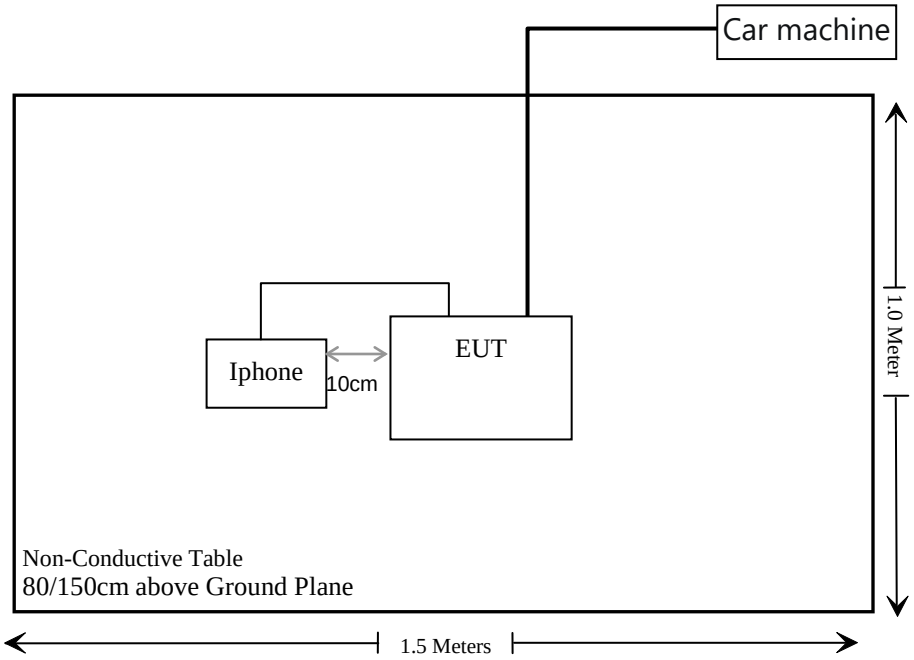
Manufacturer	Description	Model	Serial Number
Volkswagen	Car machine	H12	3GB035866A
Apple	Iphone	XS MAX	F2LZ346PKPQ7

External I/O Cable

Cable Description	Length (m)	From/Port	To
Un-shielding Detachable USB Cable	1.0	Iphone	EUT
USB extension cord	5.0	EUT	Car machine

Block Diagram of Test Setup

For Radiated Emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247(i), §1.1307(b)	RF Exposure Evaluation	Compliant
§15.203	Antenna Requirement	Compliant
§15.207(a)	AC Line Conducted Emissions	Not Applicable*
§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

Note:
1. Not Applicable*: The EUT is intend for used in vehicle.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
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
WEINSCHEL	10dB Attenuator	5324	AU 3842	2021/12/14	2022/12/13
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 §1.1310 & §2.1091 –RF EXPOSURE EVALUATION

Applicable Standard

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);

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:

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

Test Result

For worst case:

Mode	Frequency Range (MHz)	Tune-up Output Power		Antenna Gain		ERP		Evaluation Distance (cm)	ERP Limit (mW)
		(dBm)	(mW)	(dBi)	(dBd)	(dBm)	(mW)		
BDR/EDR	2402-2480	4.5	2.82	3.2	1.05	5.55	3.59	20	768
2.4G Wi-Fi	2412-2462	20	100	3.2	1.05	21.05	127.35	20	768

Note 1: The tune-up power was declared by the applicant.
Note 2: 0dBd=2.15dBi.
Note 3: The BT function can't transmit at the same time with the 2.4G Wi-Fi function.

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

Result: Compliant.

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

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

Antenna Connector Construction

The EUT has one Internal Antenna arrangement for BT, which was permanently attached and the antenna gain is 3.2 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant.

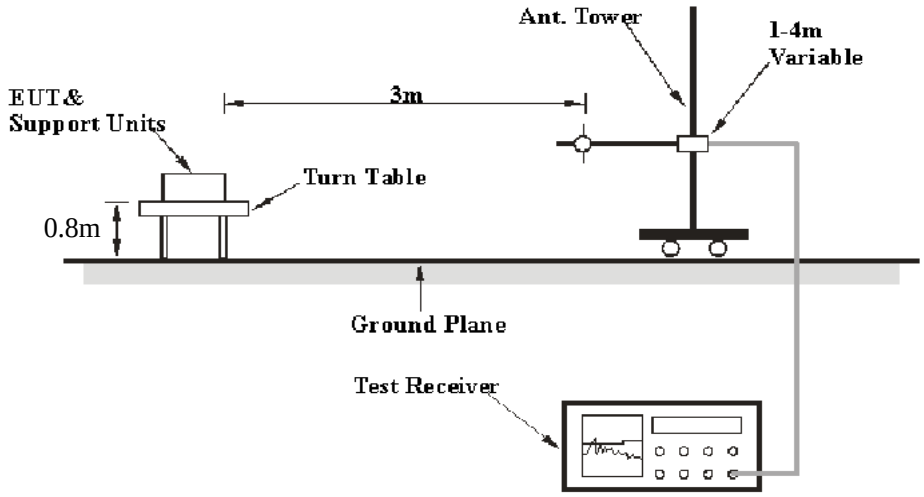
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

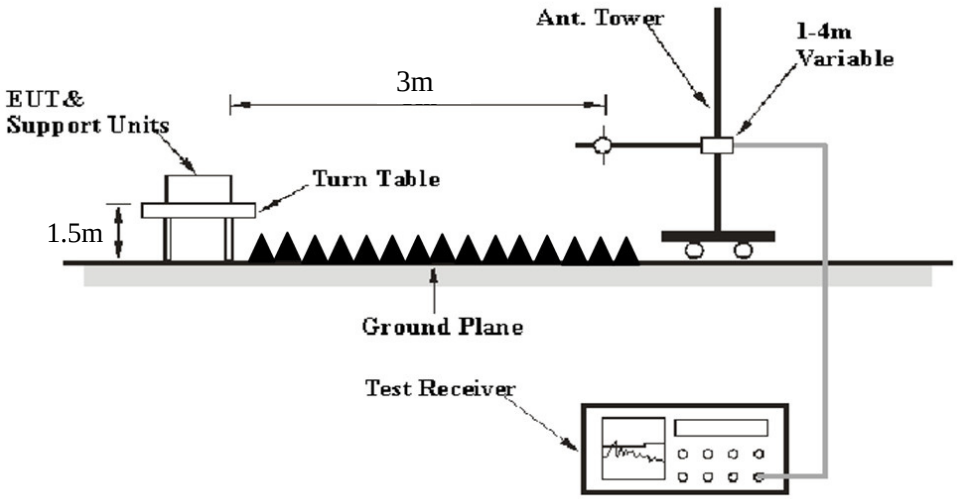
FCC §15.205; §15.209; §15.247(d)

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:	25~26 ℃
Relative Humidity:	56~60%
ATM Pressure:	101~101.2 kPa

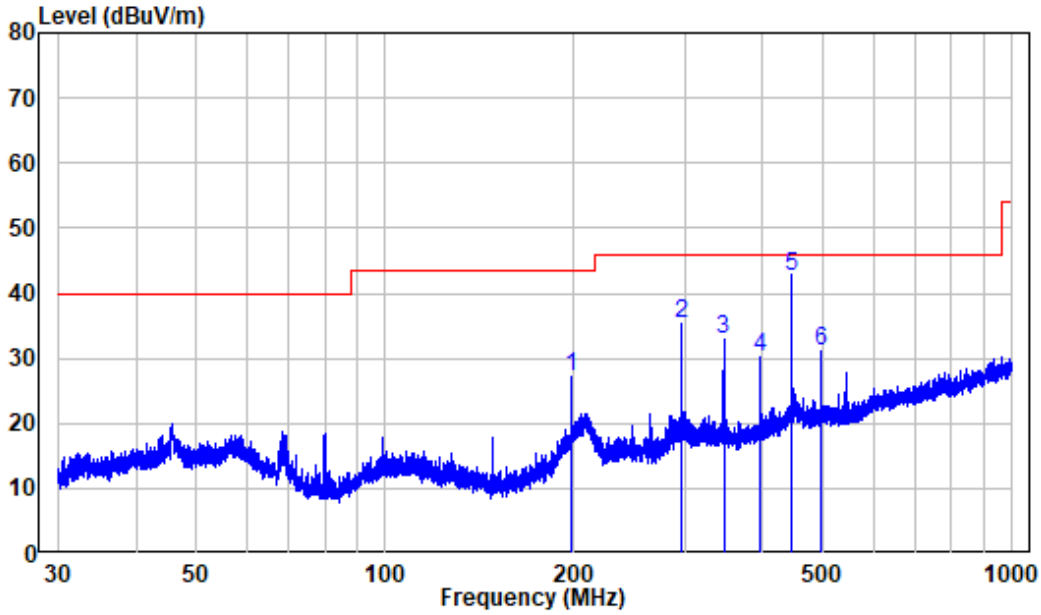
The testing was performed by Level Li from 2022-09-21 to 2022-09-23

EUT operation mode: 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: 8DPSK, High Channel:

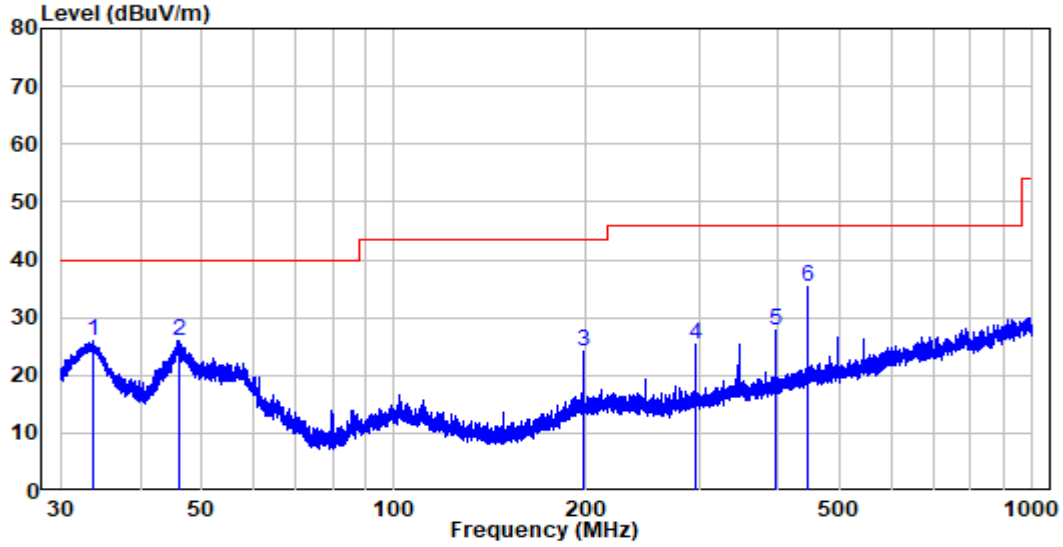
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS2220914-41668E-RF
Test Mode: BT Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	197.980	-11.54	38.84	27.30	43.50	-16.20	Peak
2	296.964	-9.25	44.55	35.30	46.00	-10.70	Peak
3	346.505	-7.24	40.07	32.83	46.00	-13.17	Peak
4	396.068	-6.79	37.10	30.31	46.00	-15.69	Peak
5	445.437	-5.63	48.30	42.67	46.00	-3.33	QP
6	495.066	-4.46	35.42	30.96	46.00	-15.04	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : SZNS2220914-41668E-RF
Test Mode: BT Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	33.769	-11.88	37.97	26.09	40.00	-13.91	Peak
2	45.896	-9.98	35.82	25.84	40.00	-14.16	Peak
3	197.980	-11.54	35.63	24.09	43.50	-19.41	Peak
4	296.964	-9.25	34.57	25.32	46.00	-20.68	Peak
5	396.068	-6.79	34.50	27.71	46.00	-18.29	Peak
6	445.632	-5.63	40.92	35.29	46.00	-10.71	Peak

Above 1GHz (worst case for 8DPSK):

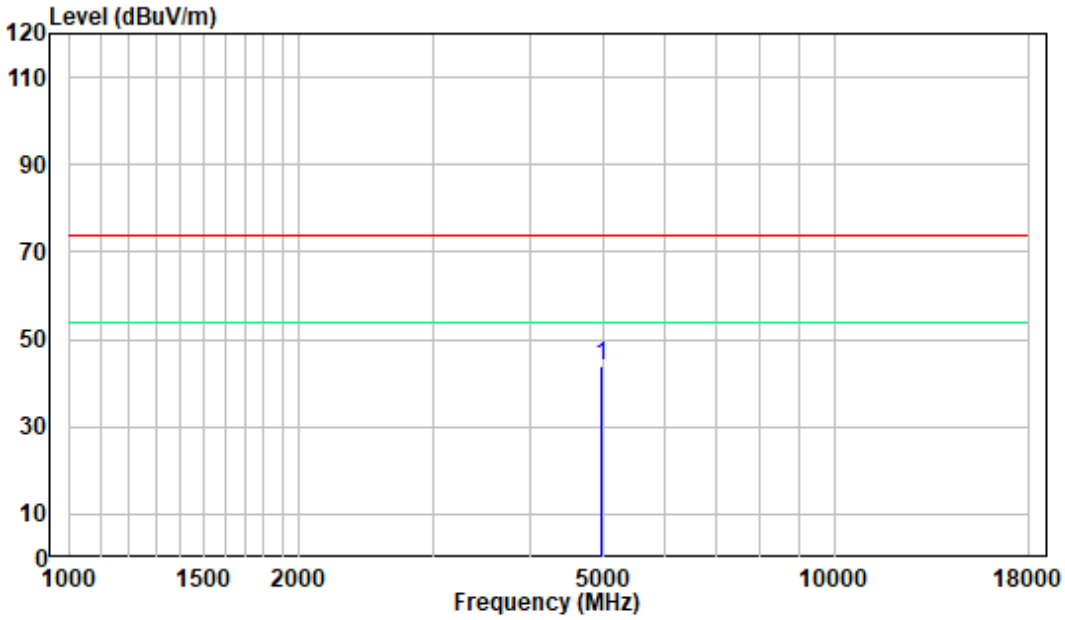
Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
	Reading (dBuV)	PK/Ave		Height (m)	Polar (H/V)				
Low Channel									
2310	45.26	PK	90	1.9	H	-7.23	38.03	74	-35.97
2310	46.82	PK	57	1.8	V	-7.23	39.59	74	-34.41
2390	44.81	PK	359	1.6	H	-7.21	37.6	74	-36.4
2390	47.06	PK	284	1.4	V	-7.21	39.85	74	-34.15
4804	44.35	PK	20	2.1	H	-3.52	40.83	74	-33.17
4804	44.84	PK	182	1.1	V	-3.52	41.32	74	-32.68
Middle Channel									
4882	44.83	PK	181	1.1	H	-3.37	41.46	74	-32.54
4882	45.22	PK	239	2.1	V	-3.37	41.85	74	-32.15
High Channel									
2483.5	43.86	PK	233	2.1	H	-7.2	36.66	74	-37.34
2483.5	44.78	PK	76	1.1	V	-7.2	37.58	74	-36.42
2500	43.86	PK	41	1.7	H	-7.18	36.68	74	-37.32
2500	44.7	PK	209	1.0	V	-7.18	37.52	74	-36.48
4960	46.86	PK	41	1.7	H	-3.01	43.85	74	-30.15
4960	47.43	PK	242	1.8	V	-3.01	44.42	74	**-29.58**

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.

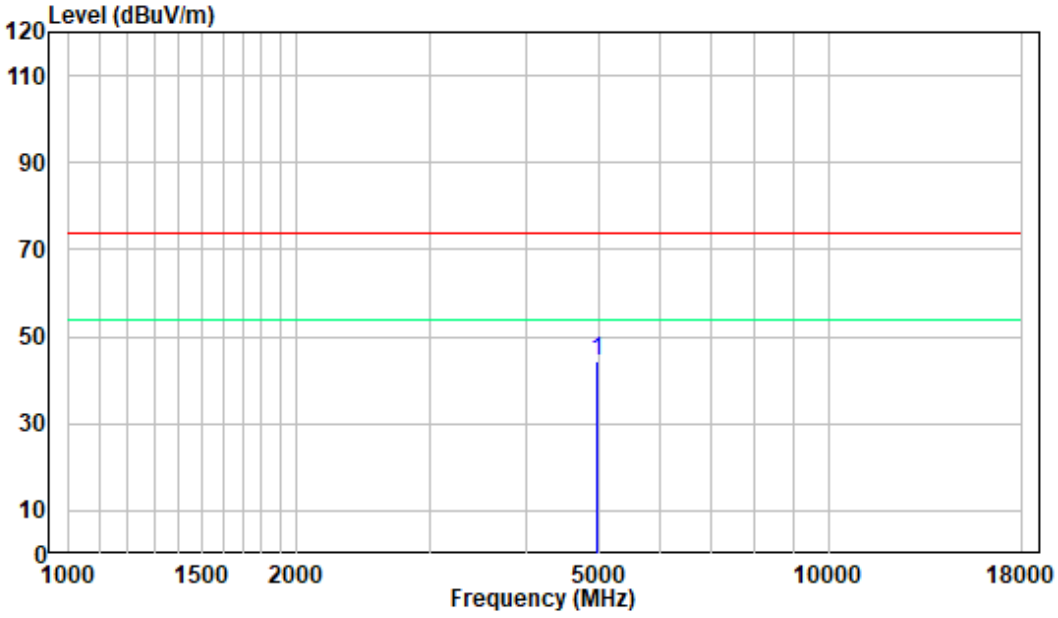
1 GHz - 18 GHz: (Pre-Scan plots)

Worst case for 8DPSK, High Channel:

Horizontal



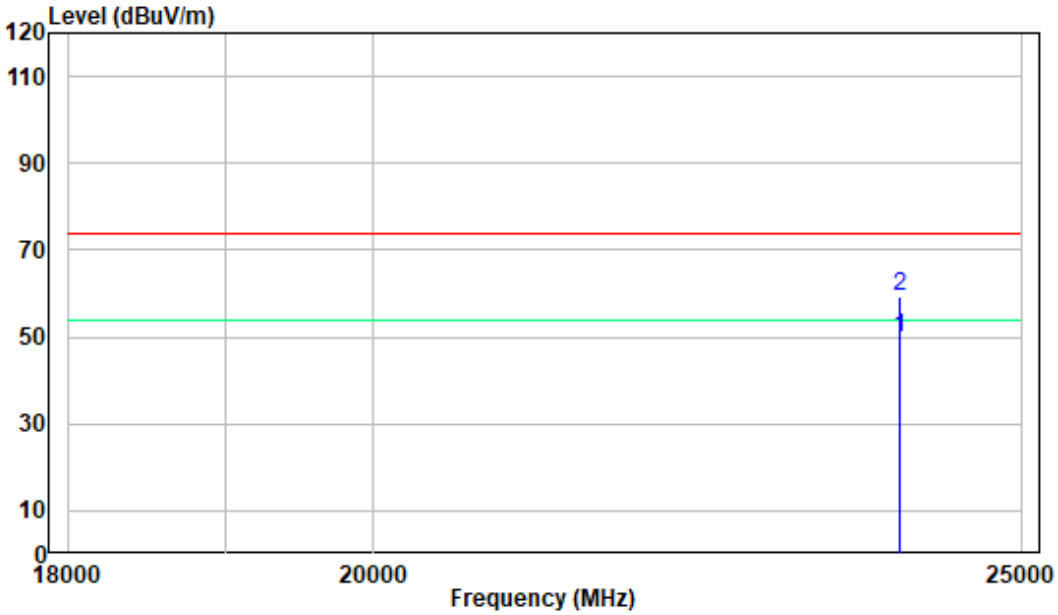
Vertical



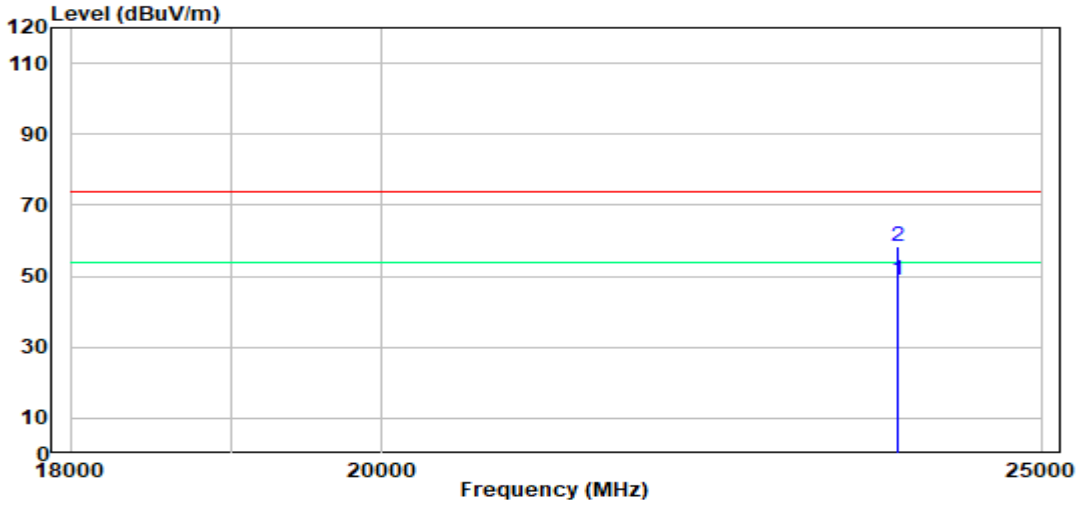
18-25GHz: (Pre-Scan plots)

Worst case for 8DPSK, High Channel:

Horizontal



Vertical



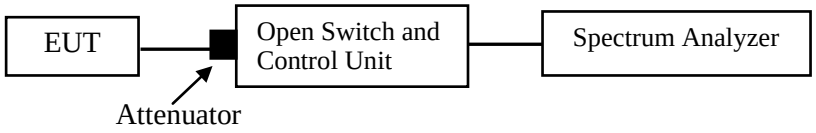
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

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

Test Procedure

1. Set the EUT in 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:	23℃
Relative Humidity:	51%
ATM Pressure:	101.1kPa

The testing was performed by Glenn. Jiang on 2022-11-23

EUT operation mode: Transmitting

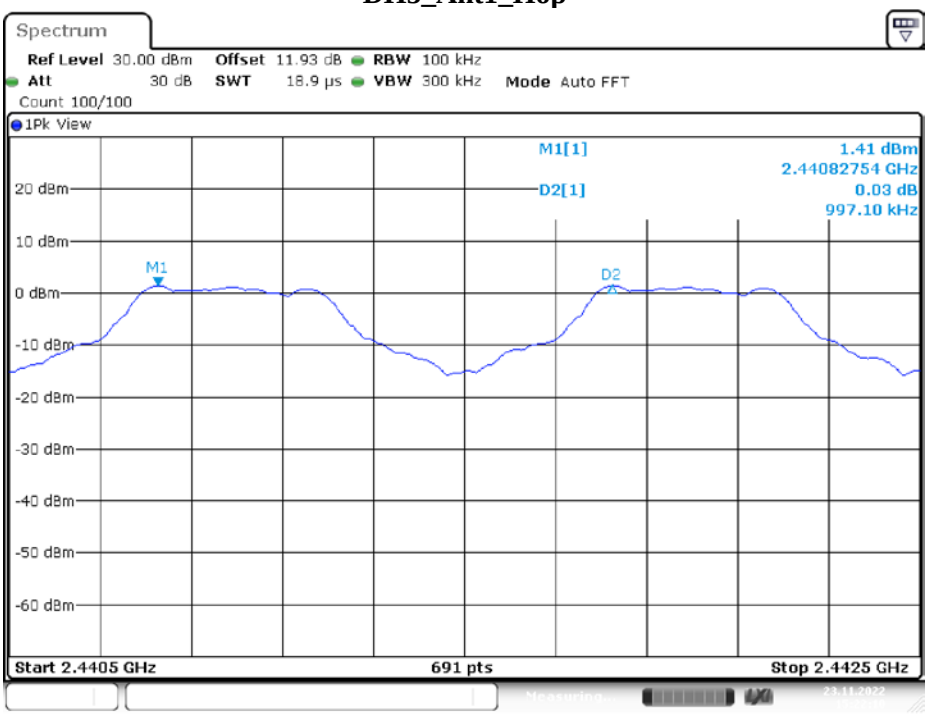
Test Result: Compliant.

Test Mode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop	0.997	>=0.690	PASS
2DH5	Ant1	Hop	1.000	>=0.906	PASS
3DH5	Ant1	Hop	1.003	>=0.866	PASS

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

Please refer to the below plots:

DH5_Ant1_Hop



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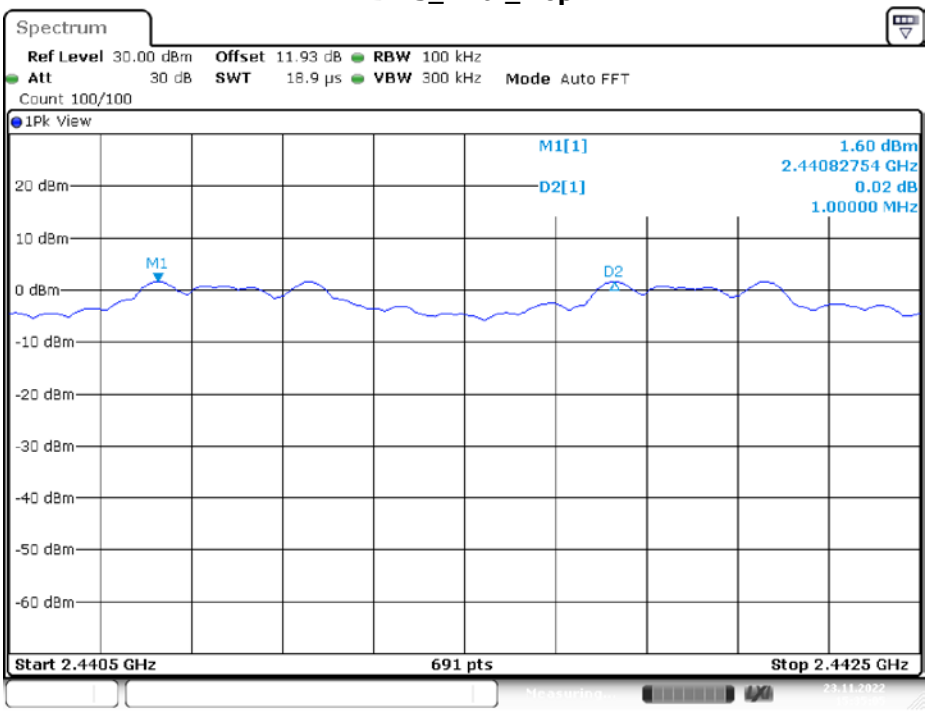
2DH5_Ant1_Hop



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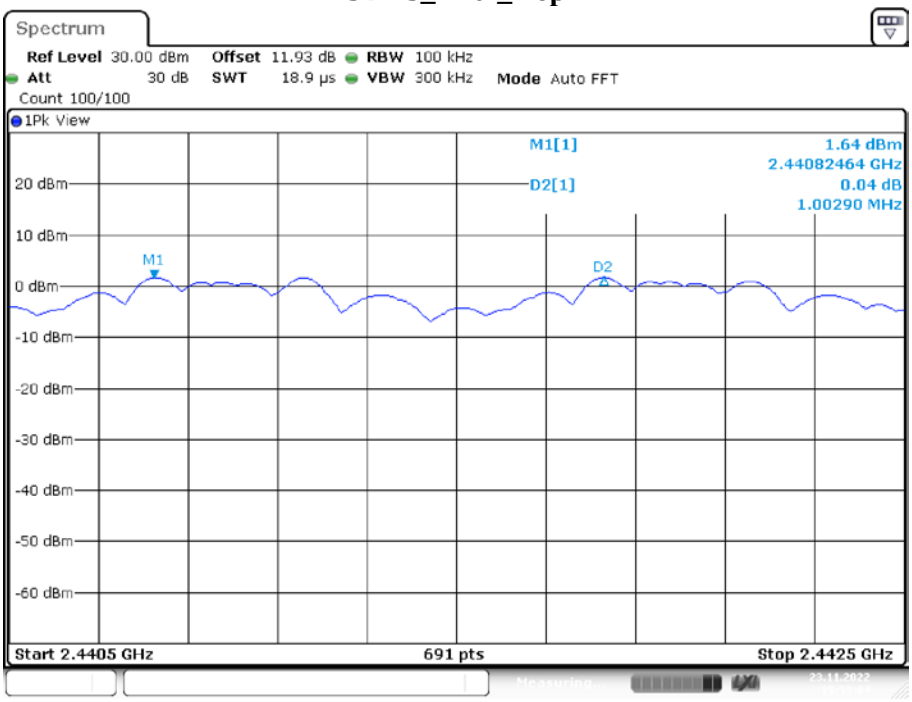
3DH5_Ant1_Hop



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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

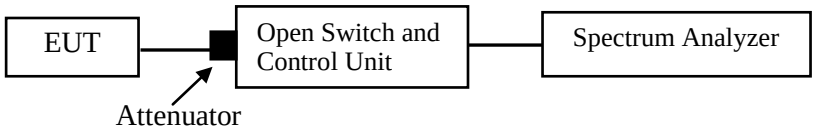
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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 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:	23℃
Relative Humidity:	51 %
ATM Pressure:	101.1kPa

The testing was performed by Glenn. Jiang on 2022-09-27

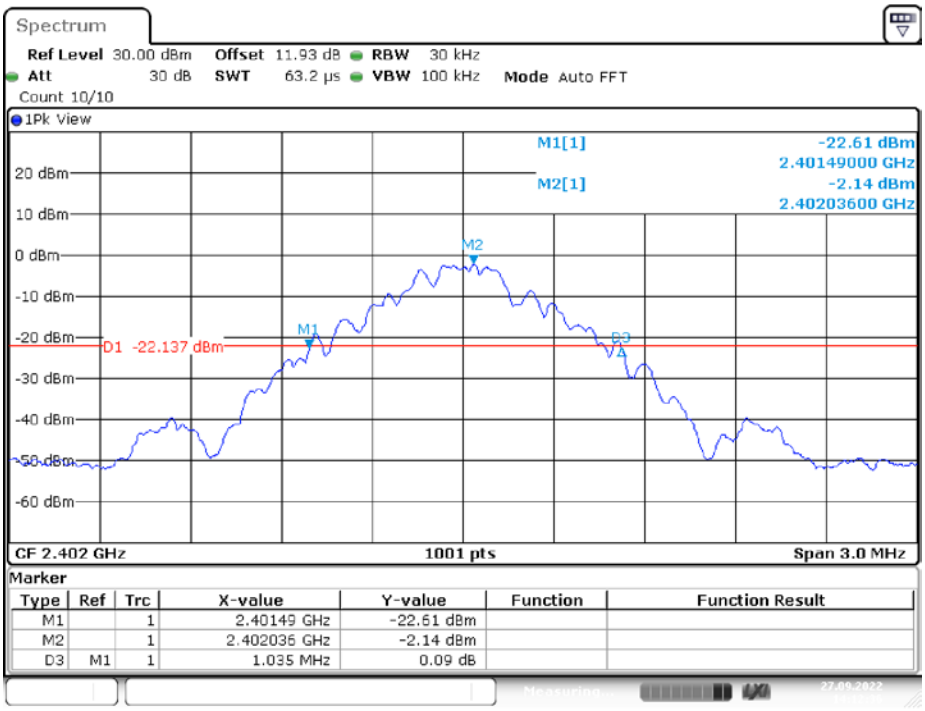
EUT operation mode: Transmitting

Test Result: Compliant.

TestMode	Antenna	Channel	20db EBW[MHz]	99% OCCUPIED BANDWIDTH[MHz]	Verdict
DH5	Ant1	2402	1.035	0.896	PASS
		2441	1.035	0.899	PASS
		2480	1.035	0.899	PASS
2DH5	Ant1	2402	1.344	1.187	PASS
		2441	1.347	1.187	PASS
		2480	1.359	1.193	PASS
3DH5	Ant1	2402	1.293	1.163	PASS
		2441	1.290	1.163	PASS
		2480	1.299	1.166	PASS

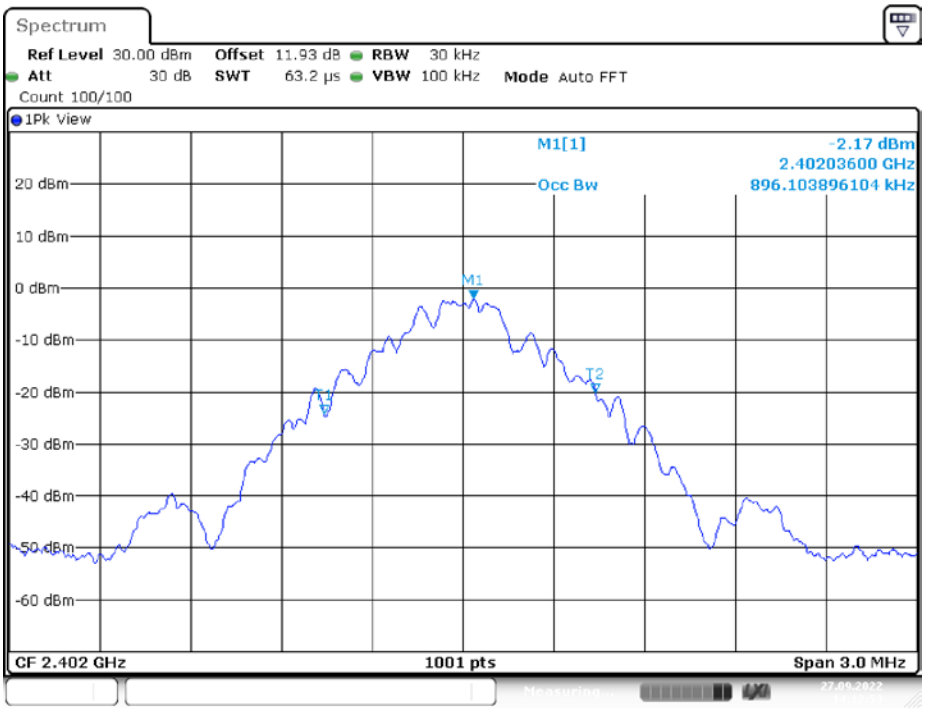
Please refer to the below plots:

20 dB EMISSION BANDWIDTH_DH5_Ant1_2402



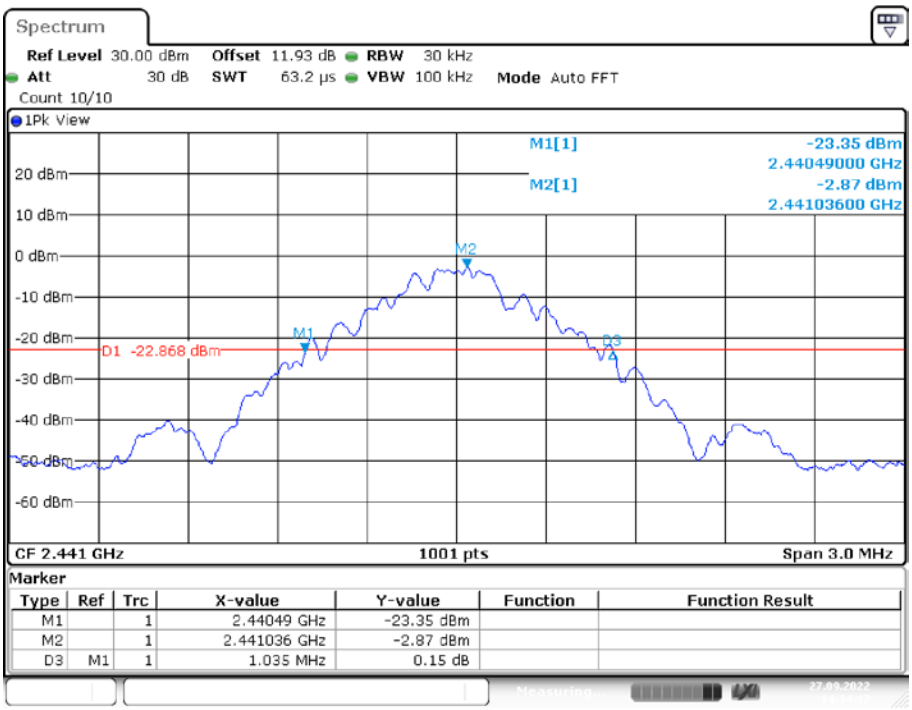
Date: 27.SEP.2022 14:12:36

99% OCCUPIED BANDWIDTH_DH5 _Ant1_2402



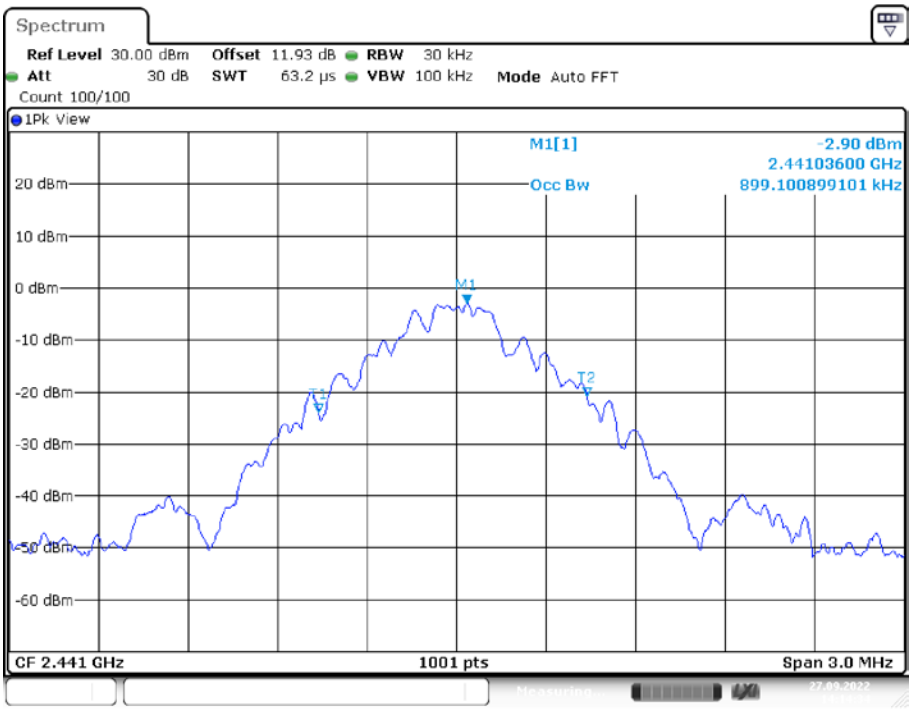
Date: 27.SEP.2022 14:12:53

20 dB EMISSION BANDWIDTH_DH5 _Ant1_2441



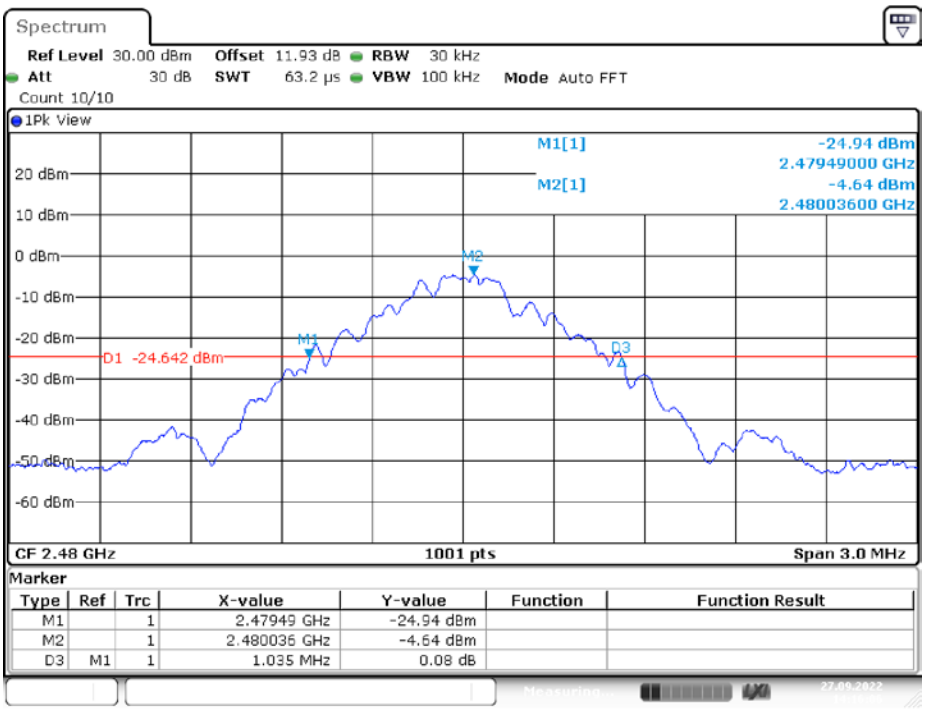
Date: 27.SEP.2022 14:14:17

99% OCCUPIED BANDWIDTH_DH5 _Ant1_2441



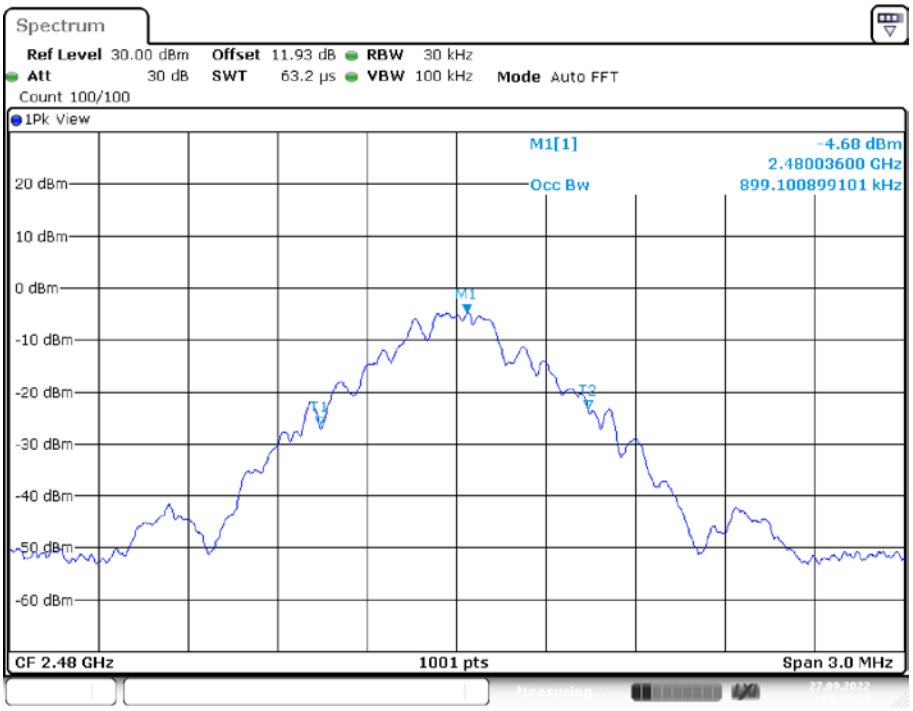
Date: 27.SEP.2022 14:14:34

20 dB EMISSION BANDWIDTH_DH5 _Ant1_2480



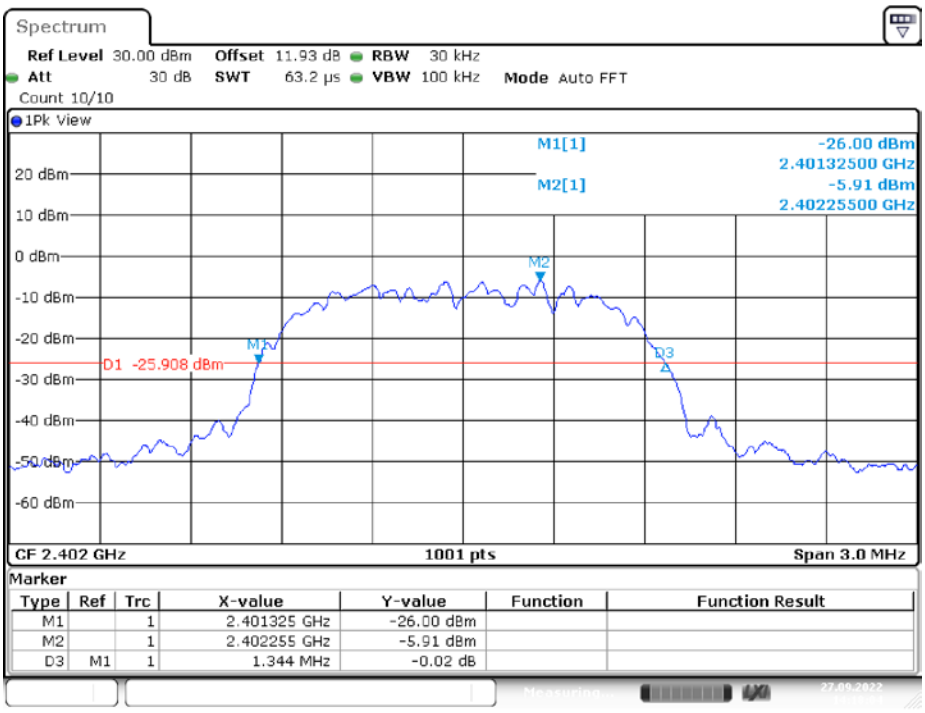
Date: 27.SEP.2022 14:16:06

99% OCCUPIED BANDWIDTH_DH5 _Ant1_2480



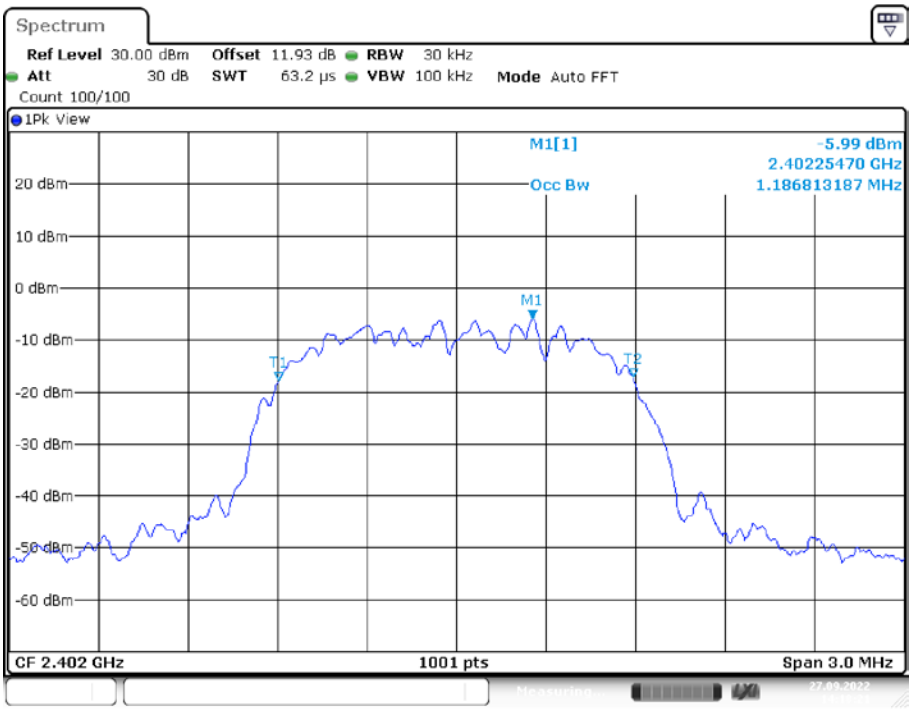
Date: 27.SEP.2022 14:16:23

20 dB EMISSION BANDWIDTH_2DH5 _Ant1_2402



Date: 27.SEP.2022 14:18:04

99% OCCUPIED BANDWIDTH_2DH5 _Ant1_2402

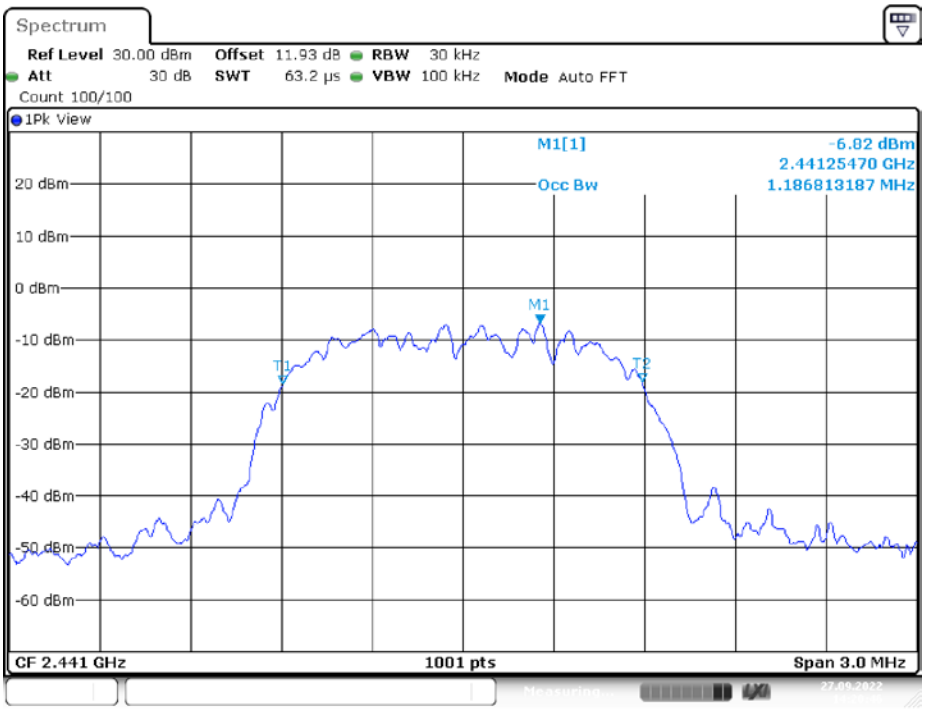


Date: 27.SEP.2022 14:18:21

20 dB EMISSION BANDWIDTH_2DH5 _Ant1_2441

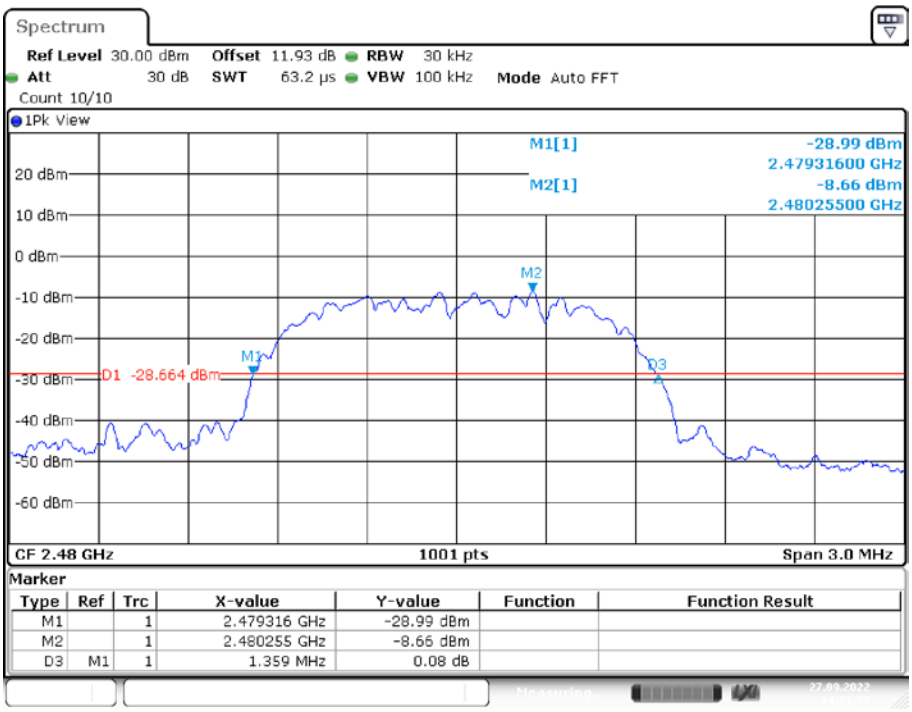
Date: 27.SEP.2022 14:20:30

99% OCCUPIED BANDWIDTH_2DH5 _Ant1_2441



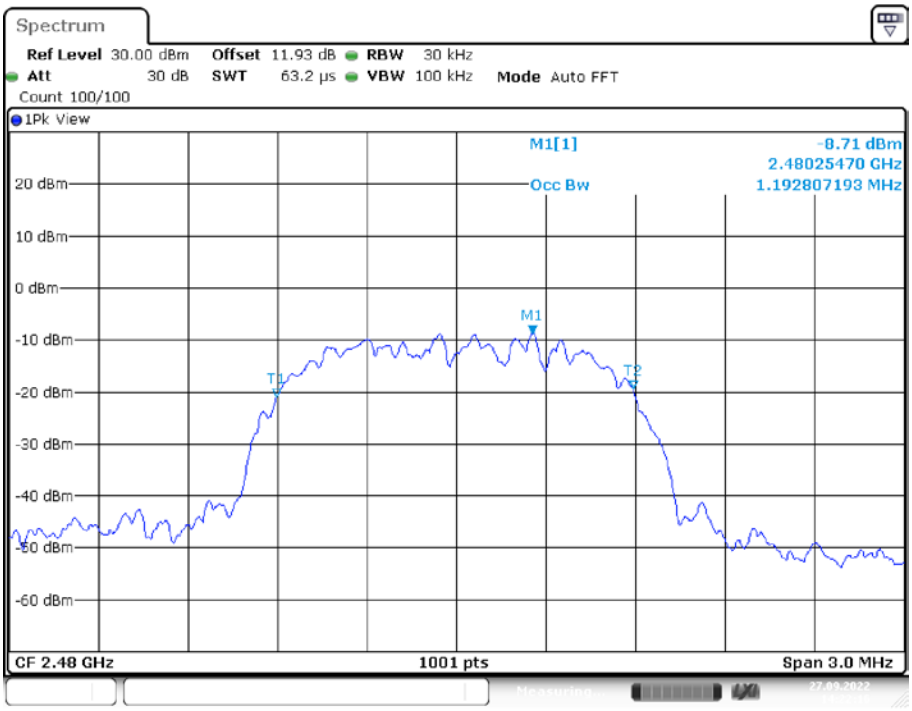
Date: 27.SEP.2022 14:20:46

20 dB EMISSION BANDWIDTH _2DH5_Ant1_2480



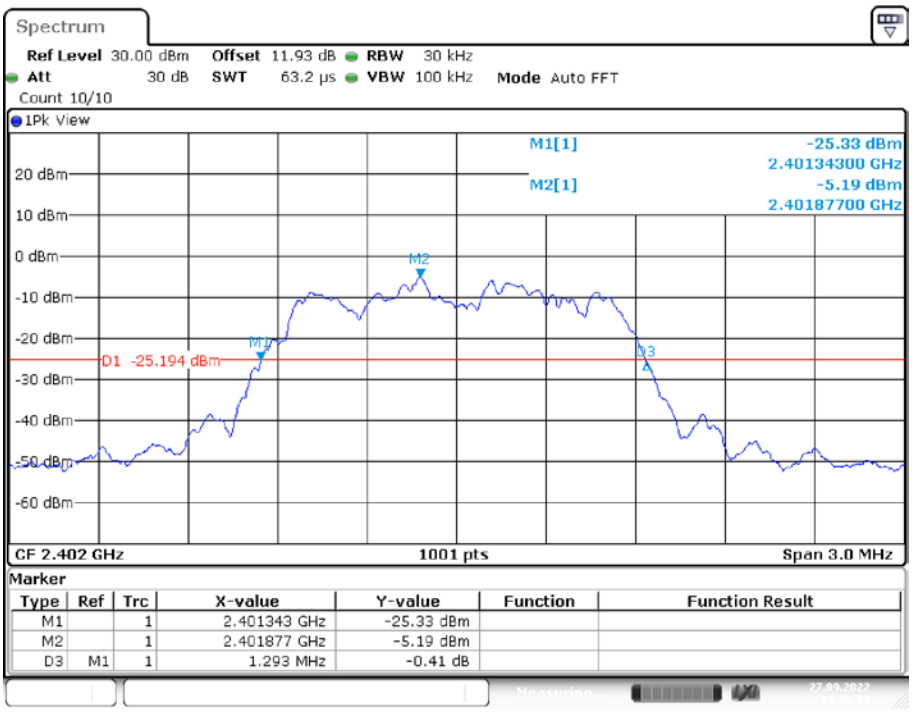
Date: 27.SEP.2022 14:21:59

99% OCCUPIED BANDWIDTH _2DH5_Ant1_2480



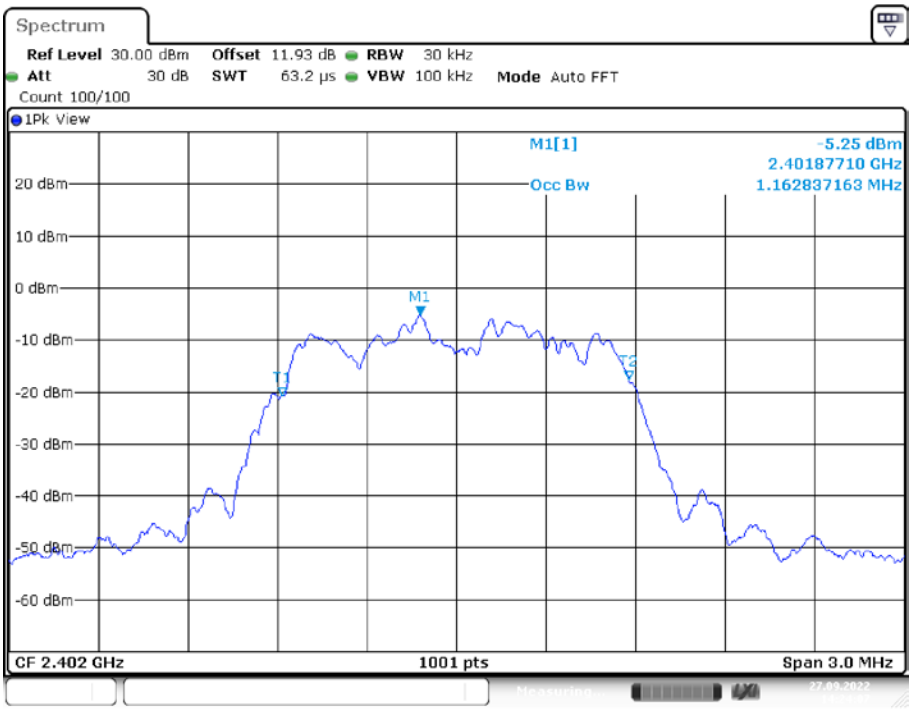
Date: 27.SEP.2022 14:22:16

20 dB EMISSION BANDWIDTH_3DH5_Ant1_2402



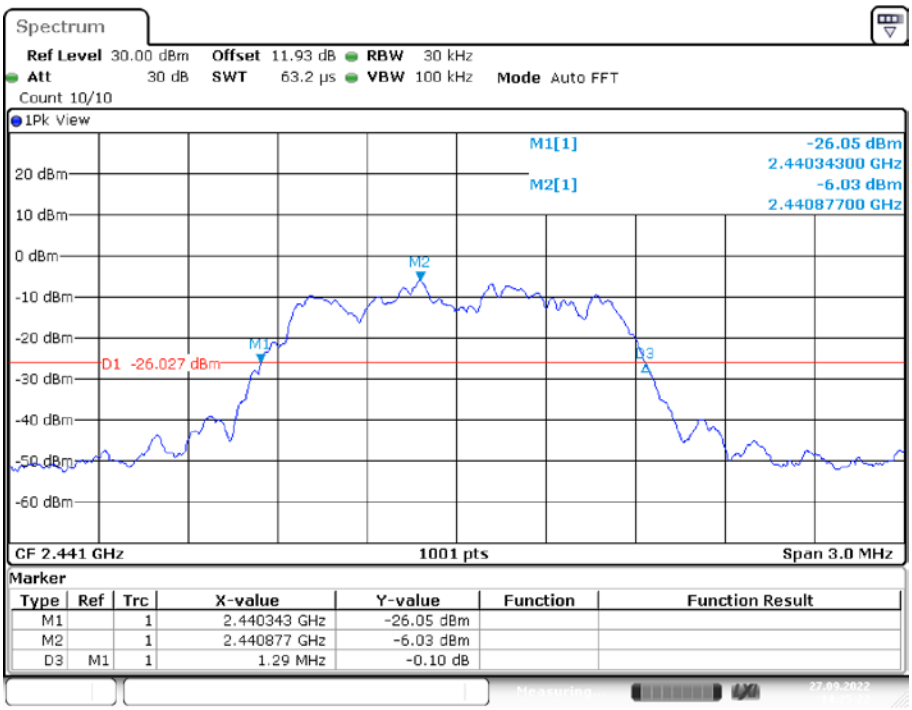
Date: 27.SEP.2022 14:23:50

99% OCCUPIED BANDWIDTH_3DH5 _Ant1_2402



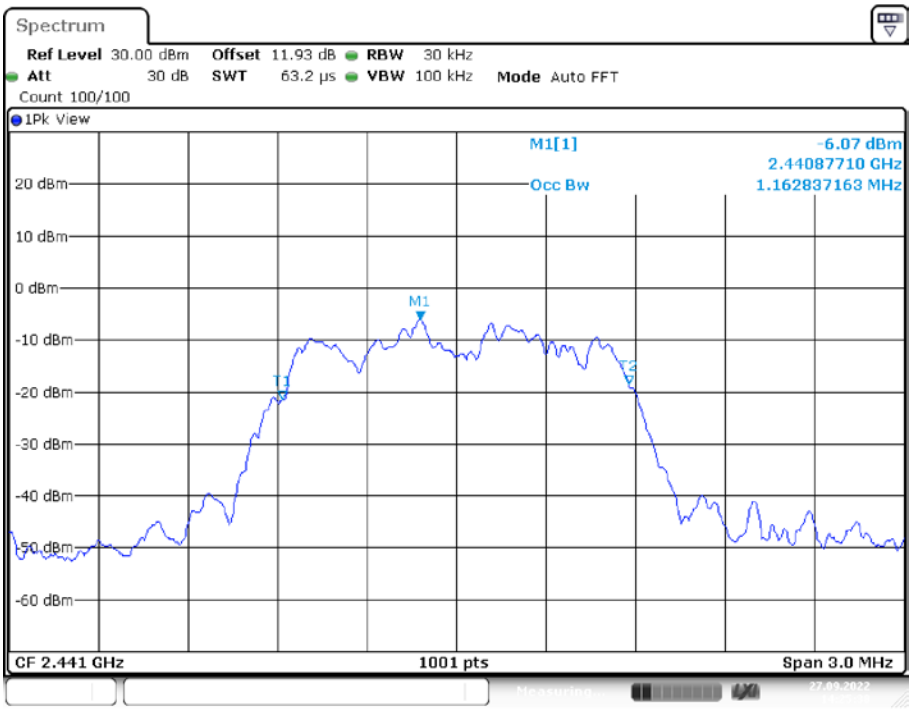
Date: 27.SEP.2022 14:24:07

20 dB EMISSION BANDWIDTH_3DH5 _Ant1_2441



Date: 27.SEP.2022 14:25:22

99% OCCUPIED BANDWIDTH_3DH5 _Ant1_2441

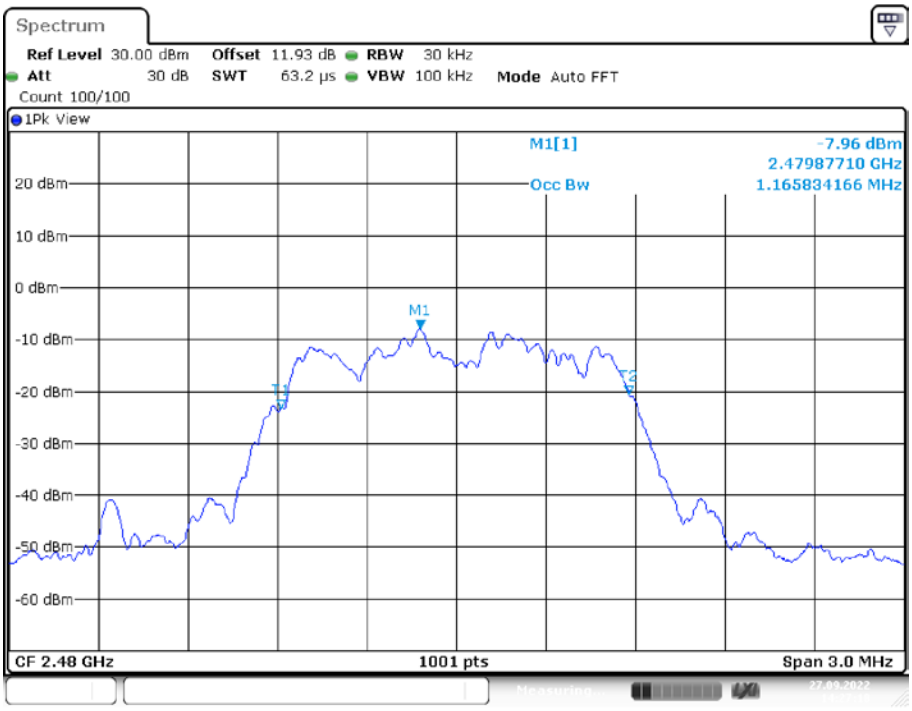


Date: 27.SEP.2022 14:25:38

20 dB EMISSION BANDWIDTH_3DH5 _Ant1_2480

Date: 27.SEP.2022 14:27:01

99% OCCUPIED BANDWIDTH_3DH5 _Ant1_2480



Date: 27.SEP.2022 14:27:18

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

Applicable Standard

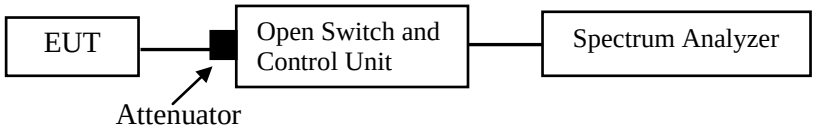
Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress 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℃
Relative Humidity:	51%
ATM Pressure:	101.1kPa

The testing was performed by Glenn. Jiang on 2022-11-23

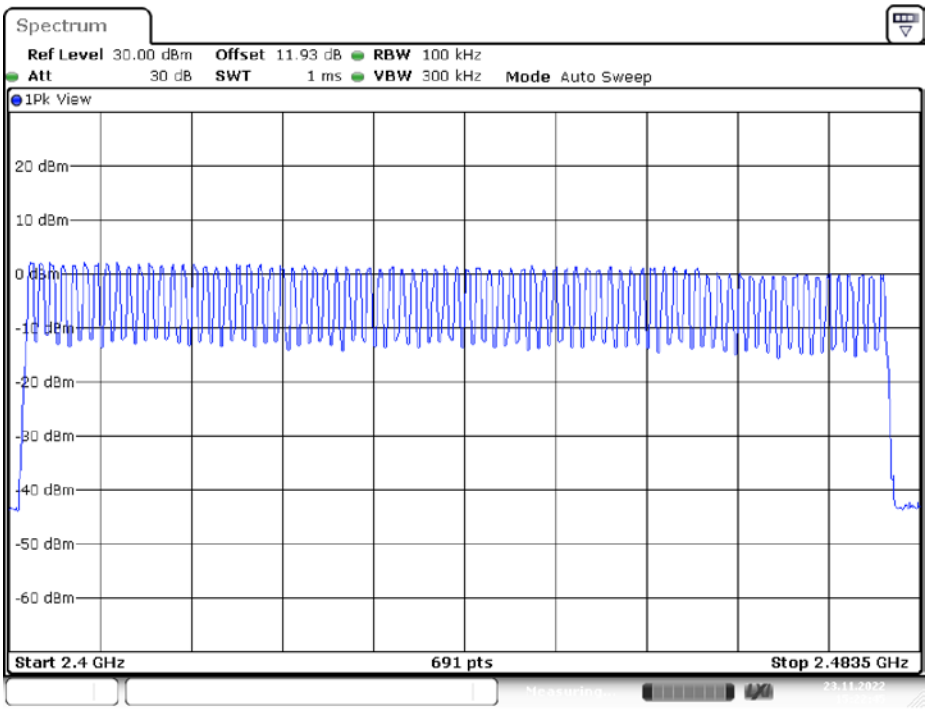
EUT operation mode: Transmitting

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

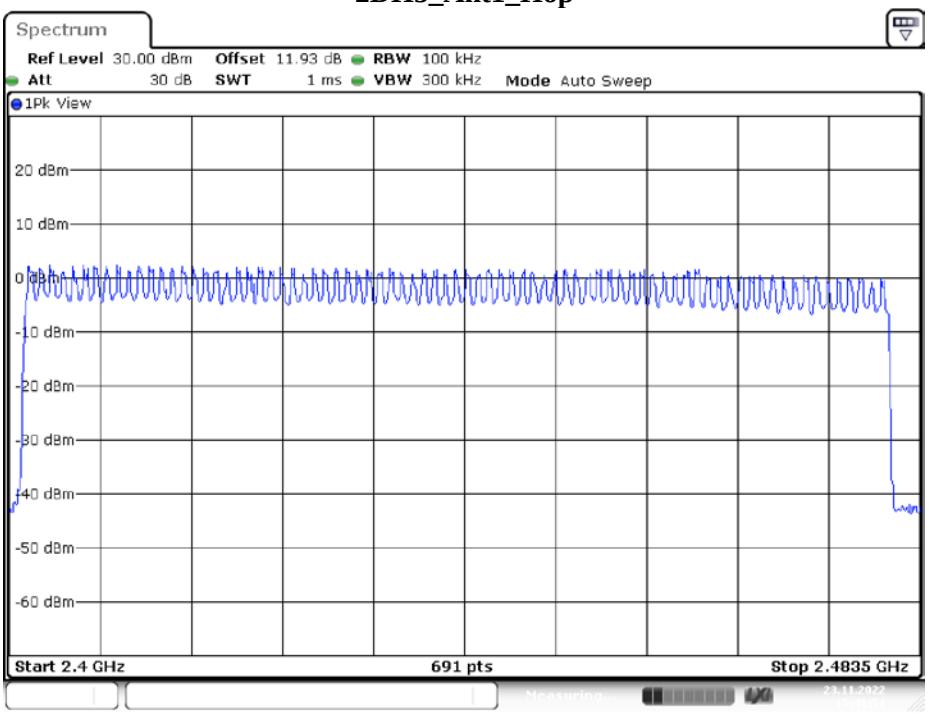
Please refer to the below plots:

DH5_Ant1_Hop



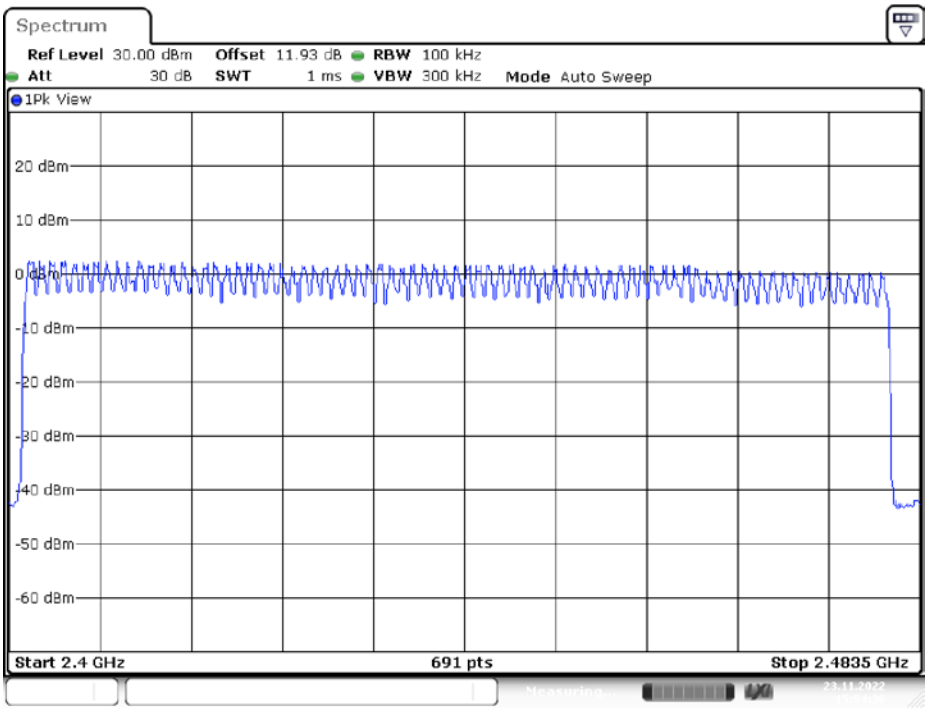
Date: 23.NOV.2022 15:22:45

2DH5_Ant1_Hop



Date: 23.NOV.2022 15:41:51

3DH5_Ant1_Hop



Date: 23.NOV.2022 15:54:37

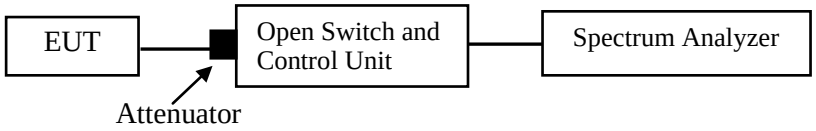
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

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

Test Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses



Test Data

Environmental Conditions

Temperature:	23℃
Relative Humidity:	51%
ATM Pressure:	101.1kPa

The testing was performed by Glenn. Jiang on 2022-11-23

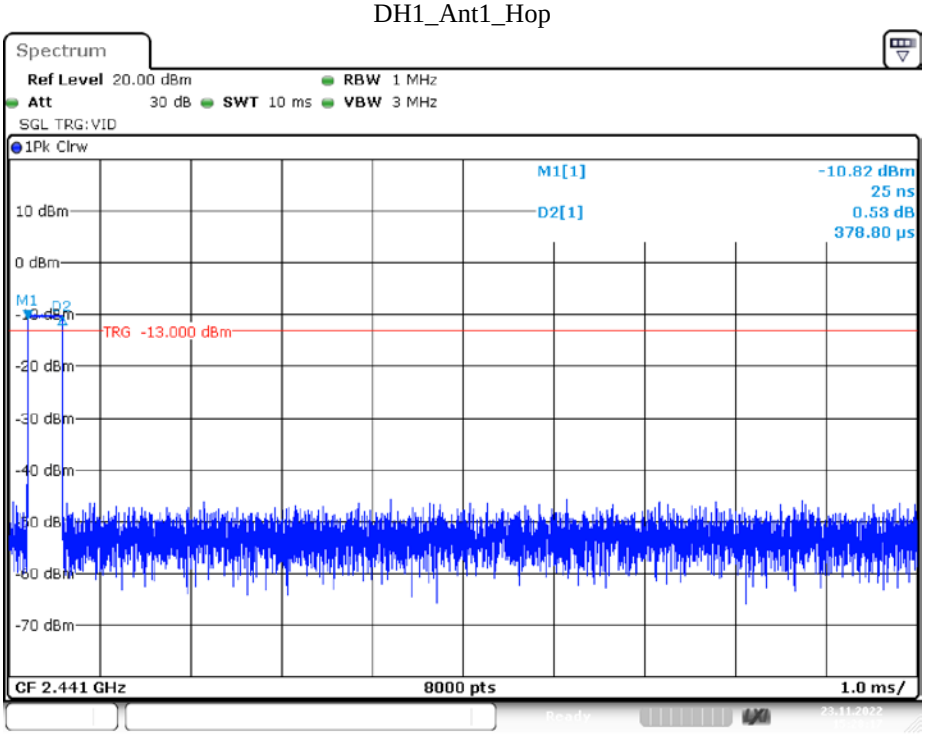
EUT operation mode: Transmitting

Test Result: Compliant.

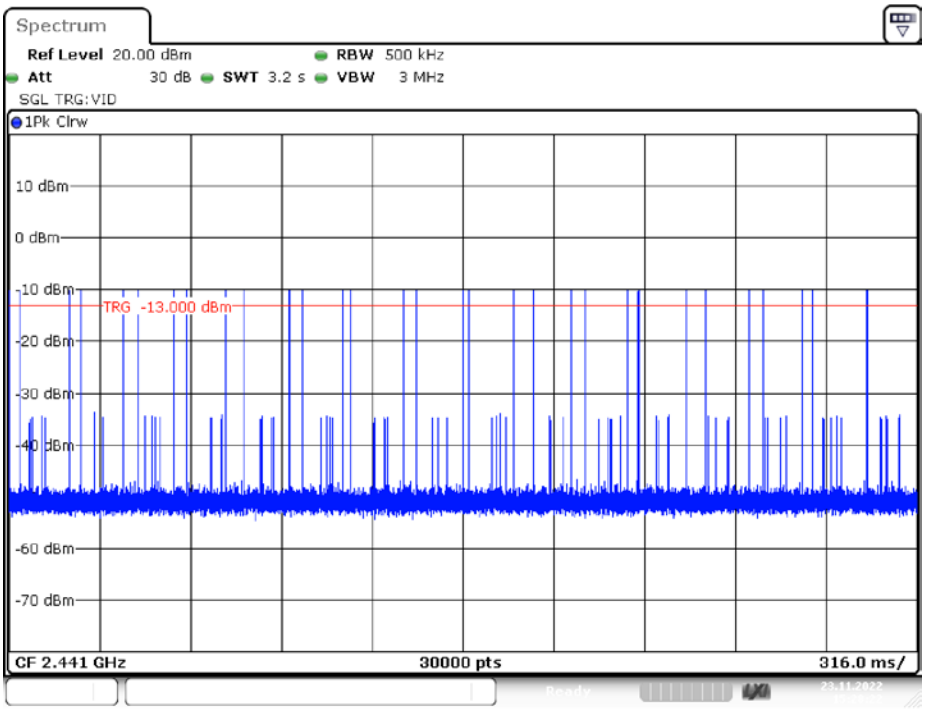
Test Mode	Antenna	Channel	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.38	320	0.121	<=0.4	PASS
DH3	Ant1	Hop	1.63	140	0.228	<=0.4	PASS
DH5	Ant1	Hop	2.87	110	0.315	<=0.4	PASS
2DH1	Ant1	Hop	0.39	330	0.128	<=0.4	PASS
2DH3	Ant1	Hop	1.63	160	0.261	<=0.4	PASS
2DH5	Ant1	Hop	2.87	130	0.373	<=0.4	PASS
3DH1	Ant1	Hop	0.39	330	0.127	<=0.4	PASS
3DH3	Ant1	Hop	1.63	180	0.293	<=0.4	PASS
3DH5	Ant1	Hop	2.88	110	0.316	<=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)

DH1_Ant1_Hop

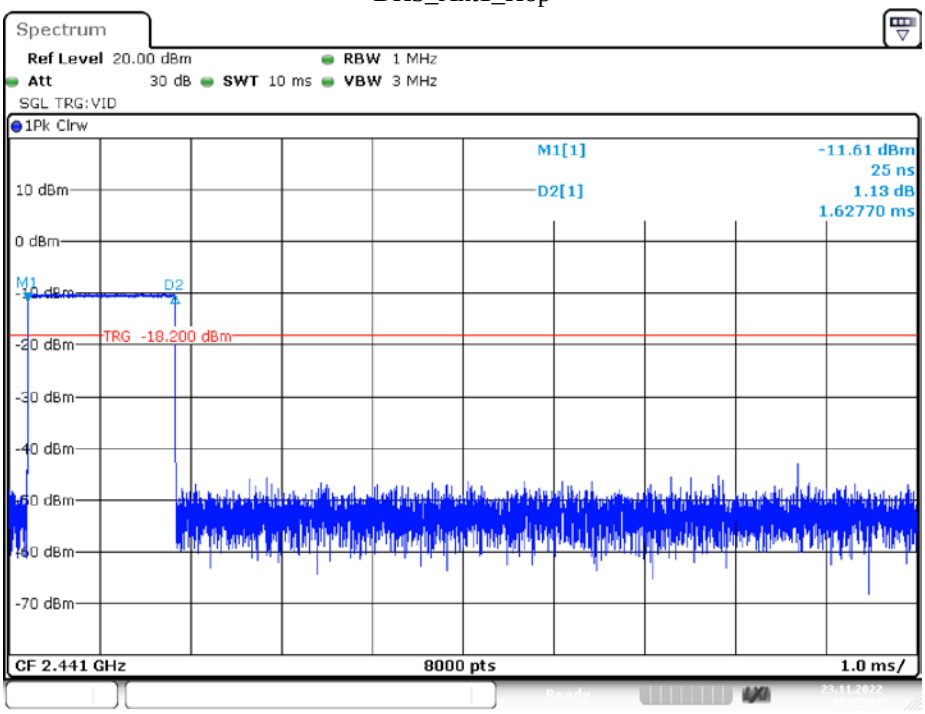


Date: 23.NOV.2022 15:26:10

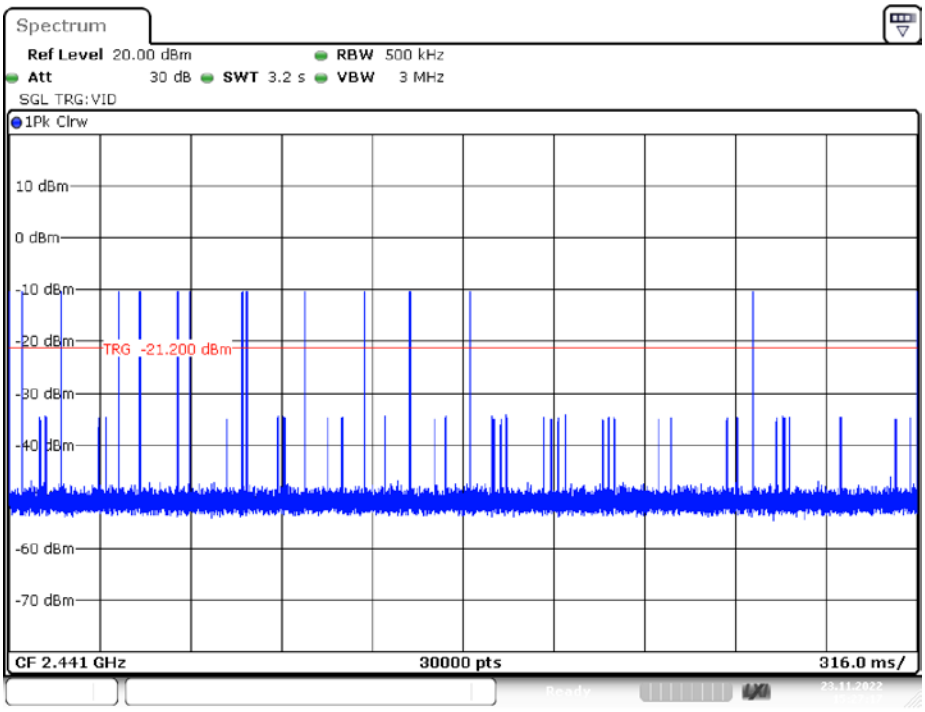


Date: 23.NOV.2022 15:26:23

DH3_Ant1_Hop

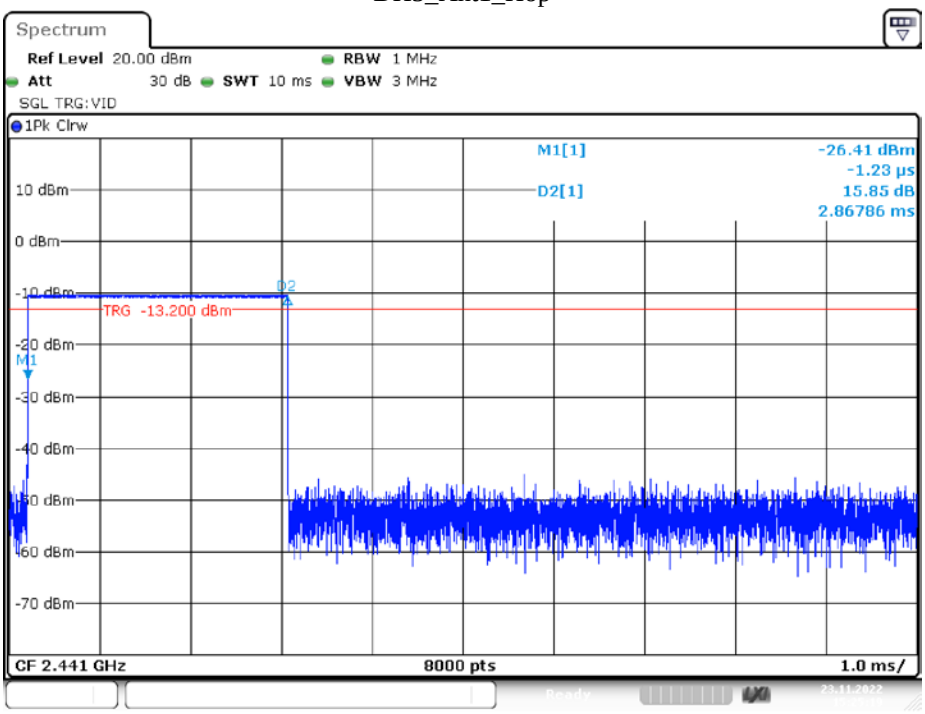


Date: 23.NOV.2022 15:27:12

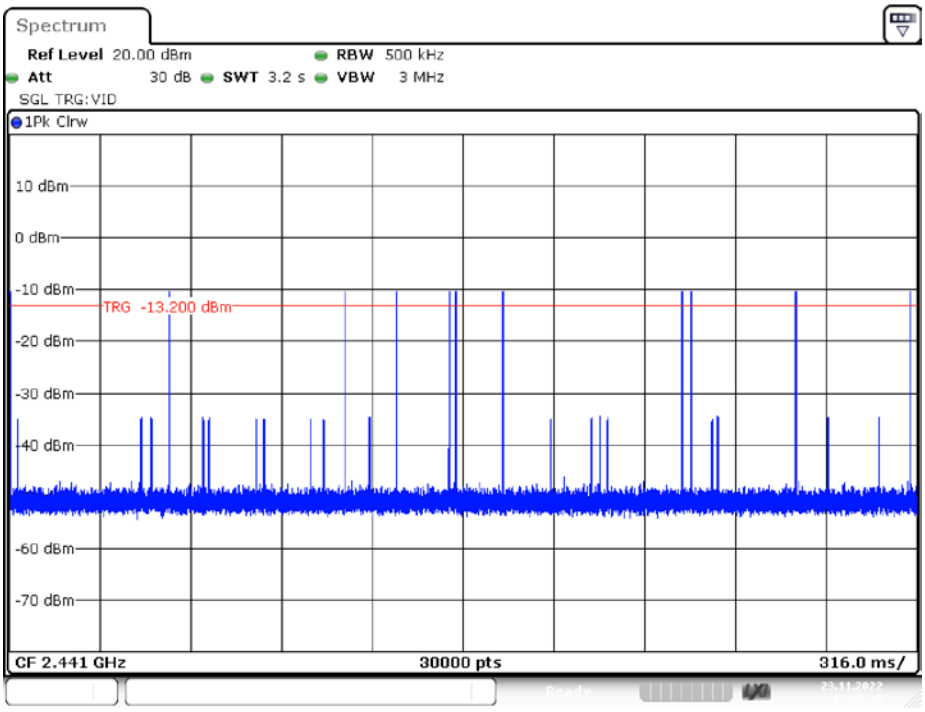


Date: 23.NOV.2022 15:27:17

DH5_Ant1_Hop

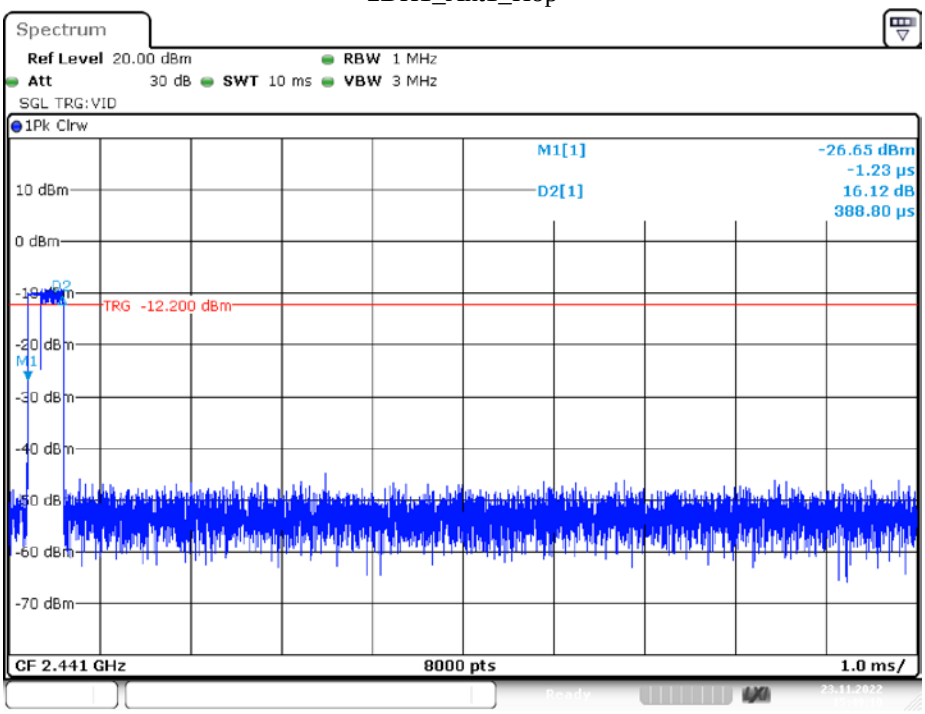


Date: 23.NOV.2022 15:25:19

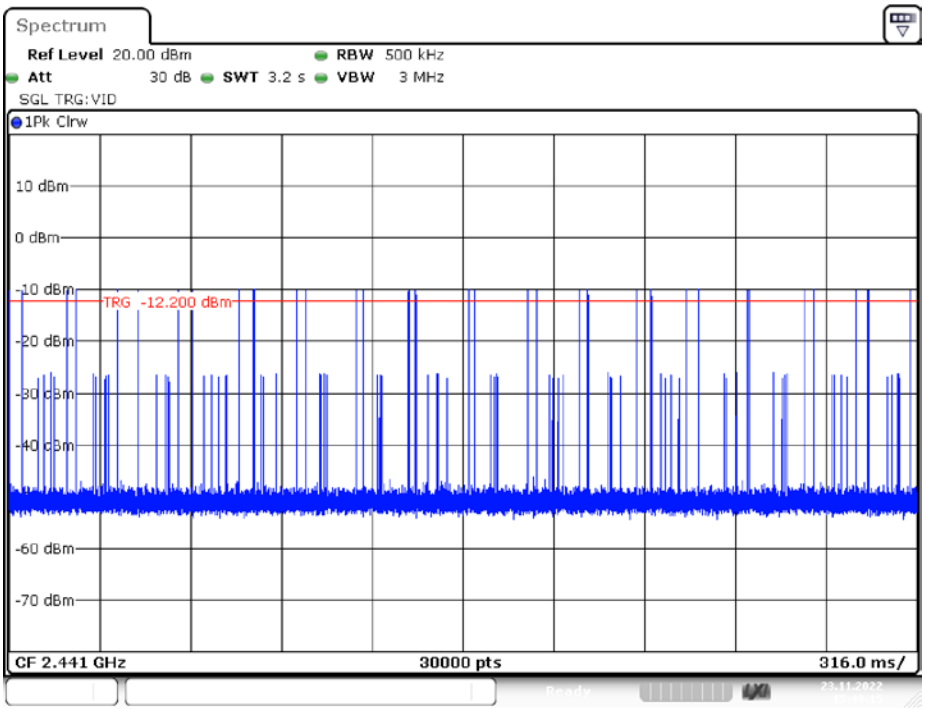


Date: 23.NOV.2022 15:25:25

2DH1_Ant1_Hop

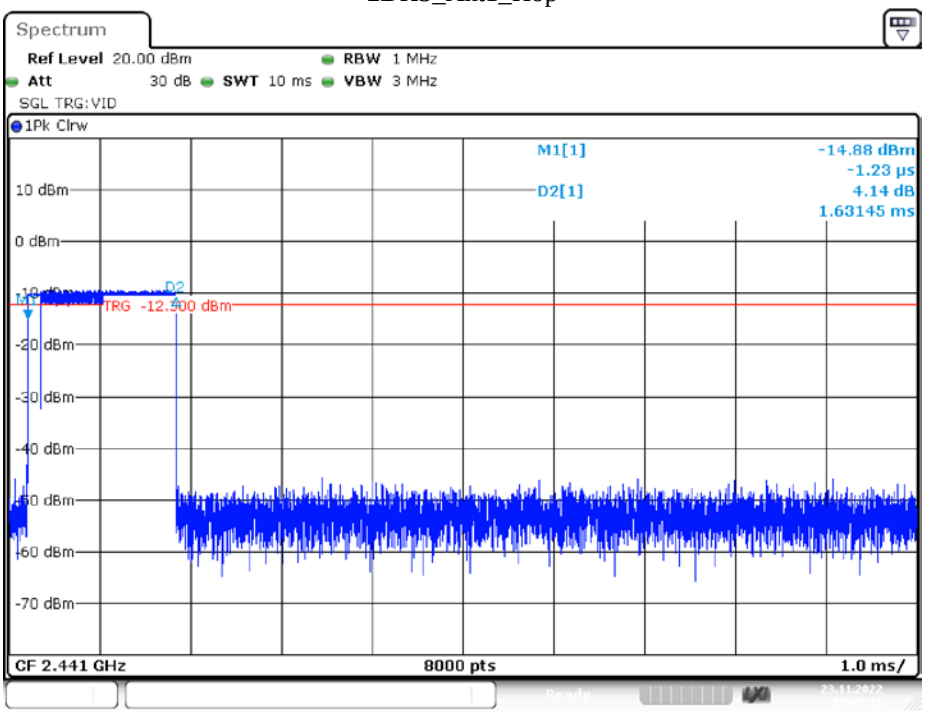


Date: 23.NOV.2022 15:49:10

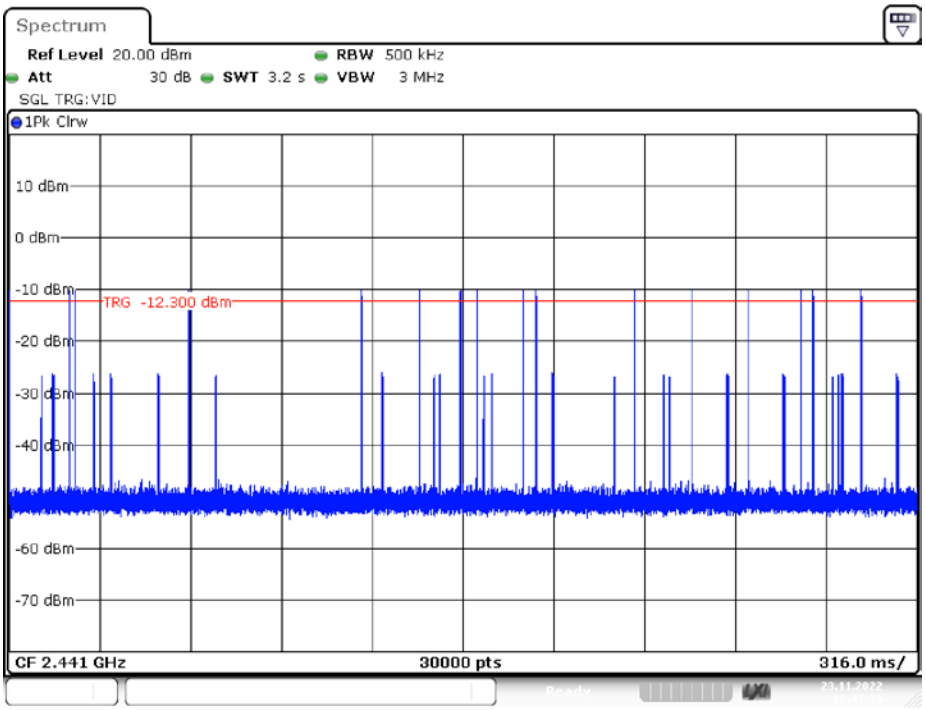


Date: 23.NOV.2022 15:49:16

2DH3_Ant1_Hop

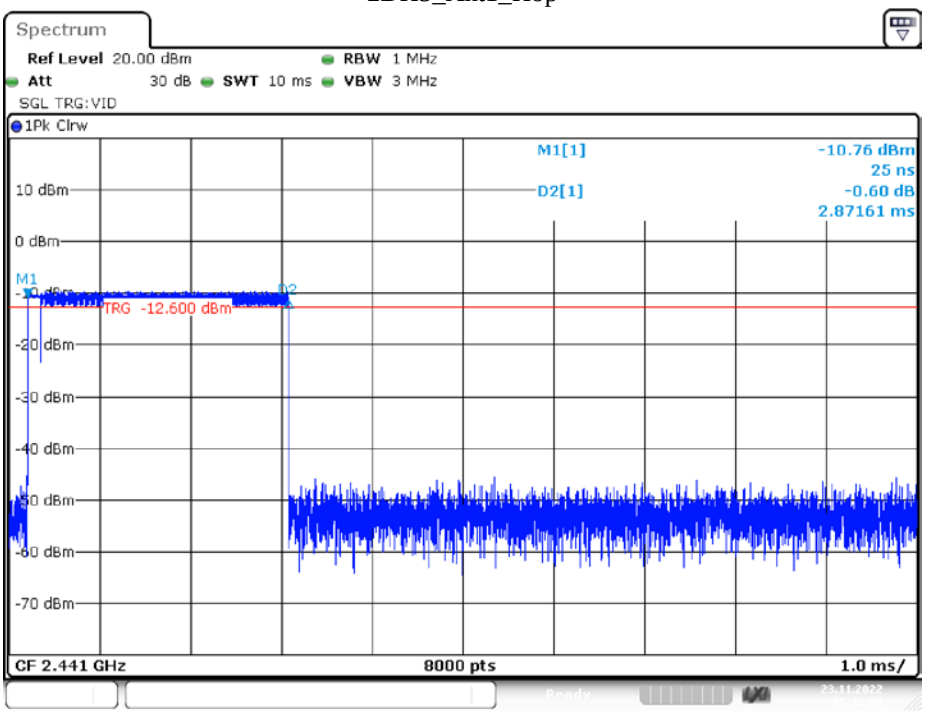


Date: 23.NOV.2022 15:47:51

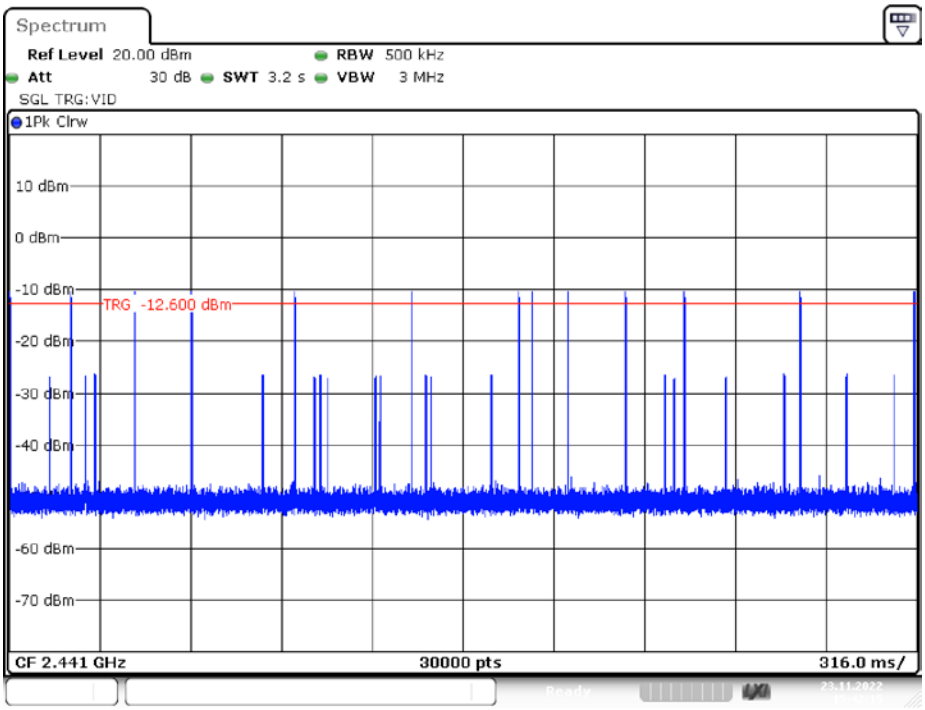


Date: 23.NOV.2022 15:47:57

2DH5_Ant1_Hop

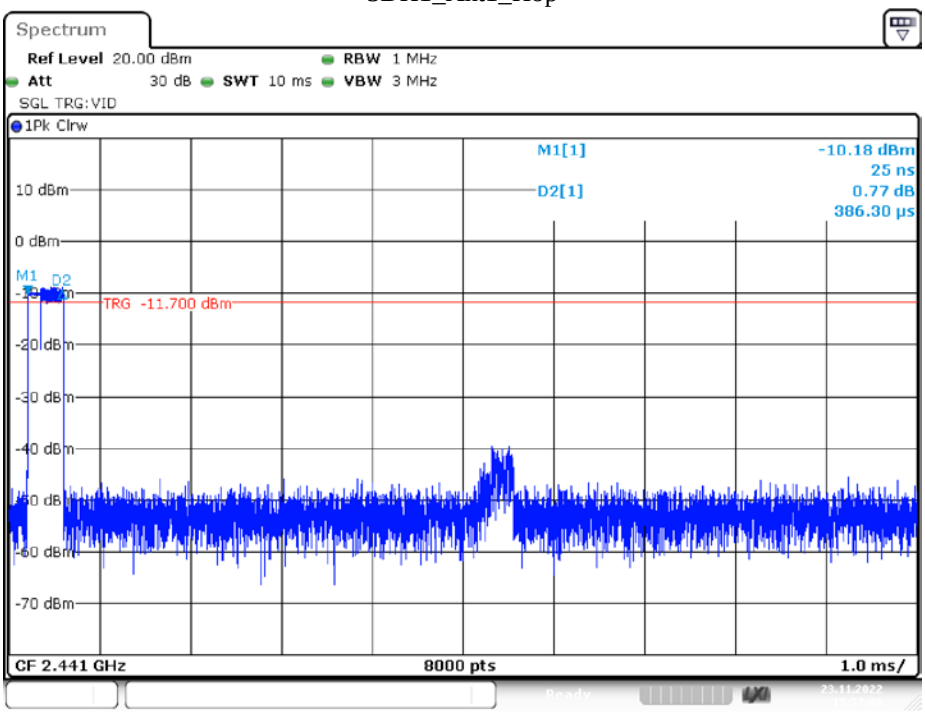


Date: 23.NOV.2022 15:42:10

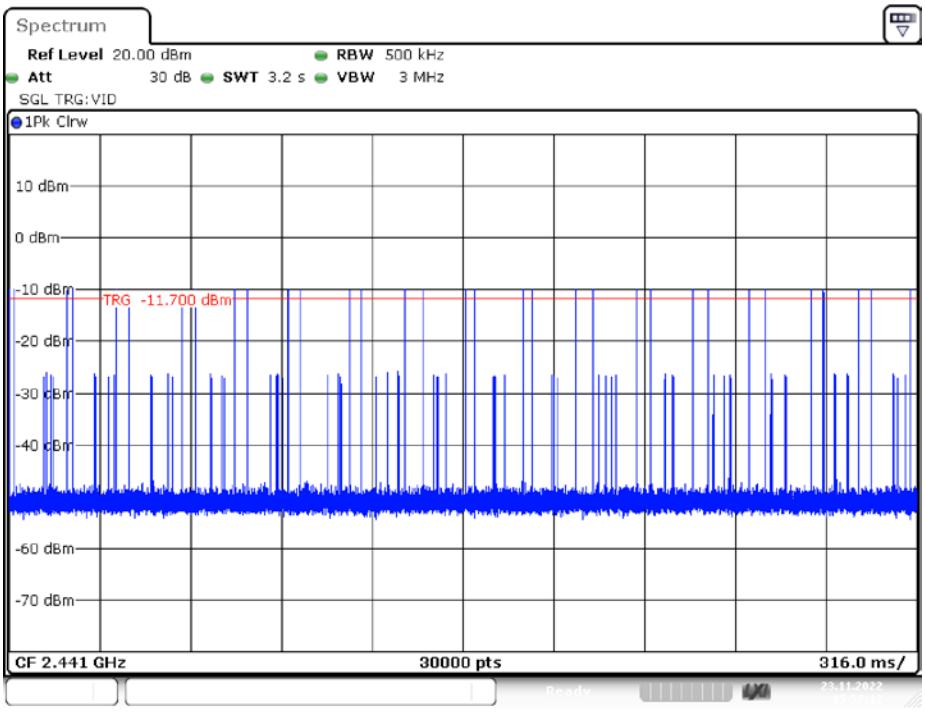


Date: 23.NOV.2022 15:42:16

3DH1_Ant1_Hop

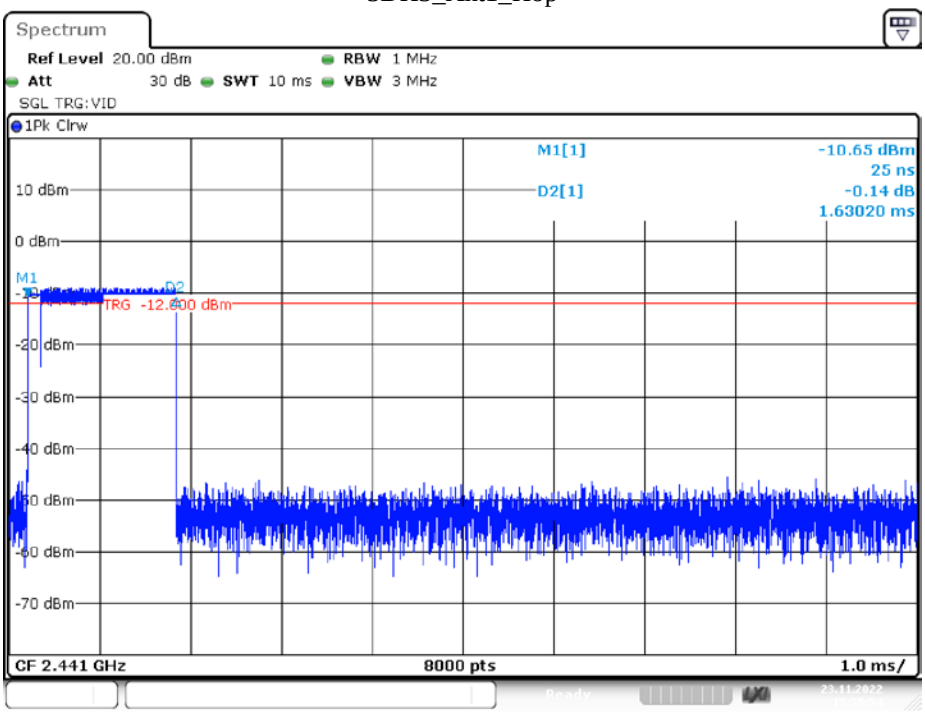


Date: 23.NOV.2022 15:57:07

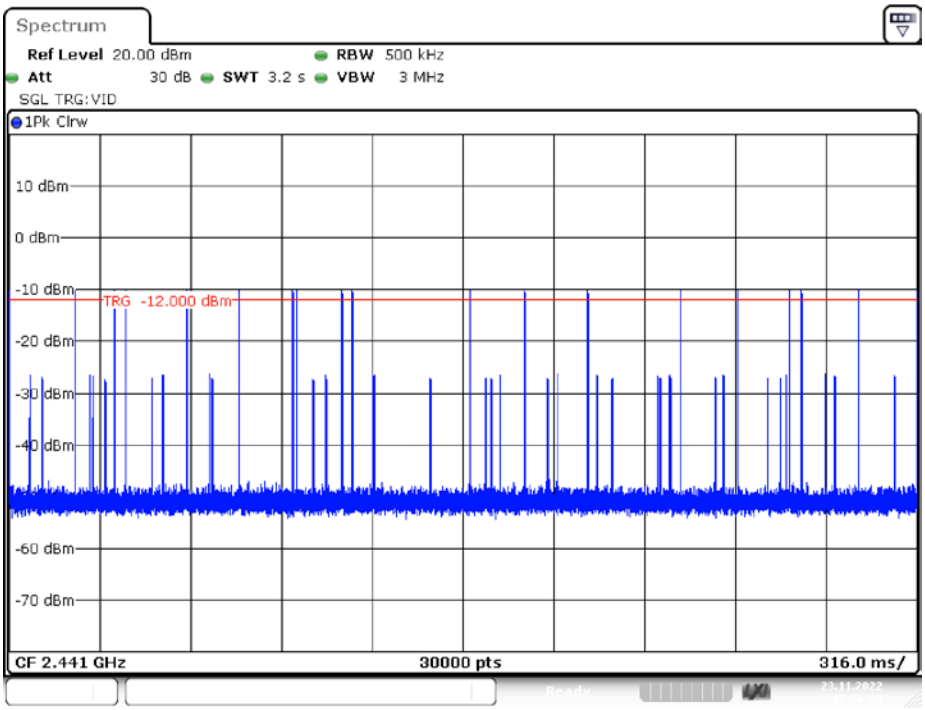


Date: 23.NOV.2022 15:57:12

3DH3_Ant1_Hop

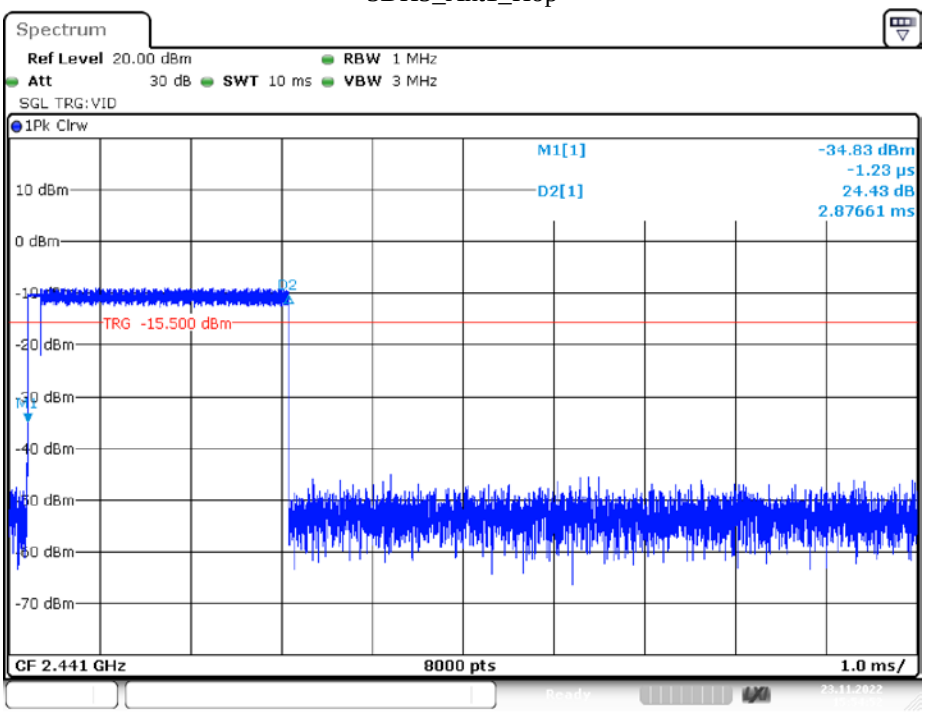


Date: 23.NOV.2022 15:55:55

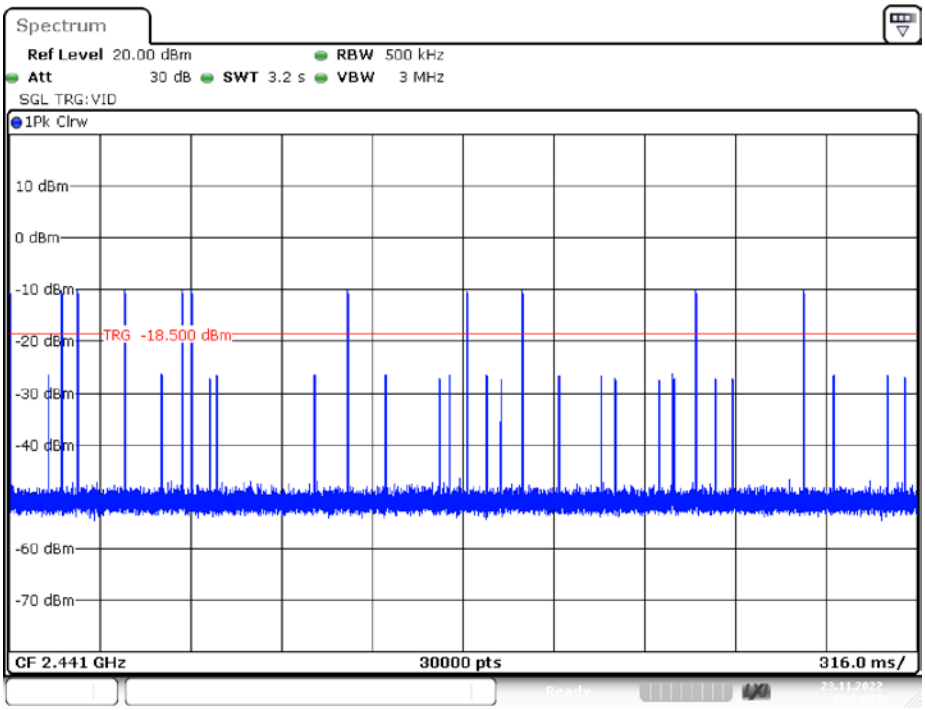


Date: 23.NOV.2022 15:56:00

3DH5_Ant1_Hop



Date: 23.NOV.2022 15:54:52



Date: 23.NOV.2022 15:54:57

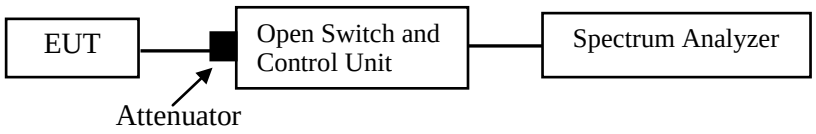
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

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 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:	23℃
Relative Humidity:	51 %
ATM Pressure:	101.1kPa

The testing was performed by Glenn. Jiang on 2022-09-27

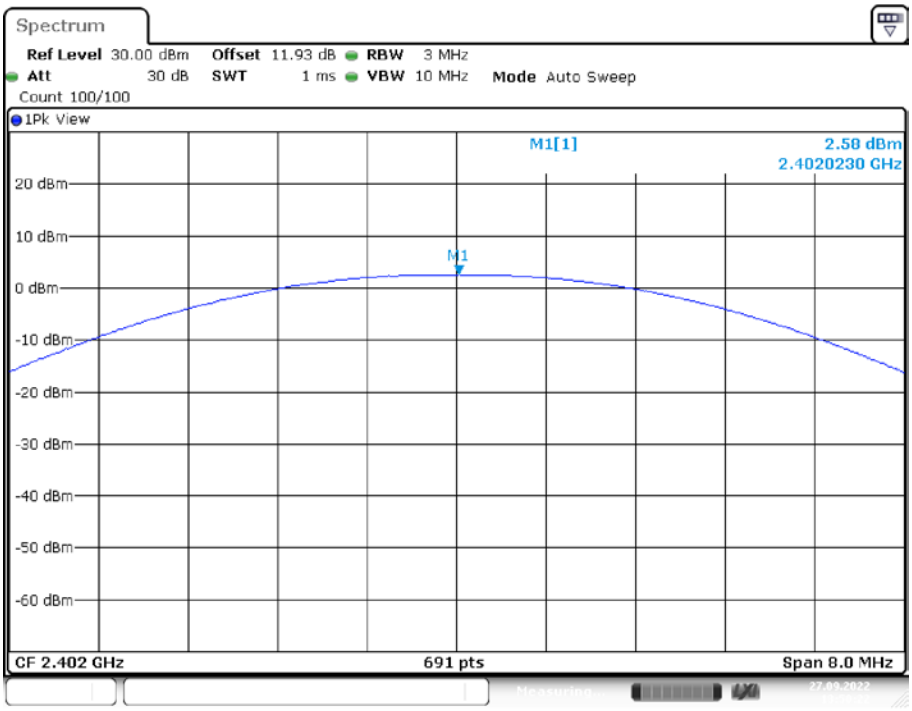
EUT operation mode: Transmitting

Test Result: Compliant.

Test Mode	Antenna	Channel	Conducted peak output power [dBm]	Limit[dBm]	Verdict
DH5	Ant1	2402	2.58	<=30	PASS
		2441	1.84	<=30	PASS
		2480	0.05	<=30	PASS
2DH5	Ant1	2402	3.98	<=30	PASS
		2441	3.21	<=30	PASS
		2480	1.39	<=30	PASS
3DH5	Ant1	2402	**4.27**	<=30	PASS
		2441	3.49	<=30	PASS
		2480	1.67	<=30	PASS

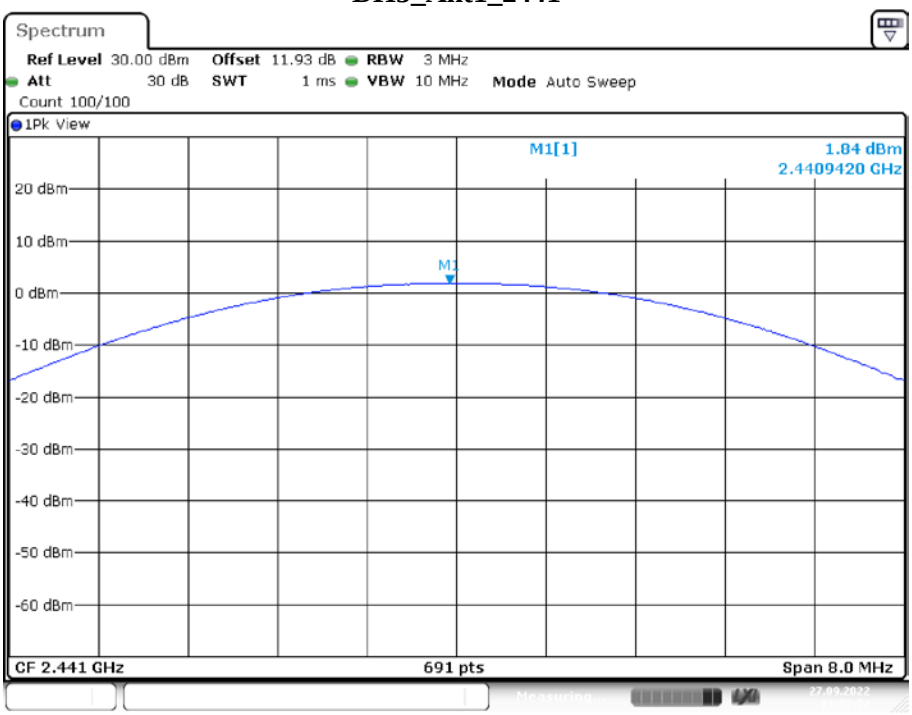
Please refer to the below plots:

DH5_Ant1_2402



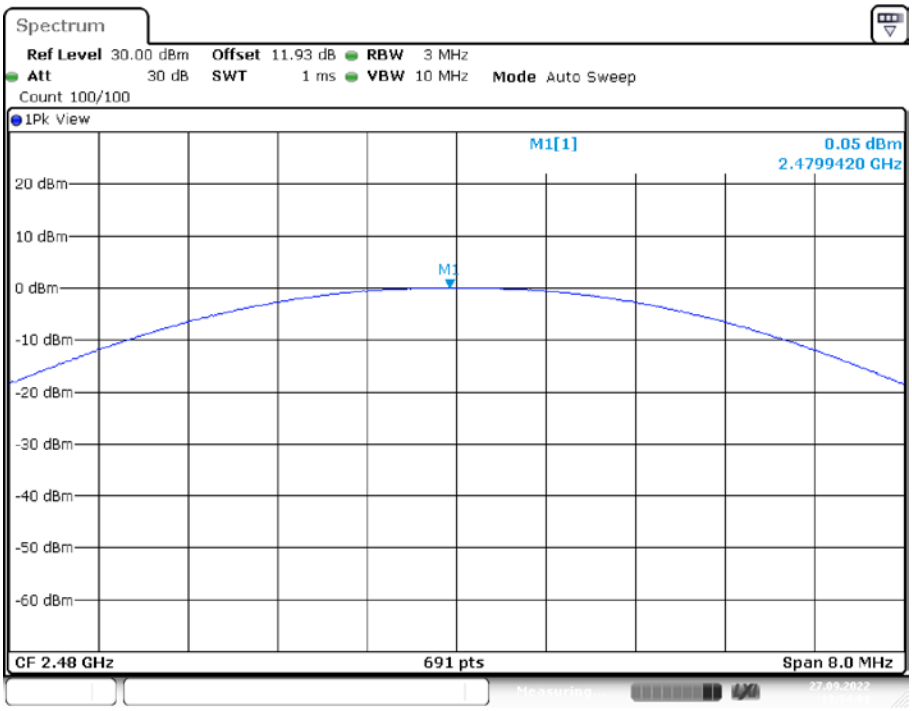
Date: 27.SEP.2022 13:50:22

DH5_Ant1_2441



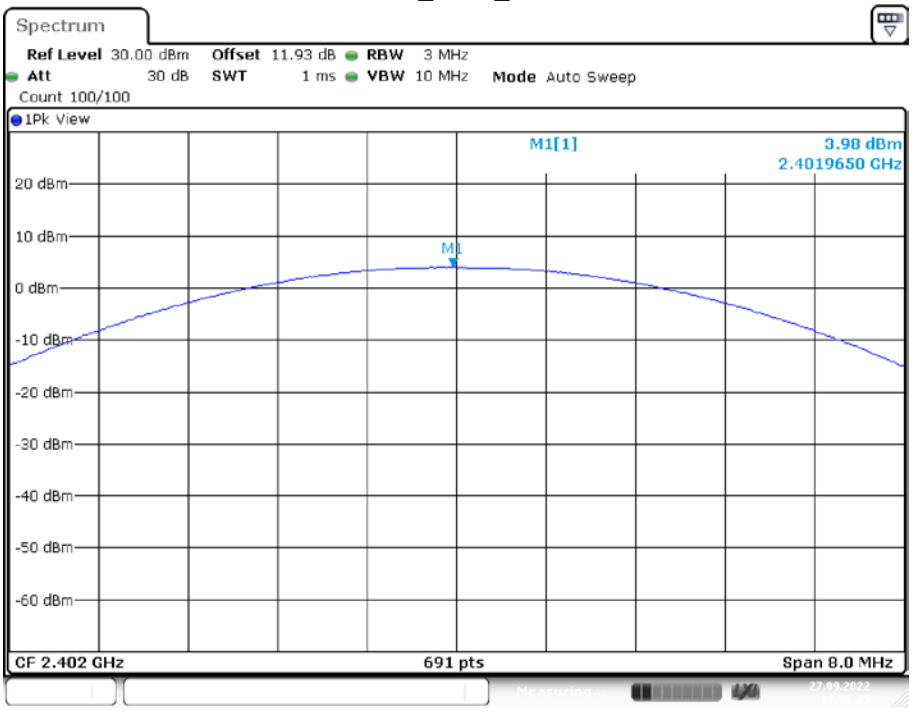
Date: 27.SEP.2022 13:52:52

DH5_Ant1_2480



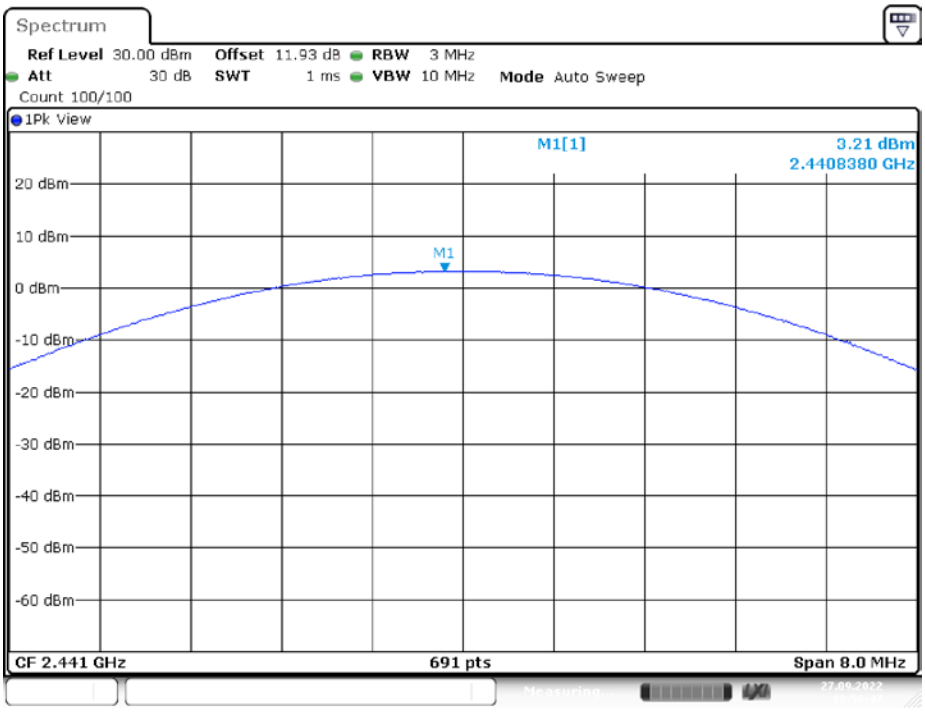
Date: 27.SEP.2022 13:54:01

2DH5_Ant1_2402



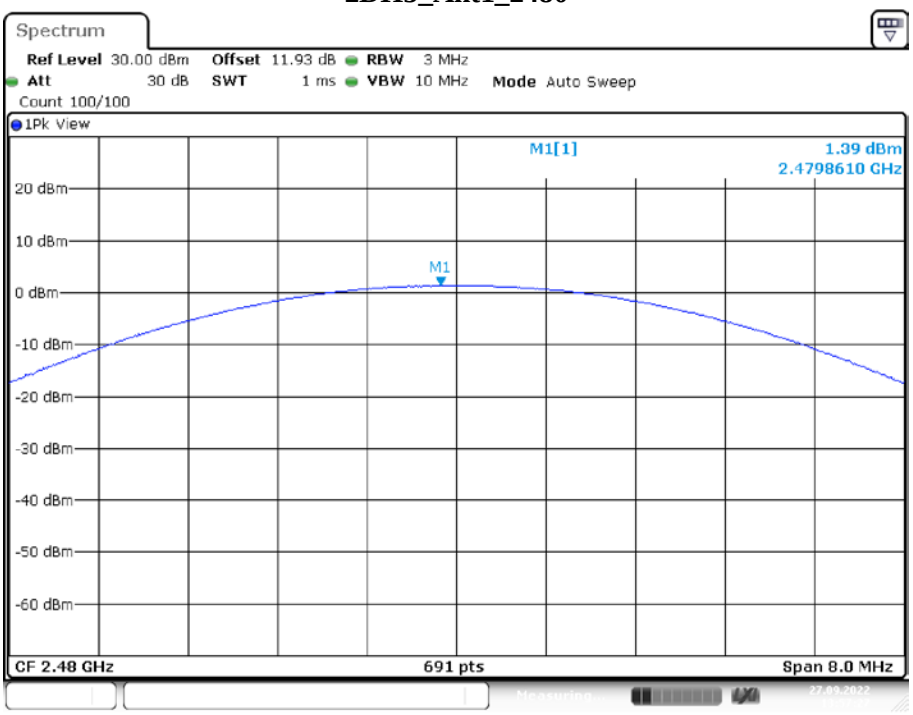
Date: 27.SEP.2022 13:55:25

2DH5_Ant1_2441



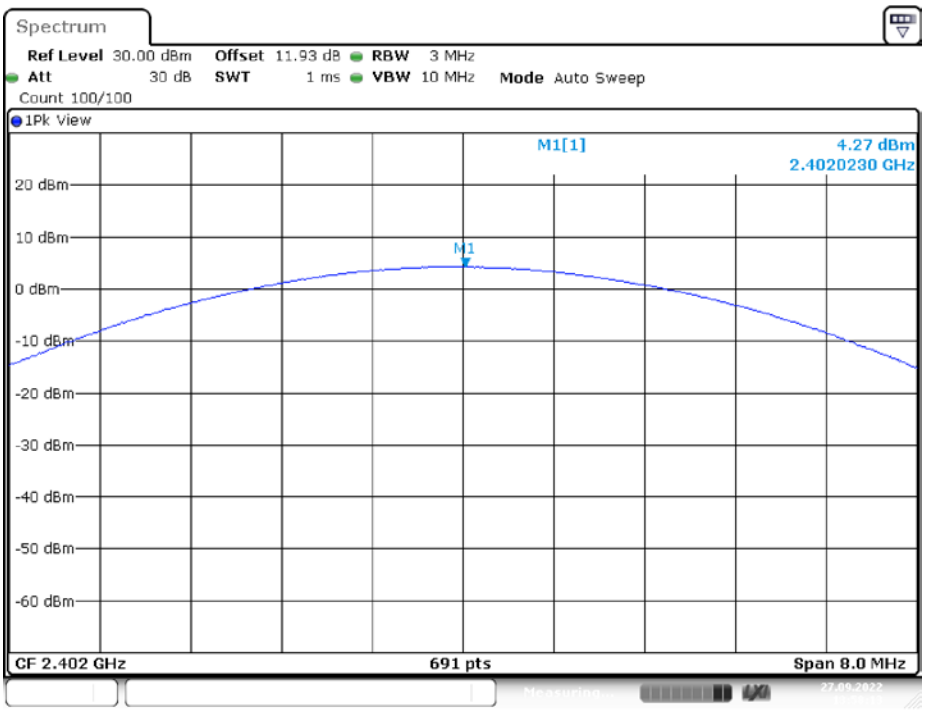
Date: 27.SEP.2022 13:56:47

2DH5_Ant1_2480



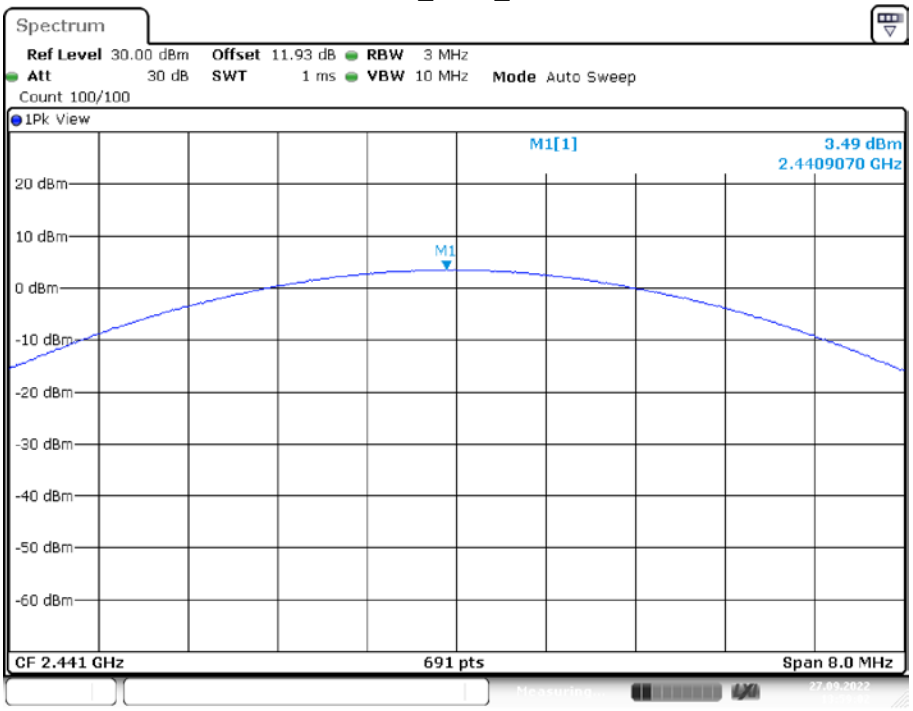
Date: 27.SEP.2022 13:57:27

3DH5_Ant1_2402



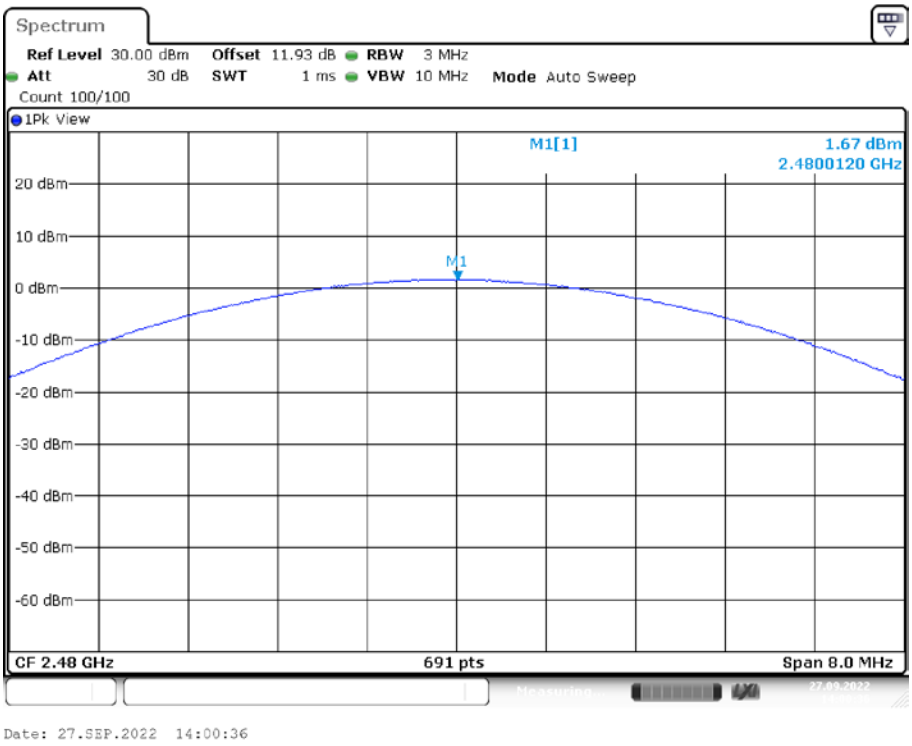
Date: 27.SEP.2022 13:58:13

3DH5_Ant1_2441



Date: 27.SEP.2022 13:59:02

3DH5_Ant1_2480



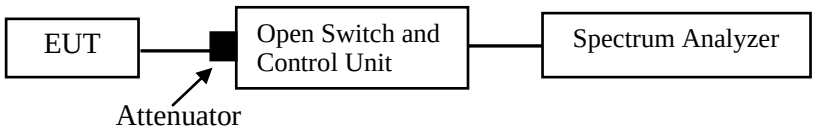
FCC §15.247(d) - BAND EDGES TESTING

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

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:	23℃
Relative Humidity:	51%
ATM Pressure:	101.1kPa

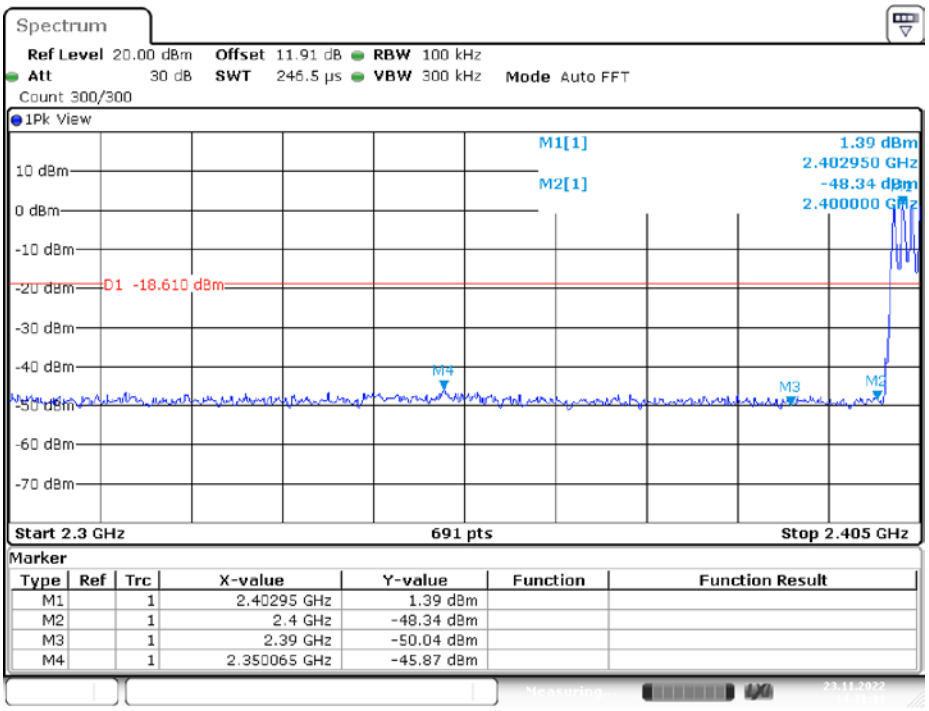
The testing was performed by Glenn. Jiang from 2022-09-27 to 2022-11-23

EUT operation mode: Transmitting

Test Result: Compliant

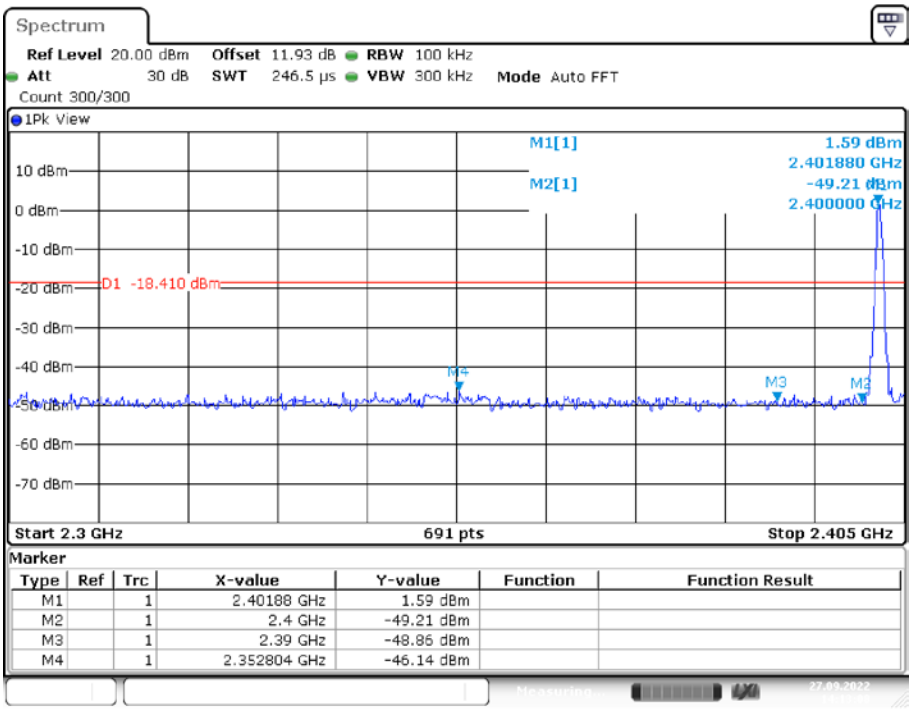
Please refer to the below plots:

DH5: Band Edge-Left Side
Hopping



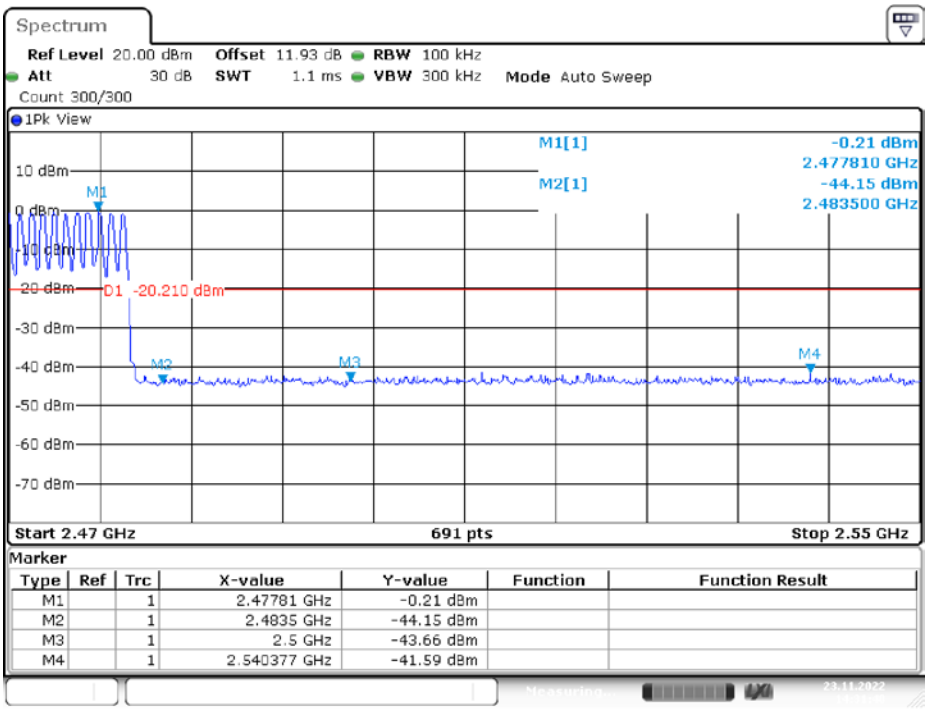
Date: 23.NOV.2022 14:31:32

Single



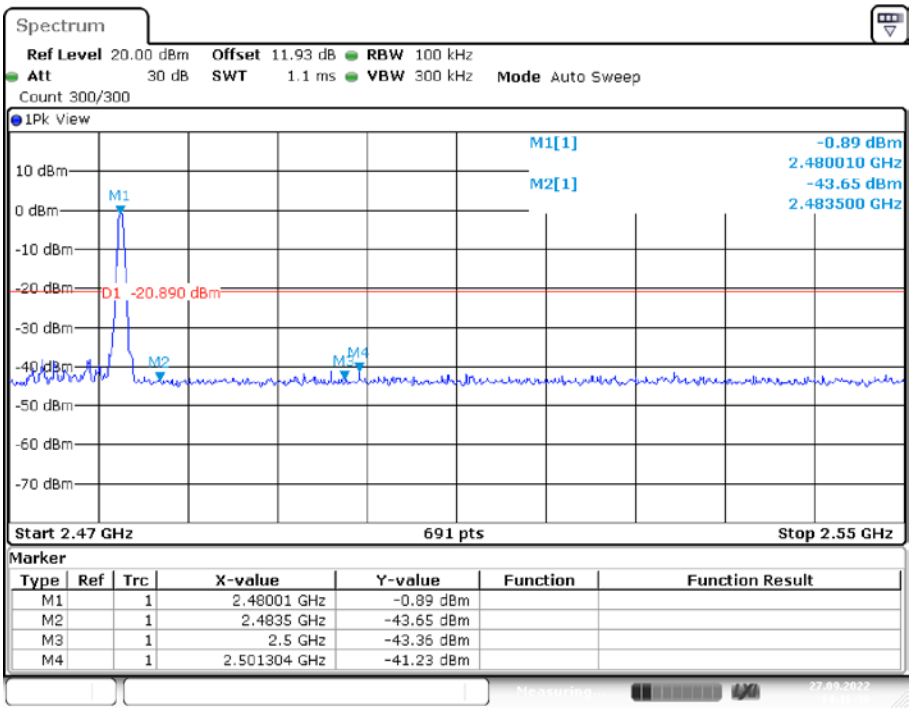
Date: 27.SEP.2022 14:13:08

DH5: Band Edge- Right Side
Hopping



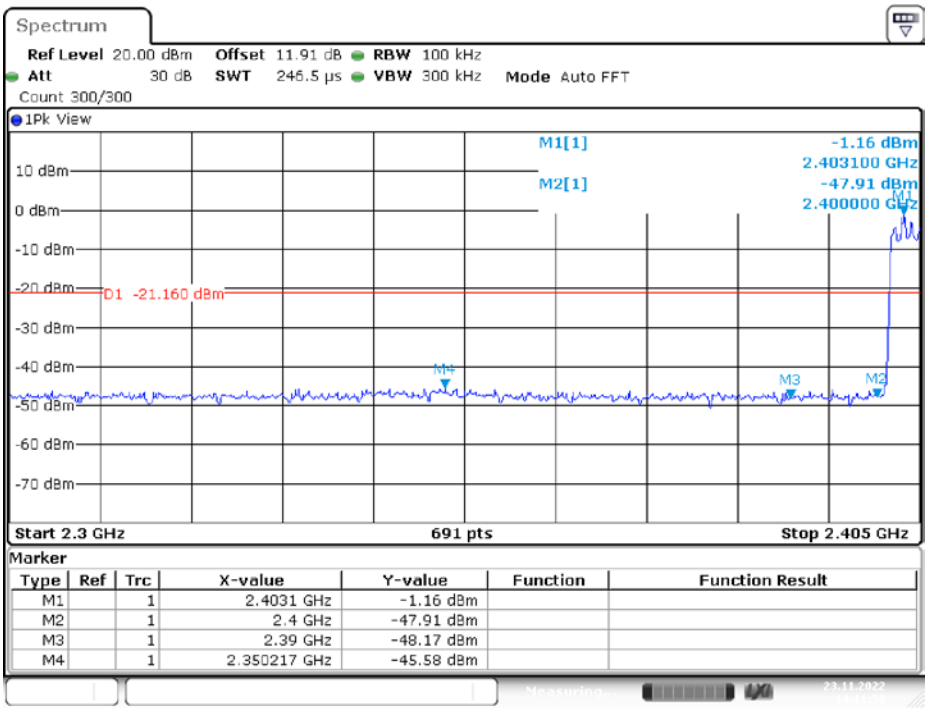
Date: 23.NOV.2022 14:31:48

Single



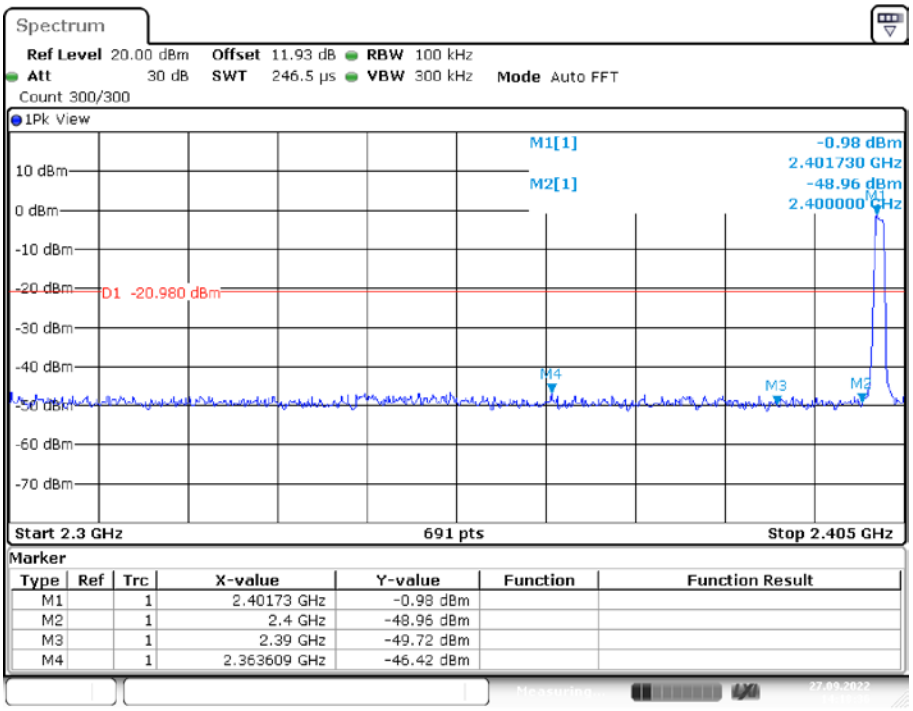
Date: 27.SEP.2022 14:16:38

2DH5: Band Edge-Left Side
Hopping



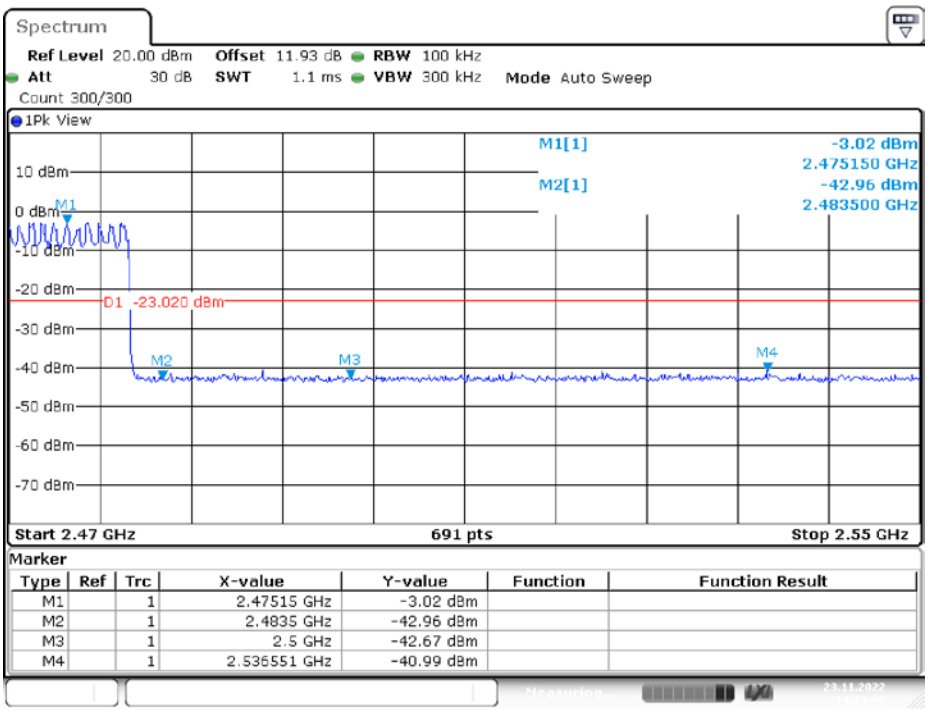
Date: 23.NOV.2022 14:11:50

Single



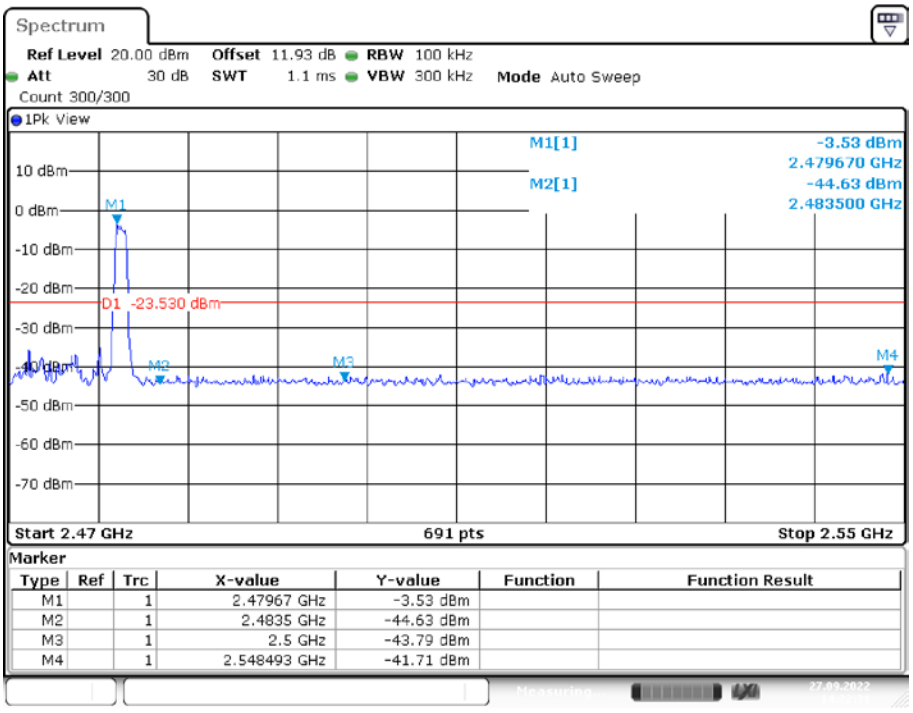
Date: 27.SEP.2022 14:18:36

2DH5: Band Edge- Right Side
Hopping



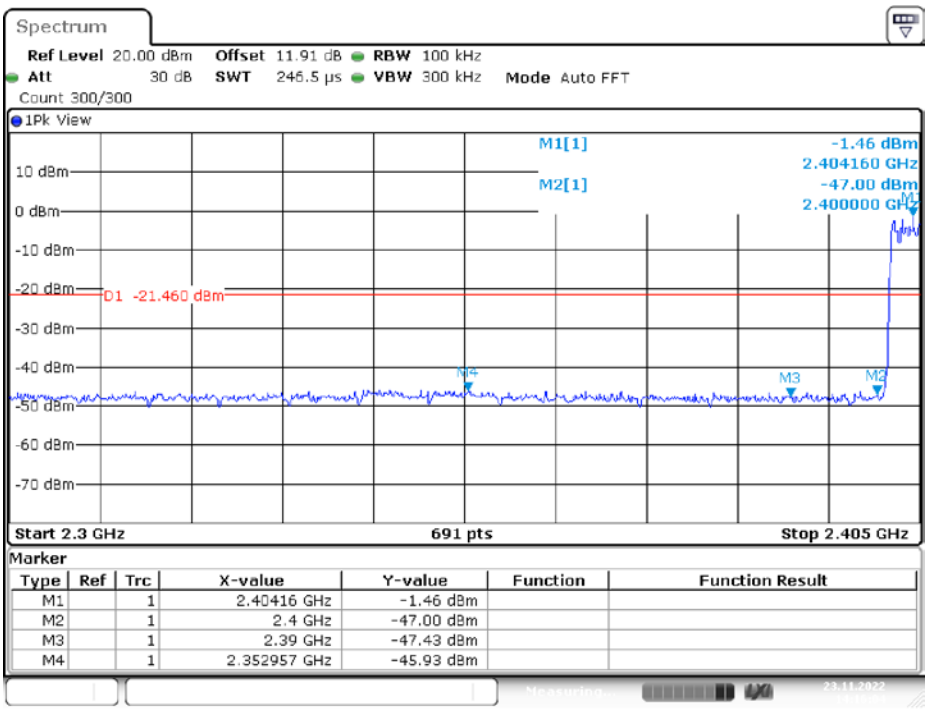
Date: 23.NOV.2022 14:13:00

Single



Date: 27.SEP.2022 14:22:31

3DH5: Band Edge-Left Side
Hopping

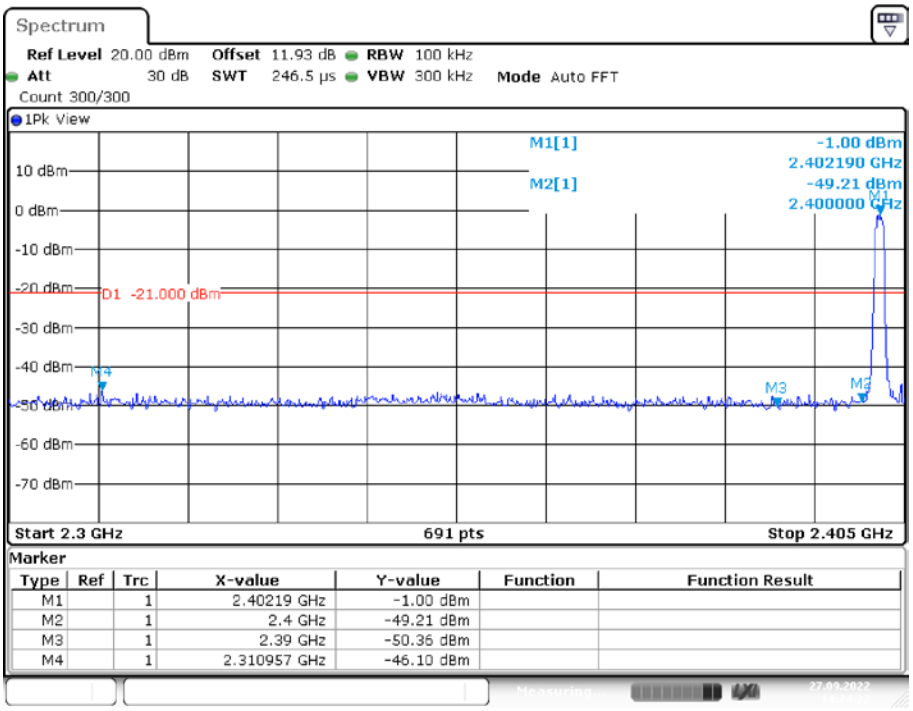


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40416 GHz	-1.46 dBm		
M2		1	2.4 GHz	-47.00 dBm		
M3		1	2.39 GHz	-47.43 dBm		
M4		1	2.352957 GHz	-45.93 dBm		

Date: 23.NOV.2022 14:16:04

Single

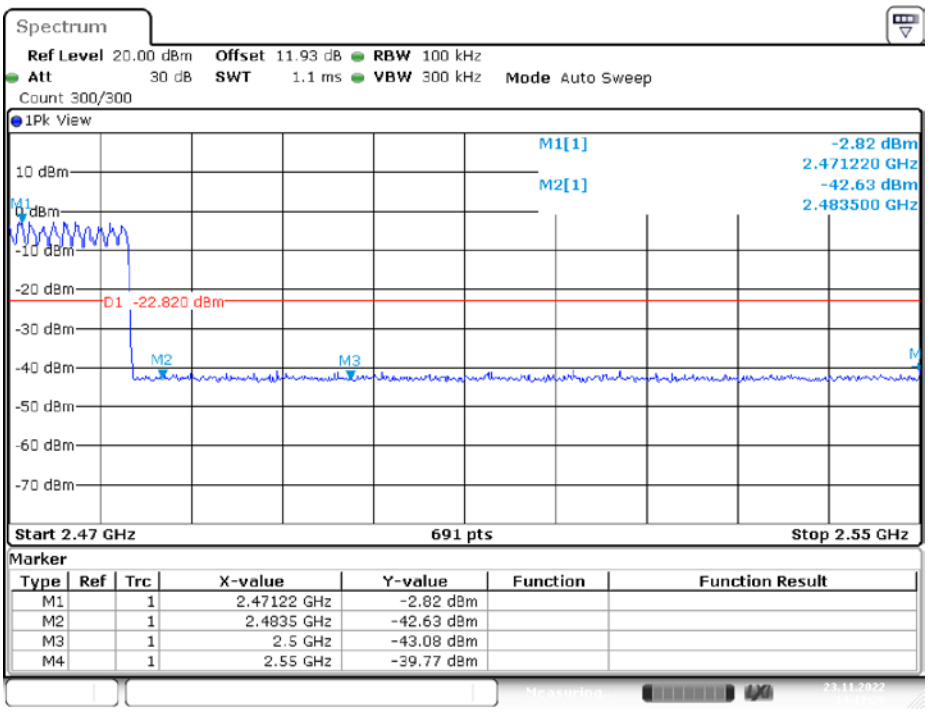


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40219 GHz	-1.00 dBm		
M2		1	2.4 GHz	-49.21 dBm		
M3		1	2.39 GHz	-50.36 dBm		
M4		1	2.310957 GHz	-46.10 dBm		

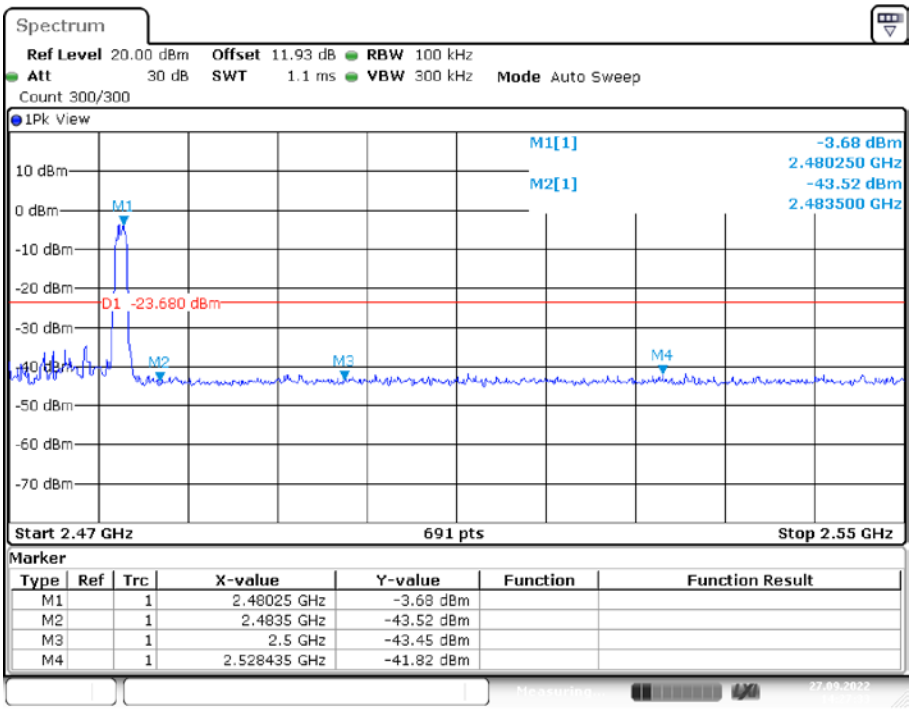
Date: 27.SEP.2022 14:24:22

3DH5: Band Edge- Right Side
Hopping



Date: 23.NOV.2022 14:17:27

Single



Date: 27.SEP.2022 14:27:33

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