FCC PART 15.247

RSS-GEN ISSUE 5, FEBRUARY 2021 AMENDMENT 2
RSS-247, ISSUE 2, FEBRUARY 2017

TEST REPORT

For

XIAMEN COMFORT SCIENCE & TECHNOLOGY GROUP CO., LTD.

(5/F) NO.168, QIANPU ROAD, SIMING DISTRICT, XIAMEN, CHINA

FCC ID: YMX-EC3209K
IC: 7284A-EC3209K

Report Type:	**Product Type:**
Original Report	Massage Chair

Report Number:	RTZ210315018-00A
Report Date:	2021-04-16
Reviewed By:	Candy Li RF Engineer
Prepared By:	Shenzhen Accurate Technology Co., Ltd. 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China Tel: (0755) 26503290 Fax: (0755) 26503396 Http://www.atc-lab.com

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

Shenzhen Accurate Technology Co., Ltd. is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk '*'. Customer model name, addresses, names, trademarks etc. are not considered data.

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Massage Chair
Tested Model	EC-3209K
Multiple Model	AM-Juno II
Model Differences	All the same except model name is different.
Frequency Range	Bluetooth: 2402~2480MHz
Transmit Peak Power	0.89dBm
Modulation Technique	Bluetooth: GFSK, π/4-DQPSK, 8DPSK
Antenna Specification	PCB Antenna: 0dBi
Voltage Range	AC110-120V/60Hz
Date of Test	2021-3-21 to 2021-04-13
Sample serial number	RTZ210315018-RF-S1
Received date	2021-03-15
Sample/EUT Status	Good condition

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication 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.

For Radiated Emissions testing, please refer to DA 00-705 Released March 30, 2000, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

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

Measurement Uncertainty

Parameter		Uncertainty
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz- 18GHz	4.98dB
	18GHz- 26.5GHz	5.06dB

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

Test Facility

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

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

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

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016. The Registration Number is 5077A-2.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

“FCC Tool”* exercise software was made to the EUT tested and the power level is 0*. 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

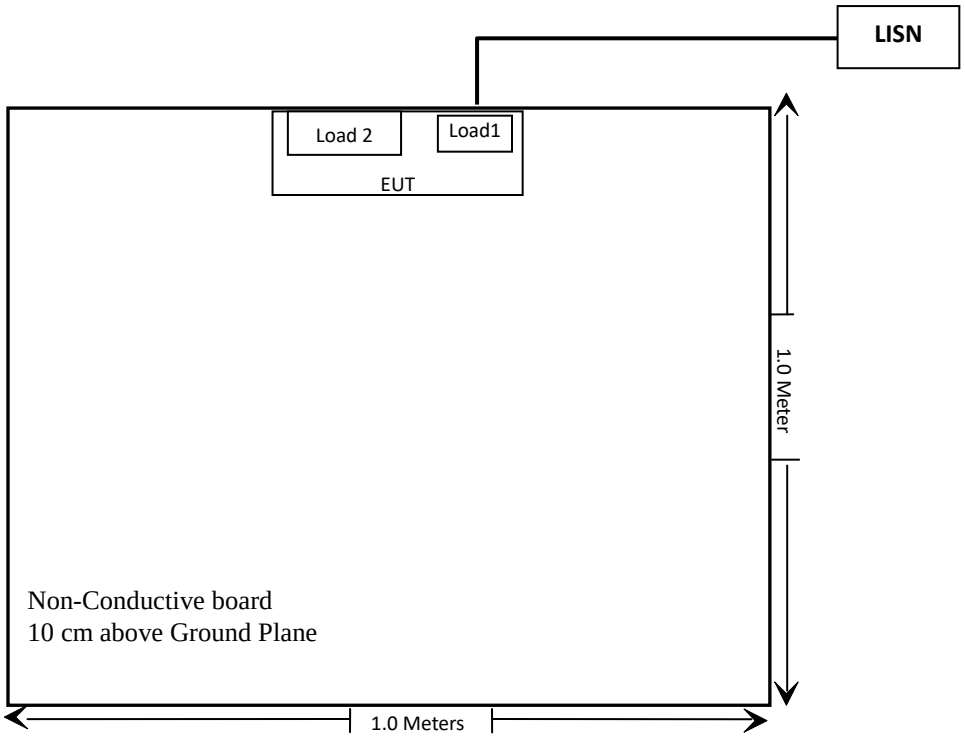
Manufacturer	Description	Model	Serial Number	Specification
Unknown	Load 1	Wireless load 01	Unknown	5W
Unknown	Load 2	USB load 02	Unknown	5V/2A

External I/O Cable

Cable Description	Length (m)	From Port	To
Unshielded Detachable AC Line	1.0	AC Main power	EUT
USB cable	0.3	EUT	USB load 02

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
FCC §15.247 (i) & §2.1091	MAXIMUM PERMISSIBLE EXPOSURE (MPE)	Compliance
RSS-102 §2.5.2	EXEMPTION LIMITS FOR ROUTINE EVALUATION-RF EXPOSURE EVALUATION	Compliance
FCC §15.203 RSS-Gen §6.8	Antenna Requirement	Compliance
FCC §15.207(a) RSS-Gen §8.8	AC Line Conducted Emissions	Compliance
FCC §15.205, §15.209, §15.247(d) RSS-247 §5.5, RSS-GEN §8.10	Radiated Emissions	Compliance
FCC §15.247(a)(1) RSS-247 §5.1(a), RSS-GEN §6.7	20 dB Emission Bandwidth & 99% Occupied Bandwidth	Compliance
FCC §15.247(a)(1) RSS-247 §5.1 (b)	Channel Separation Test	Compliance
FCC §15.247(a)(1)(iii) RSS-247 §5.1 (d)	Time of Occupancy (Dwell Time)	Compliance
FCC §15.247(a)(1)(iii) RSS-247 §5.1 (d)	Quantity of hopping channel Test	Compliance
FCC §15.247(b)(1) RSS-247 §5.1(b) & §5.4(b)	Peak Output Power Measurement	Compliance
FCC §15.247(d) RSS-247 §5.5	Band edges	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	Test Receiver	ESPI3	100396	2020/12/24	2021/12/23
R & S	L.I.S.N.	ENV216	101314	2020/12/25	2021/12/24
Anritsu Corp	50Ω Coaxial Switch	MP59B	6200506474	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-2m	No.2	2020/12/25	2021/12/24
Radiated Emissions Test					
Rohde&Schwarz	Test Receiver	ESR	101817	2020/12/24	2021/12/23
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2020/12/24	2021/12/23
A.H. Systems, inc.	Preamplifier	PAM-0118P	531	2020/07/08	2021/07/07
SONOMA INSTRUMENT	Amplifier	310 N	186131	2020/12/25	2021/12/24
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2020/01/05	2023/01/04
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	Horn Antenna	BBHA9170	9170-359	2020/01/05	2023/01/04
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2020/11/28	2021/11/27
Unknown	RF Coaxial Cable	N-5m	No.3	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-5m	No.4	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.5	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.6	2020/12/25	2021/12/24
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2020/12/24	2021/12/23
WEINSCHEL	10dB Attenuator	5324	AU 3842	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) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (Minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Frequency (MHz)	**Antenna Gain**		**Tune up conducted power**		**Evaluation Distance (cm)**	**Power Density (mW/cm^2)**	**MPE Limit (mW/cm^2)**
	(dBi)	**(numeric)**	**(dBm)**	**(mW)**			
2402-2480	0	1	1	1.26	20	0.0003	1

RSS-102 §2.5.2 –EXEMPTION LIMITS FOR ROUTINE EVALUATION-RF EXPOSURE EVALUATION

Applicable Standard

According to RSS-102 §(2.5.2):

2.5.2 Exemption Limits for Routine Evaluation — RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $22.48/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2}\ f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Calculated Data:

The maximum tune-up conducted output power is 1dBm.

And the maximum antenna gain is 0dBi.

So the maximum tune-up conducted power is 1dBm=1.26mW<2.68W.

f = 2402 MHz:

The limit is 1.31*10-2*24020.6834=2.68W

So the RF Exposure 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 PCB antenna arrangement which was permanently attached and the maximum antenna gain is 0dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Type	Antenna Gain	Impedance	Frequency Range
PCB	0dBi	50Ω	2.4~2.5GHz

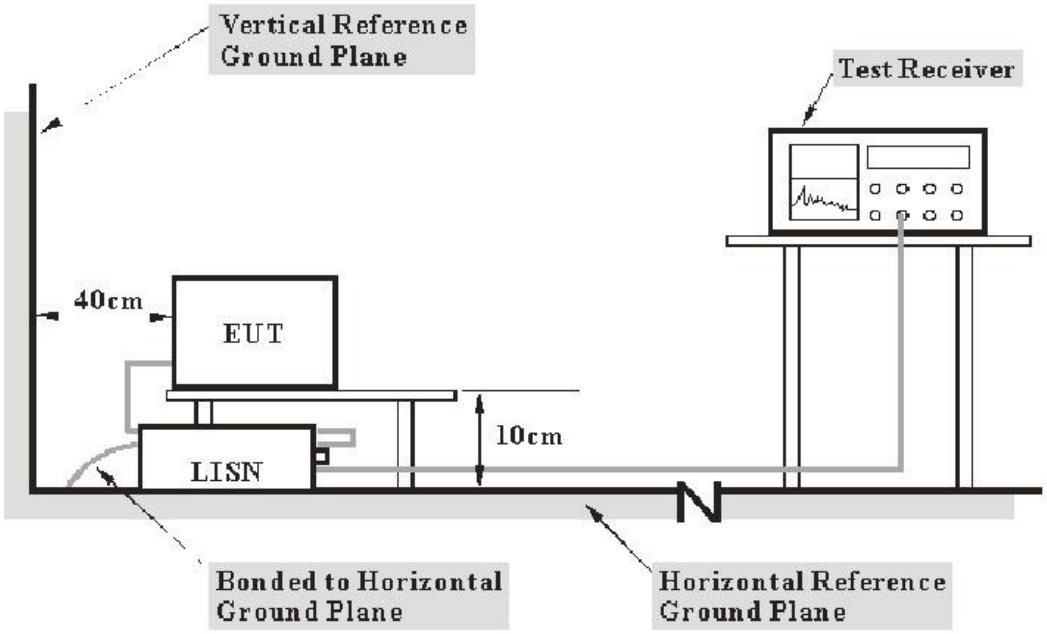
Result: Compliance

FCC §15.207 (a) & RSS-GEN §8.8 – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a), RSS-GEN §8.8

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 10 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 & RSS-Gen.

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

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

Transd Factor = LISN VDF + Cable Loss

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

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

Test Data

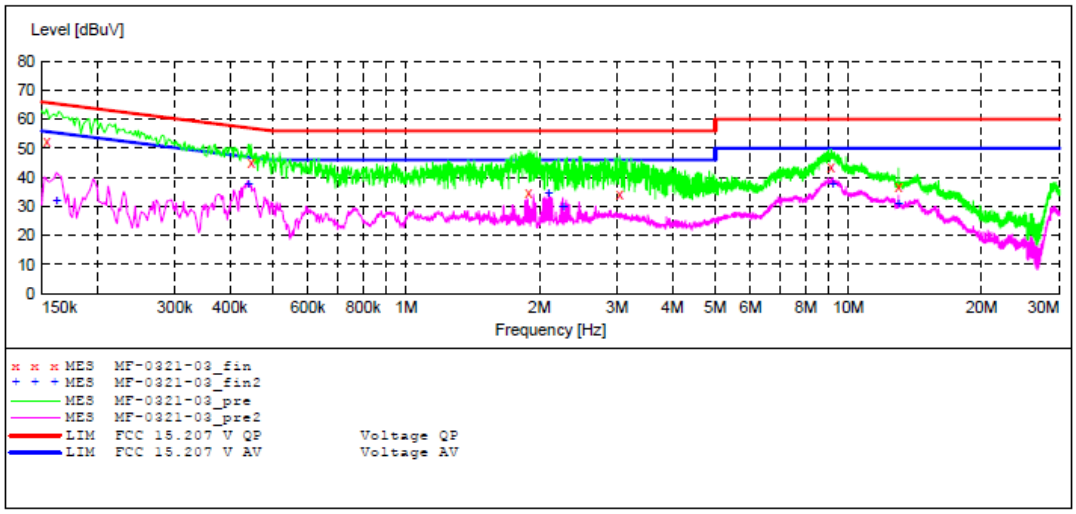
Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2021-03-21.

EUT operation mode: Transmitting & charging (the worst case is 8DPSK Mode, Low channel)

AC 120V/60 Hz, Line



MEASUREMENT RESULT: "MF-0321-03_fin"

2021-3-21 9:58

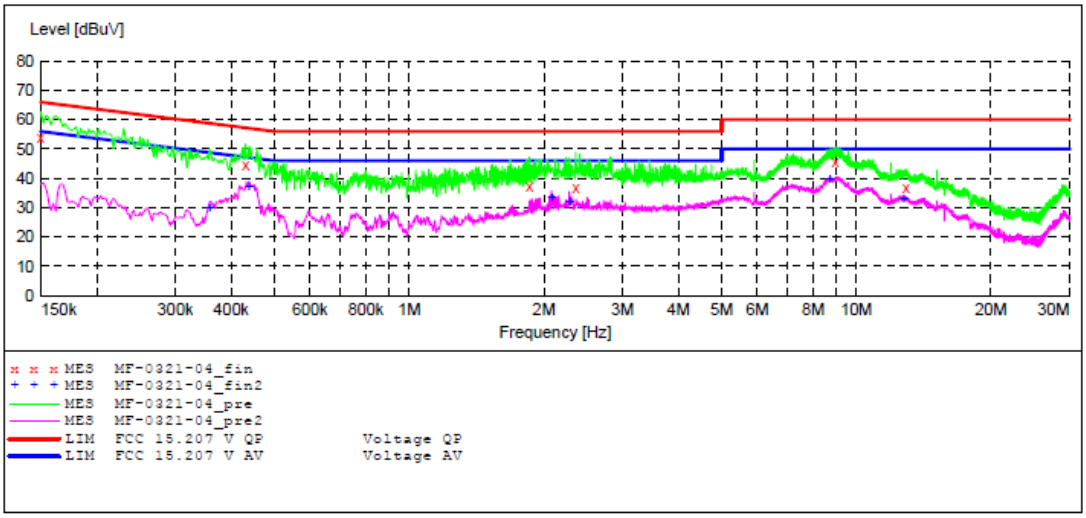
Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.154000	52.50	10.8	66	13.5	QP	L1	GND
0.446000	44.90	11.0	57	12.1	QP	L1	GND
1.894000	34.80	11.3	56	21.2	QP	L1	GND
3.035000	34.30	11.3	56	21.7	QP	L1	GND
9.140000	43.70	11.6	60	16.3	QP	L1	GND
12.965000	36.90	11.6	60	23.1	QP	L1	GND

MEASUREMENT RESULT: "MF-0321-03_fin2"

2021-3-21 9:58

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.162000	32.00	10.8	55	23.0	AV	L1	GND
0.440000	37.90	11.0	47	9.1	AV	L1	GND
2.100000	34.70	11.3	46	11.3	AV	L1	GND
2.260000	30.20	11.3	46	15.8	AV	L1	GND
9.225000	37.60	11.6	50	12.4	AV	L1	GND
12.965000	31.20	11.6	50	18.8	AV	L1	GND

AC 120V/60 Hz, Neutral



MEASUREMENT RESULT: "MF-0321-04_fin"

2021-3-21 10:07

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.150000	53.70	10.8	66	12.3	QP	N	GND
0.430000	44.50	11.0	57	12.5	QP	N	GND
1.858000	37.50	11.2	56	18.5	QP	N	GND
2.355000	36.90	11.3	56	19.1	QP	N	GND
8.970000	45.50	11.5	60	14.5	QP	N	GND
12.900000	37.00	11.6	60	23.0	QP	N	GND

MEASUREMENT RESULT: "MF-0321-04_fin2"

2021-3-21 10:07

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.358000	30.20	10.9	49	18.8	AV	N	GND
0.438000	37.40	11.0	47	9.6	AV	N	GND
2.080000	33.50	11.3	46	12.5	AV	N	GND
2.280000	32.00	11.3	46	14.0	AV	N	GND
8.730000	40.00	11.5	50	10.0	AV	N	GND
12.755000	33.30	11.6	50	16.7	AV	N	GND

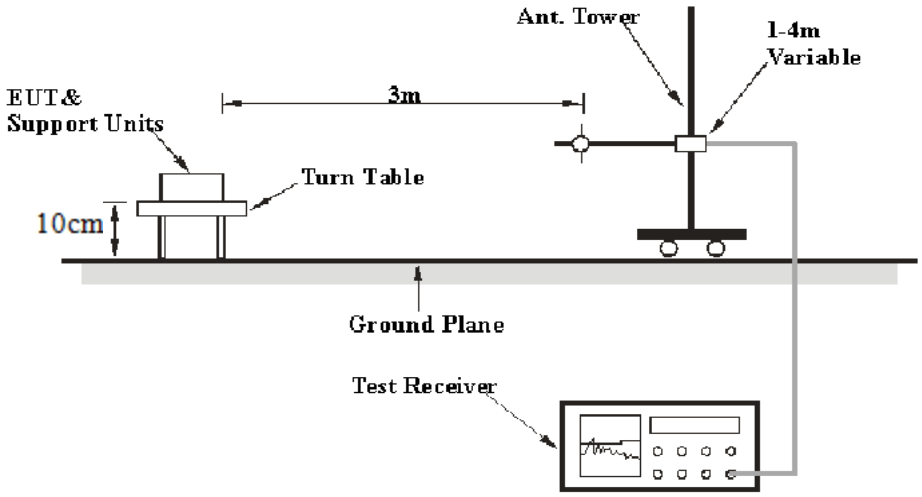
FCC §15.209, §15.205 & §15.247(d) & RSS-247§5.5 - Spurious Emissions

Applicable Standard

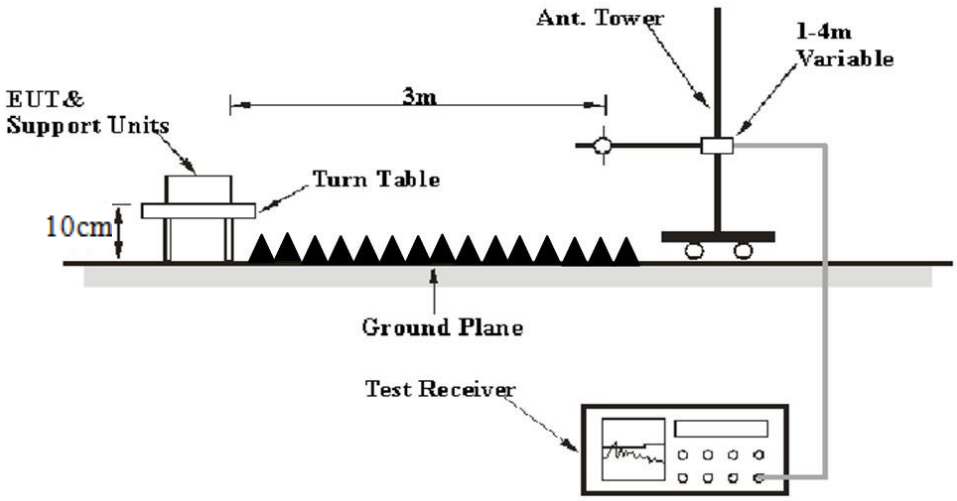
FCC §15.205; §15.209; §15.247(d); RSS-247§5.5; RSS-GEN §8.10

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

During the radiated emission test, according to the DA 00-705 Released March 30, 2000, 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 Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

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

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

Margin = Result-Limit
Result = Reading + Factor

Test Data

Environmental Conditions

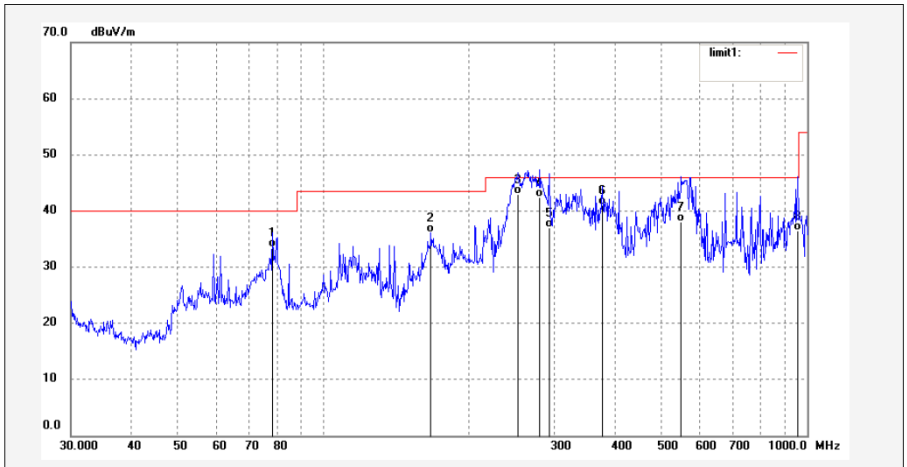
Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2021-04-10

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

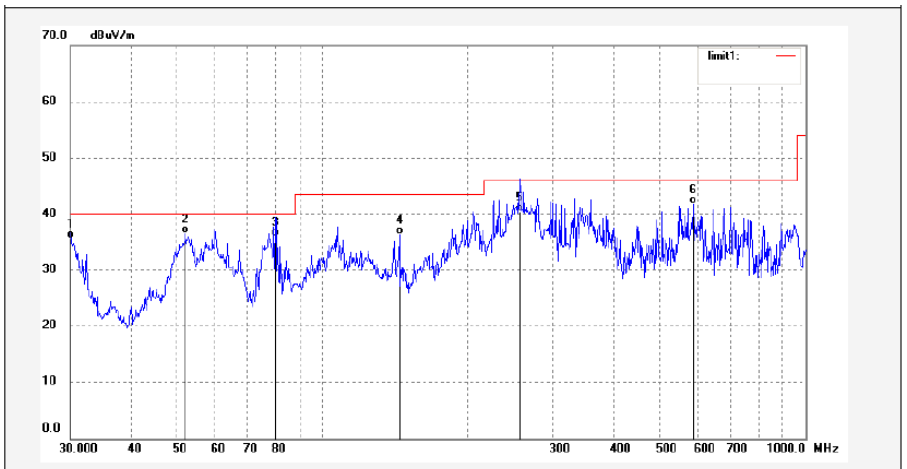
30 MHz~1 GHz: *(the worst case is 8DPSK Mode, Low channel)*

Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	78.4133	48.79	-15.26	33.53	40.00	-6.47	QP			
2	166.6511	49.30	-13.20	36.10	43.50	-7.40	QP			
3	252.0627	53.10	-10.15	42.95	46.00	-3.05	QP			
4	280.0237	51.73	-9.21	42.52	46.00	-3.48	QP			
5	293.0842	45.86	-8.80	37.06	46.00	-8.94	QP			
6	377.2590	47.38	-6.34	41.04	46.00	-4.96	QP			
7	549.0193	40.74	-2.76	37.98	46.00	-8.02	QP			
8	955.4379	32.68	3.89	36.57	46.00	-9.43	QP			

Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	30.1051	43.02	-7.43	35.59	40.00	-4.41	QP			
2	52.0251	47.96	-11.41	36.55	40.00	-3.45	QP			
3	79.8002	51.23	-15.18	36.05	40.00	-3.95	QP			
4	144.3348	50.56	-14.20	36.36	43.50	-7.14	QP			
5	255.6228	50.47	-10.12	40.35	46.00	-5.65	QP			
6	584.7894	43.82	-2.01	41.81	46.00	-4.19	QP			

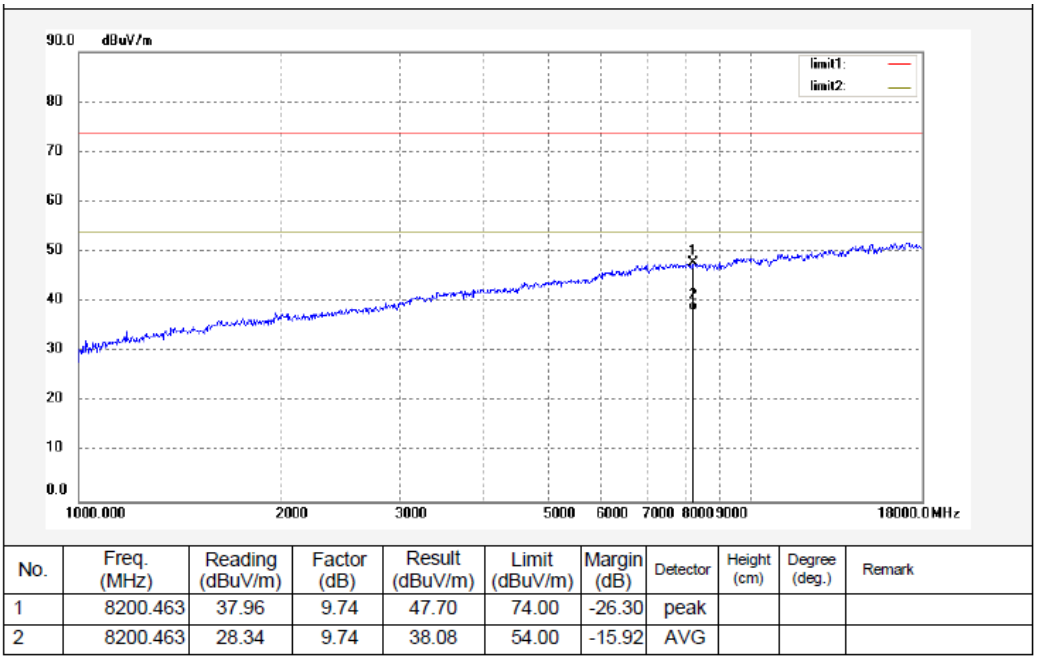
1 GHz - 18GHz:

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

18~25GHz: *The test values lower than the limits of 20dB or in the noise floor level, the test data were not recorded in the report.*

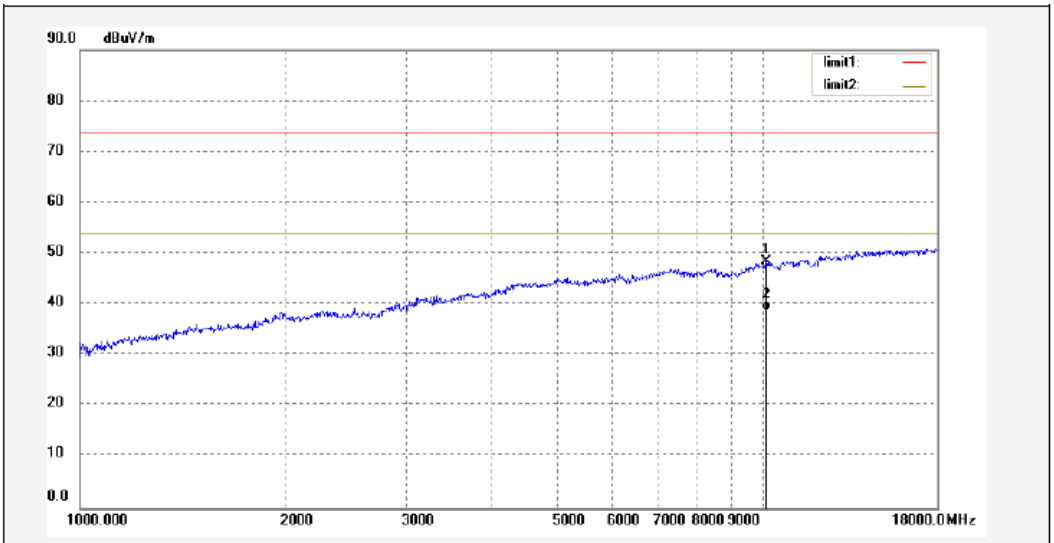
High Channel

Horizontal



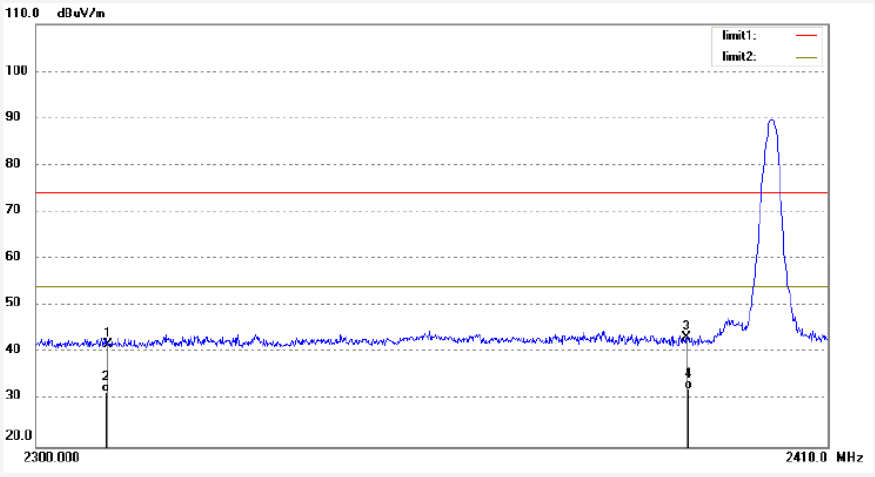
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	8200.463	37.96	9.74	47.70	74.00	-26.30	peak			
2	8200.463	28.34	9.74	38.08	54.00	-15.92	AVG			

Vertical



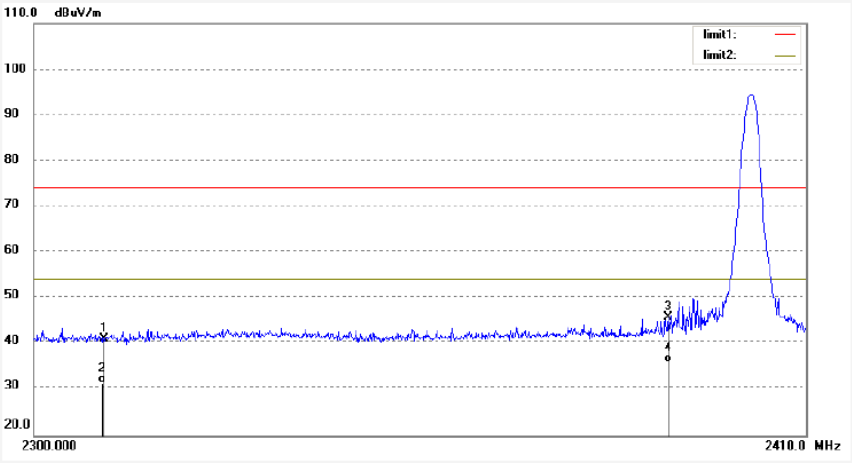
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	10126.824	34.29	14.20	48.49	74.00	-25.51	peak			
2	10126.824	24.51	14.20	38.71	54.00	-15.29	AVG			

Low Channel
Horizontal



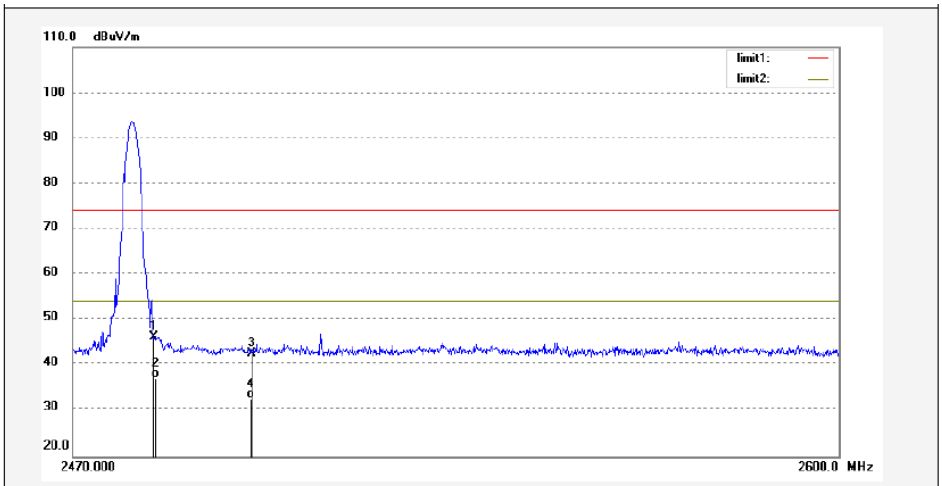
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2310.000	48.47	-6.84	41.63	74.00	-32.37	peak			
2	2310.000	38.52	-6.84	31.68	54.00	-22.32	AVG			
3	2390.000	49.64	-6.44	43.20	74.00	-30.80	peak			
4	2390.000	38.78	-6.44	32.34	54.00	-21.66	AVG			

Vertical



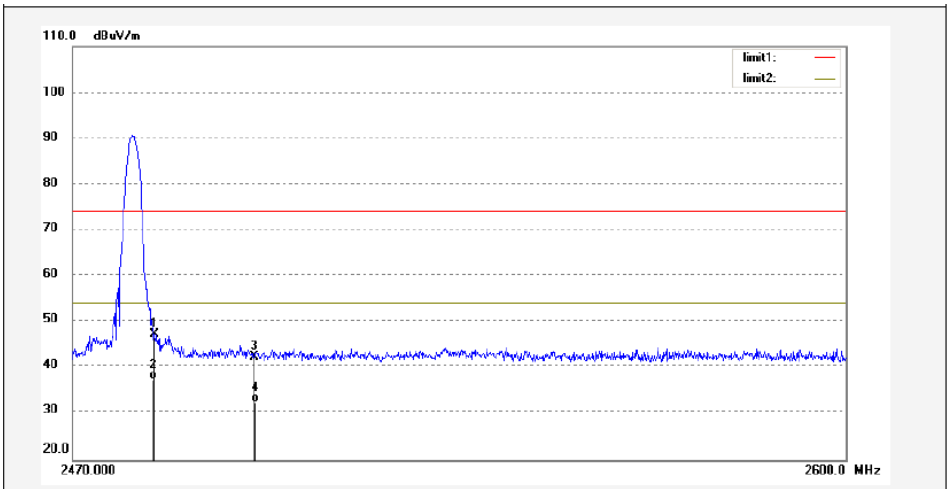
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2310.000	47.90	-6.84	41.06	74.00	-32.94	peak			
2	2310.000	38.12	-6.84	31.28	54.00	-22.72	AVG			
3	2390.000	52.12	-6.44	45.68	74.00	-28.32	peak			
4	2390.000	42.38	-6.44	35.94	54.00	-18.06	AVG			

High Channel
Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2483.500	52.27	-5.96	46.31	74.00	-27.69	peak			
2	2483.500	43.11	-5.96	37.15	54.00	-16.85	AVG			
3	2500.000	48.55	-5.88	42.67	74.00	-31.33	peak			
4	2500.000	38.67	-5.88	32.79	54.00	-21.21	AVG			

Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2483.500	53.24	-5.96	47.28	74.00	-26.72	peak			
2	2483.500	43.37	-5.96	37.41	54.00	-16.59	AVG			
3	2500.000	48.26	-5.88	42.38	74.00	-31.62	peak			
4	2500.000	38.31	-5.88	32.43	54.00	-21.57	AVG			

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

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

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

The testing was performed by Black Ding on 2021-04-13.

EUT operation mode: Transmitting

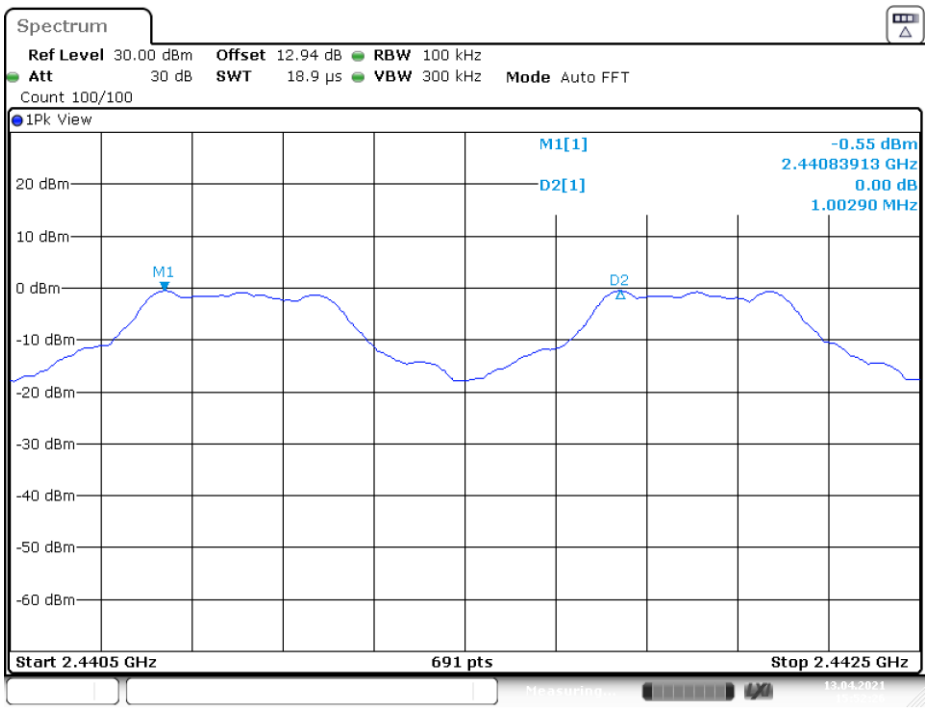
Test Result: Pass

Please refer to following table and plots.

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	≥Limit (MHz)	Result
BDR (GFSK)	Middle	2441	1.003	0.654	Pass
	Adjacent	2442			
EDR (π/4-DQPSK)	Middle	2441	1.000	0.924	Pass
	Adjacent	2442			
EDR (8DPSK)	Middle	2441	1.003	0.910	Pass
	Adjacent	2442			

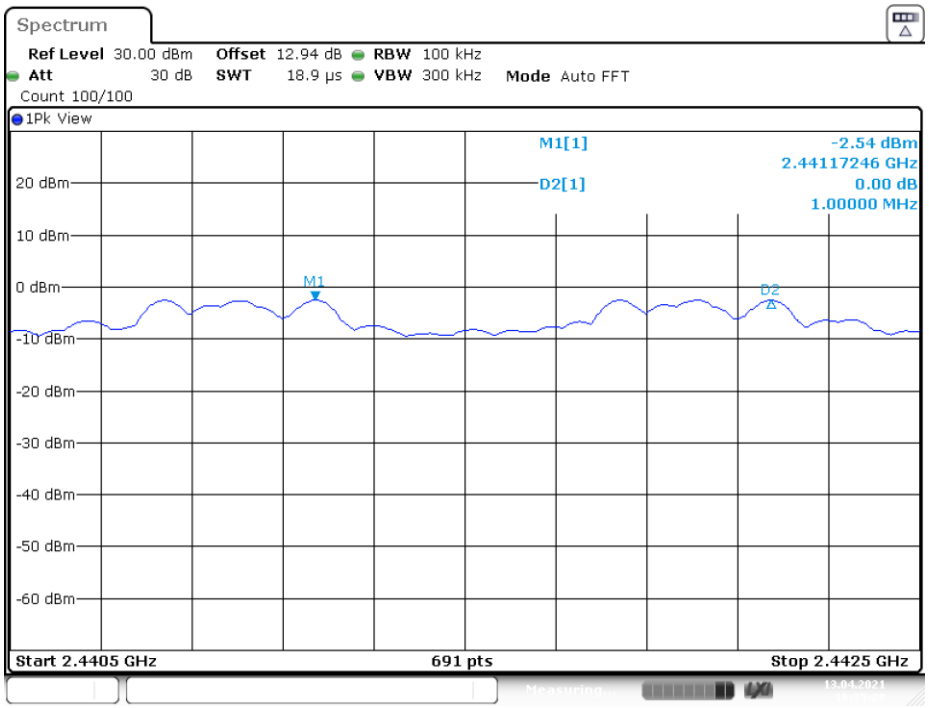
Note: the limit = (2/3) * 20dB bandwidth

BDR (GFSK): Middle Channel



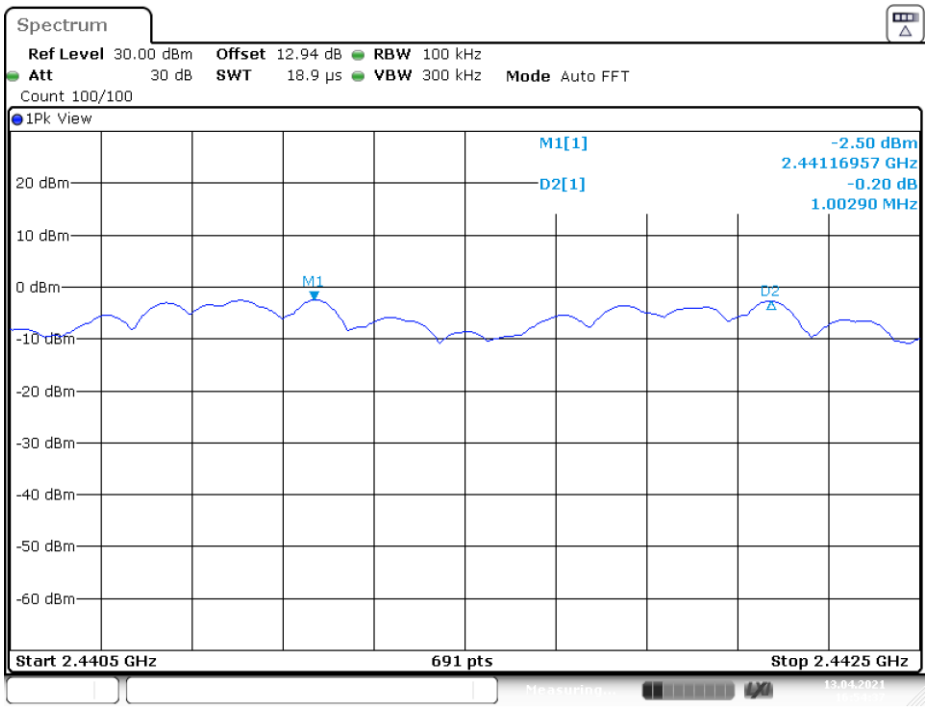
Date: 13.APR.2021 15:52:26

EDR (π/4-DQPSK): Middle Channel



Date: 13.APR.2021 16:35:29

EDR (8DPSK): Middle Channel



Date: 13.APR.2021 16:54:37

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

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

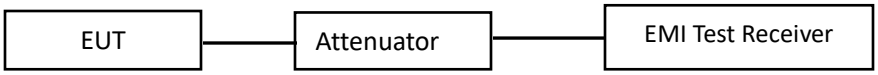
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

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

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

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

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



Test Data

Environmental Conditions

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

The testing was performed by Black Ding on 2021-04-13.

EUT operation mode: Transmitting

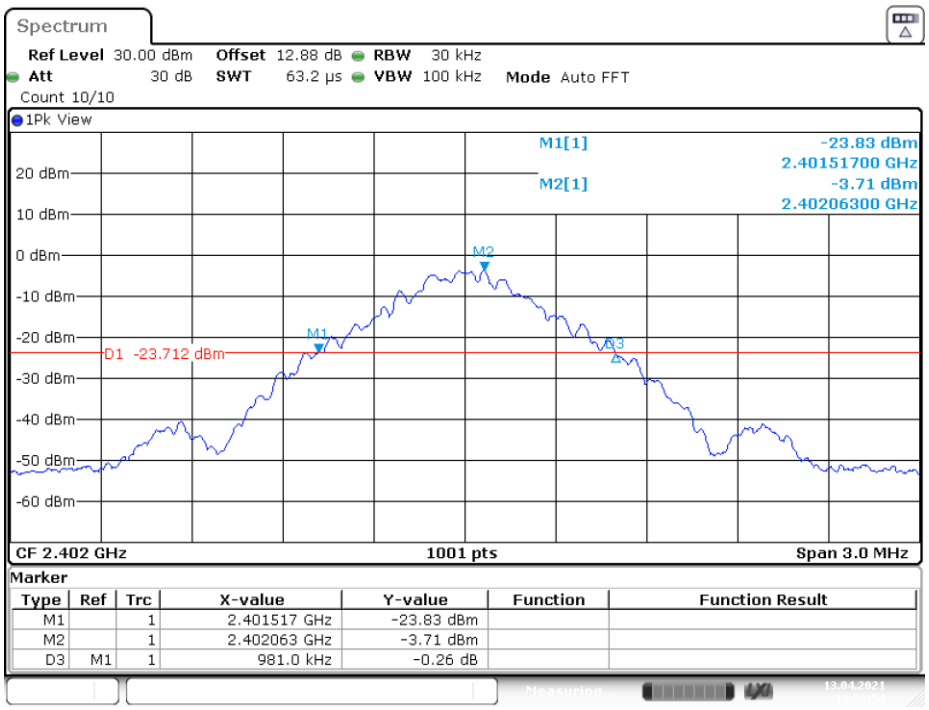
Test Result: Pass

Please refer to following table and plots.

Mode	Frequency (MHz)	99% Occupied Bandwidth (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	2402	0.914	0.981
	2441	0.914	0.978
	2480	0.908	0.981
EDR (π/4-DQPSK)	2402	1.223	1.386
	2441	1.22	1.377
	2480	1.214	1.371
EDR (8DPSK)	2402	1.226	1.362
	2441	1.229	1.365
	2480	1.223	1.359

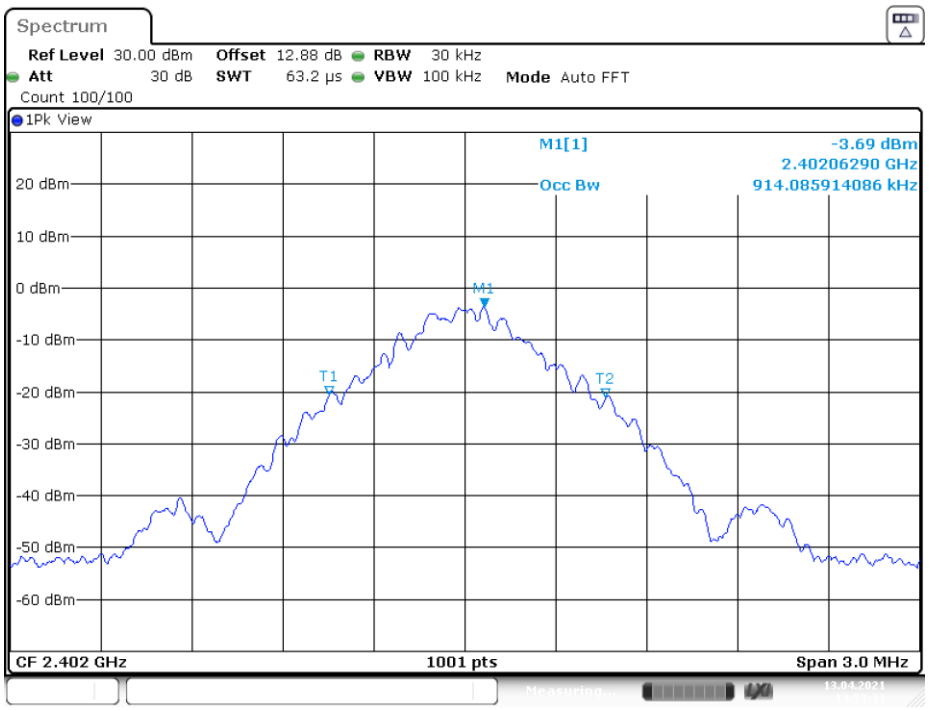
BDR (GFSK):

20dB Emission Bandwidth, Low Channel



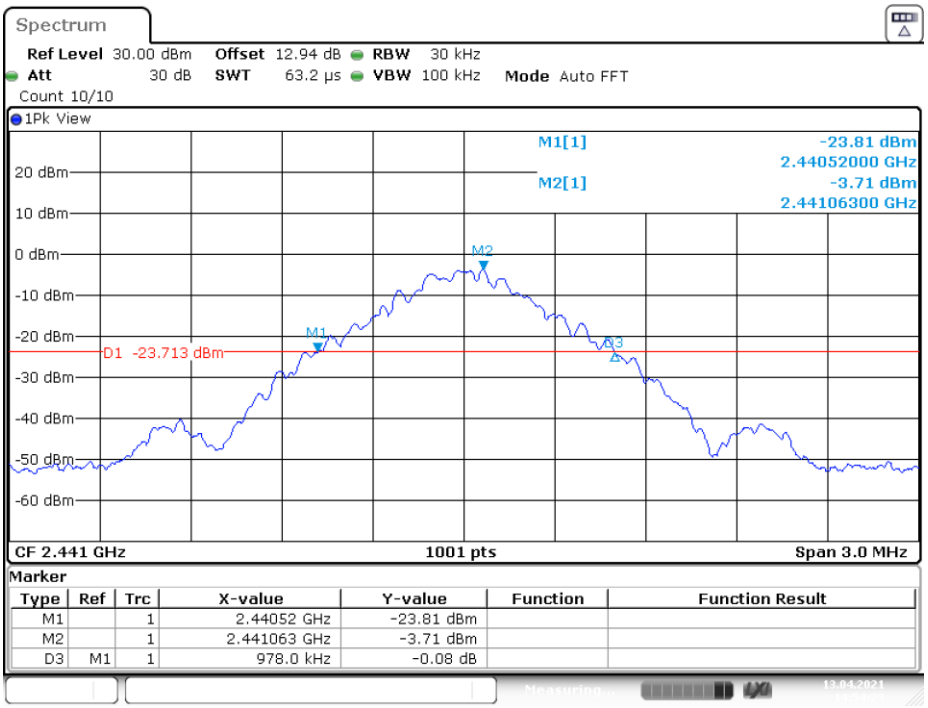
Date: 13.APR.2021 14:52:55

99% Occupied Bandwidth, Low Channel



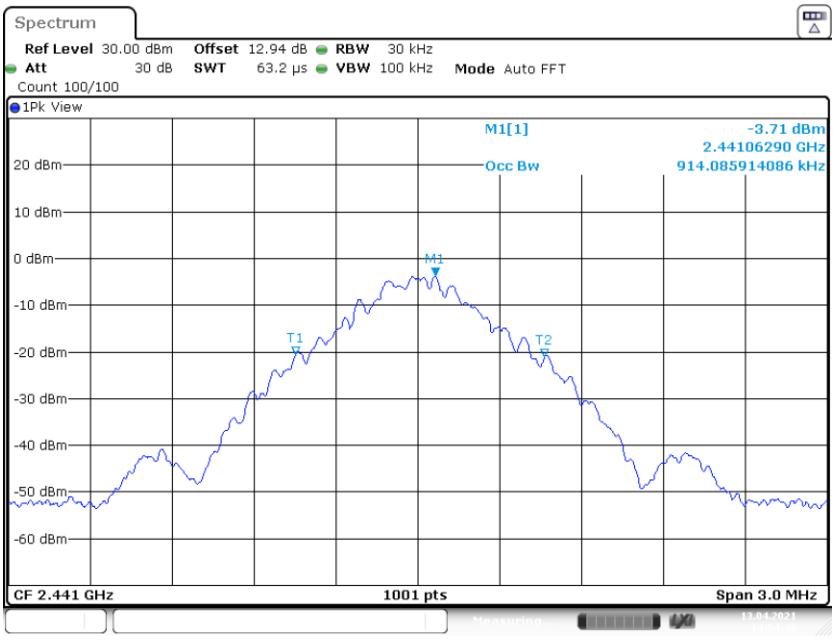
Date: 13.APR.2021 14:53:11

20dB Emission Bandwidth, Middle Channel



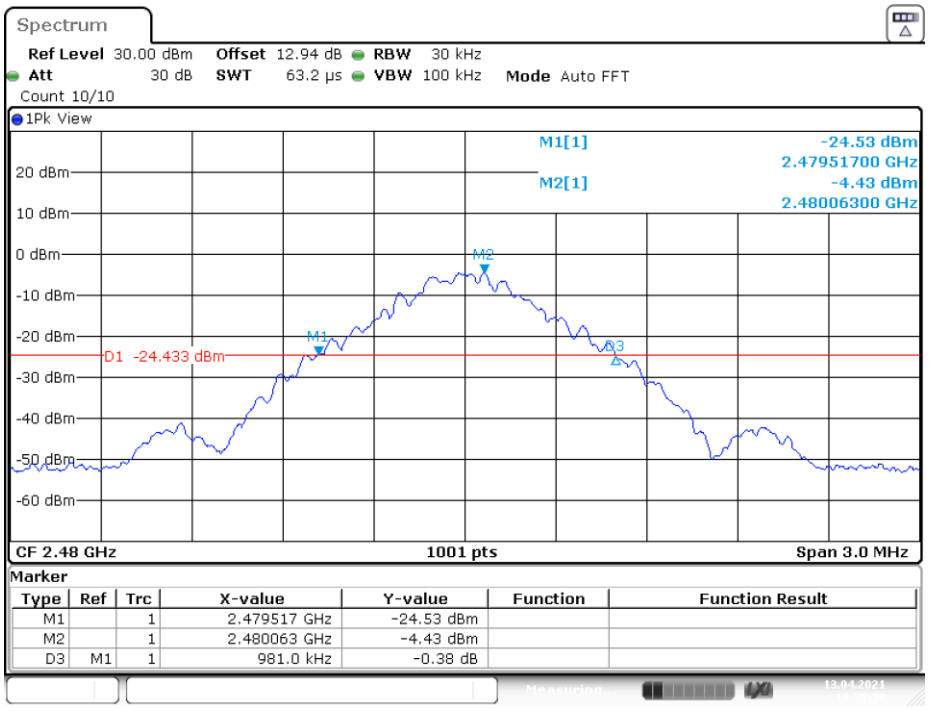
Date: 13.APR.2021 14:54:24

99% Occupied Bandwidth, Middle Channel



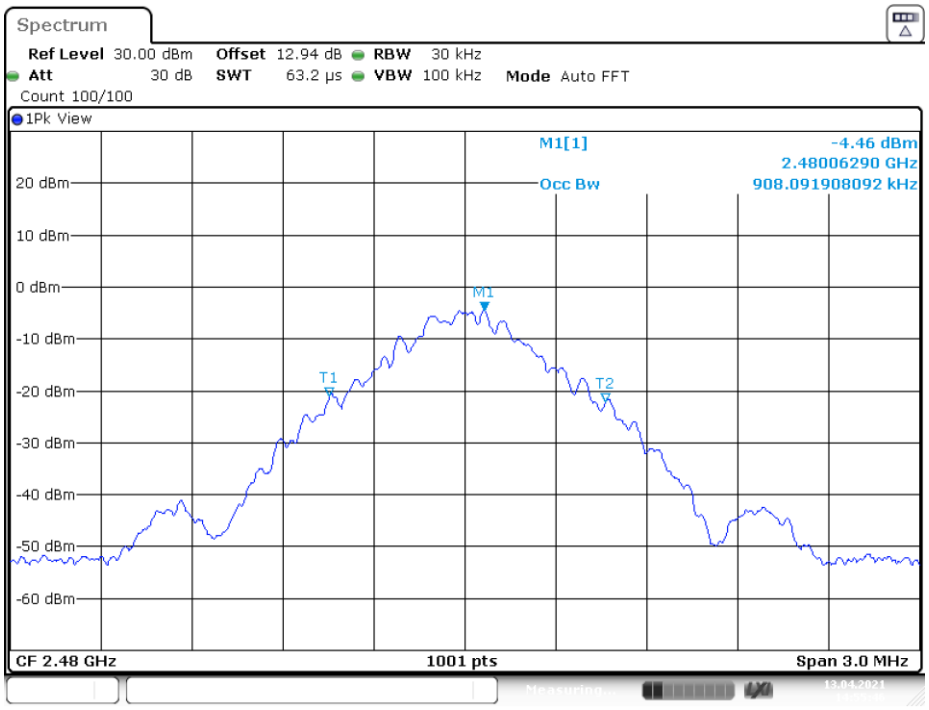
Date: 13.APR.2021 14:54:40

20dB Emission Bandwidth, High Channel



Date: 13.APR.2021 14:55:30

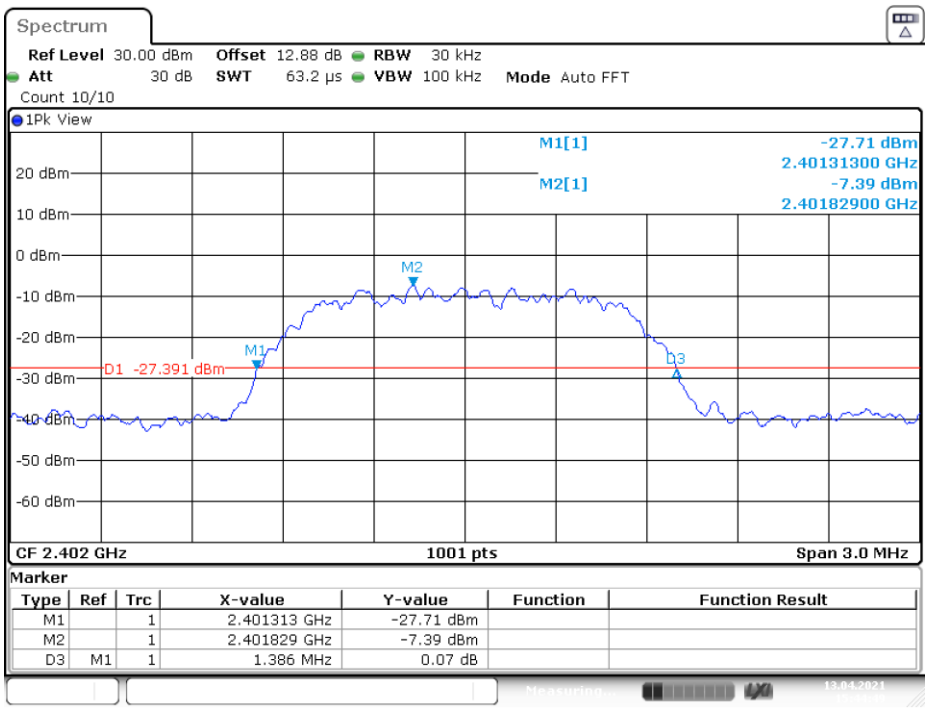
99% Occupied Bandwidth, High Channel



Date: 13.APR.2021 14:55:47

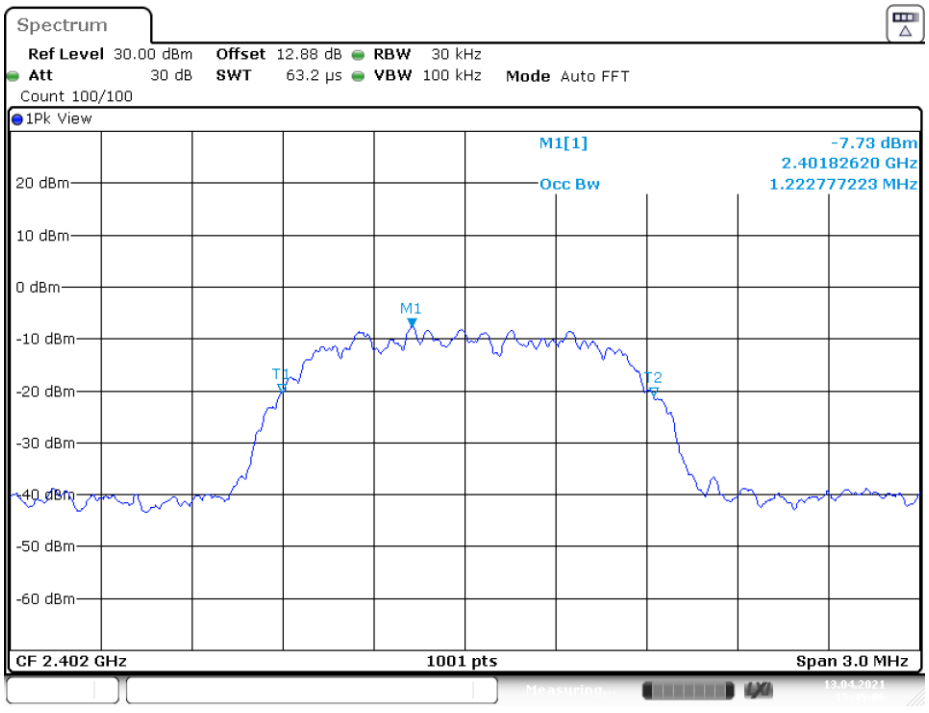
EDR (π/4-DQPSK):

20dB Emission Bandwidth, Low Channel



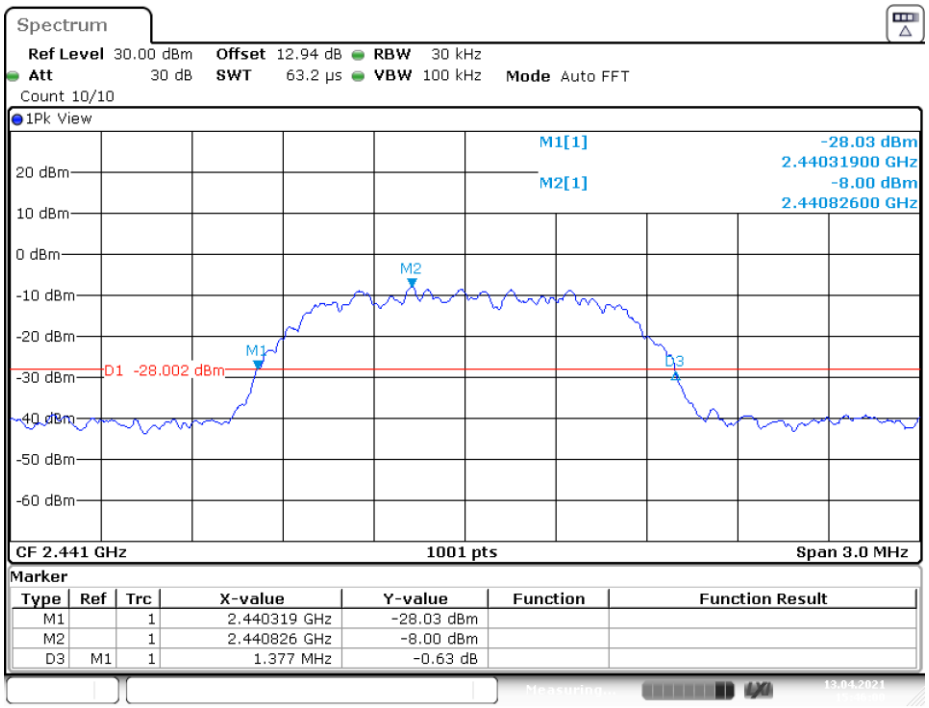
Date: 13.APR.2021 15:44:50

99% Occupied Bandwidth, Low Channel



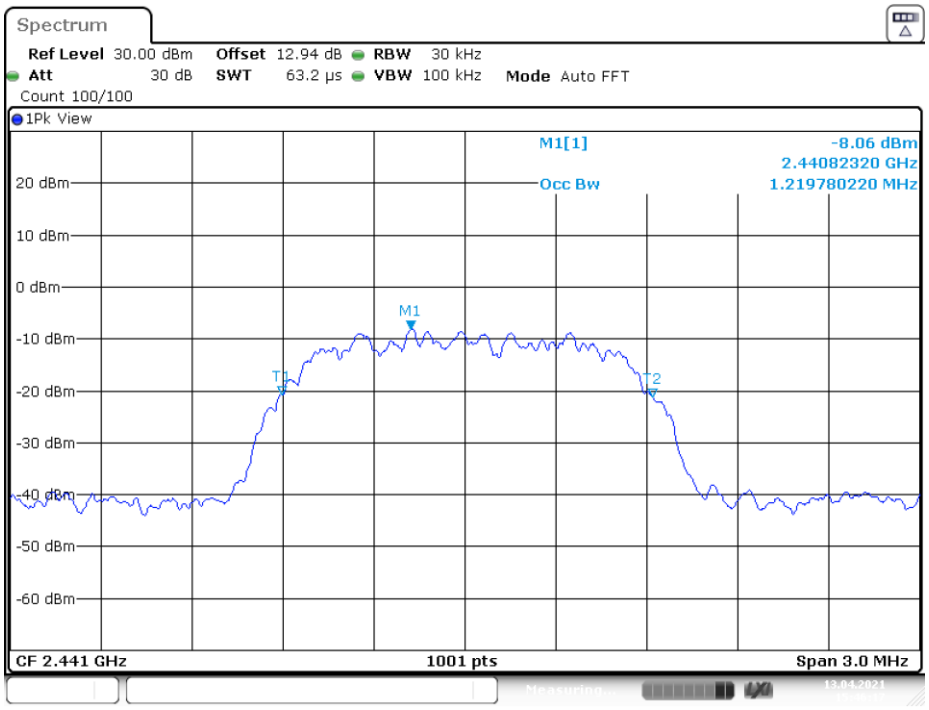
Date: 13.APR.2021 15:45:06

20dB Emission Bandwidth, Middle Channel



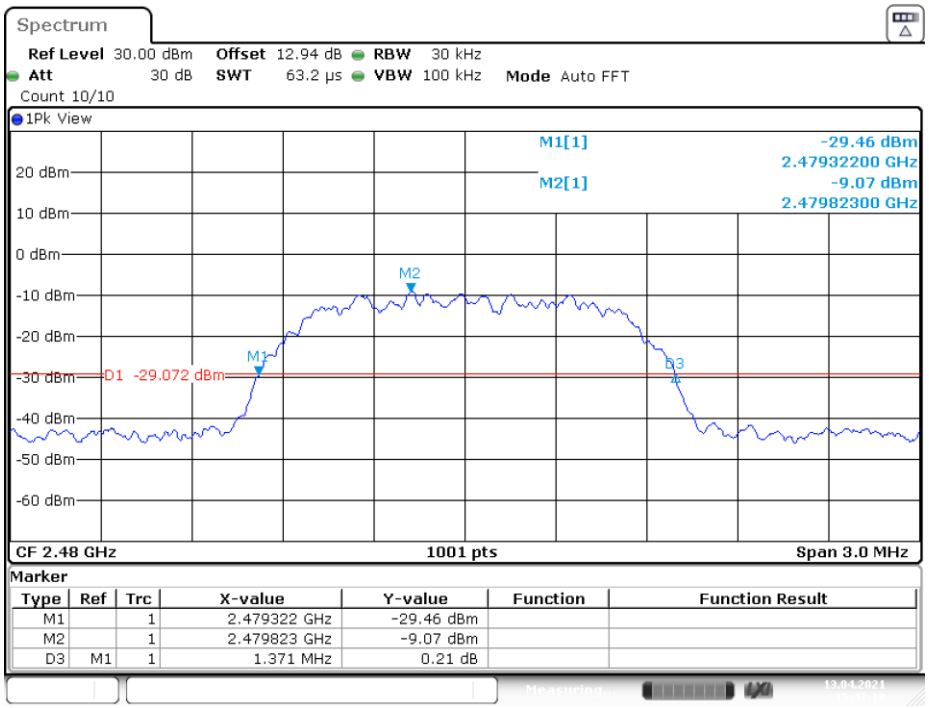
Date: 13.APR.2021 15:46:00

99% Occupied Bandwidth, Middle Channel



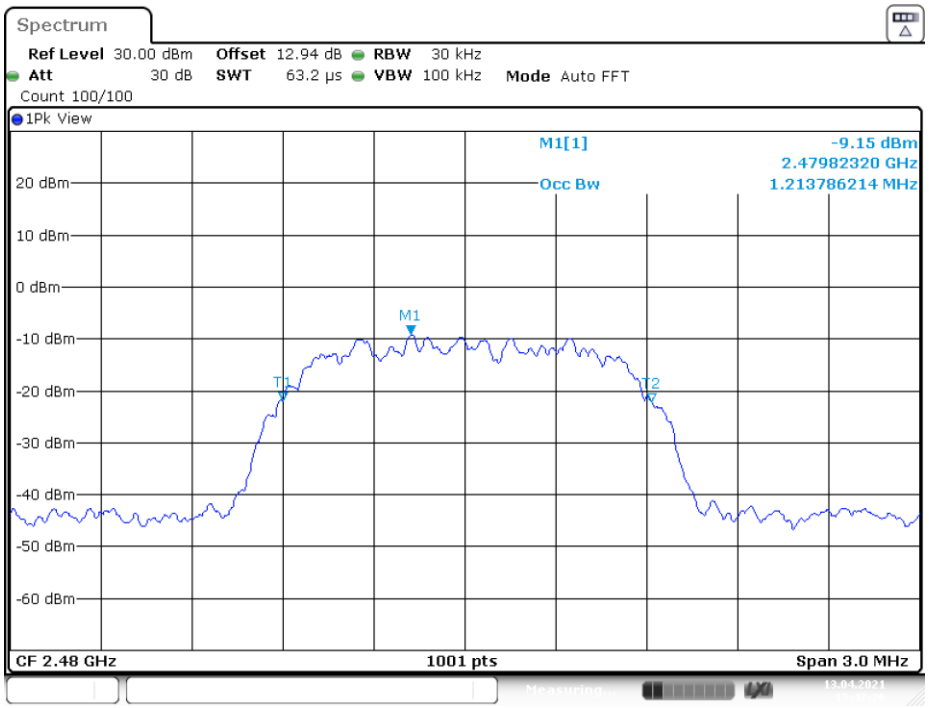
Date: 13.APR.2021 15:46:17

20dB Emission Bandwidth, High Channel



Date: 13.APR.2021 15:47:10

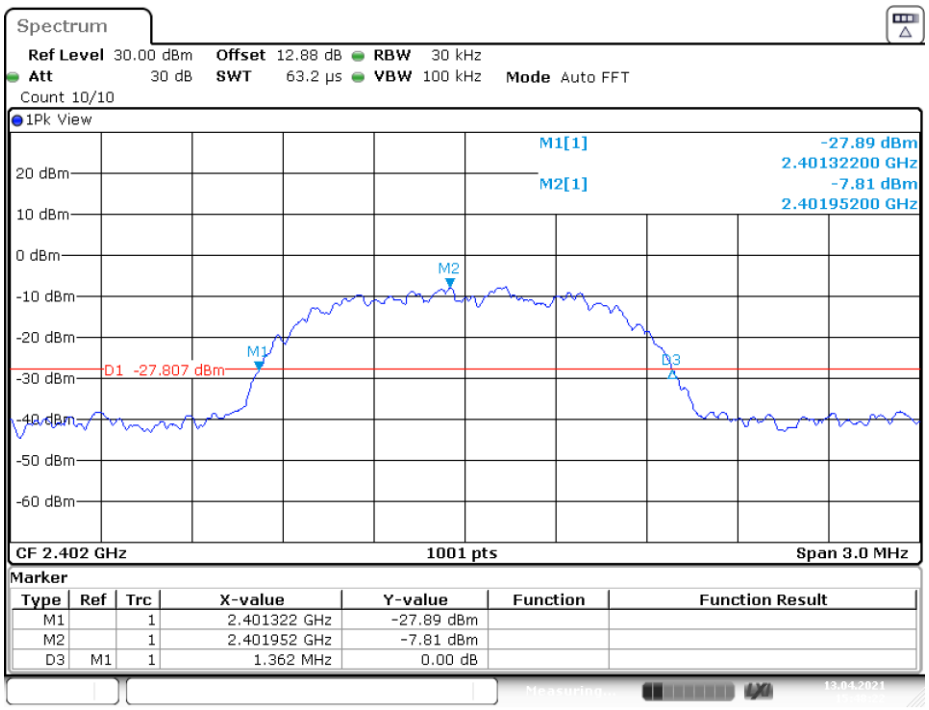
99% Occupied Bandwidth, High Channel



Date: 13.APR.2021 15:47:27

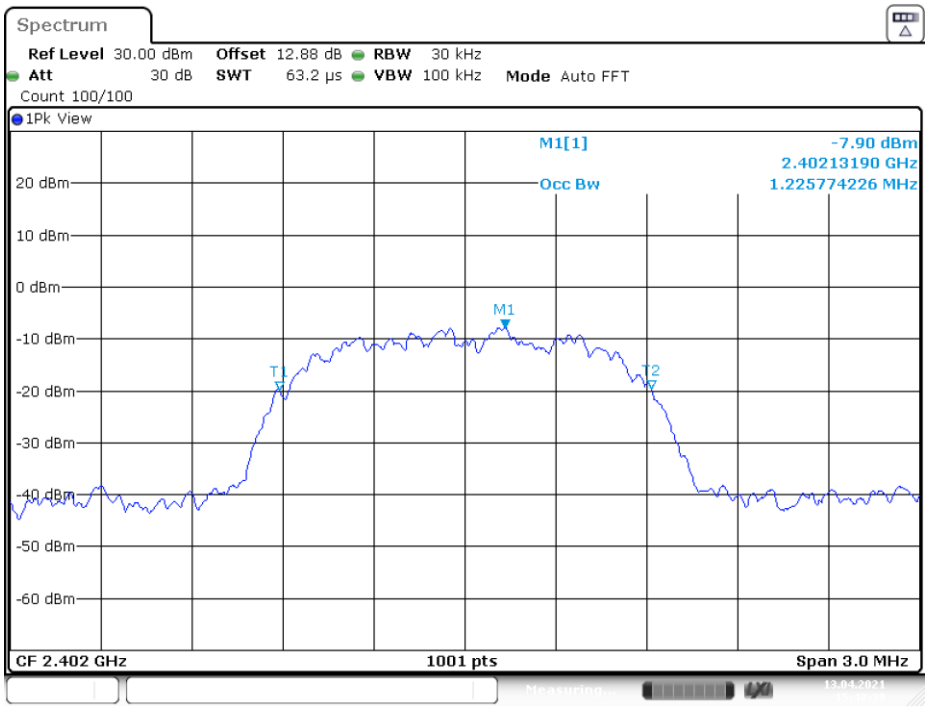
EDR (8DPSK):

20dB Emission Bandwidth, Low Channel



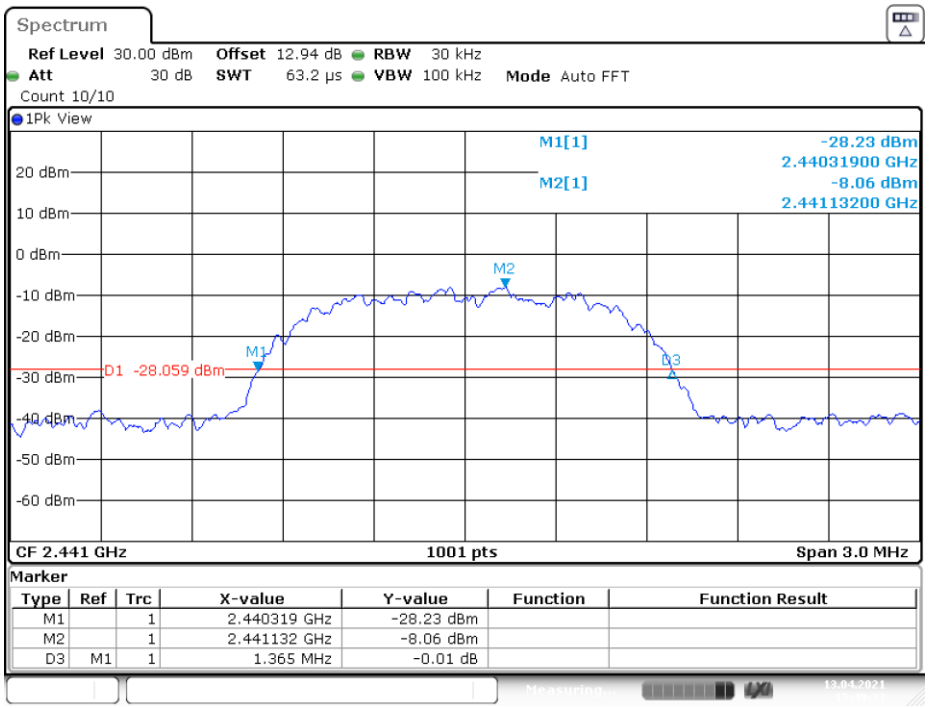
Date: 13.APR.2021 15:48:22

99% Occupied Bandwidth, Low Channel



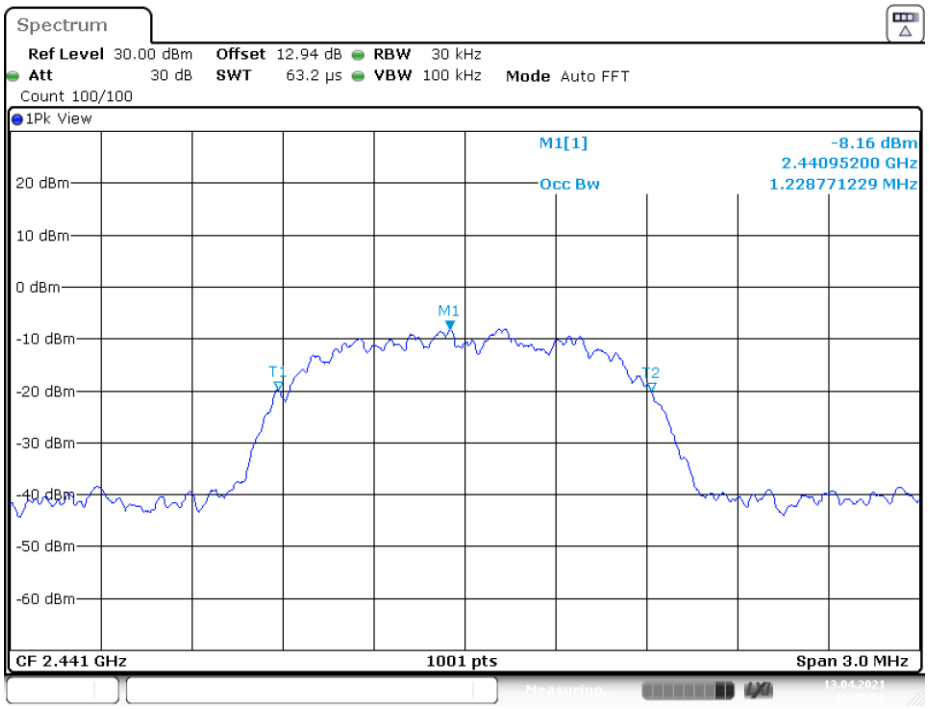
Date: 13.APR.2021 15:48:39

20dB Emission Bandwidth, middle Channel



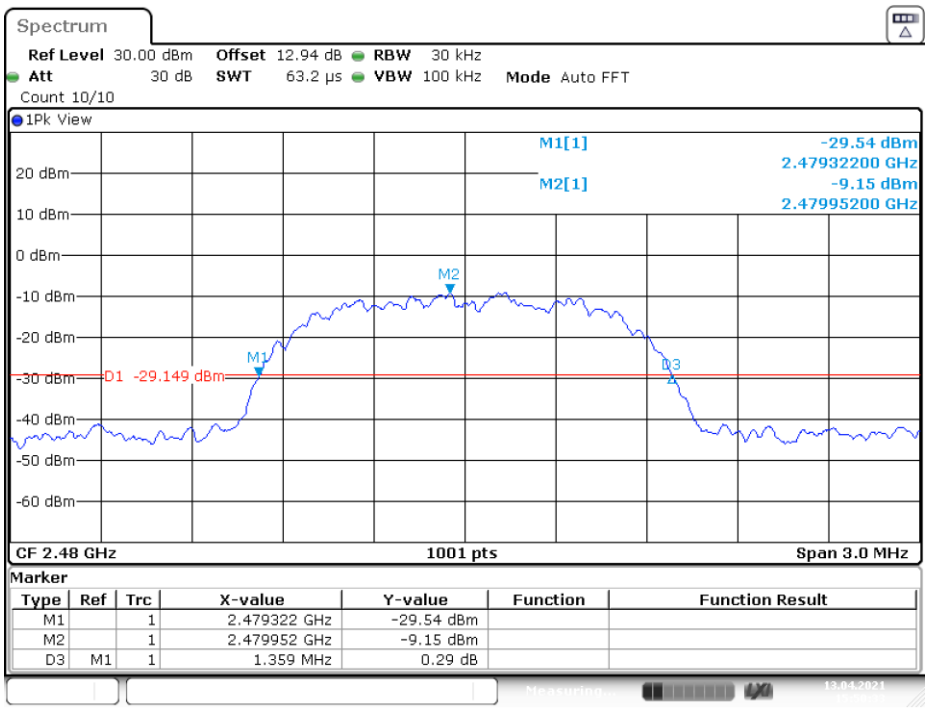
Date: 13.APR.2021 15:49:33

99% Occupied Bandwidth, Middle Channel



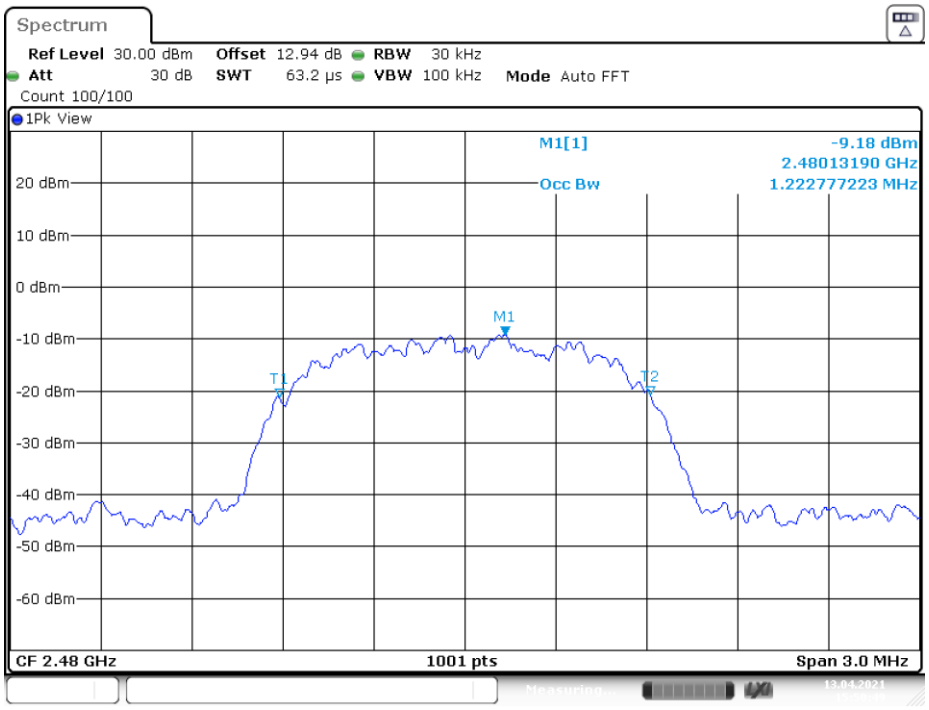
Date: 13.APR.2021 15:49:50

20dB Emission Bandwidth, High Channel



Date: 13.APR.2021 15:50:33

99% Occupied Bandwidth, High Channel



Date: 13.APR.2021 15:50:50

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

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.

2. Set the EUT in hopping mode from first channel to last.

3. By using the max-hold function record the quantity of the channel.

Test Data

Environmental Conditions

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

The testing was performed by Black Ding on 2021-04-13.

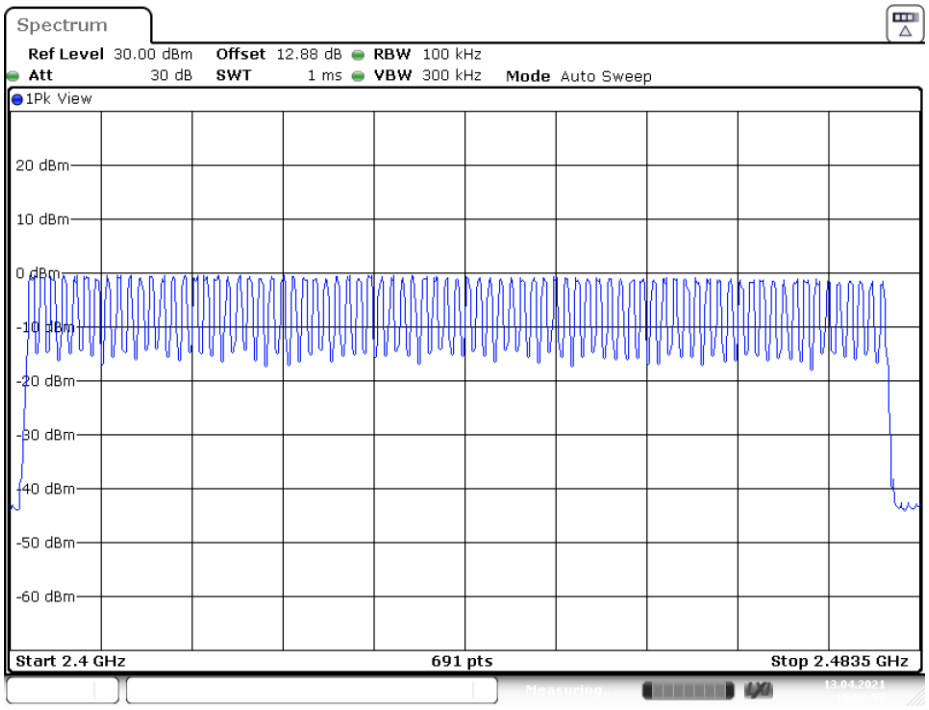
EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table and plots.

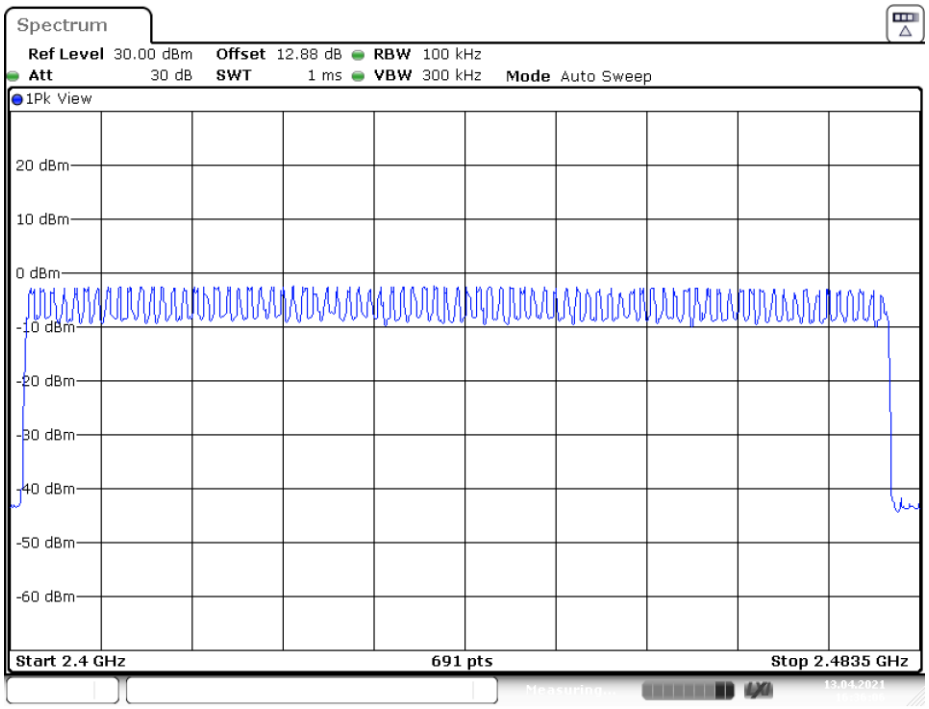
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	⩾15
EDR (π/4-DQPSK)	2400-2483.5	79	⩾15
EDR (8DPSK)	2400-2483.5	79	⩾15

BDR (GFSK): Number of Hopping Channels



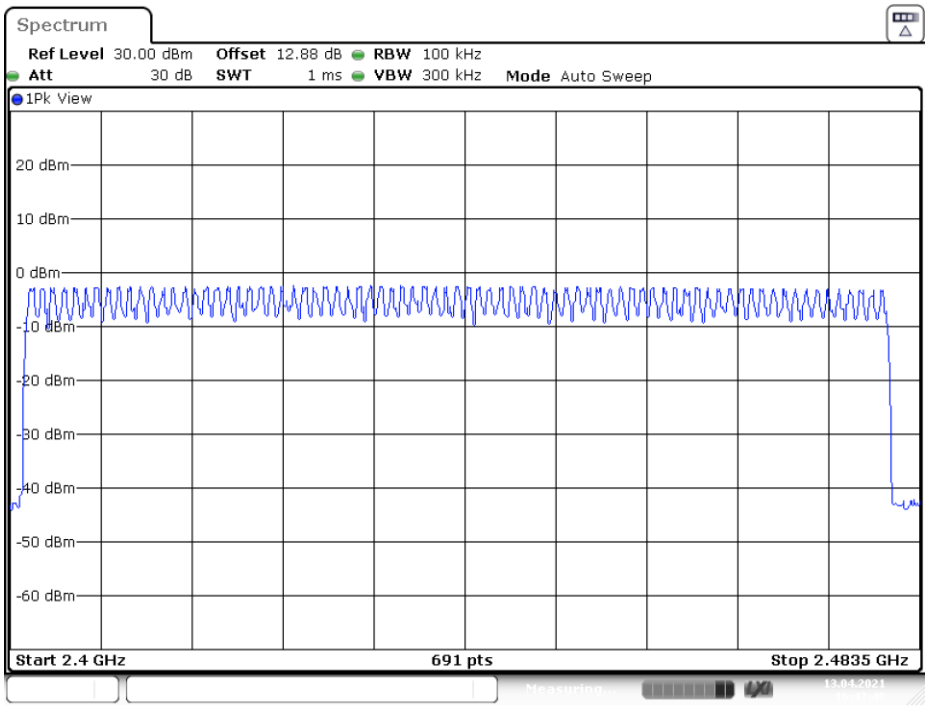
Date: 13.APR.2021 15:52:58

EDR (π/4-DQPSK): Number of Hopping Channels



Date: 13.APR.2021 16:36:06

EDR (8DPSK): Number of Hopping Channels



Date: 13.APR.2021 16:43:48

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

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

Test Data

Environmental Conditions

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

The testing was performed by Black Ding on 2021-04-13.

EUT operation mode: Transmitting

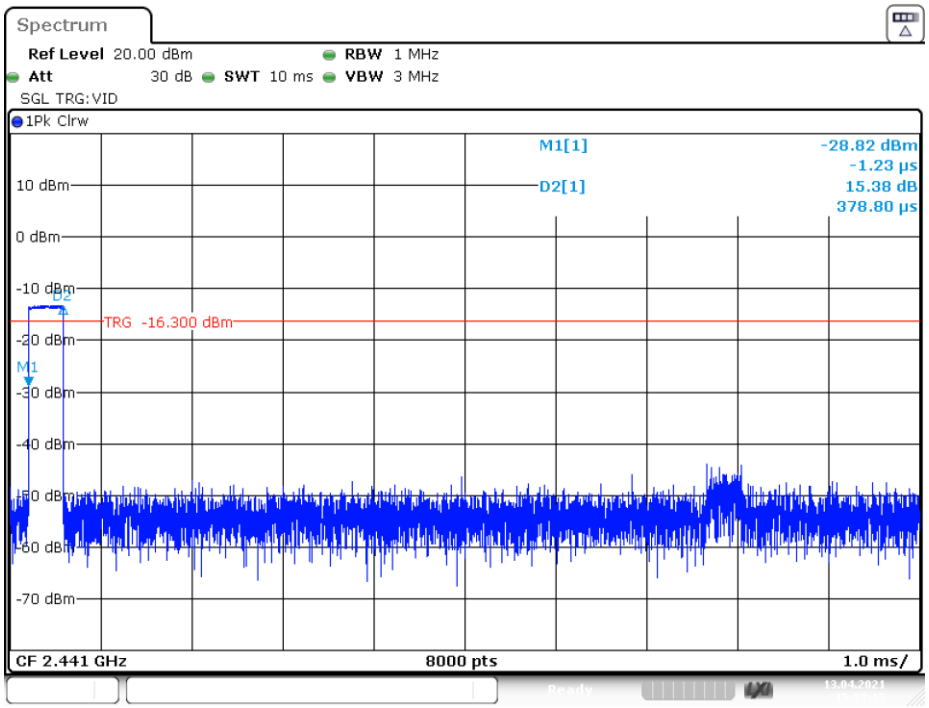
Test Result: Pass

Please refer to following table and plots

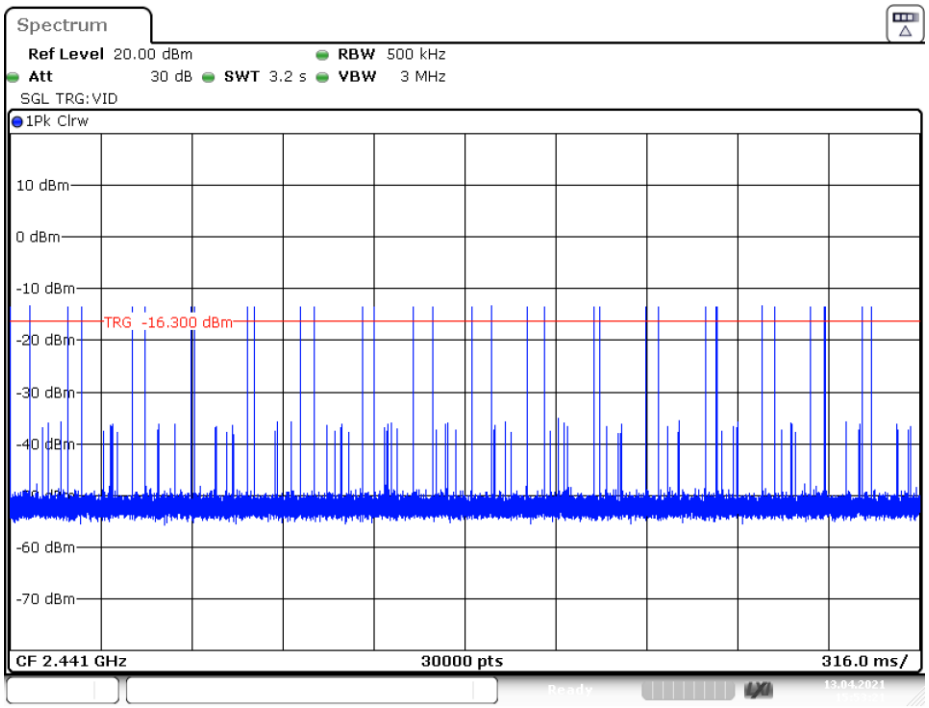
Test Mode	Channel	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Hop	0.38	320	0.121	<=0.4	PASS
DH3	Hop	1.63	130	0.212	<=0.4	PASS
DH5	Hop	2.87	110	0.315	<=0.4	PASS
2DH1	Hop	0.39	320	0.124	<=0.4	PASS
2DH3	Hop	1.63	130	0.212	<=0.4	PASS
2DH5	Hop	2.87	110	0.316	<=0.4	PASS
3DH1	Hop	0.39	320	0.124	<=0.4	PASS
3DH3	Hop	1.63	130	0.212	<=0.4	PASS
3DH5	Hop	2.88	90	0.259	<=0.4	PASS

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

BDR (GFSK):
DH1

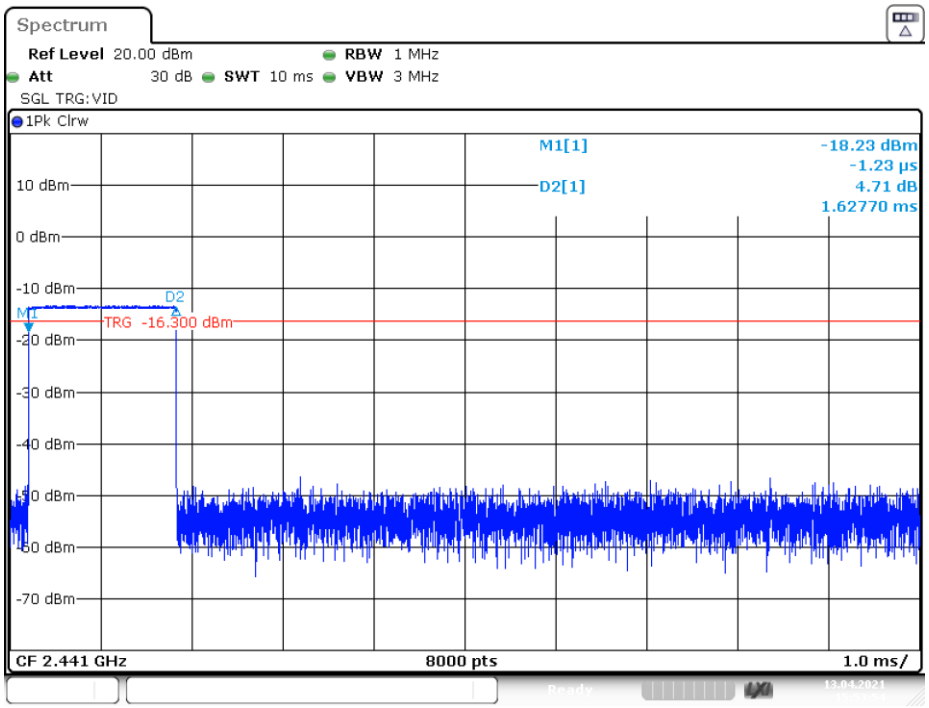


Date: 13.APR.2021 15:53:16

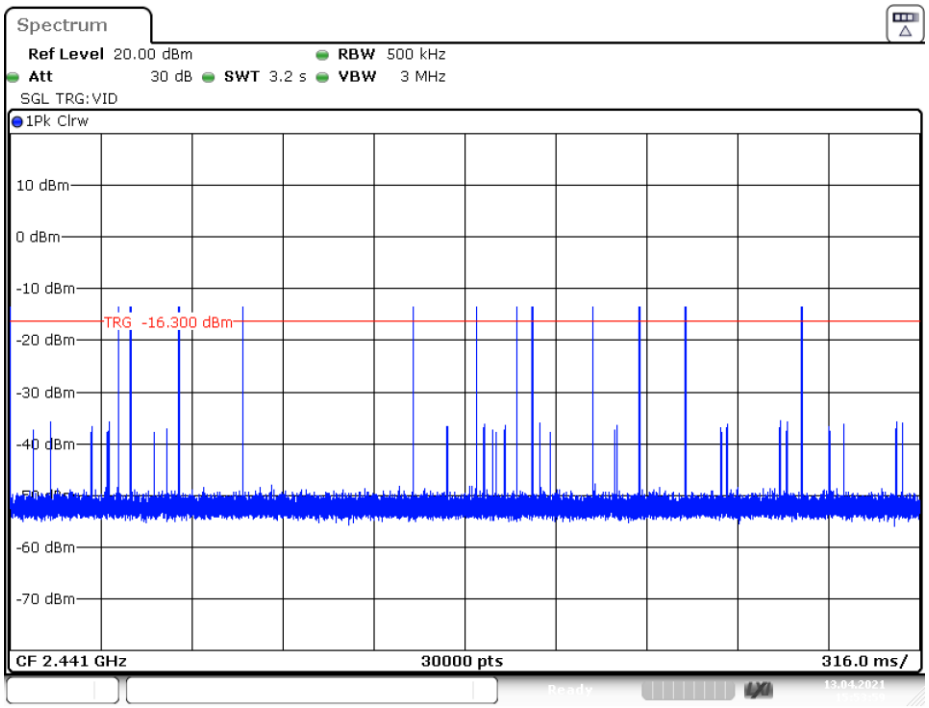


Date: 13.APR.2021 15:53:21

DH3

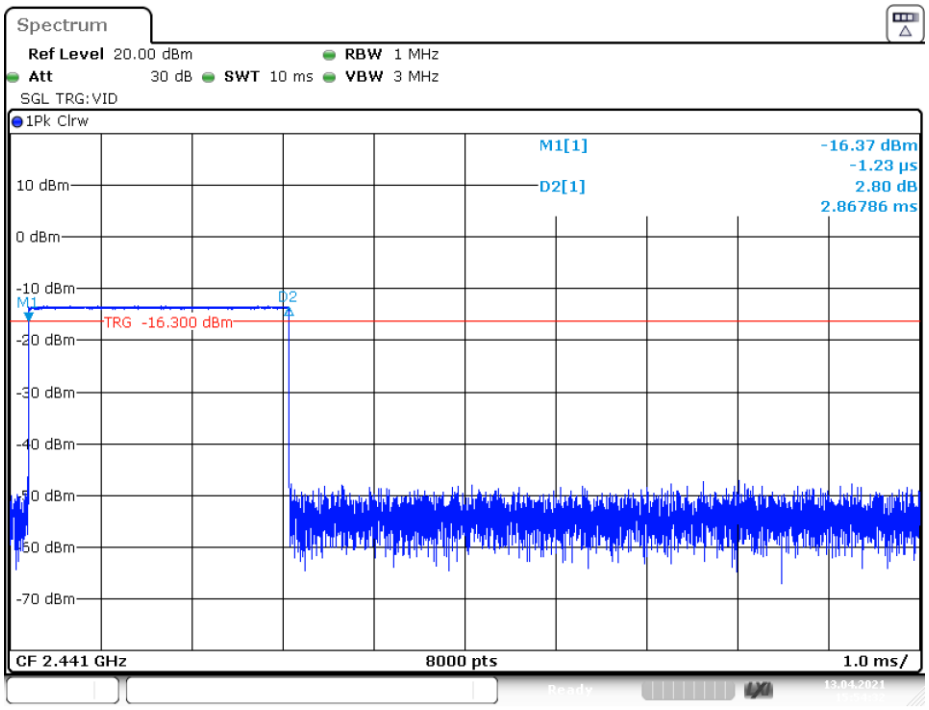


Date: 13.APR.2021 15:53:54

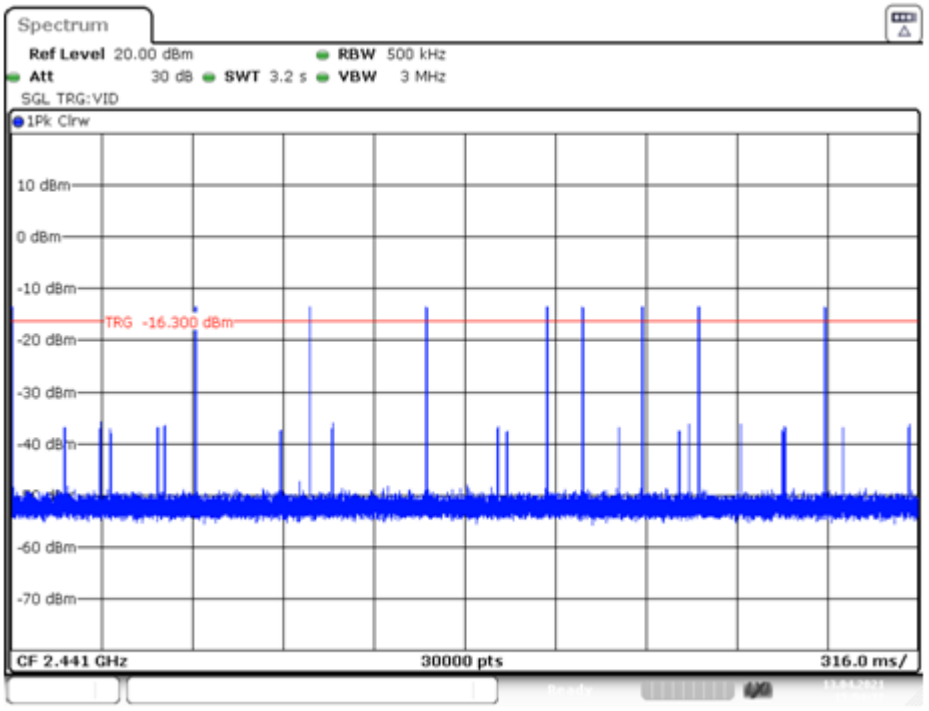


Date: 13.APR.2021 15:53:59

DH5



Date: 13.APR.2021 15:54:32



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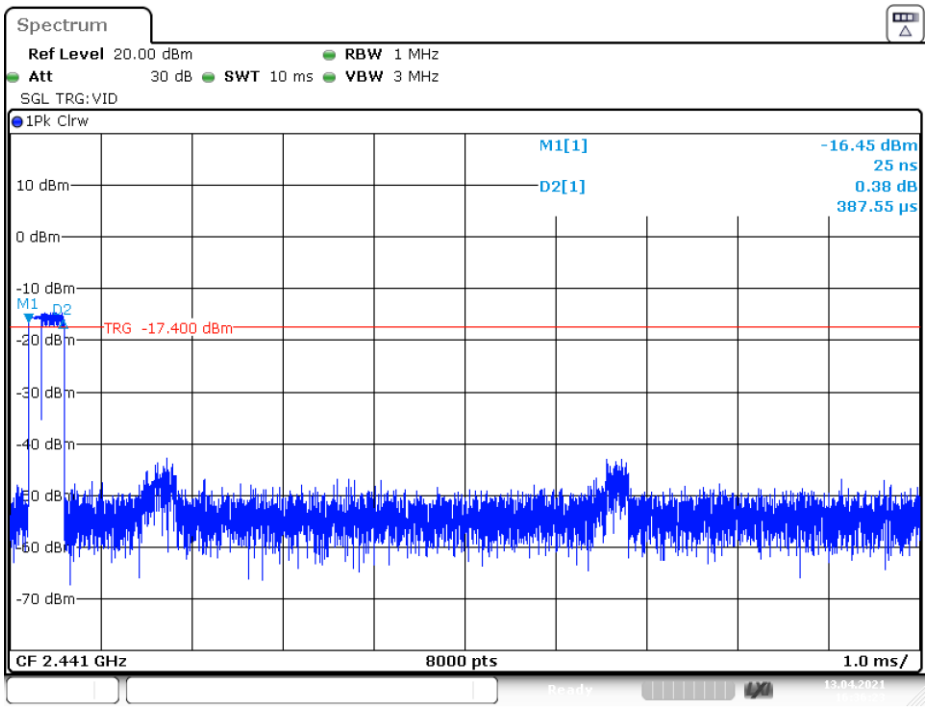
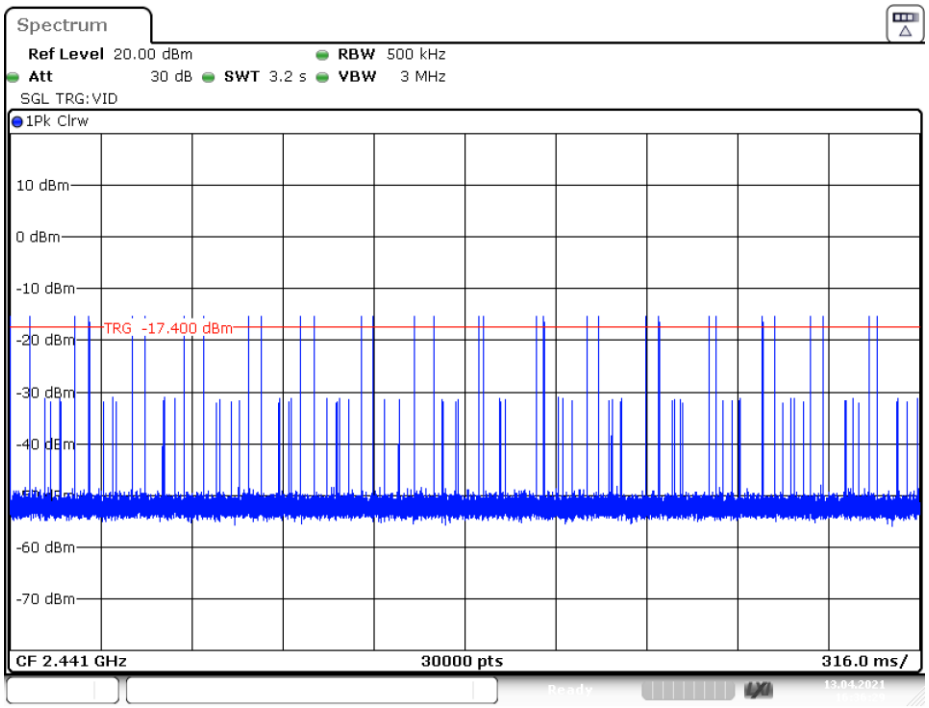
EDR(π/4-DQPSK):
2DH1

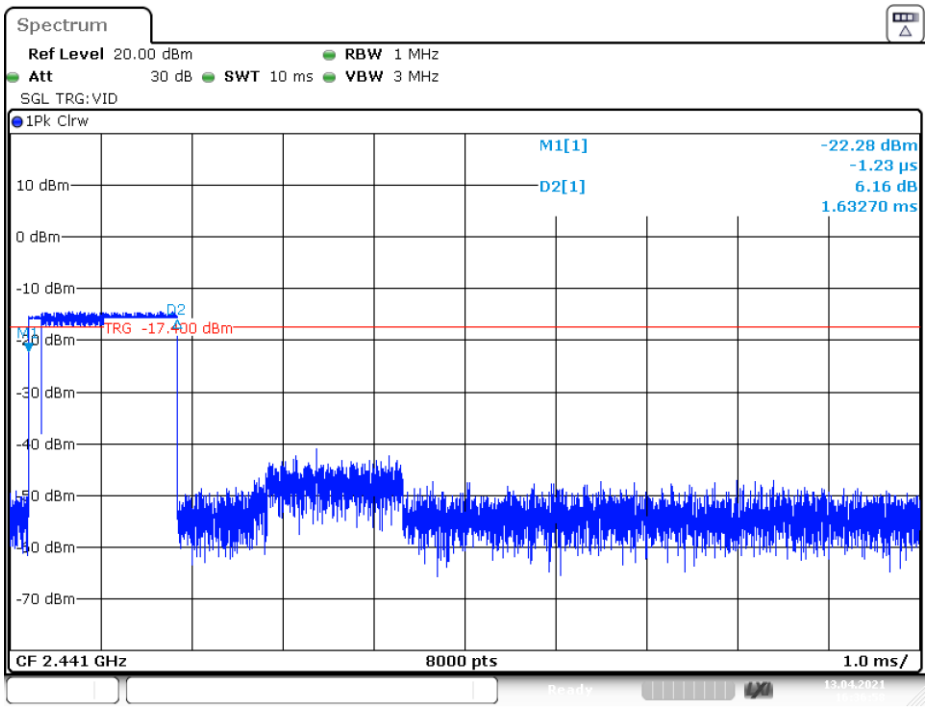


Date: 13.APR.2021 16:36:24



Date: 13.APR.2021 16:36:29

2DH3



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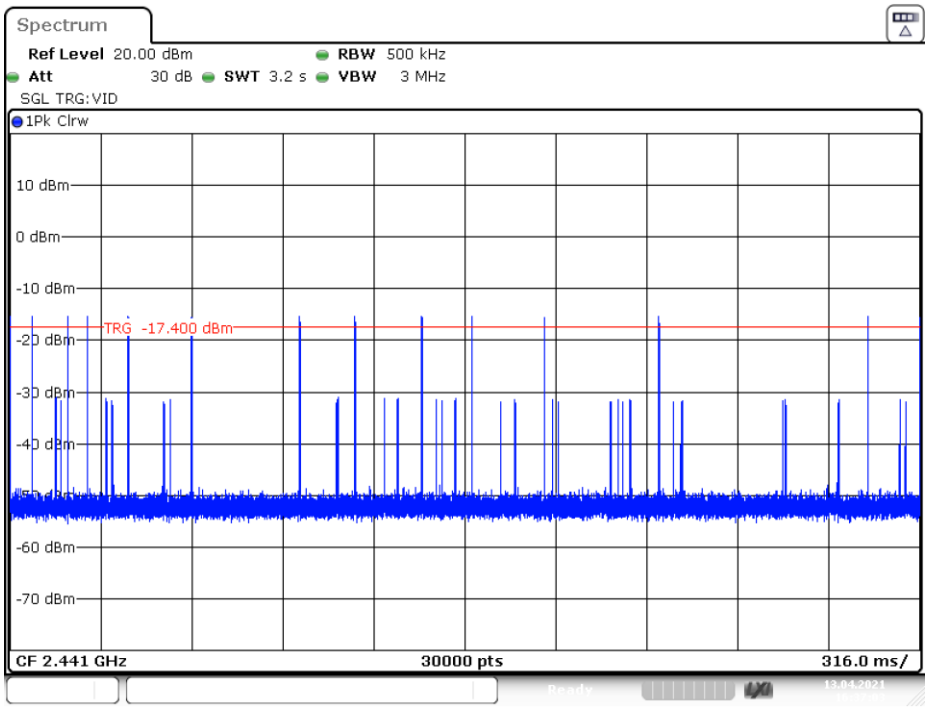
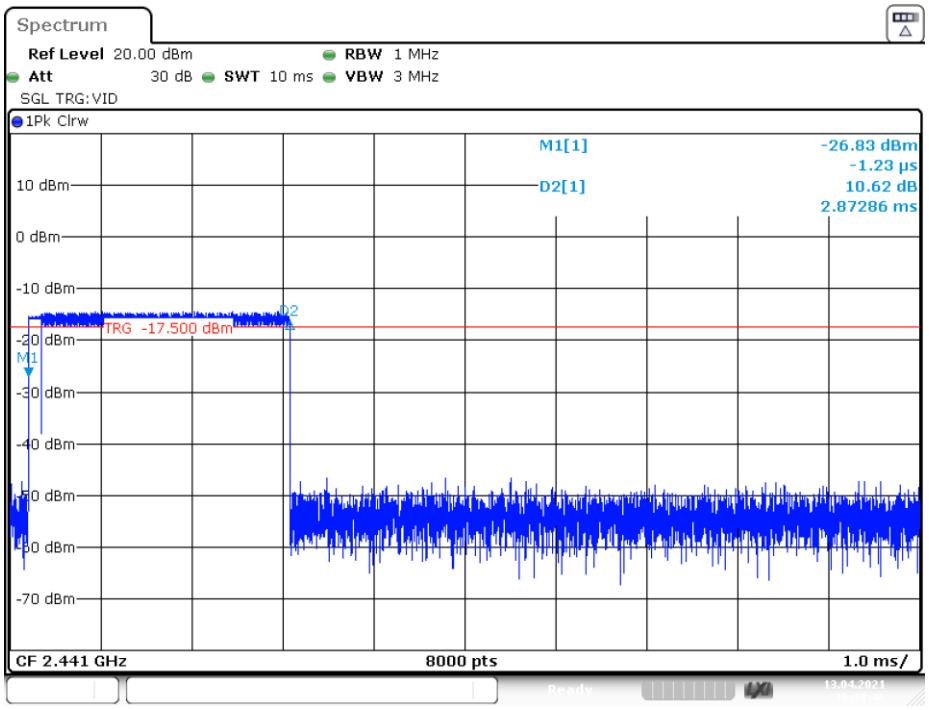
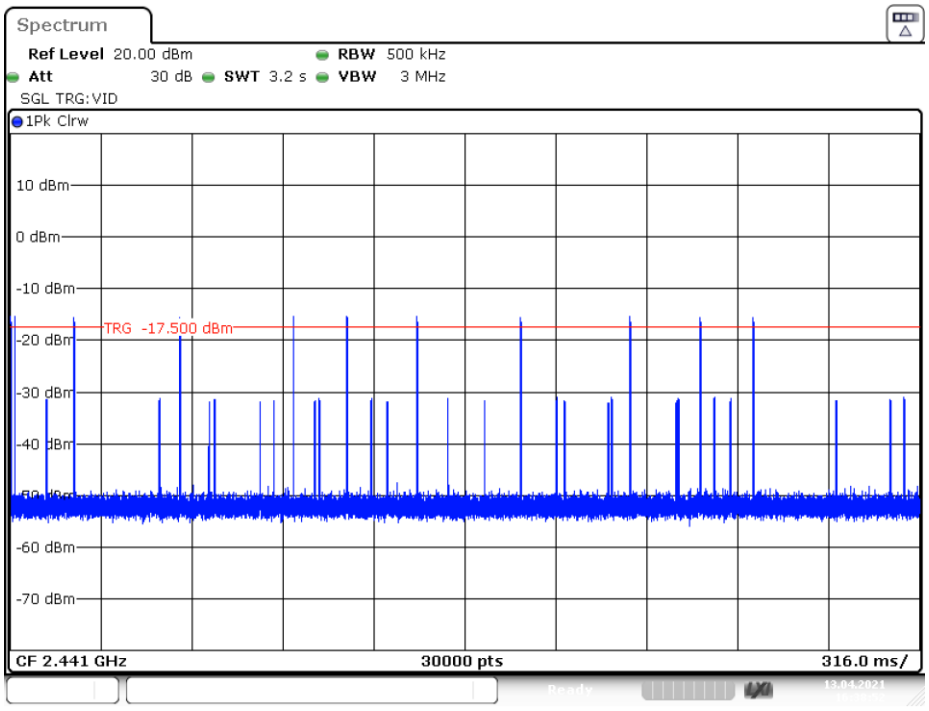


Date: 13.APR.2021 16:37:03

2DH5



Date: 13.APR.2021 16:38:47



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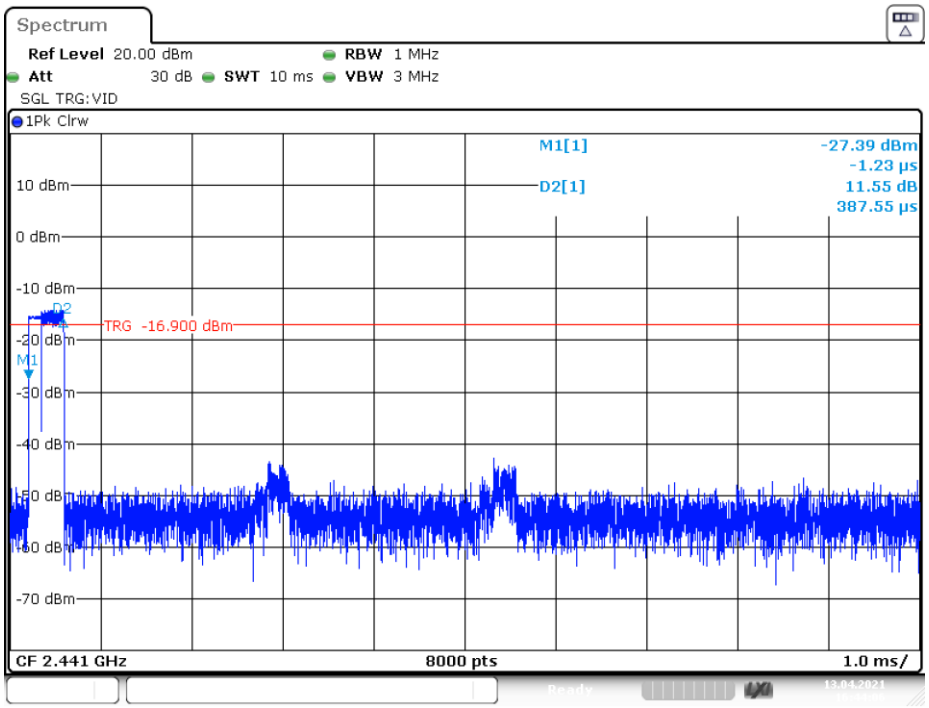
EDR (8DPSK):
3DH1



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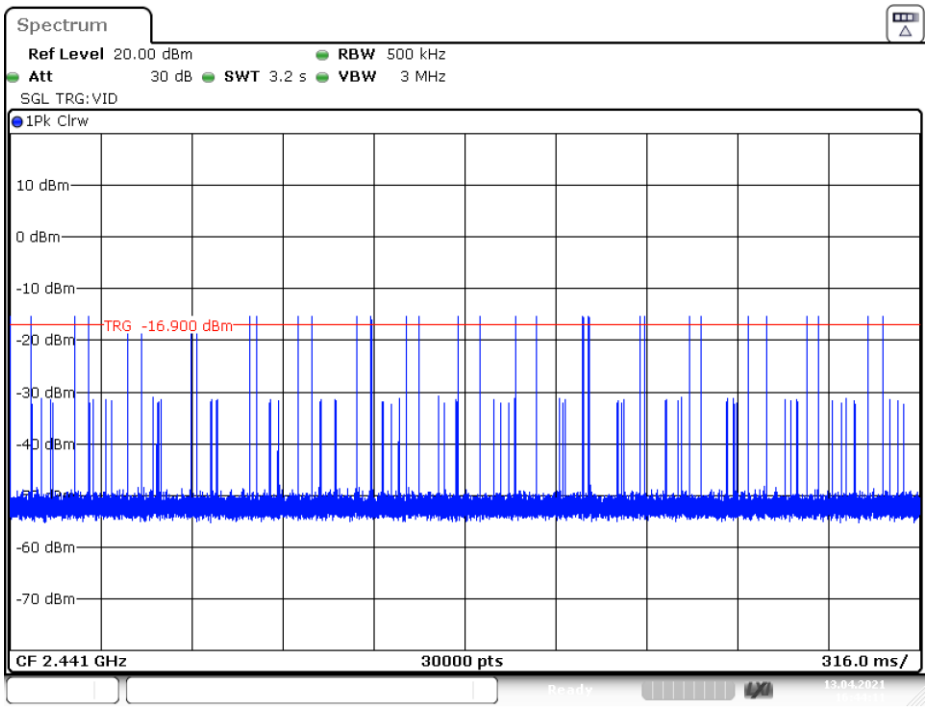
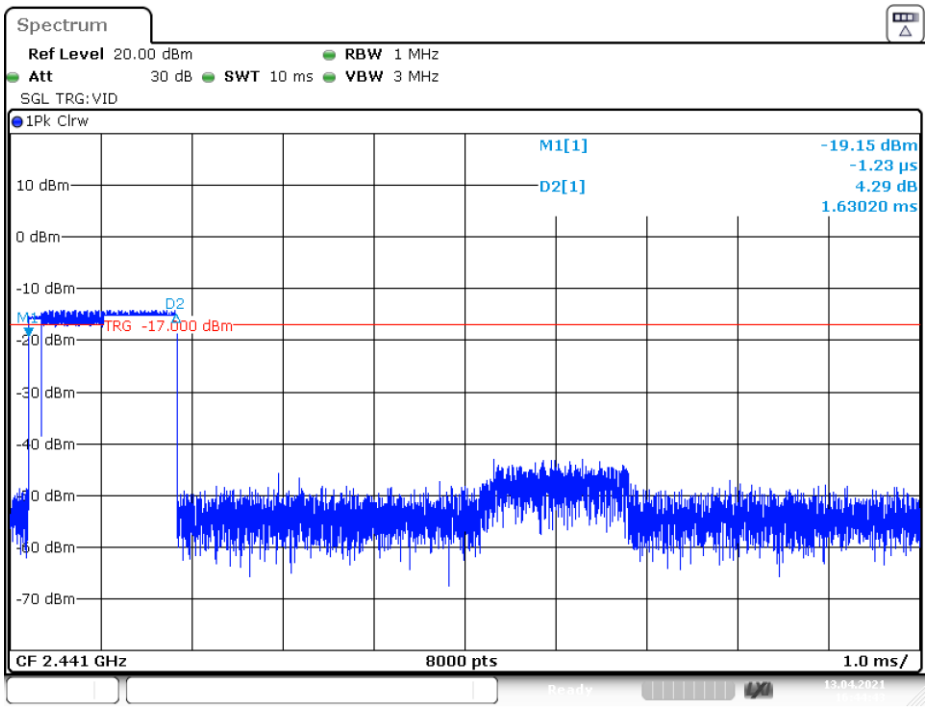


Date: 13.APR.2021 16:44:12

3DH3



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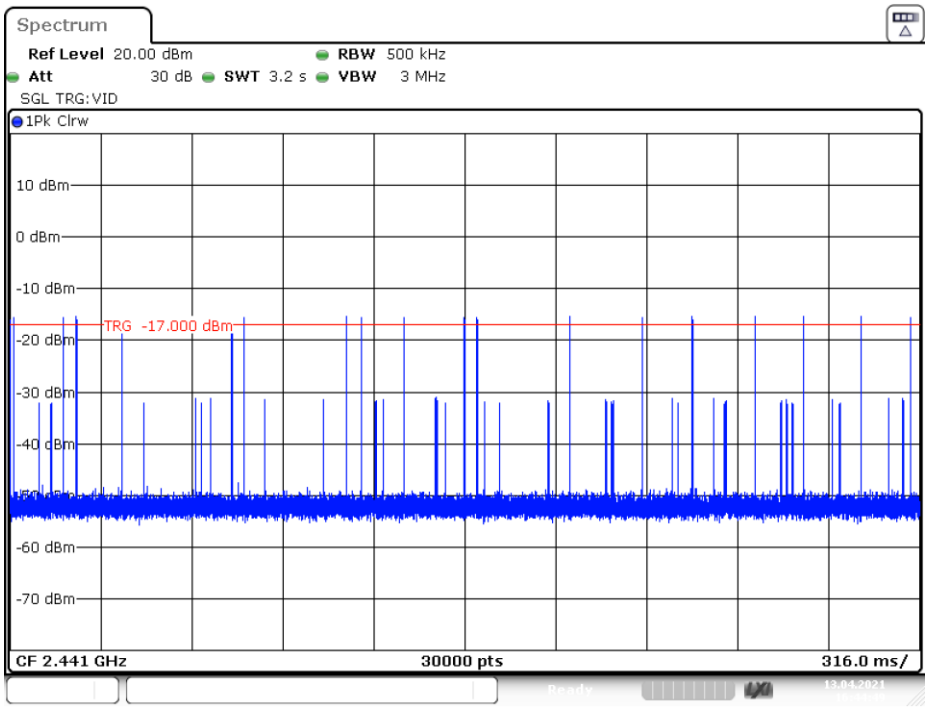
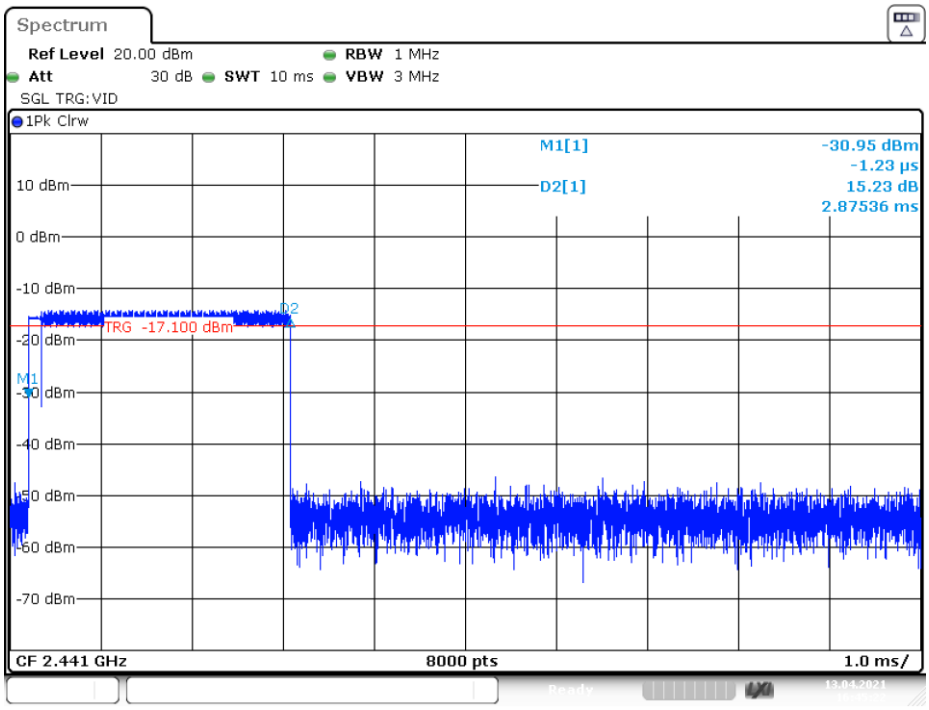


Date: 13.APR.2021 16:44:49

3DH5



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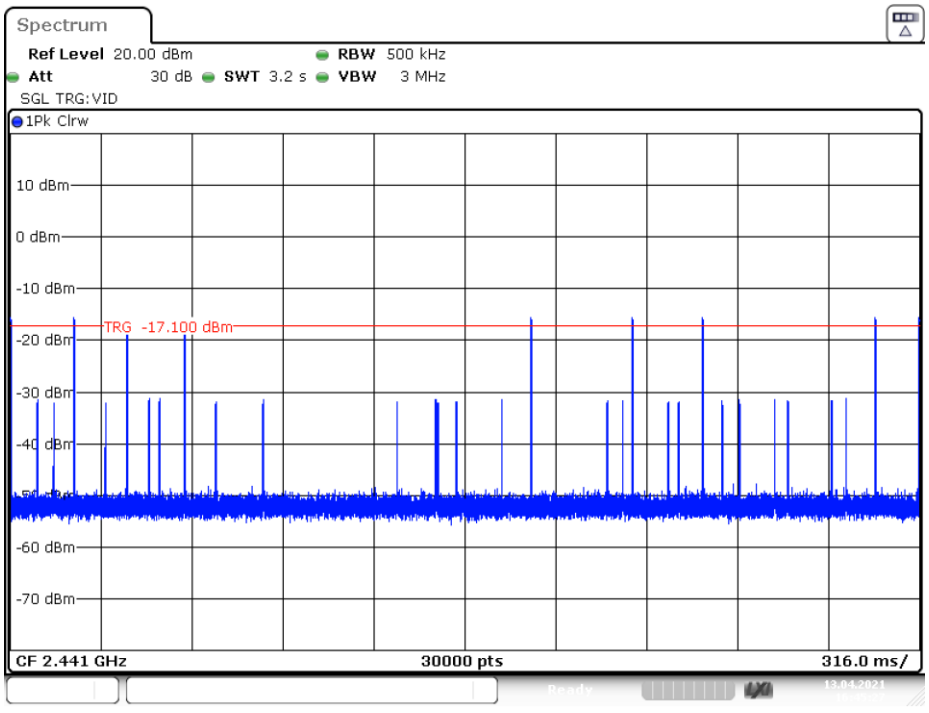

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FCC §15.247(b) (1) & RSS-247 § 5.1(b) & § 5.4(b) - PEAK OUTPUT POWER MEASUREMENT

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.

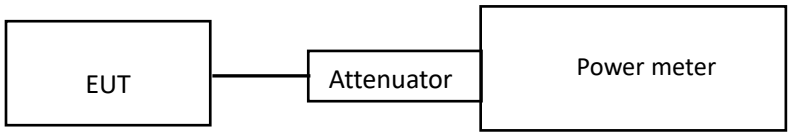
According to RSS-247 § 5.1(b) & § 5.4(b):

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

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



Test Data

Environmental Conditions

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

The testing was performed by Black Ding on 2021-04-13

EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table.

Test Mode	Channel	Output Peak power [dBm]	Limit [dBm]	Verdict
BDR (GFSK)	2402	0	<=20.97	PASS
	2441	-0.25	<=20.97	PASS
	2480	-0.98	<=20.97	PASS
EDR (π/4-DQPSK)	2402	0.58	<=20.97	PASS
	2441	0.37	<=20.97	PASS
	2480	-0.63	<=20.97	PASS
EDR (8DPSK)	2402	0.89	<=20.97	PASS
	2441	0.62	<=20.97	PASS
	2480	-0.19	<=20.97	PASS

Note 1: The data above was tested in conducted mode.
Note 2: The maximum EIRP is 0.89dBm+0dBi=0.89dBm<36dBm, so it can meet the EIRP limit of ISEDC.

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

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

Test Data

Environmental Conditions

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

The testing was performed by Black Ding on 2021-04-13

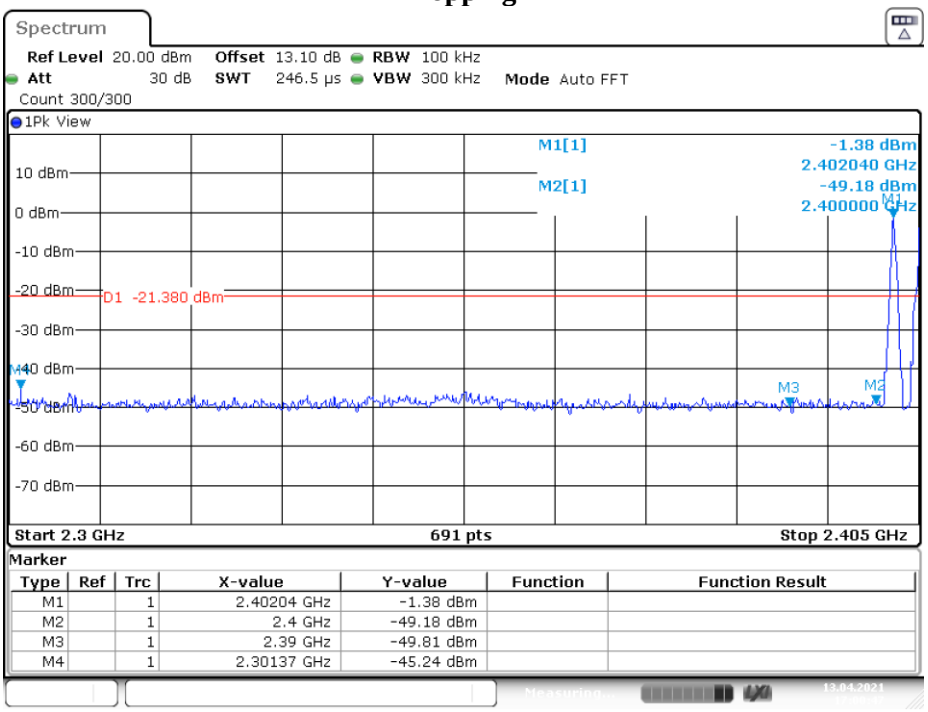
EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table and plots

BDR (GFSK): Band Edge-Left Side

Hopping



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40204 GHz	-1.38 dBm		
M2		1	2.4 GHz	-49.18 dBm		
M3		1	2.39 GHz	-49.81 dBm		
M4		1	2.30137 GHz	-45.24 dBm		

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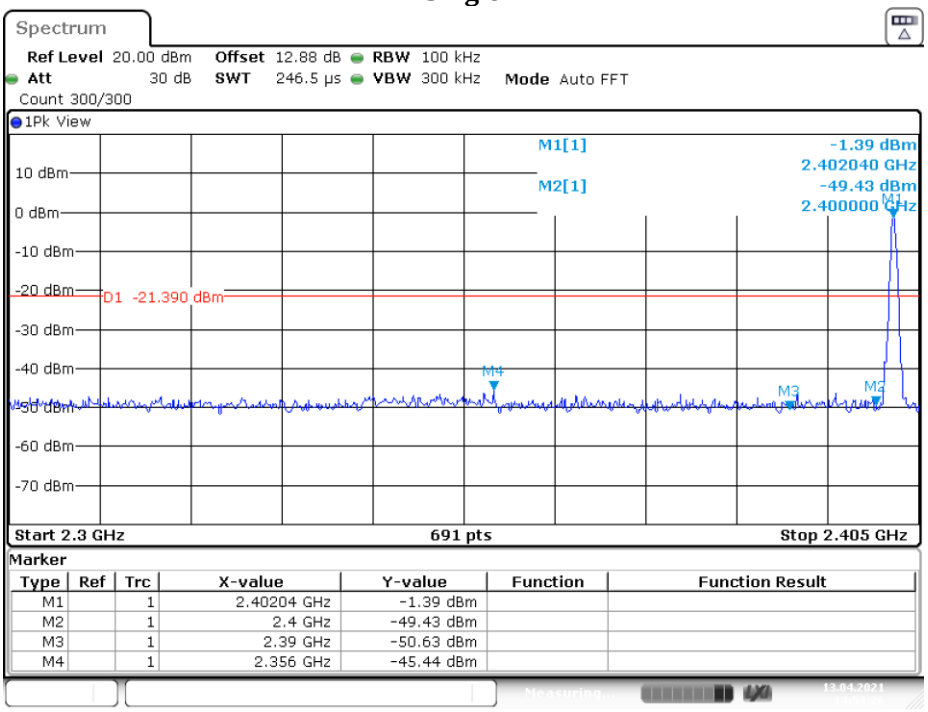
Single



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40204 GHz	-1.39 dBm		
M2		1	2.4 GHz	-49.43 dBm		
M3		1	2.39 GHz	-50.63 dBm		
M4		1	2.356 GHz	-45.44 dBm		

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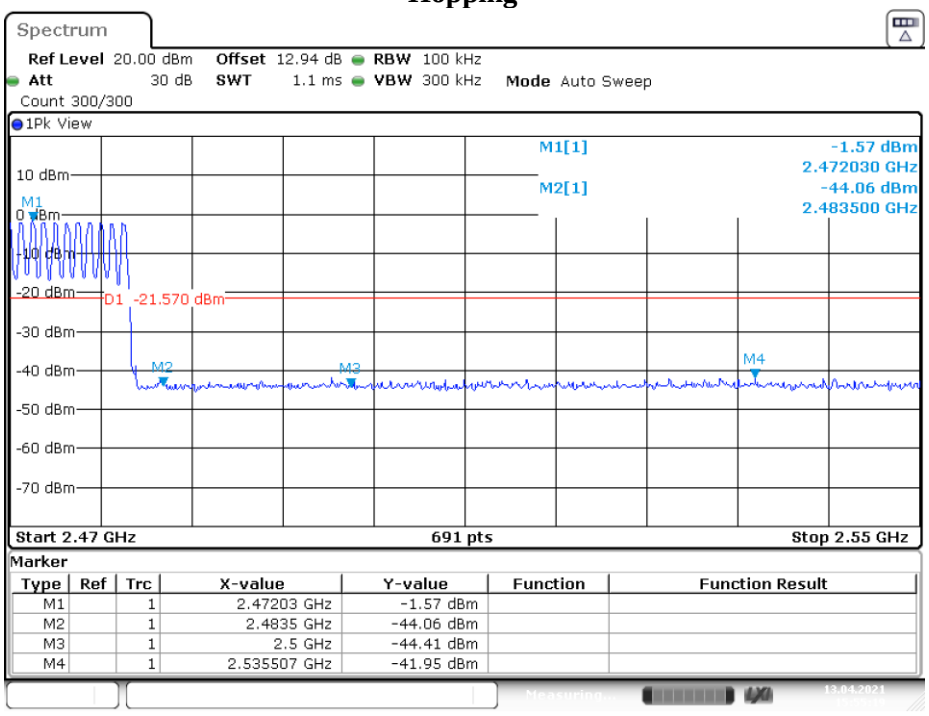
BDR (GFSK): Band Edge-Right Side Hopping



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47203 GHz	-1.57 dBm		
M2		1	2.4835 GHz	-44.06 dBm		
M3		1	2.5 GHz	-44.41 dBm		
M4		1	2.535507 GHz	-41.95 dBm		

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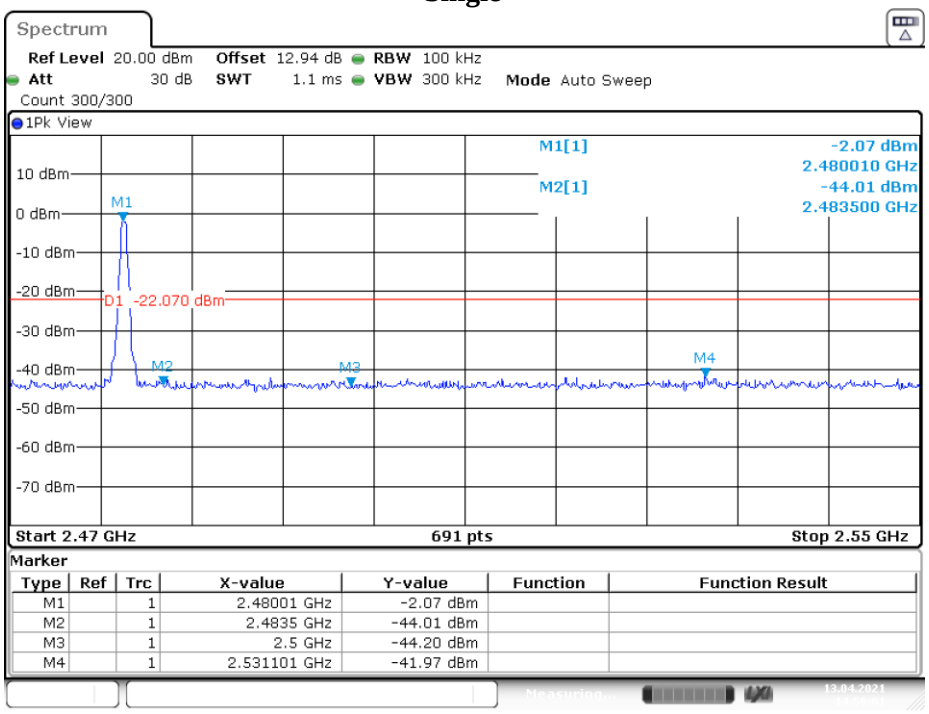
Single



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48001 GHz	-2.07 dBm		
M2		1	2.4835 GHz	-44.01 dBm		
M3		1	2.5 GHz	-44.20 dBm		
M4		1	2.531101 GHz	-41.97 dBm		

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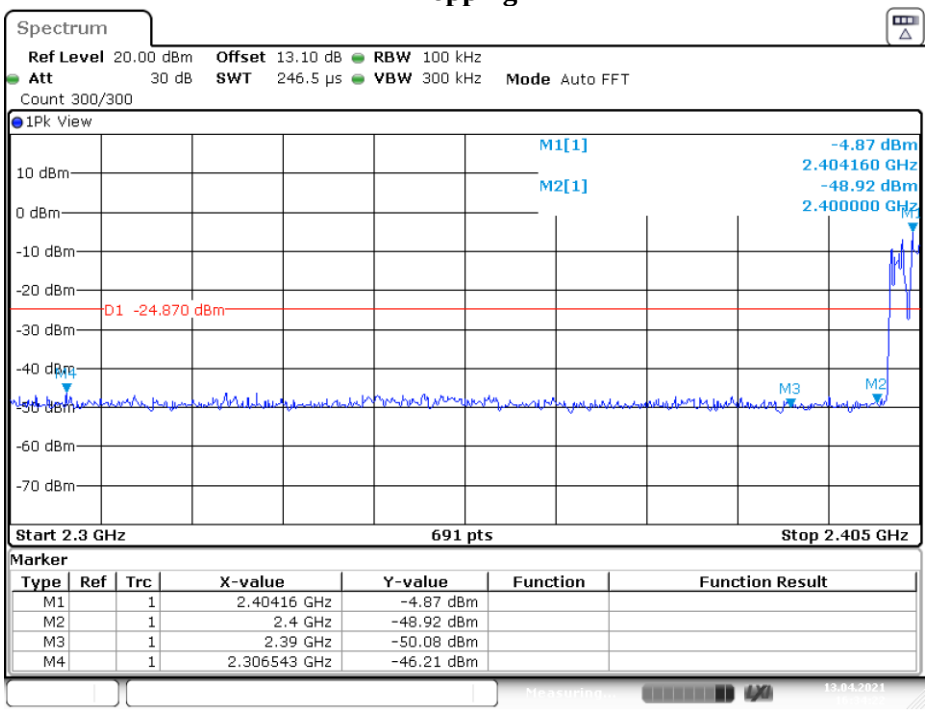
EDR (π/4-DQPSK): Band Edge-Left Side

Hopping



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40416 GHz	-4.87 dBm		
M2		1	2.4 GHz	-48.92 dBm		
M3		1	2.39 GHz	-50.08 dBm		
M4		1	2.306543 GHz	-46.21 dBm		

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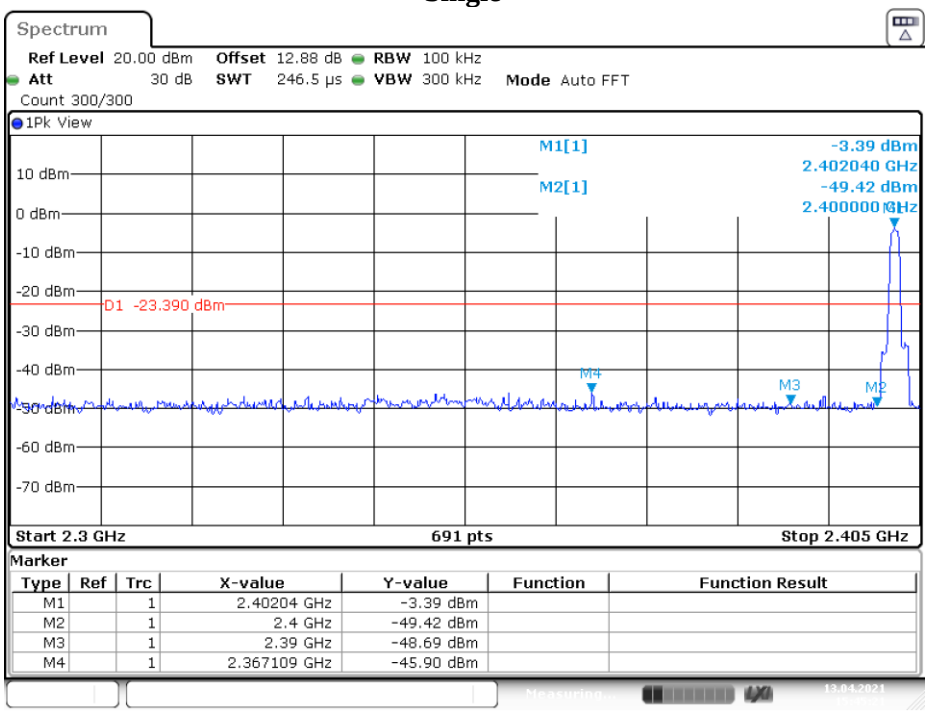
Single



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40204 GHz	-3.39 dBm		
M2		1	2.4 GHz	-49.42 dBm		
M3		1	2.39 GHz	-48.69 dBm		
M4		1	2.367109 GHz	-45.90 dBm		

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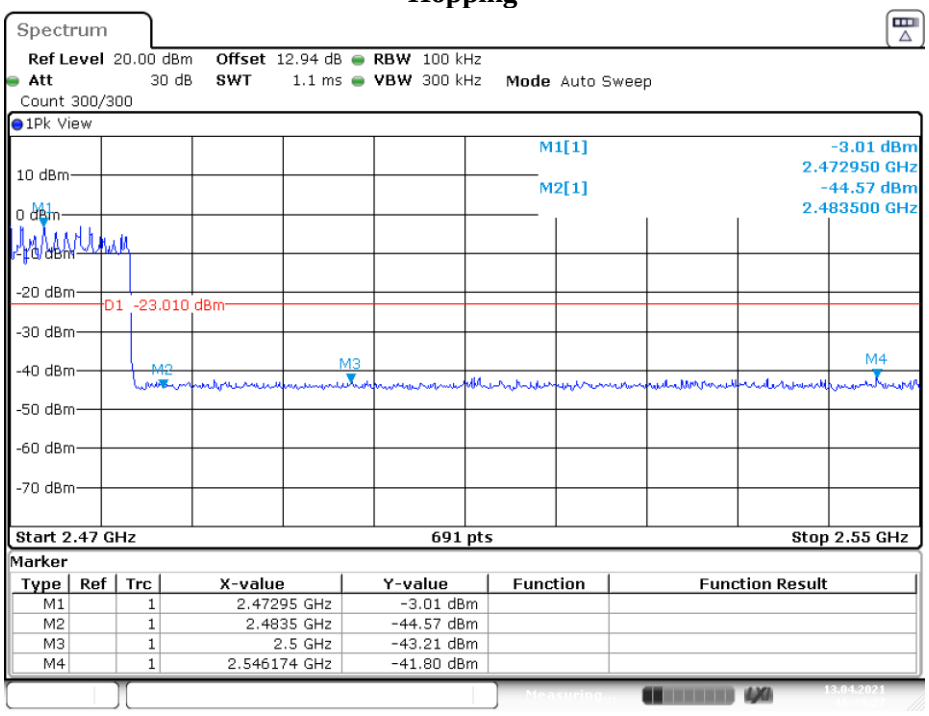
EDR (π/4-DQPSK): Band Edge-Right Side Hopping



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47295 GHz	-3.01 dBm		
M2		1	2.4835 GHz	-44.57 dBm		
M3		1	2.5 GHz	-43.21 dBm		
M4		1	2.546174 GHz	-41.80 dBm		

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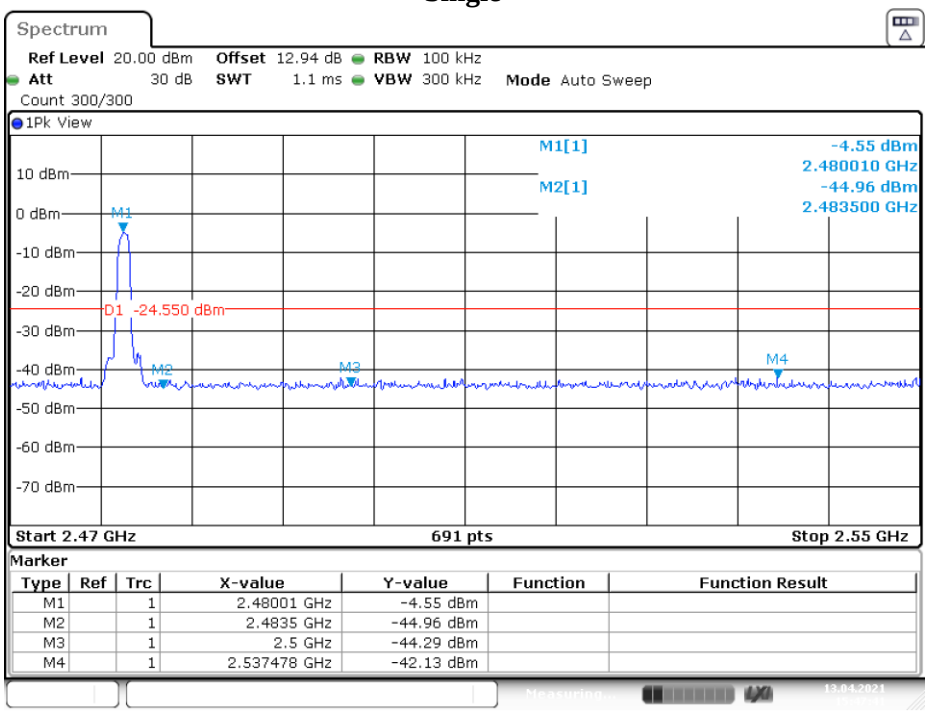
Single



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48001 GHz	-4.55 dBm		
M2		1	2.4835 GHz	-44.96 dBm		
M3		1	2.5 GHz	-44.29 dBm		
M4		1	2.537478 GHz	-42.13 dBm		

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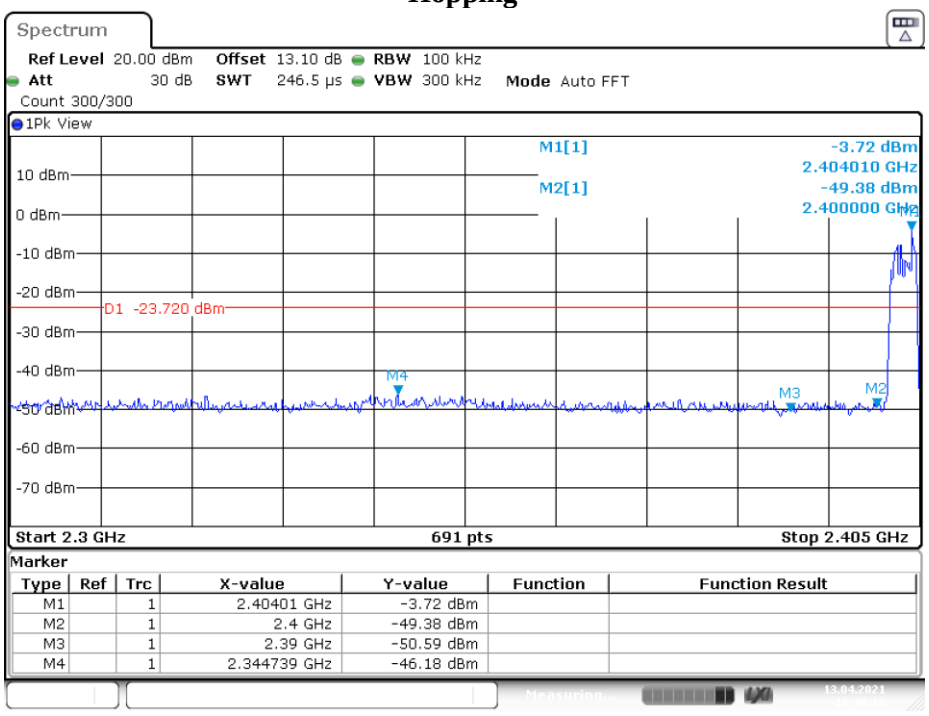
EDR (8DPSK): Band Edge-Left Side
Hopping



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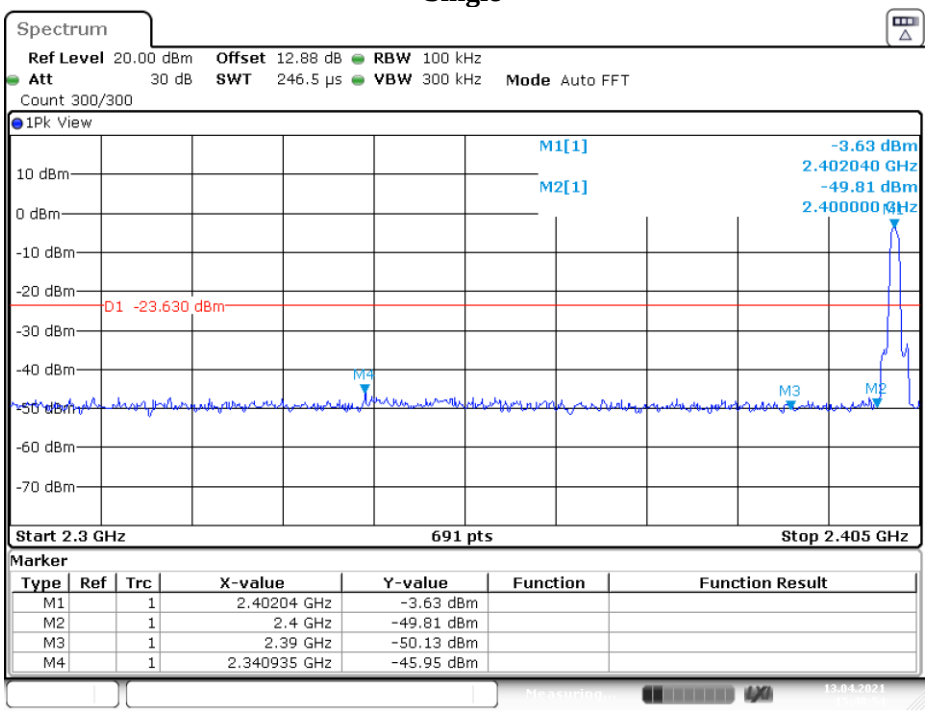
Single



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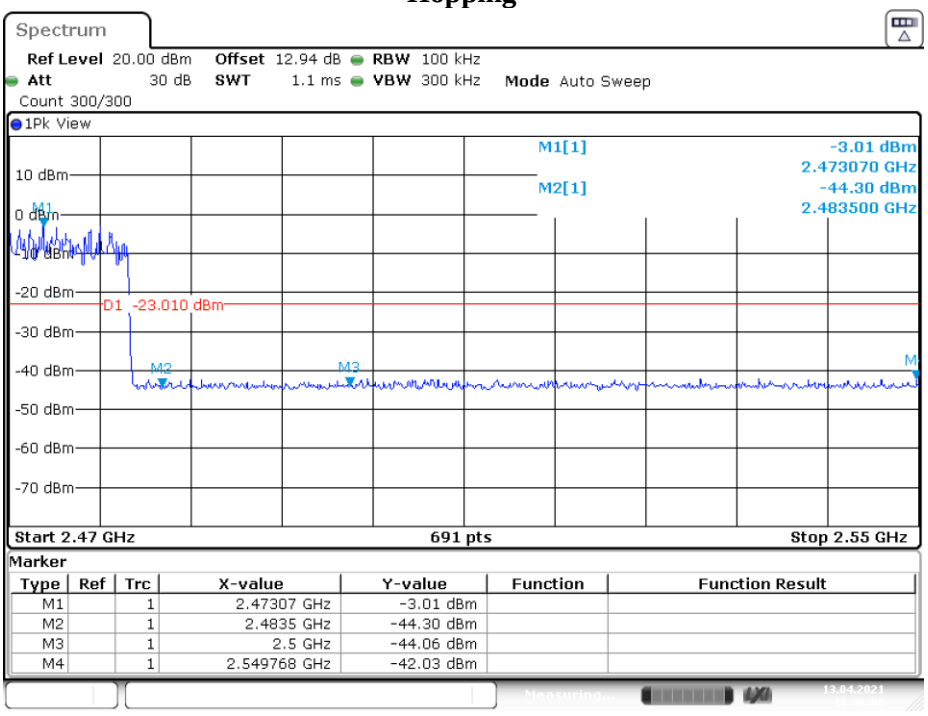
EDR (8DPSK): Band Edge-Right Side
Hopping



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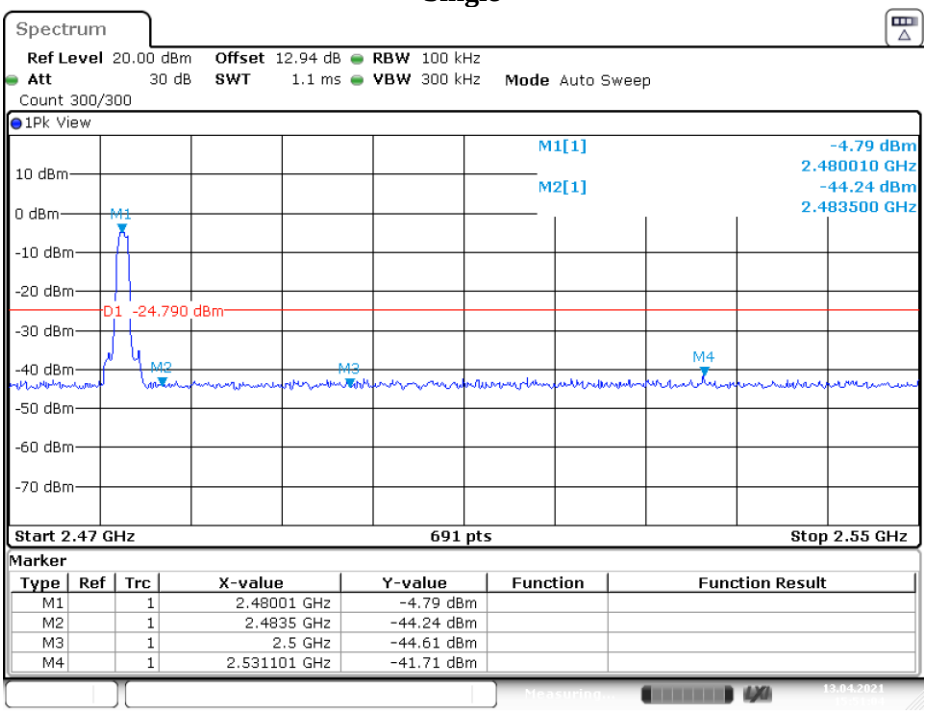
Single



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