

FCC PART 15.247 TEST REPORT

For

Zeeva International Limited

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China

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Report Type: Original Report	Product Type: TWS SPORTHOOK AST
Report Number: SZ3210618-24041E-00	
Report Date: 2021-07-19	
Reviewed By: RF Engineer	Jacob Kong 
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TABLE OF CONTENTS

GENERAL INFORMATION	4
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT)	4
OBJECTIVE	4
TEST METHODOLOGY	4
MEASUREMENT UNCERTAINTY	5
TEST FACILITY	5
SYSTEM TEST CONFIGURATION	6
DESCRIPTION OF TEST CONFIGURATION	6
EUT EXERCISE SOFTWARE	6
SPECIAL ACCESSORIES	6
EQUIPMENT MODIFICATIONS	6
SUPPORT EQUIPMENT LIST AND DETAILS	6
EXTERNAL I/O CABLE	6
BLOCK DIAGRAM OF TEST SETUP	7
SUMMARY OF TEST RESULTS	8
TEST EQUIPMENT LIST	9
FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE	10
APPLICABLE STANDARD	10
FCC §15.203 – ANTENNA REQUIREMENT	11
APPLICABLE STANDARD	11
ANTENNA CONNECTOR CONSTRUCTION	11
FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS	12
APPLICABLE STANDARD	12
EUT SETUP	12
EMI TEST RECEIVER SETUP	12
TEST PROCEDURE	12
CORRECTED FACTOR & MARGIN CALCULATION	13
TEST DATA	13
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS	16
APPLICABLE STANDARD	16
EUT SETUP	16
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP	17
TEST PROCEDURE	17
CORRECTED AMPLITUDE & MARGIN CALCULATION	17
TEST DATA	17
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST	24
APPLICABLE STANDARD	24
TEST PROCEDURE	24
TEST DATA	24
FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH	27
APPLICABLE STANDARD	27
TEST PROCEDURE	27
TEST DATA	27

FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST	33
APPLICABLE STANDARD	33
TEST PROCEDURE	33
TEST DATA	33
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....	36
APPLICABLE STANDARD	36
TEST PROCEDURE	36
TEST DATA	36
PULSE TIME, DH5	38
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT	42
APPLICABLE STANDARD	42
TEST PROCEDURE	42
TEST DATA	42
FCC §15.247(d) - BAND EDGES TESTING	48
APPLICABLE STANDARD	48
TEST PROCEDURE	48
TEST DATA	48

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	TWS SPORTHOOK AST
Tested Model	EP-0649
UPC Number	Black: 1922340350166 Blue: 1922340350173 Red: 1922340350180 Green: 1922340350197
SKU Number	Black: 4485679 Blue: 4485680 Red: 4485681 Green: 4485682
Frequency Range	Bluetooth: 2402-2480MHz
Maximum conducted Peak output power	Bluetooth: 0.62dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification*	-0.58dBi(It is provided by the applicant)
Voltage Range	DC3.7V from battery
Date of Test	2021-06-25 to 2021-07-19
Sample number	SZ3210618-24041E-RF -S1 (Assigned by BACL, Shenzhen)
Received date	2021-06-18
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.

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 Bay Area Compliance Laboratories Corp. (Shenzhen). 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 Output Power with Power meter		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
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 Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 5F(B-West) , 6F, 7F, the 3rd Phase of Wan Li Industrial Building D, Shihua Rd, FuTian Free Trade Zone, Shenzhen, 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.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

“FCC_assist_1.0.2.2”* software was used to the EUT tested and 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.

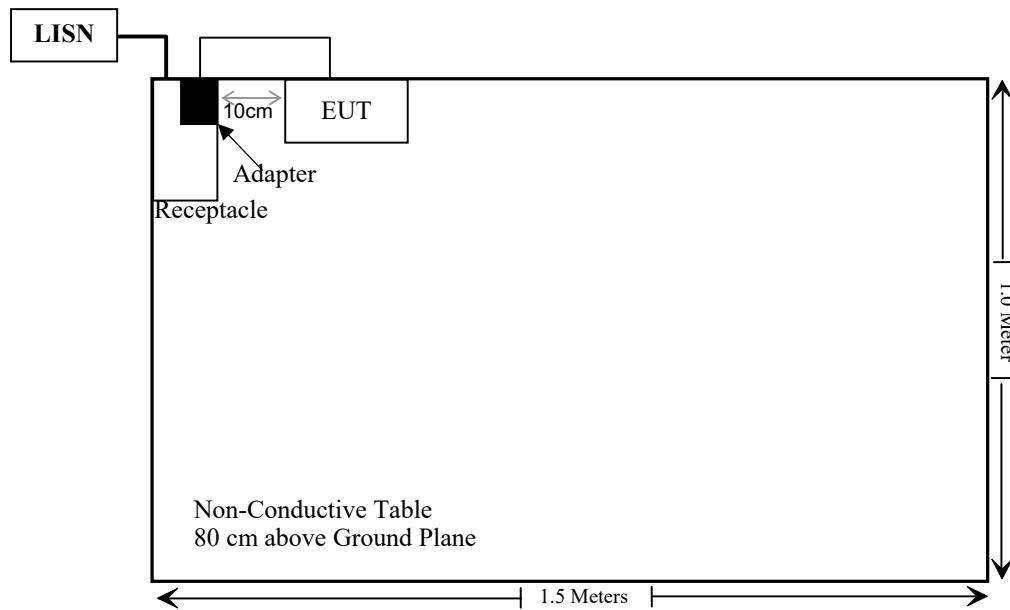
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
Dongguan Aohai Power Technology Co.,Ltd.	Adapter	A8-501000	A1906034835

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cables	0.2	EUT	Adapter

Block Diagram of Test Setup



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	EMI Test Receiver	ESCI	101120	2020/08/04	2021/08/03
Rohde & Schwarz	LISN	ENV216	101613	2020/08/04	2021/08/03
Rohde & Schwarz	Transient Limitor	ESH3Z2	DE25985	2020/11/29	2021/11/28
Unknown	CE Cable	CE Cable	UF A210B-1-0720-504504	2020/11/29	2021/11/28
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2020/08/04	2021/08/03
Sonoma instrument	Pre-amplifier	310 N	186238	2020/08/04	2021/08/03
Sunol Sciences	Broadband Antenna	JB1	A040904-2	2020/12/22	2023/12/21
Unknown	Cable 2	RF Cable 2	F-03-EM197	2020/11/29	2021/11/28
Unknown	Cable	Chamber Cable 1	F-03-EM236	2020/11/29	2021/11/28
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2020/08/04	2021/08/03
COM-POWER	Pre-amplifier	PA-122	181919	2020/11/29	2021/11/28
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2020/11/28	2021/11/27
Sunol Sciences	Horn Antenna	3115	9107-3694	2021/01/15	2024/01/14
Unknown	RF Cable	W1101-EQ1 OUT	F-19-EM005	2020/11/29	2021/11/28
Insulated Wire Inc.	RF Cable	SPS-2503-3150	02222010	2020/11/29	2021/11/28
SNSD	Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2021/04/20	2022/04/20
Ducommun Technologies	Horn antenna	ARH-4223-02	1007726-021304	2020/12/06	2023/12/05
RF Conducted Test					
Rohde & Schwarz	SPECTRUM ANALYZER	FSU26	200120	2021/04/02	2022/04/01
WEINSCHL	3dB Attenuator	Unknown	F-03-EM121	2020/11/29	2021/11/28
Unknown	RF Cable	Unknown	8082176/W6111	2020/11/29	2021/11/28

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) 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:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot$

$[\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

1. $f(\text{GHz})$ 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	1.0	1.26	5	0.4	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 antenna gain is -0.58 dBi, 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 device 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.

Corrected Factor & Margin Calculation

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

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

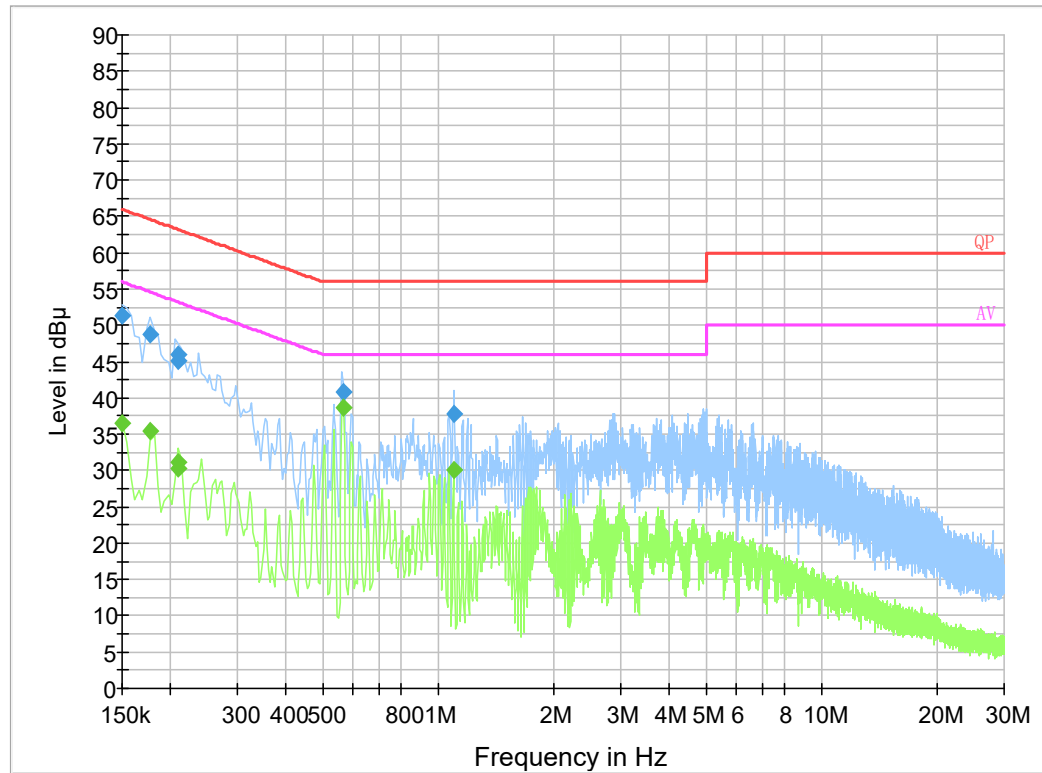
Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	70 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2021-06-26.

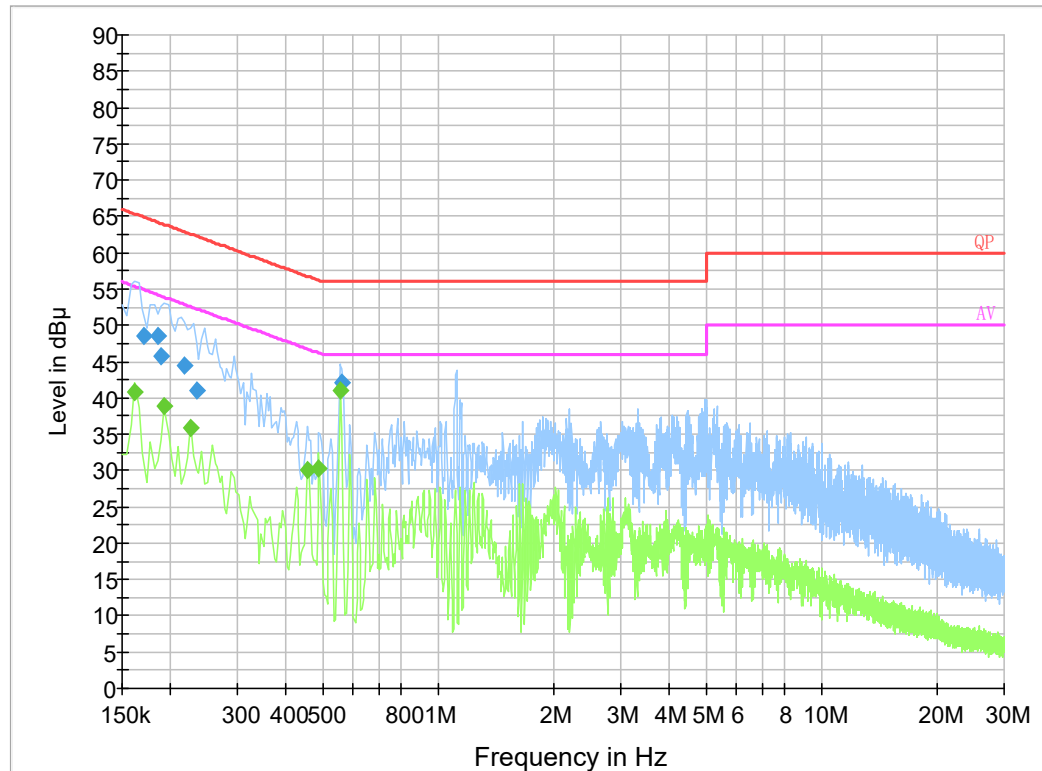
EUT operation mode: Charging

AC 120V/60 Hz, Line**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	51.3	0.200	L1	19.8	14.7	66.0
0.177500	48.8	9.000	L1	19.9	15.8	64.6
0.209500	46.0	9.000	L1	19.8	17.2	63.2
0.209500	45.2	9.000	L1	19.8	18.0	63.2
0.565570	40.8	9.000	L1	19.8	15.2	56.0
1.105470	37.9	9.000	L1	19.8	18.1	56.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	36.5	9.000	L1	19.8	19.5	56.0
0.177500	35.4	9.000	L1	19.9	19.2	54.6
0.209500	31.2	9.000	L1	19.8	22.0	53.2
0.209500	30.3	9.000	L1	19.8	22.9	53.2
0.565570	38.6	9.000	L1	19.8	7.4	46.0
1.105470	30.0	9.000	L1	19.8	16.0	46.0

AC 120V/60 Hz, Neutral**Final Result 1**

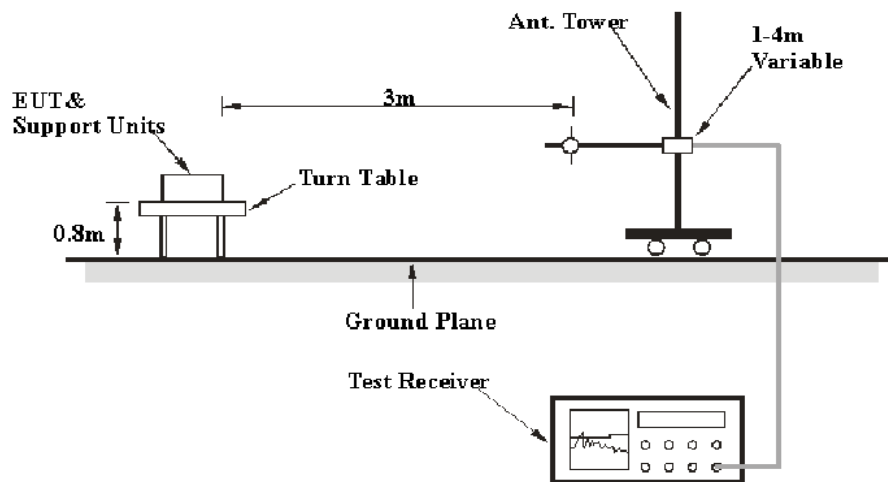
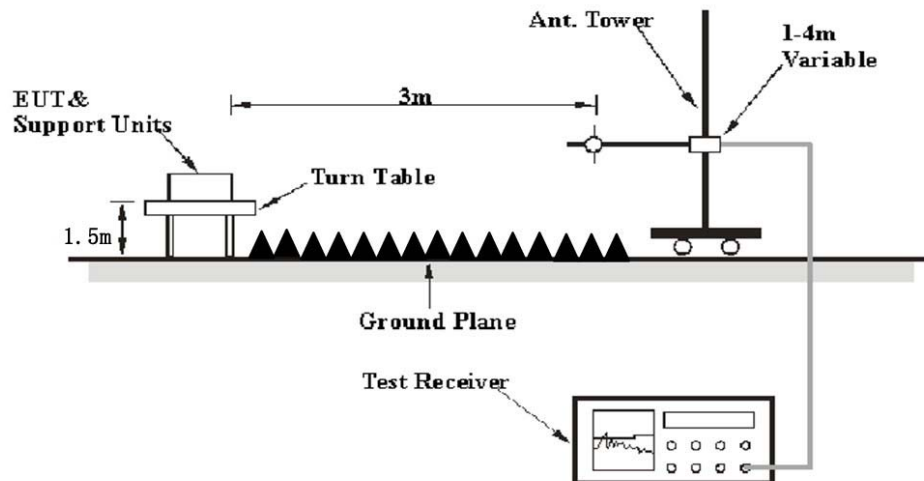
Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.170501	48.6	9.000	N	19.8	16.3	64.9
0.186500	48.6	9.000	N	19.8	15.6	64.2
0.189500	45.7	9.000	N	19.8	18.4	64.1
0.217500	44.5	9.000	N	19.8	18.4	62.9
0.234500	40.9	9.000	N	19.8	21.4	62.3
0.562310	42.1	9.000	N	19.8	13.9	56.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.162000	40.8	9.000	N	19.8	14.6	55.4
0.194000	38.8	9.000	N	19.8	15.1	53.9
0.226000	35.8	9.000	N	19.8	16.8	52.6
0.458000	30.0	9.000	N	19.8	16.7	46.7
0.490000	30.4	9.000	N	19.8	15.8	46.2
0.558000	40.9	9.000	N	19.8	5.1	46.0

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

During the radiated emission test, 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.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude 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:

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

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

Test Data

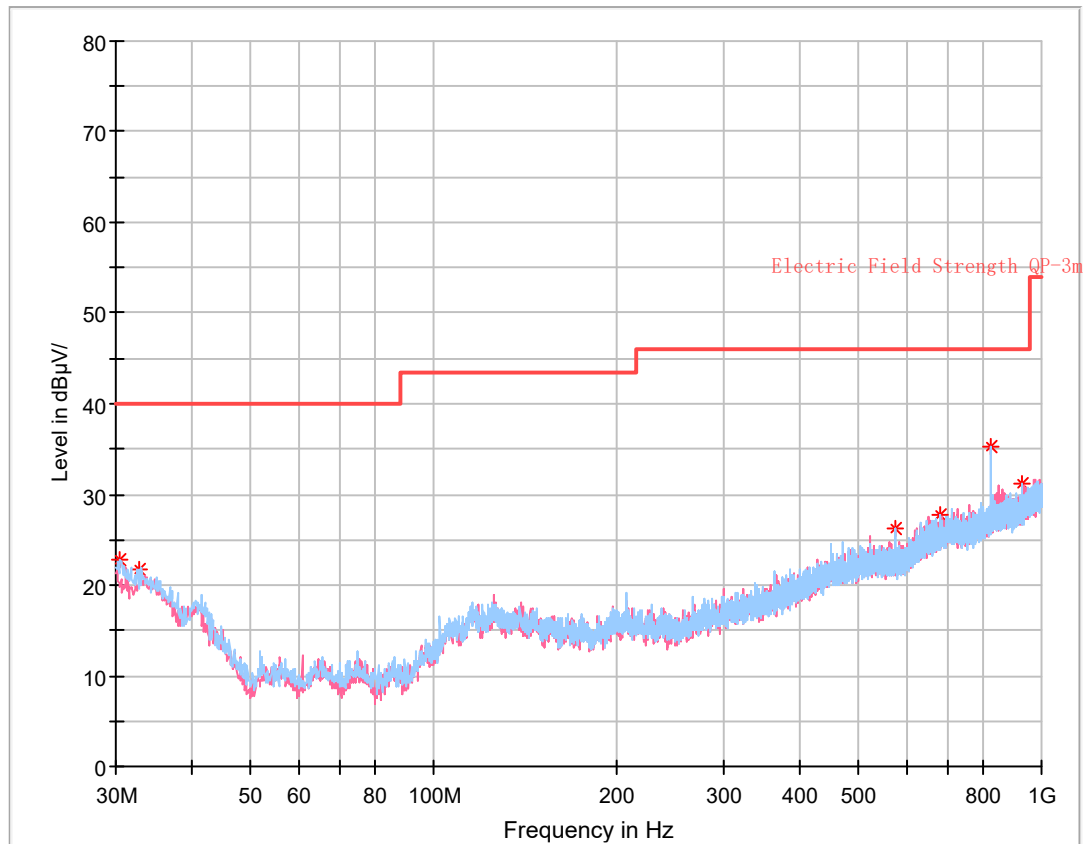
Environmental Conditions

Temperature:	26.8~ 27 °C
Relative Humidity:	51~ 57 %
ATM Pressure:	101.0~101.2 kPa

The testing was performed by Cloud Qiu on 2021-06-25 for below 1GHz and Bruce Lin on 2021-07-08 for above 1GHz.

EUT operation mode: Transmitting

30 MHz~1 GHz: (worst case is 8DPSK Mode, high channel)



Critical_Freqs

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.485000	22.75	40.00	17.25	300.0	H	217.0	-3.9
32.788750	21.80	40.00	18.20	300.0	H	239.0	-5.7
573.927500	26.16	46.00	19.84	300.0	H	217.0	-4.5
679.415000	27.64	46.00	18.36	300.0	H	121.0	-1.9
827.461250	35.26	46.00	10.74	100.0	H	83.0	-0.1
931.736250	31.13	46.00	14.87	300.0	H	302.0	1.4

1 GHz - 25 GHz: (Scan with GFSK, $\pi/4$ -DQPSK, 8DPSK mode, the 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/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2389.65	29.78	PK	244	1.9	H	31.87	61.65	74	12.35
2389.65	14.59	Ave.	244	1.9	H	31.87	46.46	54	7.54
2484.16	29.01	PK	291	1.5	H	32.13	61.14	74	12.86
2484.16	14.63	Ave.	291	1.5	H	32.13	46.76	54	7.24
4804.00	45.25	PK	33	1.7	H	6.28	51.53	74	22.47
4804.00	34.18	Ave.	33	1.7	H	6.28	40.46	54	13.54
Middle Channel (2441 MHz)									
4882.00	45.37	PK	78	1.2	H	6.76	52.13	74	21.87
4882.00	35.17	Ave.	31	1.2	H	6.76	41.93	54	12.07
High Channel (2480 MHz)									
2389.92	29.31	PK	321	2.5	H	31.87	61.18	74	12.82
2389.92	14.60	Ave.	321	2.5	H	31.87	46.47	54	7.53
2484.36	29.22	PK	301	1.0	H	32.13	61.35	74	12.65
2484.36	14.80	Ave.	301	1.0	H	32.13	46.93	54	7.07
4960.00	46.25	PK	175	1.4	H	6.80	53.05	74	20.95
4960.00	35.58	Ave.	141	1.4	H	6.80	42.38	54	11.62

Note:

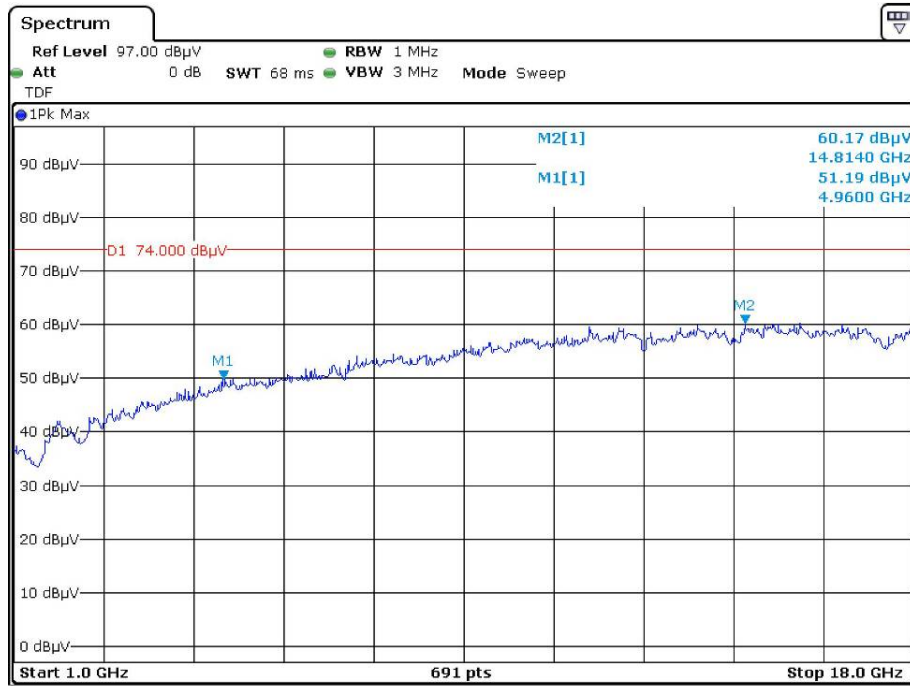
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

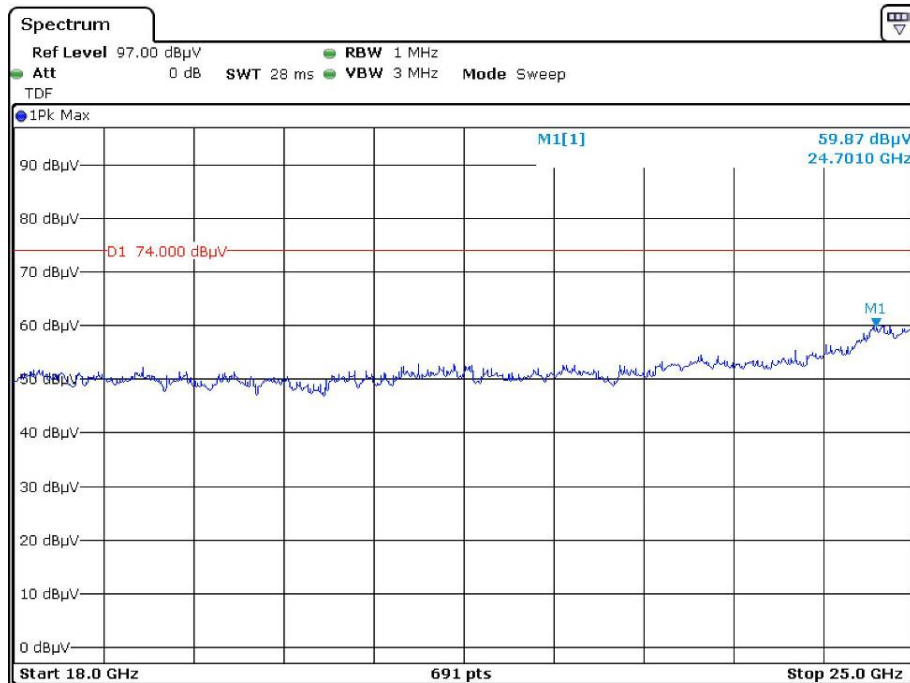
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

Pre-scan with high channel Peak Horizontal

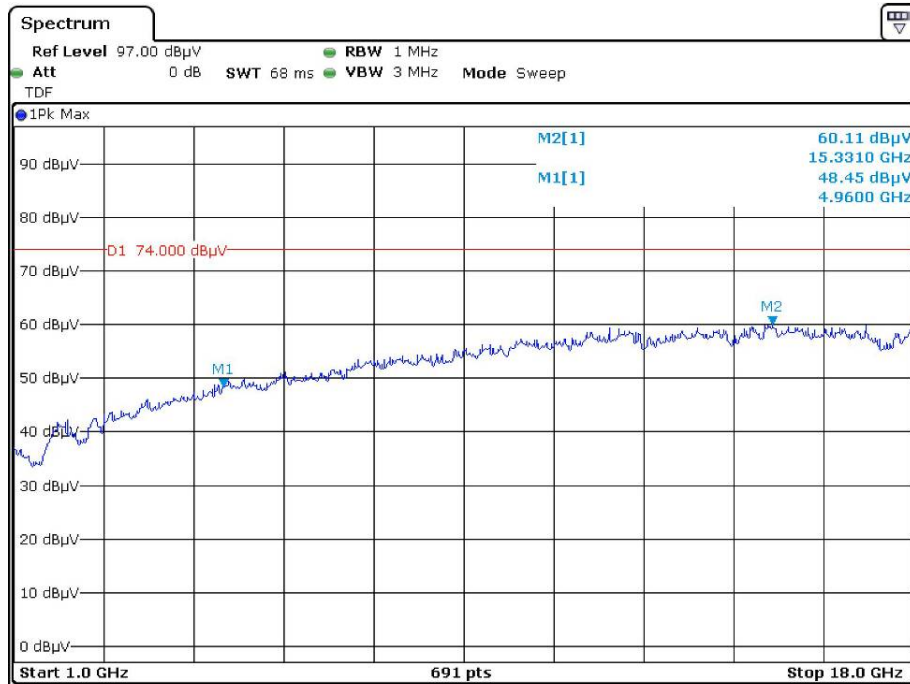


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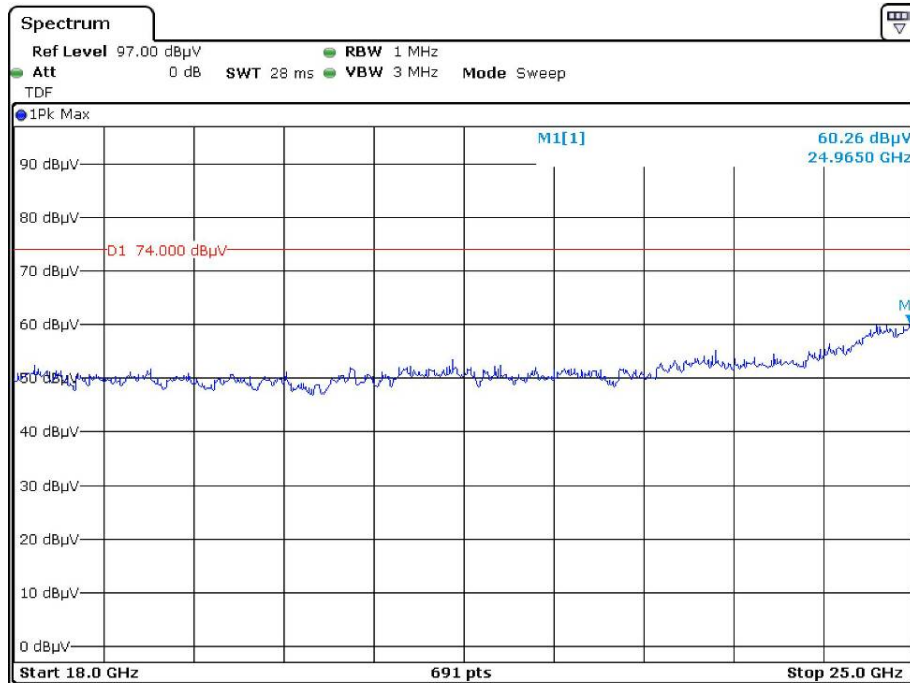


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Vertical

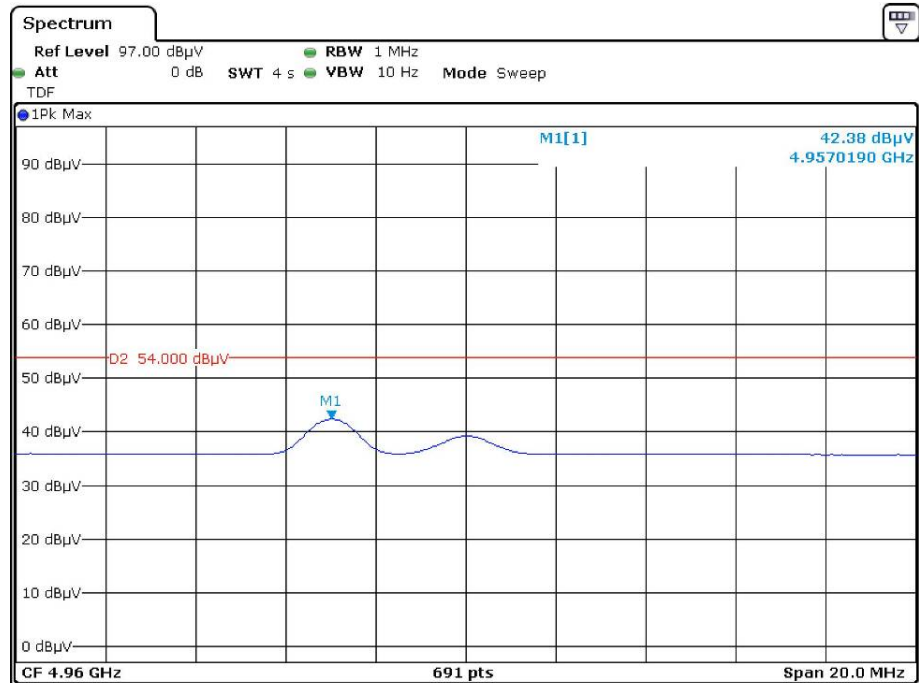


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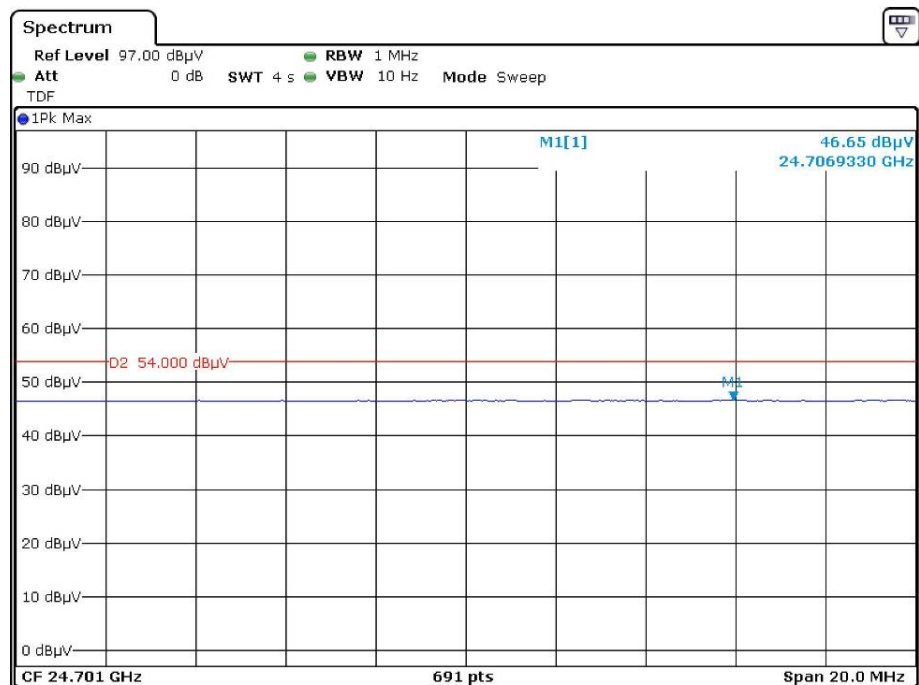


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Average Horizontal

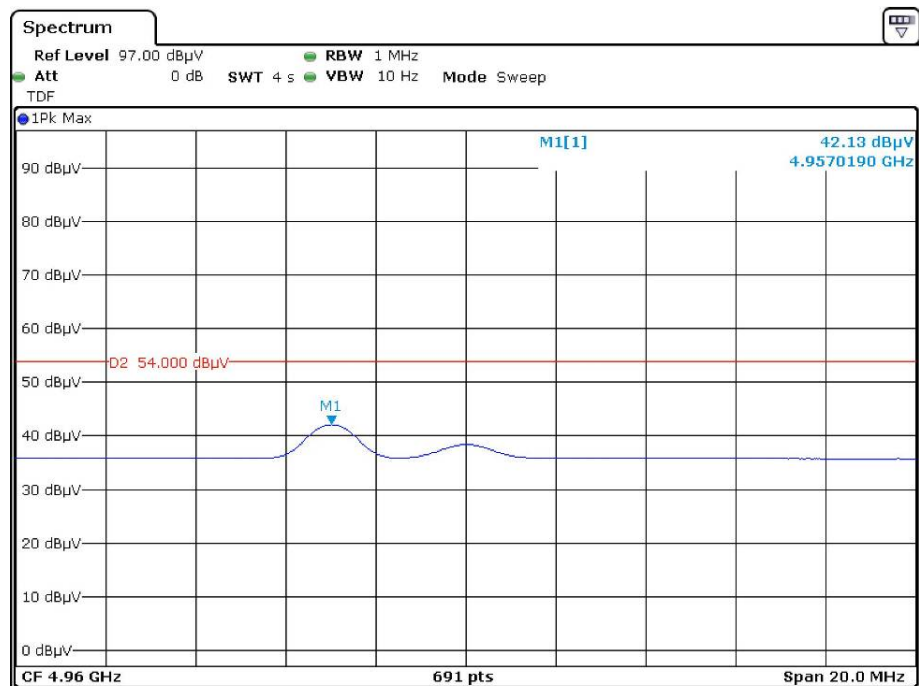


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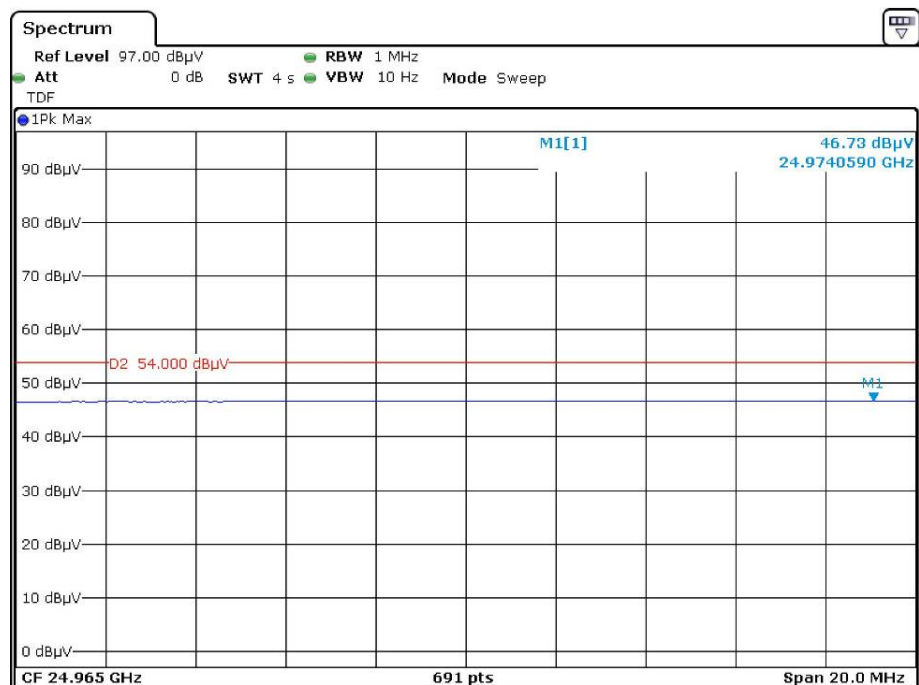


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Vertical



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

Applicable Standard

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

Test Procedure

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

Test Data

Environmental Conditions

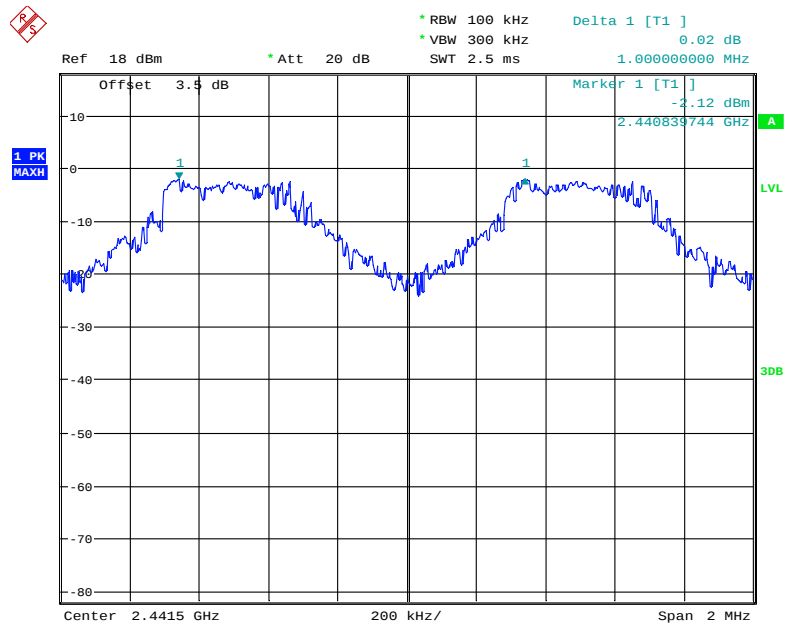
Temperature:	23.6~25.3 °C
Relative Humidity:	51~56 %
ATM Pressure:	101.0~101.2 kPa

The testing was performed by KEY from 2021-07-01 to 2021-07-19.
EUT operation mode: Transmitting

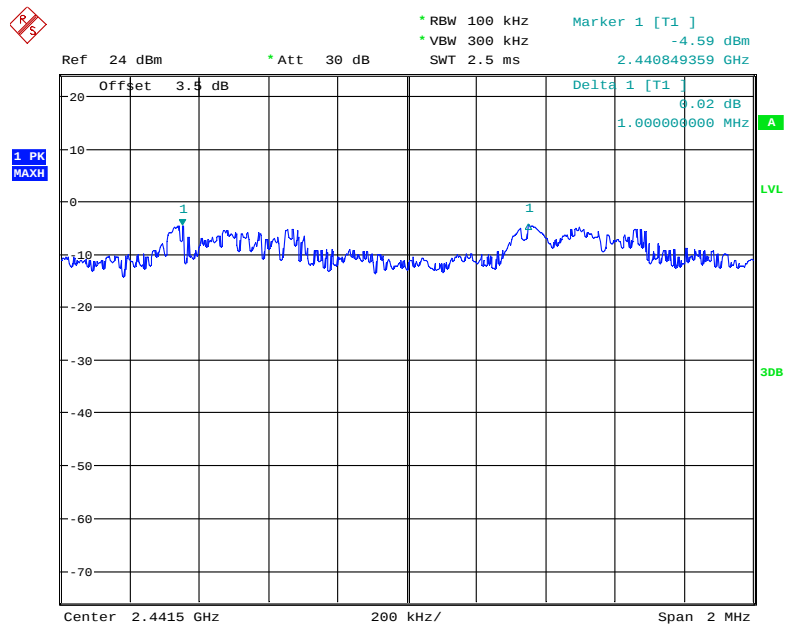
Test Result: Compliance. Please refer to following table and plots.

Test Mode	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit	Result
BDR(GFSK)					
Hopping	1.000	0.891	0.594	> two-thirds of the 20 dB bandwidth	Compliance
EDR($\pi/4$-DQPSK)					
Hopping	1.000	1.257	0.838	> two-thirds of the 20 dB bandwidth	Compliance
EDR(8DPSK)					
Hopping	0.980	1.225	0.817	> two-thirds of the 20 dB bandwidth	Compliance

Note: The limit > two-thirds of the 20 dB bandwidth
Please refer to the following plots.

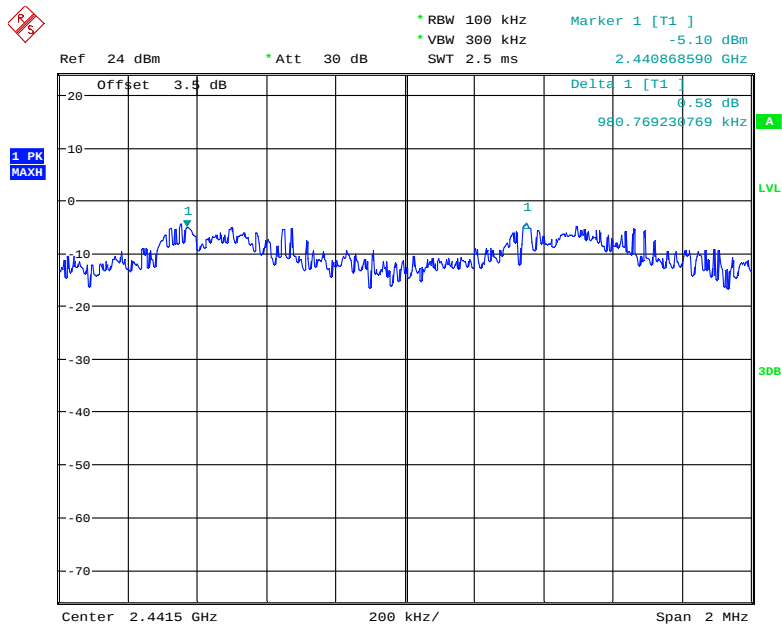
BDR (GFSK): Low Channel

Date: 19.JUL.2021 17:36:46

EDR ($\pi/4$ -DQPSK)

Date: 1.JUL.2021 17:40:43

EDR (8DPSK)



Date: 1.JUL.2021 17:42:17

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

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

Test Data

Environmental Conditions

Temperature:	23.6~25.3 °C
Relative Humidity:	51~56 %
ATM Pressure:	101.0~101.2 kPa

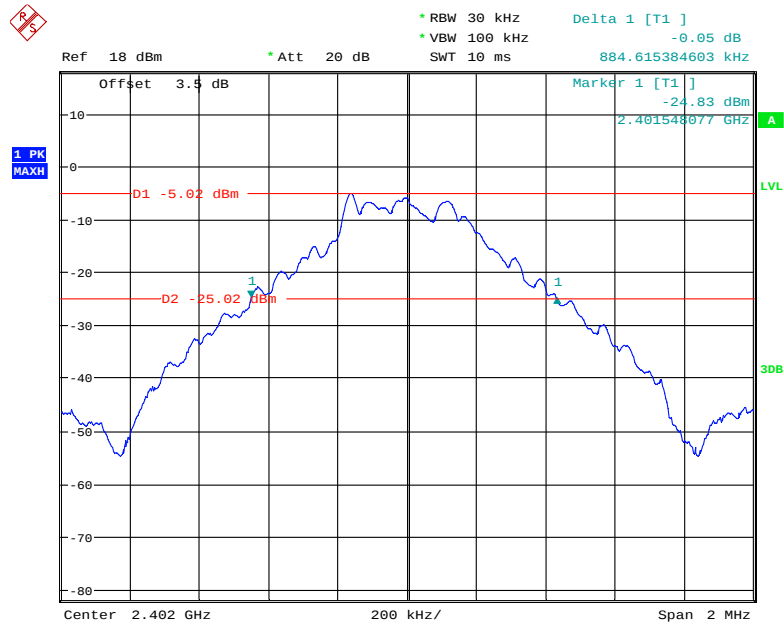
The testing was performed by KEY from 2021-07-02 to 2021-07-19.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table and plots.

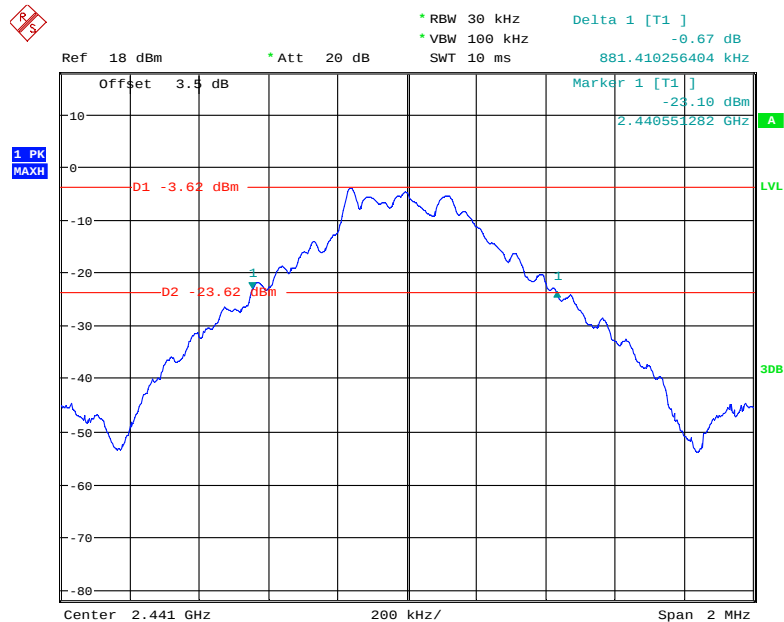
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.885
	Middle	2441	0.881
	High	2480	0.891
EDR ($\pi/4$-DQPSK)	Low	2402	1.255
	Middle	2441	1.257
	High	2480	1.256
EDR (8DPSK)	Low	2402	1.221
	Middle	2441	1.225
	High	2480	1.224

BDR (GFSK): Low Channel

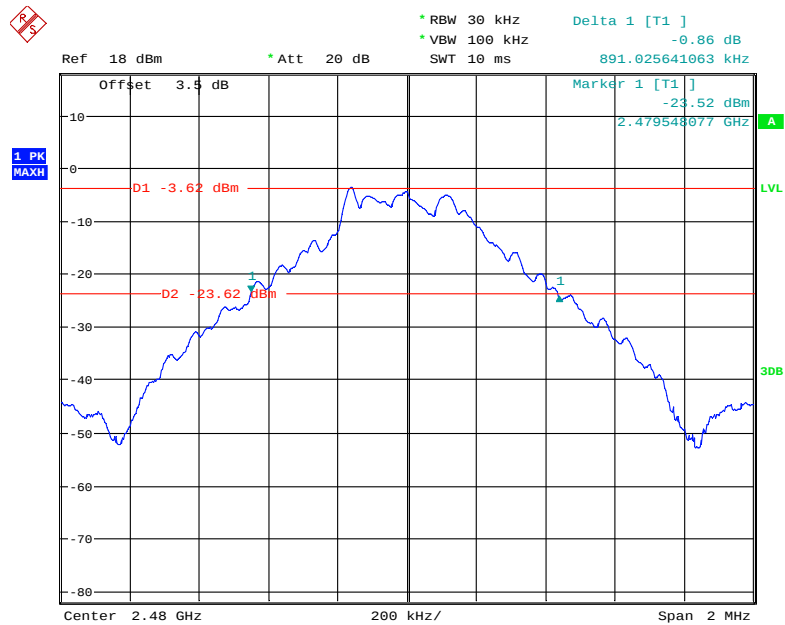


Date: 19.JUL.2021 17:28:06

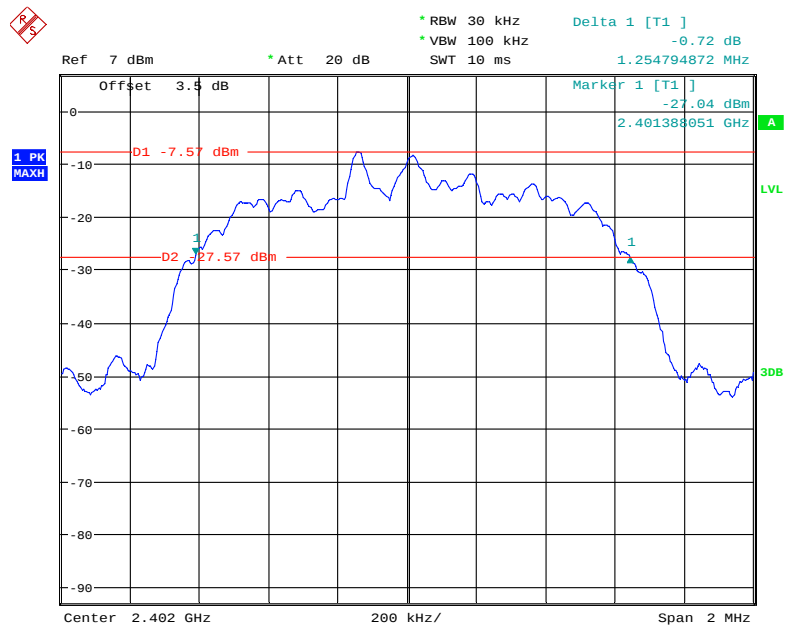
BDR (GFSK): Middle Channel



Date: 19.JUL.2021 17:26:58

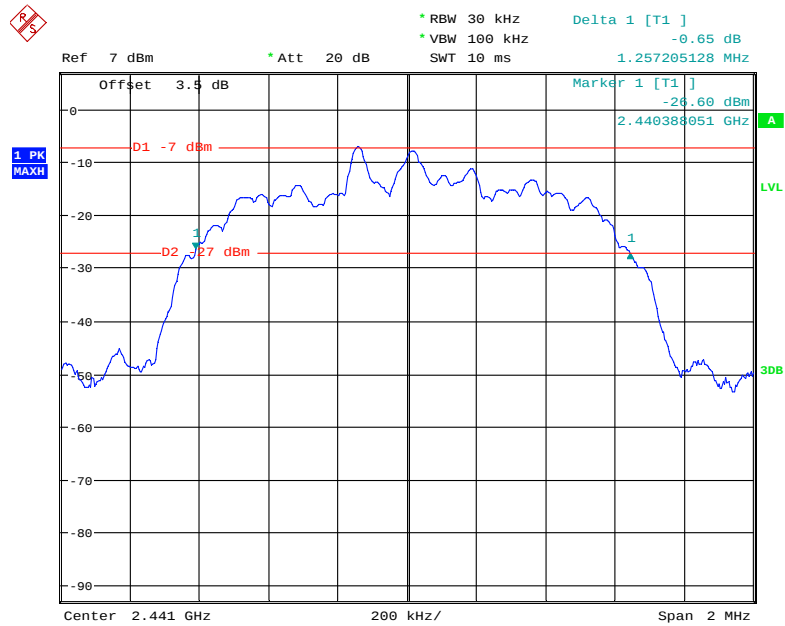
BDR (GFSK): High Channel

Date: 19.JUL.2021 17:25:46

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

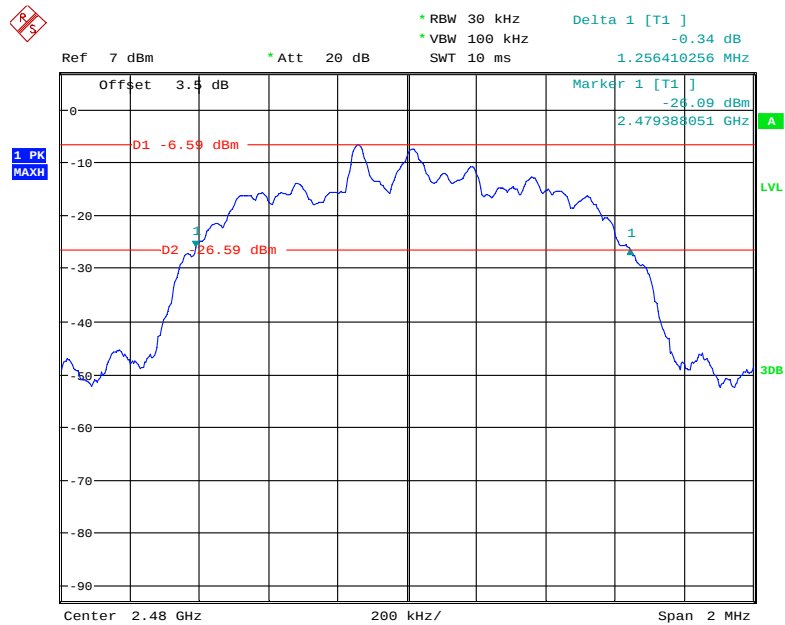
Date: 2.JUL.2021 09:51:34

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



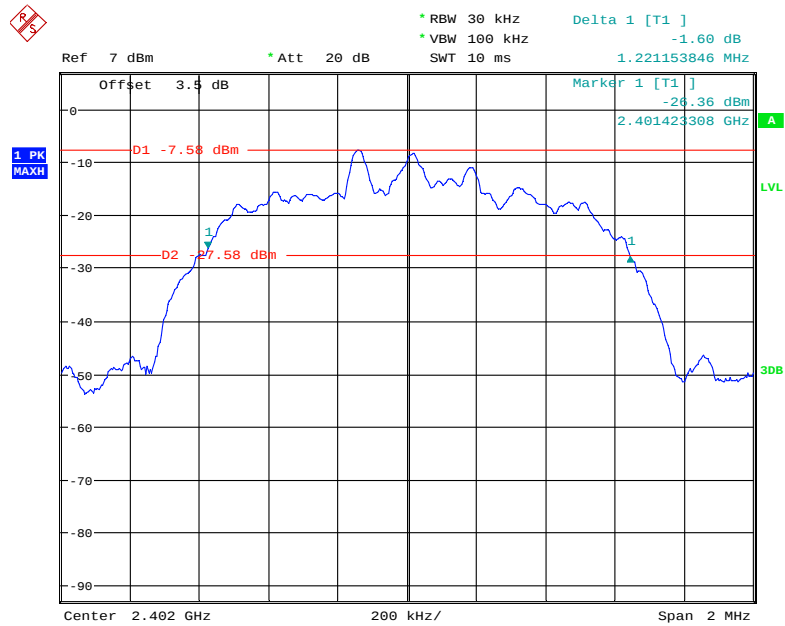
Date: 2.JUL.2021 09:50:00

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



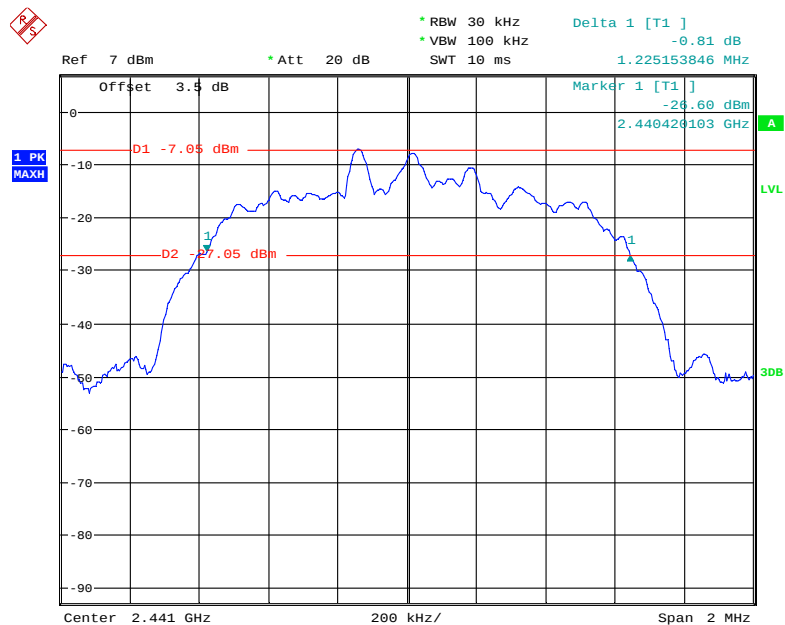
Date: 2.JUL.2021 09:48:19

EDR (8DPSK): Low Channel



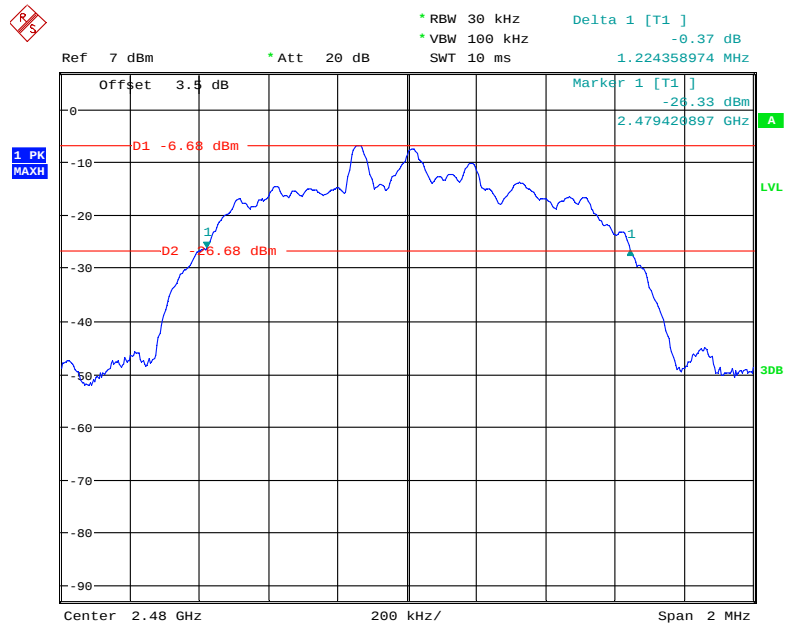
Date: 2.JUL.2021 09:53:40

EDR (8DPSK): Middle Channel



Date: 2.JUL.2021 09:55:40

EDR (8DPSK): High Channel



Date: 2.JUL.2021 09:57:40

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

Applicable Standard

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

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	23.6~25.3 °C
Relative Humidity:	51~56 %
ATM Pressure:	101.0~101.2 kPa

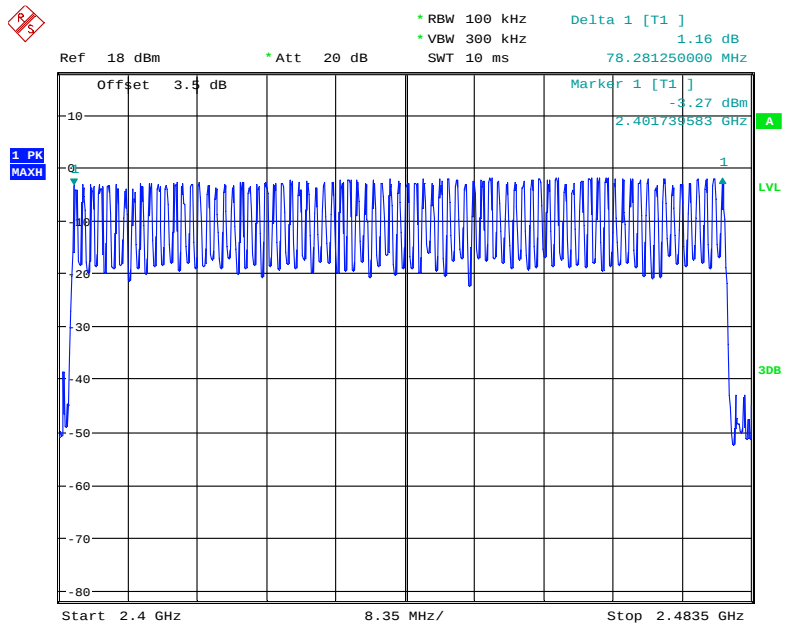
The testing was performed by KEY from 2021-07-01 to 2021-07-19.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table and plots.

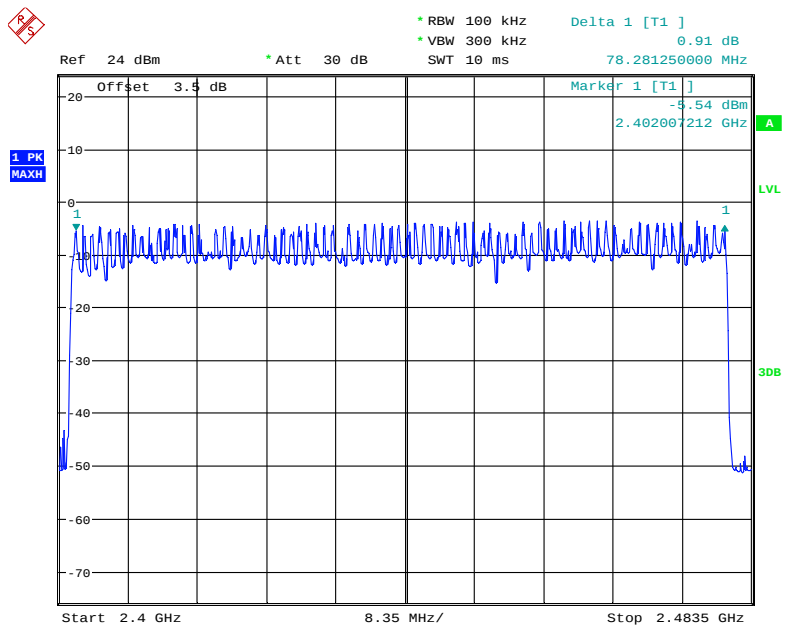
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥15
EDR ($\pi/4$ -DQPSK)	2400-2483.5	79	≥15
EDR (8DPSK)	2400-2483.5	79	≥15

BDR (GFSK): Number of Hopping Channels



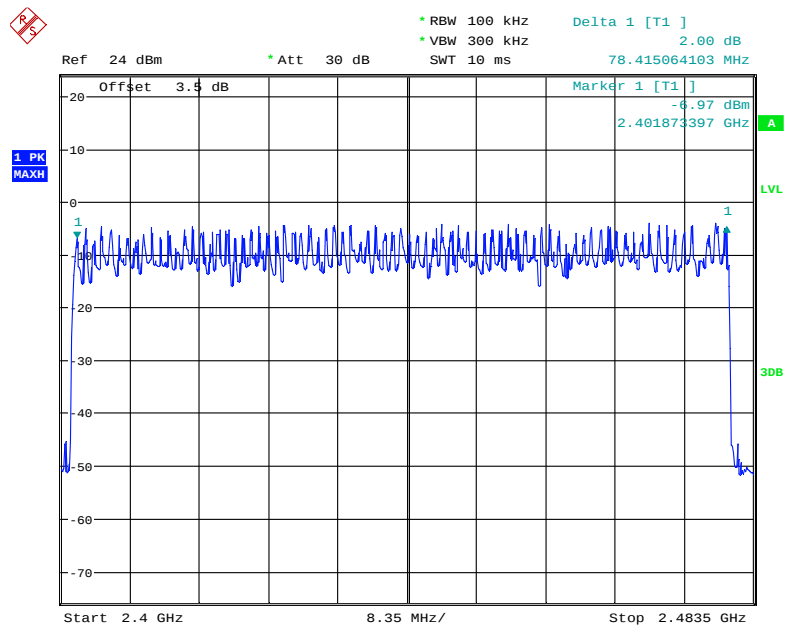
Date: 19.JUL.2021 17:38:45

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



Date: 1.JUL.2021 16:55:49

EDR (8DPSK): Number of Hopping Channels



Date: 1.JUL.2021 17:06:49

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

Test Data**Environmental Conditions**

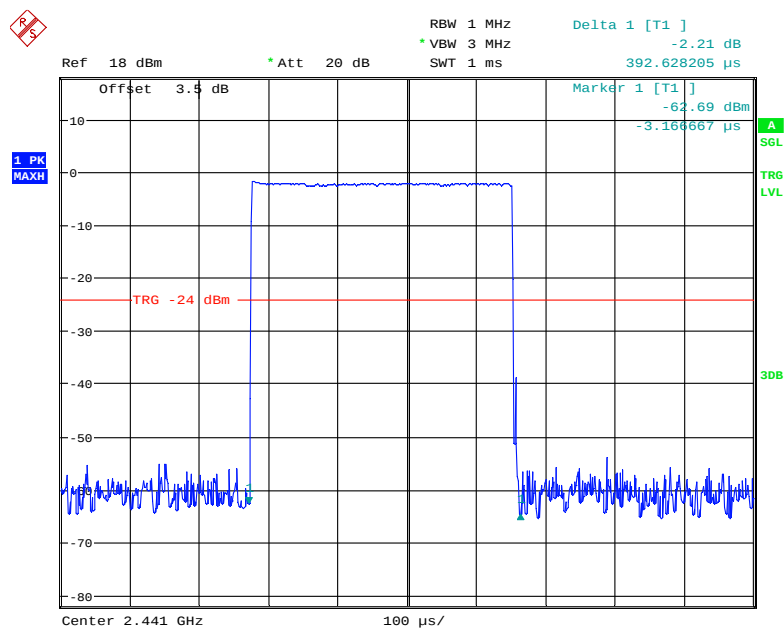
Temperature:	23.6~25.3 °C
Relative Humidity:	51~56 %
ATM Pressure:	101.0~101.2 kPa

The testing was performed by KEY from 2021-07-12 to 2021-07-19.

EUT operation mode: Transmitting

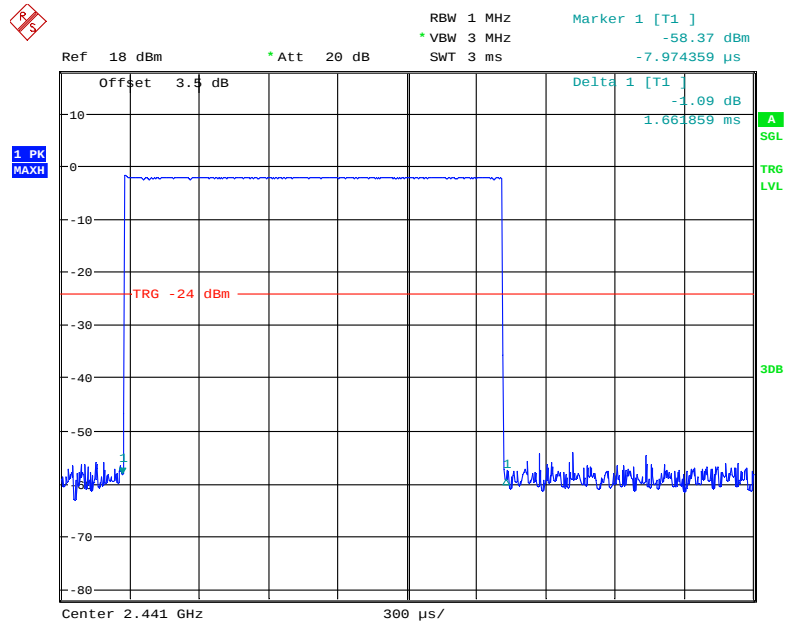
Test Result: Compliance. Please refer to following table and plots

Mode		Pulse time (ms)	Dwell Time (S)	Limit (S)	Verdict
BDR (GFSK)	DH1	0.393	0.126	0.4	Pass
	DH3	1.662	0.266	0.4	Pass
	DH5	2.912	0.311	0.4	Pass
EDR($\pi/4$ -DQPSK)	2DH1	0.405	0.130	0.4	Pass
	2DH3	1.665	0.266	0.4	Pass
	2DH5	2.934	0.313	0.4	Pass
EDR(8DPSK)	3DH1	0.402	0.129	0.4	Pass
	3DH3	1.661	0.266	0.4	Pass
	3DH5	2.918	0.311	0.4	Pass
Note: DH1/2DH1/3DH1: Dwell time = Pulse time*(1600/2/79)*31.6s DH3/2DH3/3DH3: Dwell time = Pulse time*(1600/4/79)*31.6s DH5/2DH5/3DH5: Dwell time = Pulse time*(1600/6/79)*31.6s					

BDR (GFSK):**Pulse time, DH1**

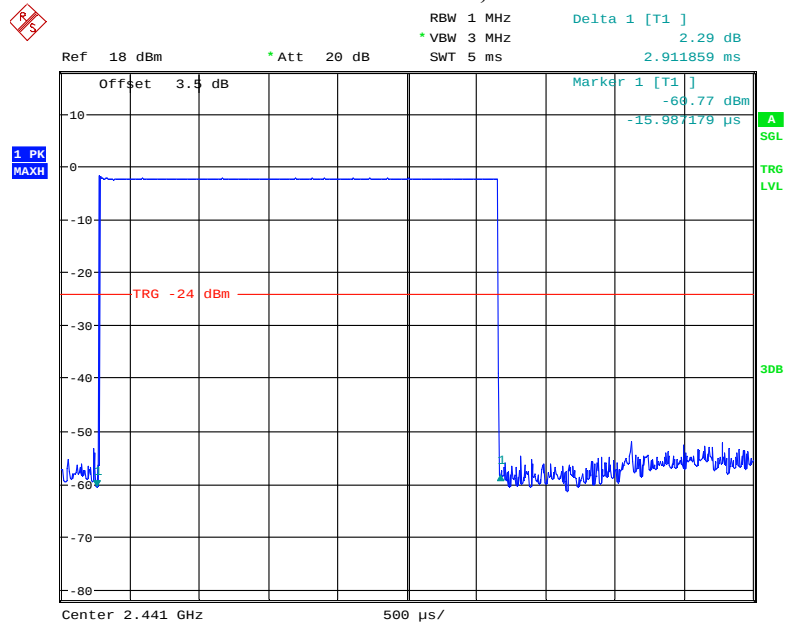
Date: 19.JUL.2021 17:42:09

Pulse time, DH3



Date: 19.JUL.2021 17:44:07

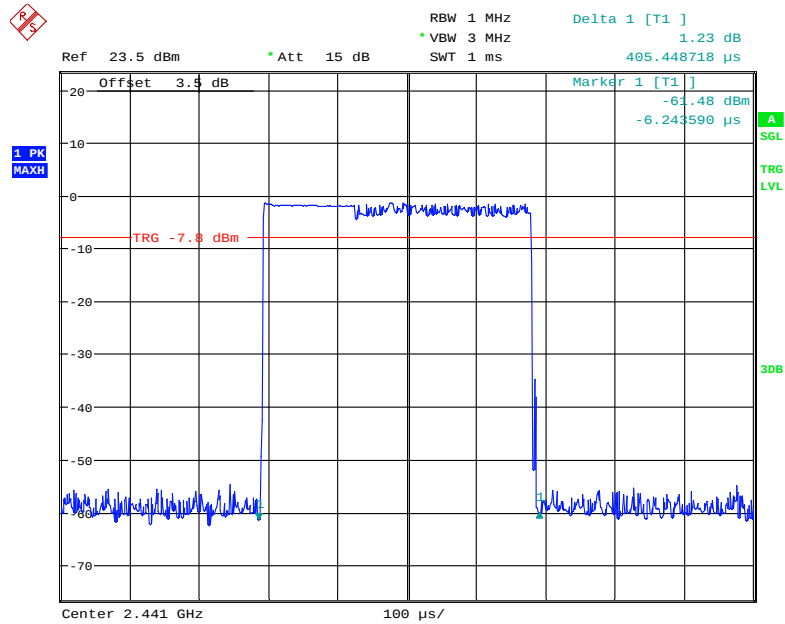
Pulse time, DH5



Date: 19.JUL.2021 17:45:28

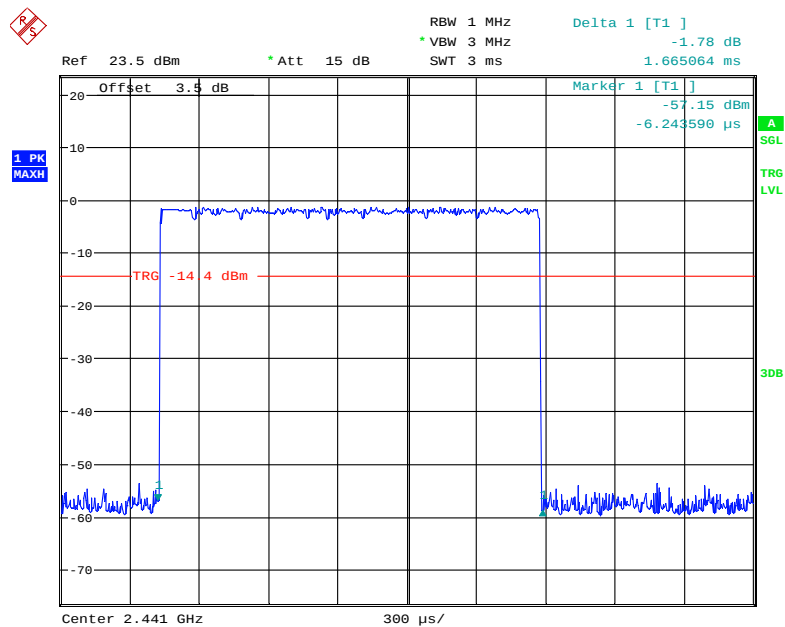
EDR ($\pi/4$ -DQPSK):

Pulse time, DH1



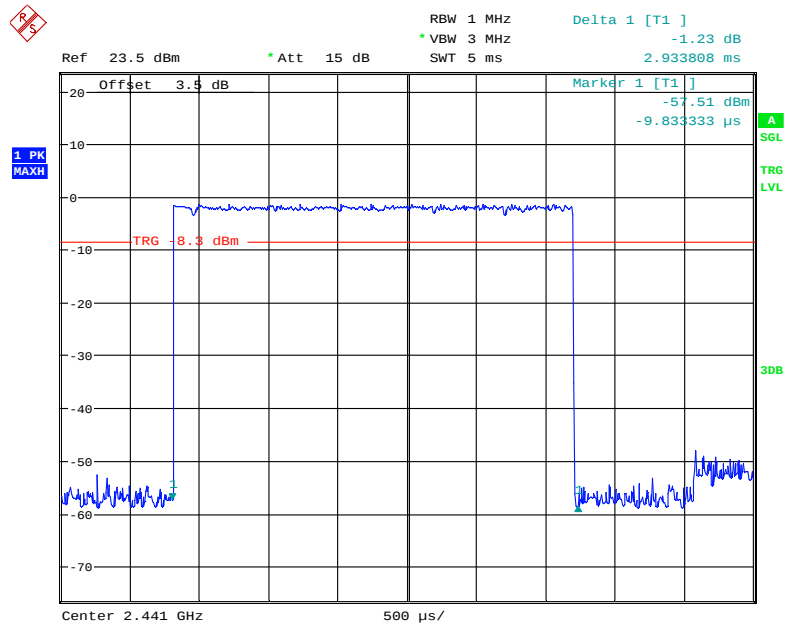
Date: 12.JUL.2021 18:53:03

Pulse time, DH3



Date: 12.JUL.2021 18:54:24

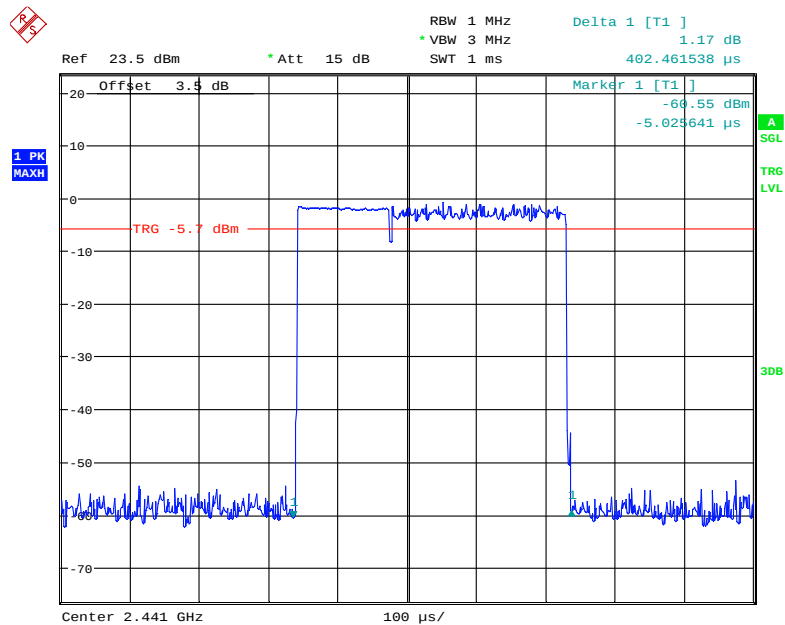
Pulse time, Middle Channel, DH5



Date: 12.JUL.2021 18:55:47

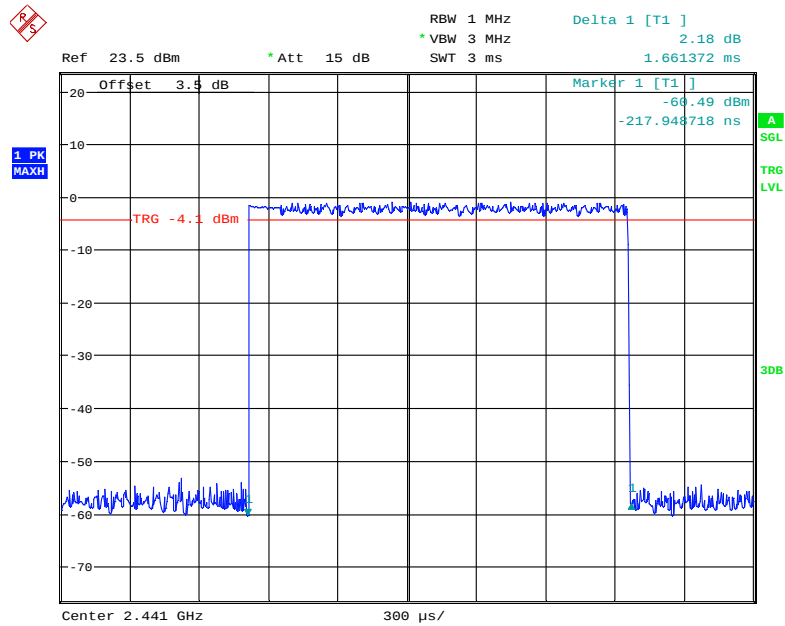
EDR (8DPSK)

Pulse time, DH1



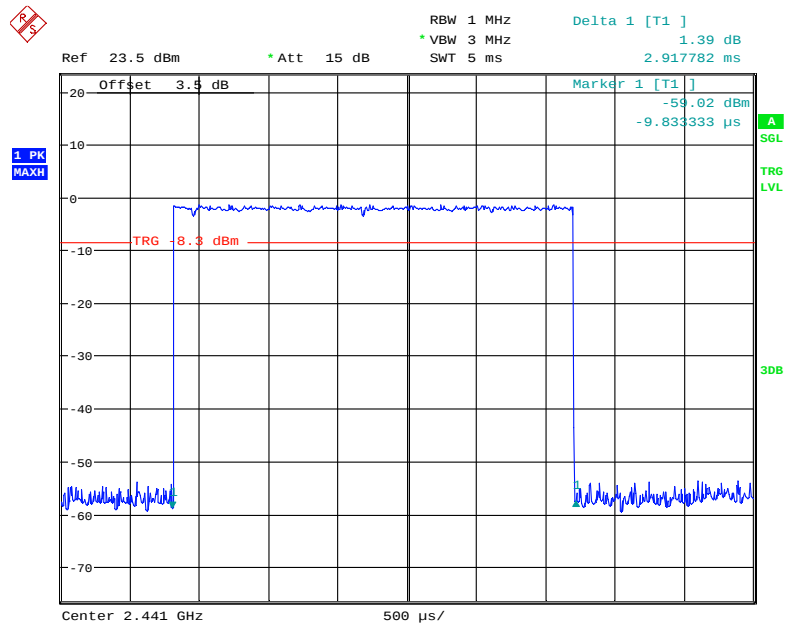
Date: 12.JUL.2021 18:57:35

Pulse time, Middle Channel, DH3



Date: 12.JUL.2021 18:56:39

Pulse time, Middle Channel, DH5



Date: 12.JUL.2021 18:56:05

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

Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

Test Data

Environmental Conditions

Temperature:	23.6~25.3 °C
Relative Humidity:	51~56 %
ATM Pressure:	101.0~101.2 kPa

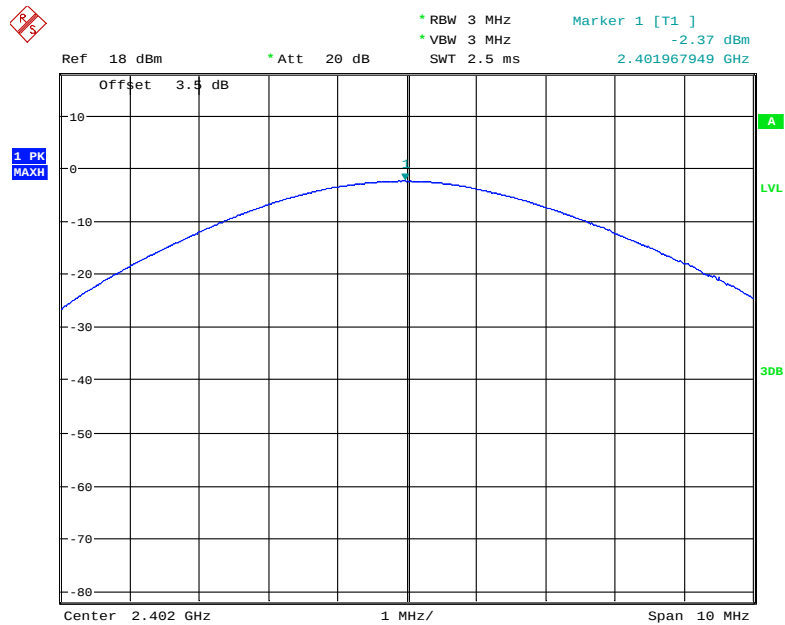
The testing was performed by KEY on 2021-07-12 to 2021-07-19.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table.

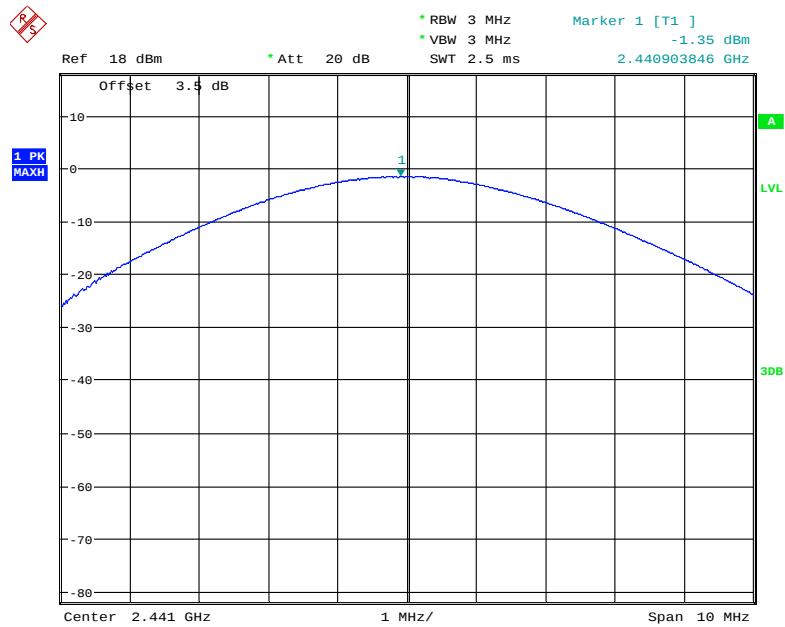
Mode	Channel	Frequency (MHz)	Peak Output Power	Limit (dBm)
			(dBm)	
BDR (GFSK)	Low	2402	-2.37	21
	Middle	2441	-1.35	21
	High	2480	-1.02	21
EDR ($\pi/4$-DQPSK)	Low	2402	-1.75	21
	Middle	2441	-0.60	21
	High	2480	0	21
EDR (8DPSK)	Low	2402	-1.10	21
	Middle	2441	0.06	21
	High	2480	0.62	21

BDR (GFSK): Low Channel



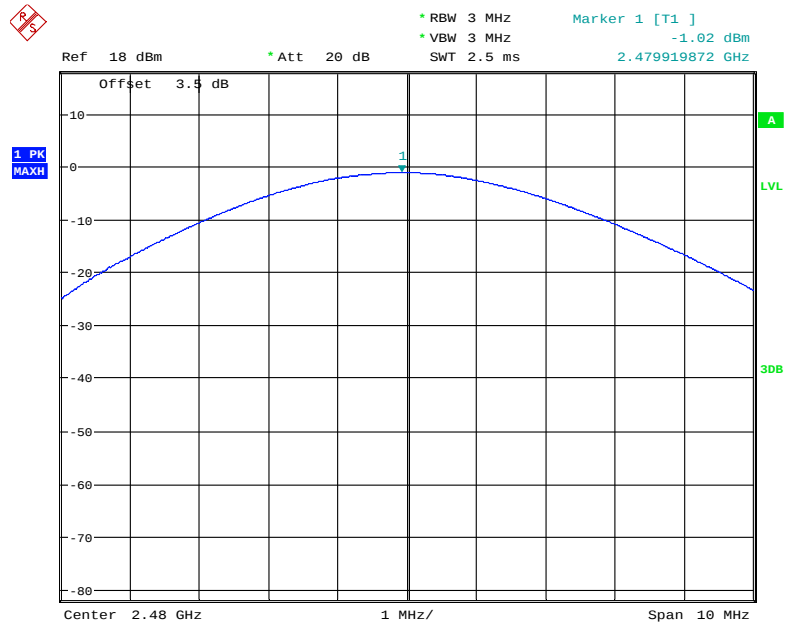
Date: 19.JUL.2021 17:20:16

BDR (GFSK): Middle Channel



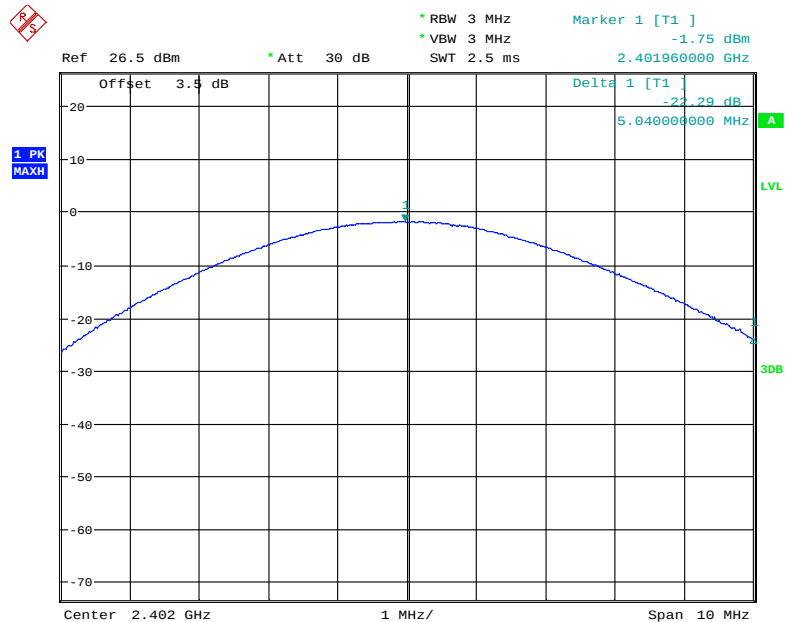
Date: 19.JUL.2021 17:22:04

BDR (GFSK): High Channel



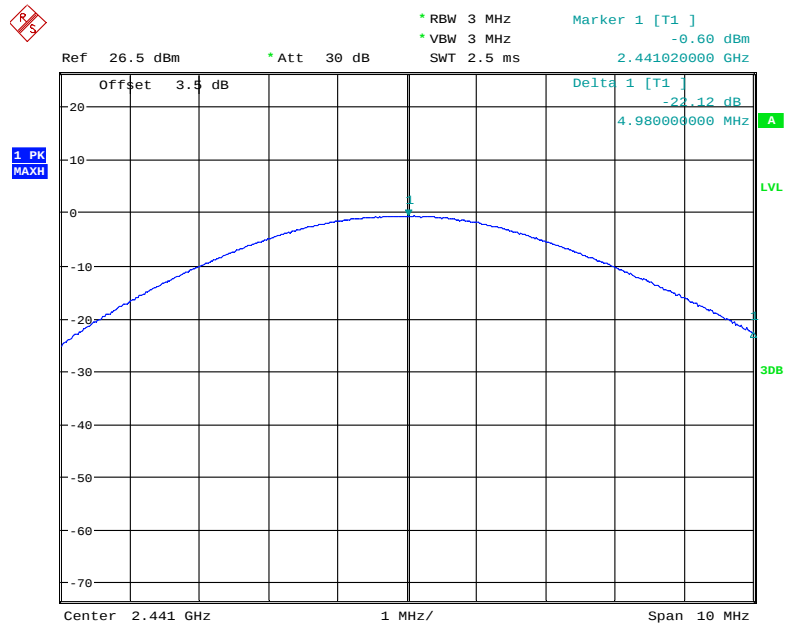
Date: 19.JUL.2021 17:24:01

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



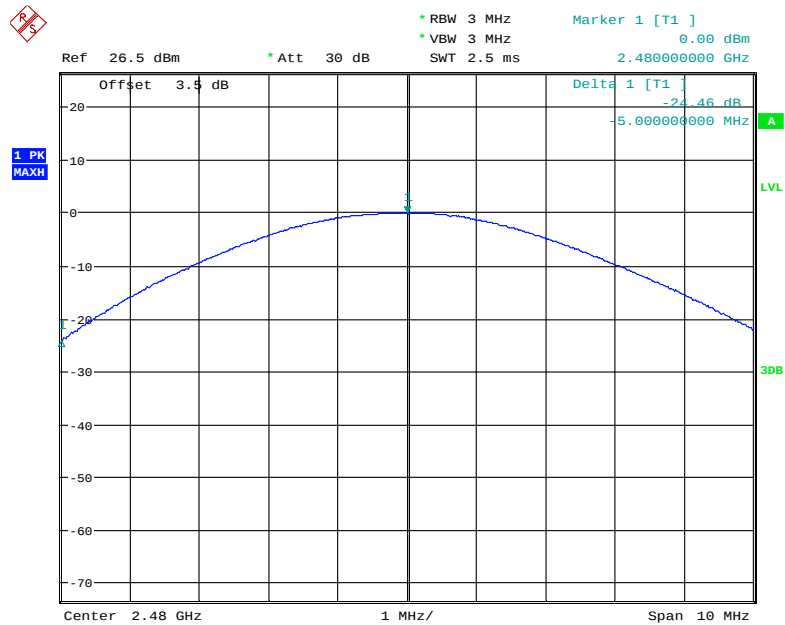
Date: 12.JUL.2021 15:09:48

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



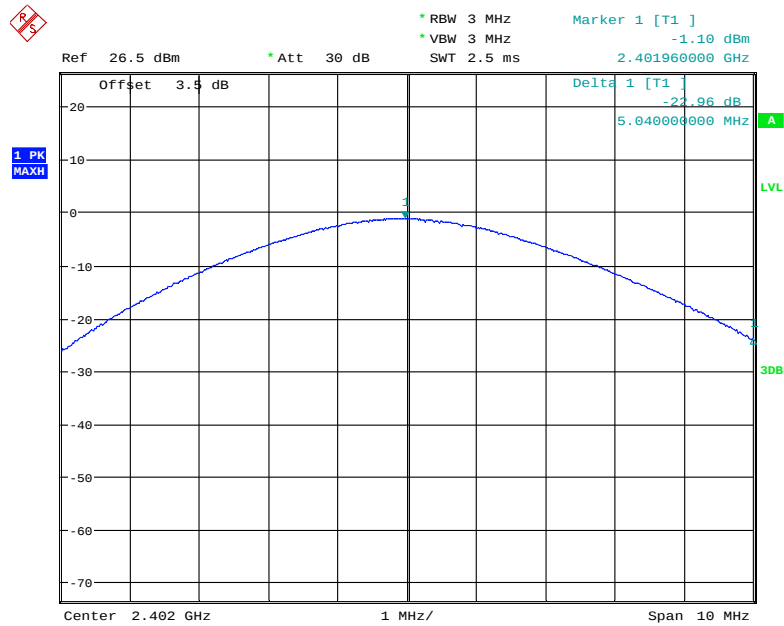
Date: 12.JUL.2021 15:09:16

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



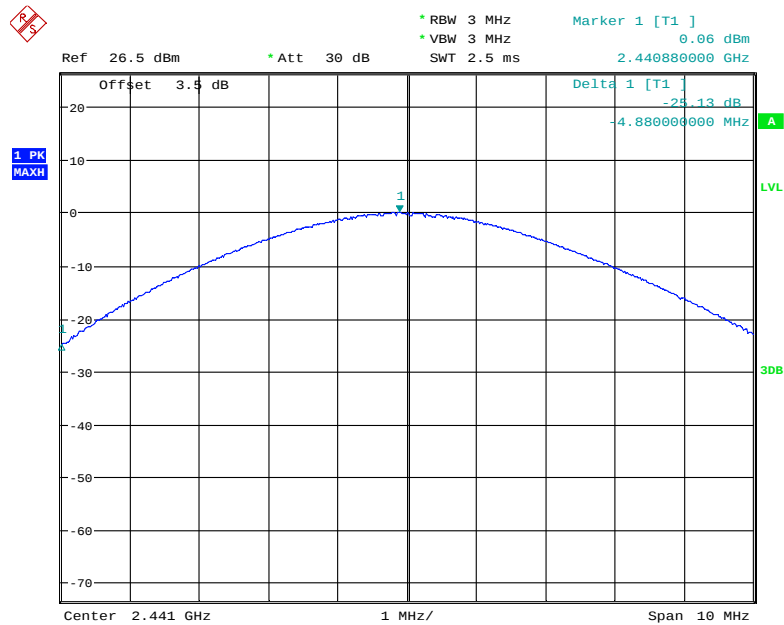
Date: 12.JUL.2021 15:08:37

EDR (8DPSK): Low Channel



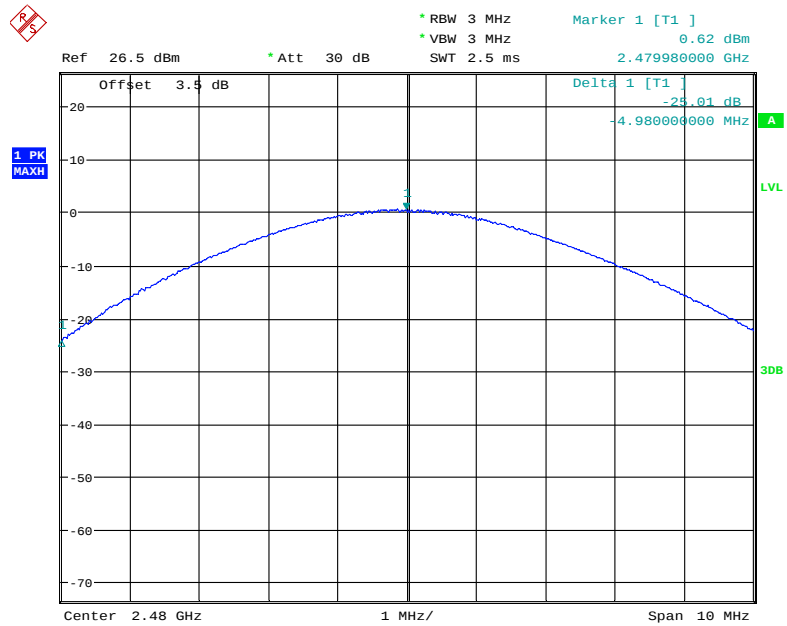
Date: 12.JUL.2021 15:10:21

EDR (8DPSK): Middle Channel



Date: 12.JUL.2021 15:11:02

EDR (8DPSK): High Channel



Date: 12.JUL.2021 15:11:33

FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

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

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	23.6~25.3 °C
Relative Humidity:	51~56 %
ATM Pressure:	101.0~101.2 kPa

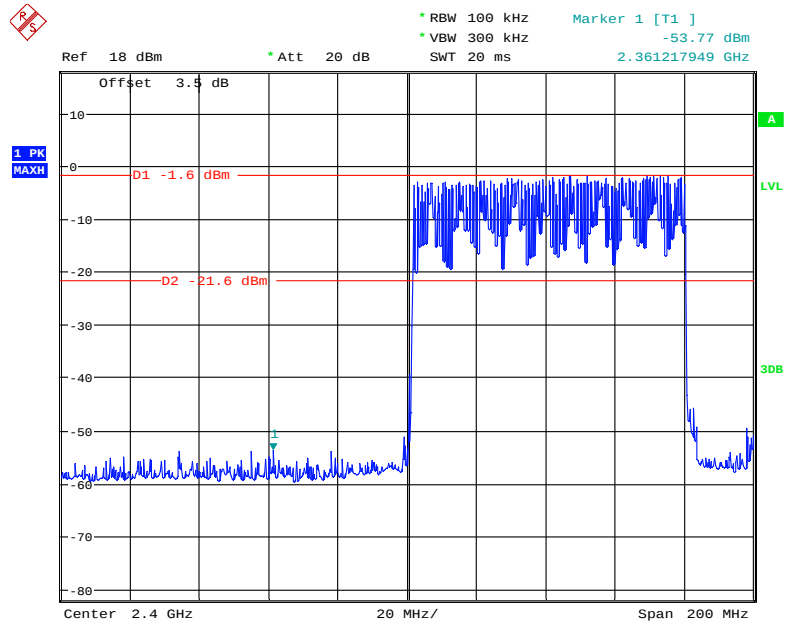
The testing was performed by KEY from 2021-07-02 to 2021-07-19.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following plots.

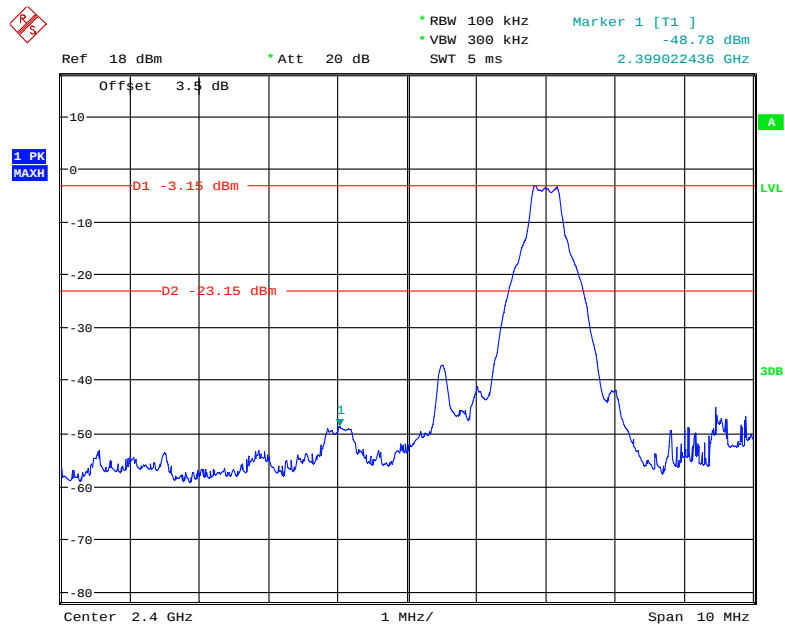
BDR (GFSK): Band Edge-Left Side

Hopping



Date: 19.JUL.2021 17:35:21

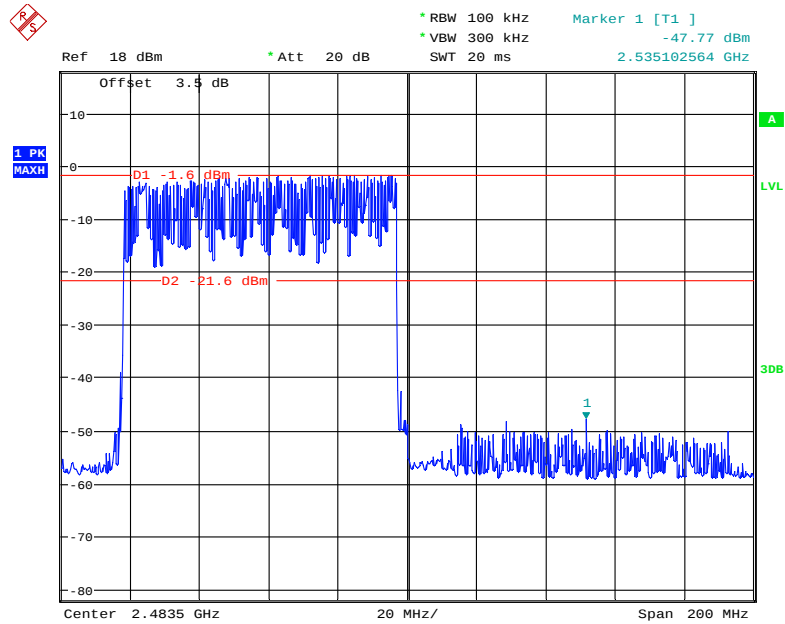
Single



Date: 19.JUL.2021 17:31:00

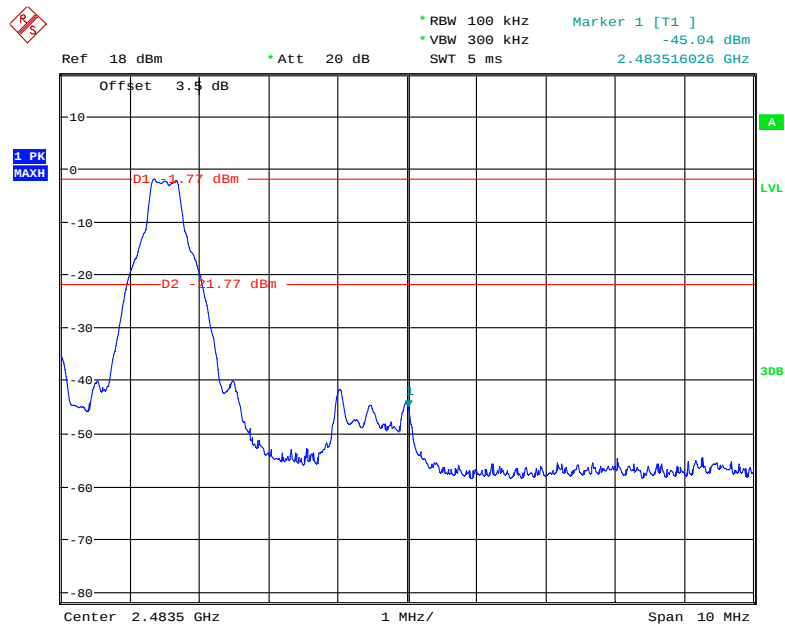
BDR (GFSK): Band Edge-Right Side

Hopping



Date: 19.JUL.2021 17:33:42

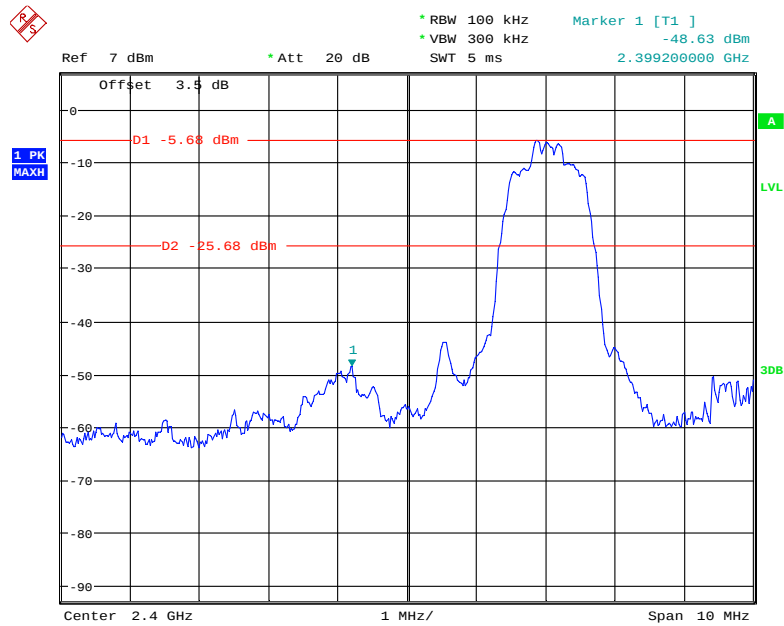
Single



Date: 19.JUL.2021 17:32:25

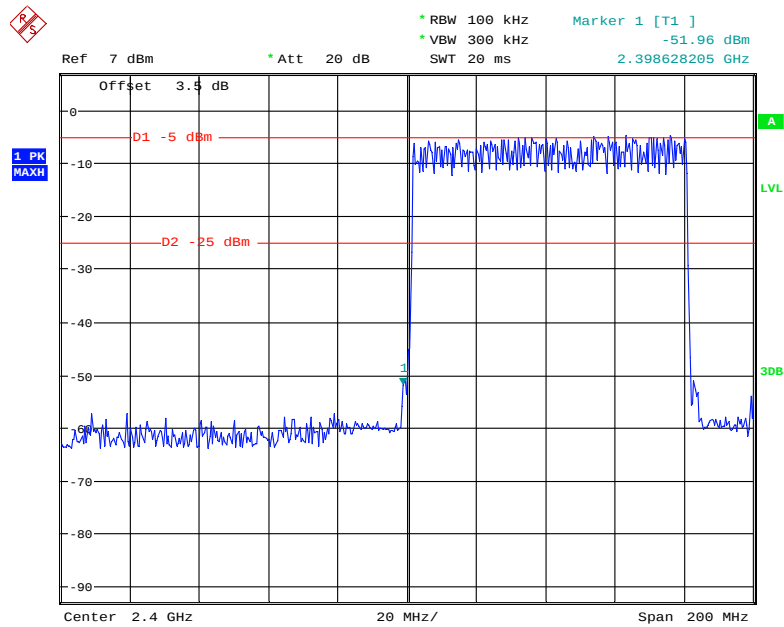
EDR ($\pi/4$ -DQPSK): Band Edge-Left Side

Single



Date: 2.JUL.2021 09:22:56

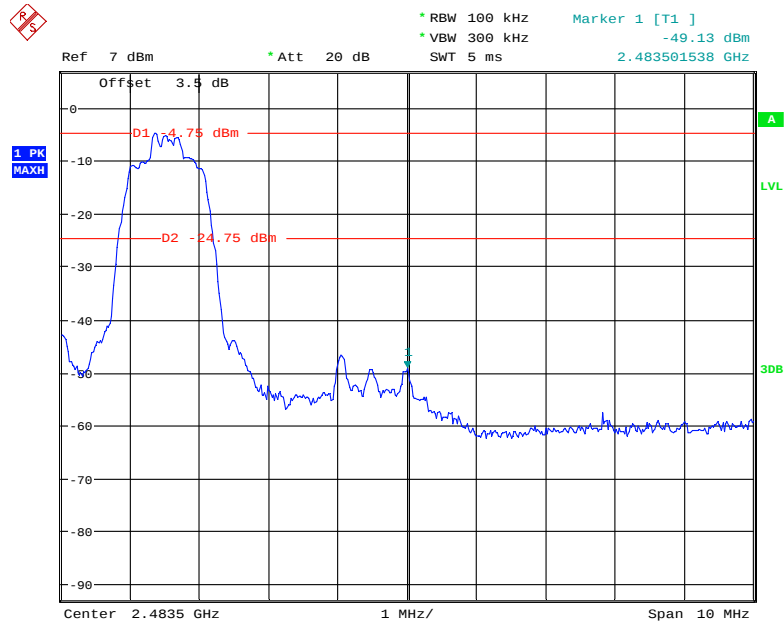
Hopping



Date: 2.JUL.2021 09:32:04

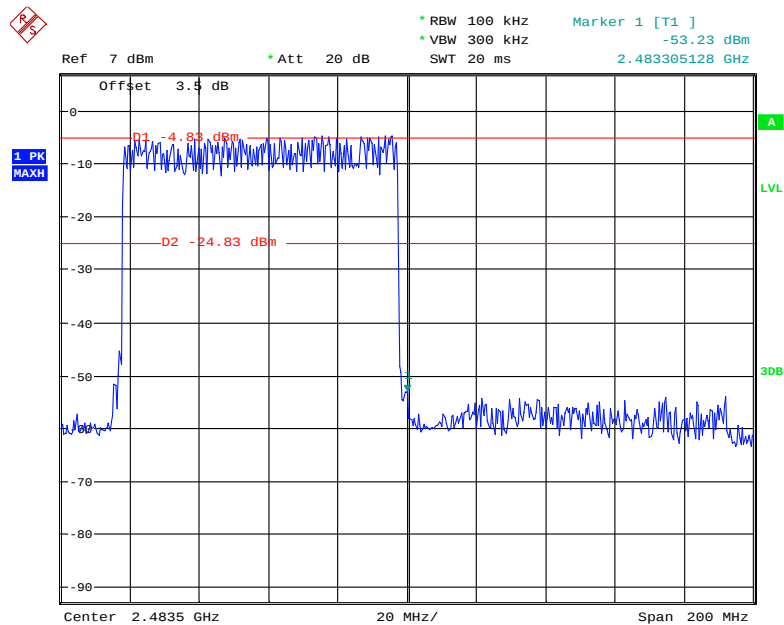
EDR ($\pi/4$ -DQPSK): Band Edge-Right Side

Single



Date: 2.JUL.2021 09:21:56

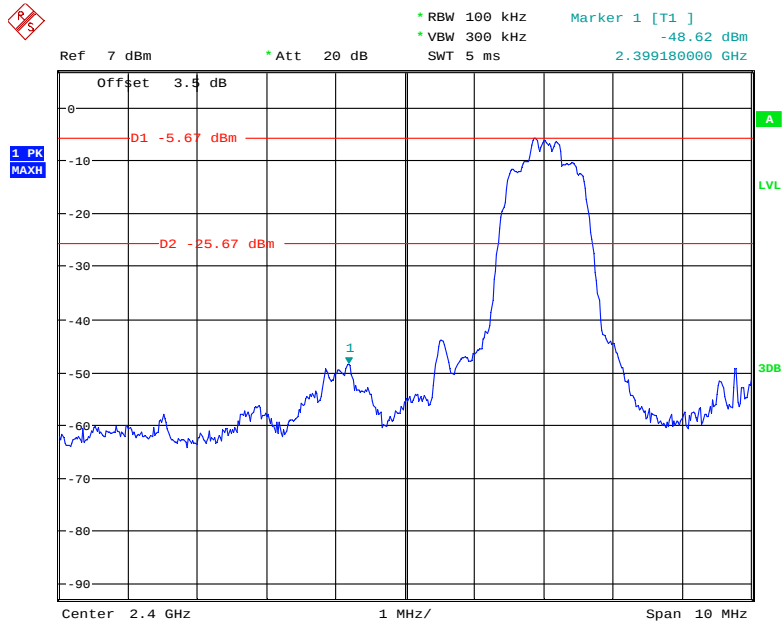
Hopping



Date: 2.JUL.2021 09:33:38

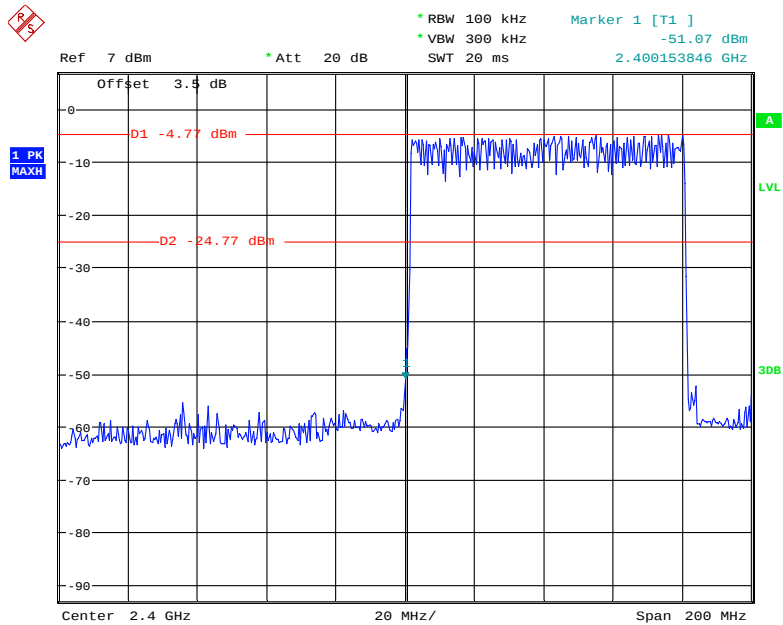
EDR (8DPSK): Band Edge-Left Side

Single

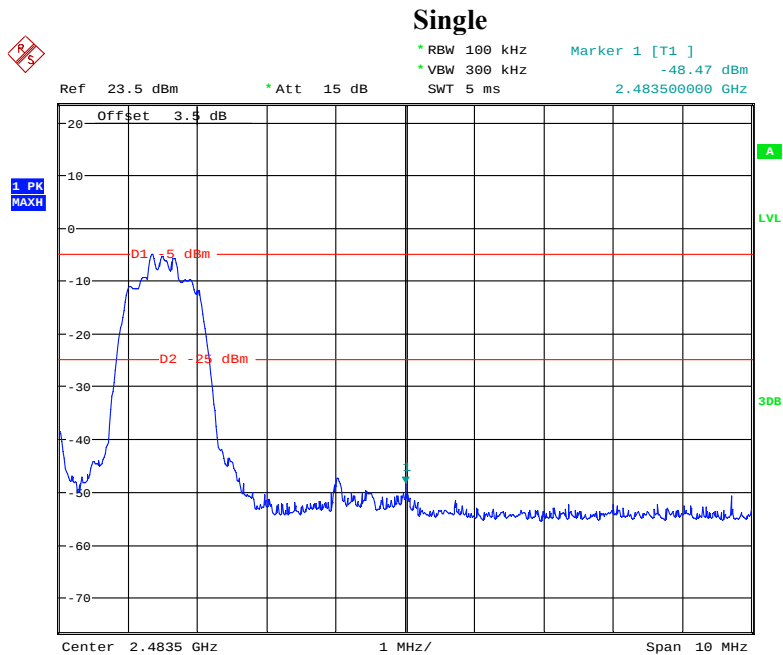


Date: 2.JUL.2021 09:24:03

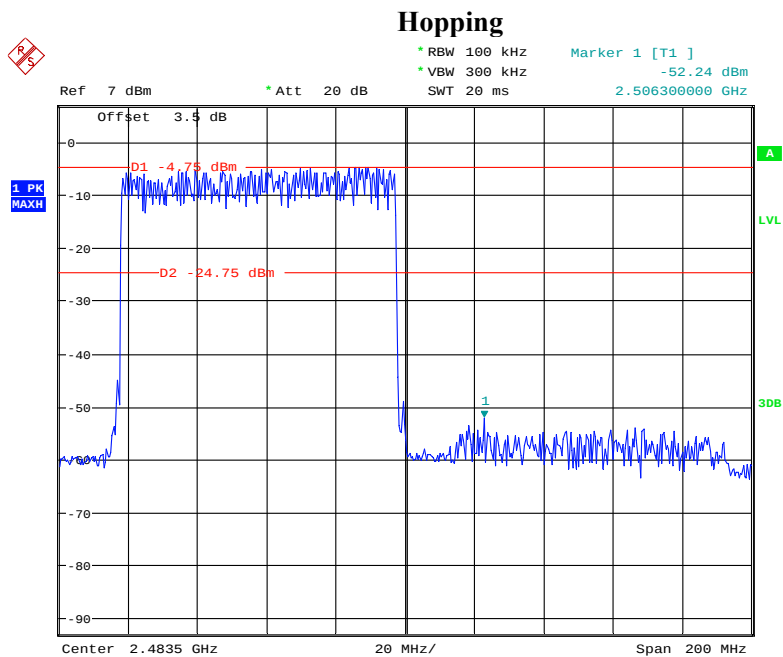
Hopping



Date: 2.JUL.2021 09:37:01

EDR (8DPSK): Band Edge-Right Side

Date: 12.JUL.2021 18:50:26



Date: 2.JUL.2021 09:35:24

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