FCC PART 15.247
TEST REPORT

For

Zeeva International Limited

Suite 1007B, 10th Floor, Exchange Tower, 33 Wang Chiu Road, Kowloon Bay, Hong Kong

FCC ID: 2ADM5-HP-2001

Report Type:	Product Type:
Original Report	BT SLEEP MASK SPEAKER

Report Number:	SZ3210915-48146E-RF-00
Report Date:	2021-10-22
Reviewed By:	Candy Li RF Engineer
Prepared By:	Shenzhen Accurate Technology Co., Ltd. 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China Tel: (0755) 26503290 Fax: (0755) 26503396 Http://www.atc-lab.com

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	BT SLEEP MASK SPEAKER
Tested Model	HP-2001
SKU Number	4910060
UPC Number	1922345050344
Frequency Range	Bluetooth: 2402~2480MHz
Maximum conducted Peak output power	Bluetooth: 8.43dBm
Modulation Technique	Bluetooth: GFSK, π/4-DQPSK, 8DPSK
Antenna Specification*	-0.58 dBi (provided by the applicant)
Voltage Range	DC 3.7V battery or DC 5.0V from USB port
Date of Test	2021-09-19 to 2021-10-22
Sample serial number	RF Conducted Test: SZ3210915-48146E-RF-S1 RF Radiated Test : SZ3210915-48146E-RF-S2
Received date	2021-09-15
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
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
Temperature		1℃
Humidity		6%
Supply voltages		0.4%

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

Test Facility

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

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode .

EUT Exercise Software

“bt__tool__v1.1.0” software was used to test, which provided by manufacturer.

The device was tested with the Power level is default.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

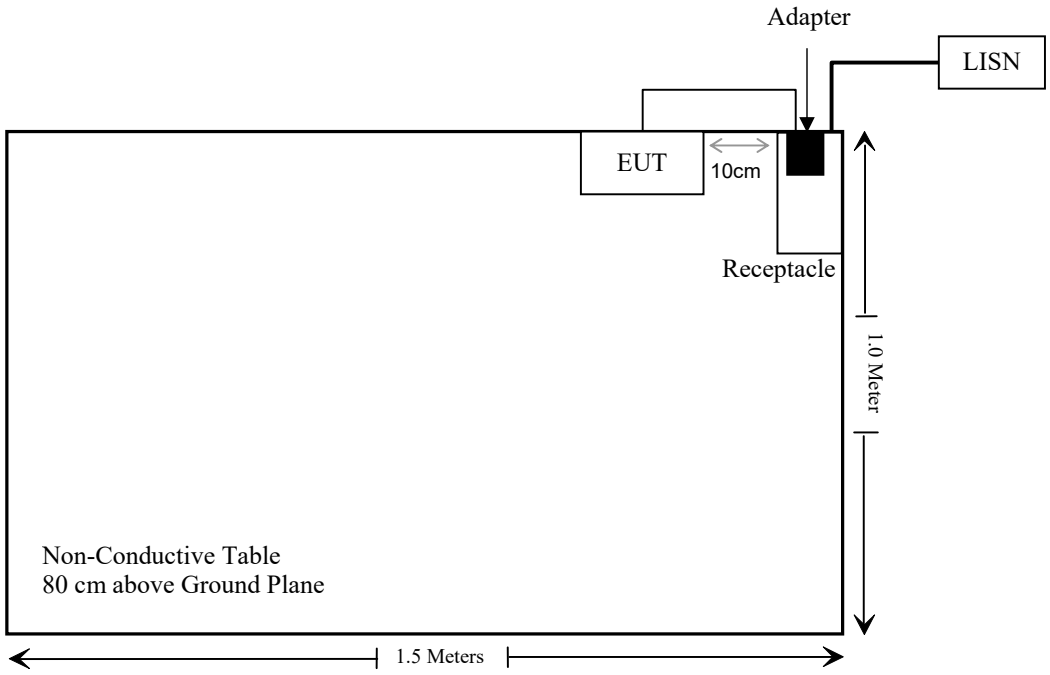
Manufacturer	Description	Model	Serial Number
Infinix	Adapter	CQ-18LX	CQ-18LX

External I/O Cable

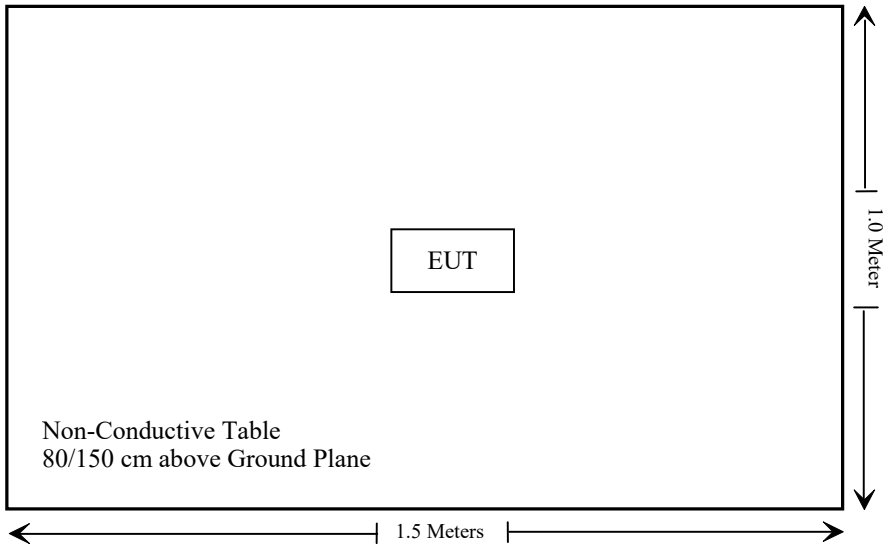
Cable Description	Length (m)	From Port	To
Un-Shielding Un-Detachable AC Cable	1.2	LISN	Receptacle
Un-Shielding Detachable USB Cable	0.5	EUT	Adapter

Block Diagram of Test Setup

For conducted emission:



For radiated emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (1)& §2.1093	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	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	Test Receiver	ESPI3	100396	2020/12/24	2021/12/23
R & S	L.I.S.N.	ENV216	101314	2020/12/25	2021/12/24
Anritsu Corp	50ΩCoaxial Switch	MP59B	6200506474	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-2m	No.2	2020/12/25	2021/12/24
Conducted Emission Test Software: ES-K1 V1.71					
Radiated Emissions Test					
Rohde& Schwarz	Test Receiver	ESR	101817	2020/12/24	2021/12/23
Rohde&Schwarz	Spectrum Analyzer	FSV40	101495	2020/12/24	2021/12/23
SONOMA INSTRUMENT	Amplifier	310 N	186131	2020/12/25	2021/12/24
A.H. Systems, inc.	Preamplifier	PAM-0118P	531	2021/07/08	2022/07/07
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2020/12/25	2021/12/24
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2020/01/05	2023/01/04
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	Horn Antenna	BBHA9170	9170-359	2020/01/05	2023/01/04
OREGON SCIENTIFIC	Temperature & Humidity Meter	JB913R	GZ-WS004	2021/01/02	2022/01/01
Unknown	RF Coaxial Cable	N-5m	No.3	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-5m	No.4	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.5	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.6	2020/12/25	2021/12/24
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2020/12/25	2021/12/24
Radiated Emission Test Software: EZ__EMC V 1.1.4.2					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2020/12/24	2021/12/23
Rohde & Schwarz	Open Switch and Control Unit	OSP120 + OSP-B157	101244 + 100866	2020/12/24	2021/12/23

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), 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 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

For worst case:

Frequency (MHz)	Maximum Tune-up power		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
	(dBm)	(mW)				
2402-2480	8.5	7.1	5	2.2	3.0	**Yes**

Result: No Standalone SAR test is required

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

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

Antenna Connector Construction

The EUT has one internal antenna arrangement which was permanently attached, and the maximum antenna gain is -0.58dBi, fulfill the requirement of this section. Please refer to the EUT photos.

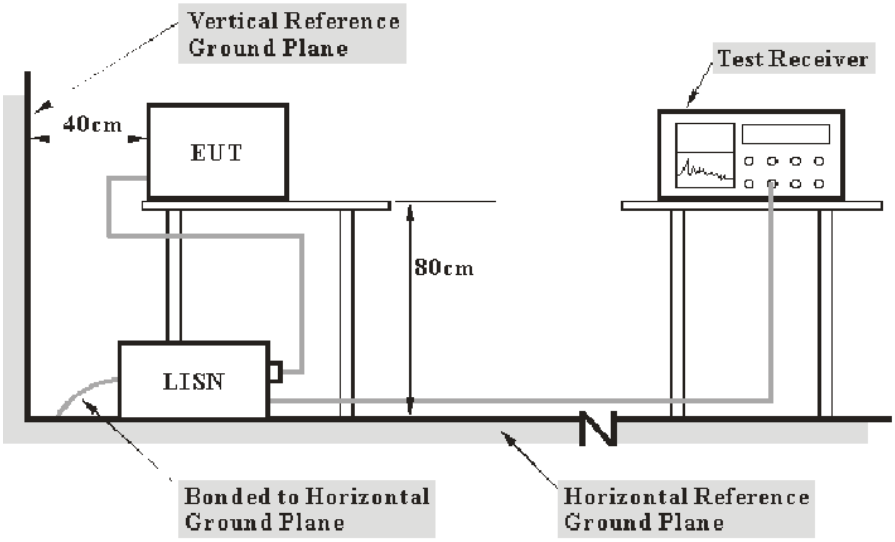
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Transd Factor & Margin Calculation

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

Transd Factor = LISN VDF + Cable Loss

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

Margin = Limit – level
Level= reading level+ Transd Factor

Test Data

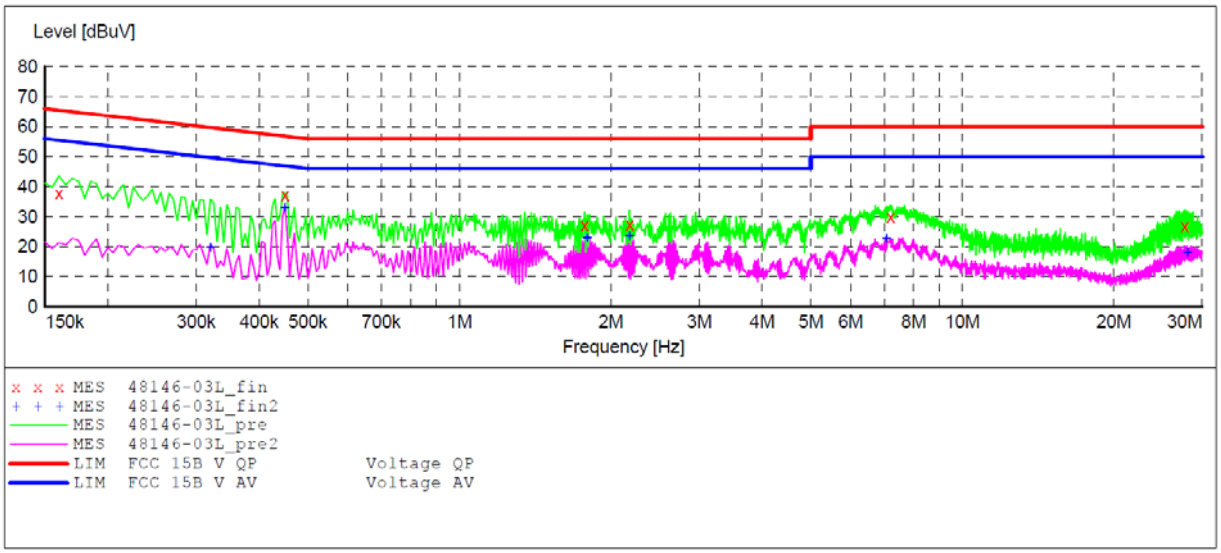
Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Black.Ding on 2021-09-30.

EUT operation mode: Charging

AC 120V/60 Hz, Line



MEASUREMENT RESULT: "48146-03L_fin"

2021-9-30 09:55

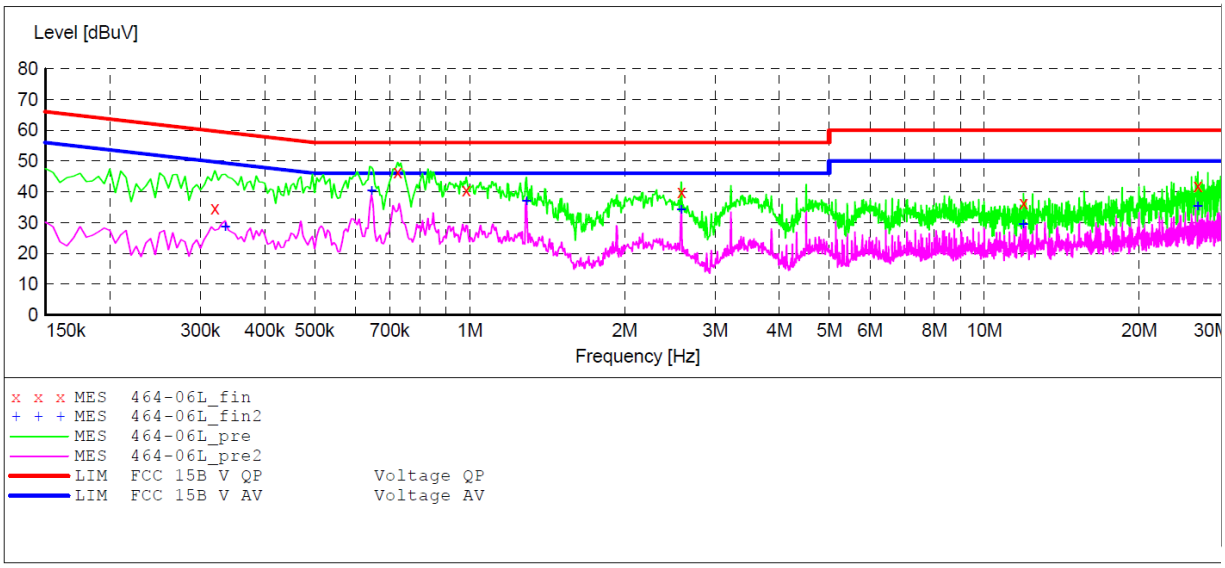
Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.160000	37.70	10.8	66	28.3	QP	L1	GND
0.450000	37.30	11.0	57	19.7	QP	L1	GND
1.775000	27.10	11.2	56	28.9	QP	L1	GND
2.180000	27.30	11.3	56	28.7	QP	L1	GND
7.200000	29.80	11.5	60	30.2	QP	L1	GND
27.725000	26.80	11.8	60	33.2	QP	L1	GND

MEASUREMENT RESULT: "48146-03L_fin2"

2021-9-30 09:55

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.320000	19.70	10.9	50	30.3	AV	L1	GND
0.450000	33.10	11.0	47	13.9	AV	L1	GND
1.795000	22.90	11.2	46	23.1	AV	L1	GND
2.180000	23.60	11.3	46	22.4	AV	L1	GND
7.070000	22.80	11.5	50	27.2	AV	L1	GND
28.025000	17.80	11.8	50	32.2	AV	L1	GND

AC 120V/60 Hz, Neutral



MEASUREMENT RESULT: "464-06L_fin"

2021-9-26 09:47

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.320000	34.70	10.9	60	25.3	QP	L1	GND
0.725000	46.50	11.1	56	9.5	QP	L1	GND
0.985000	40.50	11.1	56	15.5	QP	L1	GND
2.580000	40.00	11.3	56	16.0	QP	L1	GND
11.925000	36.40	11.6	60	23.6	QP	L1	GND
26.025000	42.00	11.8	60	18.0	QP	L1	GND

MEASUREMENT RESULT: "464-06L_fin2"

2021-9-26 09:47

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.335000	28.50	10.9	49	20.5	AV	L1	GND
0.645000	40.20	11.0	46	5.8	AV	L1	GND
1.290000	36.90	11.2	46	9.1	AV	L1	GND
2.580000	34.20	11.3	46	11.8	AV	L1	GND
11.925000	29.30	11.6	50	20.7	AV	L1	GND
26.025000	35.20	11.8	50	14.8	AV	L1	GND

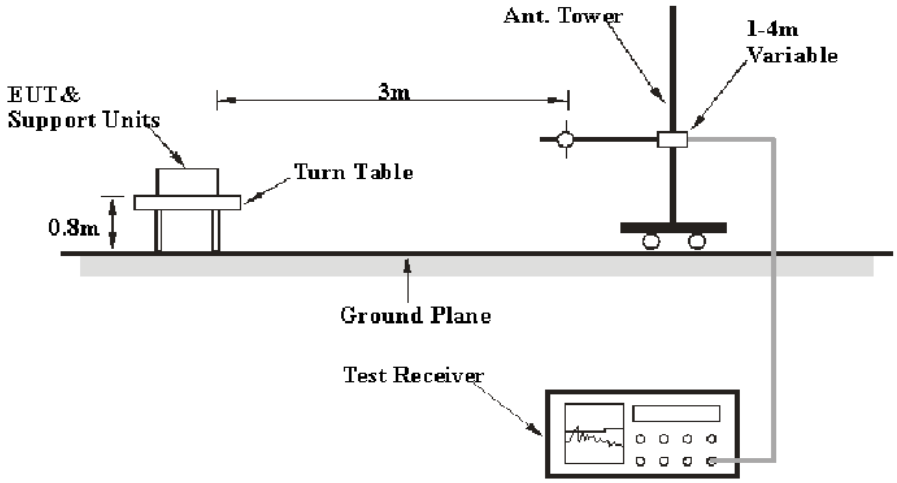
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

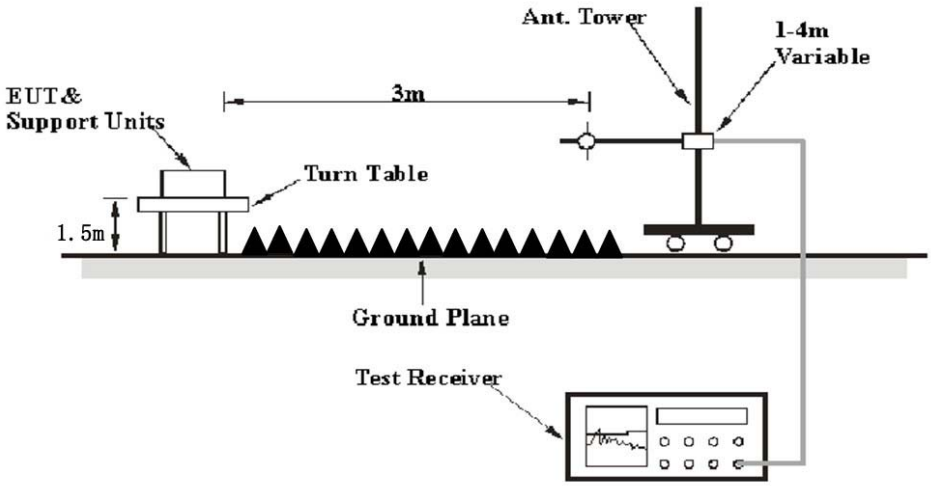
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

The EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Average

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

Factor & Margin Calculation

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

Factor = Meter Reading + Antenna Factor + Cable Loss - Amplifier Gain

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

Margin = Result-Limit
Result = Reading + Factor

Test Data

Environmental Conditions

Temperature:	23~25 ℃
Relative Humidity:	48~50 %
ATM Pressure:	101.0~103.0 kPa

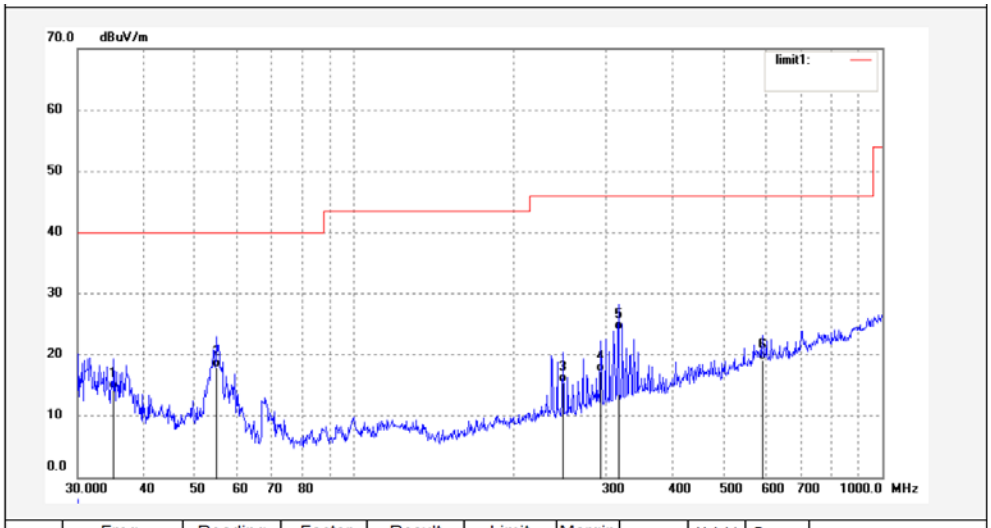
The testing was performed by Ting Lv on 2021-09-24 and 2021-10-08.

EUT operation mode: Transmitting

(Scan with GFSK, π/4-DQPSK, 8DPSK mode, the worst case is 8DPSK Mode)

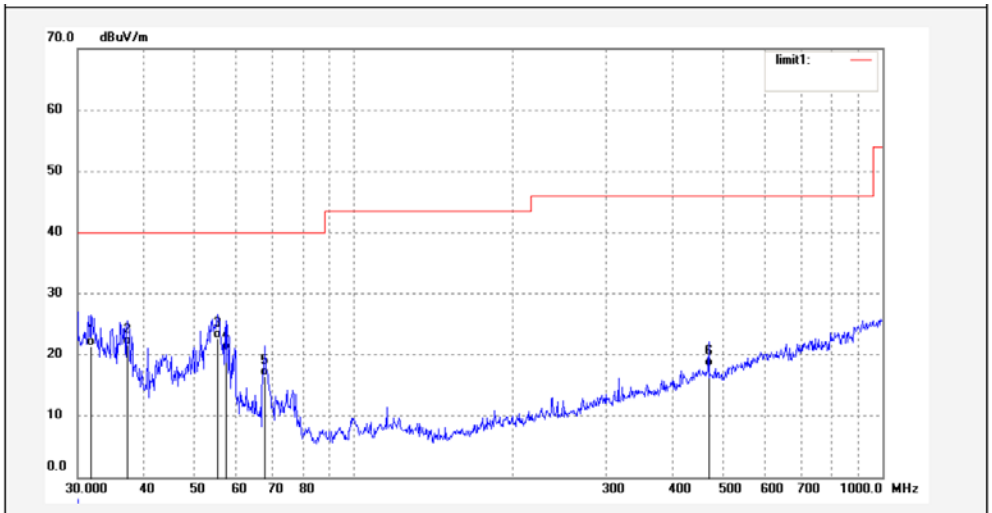
30MHz-1GHz: *(worst case, 8DPSK Mode, Middle channel)*

Horizontal:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	35.1278	29.48	-15.09	14.39	40.00	-25.61	QP			
2	55.0274	35.64	-17.69	17.95	40.00	-22.05	QP			
3	248.5519	31.88	-16.43	15.45	46.00	-30.55	QP			
4	293.0842	32.02	-14.76	17.26	46.00	-28.74	QP			
5	316.5890	38.21	-14.19	24.02	46.00	-21.98	QP			
6	593.0497	27.11	-7.94	19.17	46.00	-26.83	QP			

Vertical



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	31.8427	35.57	-14.10	21.47	40.00	-18.53	QP			
2	37.2855	37.16	-15.58	21.58	40.00	-18.42	QP			
3	55.2207	40.46	-17.73	22.73	40.00	-17.27	QP			
4	57.1914	38.84	-18.12	20.72	40.00	-19.28	QP			
5	67.9129	37.23	-20.74	16.49	40.00	-23.51	QP			
6	468.8762	28.88	-10.72	18.16	46.00	-27.84	QP			

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

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/AVG		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2310	57.38	PK	161	2.0	H	-6.84	50.54	74	-23.46
2310	59.17	PK	342	1.1	V	-6.84	52.33	74	-21.67
2390	57.11	PK	86	1.2	H	-6.44	50.67	74	-23.33
2390	60.31	PK	287	1.8	V	-6.44	53.87	74	-20.13
4804	49.7	PK	1	1.4	H	2.81	52.51	74	-21.49
4804	51.26	PK	138	1.5	V	2.81	54.07	74	-19.93
4804	44.18	AVG	138	1.5	V	2.81	46.99	54	-7.01
Middle Channel (2441 MHz)									
4882	48.86	PK	309	1.4	H	3.04	51.90	74	-22.10
4882	49.51	PK	16	1.5	V	3.04	52.55	74	-21.45
High Channel (2480 MHz)									
2483.5	57.42	PK	91	1.2	H	-5.96	51.46	74	-22.54
2483.5	57.13	PK	225	1.2	V	-5.96	51.17	74	-22.83
2500	57.36	PK	151	1.0	H	-5.88	51.48	74	-22.52
2500	57.86	PK	67	1.4	V	-5.88	51.98	74	-22.02
4960	48.62	PK	59	1.7	H	3.29	51.91	74	-22.09
4960	49.41	PK	44	1.3	V	3.29	52.70	74	-21.30

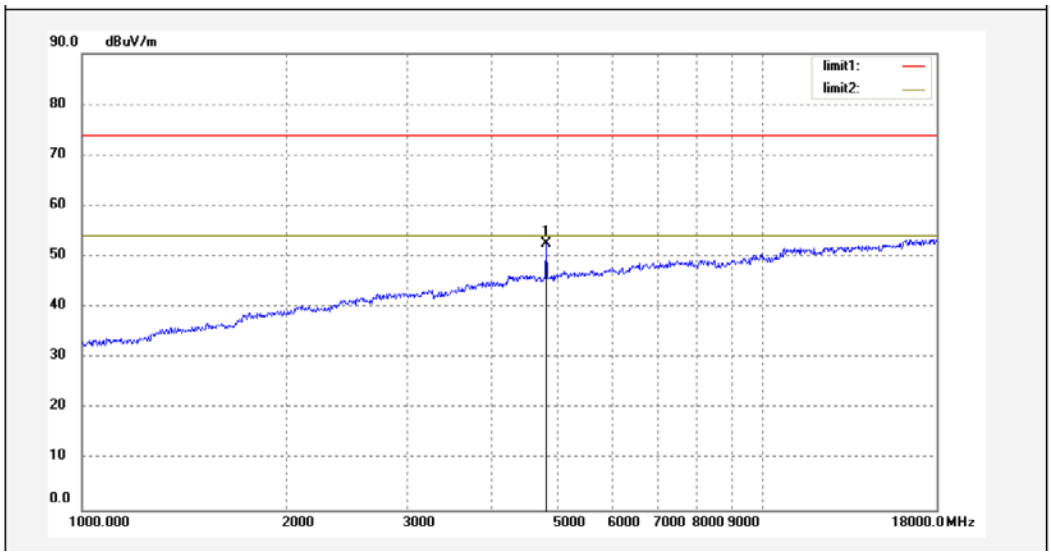
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Corrected. Amplitude -Limit
The other spurious emission which is in the noise floor level was not recorded.
The test result of peak was less than the limit of average, so just peak value were recorded.

1-18GHz

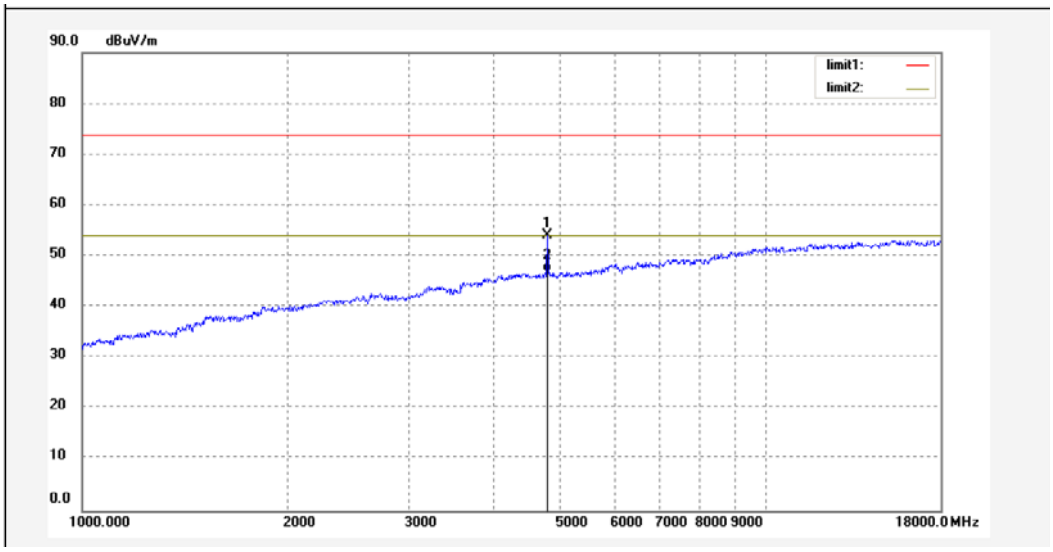
Pre-scan for Peak

Low Channel

Horizontal:



Vertical:

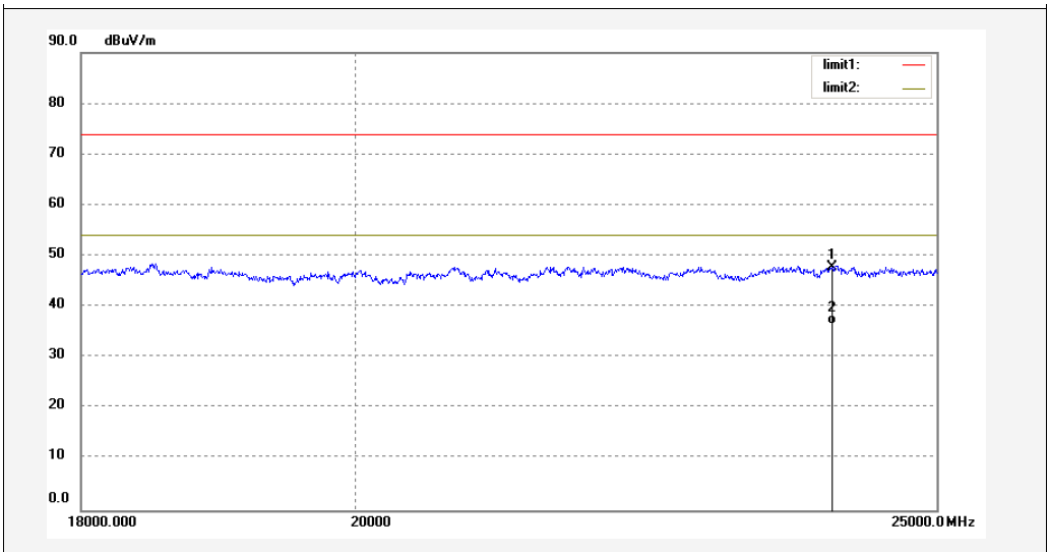


18-25GHz

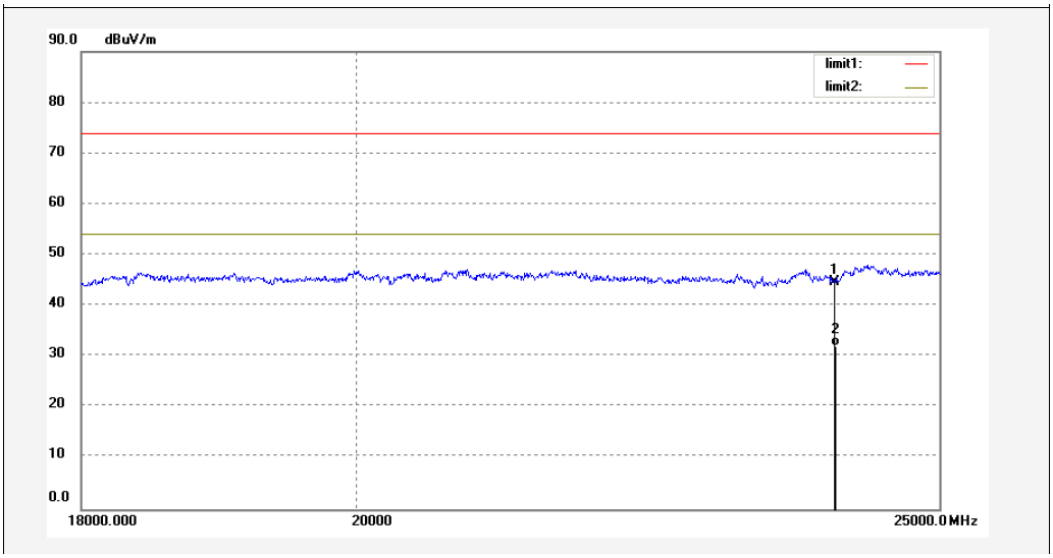
Pre-scan for Peak

Low Channel

Horizontal:



Vertical:



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

Applicable Standard

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

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lv on 2021-09-19.

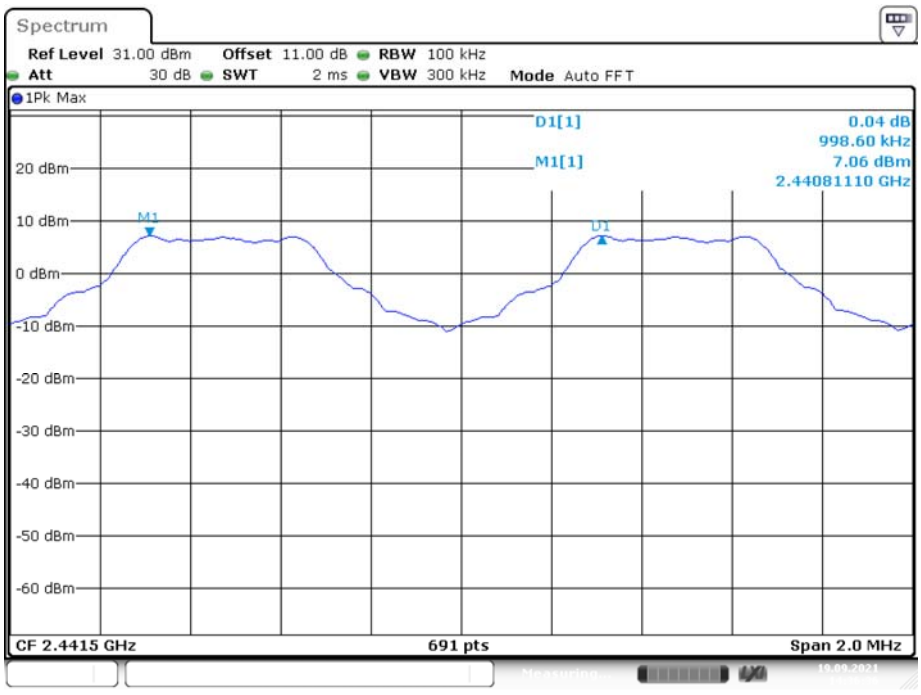
EUT operation mode: Transmitting

Test Result: Compliant.

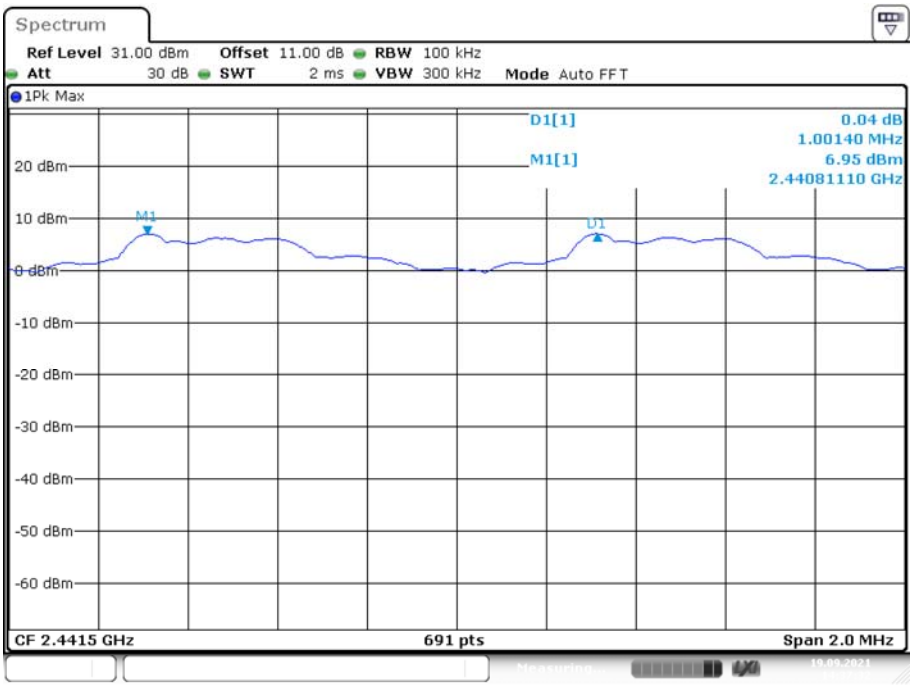
Channel	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit
BDR(GFSK)				
Middle	0.999	0.938	0.625	> two-thirds of the 20 dB bandwidth
EDR(π/4-DQPSK)				
Middle	1.001	1.245	0.830	> two-thirds of the 20 dB bandwidth
EDR(8DPSK)				
Middle	1.001	1.219	0.813	> two-thirds of the 20 dB bandwidth

Please refer to the below plots:

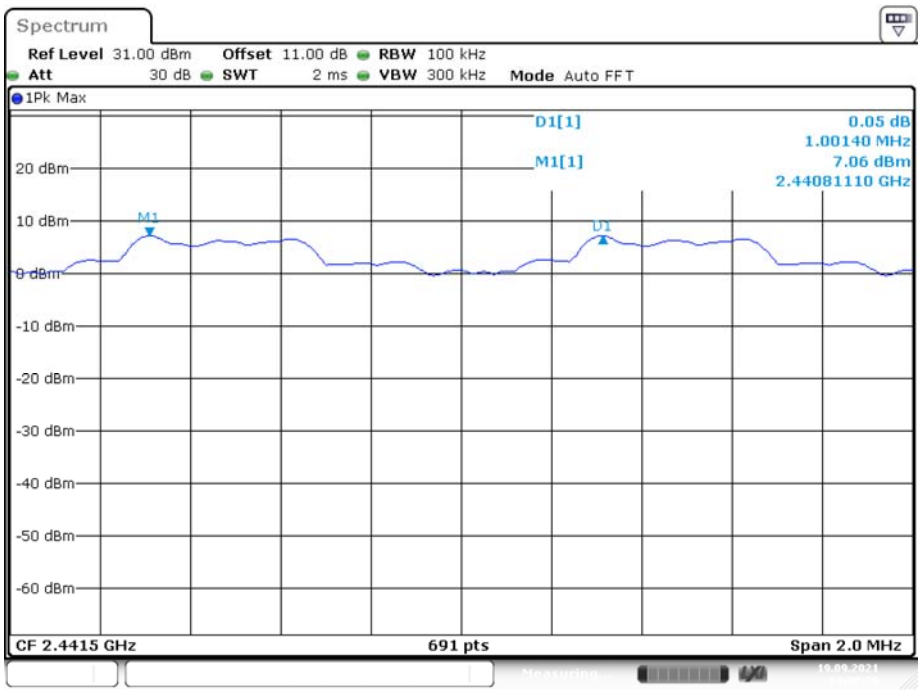
DH1_Hop



2DH1_Hop



3DH1_Hop


Spectrum
Ref Level 31.00 dBm Offset 11.00 dB RBW 100 kHz
Att 30 dB SWT 2 ms VBW 300 kHz Mode Auto FFT
1Pk Max
D1[1] 0.05 dB
1.00140 MHz
M1[1] 7.06 dBm
2.44081110 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
M1
D1
CF 2.4415 GHz
691 pts
Span 2.0 MHz
Date: 19.SEP.2021 14:38:39

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

Applicable Standard

Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Procedure

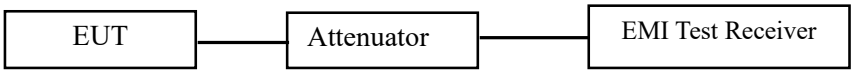
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

• The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.

• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data

Environmental Conditions

Temperature:	25.3 ℃
Relative Humidity:	47 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lv on 2021-09-19 and 2021-10-22.

EUT operation mode: Transmitting

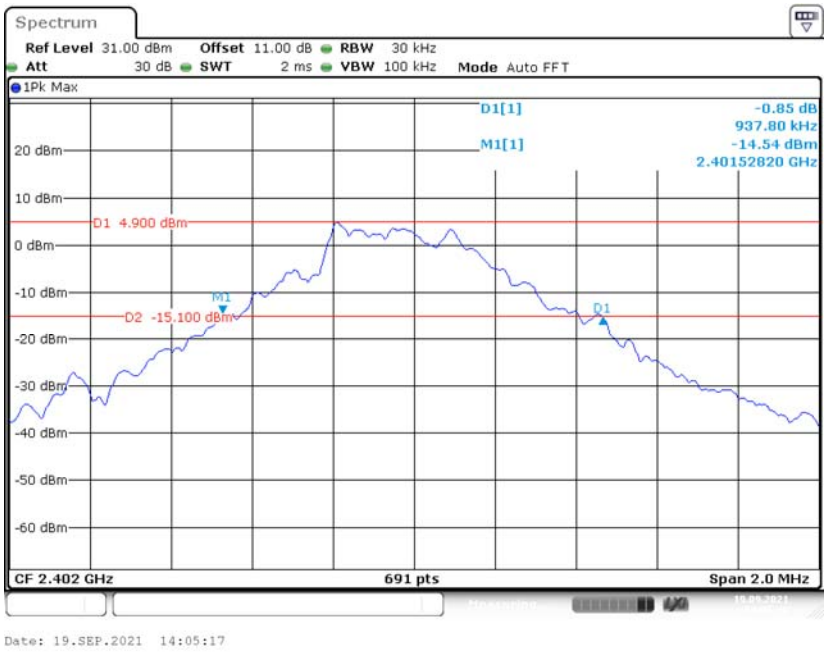
Test Result: Compliant.

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.938
	Middle	2441	0.932
	High	2480	0.932
EDR (π/4-DQPSK)	Low	2402	1.245
	Middle	2441	1.242
	High	2480	1.242
EDR (8DPSK)	Low	2402	1.219
	Middle	2441	1.201
	High	2480	1.216

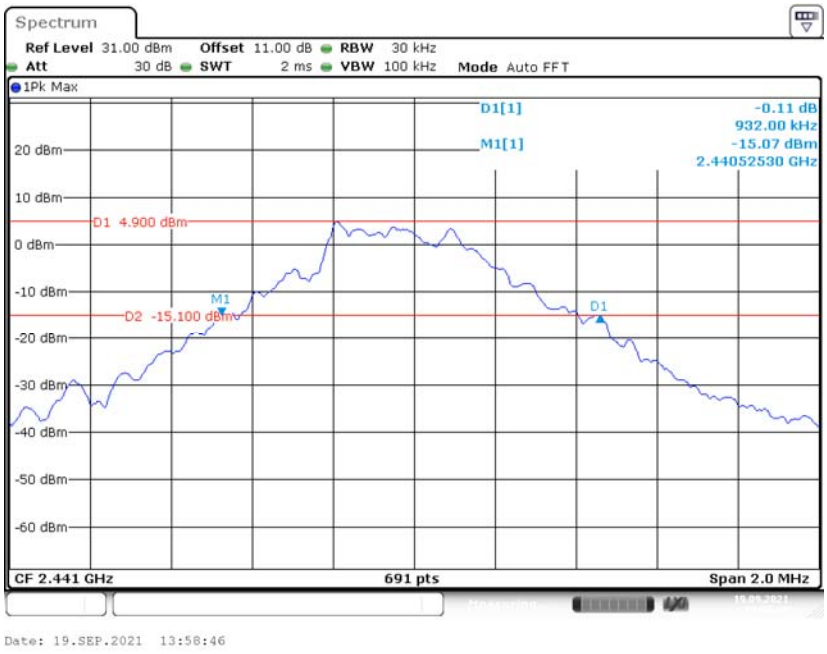
Please refer to the below plots:

20 dB EMISSION BANDWIDTH

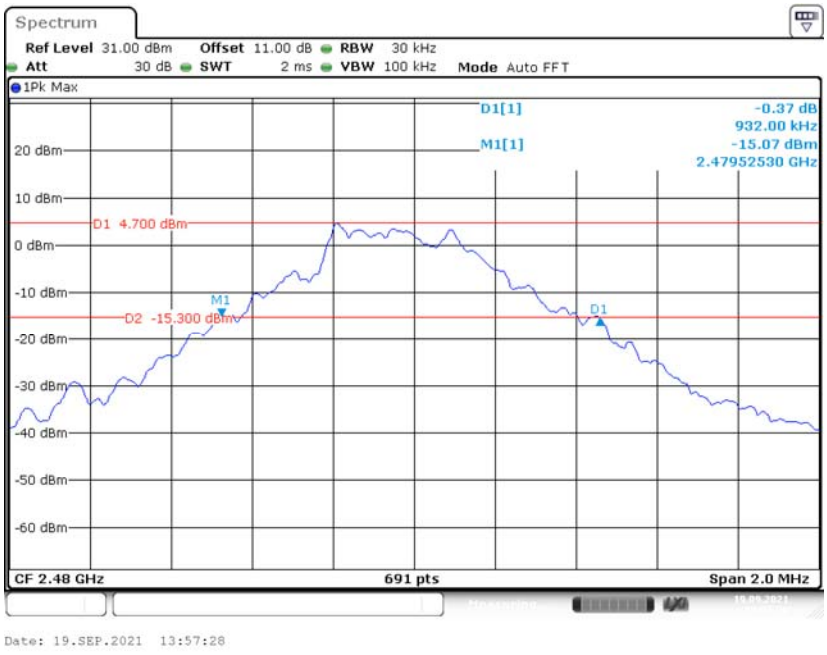
DH1_2402MHz



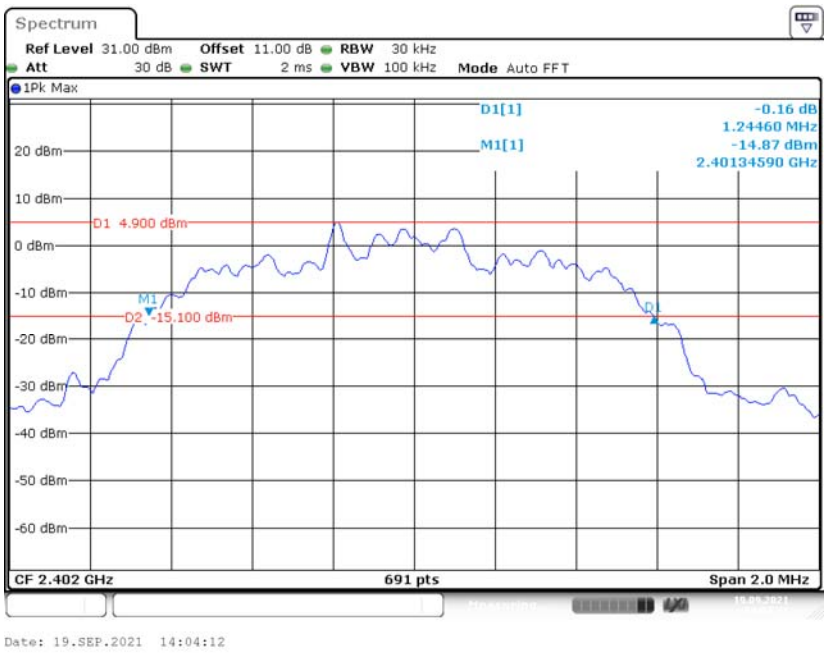
DH1_2441MHz



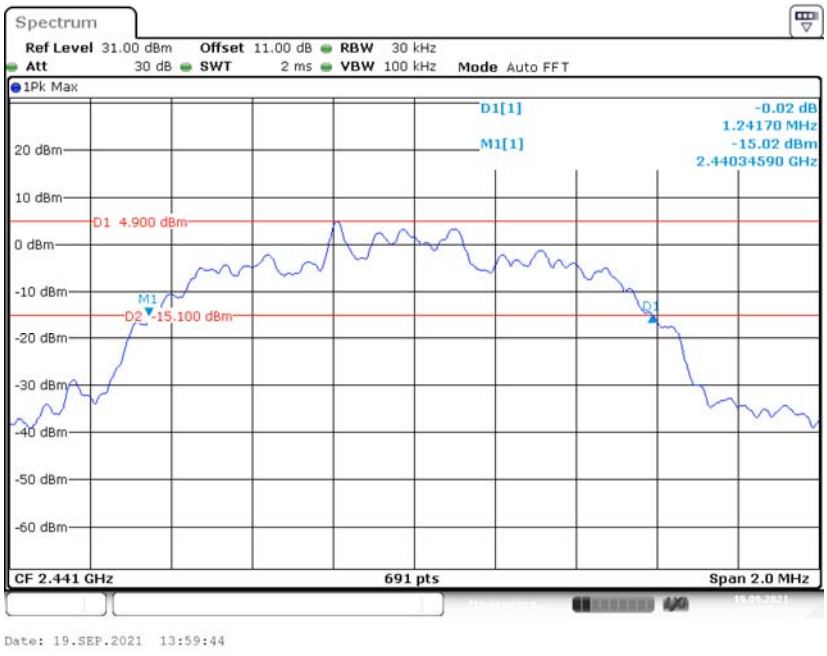
DH1_2480MHz



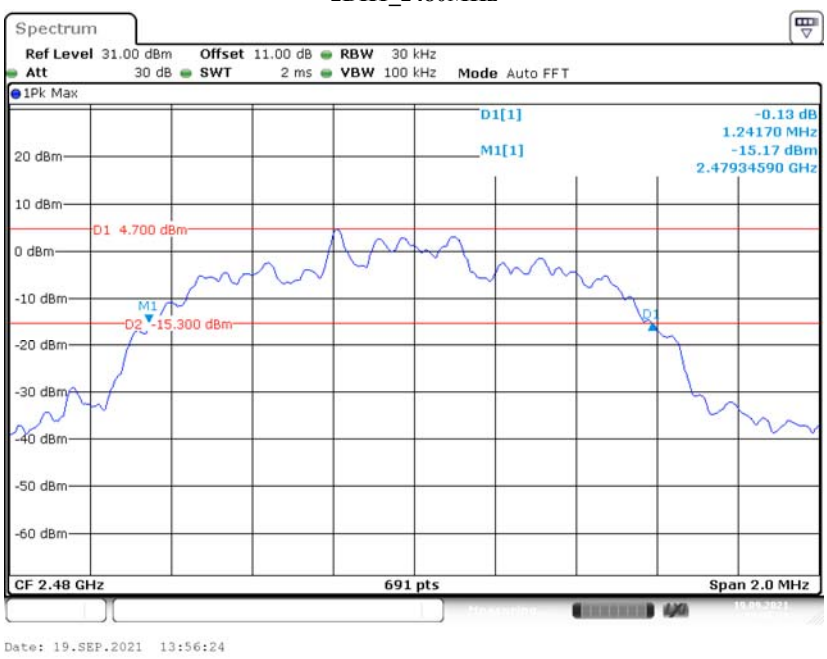
2DH1_2402MHz



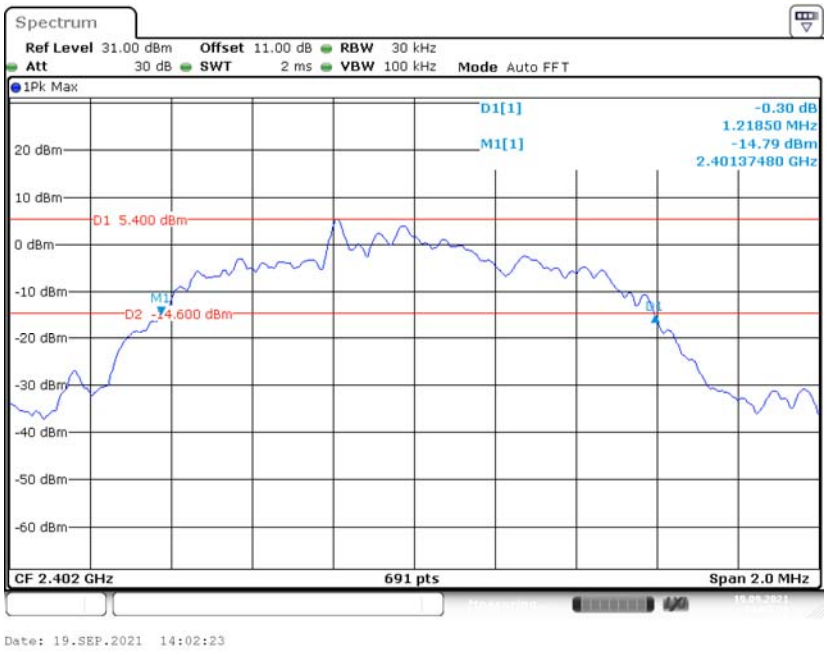
2DH1_2441MHz



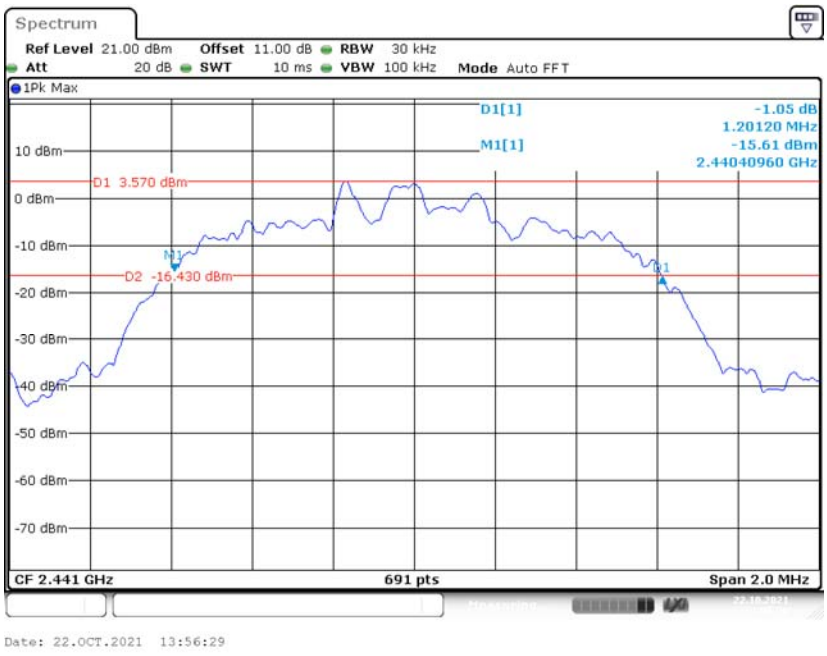
2DH1_2480MHz



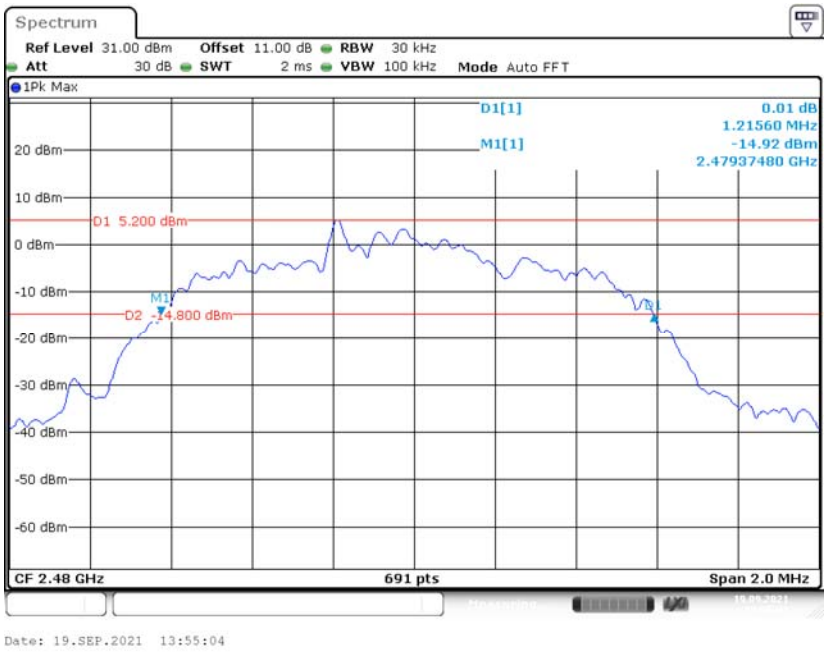
3DH1_2402MHz



3DH1_2441MHz



3DH1_2480MHz



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

Applicable Standard

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

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.

Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

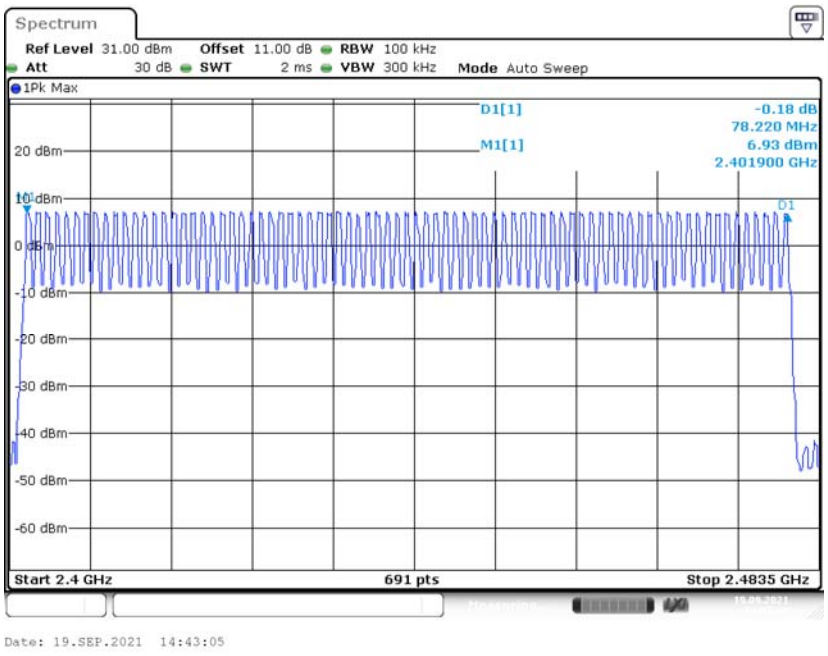
The testing was performed by Ting Lv on 2021-09-19.

EUT operation mode: Transmitting

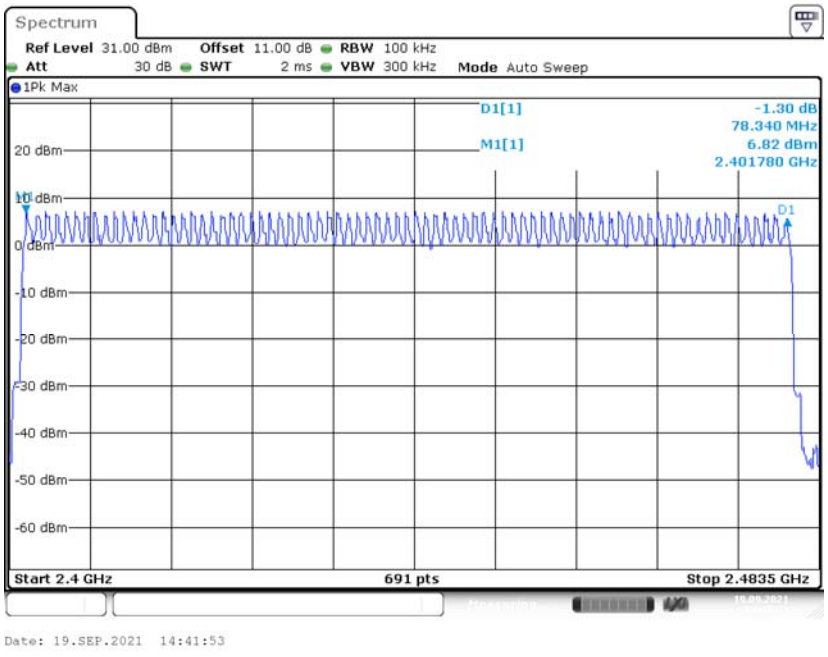
Test Result: Compliant.

Test Mode	Channel	Result[Num]	Limit[Num]	Verdict
BDR (GFSK)	Hop	79	>=15	Pass
EDR (π/4-DQPSK)	Hop	79	>=15	Pass
EDR (8DPSK)	Hop	79	>=15	Pass

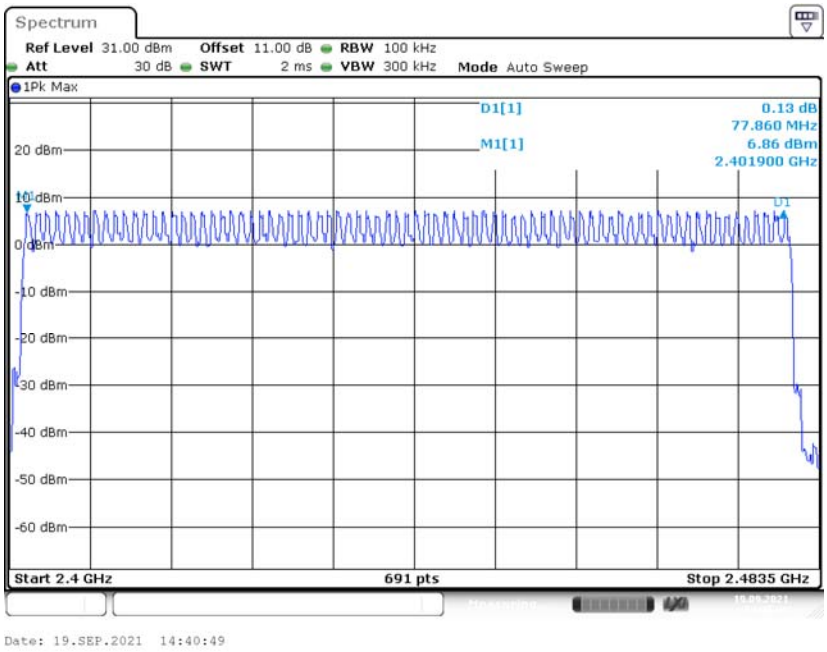
DH1_Hop



2DH1_Hop



3DH1_Hop


Spectrum
Ref Level 31.00 dBm Offset 11.00 dB RBW 100 kHz
Att 30 dB SWT 2 ms VBW 300 kHz Mode Auto Sweep
1Pk Max
D1[1] 0.13 dB
77.860 MHz
M1[1] 6.86 dBm
2.401900 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
Start 2.4 GHz
691 pts
Stop 2.4835 GHz
Date: 19.SEP.2021 14:40:49

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:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lv on 2021-09-19 and 2021-10-22.

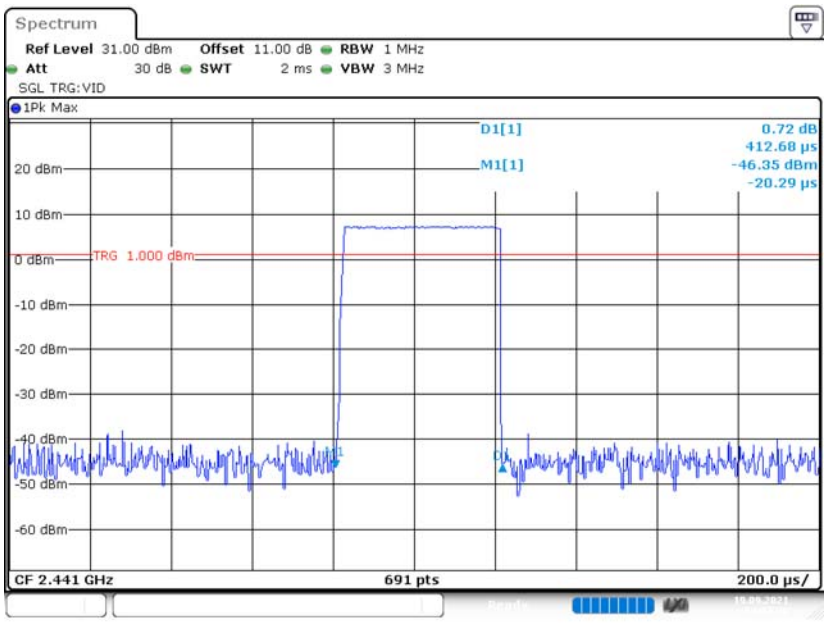
EUT operation mode: Transmitting

Test Result: Compliant.

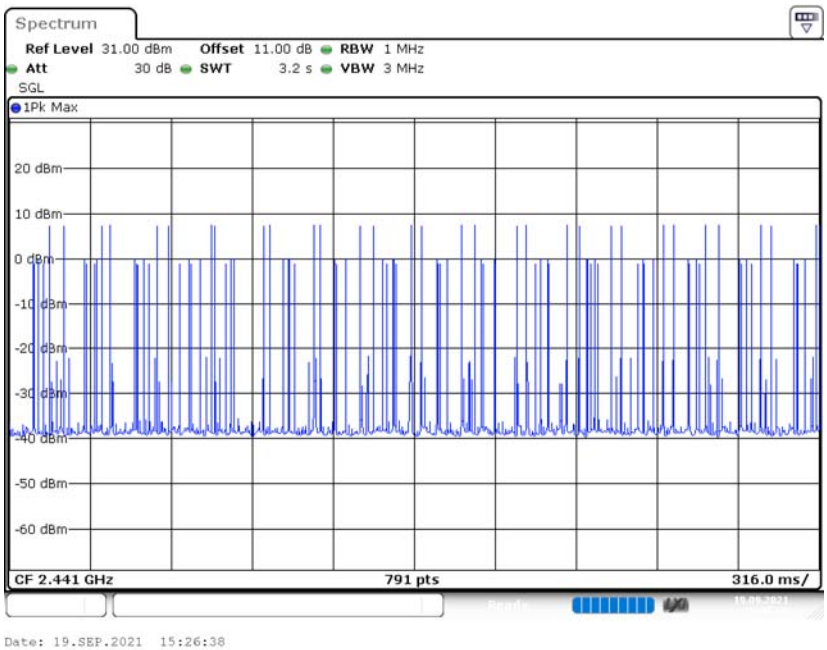
Mode		Pulse time (ms)	Total Hops [Num]	Dwell Time (S)	Limit (S)	Verdict
BDR (GFSK)	DH1	0.41	310	0.127	<=0.4	Pass
	DH3	1.69	190	0.321	<=0.4	Pass
	DH5	2.93	130	0.381	<=0.4	Pass
EDR(π/4-DQPSK)	2DH1	0.42	310	0.130	<=0.4	Pass
	2DH3	1.69	160	0.270	<=0.4	Pass
	2DH5	2.97	130	0.386	<=0.4	Pass
EDR(8DPSK)	3DH1	0.42	300	0.126	<=0.4	Pass
	3DH3	1.70	140	0.238	<=0.4	Pass
	3DH5	2.96	110	0.326	<=0.4	Pass

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

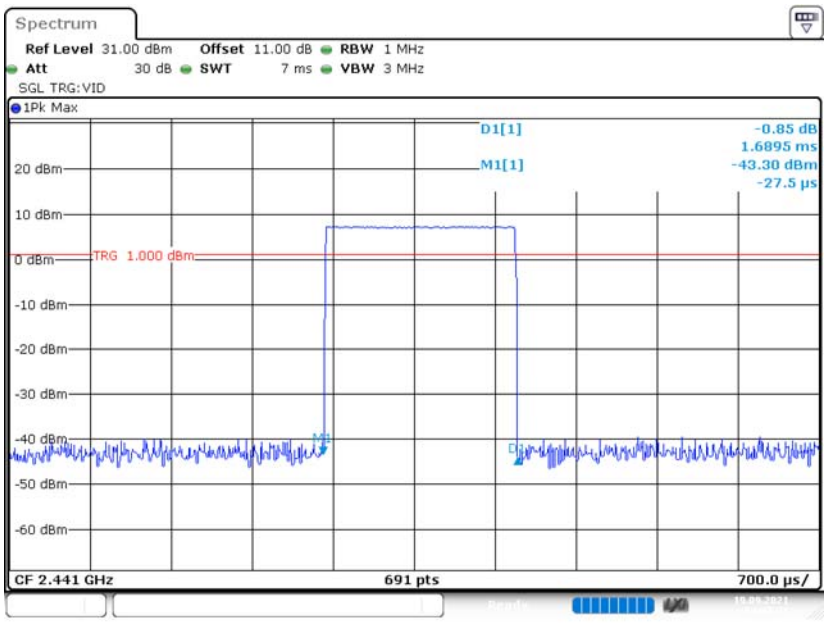
DH1


Spectrum
Ref Level 31.00 dBm Offset 11.00 dB RBW 1 MHz
Att 30 dB SWT 2 ms VBW 3 MHz
SGL TRG:VID
1Pk Max
D1[1] 0.72 dB
412.68 µs
M1[1] -46.35 dBm
-20.29 µs
20 dBm
10 dBm
0 dBm
TRG 1.000 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
691 pts
200.0 µs/
Date: 19.SEP.2021 14:44:36

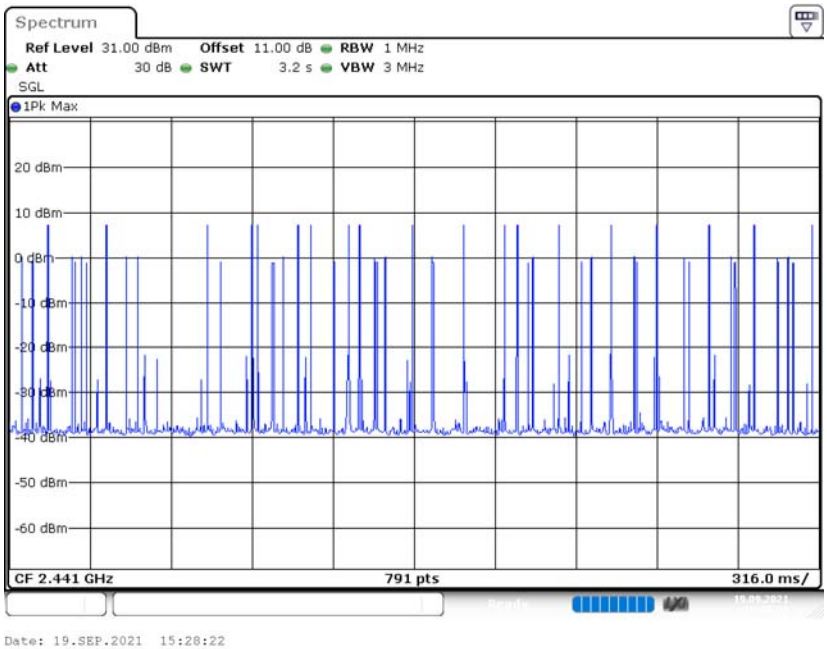
DH1_Hop


Spectrum
Ref Level 31.00 dBm Offset 11.00 dB RBW 1 MHz
Att 30 dB SWT 3.2 s VBW 3 MHz
SGL
1Pk Max
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
791 pts
316.0 ms/
Date: 19.SEP.2021 15:26:38

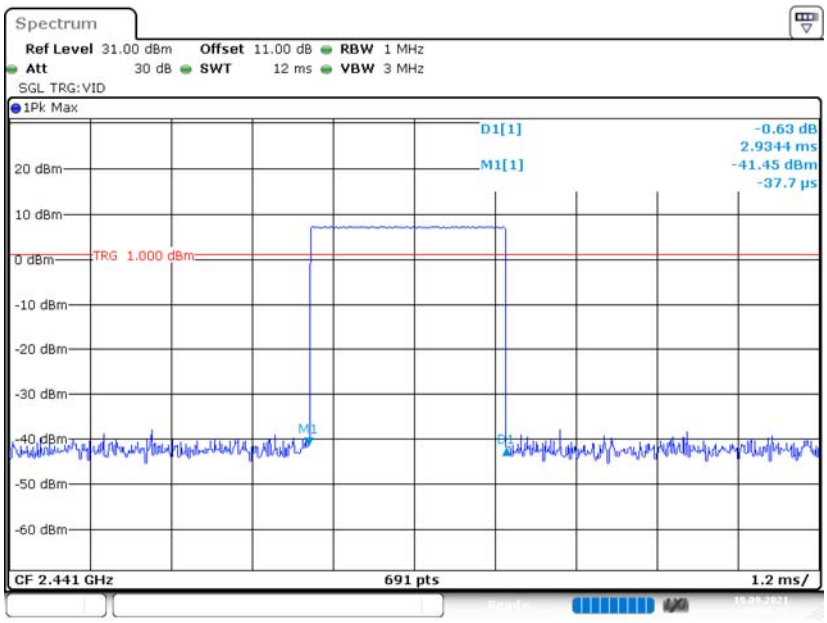
DH3


Spectrum
Ref Level 31.00 dBm Offset 11.00 dB RBW 1 MHz
Att 30 dB SWT 7 ms VBW 3 MHz
SGL TRG:VID
1Pk Max
D1[1] -0.85 dB
1.6895 ms
M1[1] -43.30 dBm
-27.5 µs
20 dBm
10 dBm
0 dBm
TRG 1.000 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
691 pts
700.0 µs/
Date: 19.SEP.2021 14:47:51

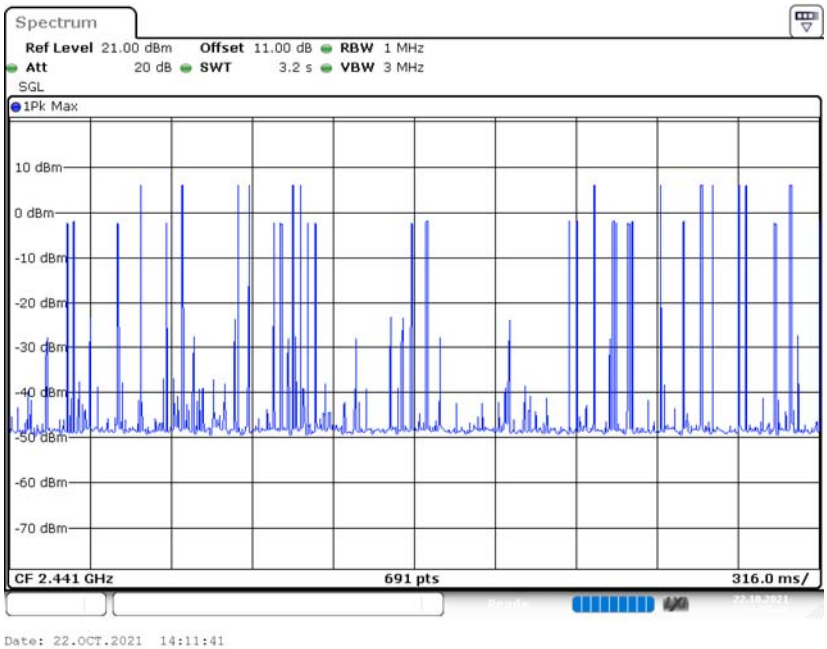
DH3_Hop


Spectrum
Ref Level 31.00 dBm Offset 11.00 dB RBW 1 MHz
Att 30 dB SWT 3.2 s VBW 3 MHz
SGL
1Pk Max
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
791 pts
316.0 ms/
Date: 19.SEP.2021 15:28:22

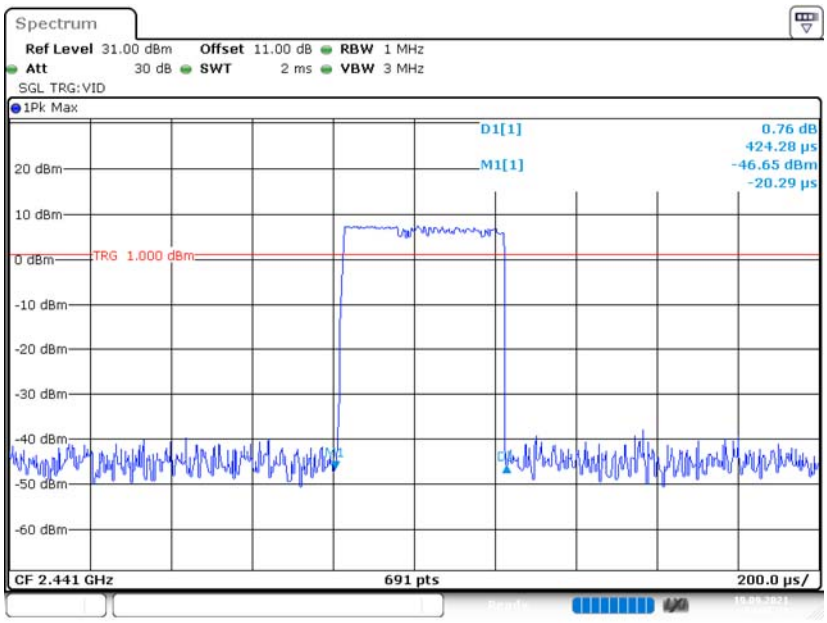
DH5


Spectrum
Ref Level 31.00 dBm Offset 11.00 dB RBW 1 MHz
Att 30 dB SWT 12 ms VBW 3 MHz
SGL TRG:VID
1Pk Max
D1[1] -0.63 dB
2.9344 ms
M1[1] -41.45 dBm
-37.7 µs
20 dBm
10 dBm
0 dBm
TRG 1.000 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
691 pts
1.2 ms/
Date: 19.SEP.2021 14:50:31

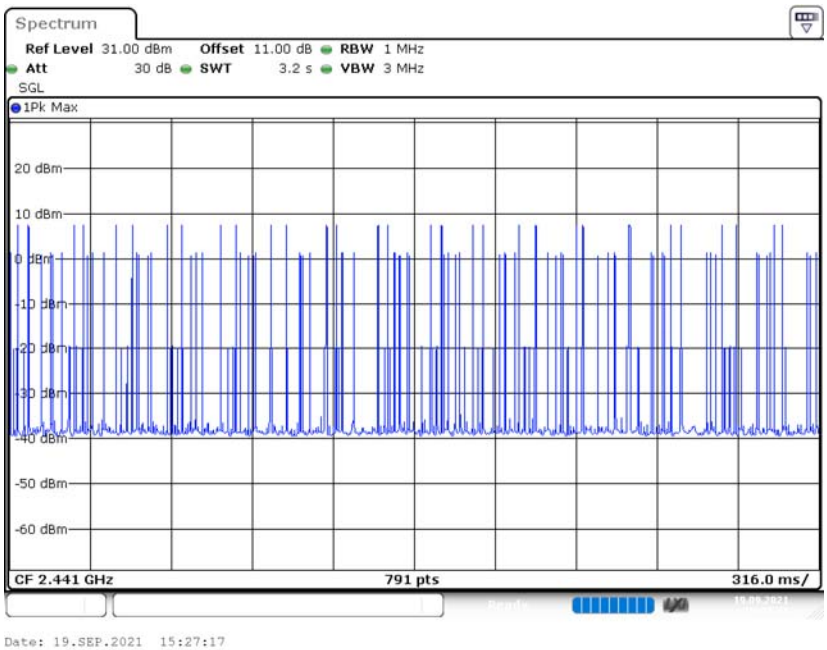
DH5-Hop


Spectrum
Ref Level 21.00 dBm Offset 11.00 dB RBW 1 MHz
Att 20 dB SWT 3.2 s VBW 3 MHz
SGL
1Pk Max
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
CF 2.441 GHz
691 pts
316.0 ms/
Date: 22.OCT.2021 14:11:41

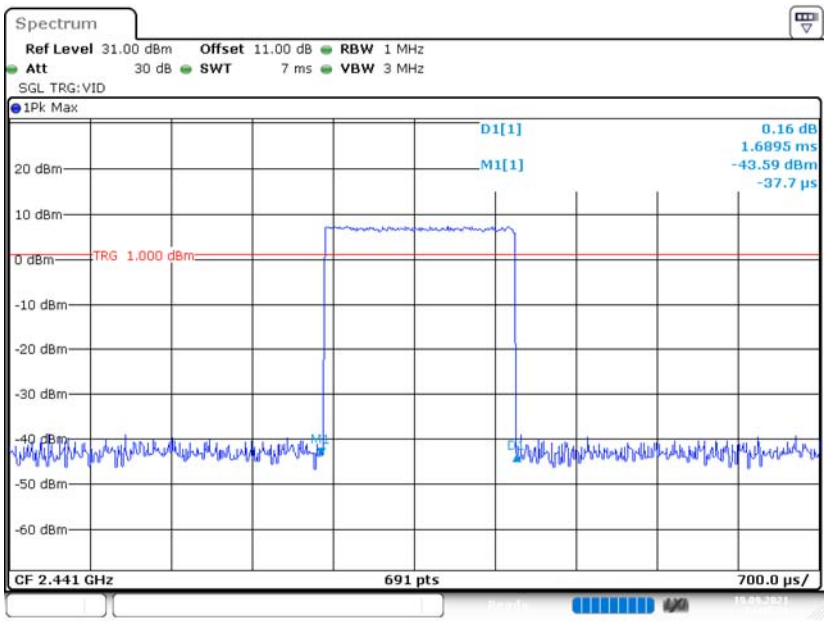
2DH1



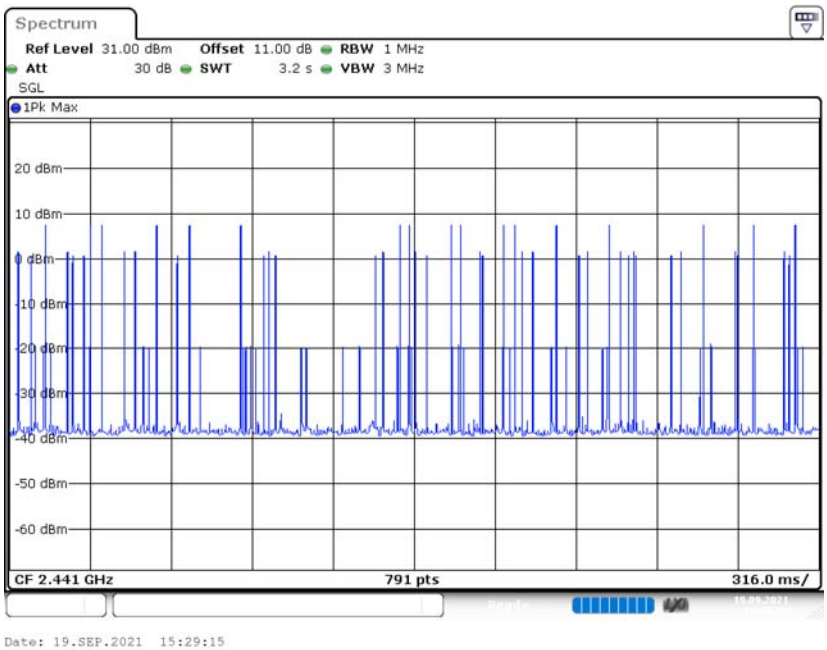
2DH1_Hop



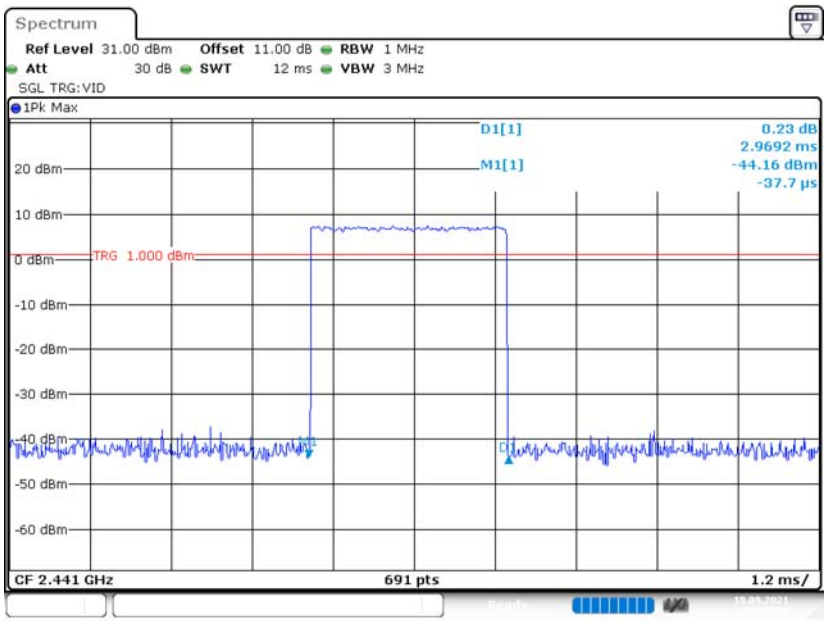
2DH3



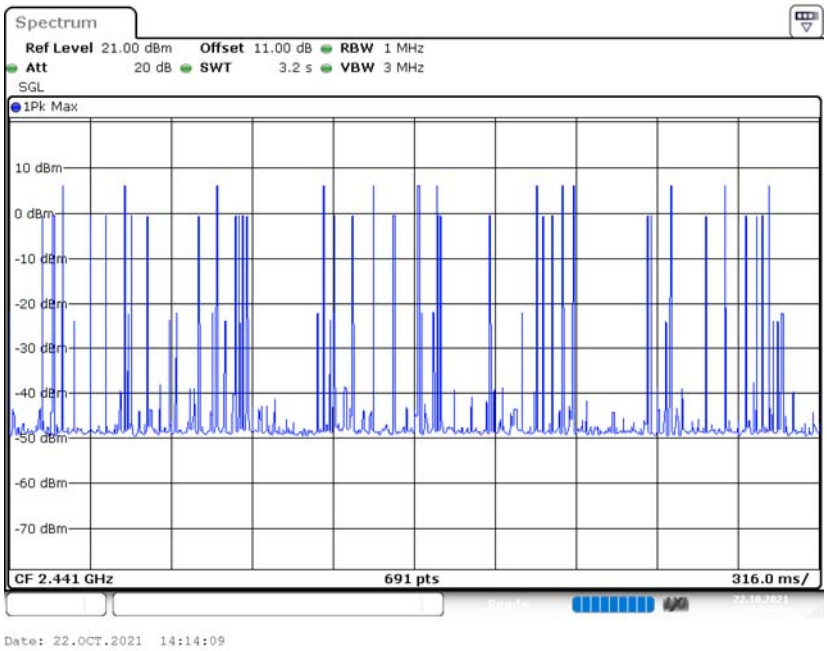
2DH3_Hop



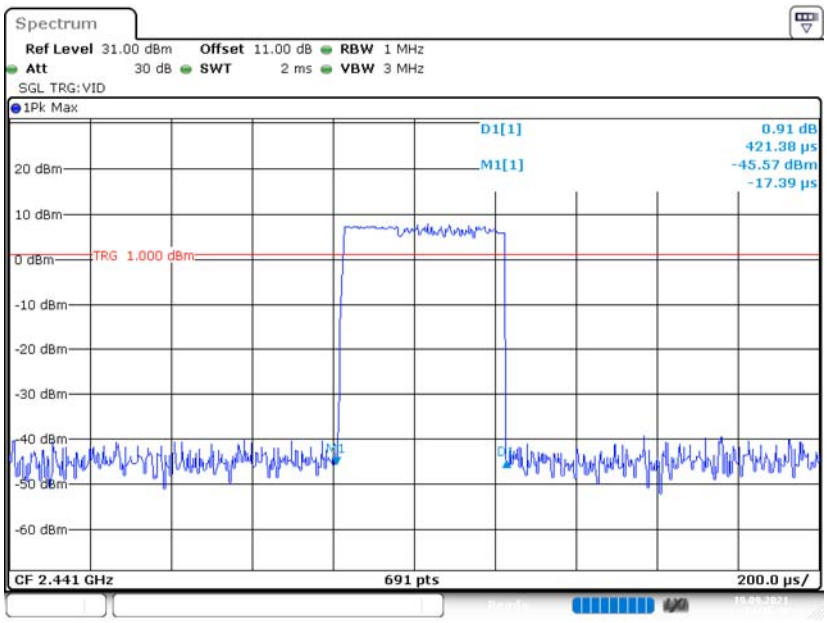
2DH5



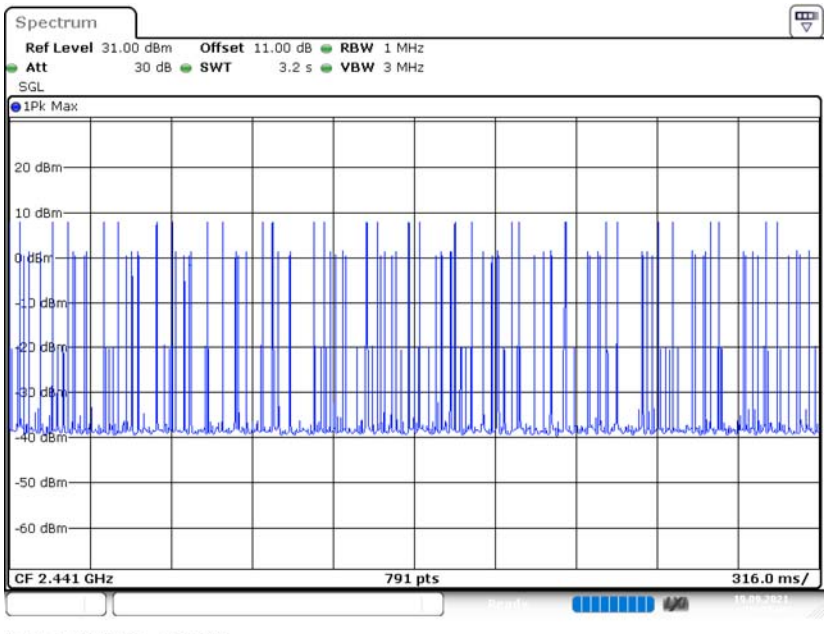
2DH5_Hop



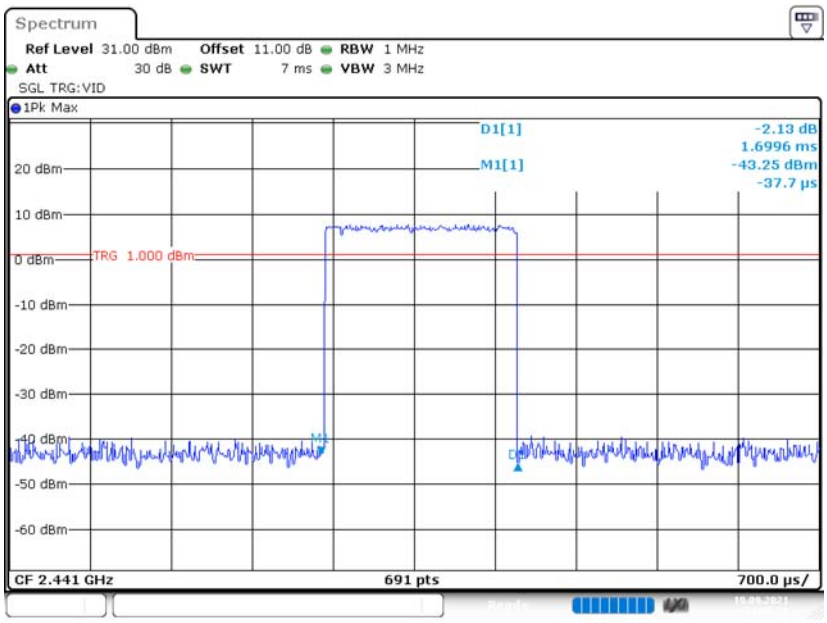
3DH1



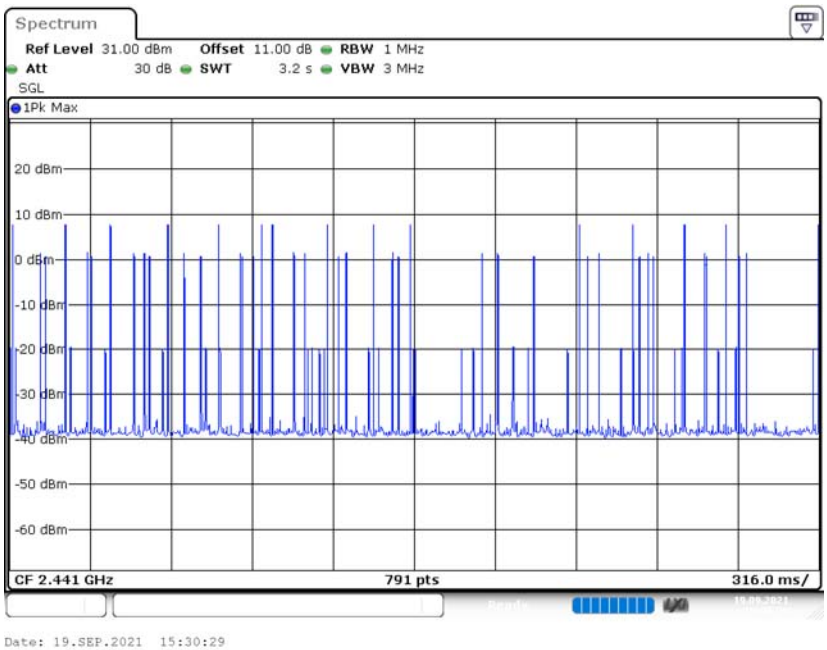
3DH1_Hop



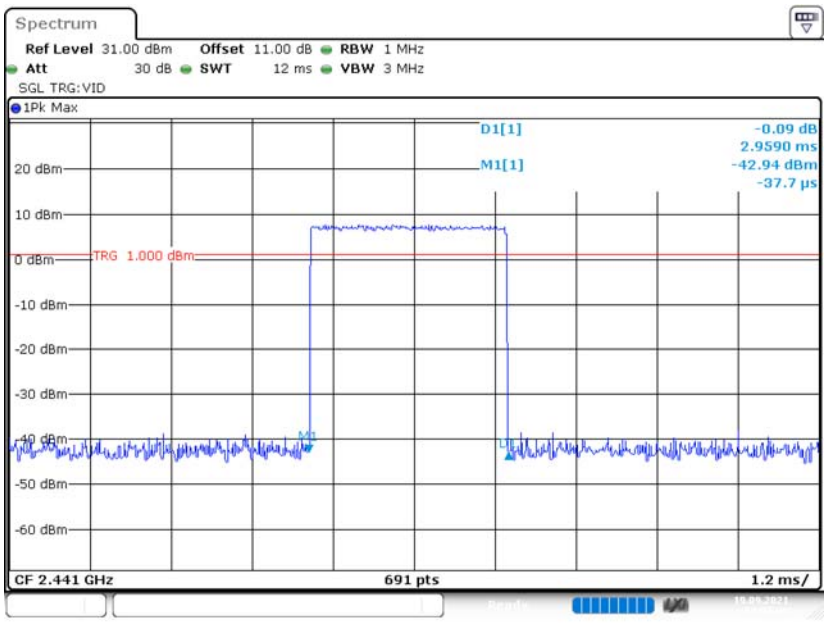
3DH3



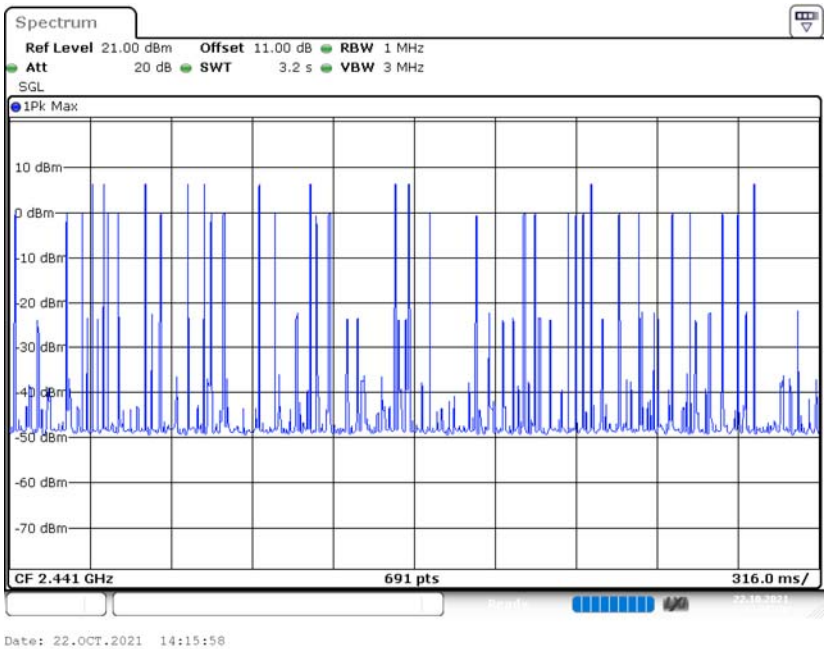
3DH3_Hop



3DH5



3DH5_Hop



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:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

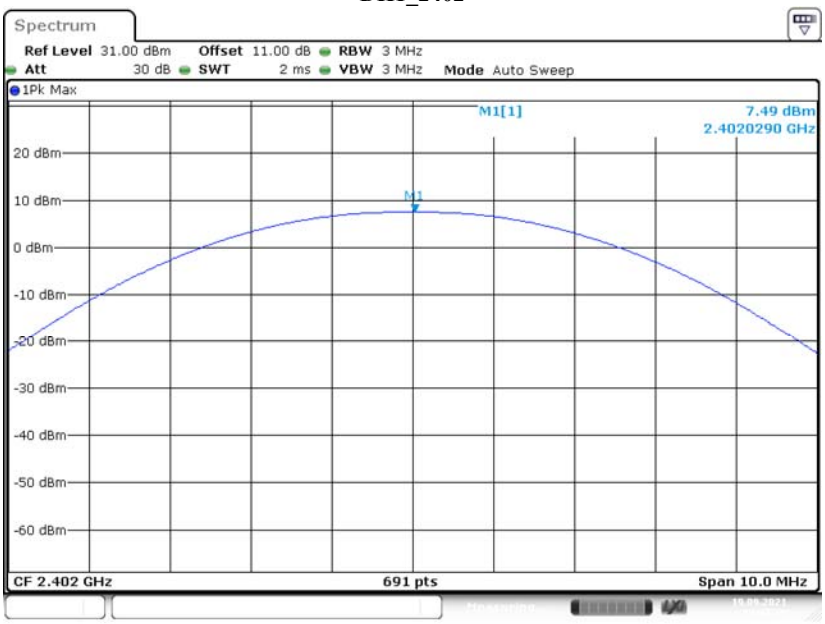
The testing was performed by Ting Lv on 2021-09-19.

EUT operation mode: Transmitting

Test Result: Compliant.

Mode	Channel	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)
BDR (GFSK)	Low	2402	7.49	21
	Middle	2441	7.43	21
	High	2480	7.31	21
EDR (π/4-DQPSK)	Low	2402	7.86	21
	Middle	2441	7.87	21
	High	2480	7.78	21
EDR (8DPSK)	Low	2402	8.36	21
	Middle	2441	8.43	21
	High	2480	8.36	21

DH1_2402



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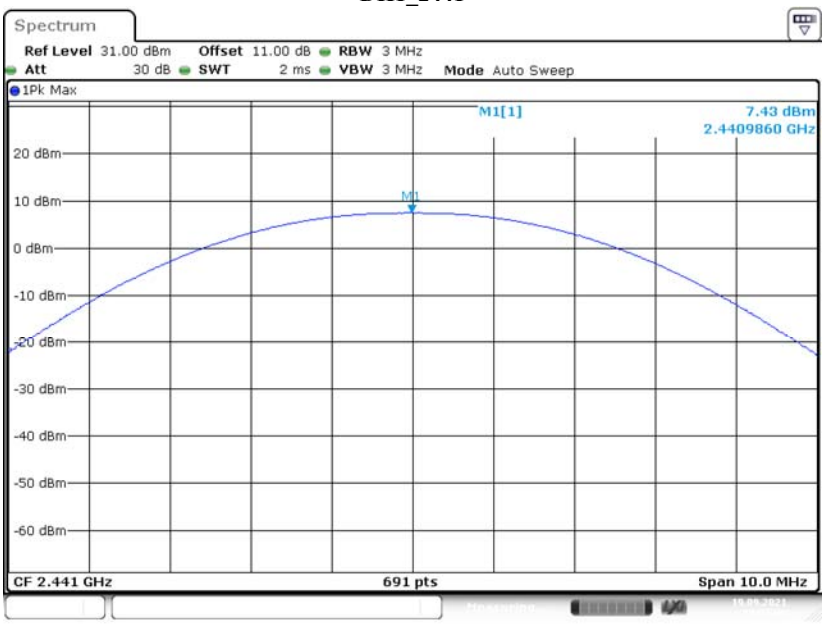
DH1_2441



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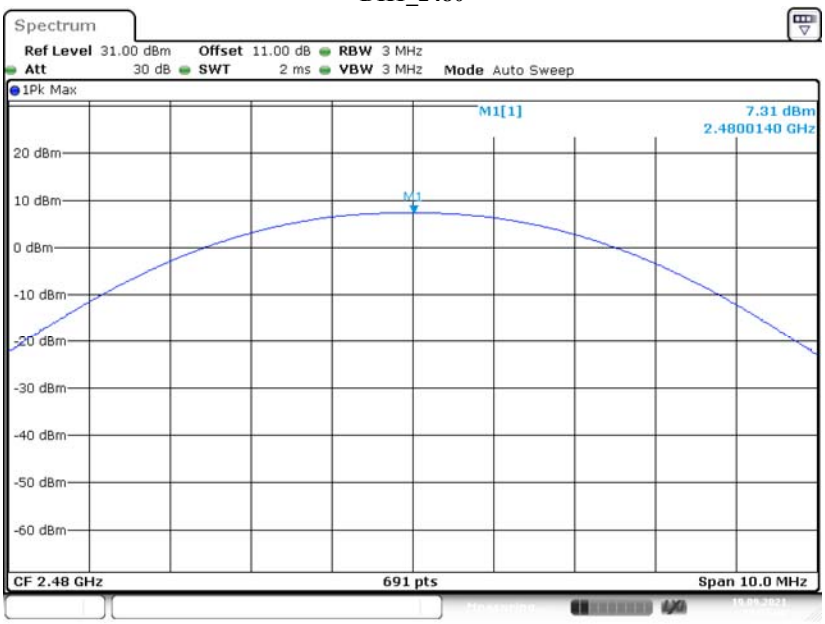
DH1_2480



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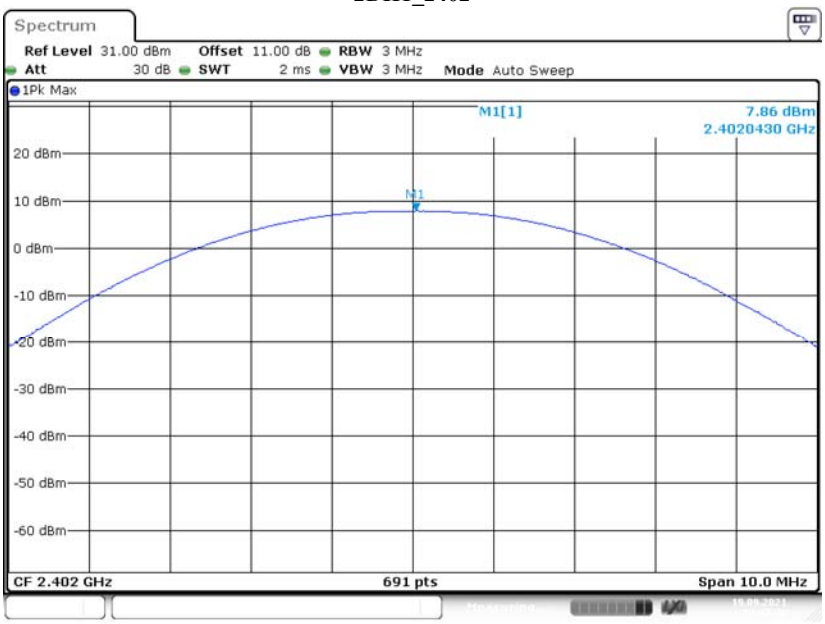
2DH1_2402



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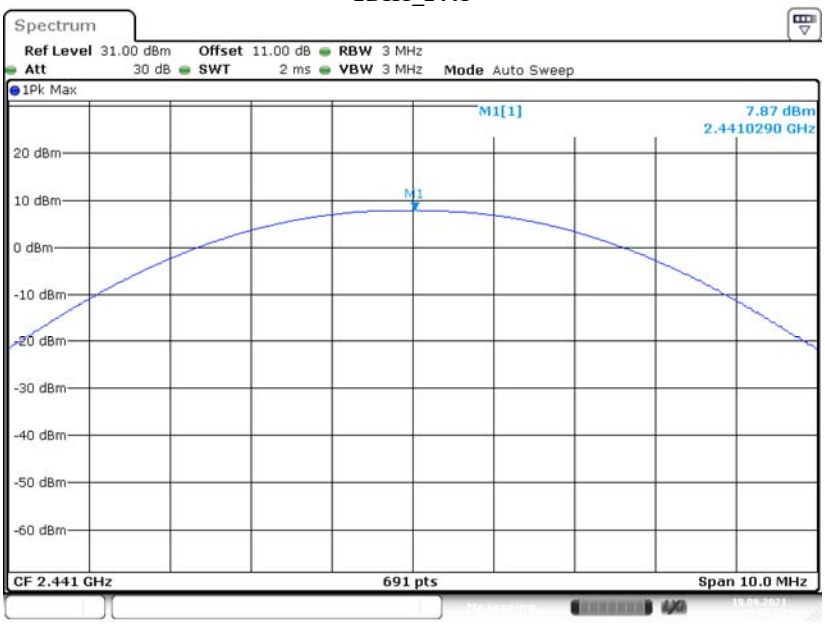

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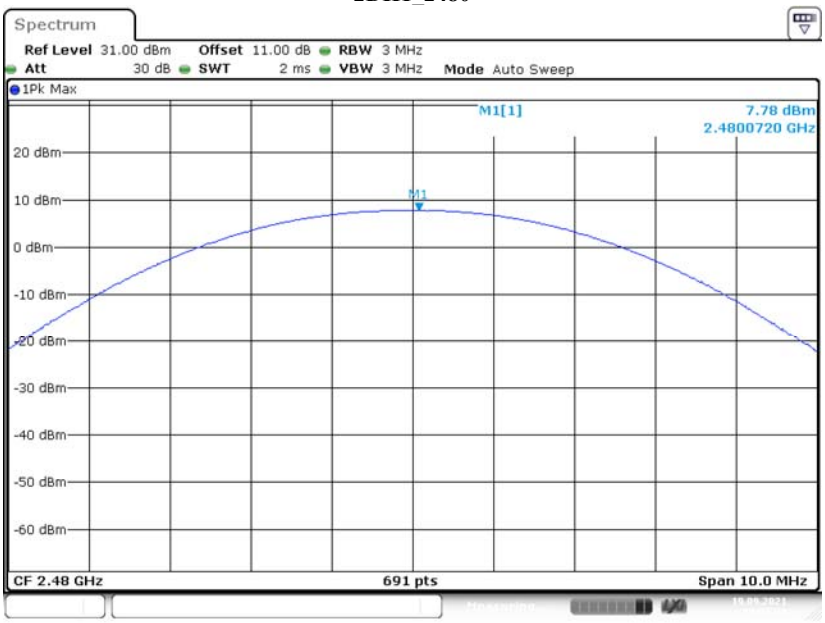

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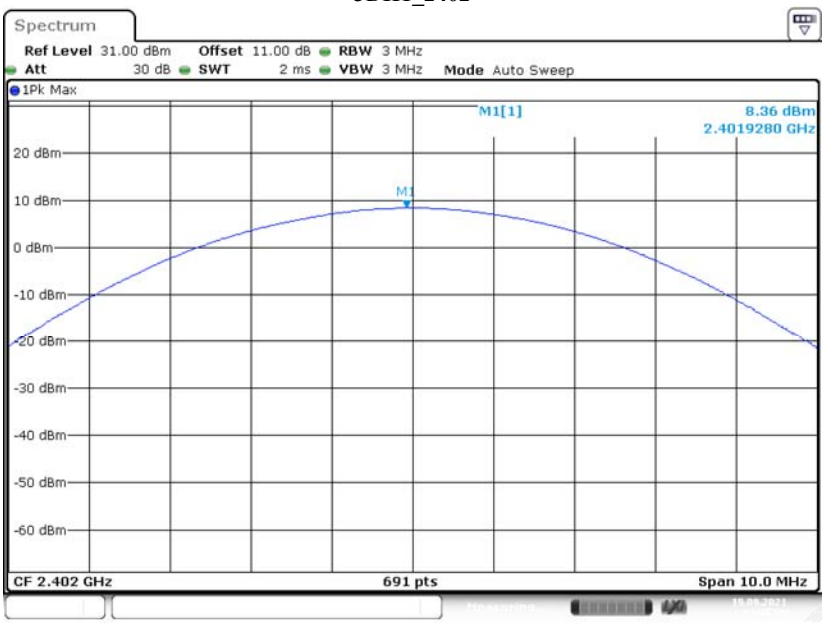
3DH1_2402



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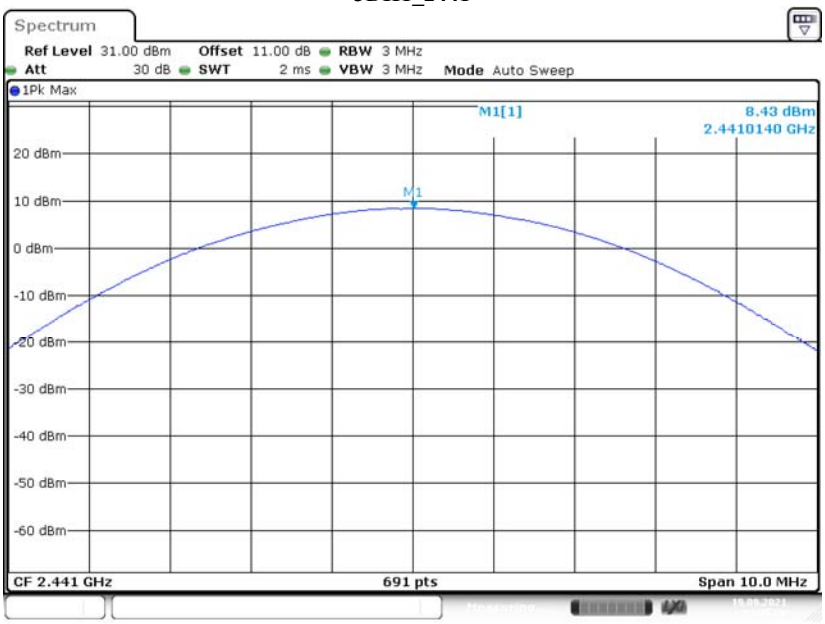
3DH1_2441



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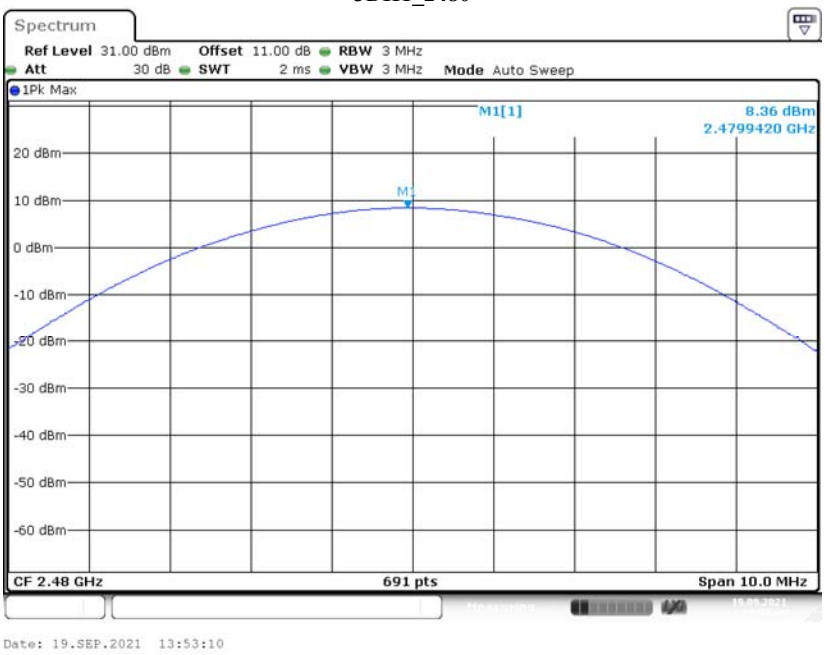
3DH1_2480


Spectrum
Ref Level 31.00 dBm Offset 11.00 dB RBW 3 MHz
Att 30 dB SWT 2 ms VBW 3 MHz Mode Auto Sweep
1Pk Max
M1[1] 8.36 dBm
2.4799420 GHz
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.48 GHz
691 pts
Span 10.0 MHz
Date: 19.SEP.2021 13:53:10

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:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

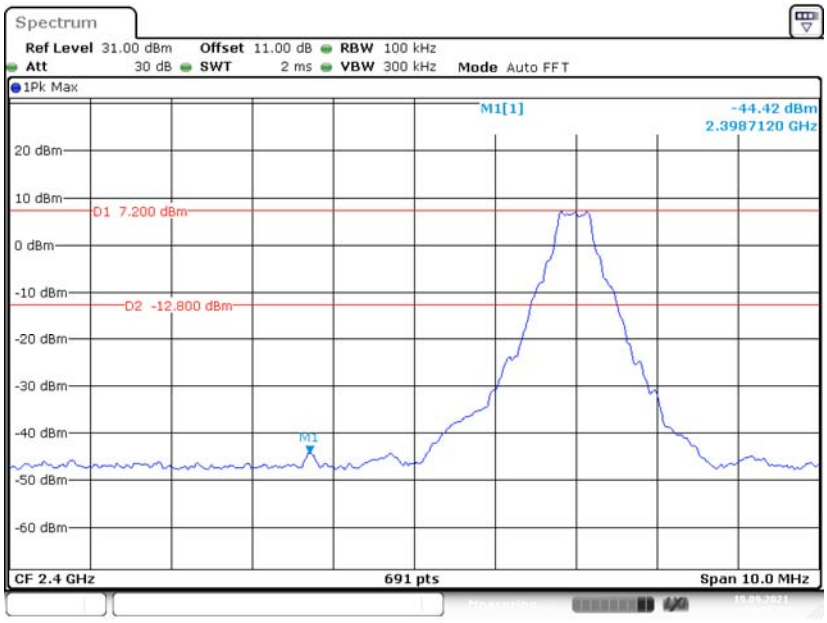
The testing was performed by Ting Lv on 2021-09-19.

EUT operation mode: Transmitting

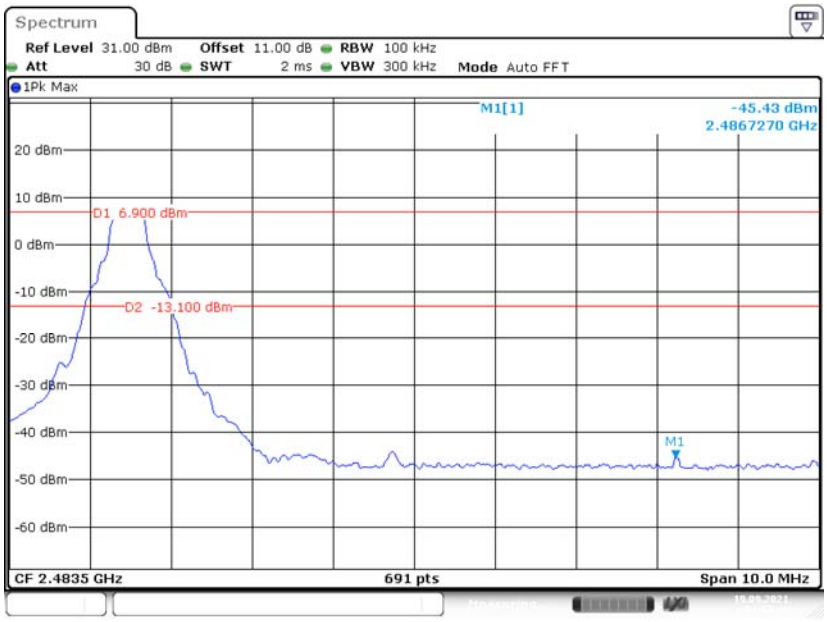
Test Result: Compliant.

Conducted Band Edge Result:

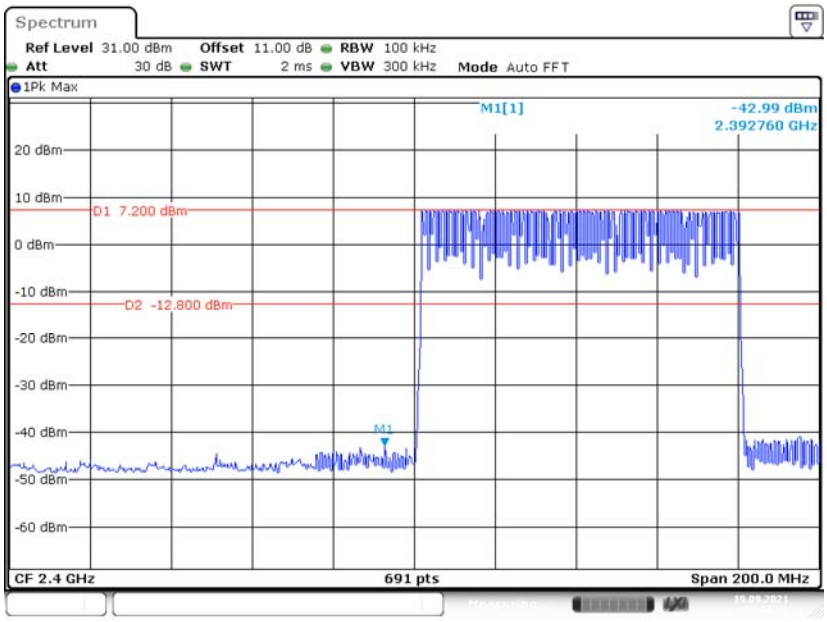
DH1_Left



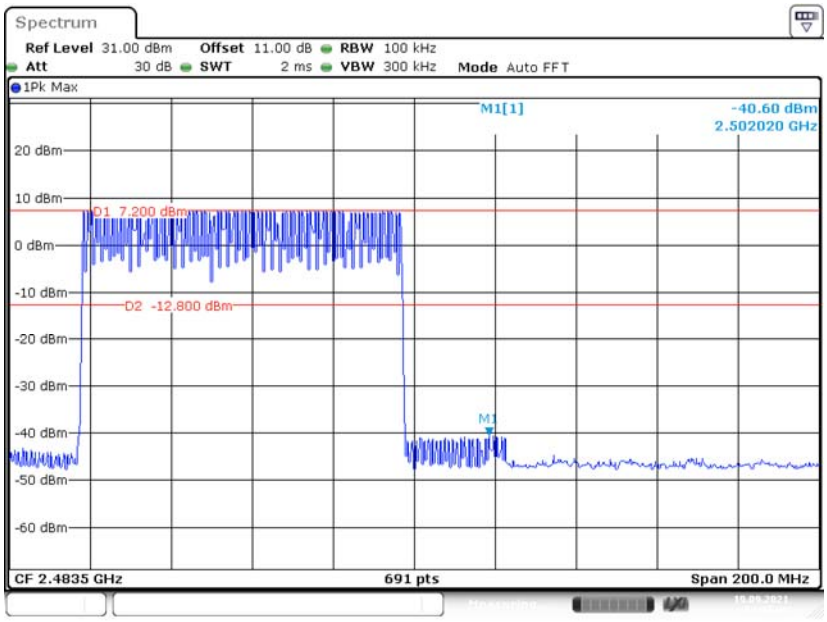
DH1_Right



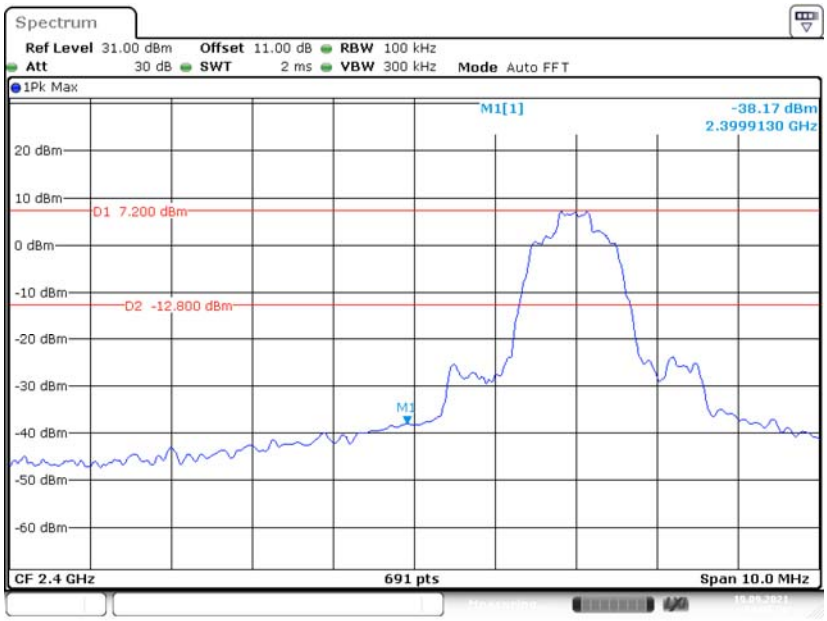
DH1_Left_Hop



DH1_Right_Hop



2DH1_Left



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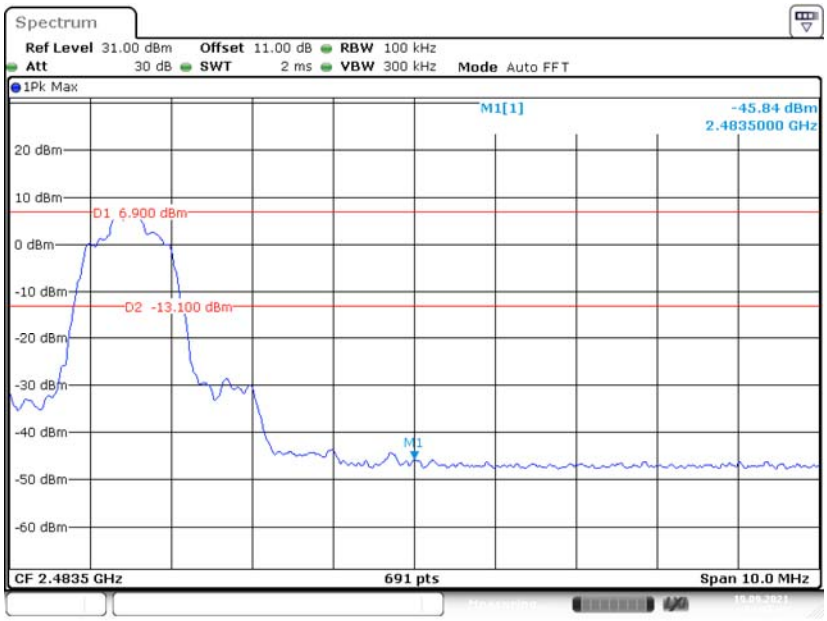
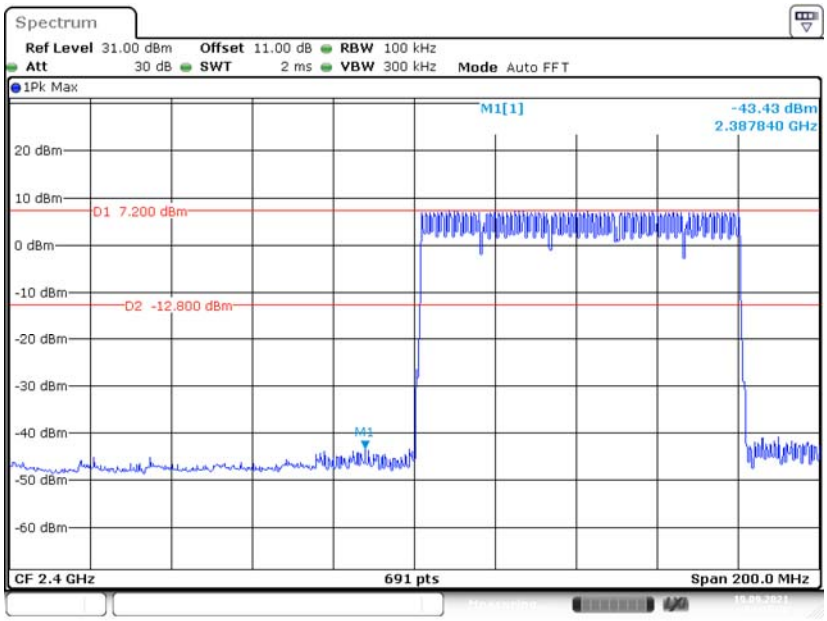
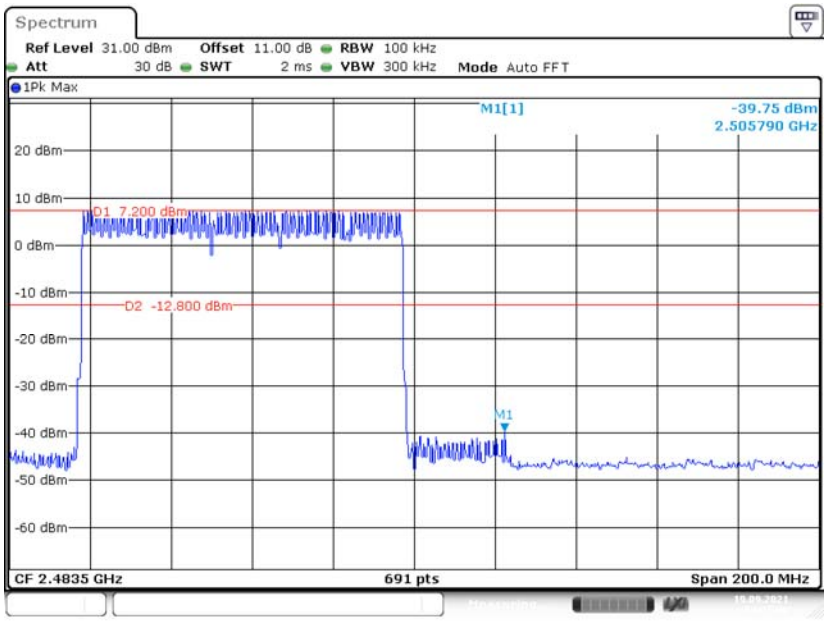


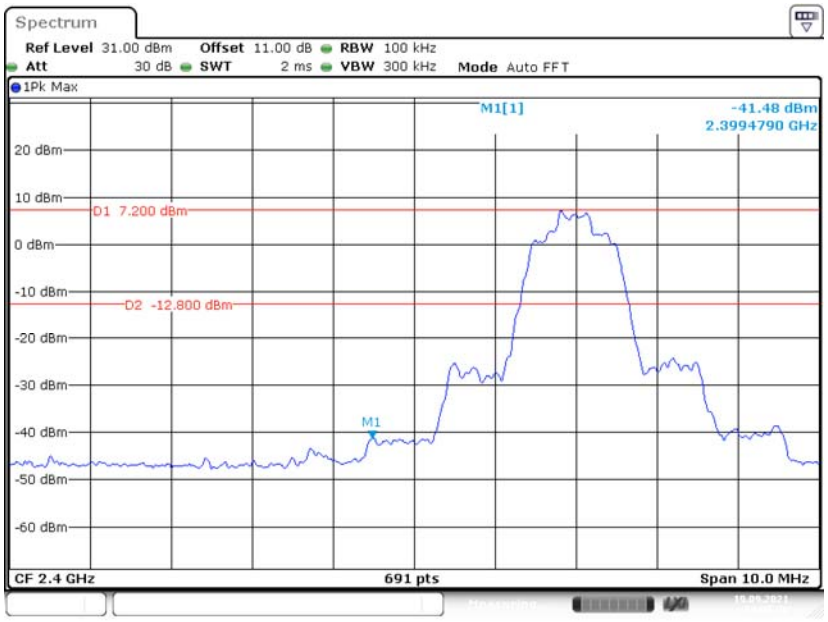
2DH1_Left_Hop



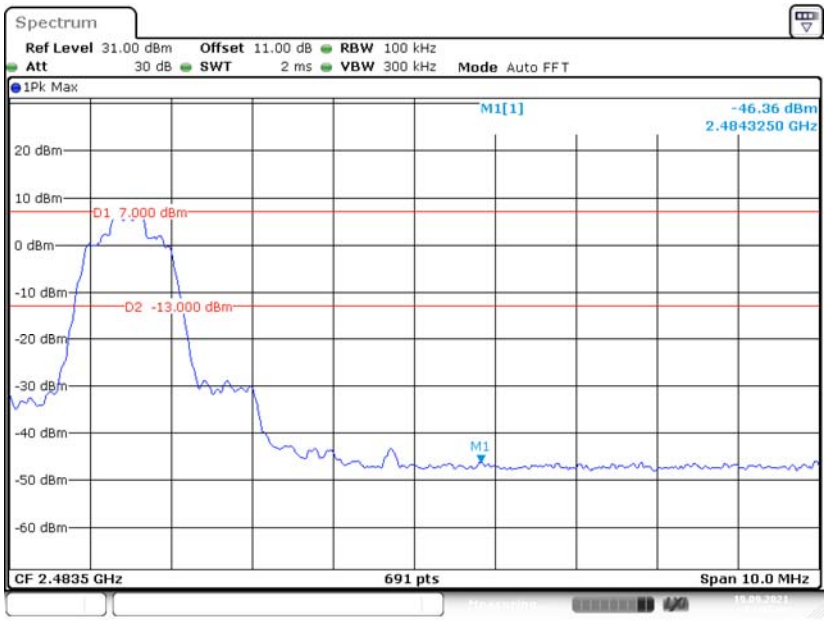
2DH1_Right_Hop



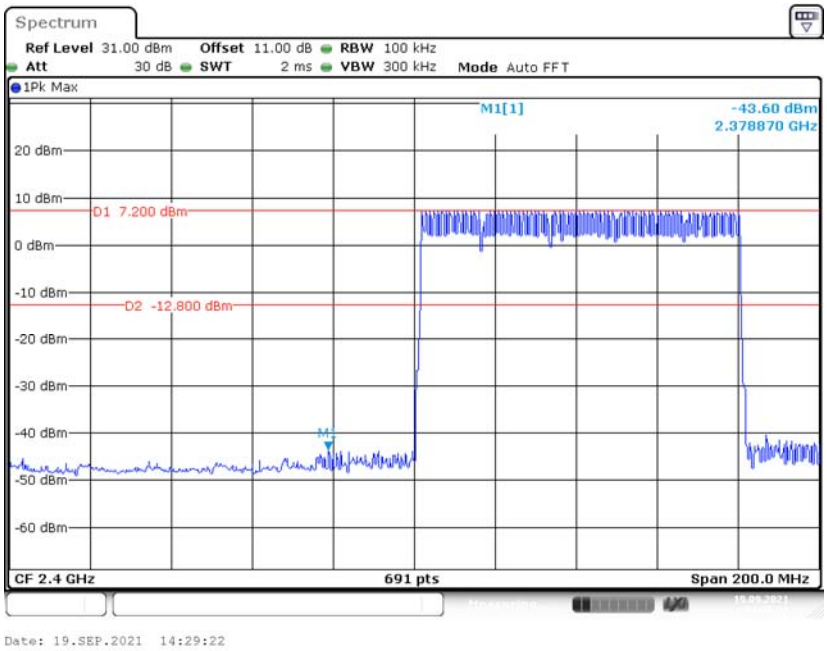
3DH1_Left



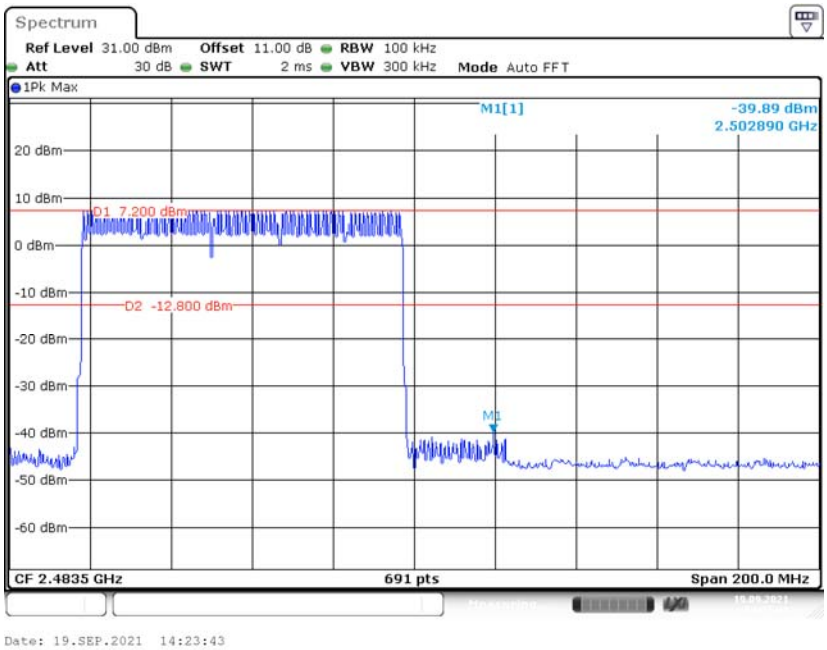
3DH1_Right



3DH1_Left_Hop



3DH1_Right_Hop



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