

TEST REPORT

Applicant Name : Heavys Inc
Address : FCC: 1216 Broadway New York NY 10001 United States
IC : 1216 Broadway New York NY 10001 United States Of America
Report Number : RA230322-13930E-RF
FCC ID: 2BAOA-H1H
IC: 30263-H1H

Test Standard (s)

FCC PART 15.247; RSS-GEN ISSUE 5, FEBRUARY 2021 AMENDMENT 2; RSS-247, ISSUE 2, FEBRUARY 2017

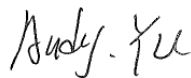
Sample Description

Product Type: Heavys H1H
Model No.: H1H
Multiple Model(s) No.: N/A
Trade Mark: Heavys
Date Received: 2023/03/22
Report Date: 2023/04/18

Test Result:	Pass*
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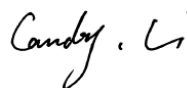
* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:



Andy Yu
EMC Engineer

Approved By:



Candy Li
EMC Engineer

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

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	RA230322-13930E-RF	Original Report	2023-04-18

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

HVIN	H1H
FVIN	N/A
Frequency Range	Bluetooth: 2402~2480MHz
Transmit Peak Power	2.13dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification*	1.02dBi
Voltage Range	DC 3.7V from Battery
Sample serial number	23IL_1 for RF Conducted 23IL_2 for Radiated Emissions (Assigned by ATC)
Sample/EUT Status	Good condition

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules and RSS-247, Issue 2, February 2017, RSS-GEN Issue 5, Feb. 2021Amendment 2 of the Innovation, Science and Economic Development Canada 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 and RSS-247, Issue 2, February 2017, RSS-GEN Issue 5, Feb. 2021Amendment 2 of the Innovation, Science and Economic Development Canada rules.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF Frequency		0.082×10^{-7}
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Audio Frequency Response		0.1dB
Low Pass Filter Response		1.2dB
Modulation Limiting		1%
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°C
Humidity		6%
Supply voltages		0.4%

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

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the Floor 1, KuMaKe Building, Dongzhou Community, Guangming Street, Guangming District, Shenzhen, Guangdong, China.

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

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

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 30241.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

“Bluetest3*” exercise software was used and the power level is Default*. The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

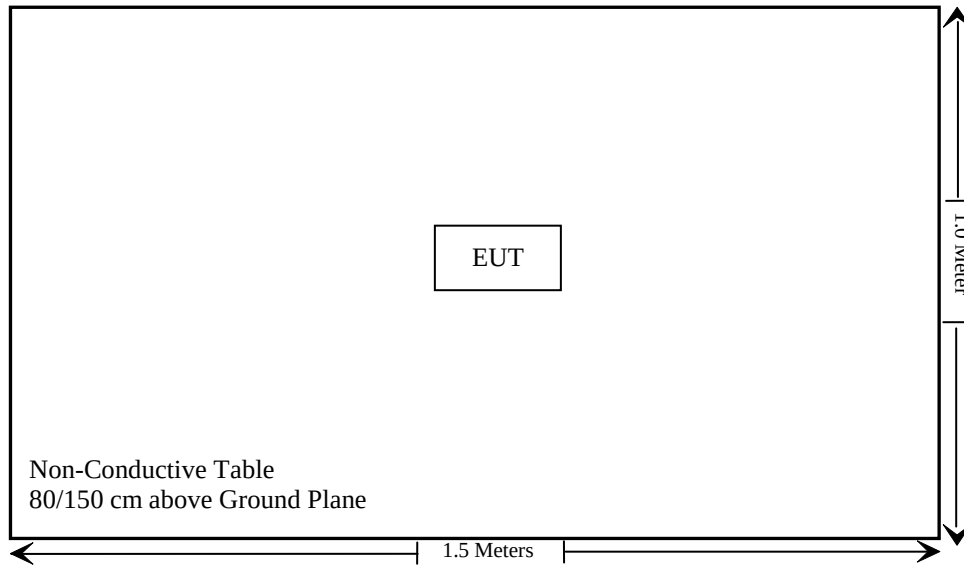
Manufacturer	Description	Model	Serial Number	Specification
/	/	/	/	/

External I/O Cable

Cable Description	Length (m)	From Port	To
/	/	/	/

Block Diagram of Test Setup

For Radiated Emissions:



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (3) & §2.1093	RF Exposure	Compliant
RSS-102 § 2.5.1	EXEMPTION LIMITS FOR ROUTINE EVALUATION-SAR EVALUATION	Compliant
FCC §15.203 RSS-Gen §6.8	Antenna Requirement	Compliant
FCC §15.207(a) RSS-Gen §8.8	AC Line Conducted Emissions	Not Applicable
FCC §15.205, §15.209, §15.247(d) RSS-247 § 5.5, RSS-GEN § 8.10	Radiated Emissions	Compliant
FCC §15.247(a)(1) RSS-247 § 5.1(a), RSS-GEN § 6.7	20 dB Emission Bandwidth & 99% Occupied Bandwidth	Compliant
FCC §15.247(a)(1) RSS-247 § 5.1 (b)	Channel Separation Test	Compliant
FCC §15.247(a)(1)(iii) RSS-247 § 5.1 (d)	Time of Occupancy (Dwell Time)	Compliant
FCC §15.247(a)(1)(iii) RSS-247 § 5.1 (d)	Quantity of hopping channel Test	Compliant
FCC §15.247(b)(1) RSS-247 § 5.1(b) & § 5.4(b)	Peak Output Power Measurement	Compliant
FCC §15.247(d) RSS-247 § 5.5	Band edges	Compliant

Not Applicable: This device is not applicable to the test in this section

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emissions Test					
Rohde& Schwarz	Test Receiver	ESR	102725	2022/11/25	2023/11/24
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2022/11/25	2023/11/24
SONOMA INSTRUMENT	Amplifier	310 N	186131	2022/11/08	2023/11/07
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2022/11/08	2023/11/07
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2022/11/08	2023/11/07
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2022/11/30	2025/11/29
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2022/12/26	2025/12/25
Radiated Emission Test Software: e3 19821b (V9)					
Unknown	RF Coaxial Cable	No.10	N050	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.11	N1000	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.12	N040	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.13	N300	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.14	N800	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.15	N600	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.16	N650	2022/11/25	2023/11/24
RF Conducted Test					
Rohde&Schwarz	Spectrum Analyzer	FSV-40	101948	2022/11/25	2023/11/24
WEINSCHHEL	10dB Attenuator	5324	AU 3842	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.31	RF-01	Each time	

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

FCC §15.247 (i), §1.1307 (b) (3) & §2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) (3), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D04 Interim General RF Exposure Guidance

SAR-Based Exemption:

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum timeaveraged power or maximum time-averaged ERP, whichever is greater.

Per § 1.1307(b)(3)(i)(B), for single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

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

Where

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

and

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

d = the separation distance (cm);

For worst case:

Exemption limit:

For $f=2.48\text{GHz}$, $d=0.5\text{cm}$, the $P_{th}=2.72\text{mW}$

The higher of the available maximum time-averaged power or effective radiated power (ERP):

The antenna gain is 1.02dBi (-1.13dBd), 0dBd=2.15dBi

The maximum tune-up conducted power is 2.5dBm (1.78mW), which less than 2.72 mW@2480MHz exemption limit

So the stand-alone SAR evaluation can be exempted.

RSS-102 § 2.5.1 –EXEMPTION LIMITS FOR ROUTINE EVALUATION-SAR EVALUATION

Applicable Standard

According to RSS-102 Issue 5 §(2.5.1), SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance^{4,5}

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

4. The exemption limits in Table 1 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

5. Transmitters operating between 0.003-10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in Section 4.

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.

Test Result:

For worst case:

The higher of the conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power:

$$(2480-2450)/(3500-2450) = (4-P)/(4-2)$$

The exemption limit of 2480MHz is $P = 3.94\text{mW}$

The maximum tune-up conducted power is 2.5dBm, The antenna gain is 1.02dBi, so the EIRP is 3.52dBm (2.25mW), which less than 3.94 mW@2480MHz exemption limit

So the stand-alone SAR evaluation can be exempted.

FCC §15.203 & RSS-GEN §6.8 – 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.

According to FCC § 15.203, the applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device. Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

Antenna Connector Construction

The EUT has one internal antenna arrangement which was permanently attached and the maximum antenna gain is 1.02dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	Antenna Gain	Impedance	Frequency Range
PCB	1.02dBi	50Ω	2.4~2.5GHz

Result: Compliance

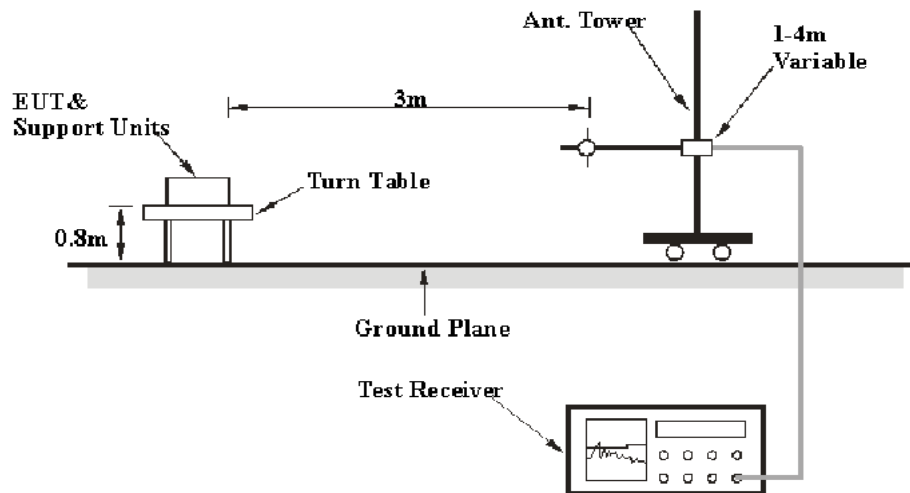
FCC §15.209, §15.205 & §15.247(d) & RSS-247 §5.5 - SPURIOUS EMISSIONS

Applicable Standard

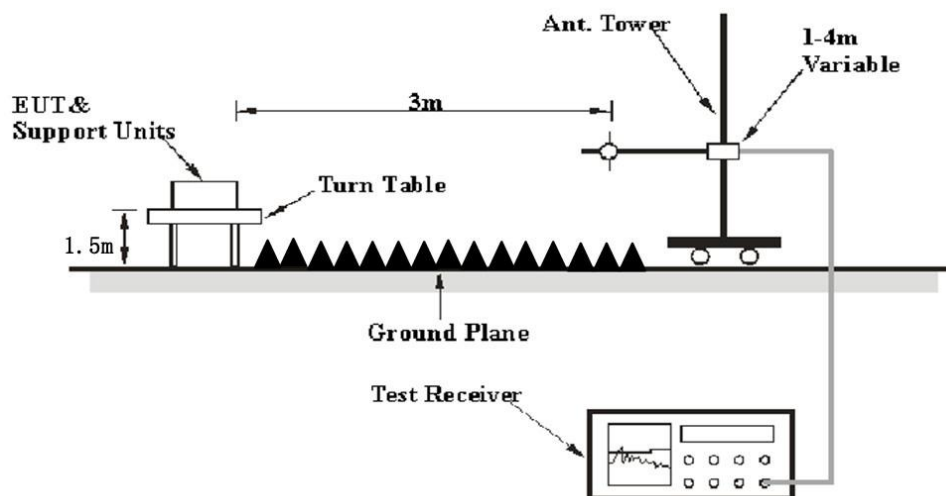
FCC §15.205; §15.209; §15.247(d); RSS-247 §5.5; RSS-GEN §8.10

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, RSS-247, RSS-Gen 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= $N_1 \cdot L_1 + N_2 \cdot L_2 + \dots + N_{n-1} \cdot L_{n-1} + N_n \cdot L_n$,

where N_1 is number of type 1 pulses, L_1 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.

Corrected Factor & Margin Calculation

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

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

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

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

Test Data

Environmental Conditions

Temperature:	24~26 °C
Relative Humidity:	56~60 %
ATM Pressure:	101.0 kPa

The testing was performed by Jimi Zheng on 2023-04-13 for below 1GHz, Jason liu on 2023-04-06 for above 1GHz

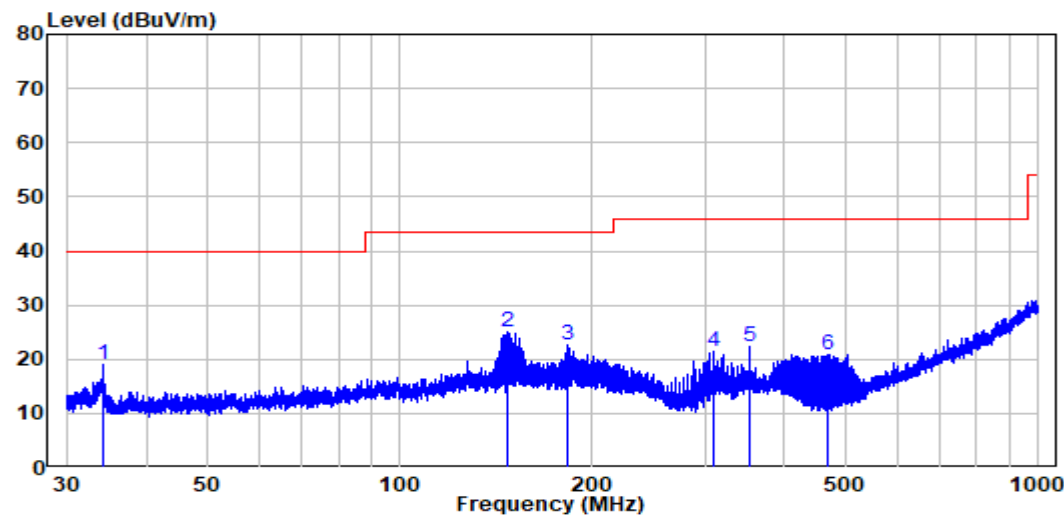
EUT operation mode: Transmitting (Scan with GFSK, $\pi/4$ -DQPSK, 8DPSK mode, the worst case is 8DPSK Mode)

Note: Pre-scan in the X,Y and Z axes of orientation, the worst case X-axes of orientation was recorded

Below 1GHz: (worst case is 8DPSK high channel)

Note: When the test result of Peak was below the limit of QP more than 6dB, just the peak value was recorded.

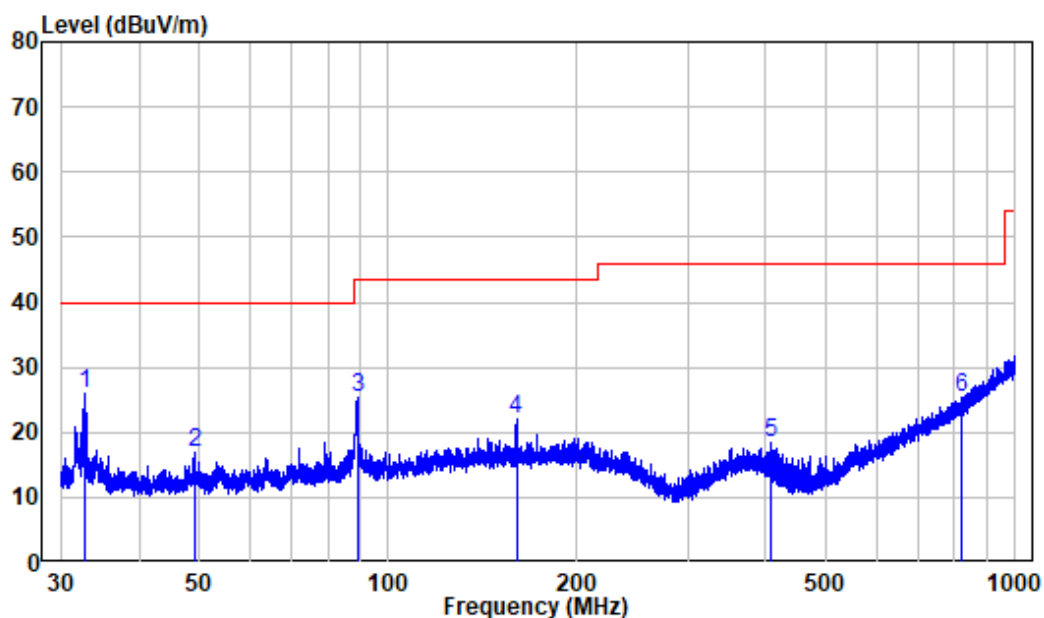
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230322-13930E-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	34.276	-14.45	33.39	18.94	40.00	-21.06	Peak
2	147.339	-10.40	35.58	25.18	43.50	-18.32	Peak
3	182.639	-10.32	32.82	22.50	43.50	-21.00	Peak
4	309.998	-15.09	36.65	21.56	46.00	-24.44	Peak
5	352.016	-12.02	34.34	22.32	46.00	-23.68	Peak
6	466.008	-14.86	35.82	20.96	46.00	-25.04	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : RA230322-13930E-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	32.691	-14.37	40.29	25.92	40.00	-14.08	Peak
2	49.057	-14.31	31.14	16.83	40.00	-23.17	Peak
3	89.198	-12.51	37.88	25.37	43.50	-18.13	Peak
4	159.995	-10.29	32.47	22.18	43.50	-21.32	Peak
5	408.051	-12.81	31.29	18.48	46.00	-27.52	Peak
6	820.631	-3.67	28.97	25.30	46.00	-20.70	Peak

Above 1GHz: (worst case for 8DPSK)

Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave		Height (m)	Polar (H/V)				
Low Channel(2402MHz)									
2387.79	65.81	PK	206	2.3	H	-10.71	55.10	74	-18.90
2358.64	66.02	PK	257	2.4	V	-10.77	55.25	74	-18.75
2390	65.86	PK	39	2	H	-10.70	55.16	74	-18.84
2390	66.08	PK	328	1.2	V	-10.70	55.38	74	-18.62
4804	63.92	PK	121	1.1	H	-6.11	57.81	74	-16.19
4804	61.66	PK	60	1.1	V	-6.11	55.55	74	-18.45
Middle Channel(2441MHz)									
4882	61.65	PK	224	1.3	H	-5.90	55.75	74	-18.25
4882	61.97	PK	72	1.3	V	-5.90	56.07	74	-17.93
High Channel(2480 MHz)									
2483.5	66.09	PK	116	1.1	H	-10.55	55.54	74	-18.46
2483.5	65.92	PK	358	1.4	V	-10.55	55.37	74	-18.63
2487.92	67.70	PK	304	2.4	H	-10.51	57.19	74	-16.81
2489.31	70.15	PK	156	1.8	V	-10.50	59.65	74	-14.35
4960	62.59	PK	25	1.5	H	-5.47	57.12	74	-16.88
4960	61.64	PK	177	1.5	V	-5.47	56.17	74	-17.83

Field Strength of Average							
Frequency (MHz)	Peak Measurement @3m (dBµV/m)	Polar (H/V)	Duty Cycle Correction Factor (dB)	Corrected Amplitude (dBµV/m)	FCC Part 15.247		
					Limit (dBµV/m)	Margin (dB)	Comment
Low Channel(2402MHz)							
2387.79	55.10	H	-30.71	24.39	54	-29.61	Bandedge
2358.64	55.25	V	-30.71	24.54	54	-29.46	Bandedge
2390	55.16	H	-30.71	24.45	54	-29.55	Bandedge
2390	55.38	V	-30.71	24.67	54	-29.33	Bandedge
4804	57.81	H	-30.71	27.10	54	-26.90	Harmonic
4804	55.55	V	-30.71	24.84	54	-29.16	Harmonic
Middle Channel(2441MHz)							
4882	55.75	H	-30.71	25.04	54	-28.96	Harmonic
4882	56.07	V	-30.71	25.36	54	-28.64	Harmonic
High Channel(2480MHz)							
2483.5	55.54	H	-30.71	24.83	54	-29.17	Bandedge
2483.5	55.37	V	-30.71	24.66	54	-29.34	Bandedge
2487.92	57.19	H	-30.71	26.48	54	-27.52	Bandedge
2489.31	59.65	V	-30.71	28.94	54	-25.06	Bandedge
4960	57.12	H	-30.71	26.41	54	-27.59	Harmonic
4960	56.17	V	-30.71	25.46	54	-28.54	Harmonic

Note:

Absolute Level = Corrected Factor + Reading

Margin = Corrected. Amplitude - Limit

Average level= Peak level+ Duty Cycle Corrected Factor

The other emissions which was 20dB below the limit or in noise floor level was not recorded.

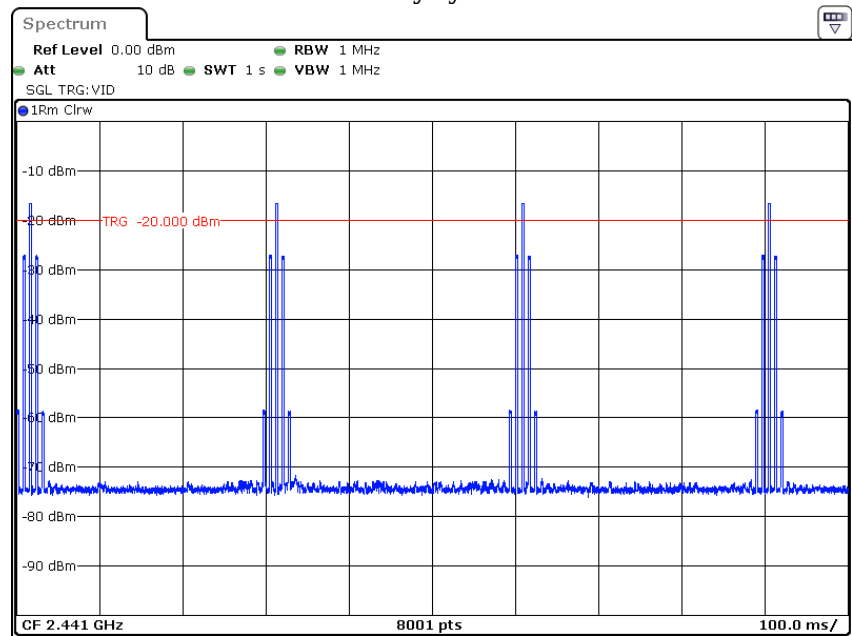
Worst case duty cycle:

Refer below plot, the maximum hops in 100ms period was 1(second high was from other channels)

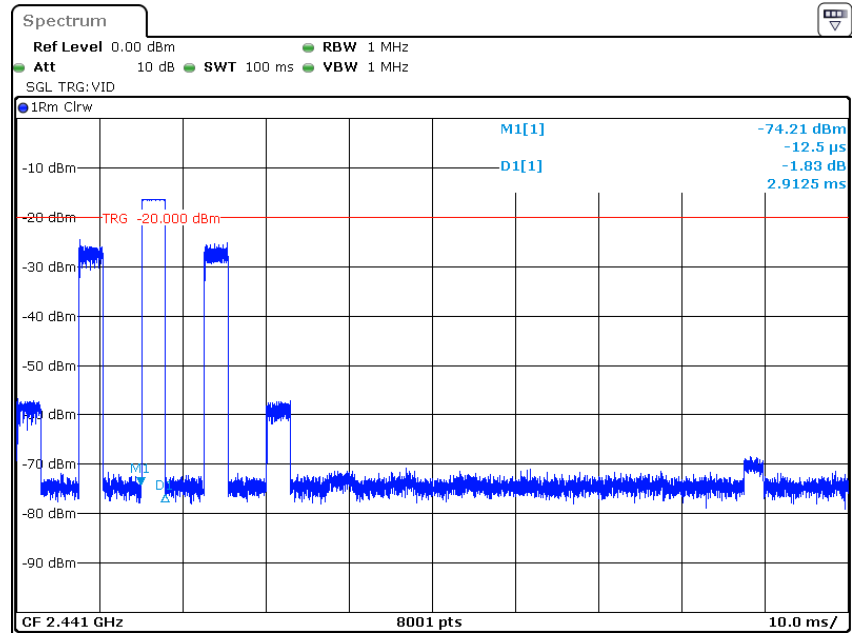
Duty cycle = $T_{on}/100ms = 2.9125 \times 1/100 = 0.029125$

Duty Cycle Corrected Factor = $20\lg(\text{Duty cycle}) = 20\lg 0.029125 = -30.71$

Duty cycle



Date: 6.APR.2023 09:46:01

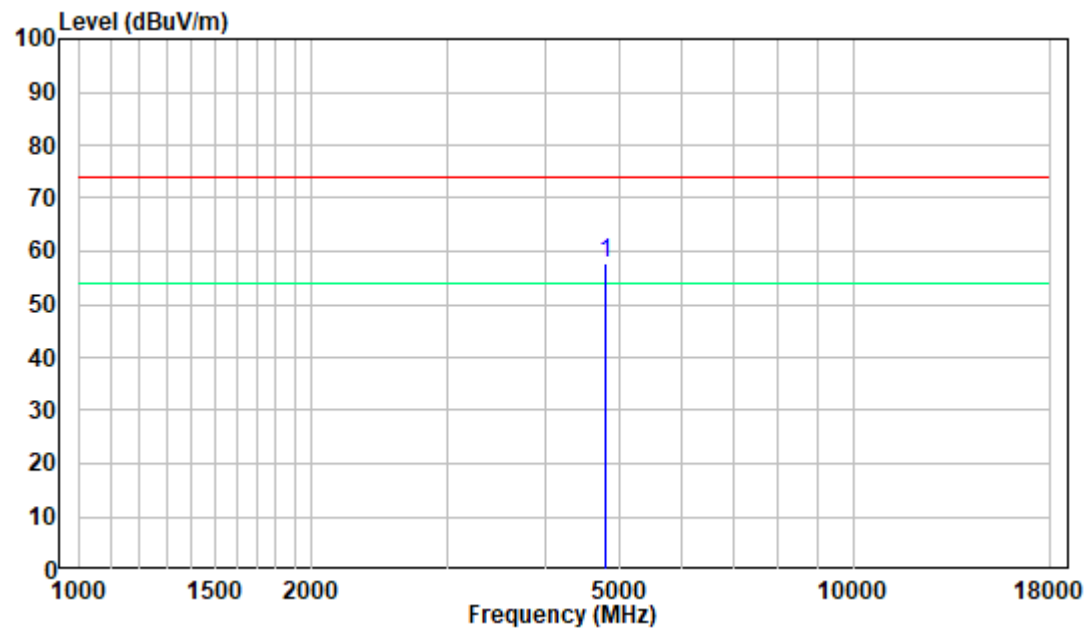


Date: 6.APR.2023 09:48:01

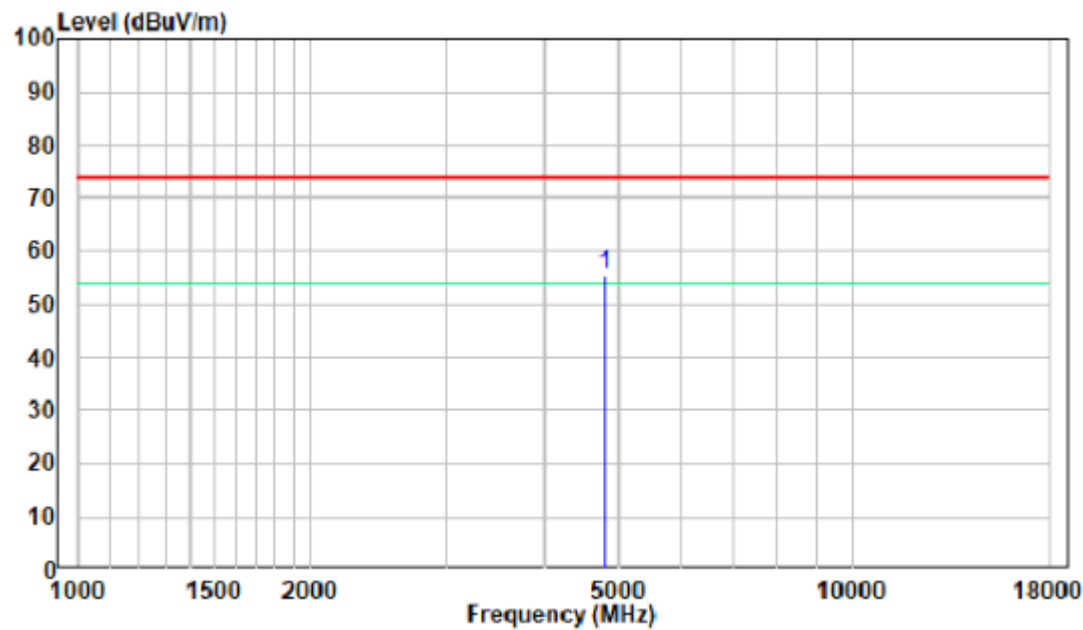
1 GHz - 18 GHz: (Pre-Scan plots)

Low channel

Horizontal



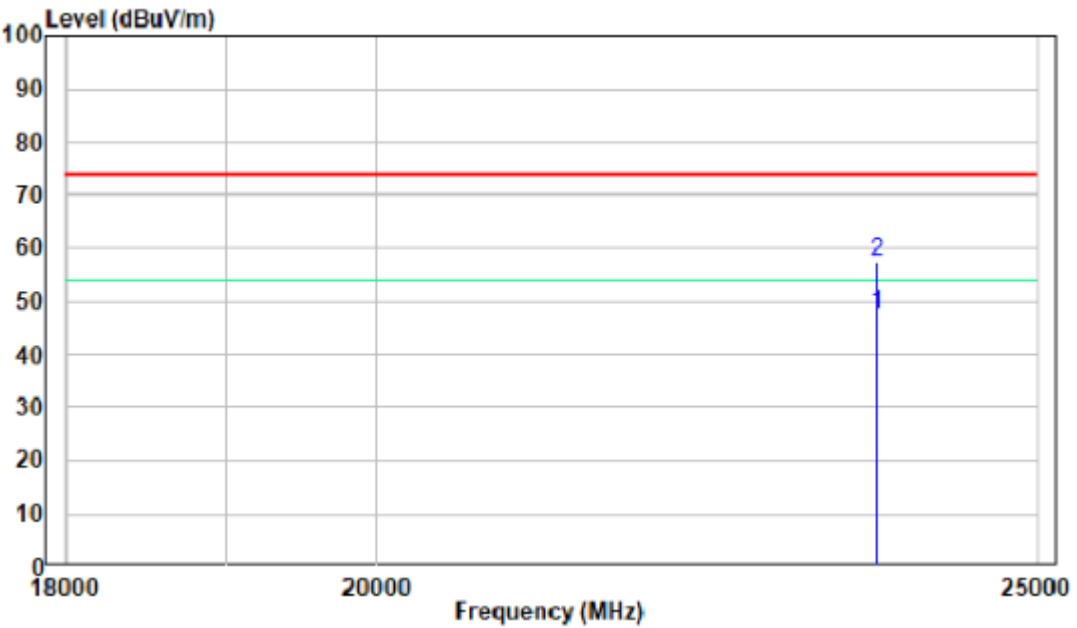
Vertical



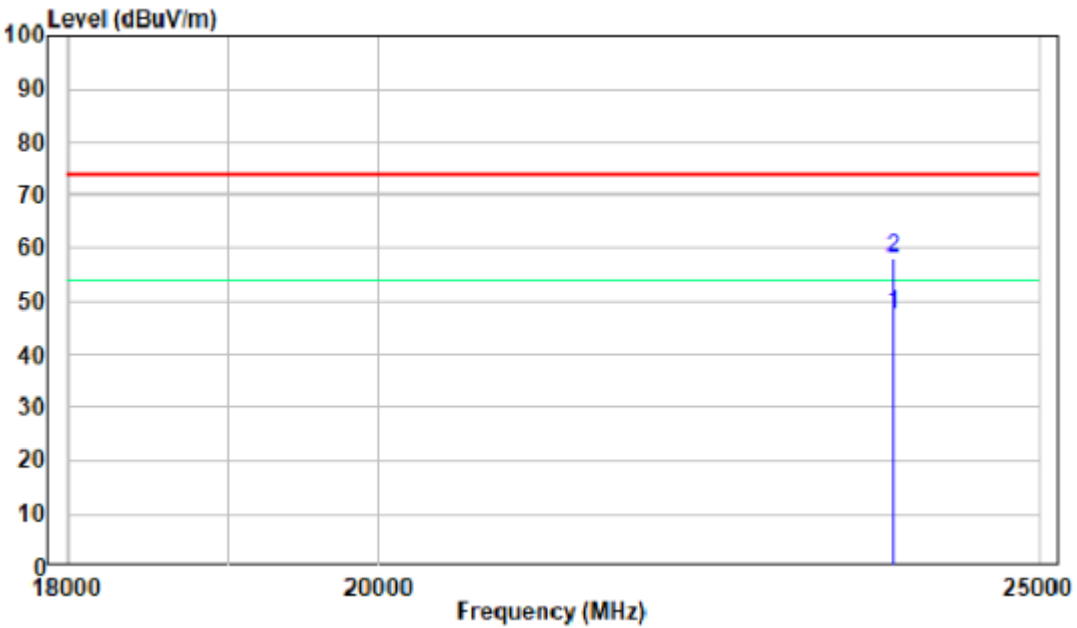
18-25GHz: (Pre-Scan plots)

Low channel

Horizontal



Vertical



FCC §15.247(a) (1) & RSS-247 §5.1 (b) -CHANNEL SEPARATION TEST

Applicable Standard

According to FCC §15.247(a) (1):

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

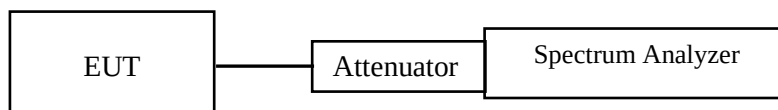
According to RSS-247 §5.1 (b):

Frequency hopping systems (FHSs) shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W. 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

Test Method: ANSI C63.10-2013 Clause 7.8.2

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



Test Data

Environmental Conditions

Temperature:	26.5 °C
Relative Humidity:	50%
ATM Pressure:	101.0 kPa

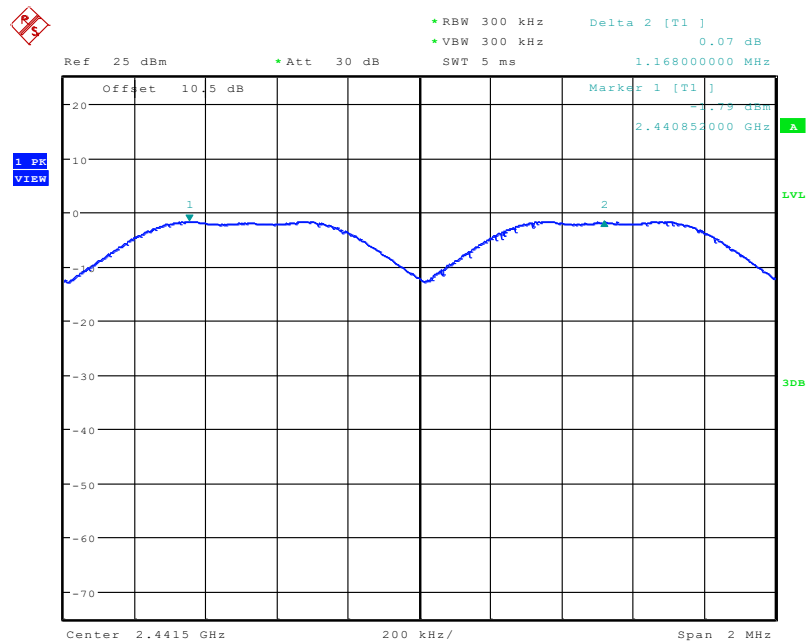
The testing was performed by Jacob Huang on 2023-04-08.

EUT operation mode: Transmitting

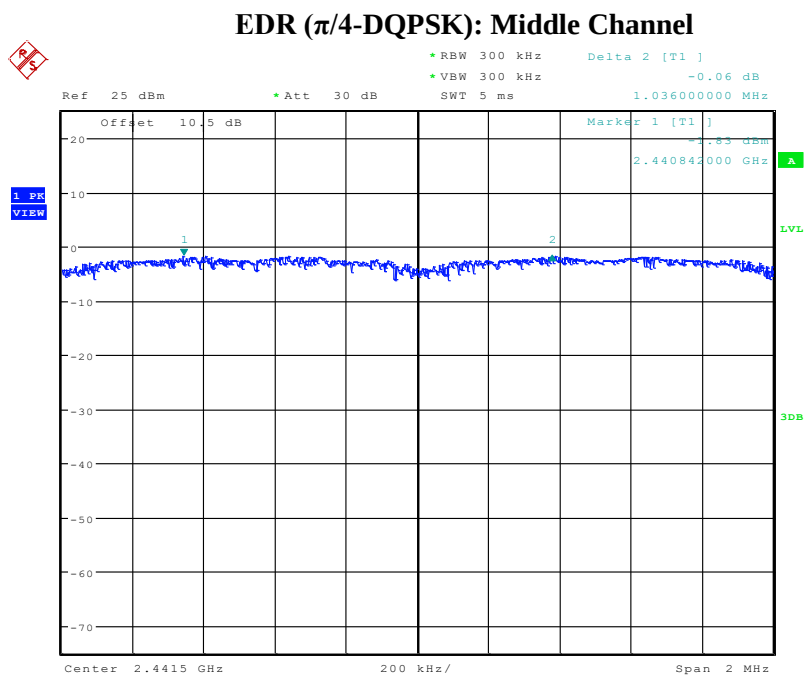
Please refer to following table and plots.

Channel	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit
BDR(GFSK)				
Middle	1.168	0.96	0.640	> two-thirds of the 20 dB bandwidth
EDR($\pi/4$-DQPSK)				
Middle	1.036	1.341	0.894	> two-thirds of the 20 dB bandwidth
EDR(8DPSK)				
Middle	1.092	1.311	0.874	> two-thirds of the 20 dB bandwidth

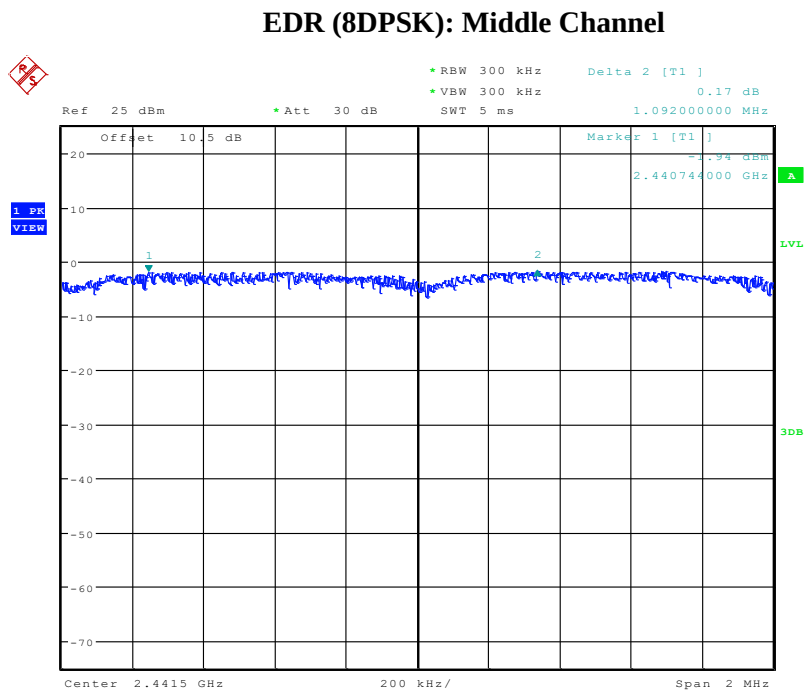
BDR (GFSK): Middle Channel



Date: 8.APR.2023 20:49:59



Date: 8.APR.2023 20:57:06



Date: 8.APR.2023 21:07:08

FCC §15.247(a) (1) & RSS-247 §5.1 (a), RSS-GEN §6.7 – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

Applicable Standard

According to FCC §15.247(a) (1):

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.

According to RSS-247 §5.1 (a), RSS-GEN §6.7:

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the “20 dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated 20 dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

Test Procedure

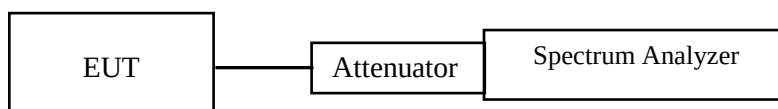
Test Method: ANSI C63.10-2013 Clause 7.8.7 & Clause 6.9.2

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

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not 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:	26.5 °C
Relative Humidity:	50%
ATM Pressure:	101.0 kPa

The testing was performed by Jacob Huang on 2023-04-08.

EUT operation mode: Transmitting

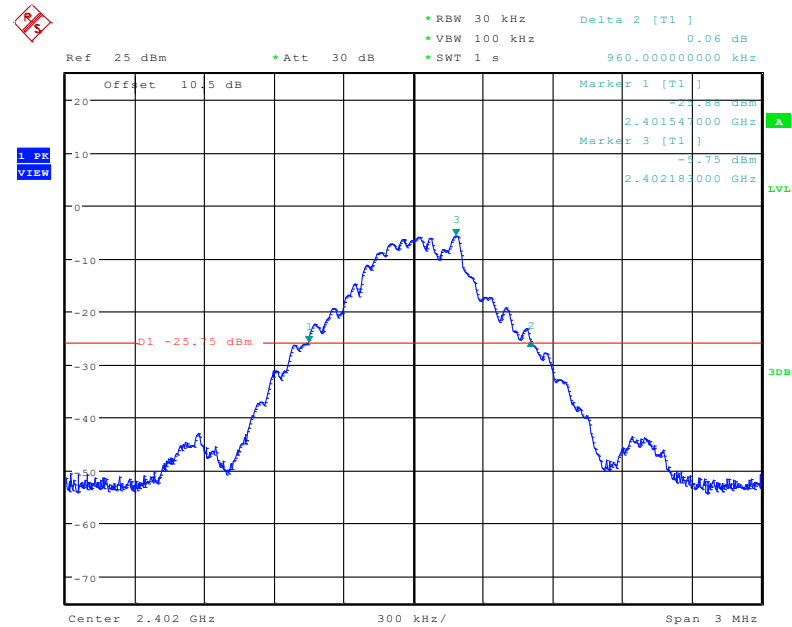
Test Result: Pass

Please refer to following table and plots.

Mode	Channel	Frequency (MHz)	99% Emission Bandwidth (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.882	0.960
	Middle	2441	0.876	0.960
	High	2480	0.873	0.960
EDR ($\pi/4$-DQPSK)	Low	2402	1.200	1.338
	Middle	2441	1.200	1.341
	High	2480	1.200	1.344
EDR (8DPSK)	Low	2402	1.185	1.308
	Middle	2441	1.188	1.311
	High	2480	1.185	1.311

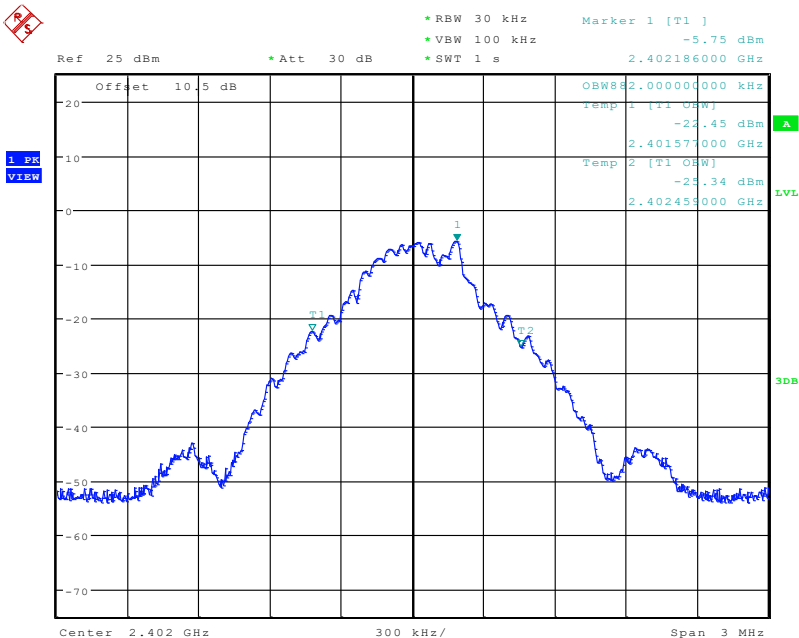
BDR (GFSK):

20dB Emission Bandwidth, Low Channel



Date: 8.APR.2023 20:29:32

99% Occupied Bandwidth, Low Channel



Date: 8.APR.2023 20:28:57

1 PK
VIEW

Offset 10.5 dB

Ref 25 dBm

Att 30 dB

RBW 30 kHz

VBW 100 kHz

SWT 1 s

Delta 2 [T1] 0.38 dB

960.00000000 kHz

Marker 1 [T1] -24.38 dBm 2.440495000 GHz

Marker 3 [T1] -4.38 dBm 2.441138000 GHz

Center 2.441 GHz 300 kHz/ Span 3 MHz

Date: 8.APR.2023 20:22:07

Ref 25 dBm *Att 30 dB •RBW 30 kHz Marker 1 [T1] -4.39 dBm
 •VBW 100 kHz •SWT 1 s 2.441141000 GHz

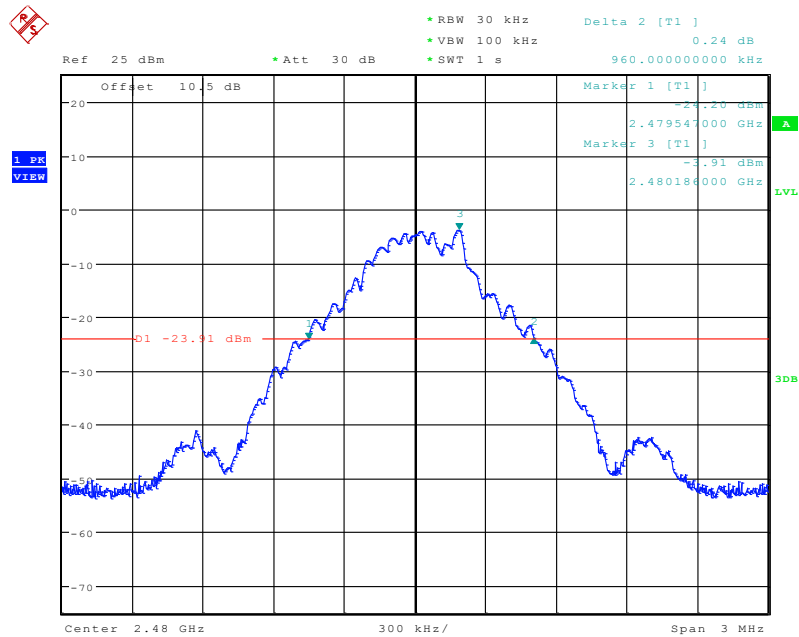
Offset 10.5 dB

OBW8 6.000000000 kHz
 Temp 1 [T1 OBW] -23.08 dBm
 2.440532000 GHz
 Temp 2 [T1 OBW] -23.86 dBm
 2.441408000 GHz

Center 2.441 GHz 300 kHz/ Span 3 MHz

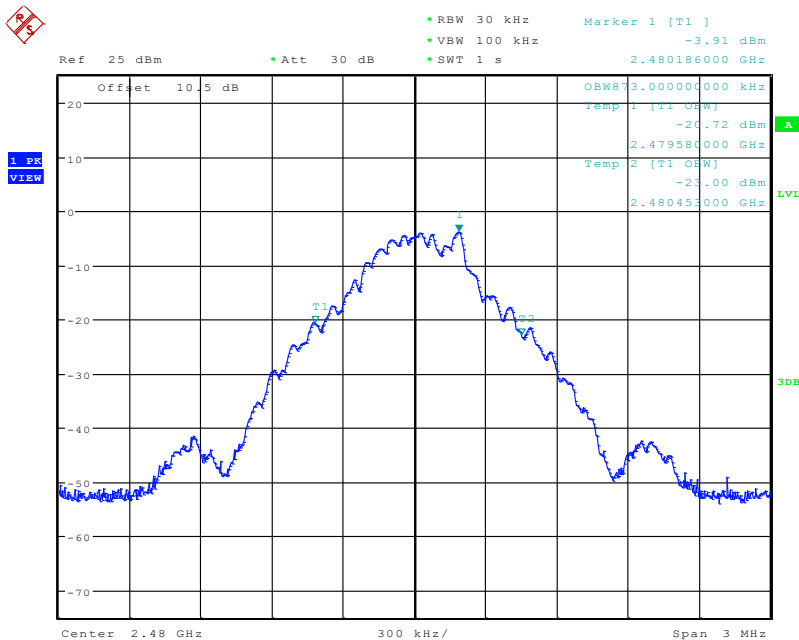
Date: 8.APR.2023 20:21:32

20dB Emission Bandwidth, High Channel



Date: 8.APR.2023 20:38:13

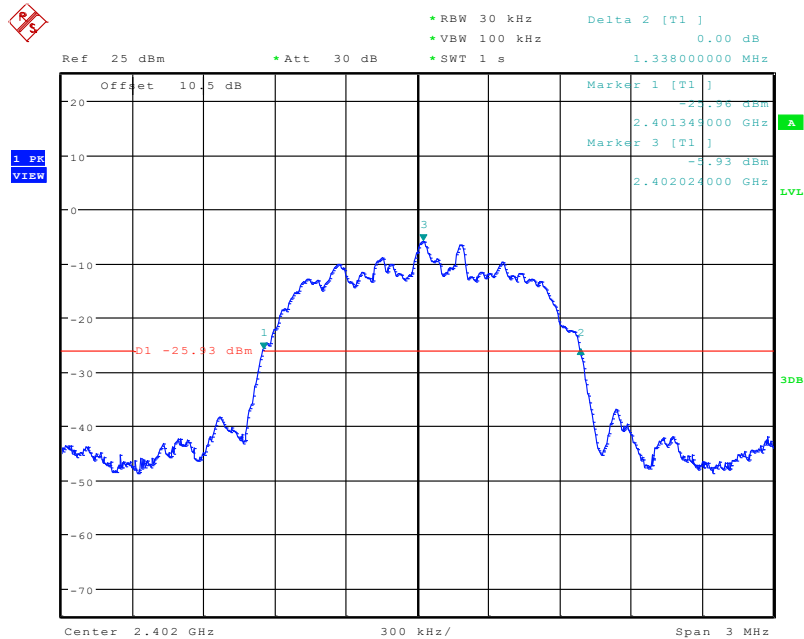
99% Occupied Bandwidth, High Channel



Date: 8.APR.2023 20:37:38

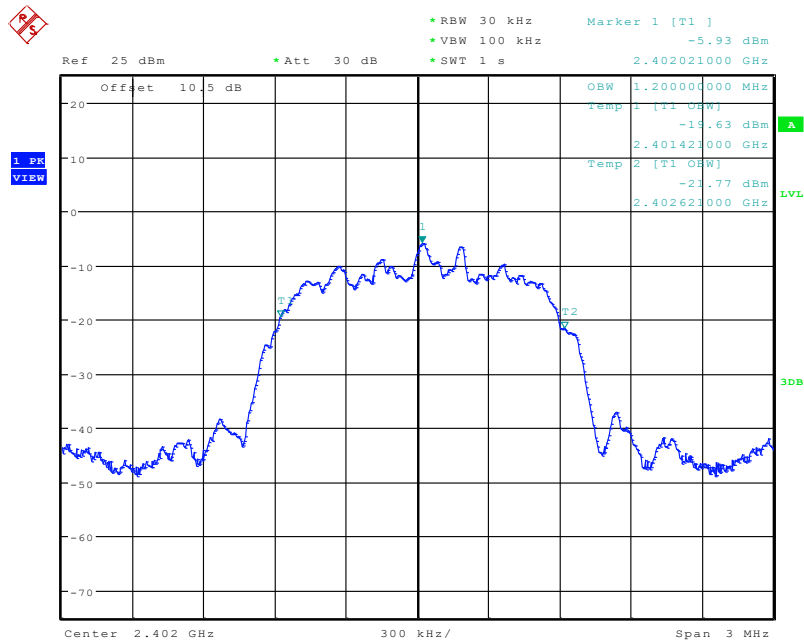
EDR ($\pi/4$ -DQPSK):

20dB Emission Bandwidth, Low Channel



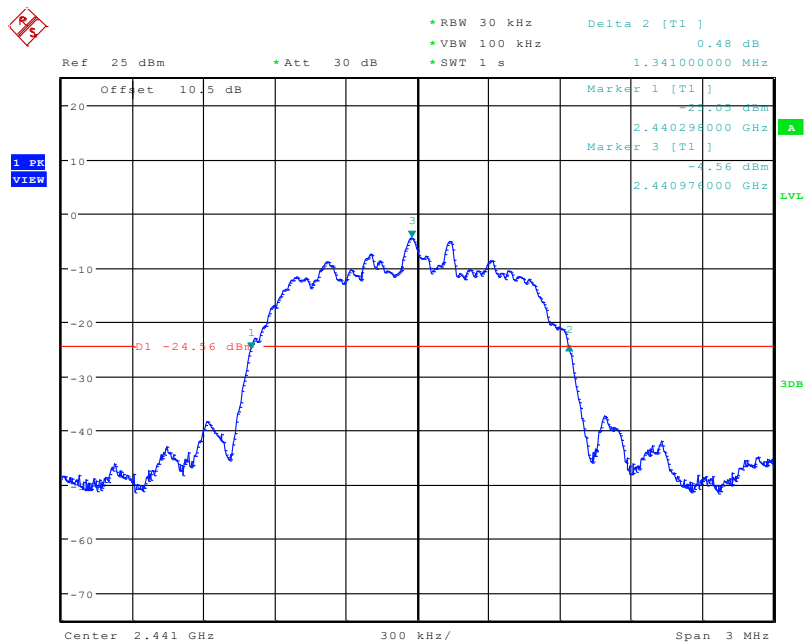
Date: 8.APR.2023 20:32:32

99% Occupied Bandwidth, Low Channel



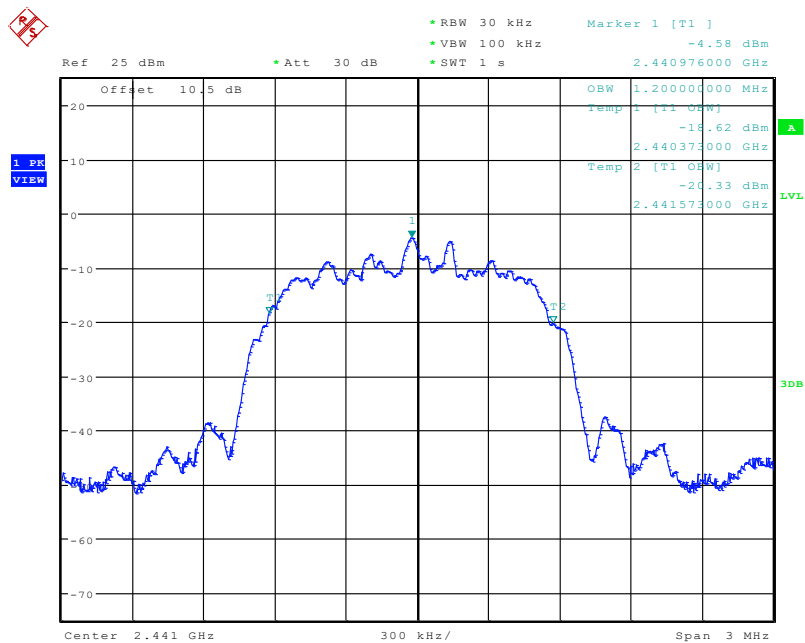
Date: 8.APR.2023 20:31:55

20dB Emission Bandwidth, Middle Channel



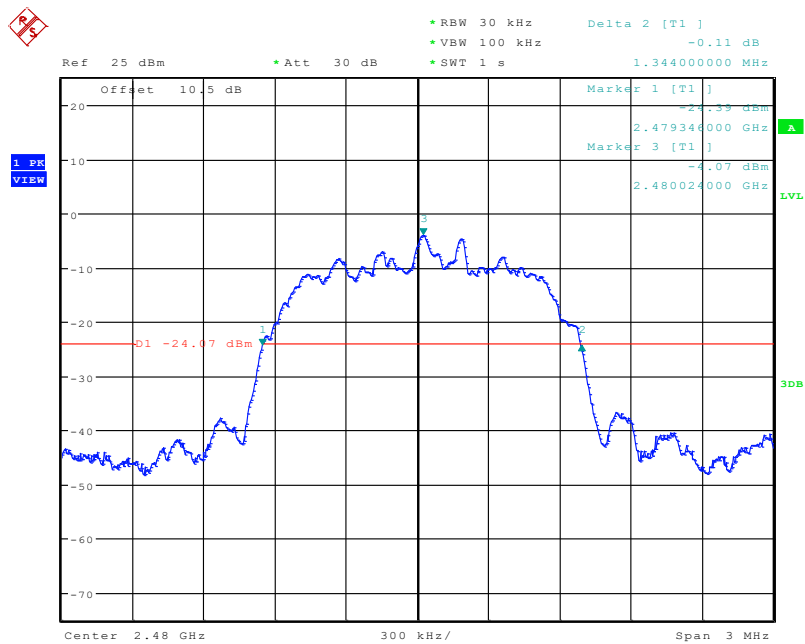
Date: 8.APR.2023 20:24:18

99% Occupied Bandwidth, Middle Channel



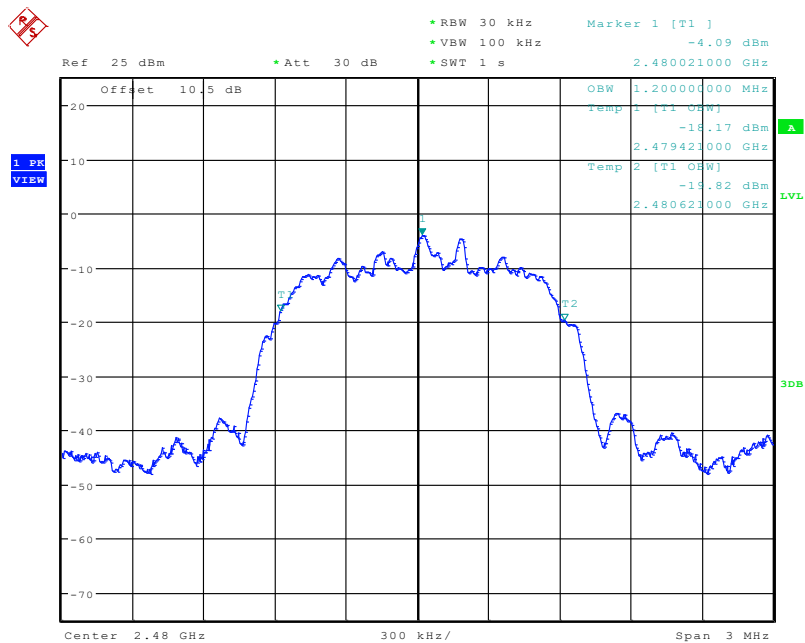
Date: 8.APR.2023 20:23:43

20dB Emission Bandwidth, High Channel



Date: 8.APR.2023 20:41:05

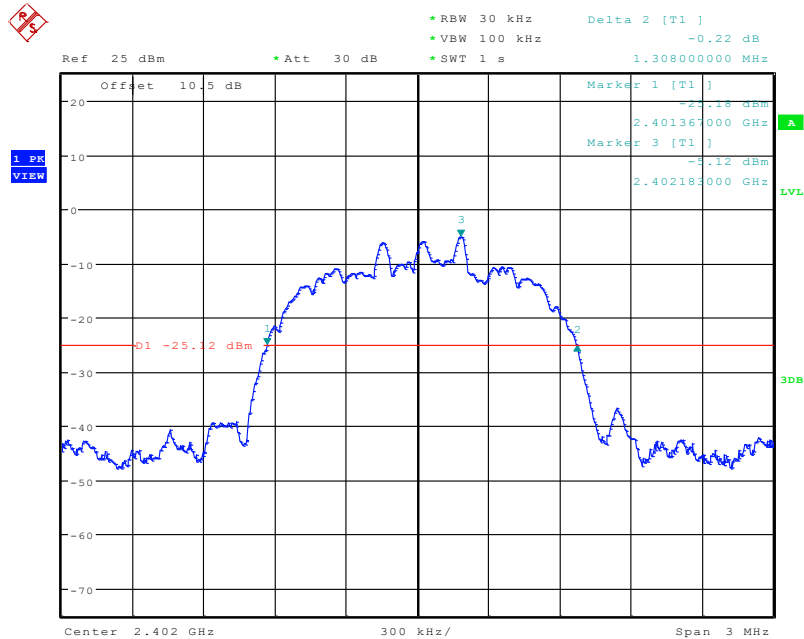
99% Occupied Bandwidth, High Channel



Date: 8.APR.2023 20:40:29

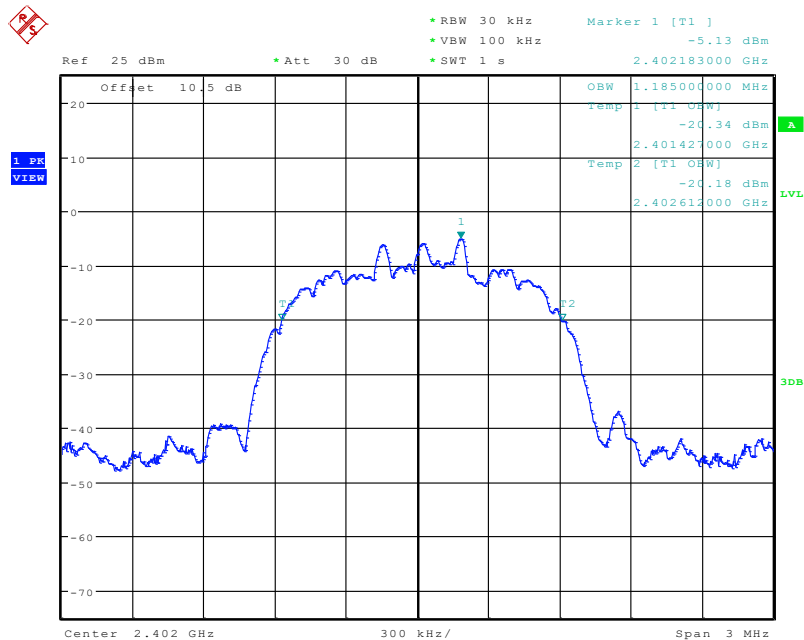
EDR (8DPSK):

20dB Emission Bandwidth, Low Channel



Date: 8.APR.2023 20:35:08

99% Occupied Bandwidth, Low Channel



Date: 8.APR.2023 20:34:33

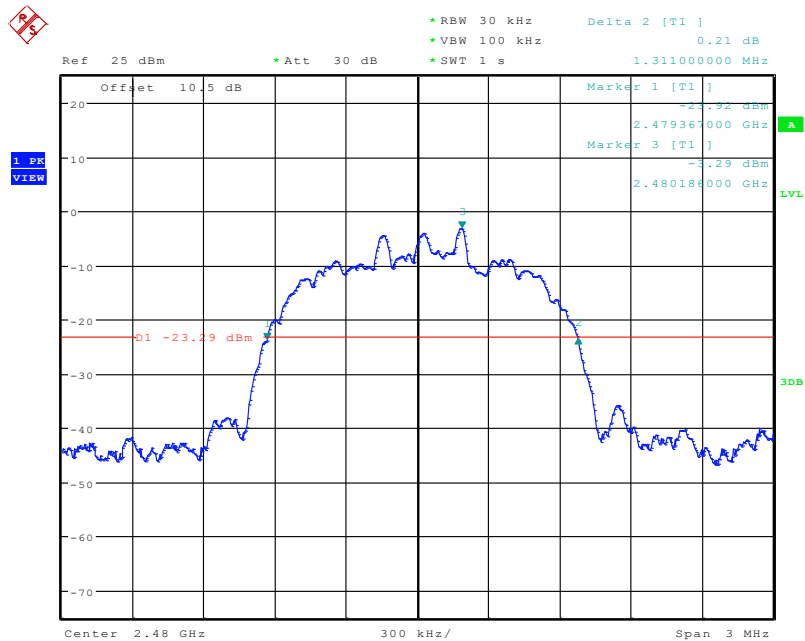


A



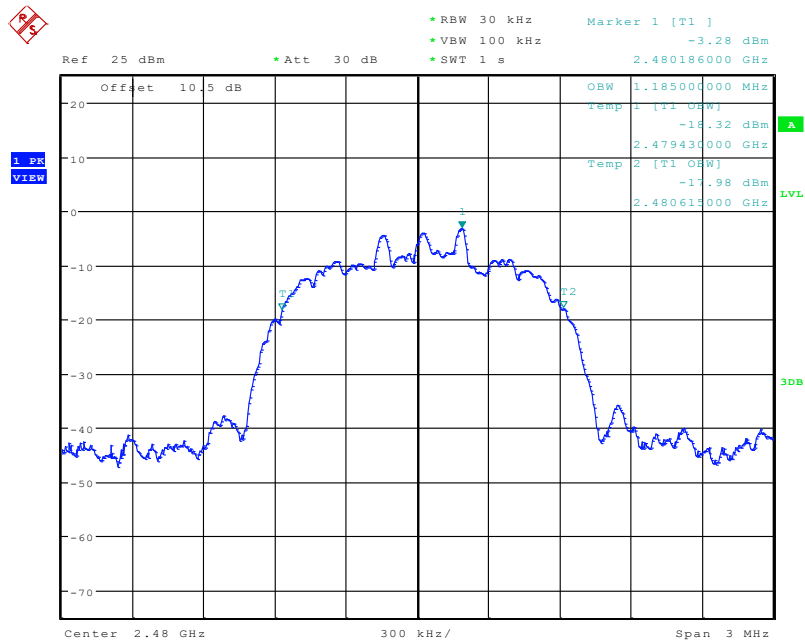
A

20dB Emission Bandwidth, High Channel



Date: 8.APR.2023 20:43:53

99% Occupied Bandwidth, High Channel



Date: 8.APR.2023 20:43:17

FCC §15.247(a) (1) (iii) & RSS-247 § 5.1 (d) - QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

According to FCC §15.247(a) (1) (iii):

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.

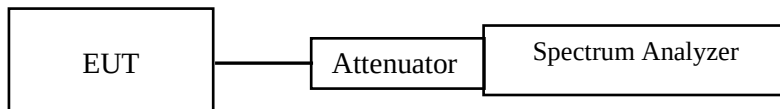
According to RSS-247 § 5.1 (d):

Frequency hopping systems (FHSS) operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.3

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



Test Data

Environmental Conditions

Temperature:	26.5 °C
Relative Humidity:	50%
ATM Pressure:	101.0 kPa

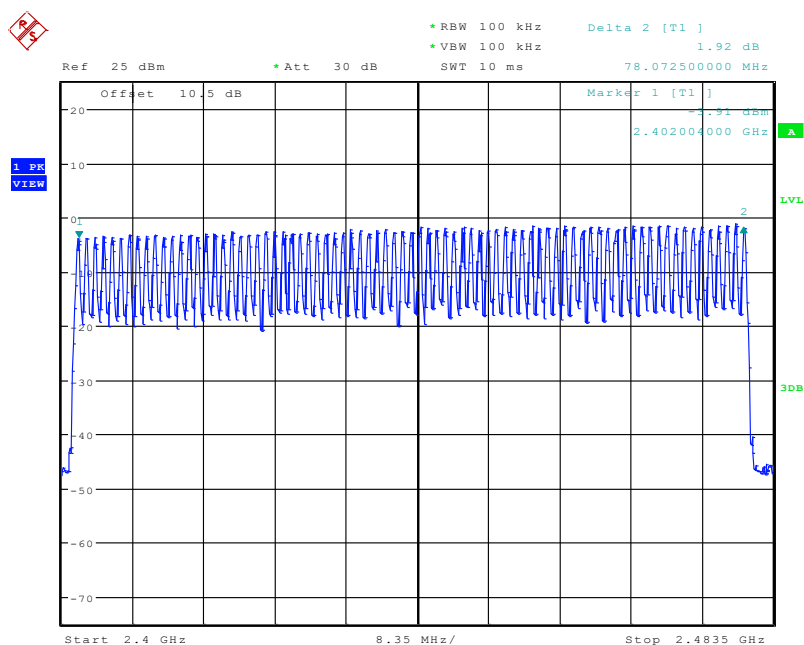
The testing was performed by Jacob Huang on 2023-04-08.

EUT operation mode: Transmitting

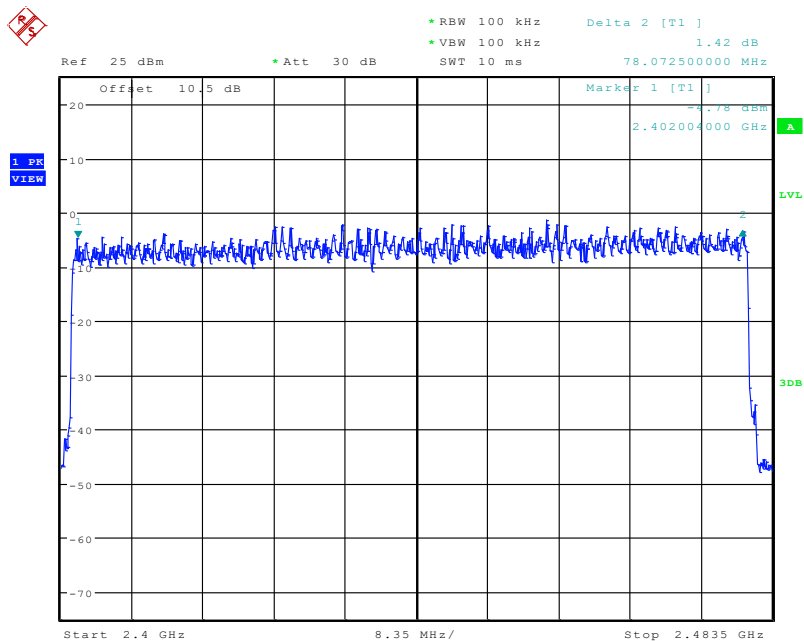
Test Result: Pass

Please refer to following table and plots.

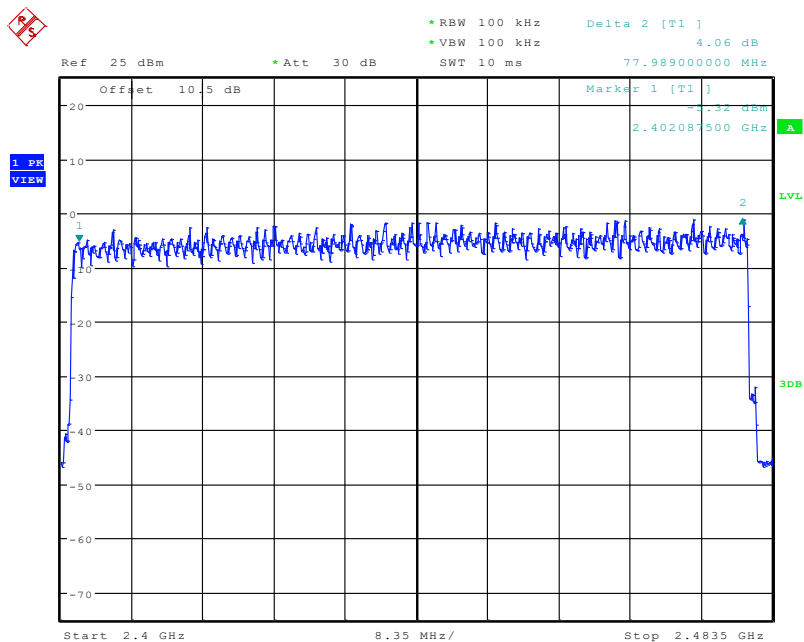
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥ 15
EDR ($\pi/4$ -DQPSK)	2400-2483.5	79	≥ 15
EDR (8DPSK)	2400-2483.5	79	≥ 15

BDR (GFSK): Number of Hopping Channels

Date: 8.APR.2023 20:49:07

EDR ($\pi/4$ -DQPSK): Number of Hopping Channels

Date: 8.APR.2023 20:56:24

EDR (8DPSK): Number of Hopping Channels

Date: 8.APR.2023 21:06:26

FCC §15.247(a) (1) (iii) & RSS-247 §5.1 (d) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

According to FCC §15.247(a) (1) (iii):

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.

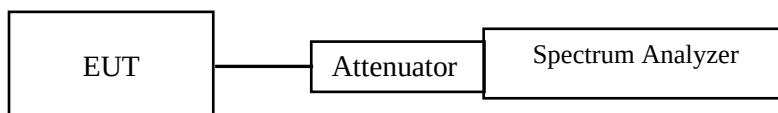
According to RSS-247 §5.1 (d):

Frequency hopping systems (FHSs) operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.4

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



Test Data

Environmental Conditions

Temperature:	26.5 °C
Relative Humidity:	50%
ATM Pressure:	101.0 kPa

The testing was performed by Jacob Huang on 2023-04-08.

EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table and plots

Test Mode	Channel	Pulse Time [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Hop	0.386	320	0.124	≤ 0.4	PASS
DH3	Hop	1.644	160	0.263	≤ 0.4	PASS
DH5	Hop	2.910	110	0.320	≤ 0.4	PASS
2DH1	Hop	0.396	320	0.127	≤ 0.4	PASS
2DH3	Hop	1.650	160	0.264	≤ 0.4	PASS
2DH5	Hop	2.910	110	0.320	≤ 0.4	PASS
3DH1	Hop	0.397	320	0.127	≤ 0.4	PASS
3DH3	Hop	1.650	160	0.264	≤ 0.4	PASS
3DH5	Hop	2.915	110	0.321	≤ 0.4	PASS

Note 1: A period time= $0.4 \times 79 = 31.6(S)$, Result= Pulse Time *Total hops

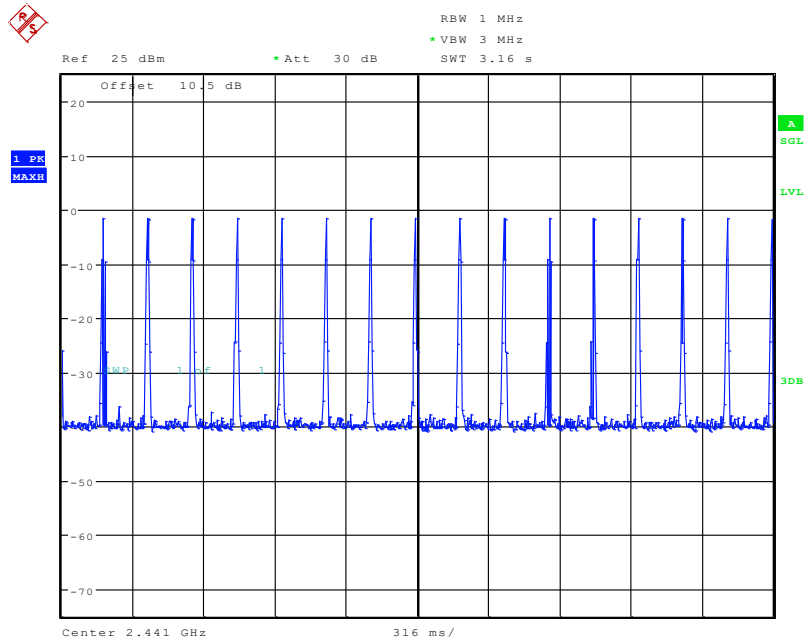
Note 2: Total hops=Hopping Number in $3.16s \times 10$

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

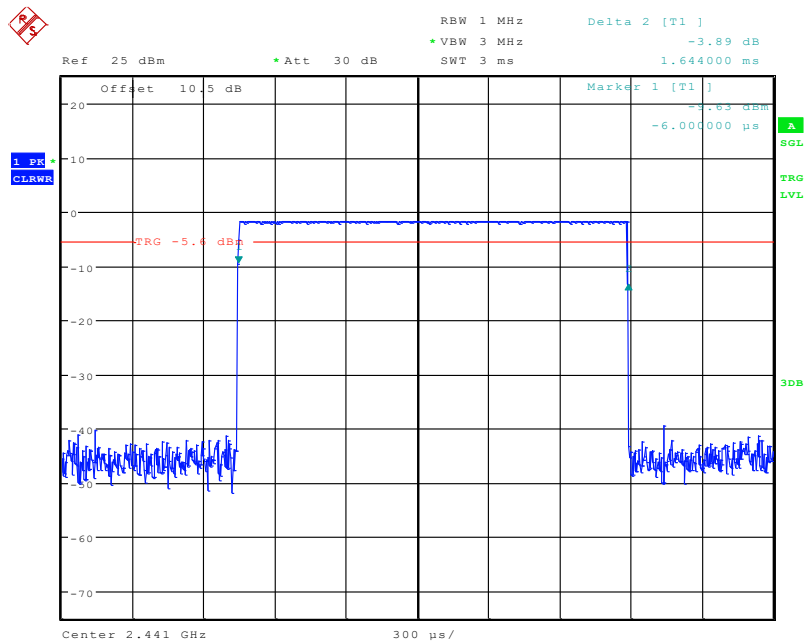
Date: 8.APR.2023 20:46:11



DH3

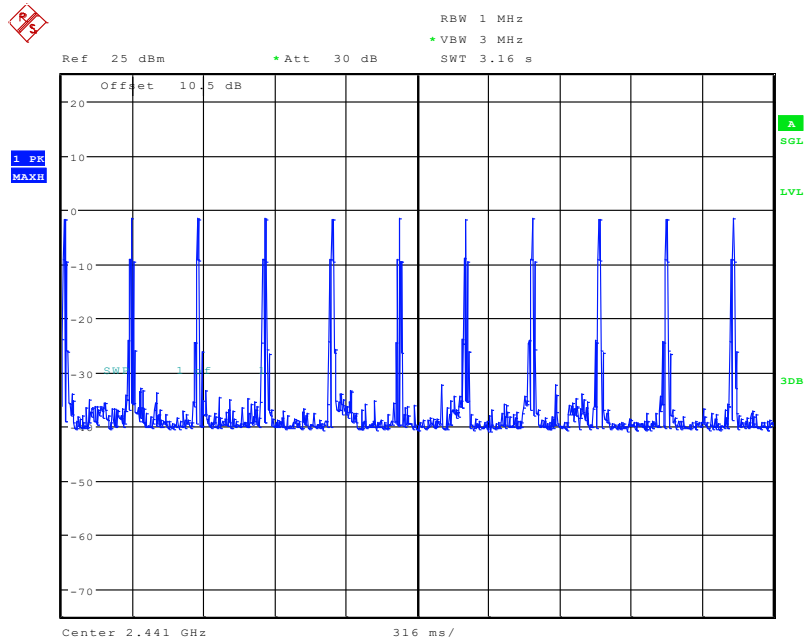


Date: 8.APR.2023 20:47:03

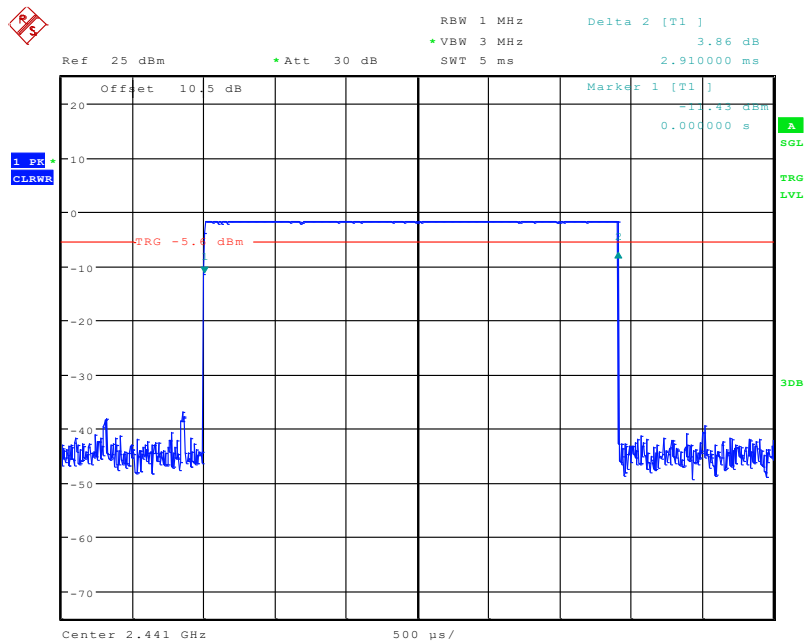


Date: 8.APR.2023 20:47:22

DH5

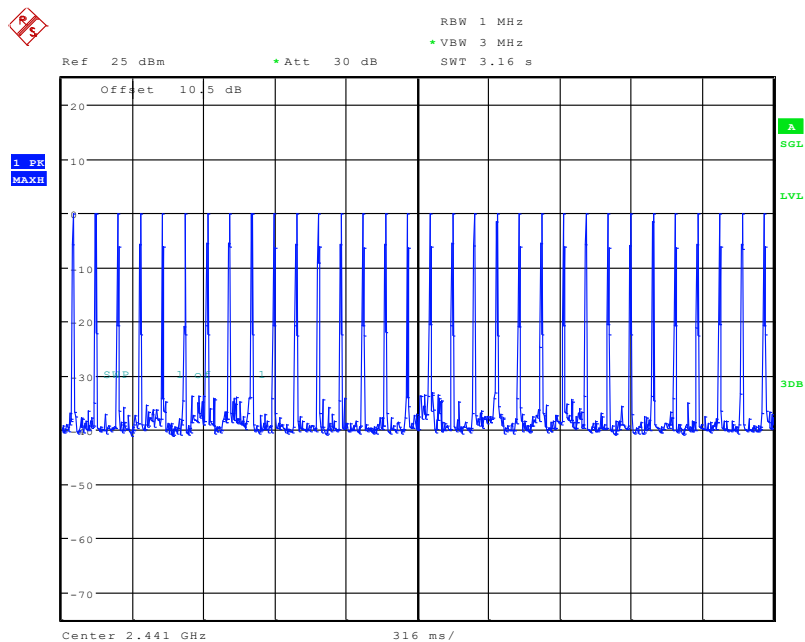


Date: 8.APR.2023 20:50:15

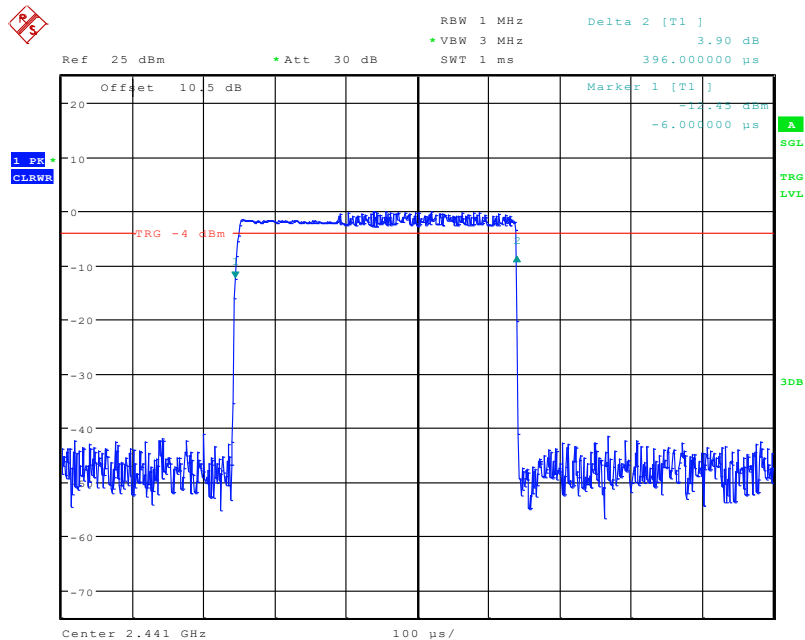


Date: 8.APR.2023 20:50:34

EDR($\pi/4$ -DQPSK):
2DH1

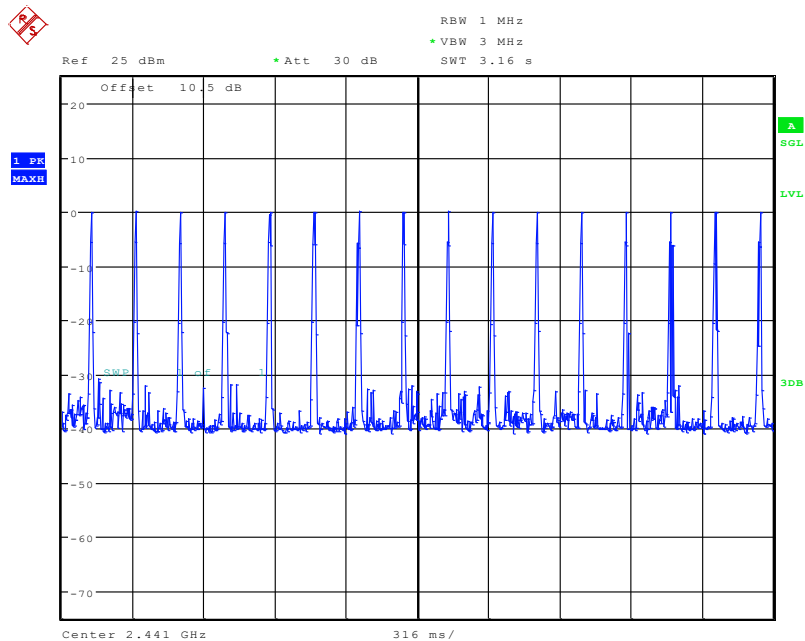


Date: 8.APR.2023 20:53:43

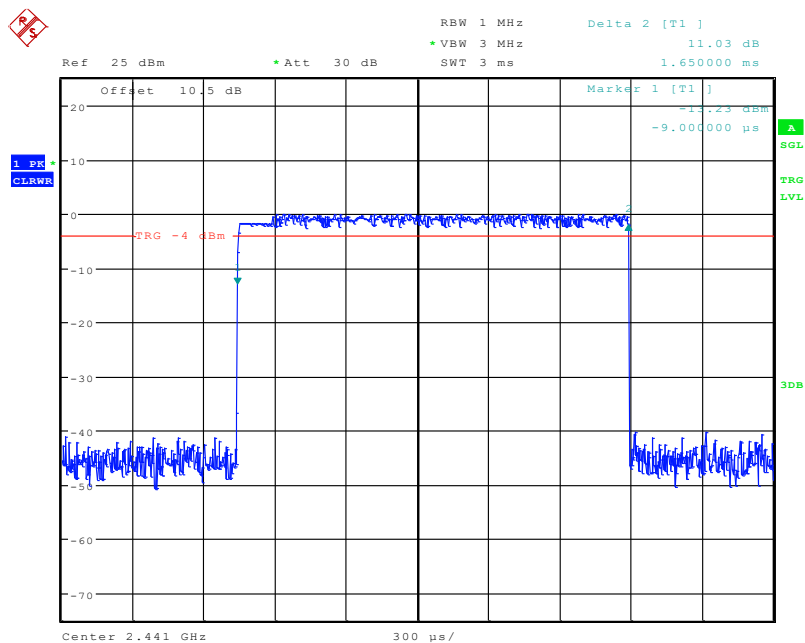


Date: 8.APR.2023 20:54:02

2DH3

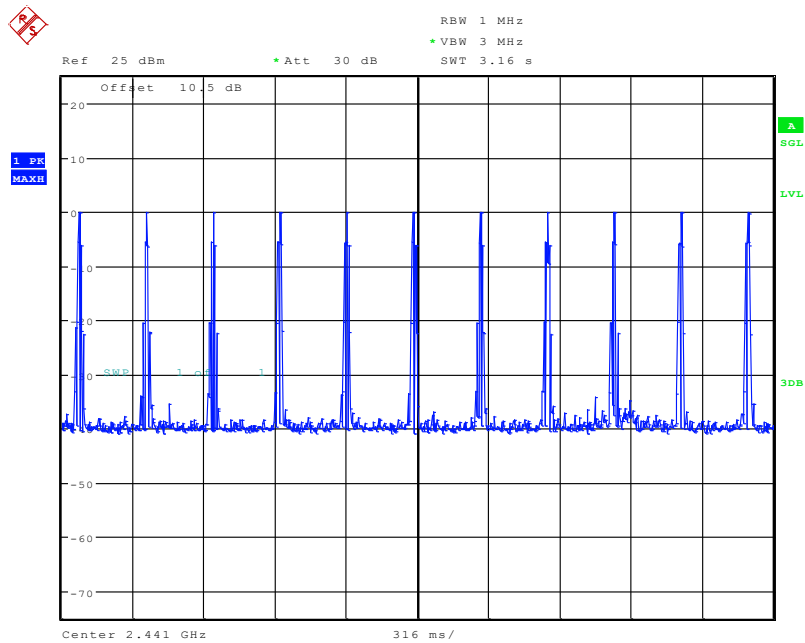


Date: 8.APR.2023 20:54:37

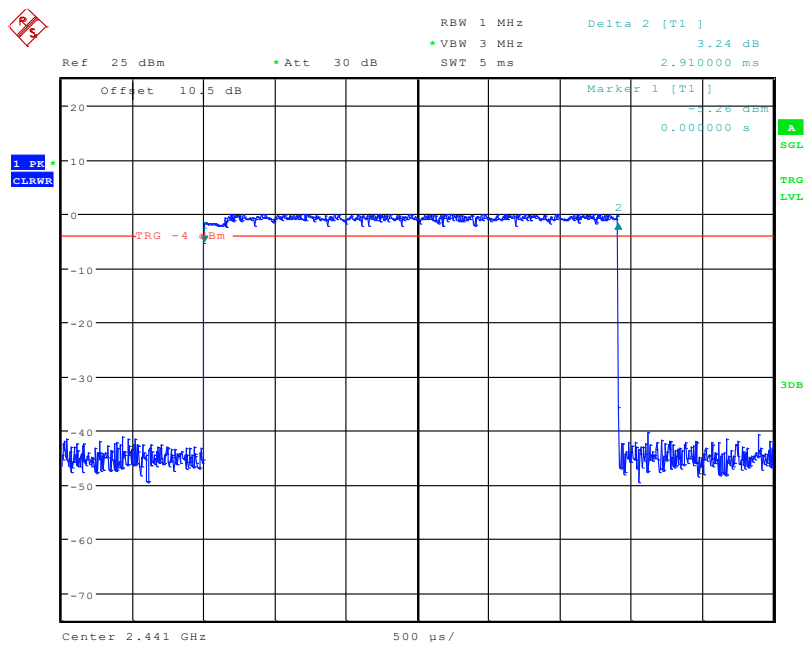


Date: 8.APR.2023 20:54:56

2DH5

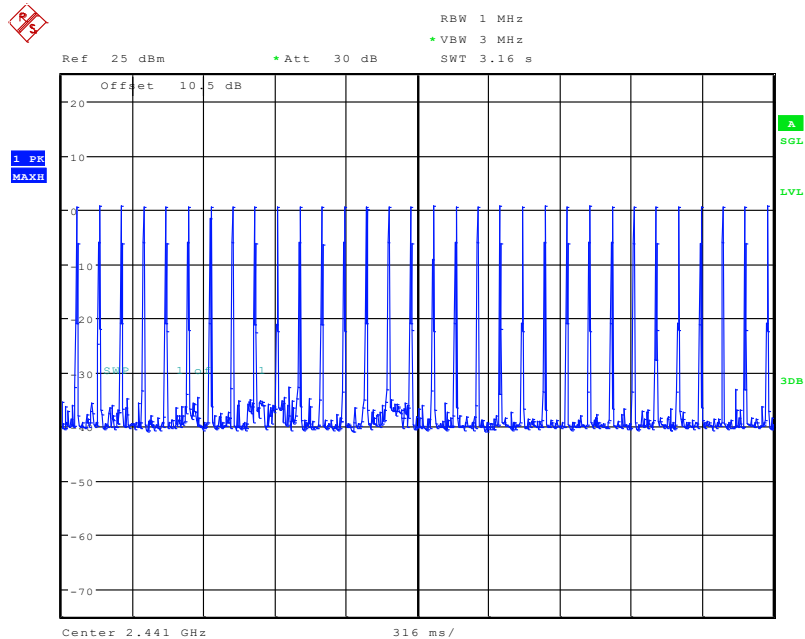


Date: 8.APR.2023 20:57:22

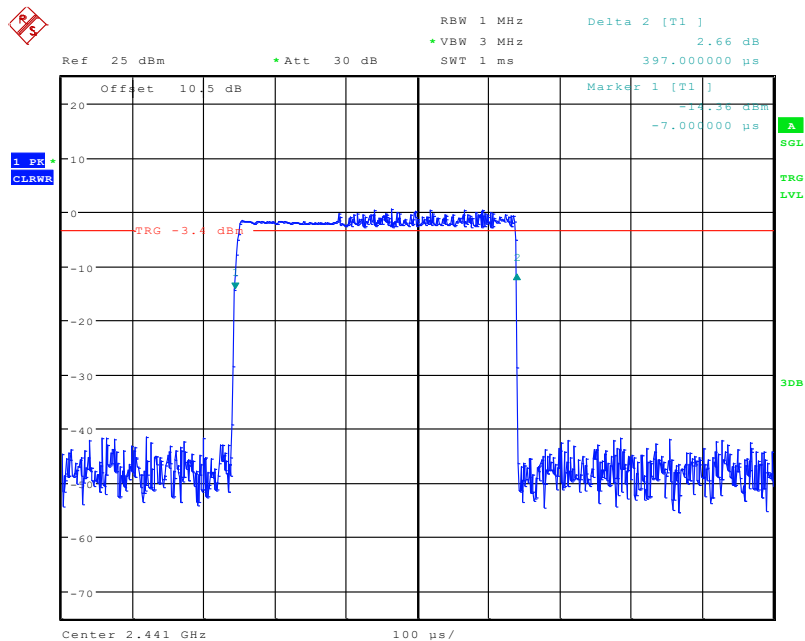


Date: 8.APR.2023 20:57:41

EDR (8DPSK):
3DH1

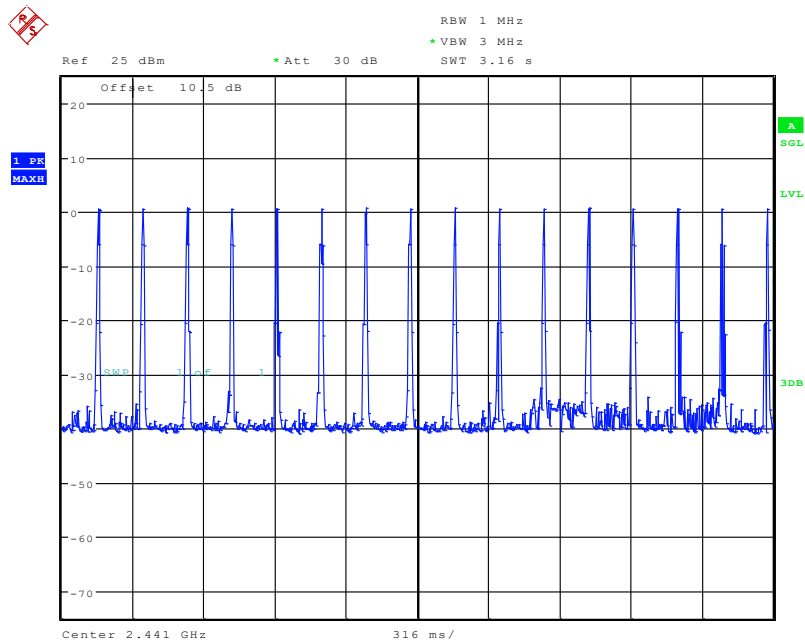


Date: 8.APR.2023 21:00:28

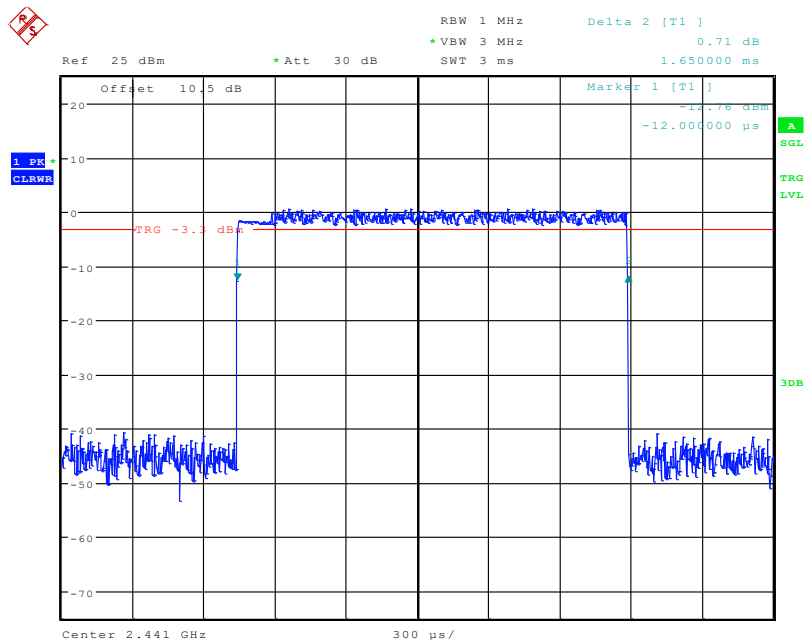


Date: 8.APR.2023 21:00:47

3DH3

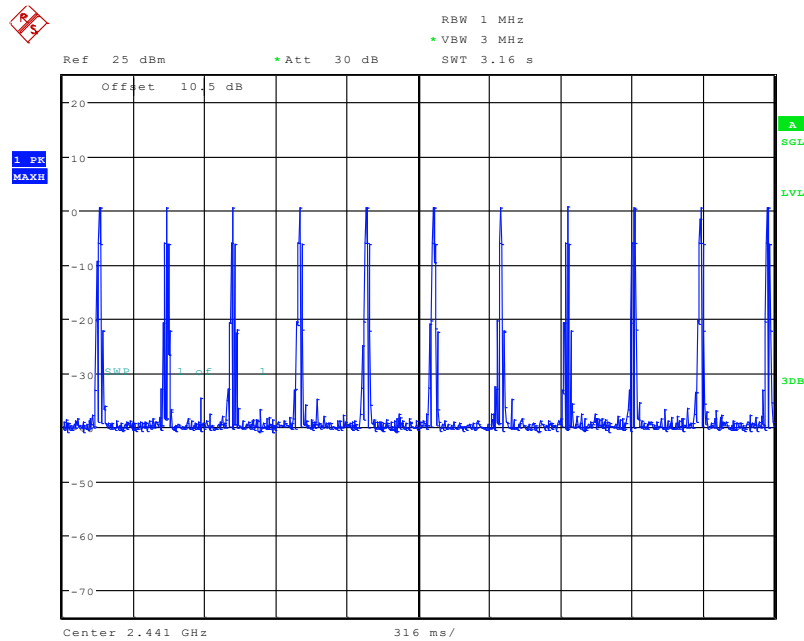


Date: 8.APR.2023 21:01:26

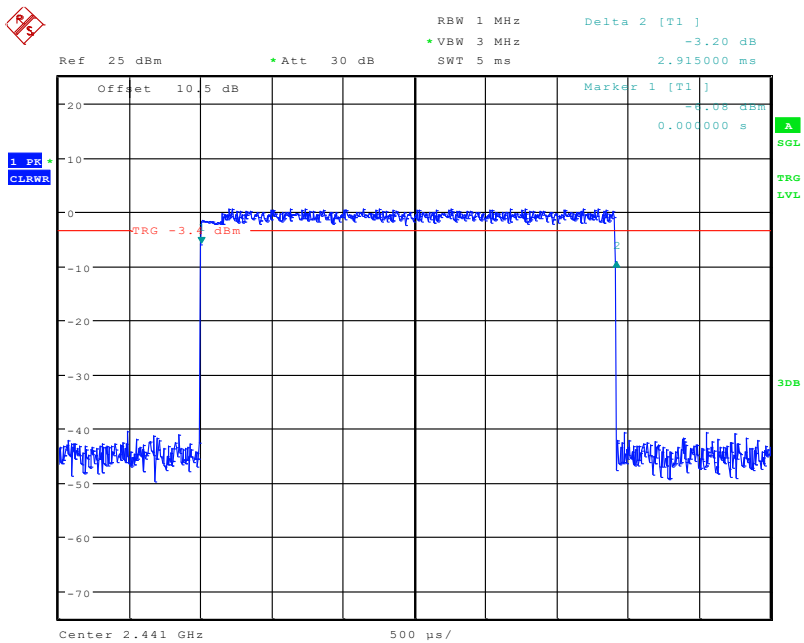


Date: 8.APR.2023 21:01:45

3DH5



Date: 8.APR.2023 21:07:25



Date: 8.APR.2023 21:07:43

FCC §15.247(b) (1) & RSS-247 §5.1(b) & §5.4(b) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to FCC §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.

According to RSS-247 §5.1(b) & §5.4(b):

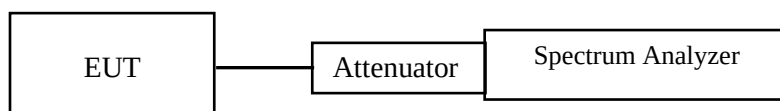
For frequency hopping systems (FHSs) operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W (see Section 5.4(e) for exceptions).

Frequency hopping systems (FHSs) shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.5

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:	26.5 °C
Relative Humidity:	50%
ATM Pressure:	101.0 kPa

The testing was performed by Jacob Huang on 2023-04-08.

EUT operation mode: Transmitting

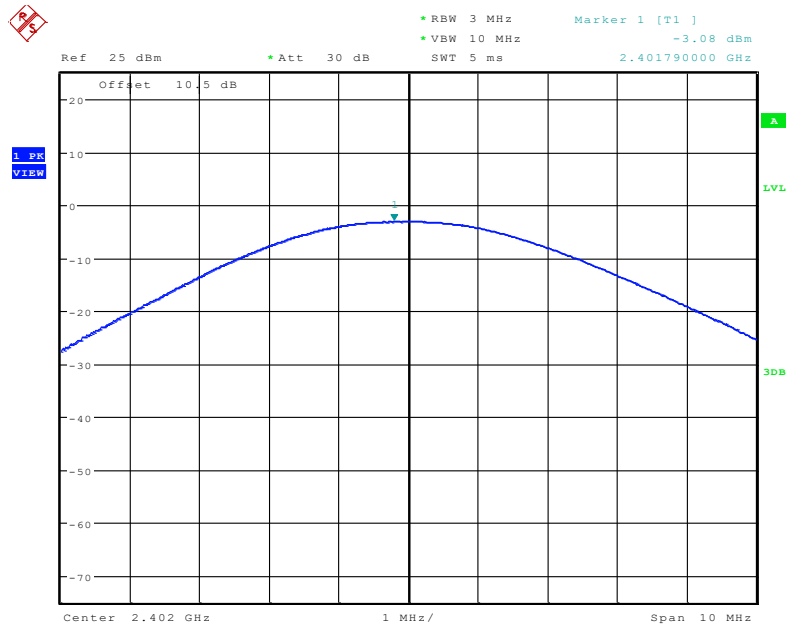
Test Result: Pass

Please refer to following table and plots.

Mode	Channel	Frequency (MHz)	Peak Output Power	Limit (dBm)
			(dBm)	
BDR (GFSK)	Low	2402	-3.08	21
	Middle	2441	-1.70	21
	High	2480	-1.08	21
EDR ($\pi/4$-DQPSK)	Low	2402	-0.46	21
	Middle	2441	0.53	21
	High	2480	1.25	21
EDR (8DPSK)	Low	2402	0.33	21
	Middle	2441	1.18	21
	High	2480	2.13	21

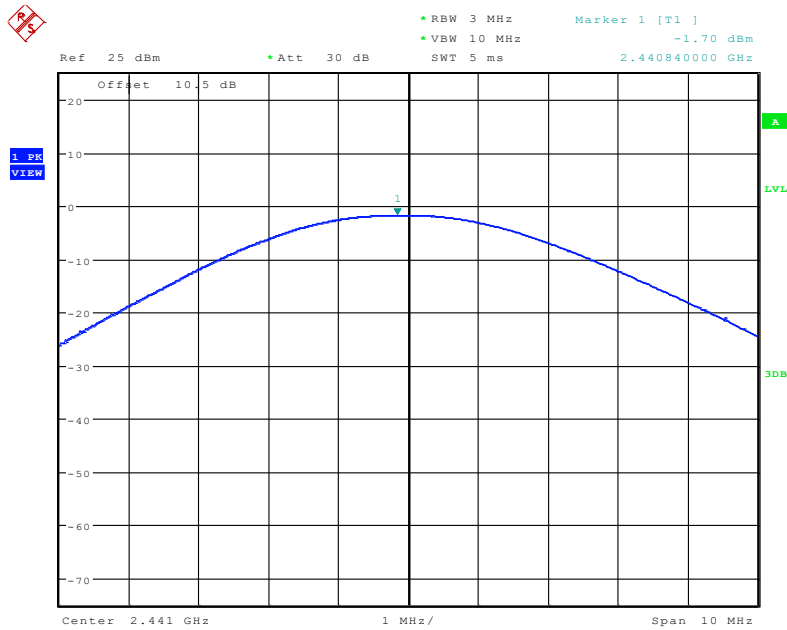
BDR (GFSK):

Low Channel



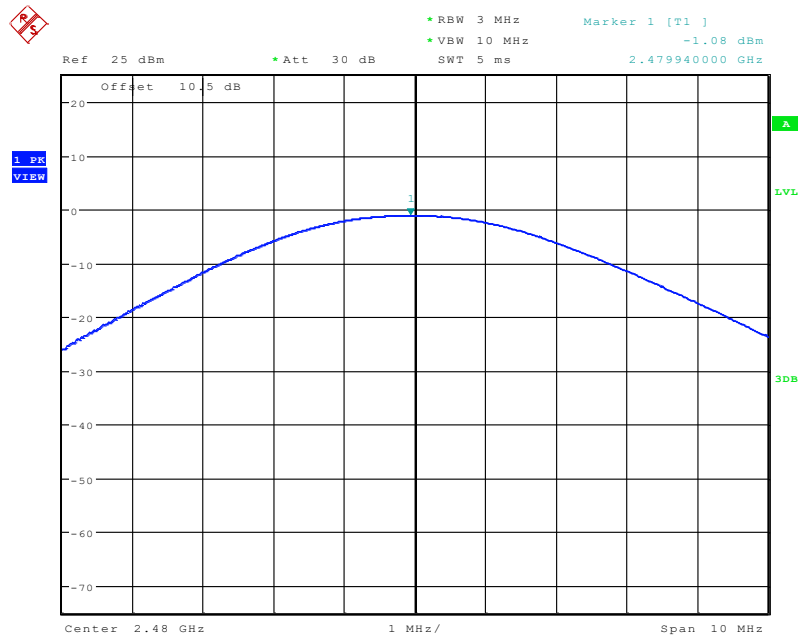
Date: 8.APR.2023 20:28:21

Middle Channel



Date: 8.APR.2023 20:20:56

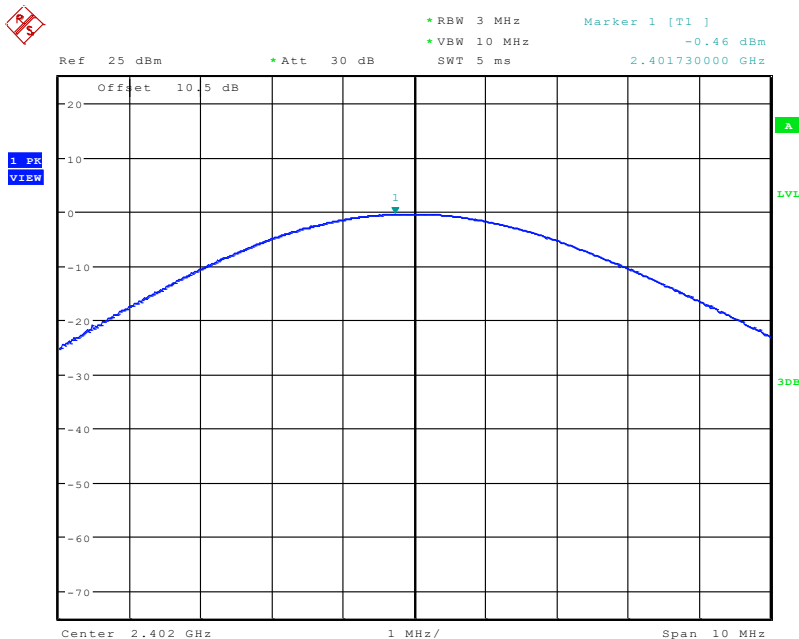
High Channel



Date: 8.APR.2023 20:37:02

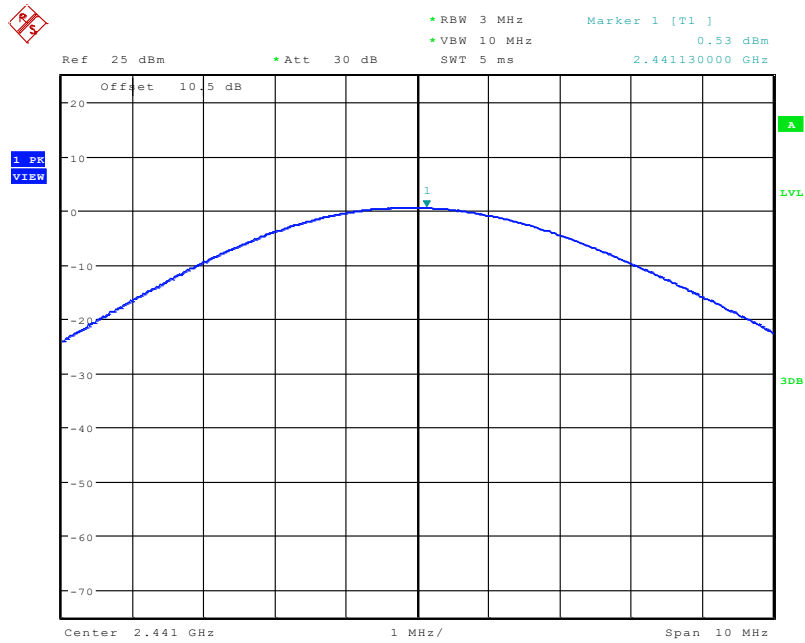
EDR ($\pi/4$ -DQPSK):

Low Channel



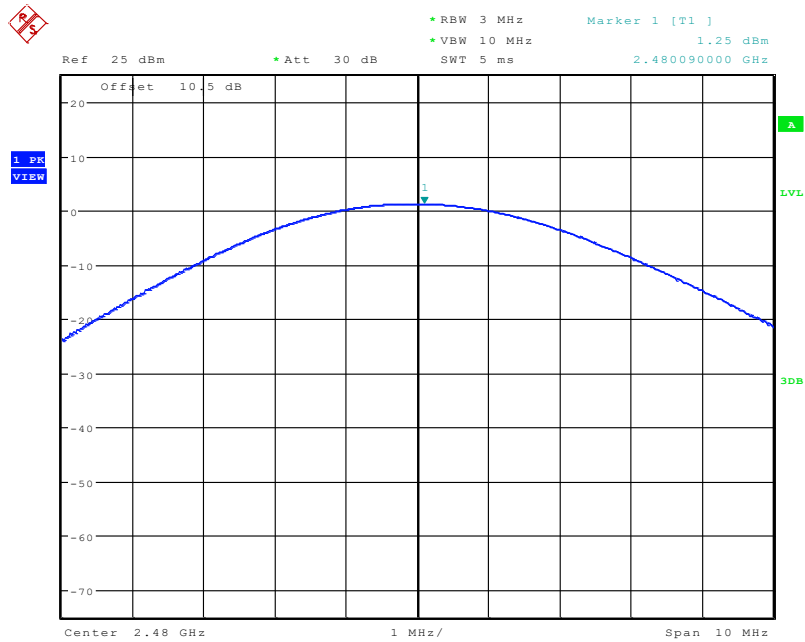
Date: 8.APR.2023 20:31:21

Middle Channel



Date: 8.APR.2023 20:23:07

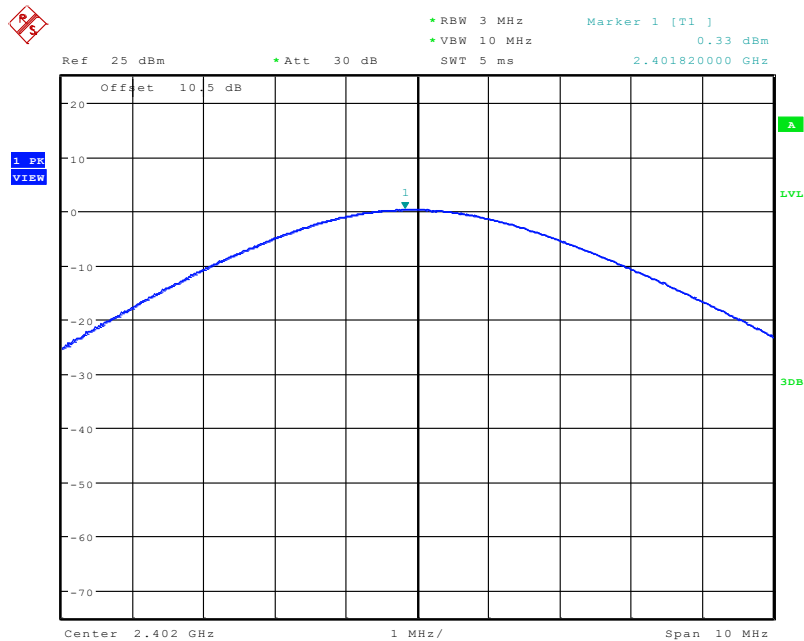
High Channel



Date: 8.APR.2023 20:39:54

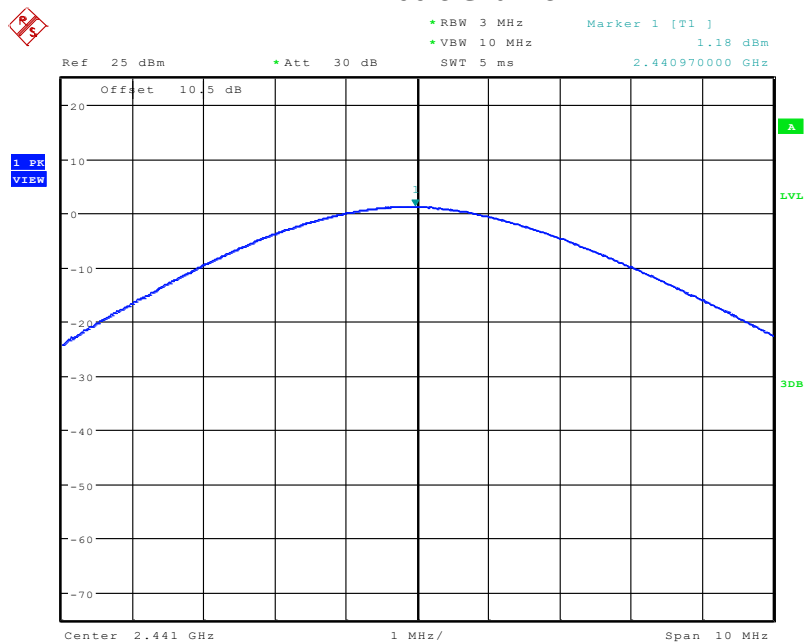
EDR (8DPSK):

Low Channel

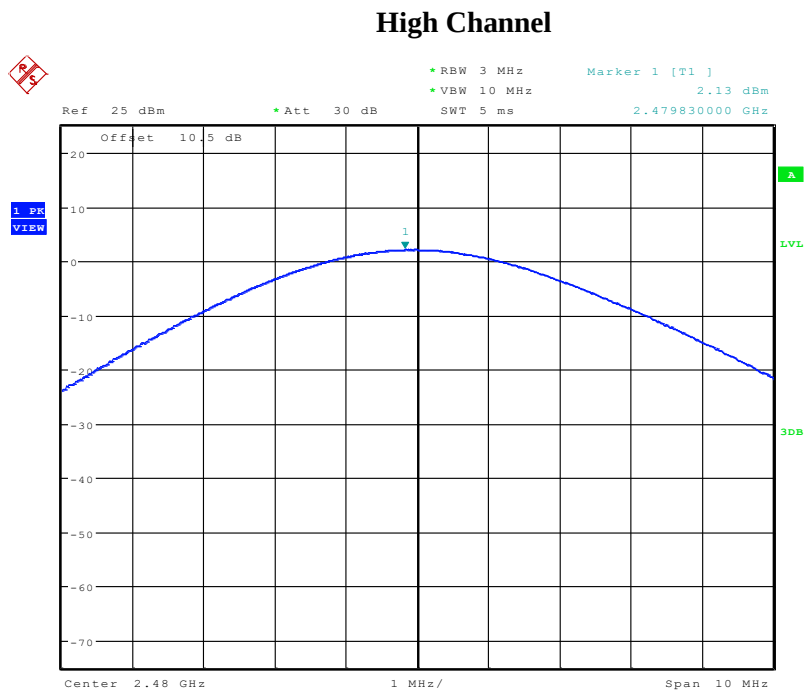


Date: 8.APR.2023 20:33:58

middle Channel



Date: 8.APR.2023 20:25:19



Date: 8.APR.2023 20:42:42

FCC §15.247(d) & RSS-247 §5.5 - BAND EDGES TESTING

Applicable Standard

According to FCC §15.247(d).

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)).

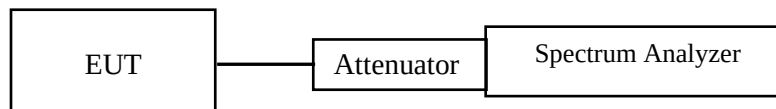
According to RSS-247 §5.5.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(e), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.6 & Clause 6.10

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in 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:	26.5 °C
Relative Humidity:	50%
ATM Pressure:	101.0 kPa

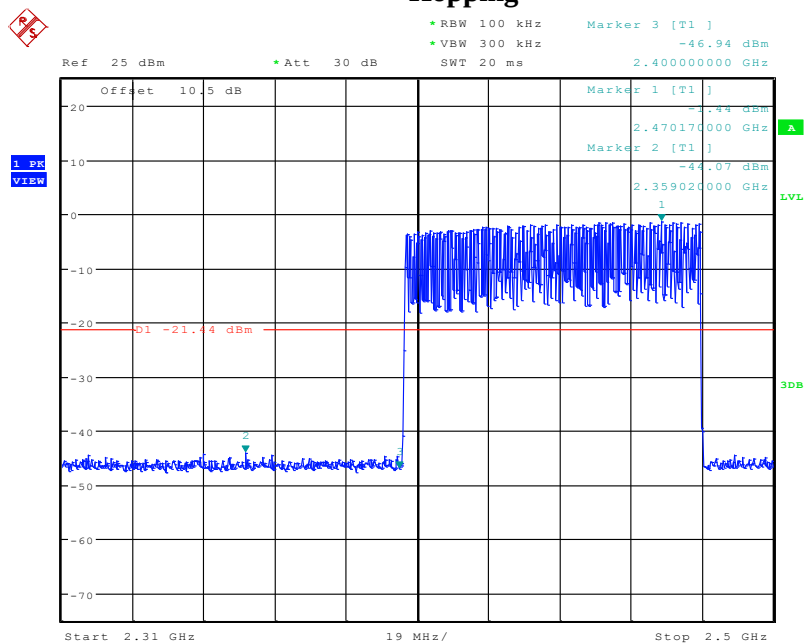
The testing was performed by Jacob Huang on 2023-04-08.

EUT operation mode: Transmitting

Test Result: Pass

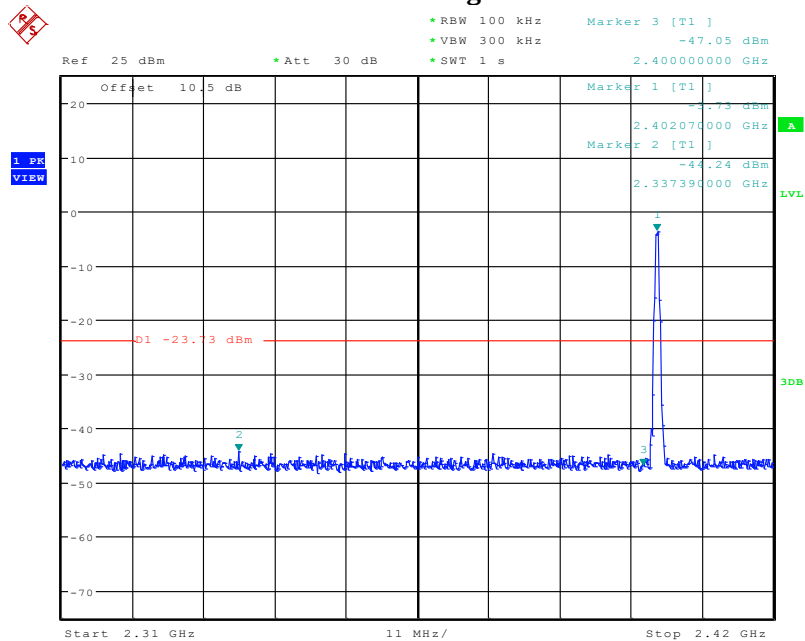
Please refer to following plots

BDR (GFSK): Band Edge-Left Side Hopping



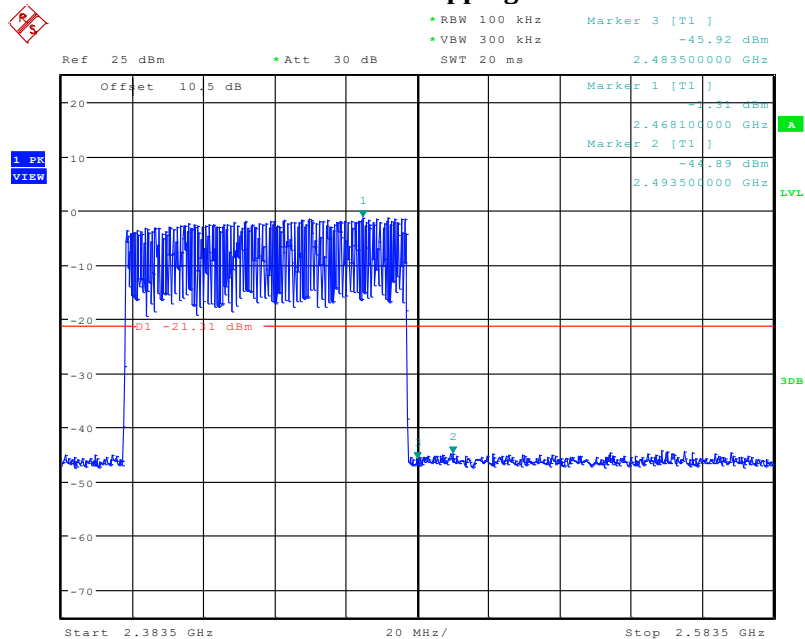
Date: 8.APR.2023 20:51:47

Single



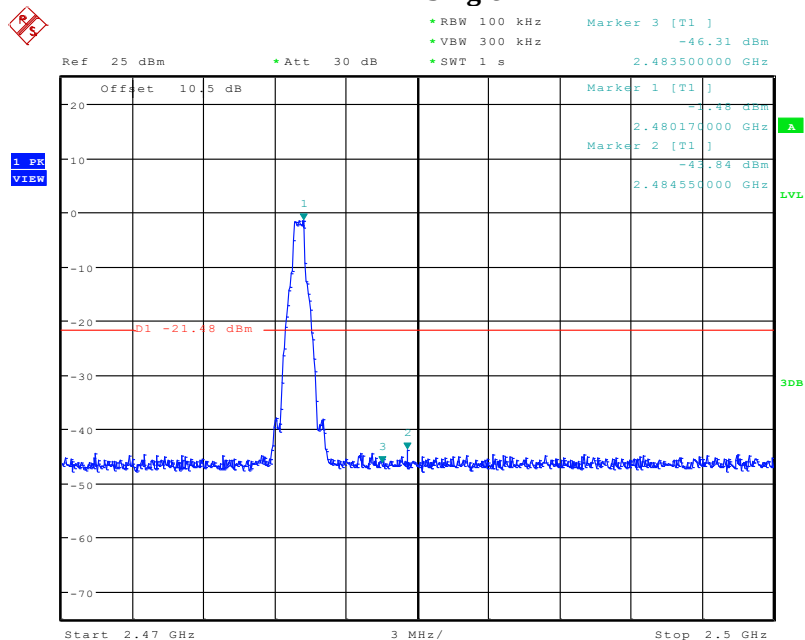
Date: 8.APR.2023 20:29:56

BDR (GFSK): Band Edge-Right Side Hopping



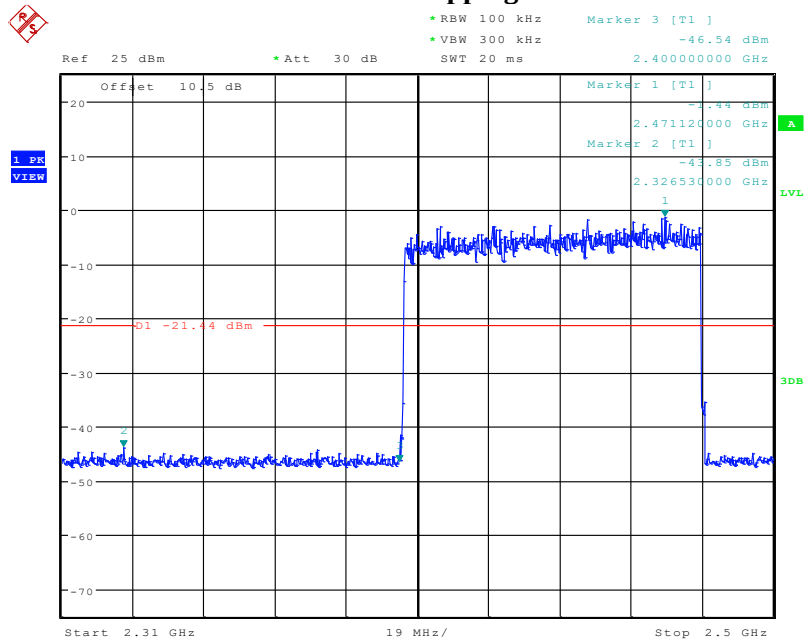
Date: 8.APR.2023 20:52:59

Single



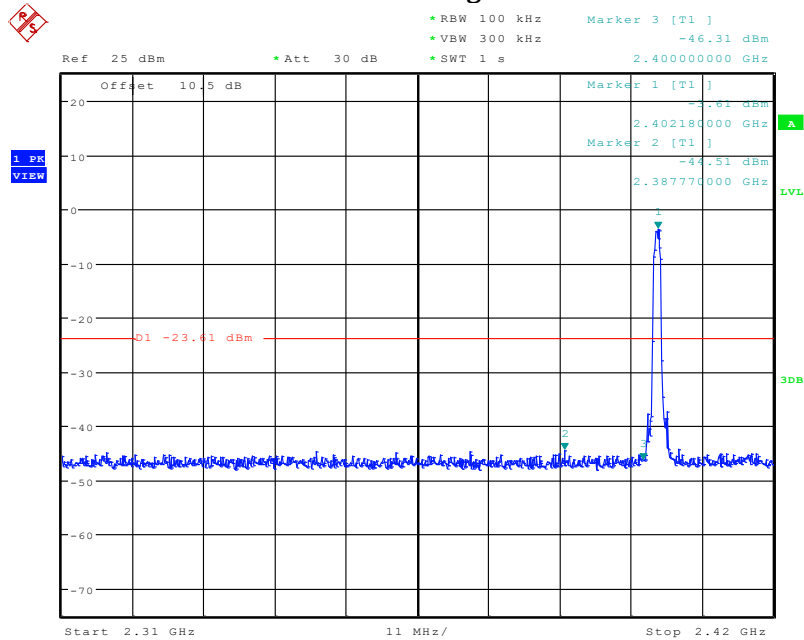
Date: 8.APR.2023 20:38:36

EDR ($\pi/4$ -DQPSK): Band Edge-Left Side Hopping



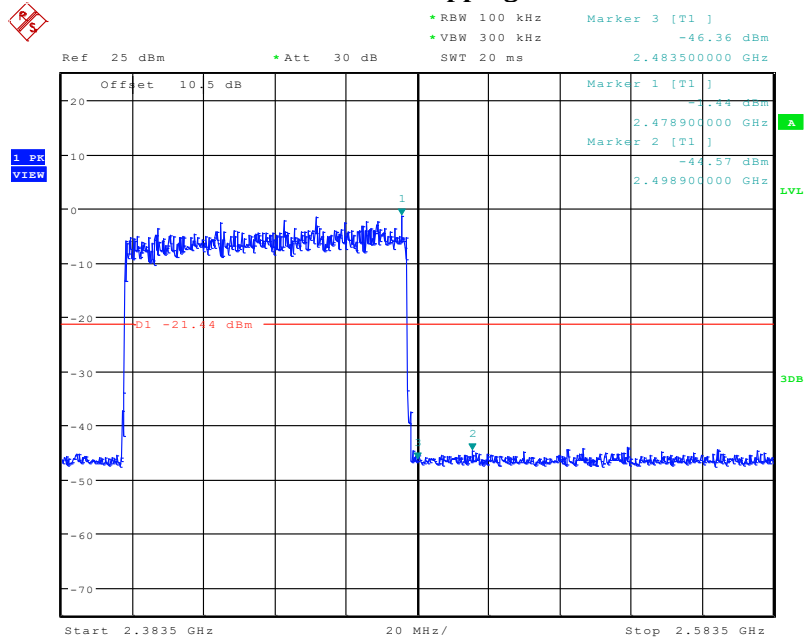
Date: 8.APR.2023 20:58:43

Single

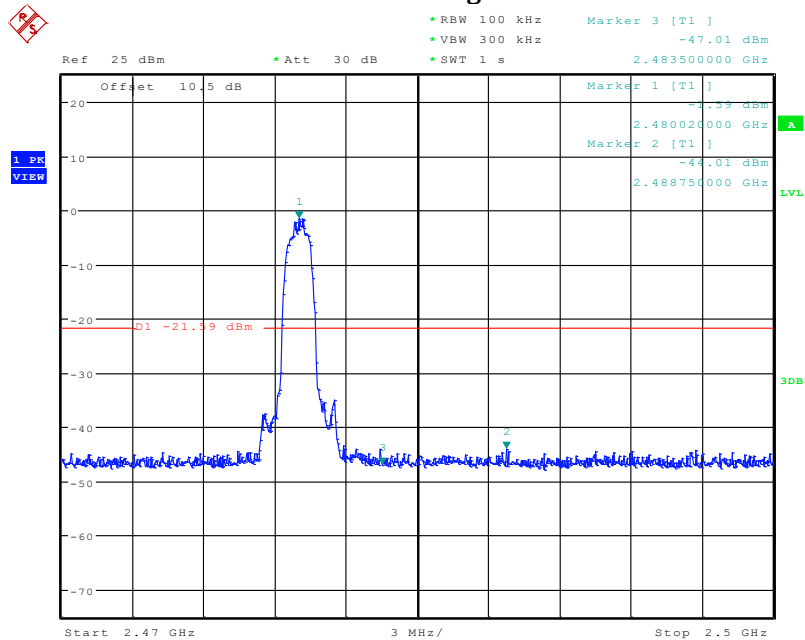


Date: 8.APR.2023 20:32:55

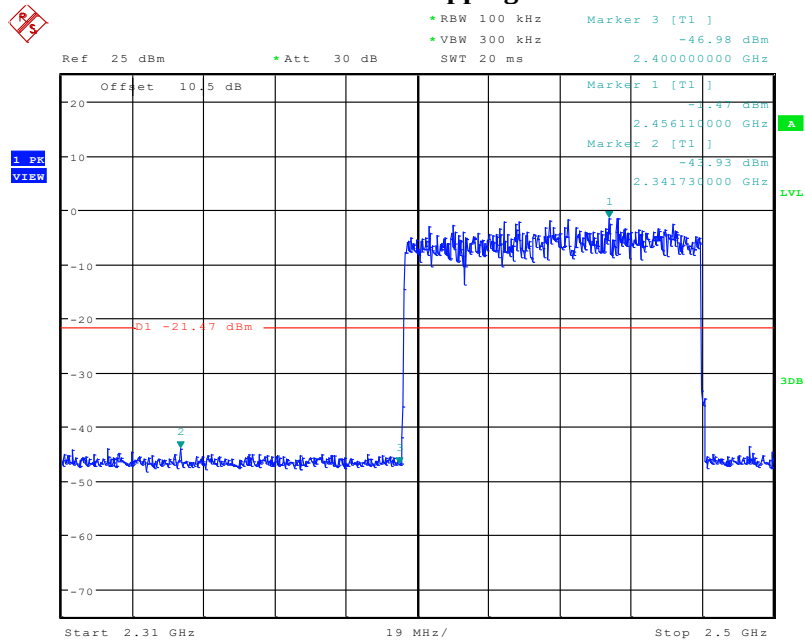
EDR ($\pi/4$ -DQPSK): Band Edge-Right Side Hopping



Single

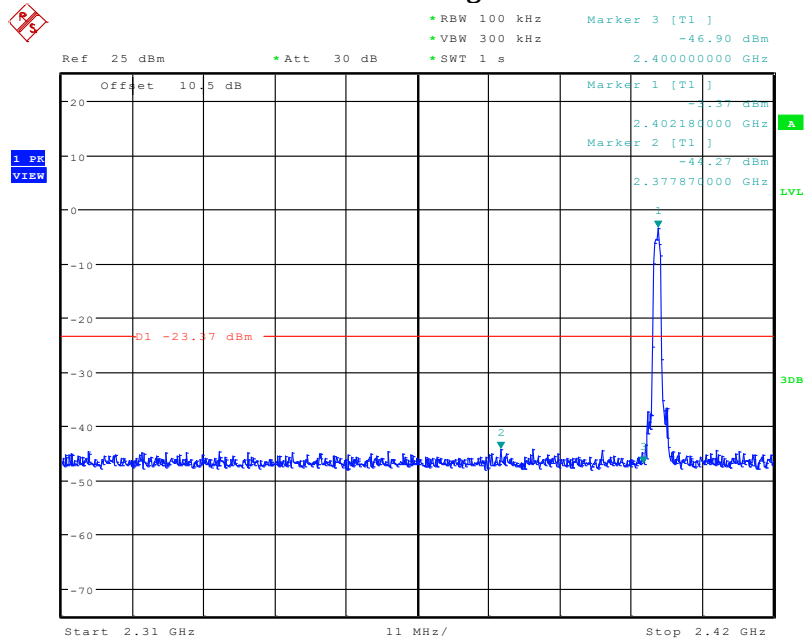


EDR (8DPSK): Band Edge-Left Side
Hopping



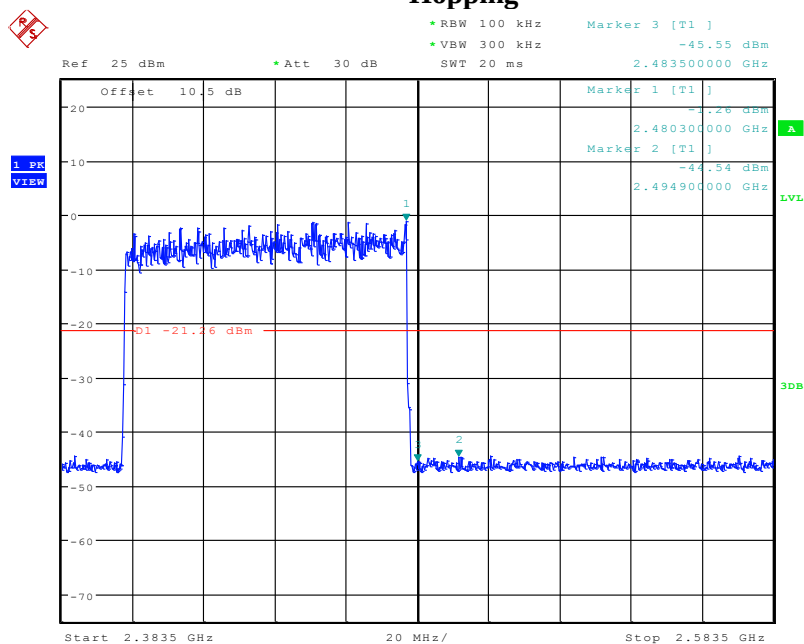
Date: 8.APR.2023 21:08:35

Single



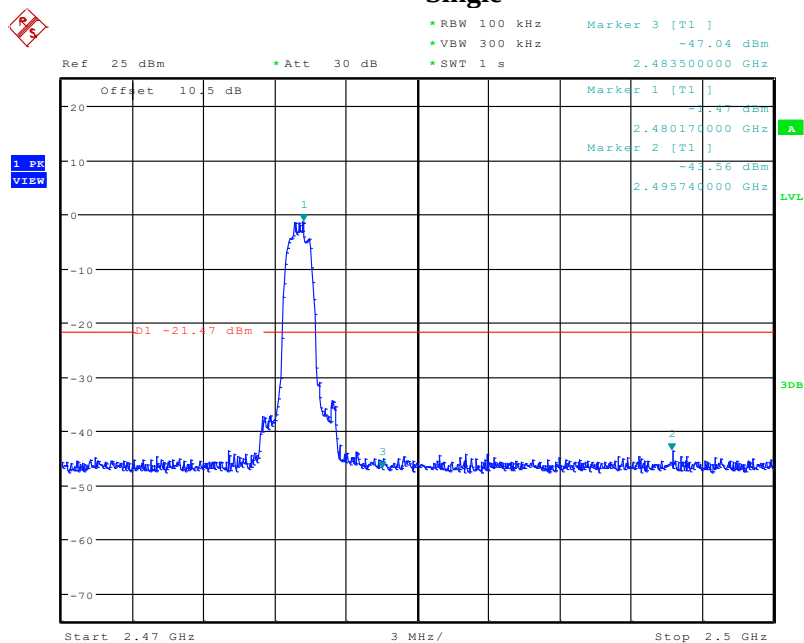
Date: 8.APR.2023 20:35:32

EDR (8DPSK): Band Edge-Right Side Hopping



Date: 8.APR.2023 21:09:37

Single



Date: 8.APR.2023 20:44:16

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