FCC PART 15.247

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TEST REPORT

For

Grandstream Networks, Inc.

126 Brookline Ave., 3rd Floor Boston, MA 02215, USA

FCC ID: YZZGUV3050V20
IC: 11964A-GUV3050V2

Report Type:	**Product Type:**
Original Report	Wireless Bluetooth Headset

Report Number: RSZ210302001-00B

Report Date: 2021-03-08

Reviewed By: Candy Li, RF Engineer

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Wireless Bluetooth Headset
Tested Model	GUV3050
Frequency Range	Bluetooth: 2402~2480MHz
Transmit Power	0.62dBm
Modulation Technique	Bluetooth: GFSK, π/4-DQPSK, 8DPSK
Antenna Specification	PCB Antenna: 0dBi
Voltage Range	DC 3.7 V from battery or DC 5.0V from adapter(provided by laboratory)
Date of Test	2021-03-02 to 2021-03-05
Sample serial number	RSZ210302001-RF-S1
Received date	2021-02-25
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.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016.

Listed by Innovation, Science and Economic Development Canada (ISEDC)
The Registration Number is 5077A-2

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

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

"Bluetooth Test3"* exercise software was made to the EUT tested and the power level is 255, 50*. 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.

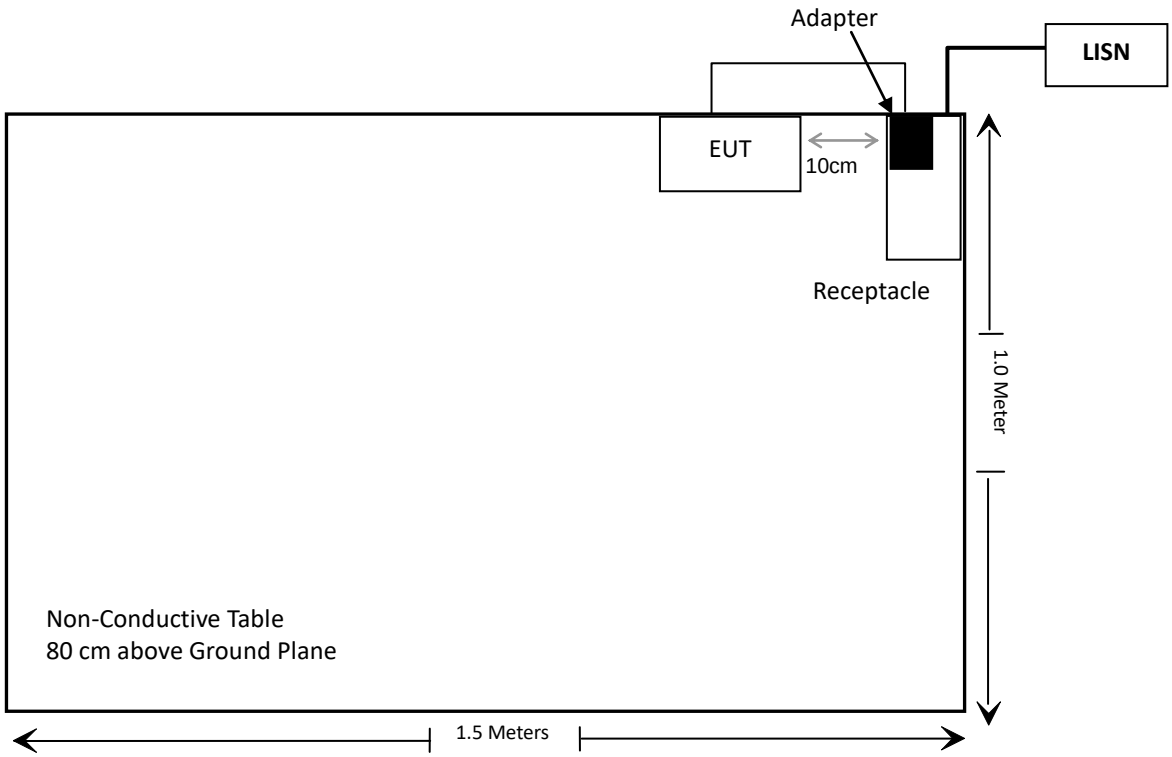
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
HUAWEI	Adapter	HW-050200C01	/
DELL	PC	Latitude E5570	28693335458

External I/O Cable

Cable Description	Length (m)	From/Port	To
Un-shielding Detachable USB Cable	1.0	EUT	Adapter

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
FCC §15.247 (i), §1.1307 (b) (1) & §2.1093	RF EXPOSURE	Compliance
RSS-102 § 2.5.1	Exemption Limits for Routine Evaluation – SAR 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	ESCS30	100307	2020/12/25	2021/12/24
Schwarzbeck	L.I.S.N.	NLSK8126	8126431	2020/12/25	2021/12/24
Rohde & Schwarz	Pulse Limiter	ESH3-Z2	100815	2020/12/25	2021/12/24
Anritsu Corp	50Ω Coaxial Switch	MP59B	6200506474	2020/12/25	2021/12/24
RF Coaxial Cable	Unknown	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	2020/01/04	2023/01/03
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
RF Coaxial Cable	Unknown	N-5m	No.3	2020/12/25	2021/12/24
RF Coaxial Cable	Unknown	N-5m	No.4	2020/12/25	2021/12/24
RF Coaxial Cable	Unknown	N-1m	No.5	2020/12/25	2021/12/24
RF Coaxial Cable	Unknown	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), §1.1307 (b) (1) & §2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

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

Test Result:

For worst case:

Mode	Frequency (MHz)	Maximum Tune-up power		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
		(dBm)	(mW)				
BDR (GFSK)	2480	1	1.26	5	0.4	3.0	Yes

Result: No Standalone SAR test is required

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

Applicable Standard

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

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance4,5

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

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

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

Test Result:

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

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

The exemption limit of 2480MHz is P= 3.94mW

Ant gain:0dBi

Tune up conducted power= 1dBm =1.26mW <3.94mW

So the stand-alone SAR evaluation can be exempted.

FCC §15.203 & RSS-GEN §6.8 – ANTENNA REQUIREMENT

Applicable Standard

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

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

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

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

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

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

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

Antenna Connector Construction

The EUT has one internal 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

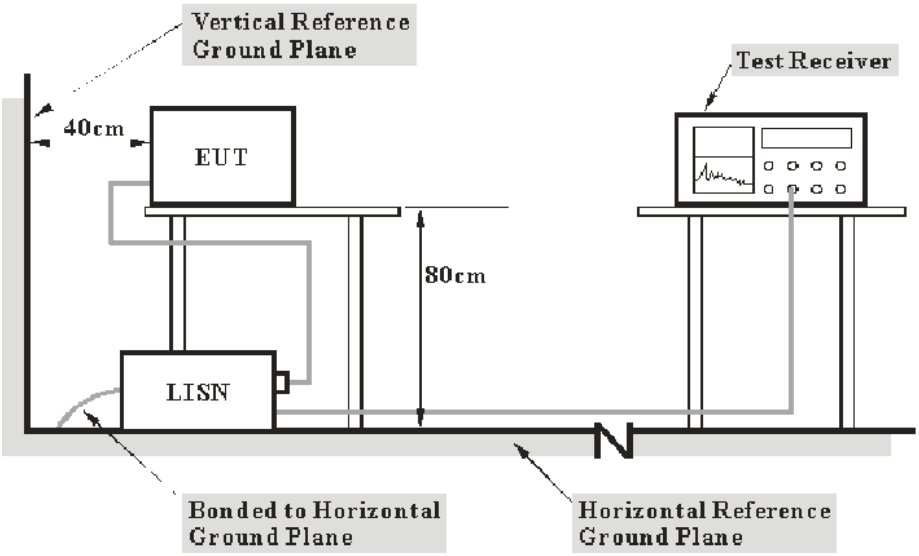
Result: Compliance

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

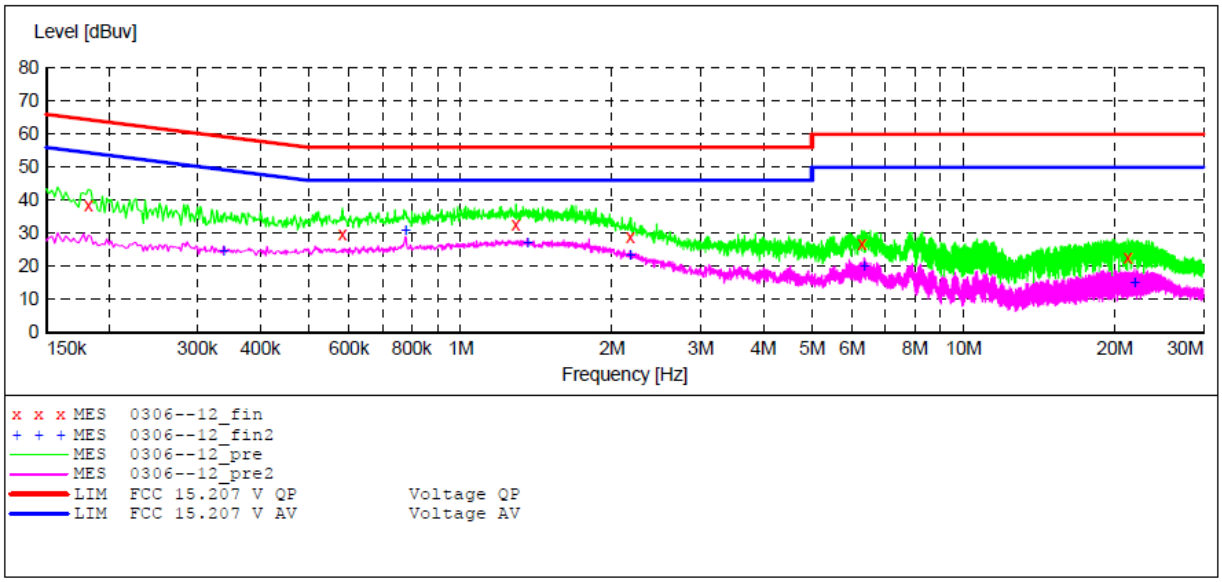
Environmental Conditions

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

The testing was performed by Fan Yang on 2021-03-06.

EUT operation mode: Transmitting & charging (the worst case is GFSK Mode, High channel)

AC 120V/60 Hz, Line



MEASUREMENT RESULT: "0306--12_fin"

2021-3-6 14:34

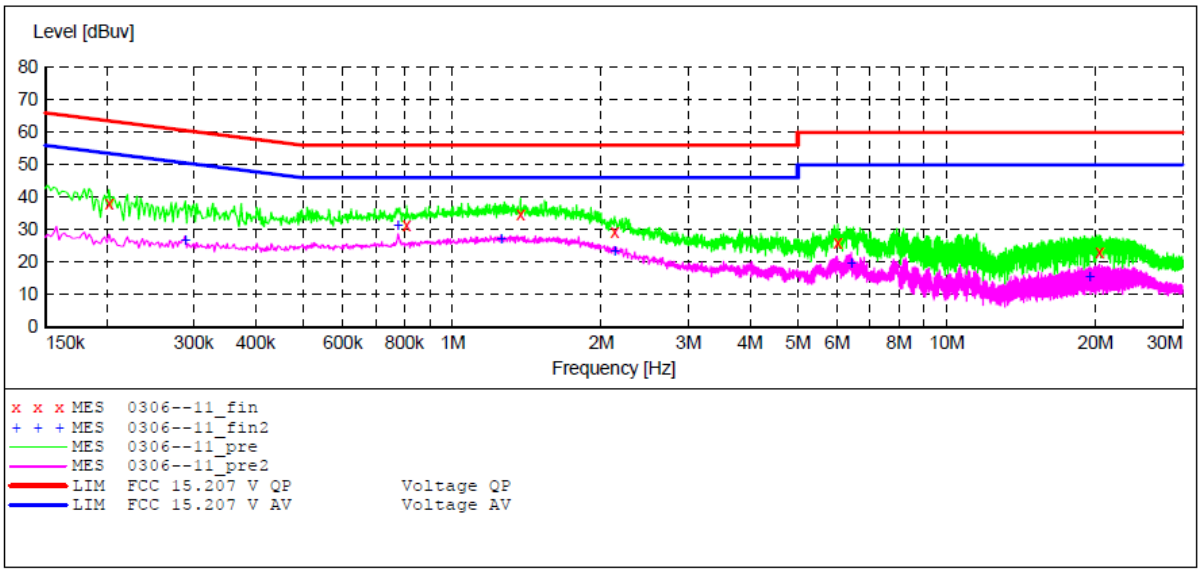
Frequency MHz	Level dBuv	Transd dB	Limit dBuv	Margin dB	Detector	Line	PE
0.182000	38.30	10.8	64	25.7	QP	L1	GND
0.582000	29.70	11.0	56	26.3	QP	L1	GND
1.288000	32.70	11.2	56	23.3	QP	L1	GND
2.175000	28.90	11.3	56	27.1	QP	L1	GND
6.280000	26.60	11.5	60	33.4	QP	L1	GND
21.215000	22.70	11.7	60	37.3	QP	L1	GND

MEASUREMENT RESULT: "0306--12_fin2"

2021-3-6 14:34

Frequency MHz	Level dBuv	Transd dB	Limit dBuv	Margin dB	Detector	Line	PE
0.338000	24.50	10.9	49	24.5	AV	L1	GND
0.778000	31.00	11.1	46	15.0	AV	L1	GND
1.358000	27.40	11.2	46	18.6	AV	L1	GND
2.175000	23.50	11.3	46	22.5	AV	L1	GND
6.340000	20.10	11.5	50	29.9	AV	L1	GND
21.885000	15.20	11.7	50	34.8	AV	L1	GND

AC 120V/60 Hz, Neutral



MEASUREMENT RESULT: "0306--11_fin"

2021-3-6 14:31

Frequency MHz	Level dBuv	Transd dB	Limit dBuv	Margin dB	Detector	Line	PE
0.202000	38.50	10.8	64	25.5	QP	N	GND
0.808000	31.20	11.1	56	24.8	QP	N	GND
1.372000	34.80	11.2	56	21.2	QP	N	GND
2.130000	29.50	11.3	56	26.5	QP	N	GND
6.025000	25.80	11.5	60	34.2	QP	N	GND
20.365000	23.10	11.7	60	36.9	QP	N	GND

MEASUREMENT RESULT: "0306--11_fin2"

2021-3-6 14:31

Frequency MHz	Level dBuv	Transd dB	Limit dBuv	Margin dB	Detector	Line	PE
0.288000	26.70	10.9	51	24.3	AV	N	GND
0.776000	31.30	11.1	46	14.7	AV	N	GND
1.256000	27.10	11.2	46	18.9	AV	N	GND
2.130000	23.60	11.3	46	22.4	AV	N	GND
6.415000	19.90	11.5	50	30.1	AV	N	GND
19.440000	15.40	11.7	50	34.6	AV	N	GND

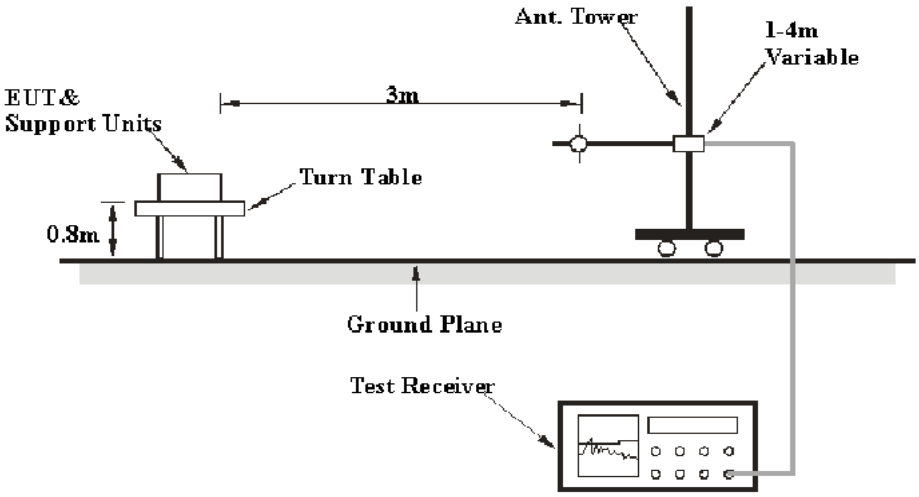
FCC §15.209, §15.205 & §15.247(d) & RSS-247 § 5.5 - Spurious Emissions

Applicable Standard

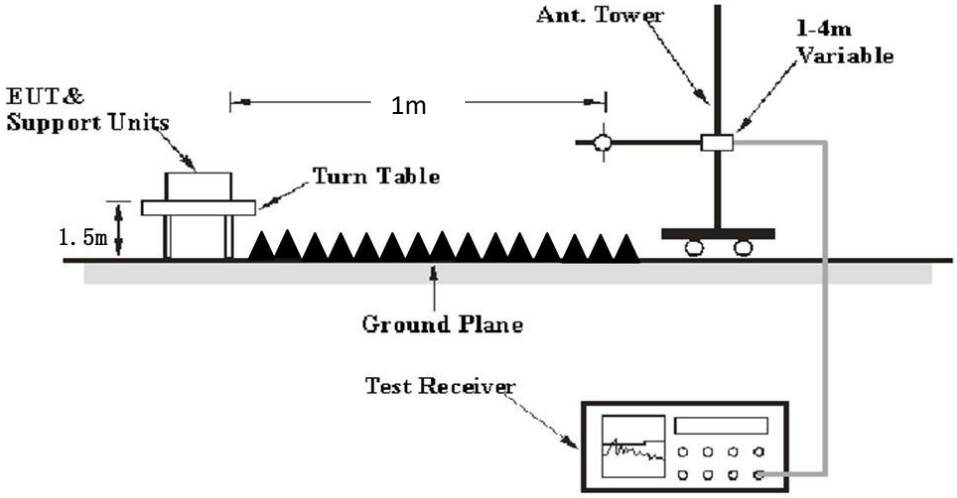
FCC §15.205; §15.209; §15.247(d); RSS-247 § 5.5; RSS-GEN § 8.10

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 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:

Corrected Amplitude = 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 = Limit – Corrected Amplitude

Test Data

Environmental Conditions

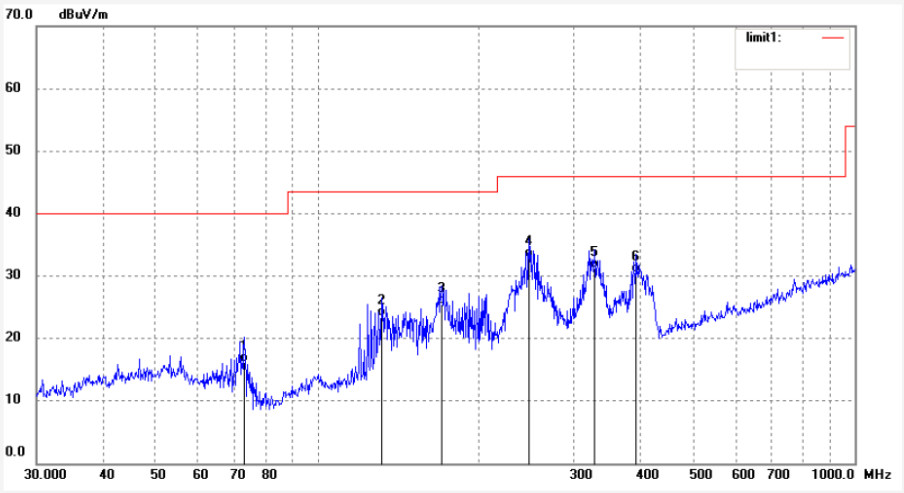
Temperature:	25 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Fan Yang on 2021-03-05

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

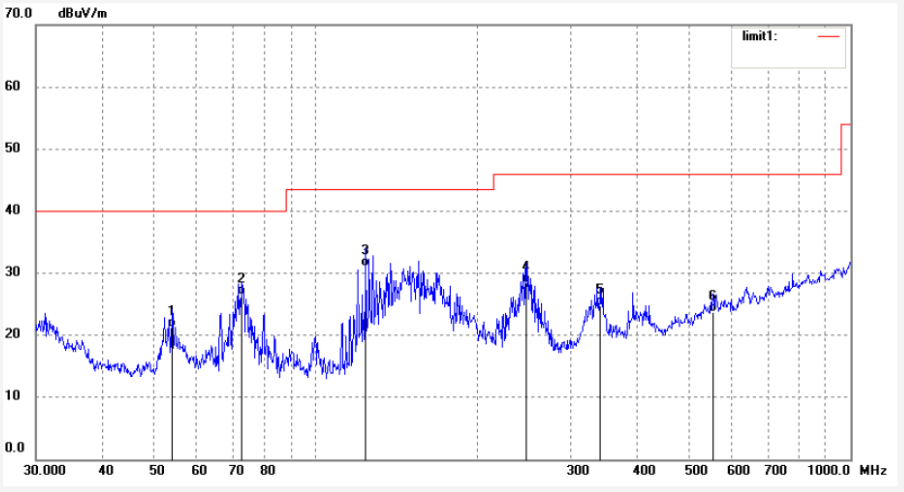
30 MHz~1 GHz: *(the worst case is GFSK Mode, High channel)*

Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	73.1025	32.04	-15.89	16.15	40.00	-23.85	QP			
2	131.7577	36.33	-12.83	23.50	43.50	-20.00	QP			
3	170.1948	38.10	-12.67	25.43	43.50	-18.07	QP			
4	247.6819	43.06	-10.15	32.91	46.00	-13.09	QP			
5	327.8873	38.78	-7.56	31.22	46.00	-14.78	QP			
6	392.0951	36.66	-6.07	30.59	46.00	-15.41	QP			

Vertical

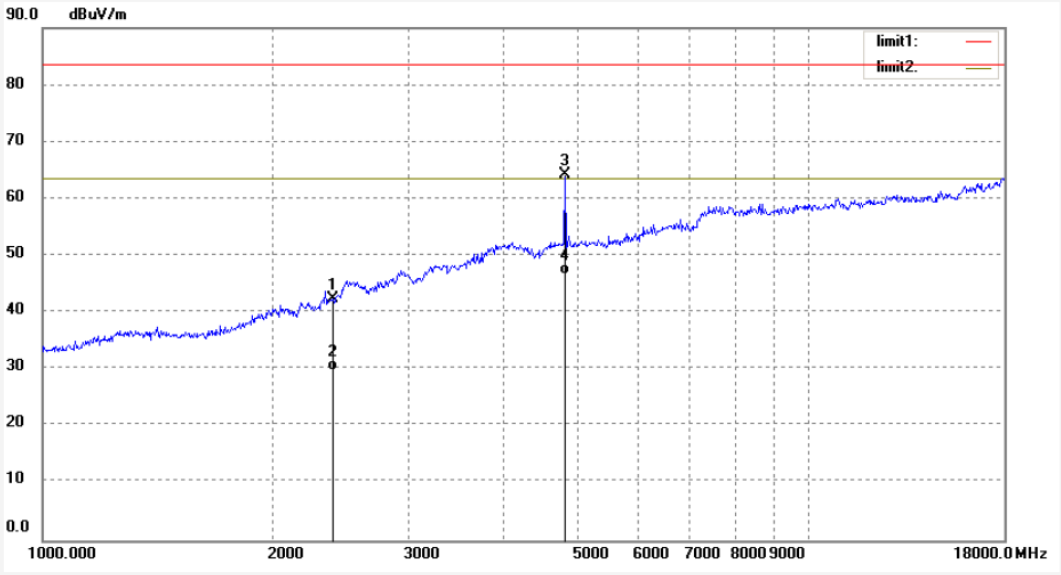


No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	53.8818	32.75	-11.55	21.20	40.00	-18.80	QP			
2	72.8466	41.69	-15.14	26.55	40.00	-13.45	QP			
3	124.1330	43.53	-12.47	31.06	43.50	-12.44	QP			
4	247.6819	38.62	-10.15	28.47	46.00	-17.53	QP			
5	340.7817	31.88	-7.08	24.80	46.00	-21.20	QP			
6	552.8832	26.32	-2.65	23.67	46.00	-22.33	QP			

1 GHz - 18 GHz: (*Scan with GFSK, π/4-DQPSK, 8DPSK mode, the worst case is in GFSK Mode*)

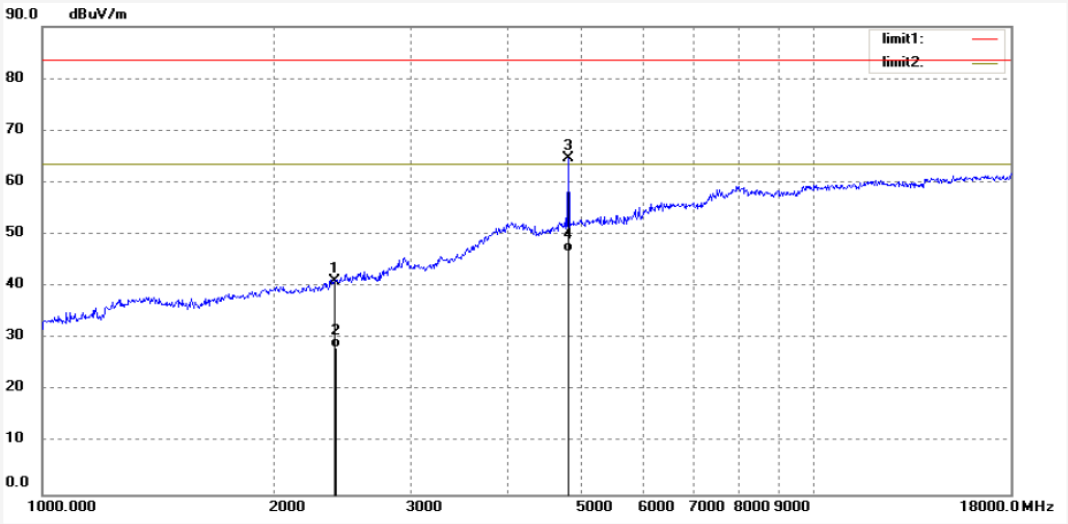
Low Channel

Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2390.000	48.96	-6.44	42.52	83.50	-40.98	peak			
2	2390.000	36.25	-6.44	29.81	63.50	-33.69	AVG			
3	4804.110	61.43	2.81	64.24	83.50	-19.26	peak			
4	4804.110	43.99	2.81	46.80	63.50	-16.70	AVG			

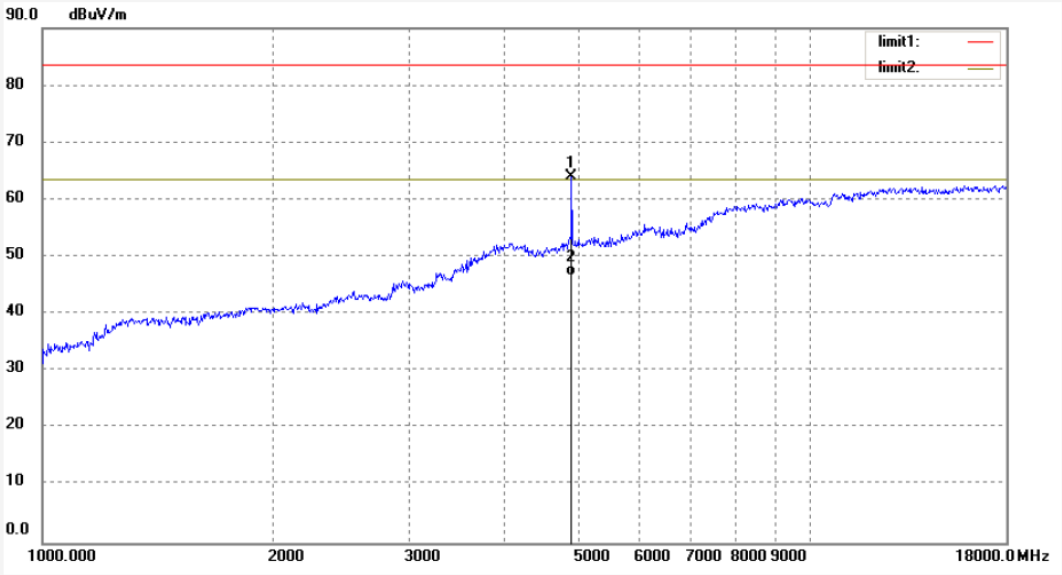
Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	2390.000	47.59	-6.44	41.15	83.50	-42.35	peak			
2	2390.000	34.65	-6.44	28.21	63.50	-35.29	AVG			
3	4804.110	61.79	2.81	64.60	83.50	-18.90	peak			
4	4804.110	43.99	2.81	46.80	63.50	-16.70	AVG			

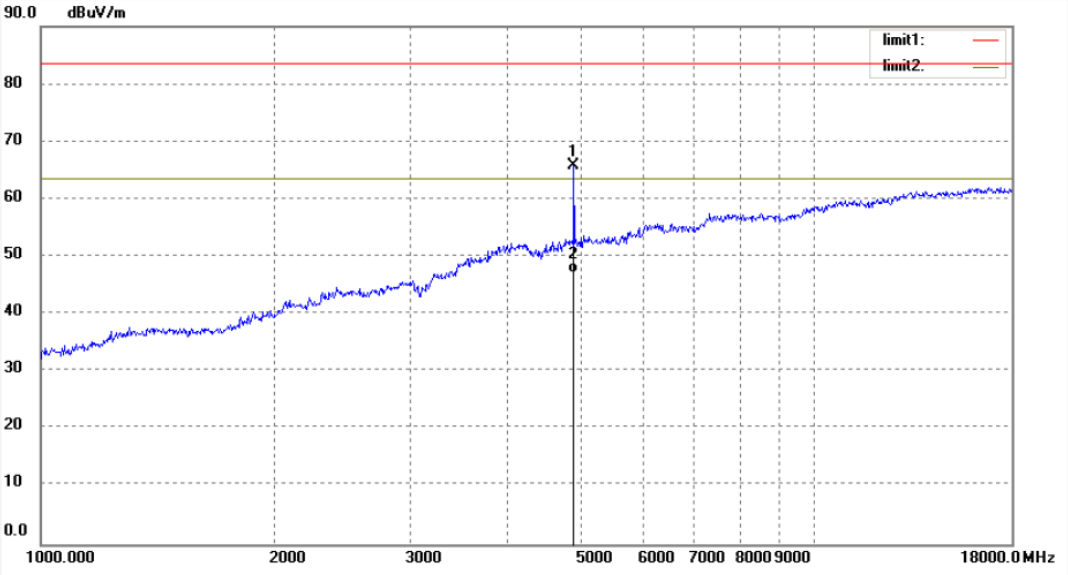
Middle Channel

Horizontal



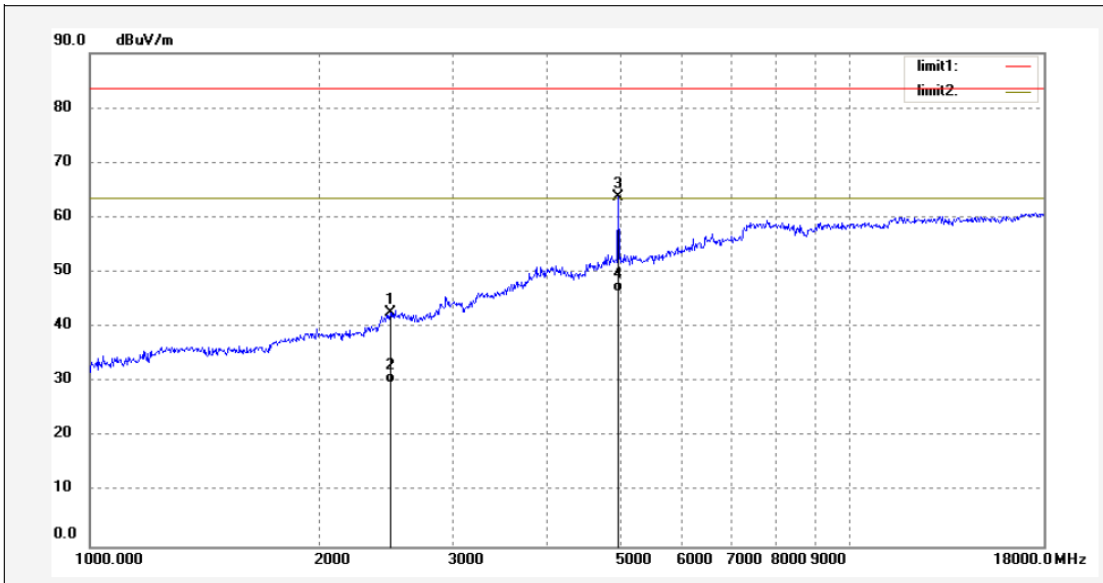
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	4882.151	60.89	3.06	63.95	83.50	-19.55	peak			
2	4882.151	43.71	3.06	46.77	63.50	-16.73	AVG			

Vertical



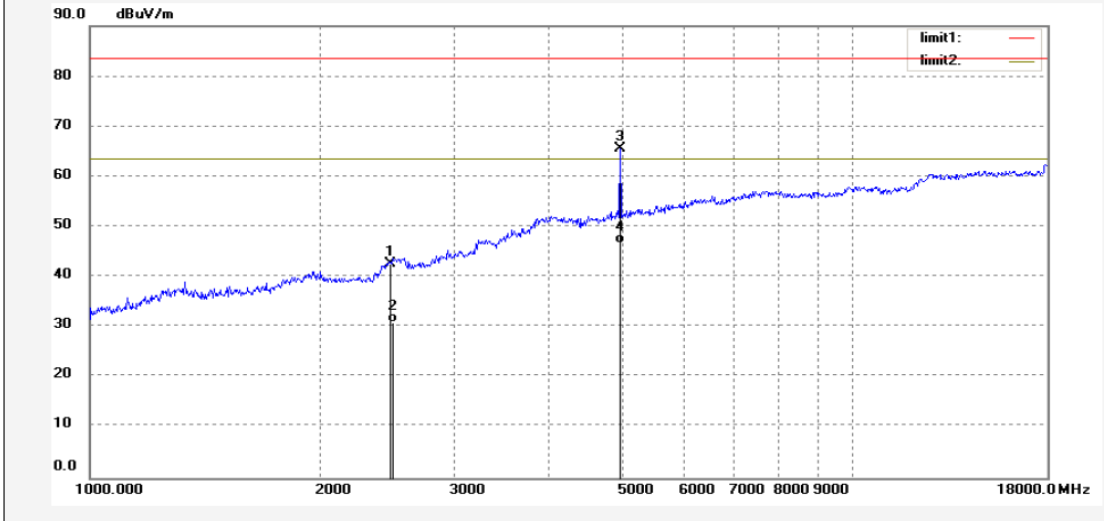
No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	4882.151	62.86	3.06	65.92	83.50	-17.58	peak			
2	4882.151	44.12	3.06	47.18	63.50	-16.32	AVG			

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	48.59	-5.96	42.63	83.50	-40.87	peak			
2	2483.500	35.80	-5.96	29.84	63.50	-33.66	AVG			
3	4960.307	60.57	3.28	63.85	83.50	-19.65	peak			
4	4960.307	43.22	3.28	46.50	63.50	-17.00	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	48.69	-5.96	42.73	83.50	-40.77	peak			
2	2483.500	36.93	-5.96	30.97	63.50	-32.53	AVG			
3	4960.307	62.21	3.28	65.49	83.50	-18.01	peak			
4	4960.307	43.51	3.28	46.79	63.50	-16.71	AVG			

Note: Limit (dBμV/m)@1m = Limit (dBμV/m)@3m + 20log (3/1)

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 Fan Yang on 2021-03-02.

EUT operation mode: Transmitting

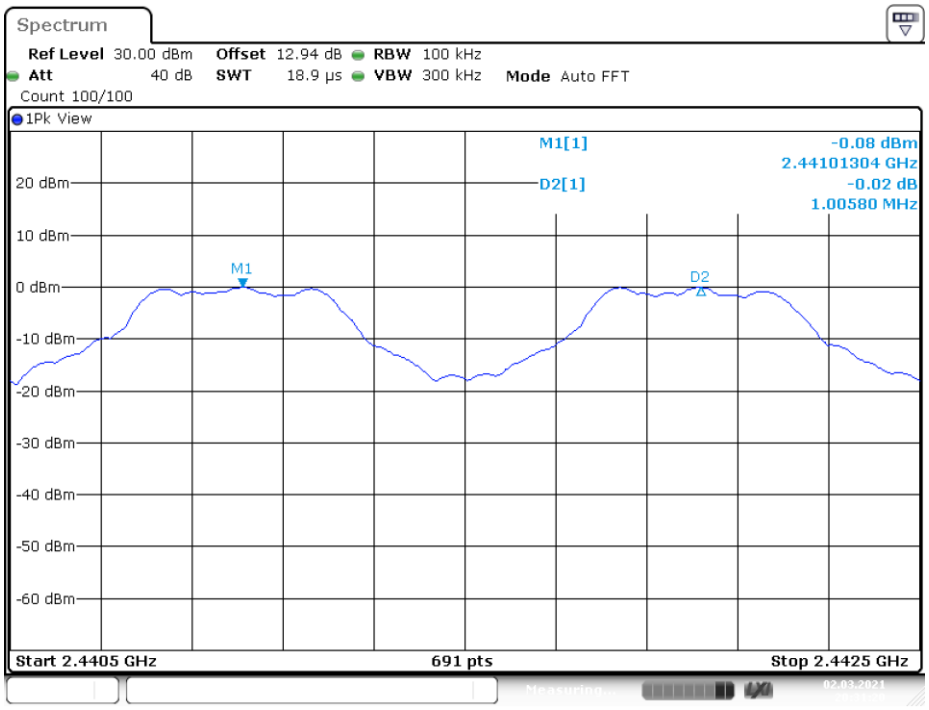
Test Result: Pass

Please refer to following table and plots.

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	≥Limit (MHz)	Result
BDR (GFSK)	Middle	2441	1.006	0.619	Pass
	Adjacent	2442			
EDR (π/4-DQPSK)	Middle	2441	1.006	0.813	Pass
	Adjacent	2442			
EDR (8DPSK)	Middle	2441	0.997	0.816	Pass
	Adjacent	2442			

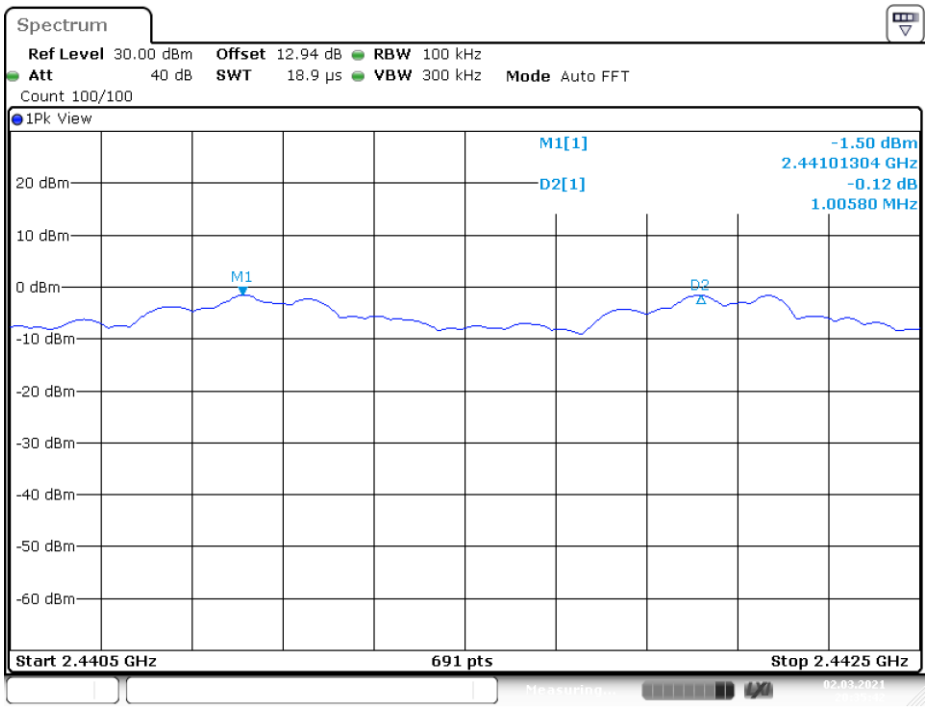
Note: the limit = (2/3) * 20dB bandwidth

BDR (GFSK): Middle Channel



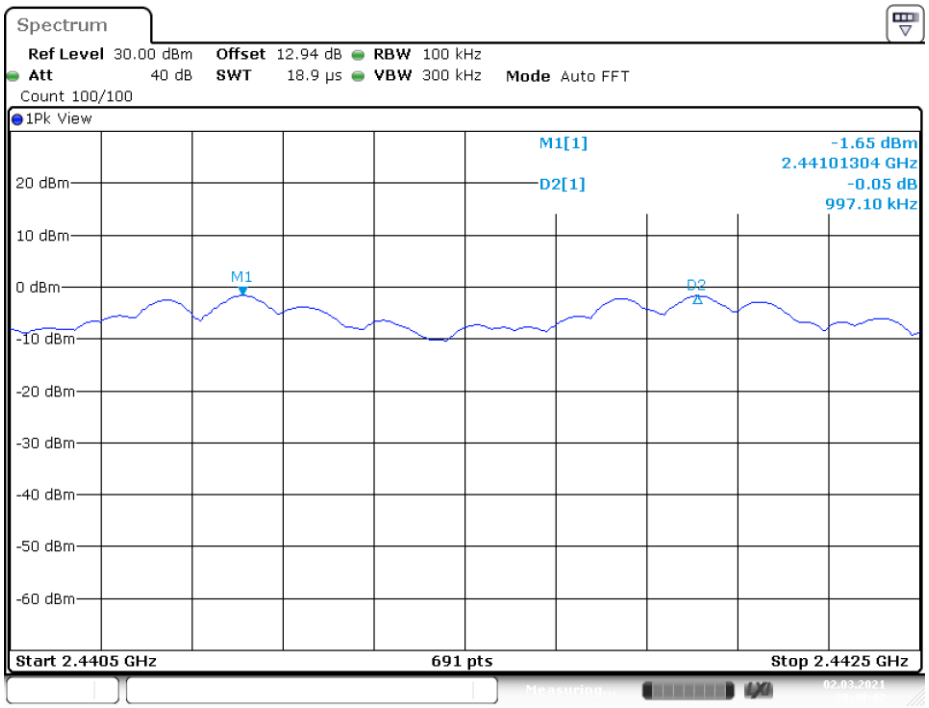
Date: 2.MAR.2021 20:31:21

EDR (π/4-DQPSK): Middle Channel



Date: 2.MAR.2021 20:35:43

EDR (8DPSK): Middle Channel



Date: 2.MAR.2021 20:40:43

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:

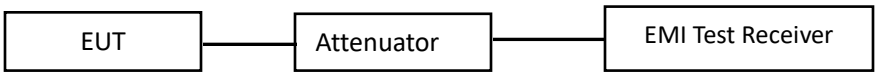
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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 Fan Yang on 2021-03-02.

EUT operation mode: Transmitting

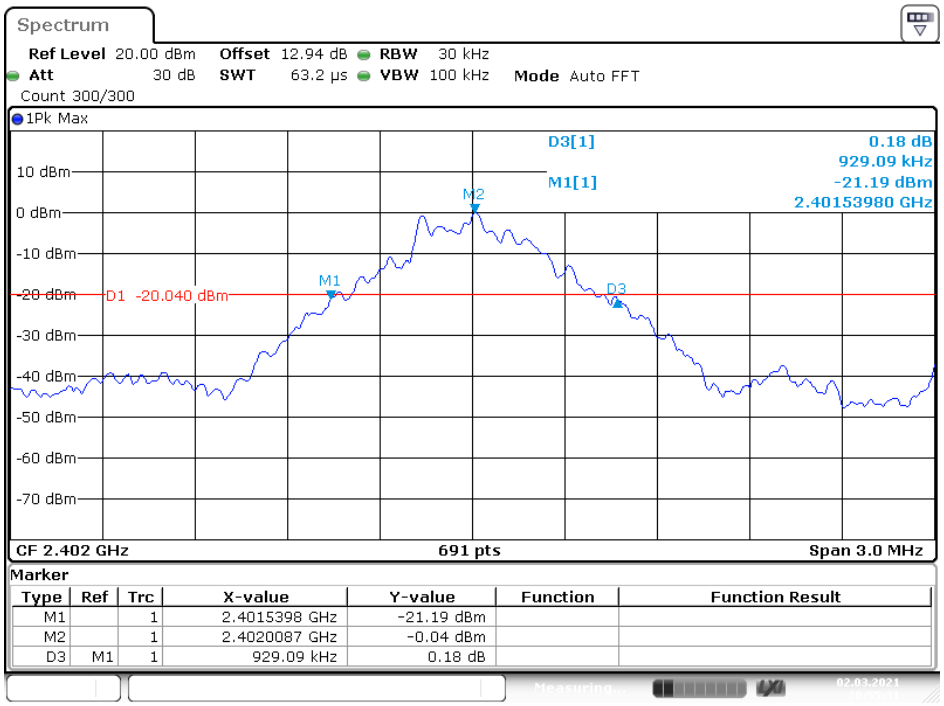
Test Result: Pass

Please refer to following table and plots.

Mode	Frequency (MHz)	99% Occupied Bandwidth (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	2402	0.877	0.929
	2441	0.873	0.929
	2480	0.885	0.912
EDR (π/4-DQPSK)	2402	1.193	1.250
	2441	1.185	1.220
	2480	1.183	1.211
EDR (8DPSK)	2402	1.177	1.224
	2441	1.173	1.224
	2480	1.173	1.233

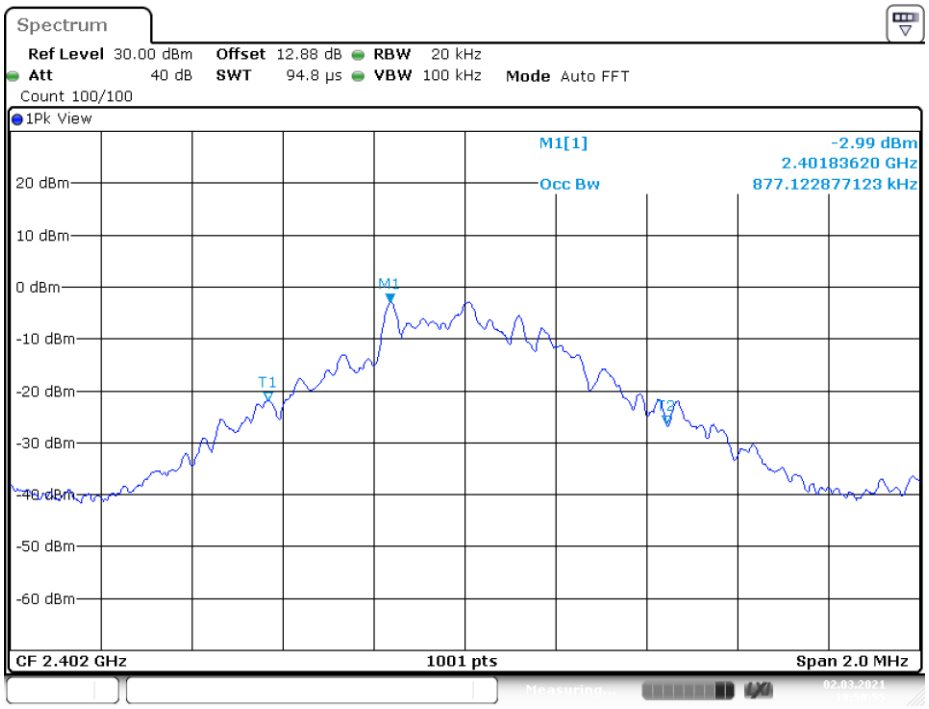
BDR (GFSK):

20dB Emission Bandwidth, Low Channel



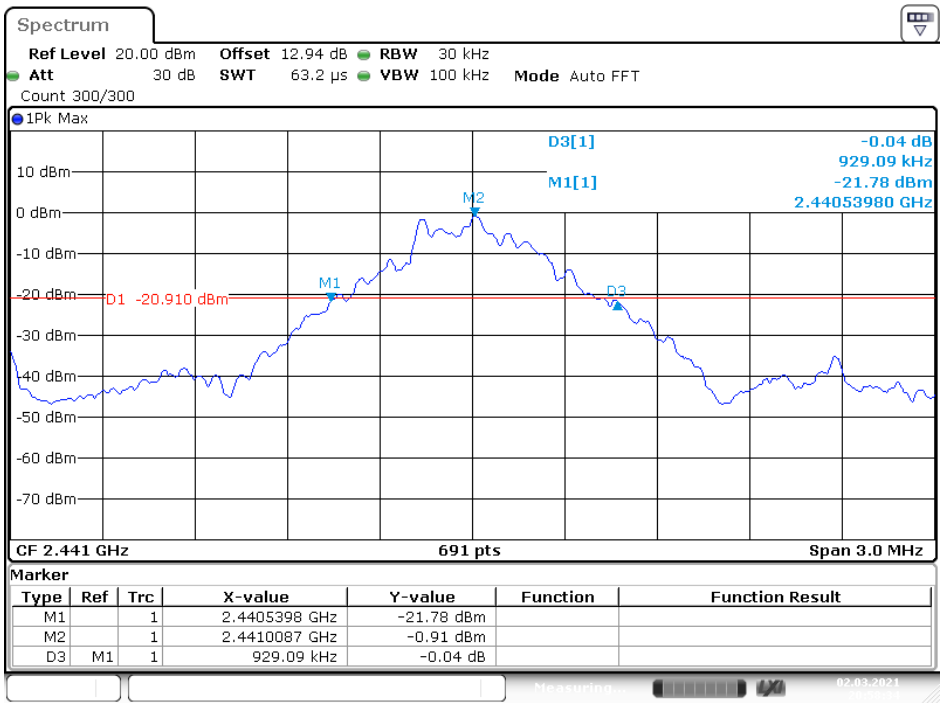
Date: 2.MAR.2021 20:55:32

99% Occupied Bandwidth, Low Channel



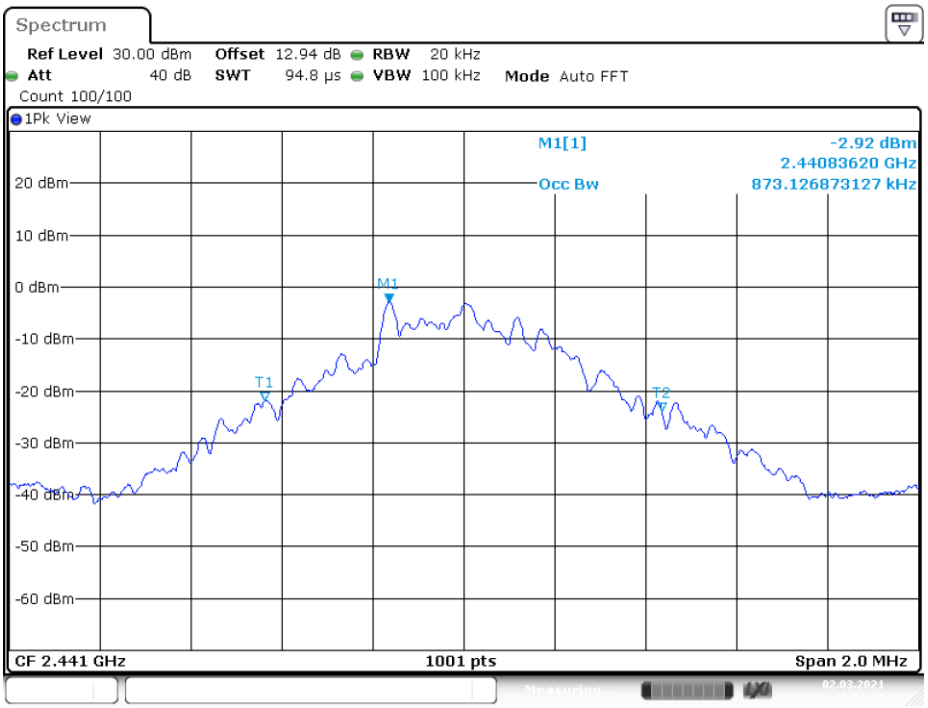
Date: 2.MAR.2021 19:50:56

20dB Emission Bandwidth, Middle Channel



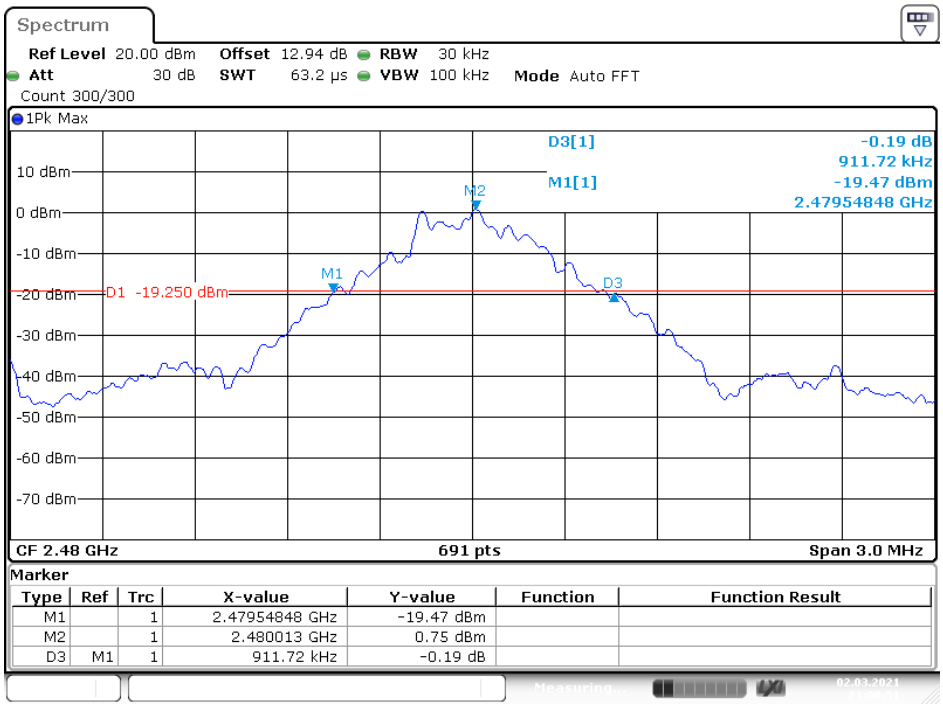
Date: 2.MAR.2021 20:58:34

99% Occupied Bandwidth, Middle Channel



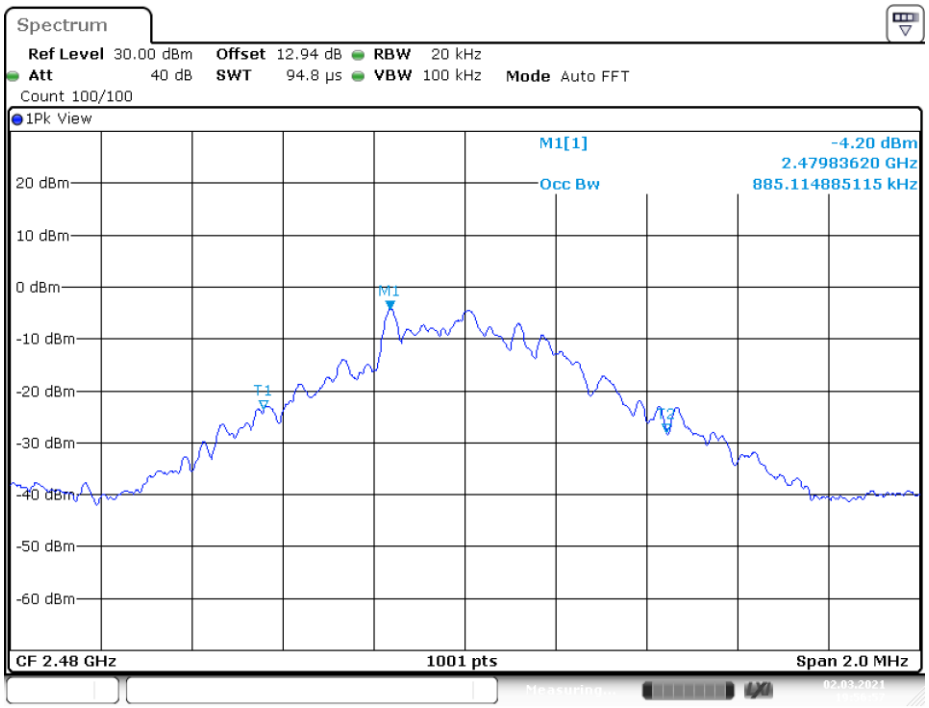
Date: 2.MAR.2021 19:54:34

20dB Emission Bandwidth, High Channel



Date: 2.MAR.2021 21:00:51

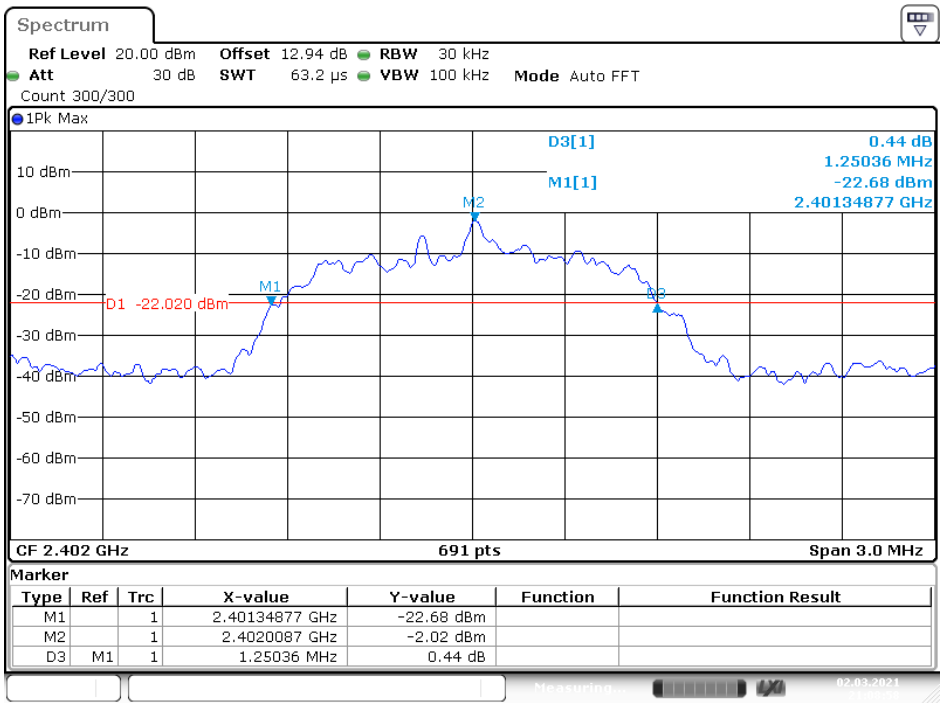
99% Occupied Bandwidth, High Channel



Date: 2.MAR.2021 19:56:58

EDR (π/4-DQPSK):

20dB Emission Bandwidth, Low Channel



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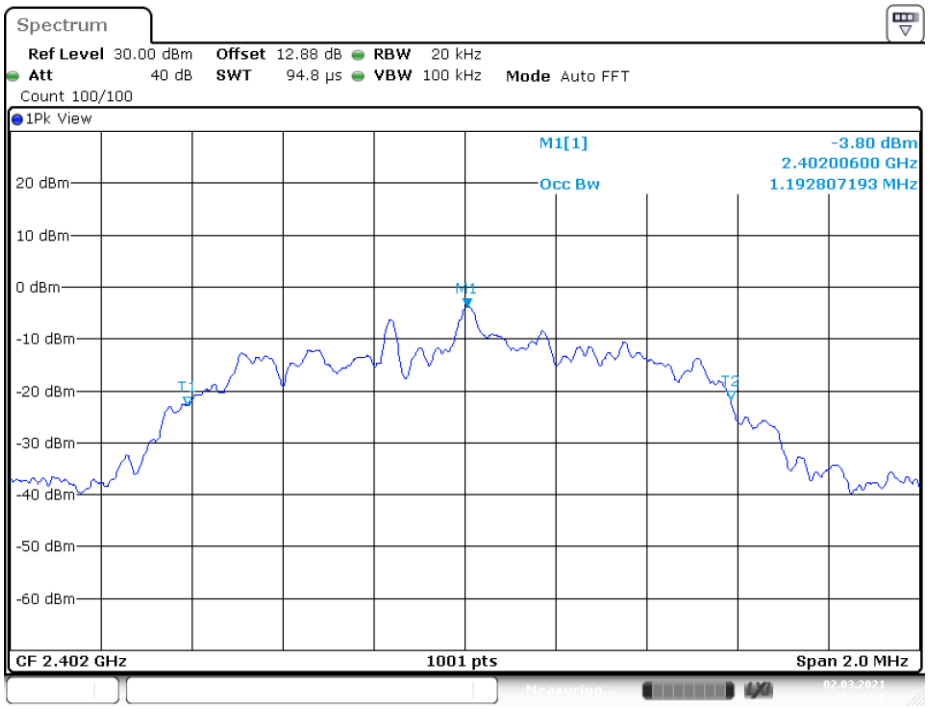
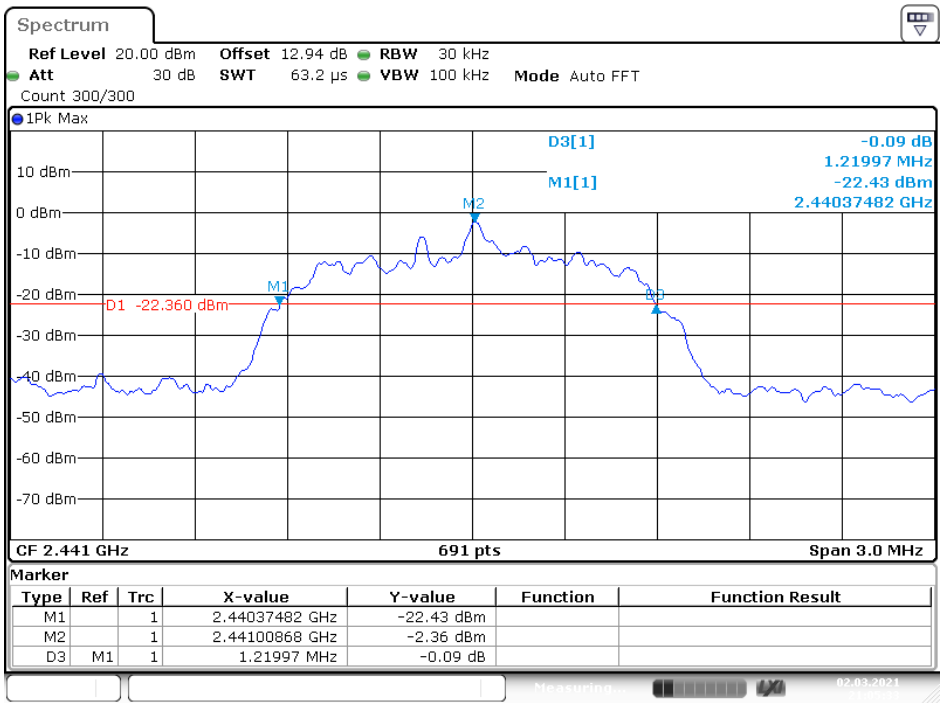
99% Occupied Bandwidth, Low Channel



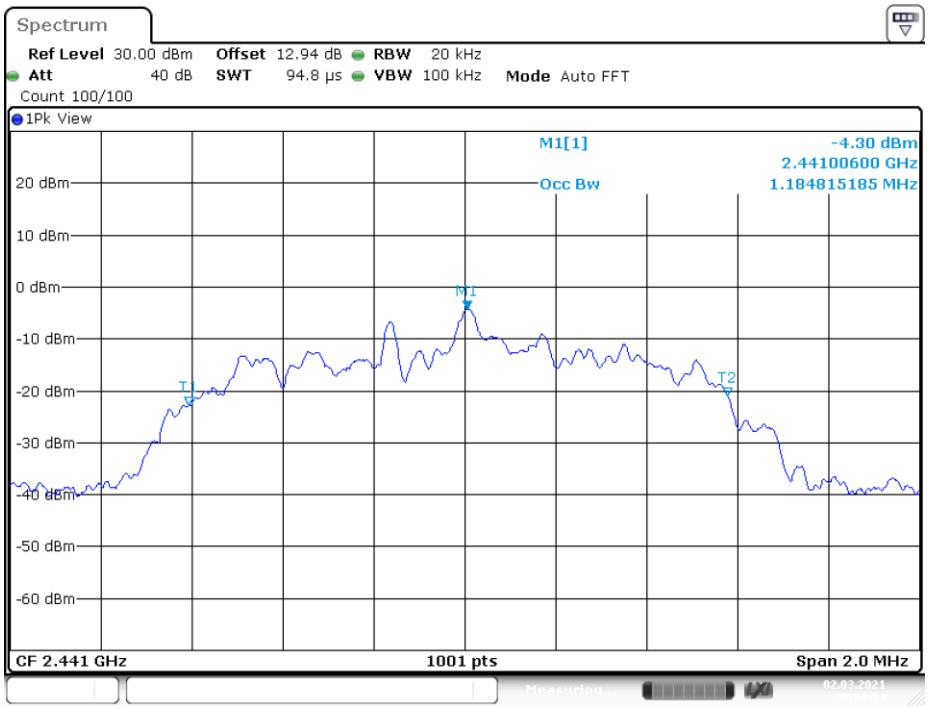
Date: 2.MAR.2021 20:01:11

20dB Emission Bandwidth, Middle Channel



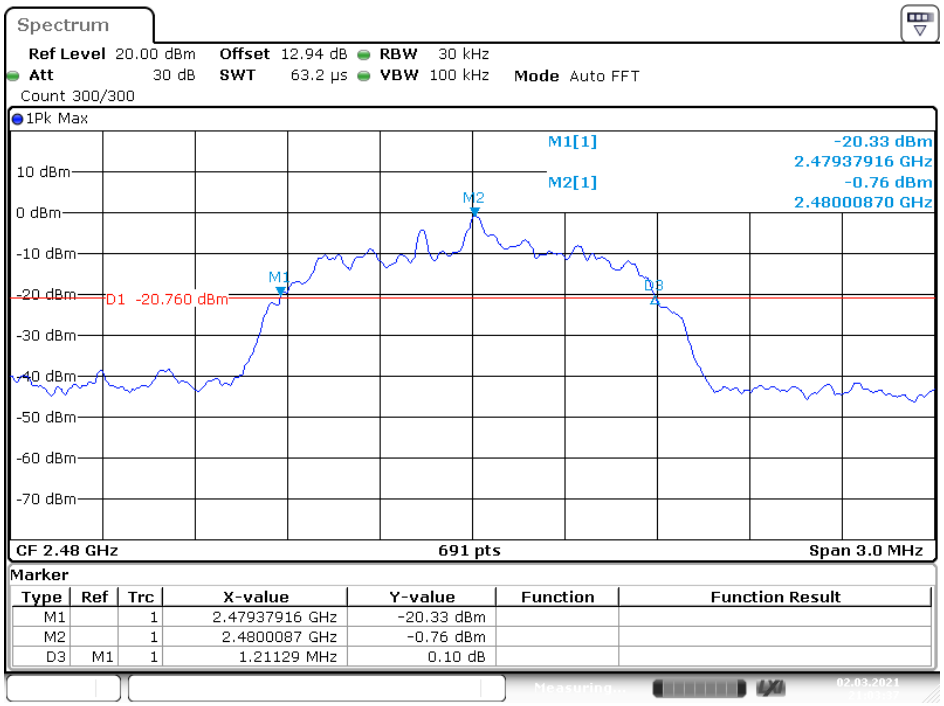
Date: 2.MAR.2021 21:05:34

99% Occupied Bandwidth, Middle Channel



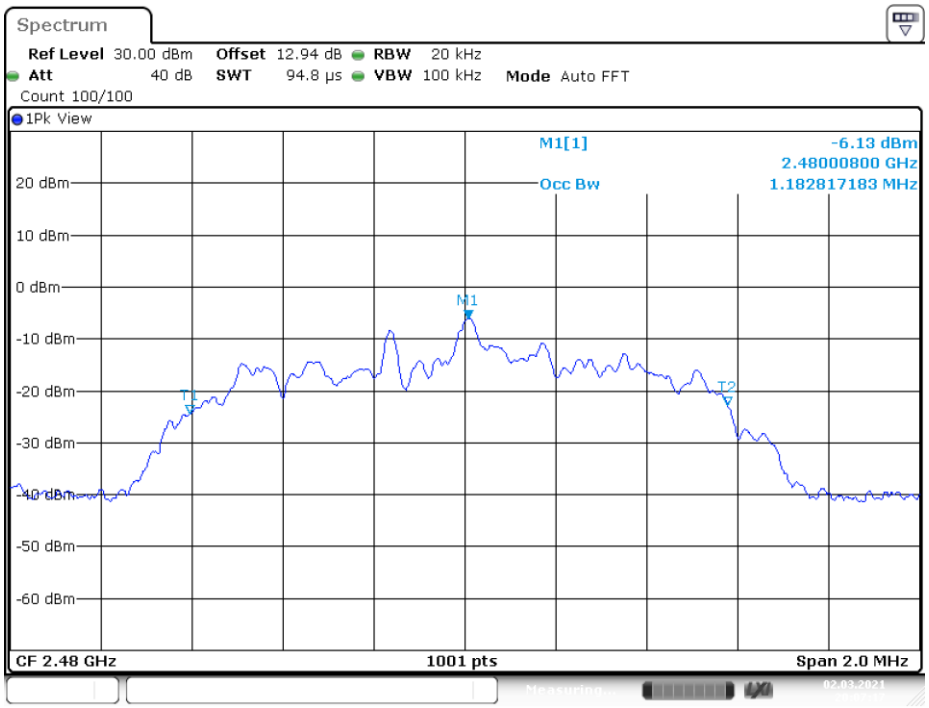
Date: 2.MAR.2021 20:04:55

20dB Emission Bandwidth, High Channel



Date: 2.MAR.2021 21:03:38

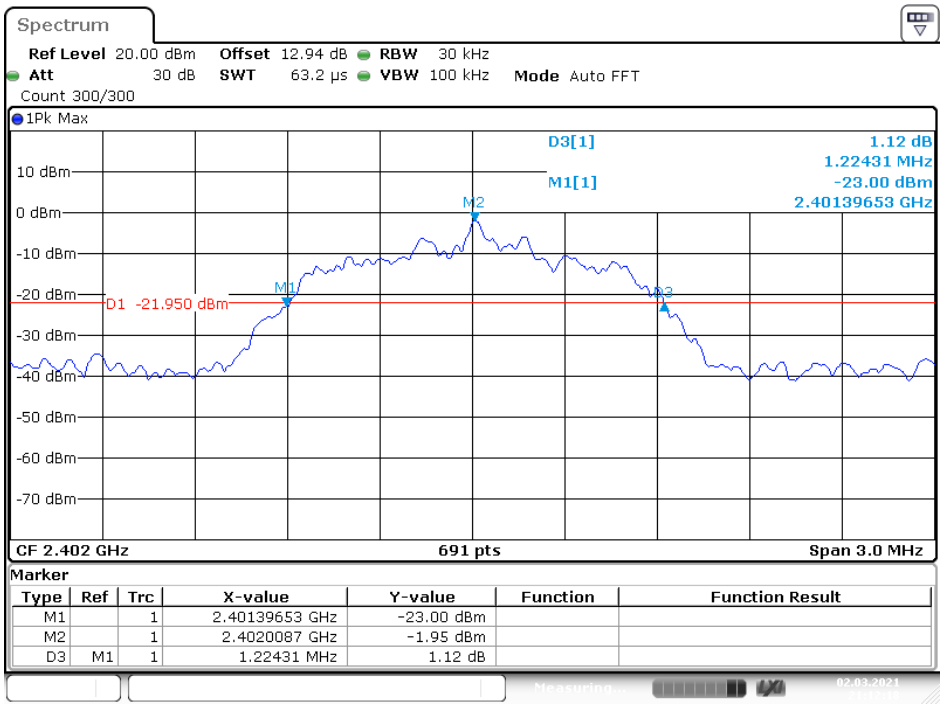
99% Occupied Bandwidth, High Channel



Date: 2.MAR.2021 20:07:18

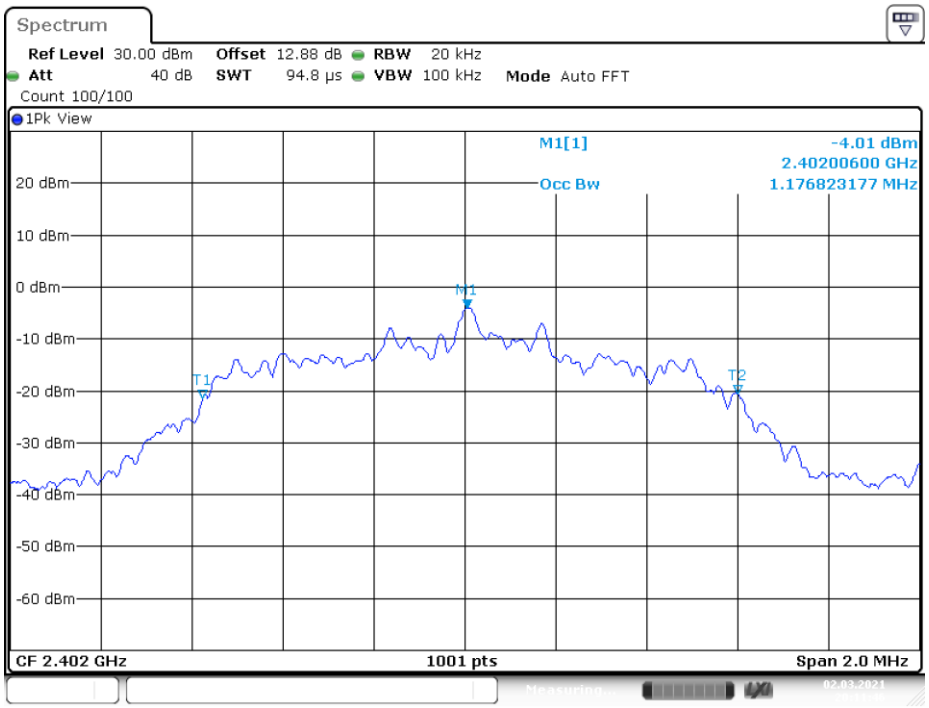
EDR (8DPSK):

20dB Emission Bandwidth, Low Channel



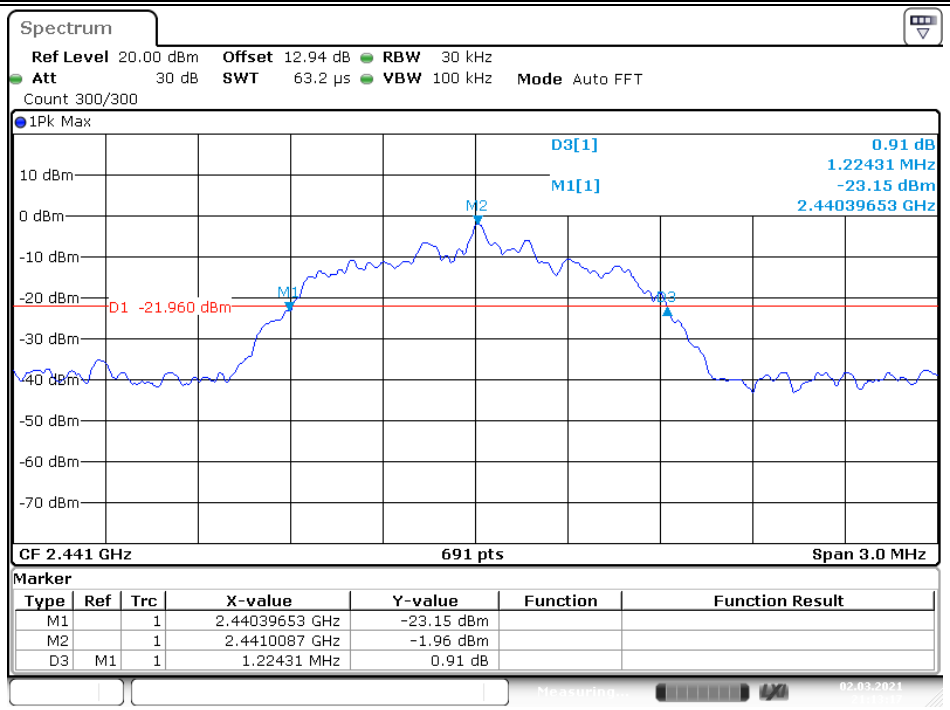
Date: 2.MAR.2021 21:12:19

99% Occupied Bandwidth, Low Channel



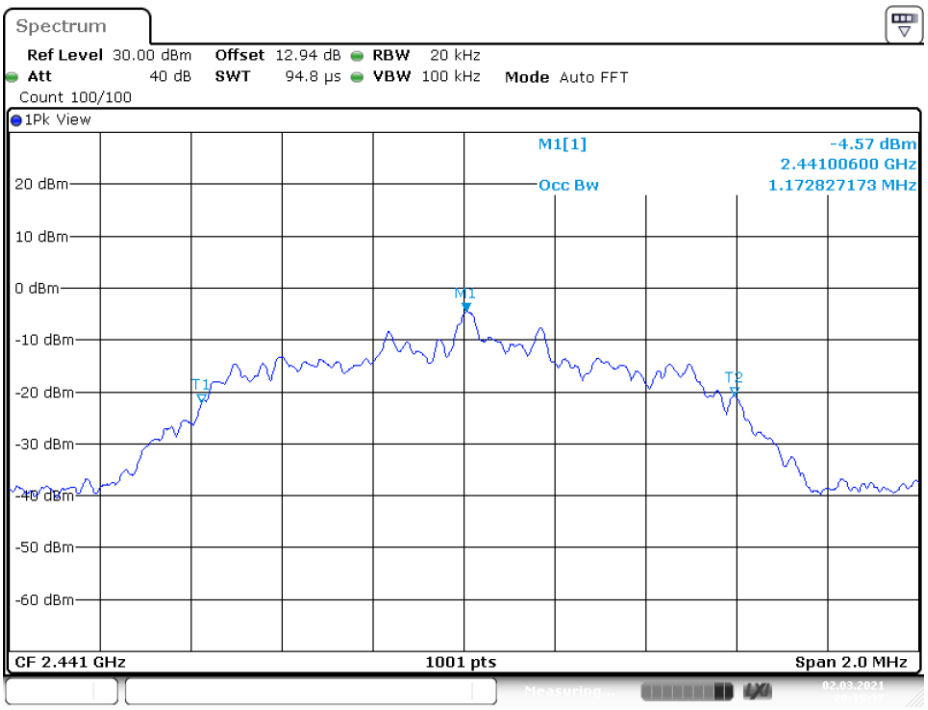
Date: 2.MAR.2021 20:11:46

20dB Emission Bandwidth, middle Channel



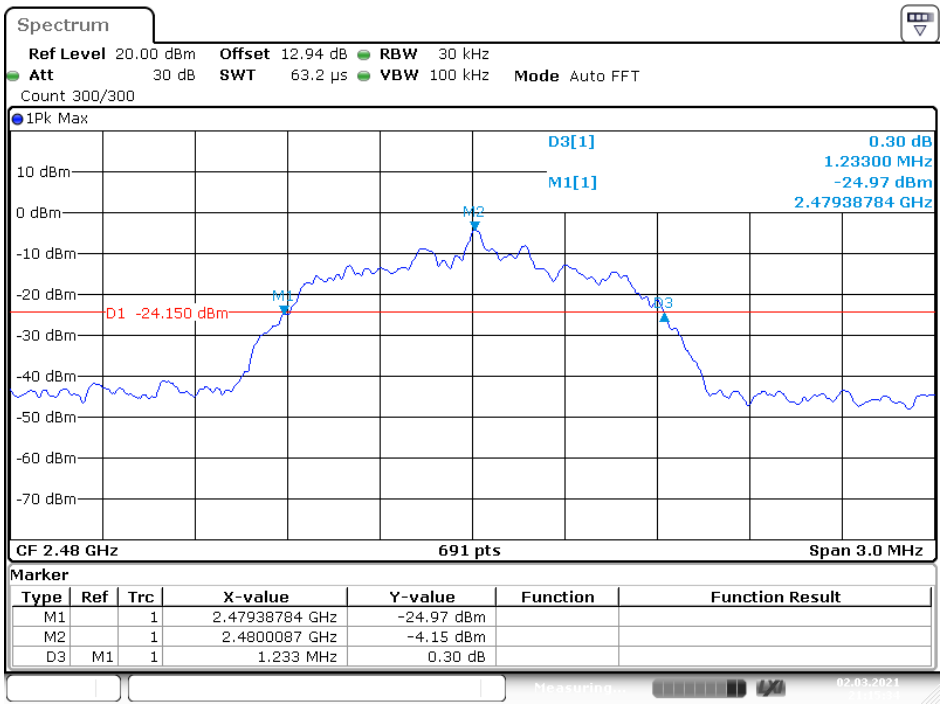
Date: 2.MAR.2021 21:13:18

99% Occupied Bandwidth, Middle Channel



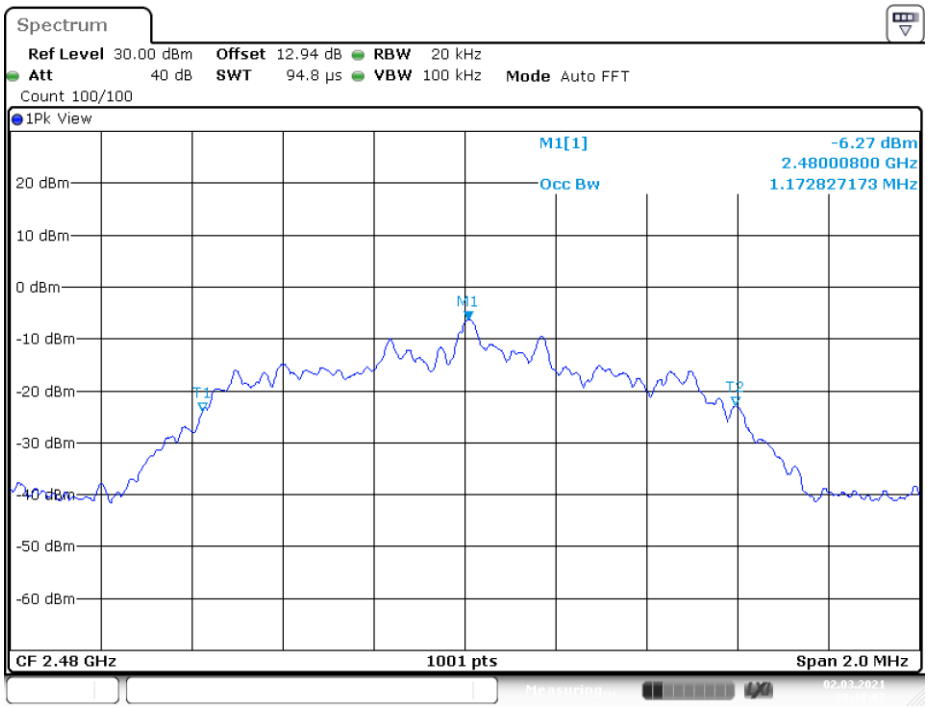
Date: 2.MAR.2021 20:15:38

20dB Emission Bandwidth, High Channel



Date: 2.MAR.2021 21:15:34

99% Occupied Bandwidth, High Channel



Date: 2.MAR.2021 20:18:08

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 Fan Yang on 2021-03-02.

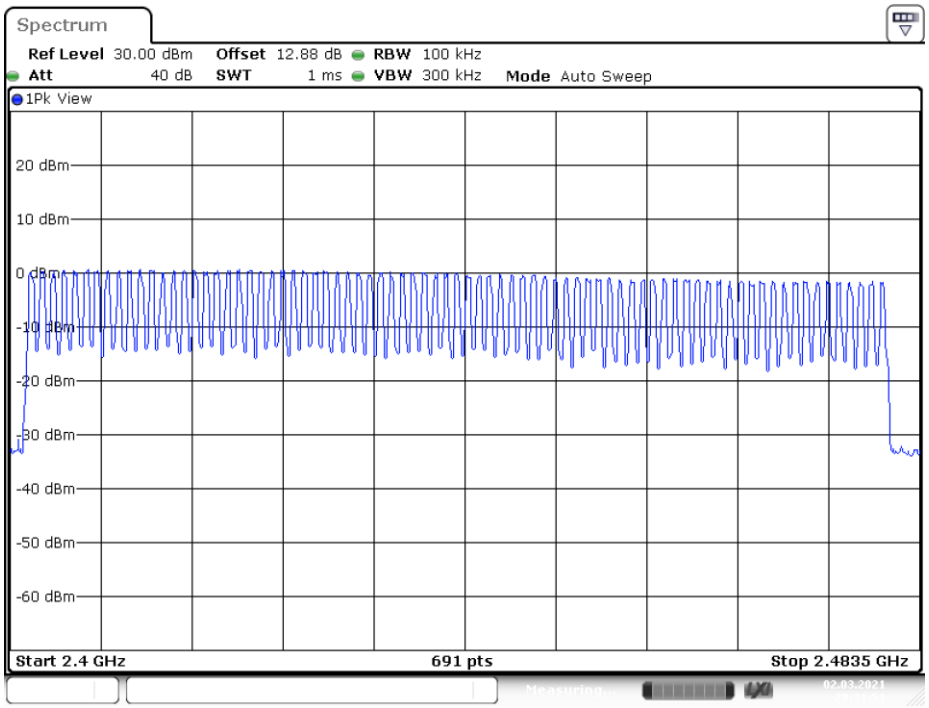
EUT operation mode: Transmitting

Test Result: Pass

Please refer to following table and plots.

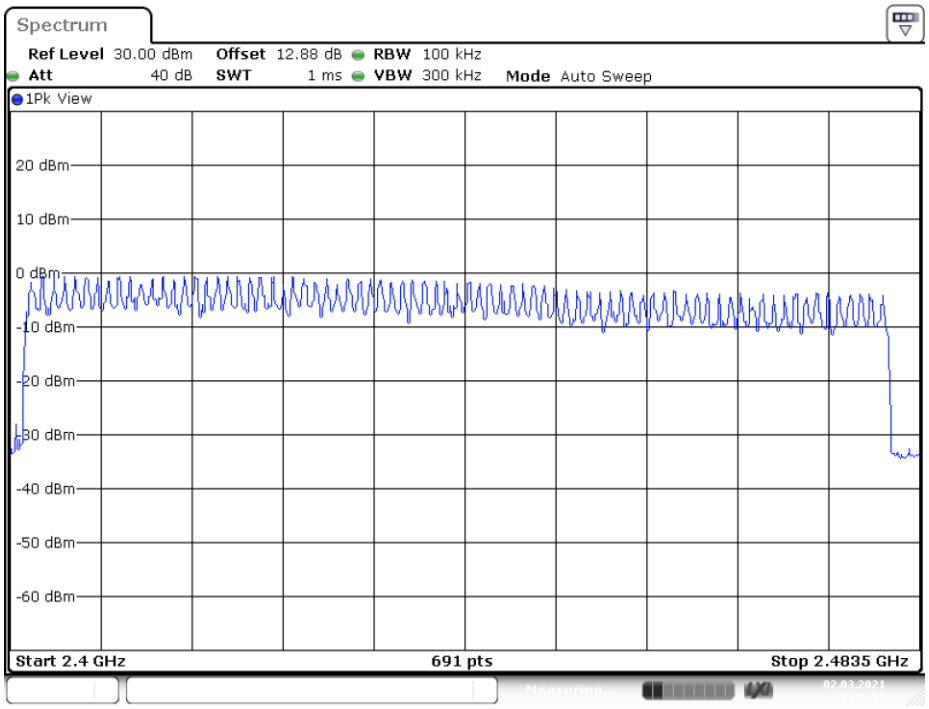
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	⩾15
EDR (π/4-DQPSK)	2400-2483.5	79	⩾15
EDR (8DPSK)	2400-2483.5	79	⩾15

BDR (GFSK): Number of Hopping Channels



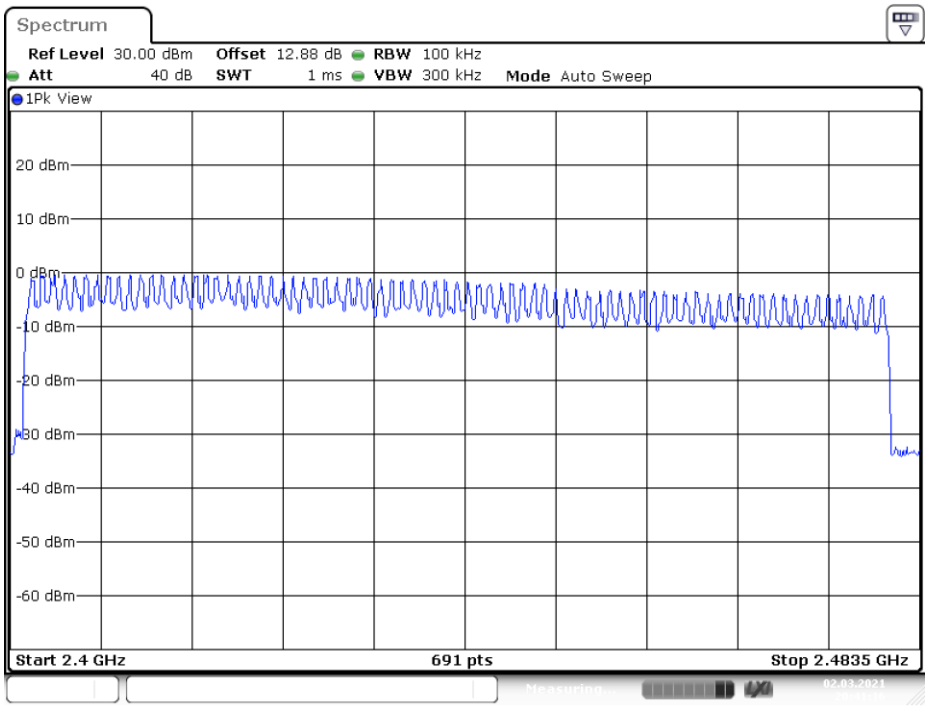
Date: 2.MAR.2021 20:31:52

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



Date: 2.MAR.2021 20:36:05

EDR (8DPSK): Number of Hopping Channels



Date: 2.MAR.2021 20:41:17

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 Fan Yang on 2021-03-02.

EUT operation mode: Transmitting

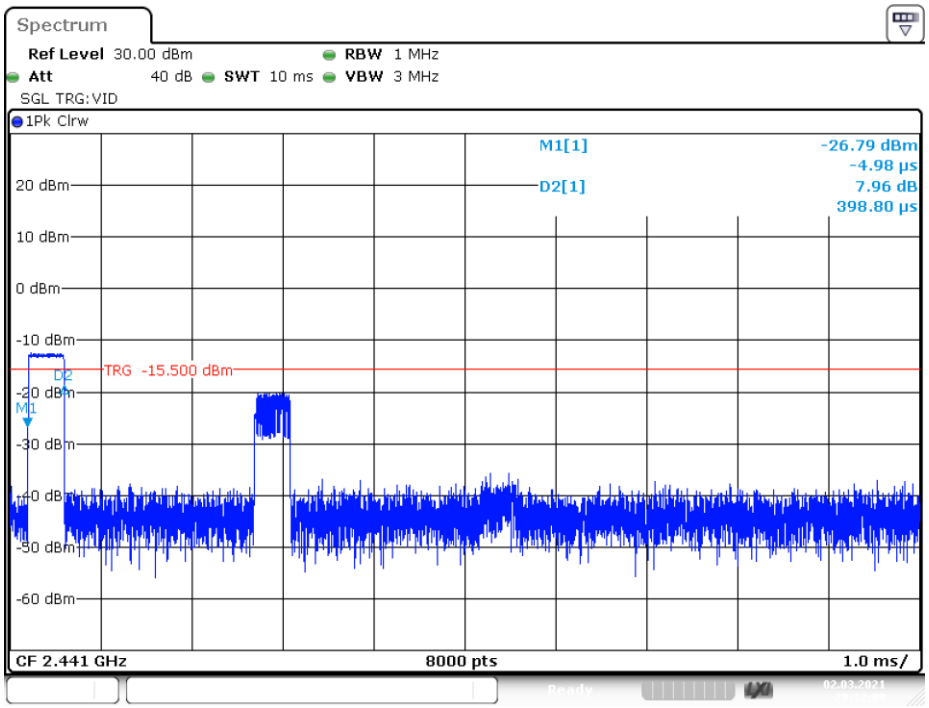
Test Result: Pass

Please refer to following table and plots

Test Mode	Channel	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Hop	0.40	320	0.128	<=0.4	PASS
DH3	Hop	1.65	160	0.264	<=0.4	PASS
DH5	Hop	2.89	110	0.318	<=0.4	PASS
2DH1	Hop	0.42	320	0.134	<=0.4	PASS
2DH3	Hop	1.65	160	0.215	<=0.4	PASS
2DH5	Hop	2.93	110	0.322	<=0.4	PASS
3DH1	Hop	0.41	320	0.131	<=0.4	PASS
3DH3	Hop	1.65	160	0.264	<=0.4	PASS
3DH5	Hop	2.90	110	0.319	<=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



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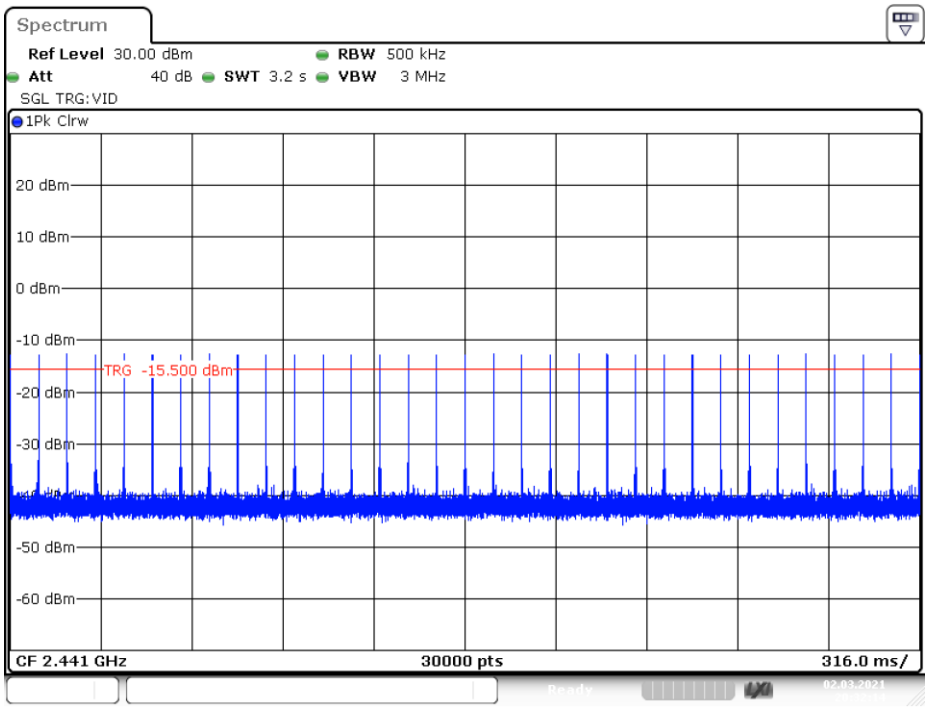
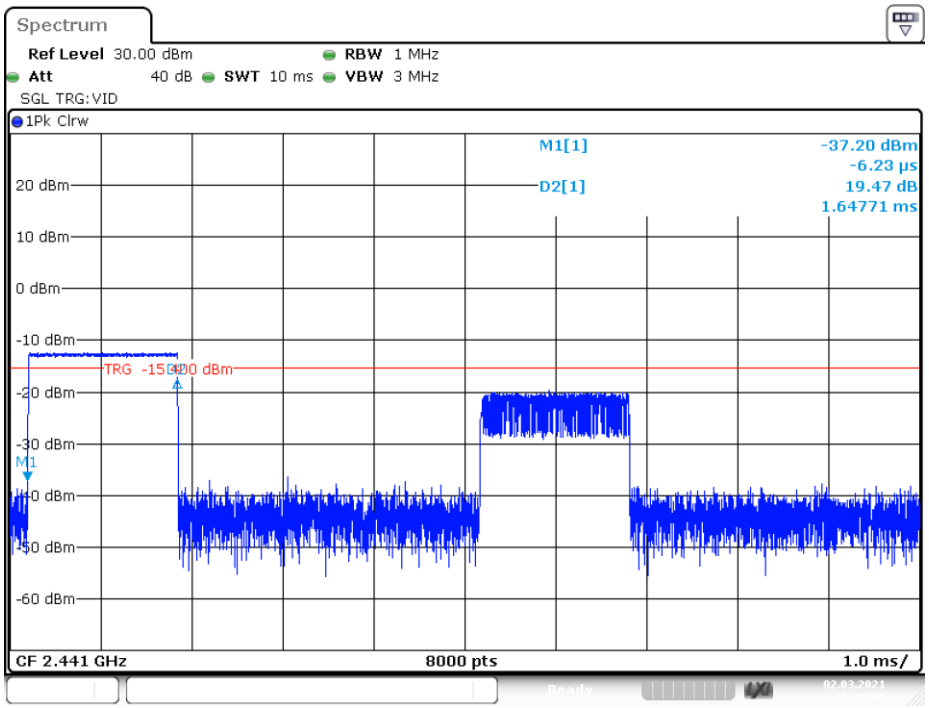


Date: 2.MAR.2021 20:32:15

DH3



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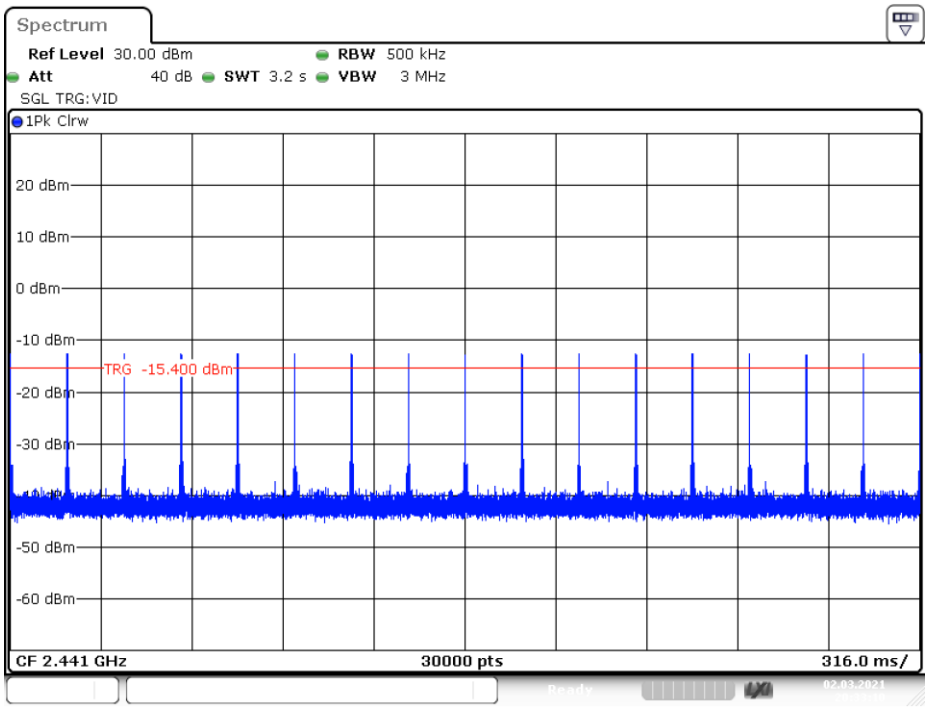
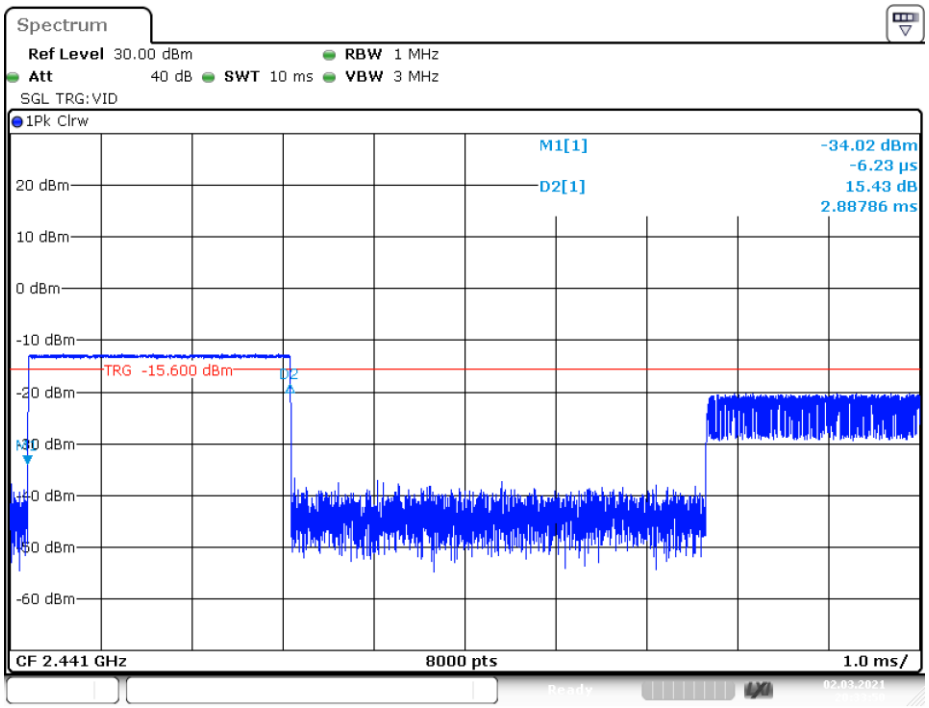
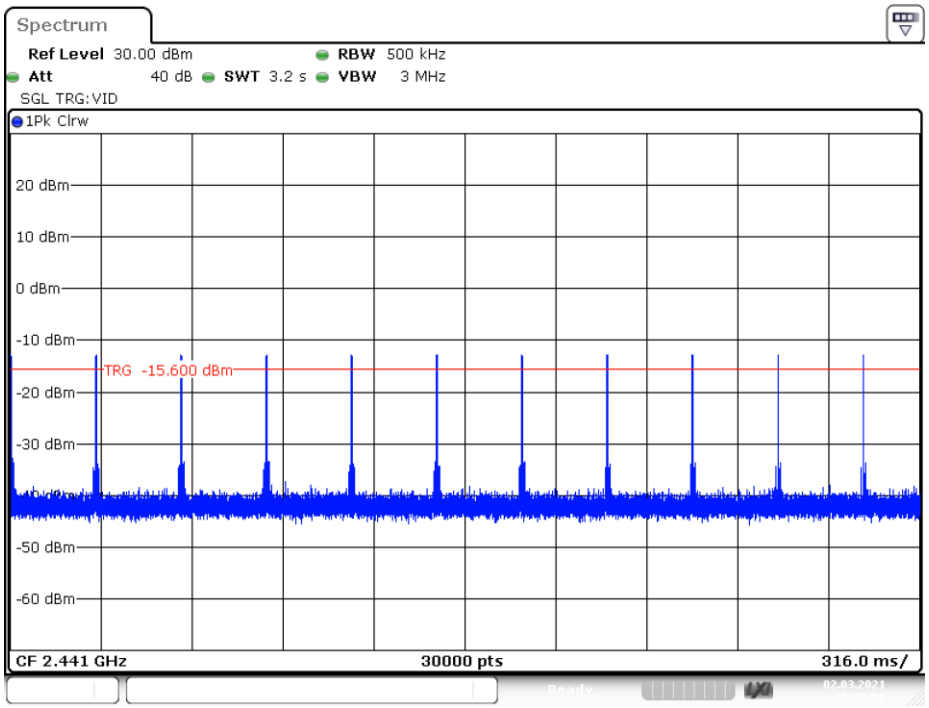


Date: 2.MAR.2021 20:33:11

DH5

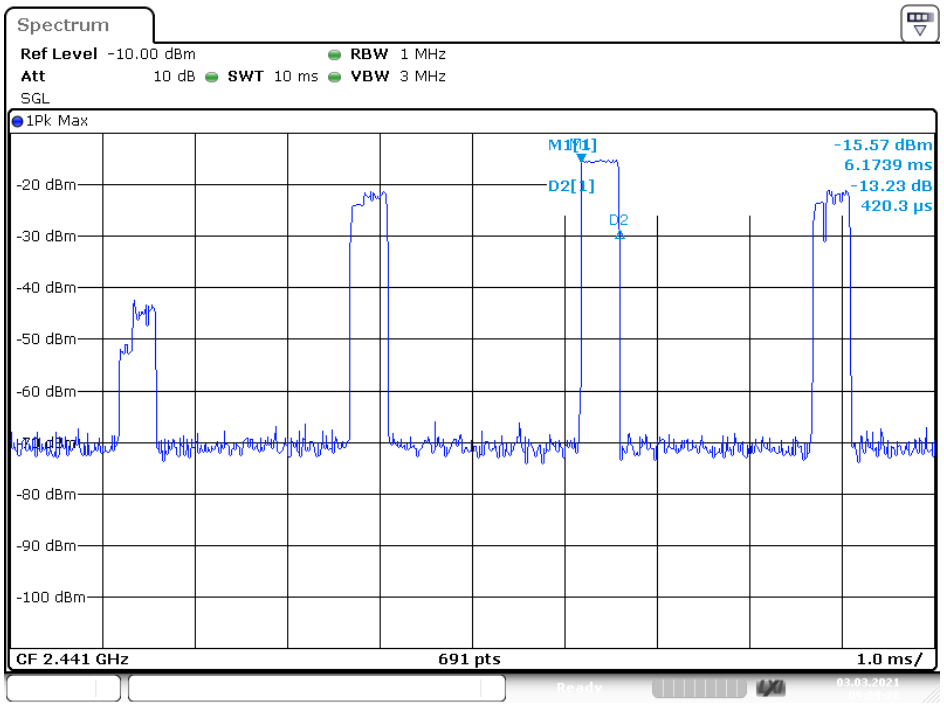


Date: 2.MAR.2021 20:33:51

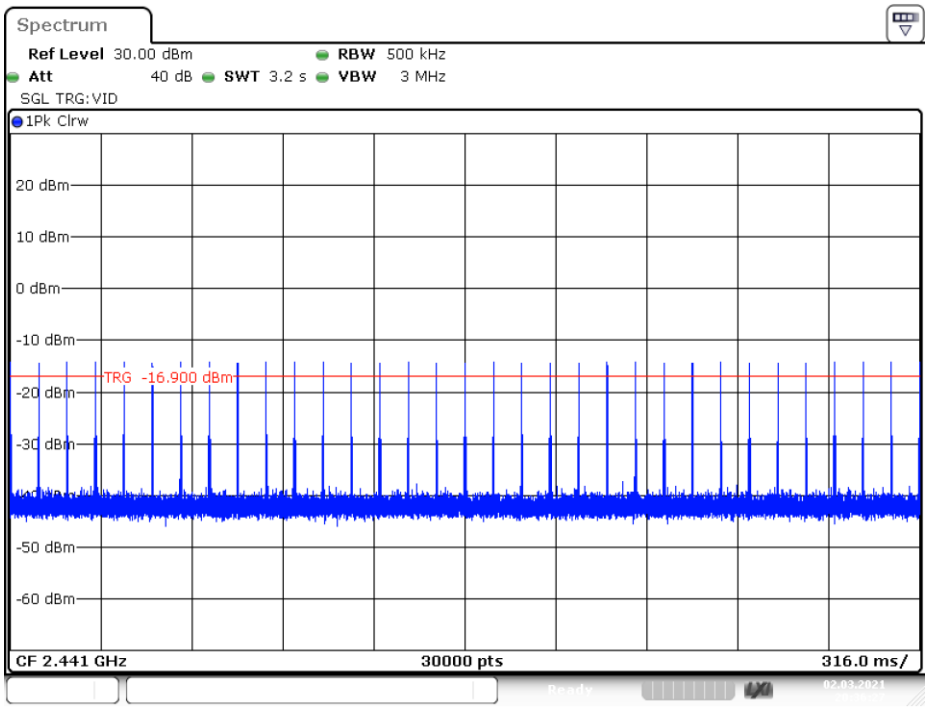


Date: 2.MAR.2021 20:33:57

EDR(π/4-DQPSK):
2DH1

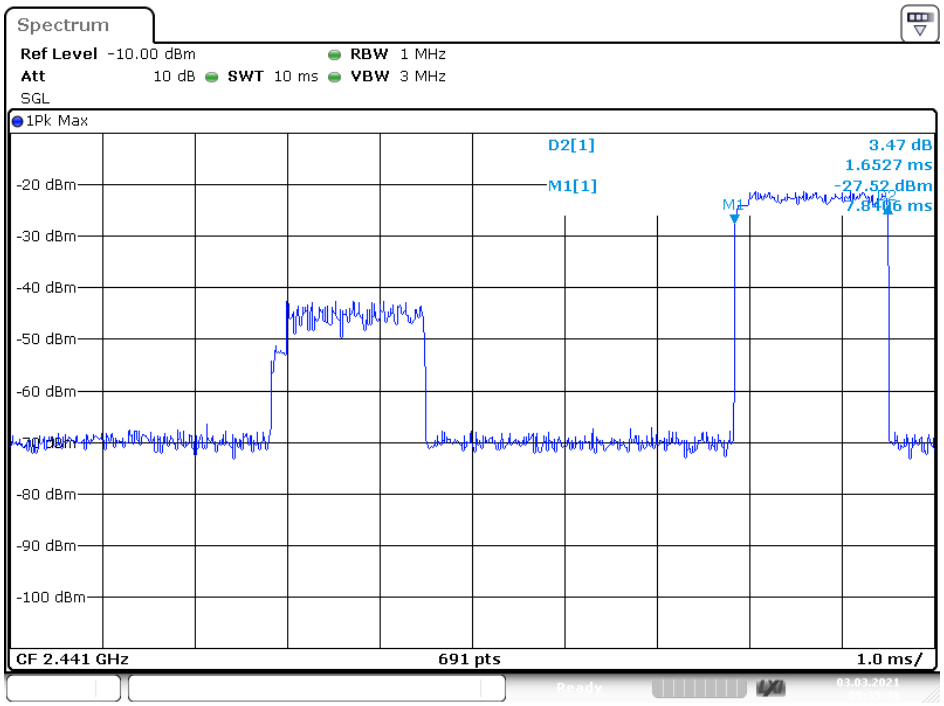


Date: 3.MAR.2021 09:09:29



Date: 2.MAR.2021 20:36:28

2DH3



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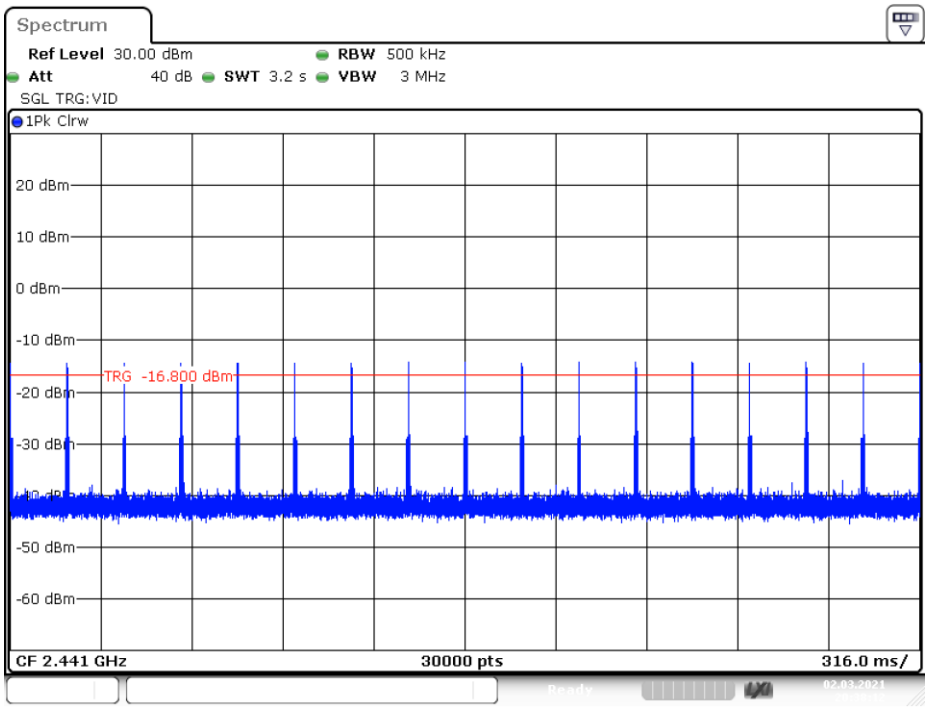
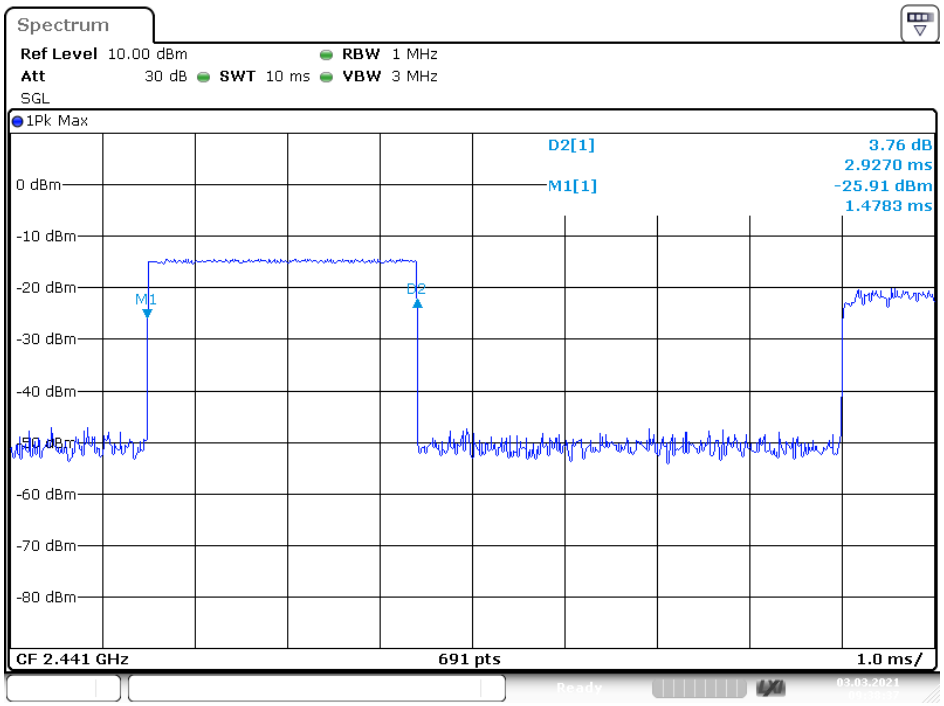
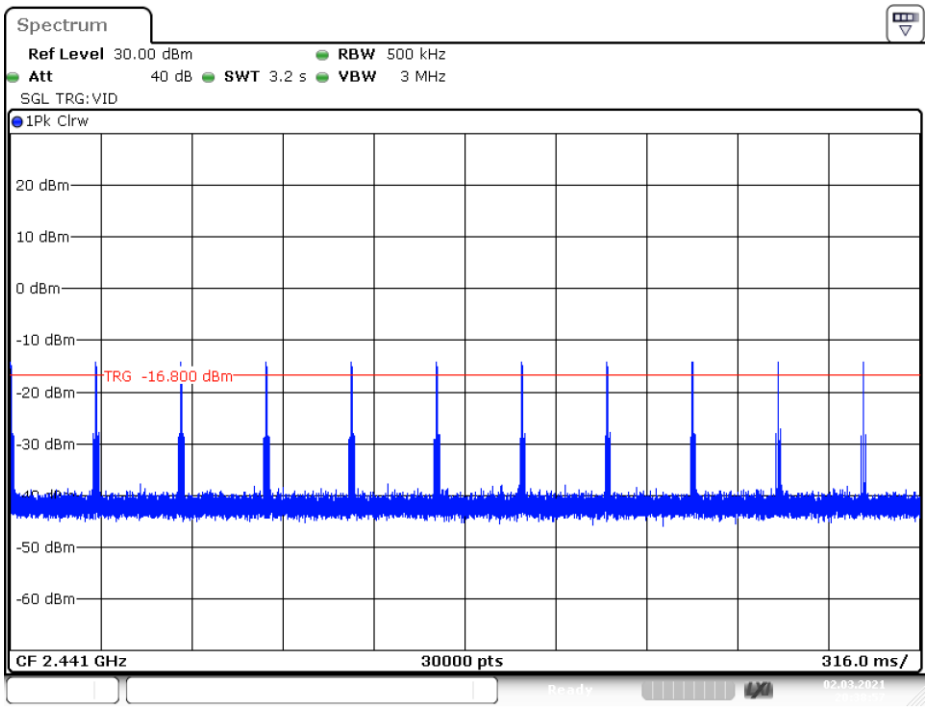


Date: 2.MAR.2021 20:38:13

2DH5

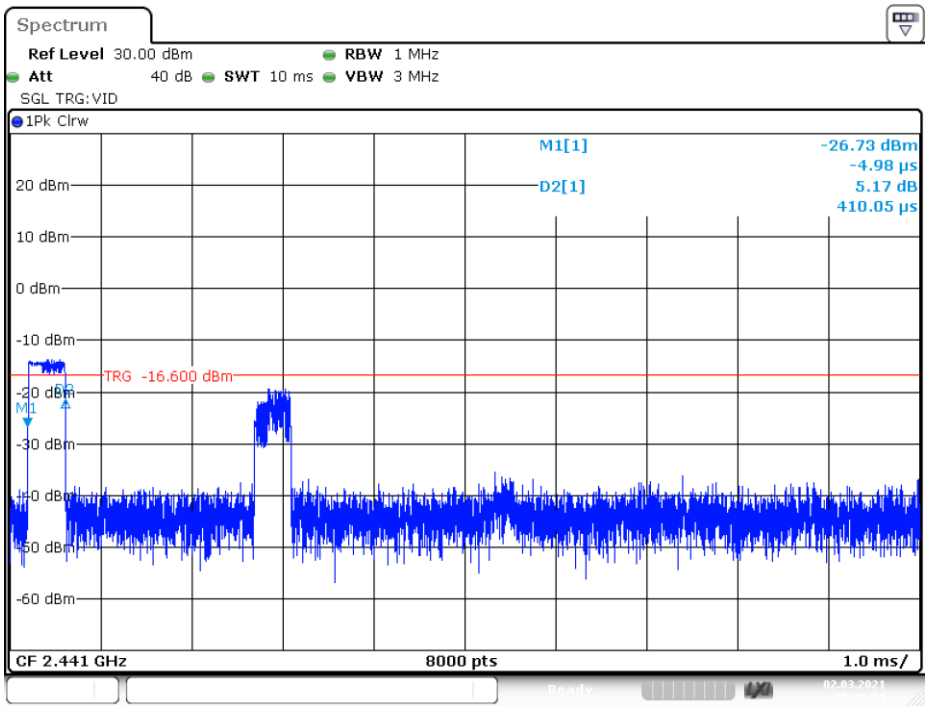


Date: 3.MAR.2021 09:38:37

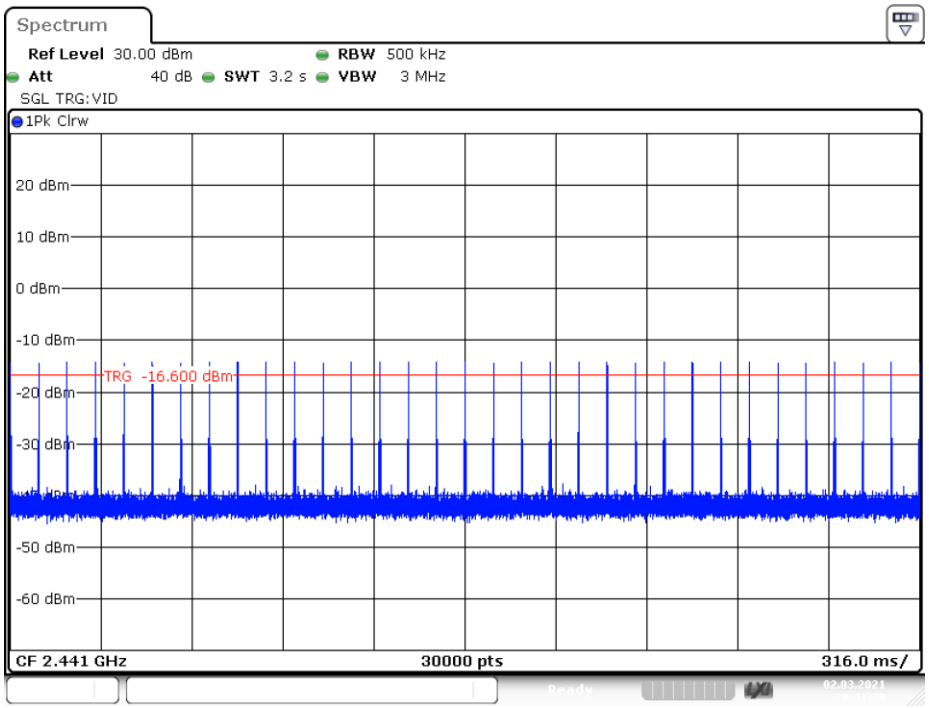


Date: 2.MAR.2021 20:38:58

EDR (8DPSK):
3DH1

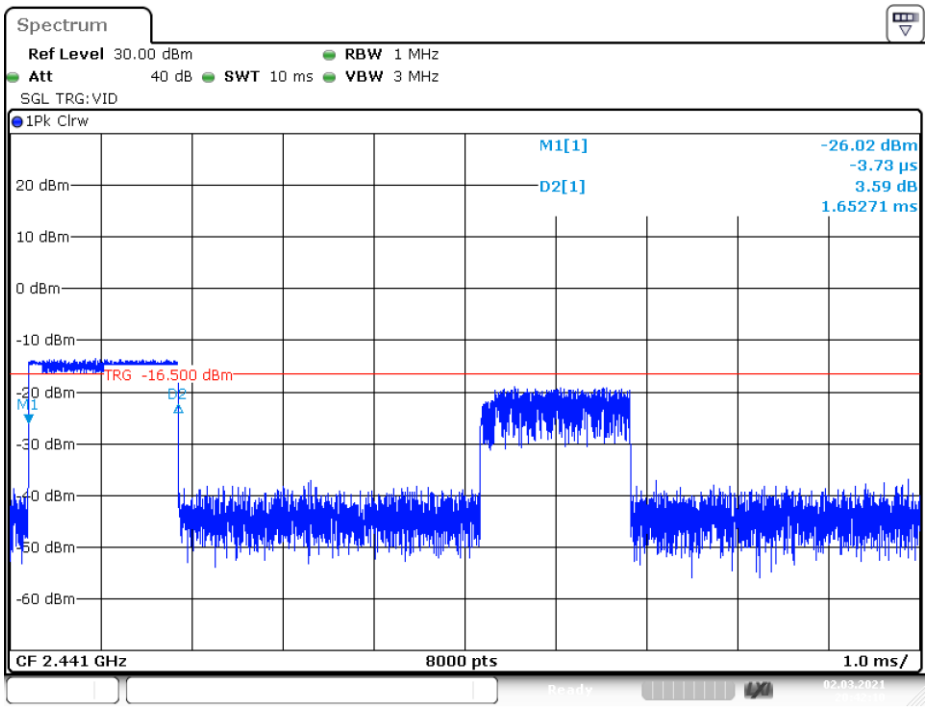


Date: 2.MAR.2021 20:41:35

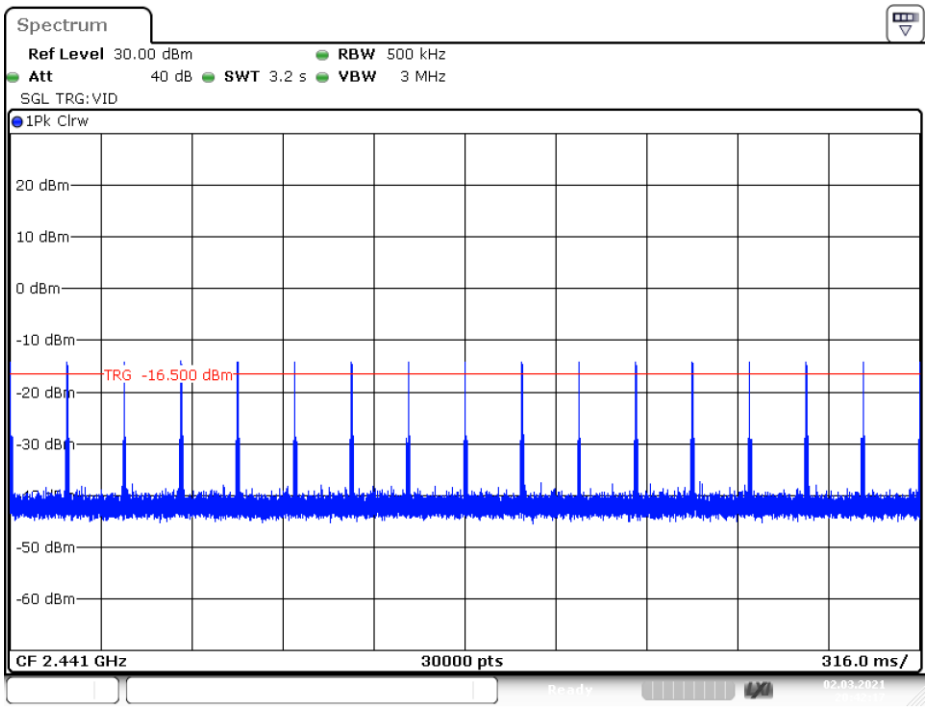


Date: 2.MAR.2021 20:41:40

3DH3



Date: 2.MAR.2021 20:42:11



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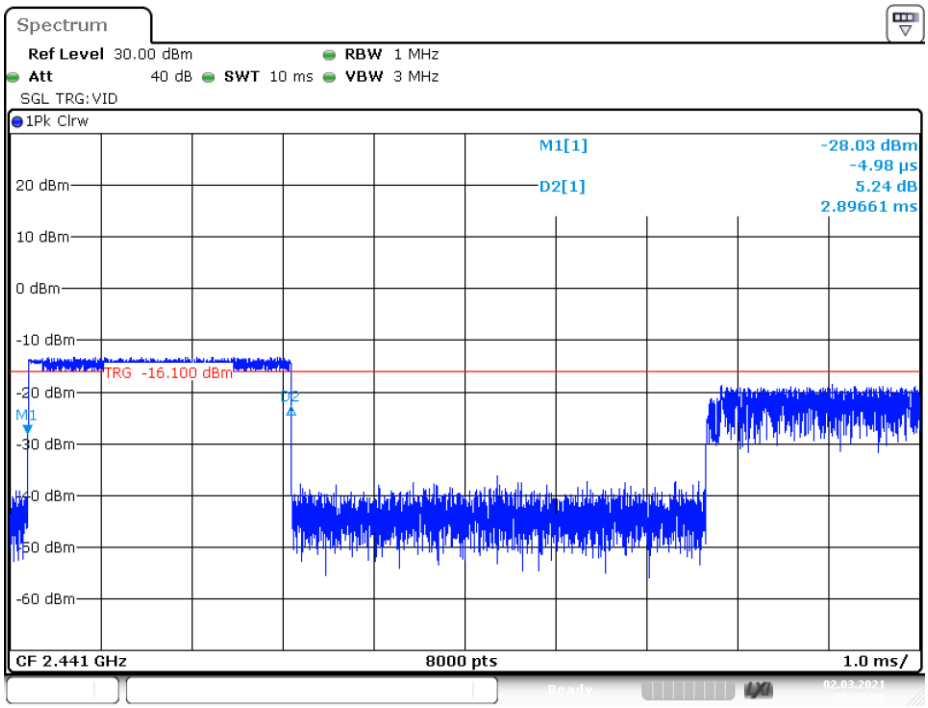
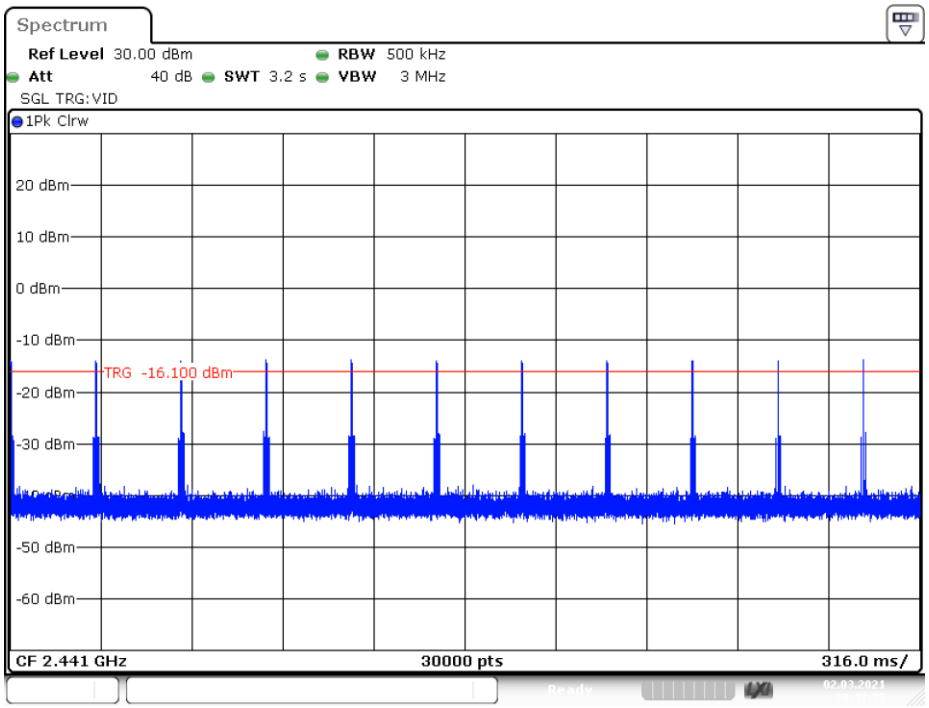
3DH5



Date: 2.MAR.2021 20:43:30



Date: 2.MAR.2021 20:43:36

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.

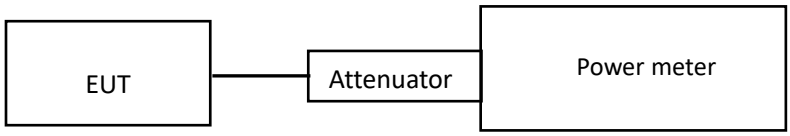
According to RSS-247 § 5.1(b) & § 5.4(b):

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 Fan Yang on 2021-03-02

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	0.62	<=20.97	PASS
	2441	0.42	<=20.97	PASS
	2480	-0.57	<=20.97	PASS
EDR (π/4-DQPSK)	2402	-0.09	<=20.97	PASS
	2441	-0.51	<=20.97	PASS
	2480	-1.86	<=20.97	PASS
EDR (8DPSK)	2402	-0.15	<=20.97	PASS
	2441	-0.67	<=20.97	PASS
	2480	-1.69	<=20.97	PASS

Note 1: The data above was tested in conducted mode.
Note 2: The maximum EIRP is 0.62dBm+0dBi=0.62dBm<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

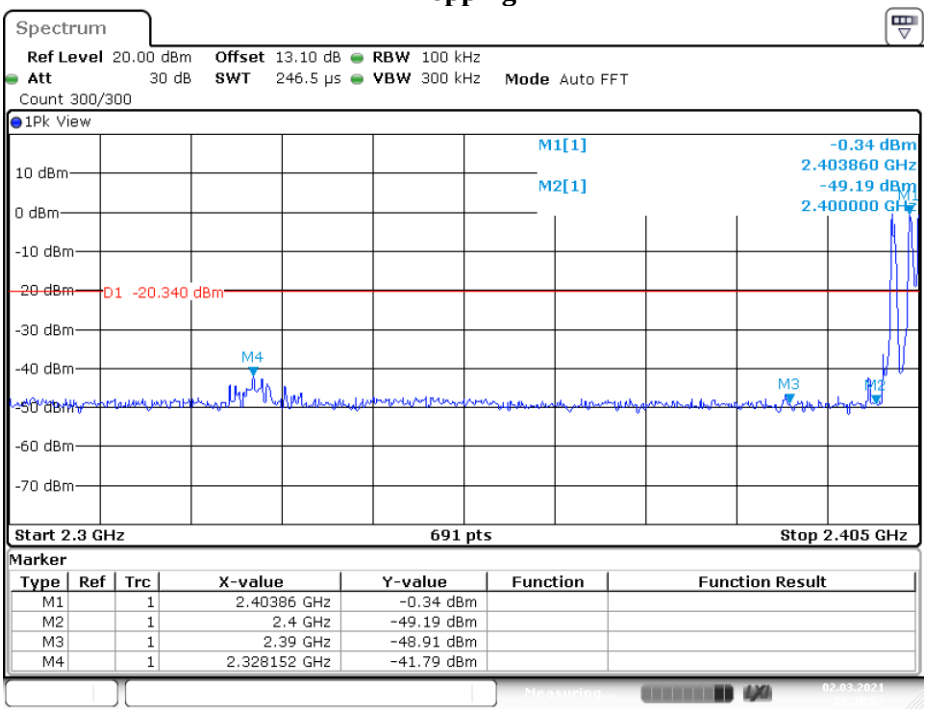
The testing was performed by Fan Yang on 2021-03-02

EUT operation mode: Transmitting

Test Result: Pass

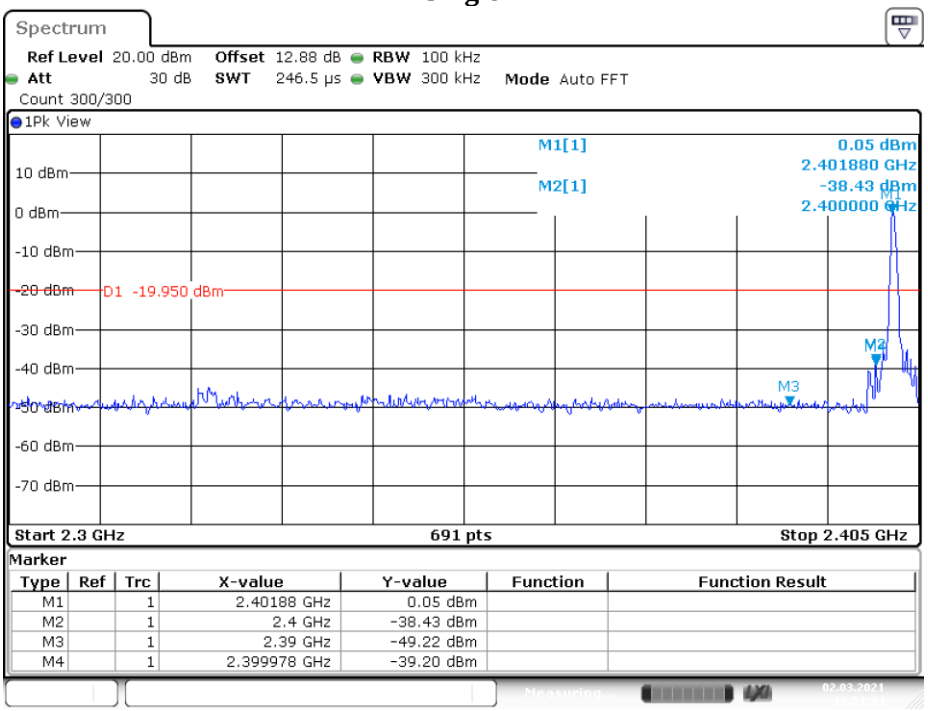
Please refer to following table and plots

BDR (GFSK): Band Edge-Left Side Hopping



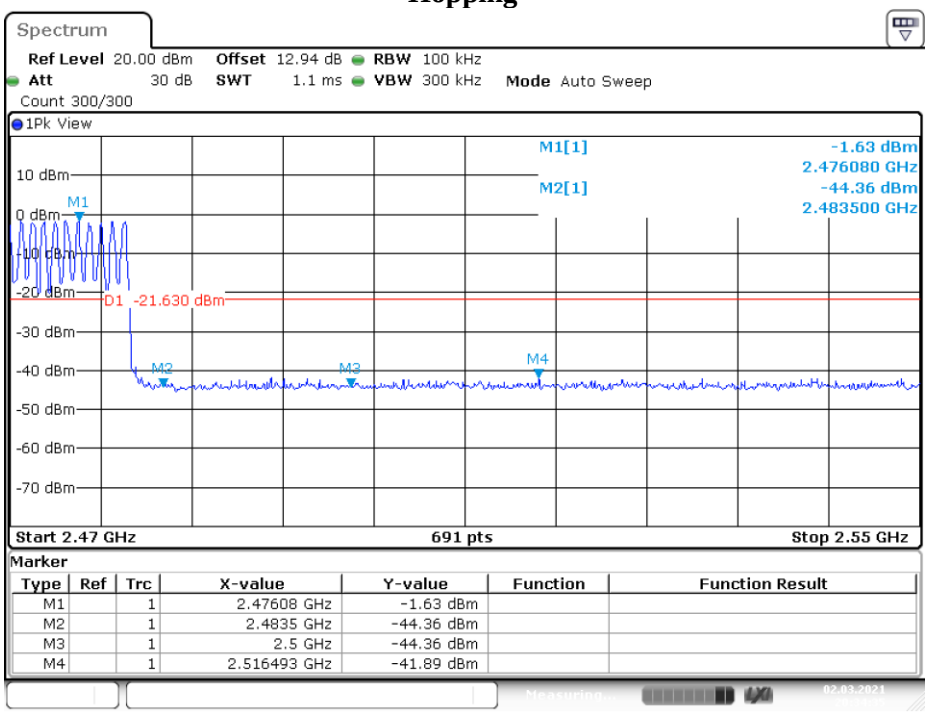
Date: 2.MAR.2021 20:30:58

Single



Date: 2.MAR.2021 19:51:35

BDR (GFSK): Band Edge-Right Side Hopping

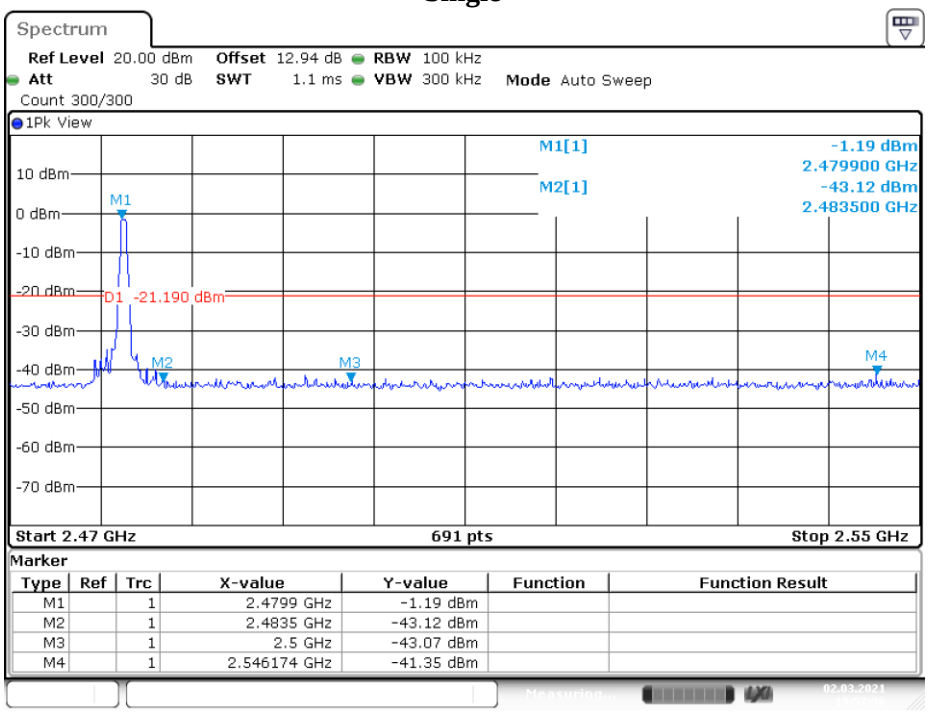


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47608 GHz	-1.63 dBm		
M2		1	2.4835 GHz	-44.36 dBm		
M3		1	2.5 GHz	-44.36 dBm		
M4		1	2.516493 GHz	-41.89 dBm		

Date: 2.MAR.2021 20:34:36

Single



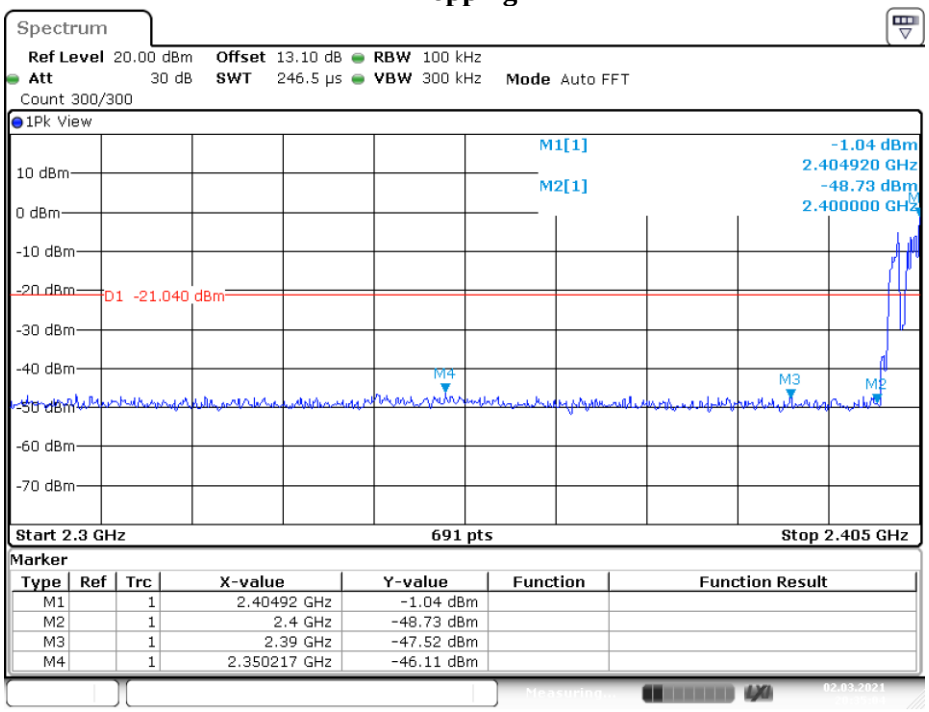
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4799 GHz	-1.19 dBm		
M2		1	2.4835 GHz	-43.12 dBm		
M3		1	2.5 GHz	-43.07 dBm		
M4		1	2.546174 GHz	-41.35 dBm		

Date: 2.MAR.2021 19:57:37

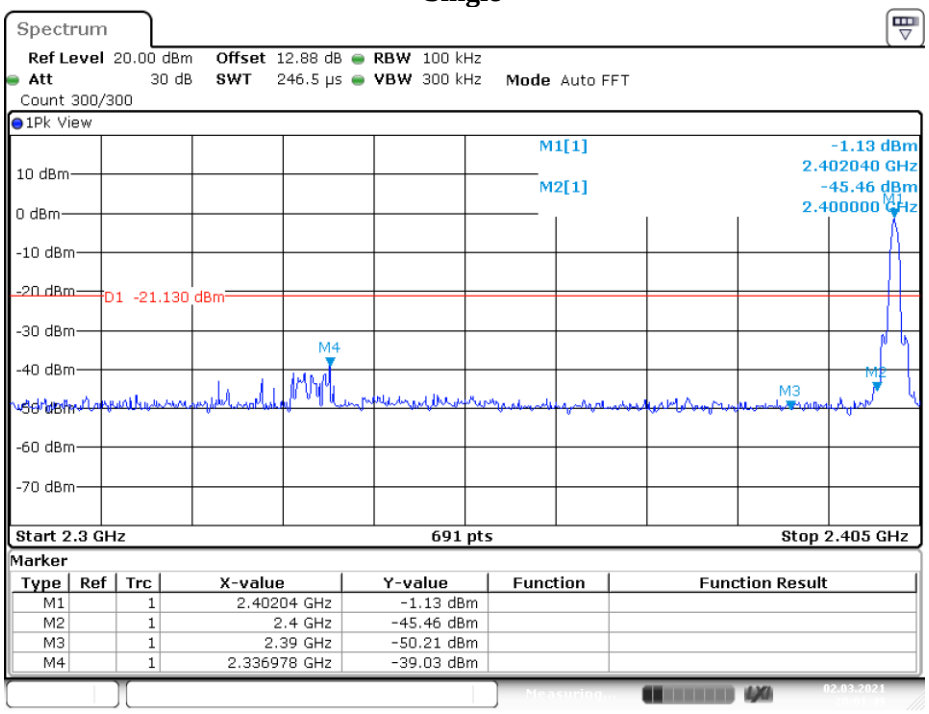
EDR (π/4-DQPSK): Band Edge-Left Side

Hopping



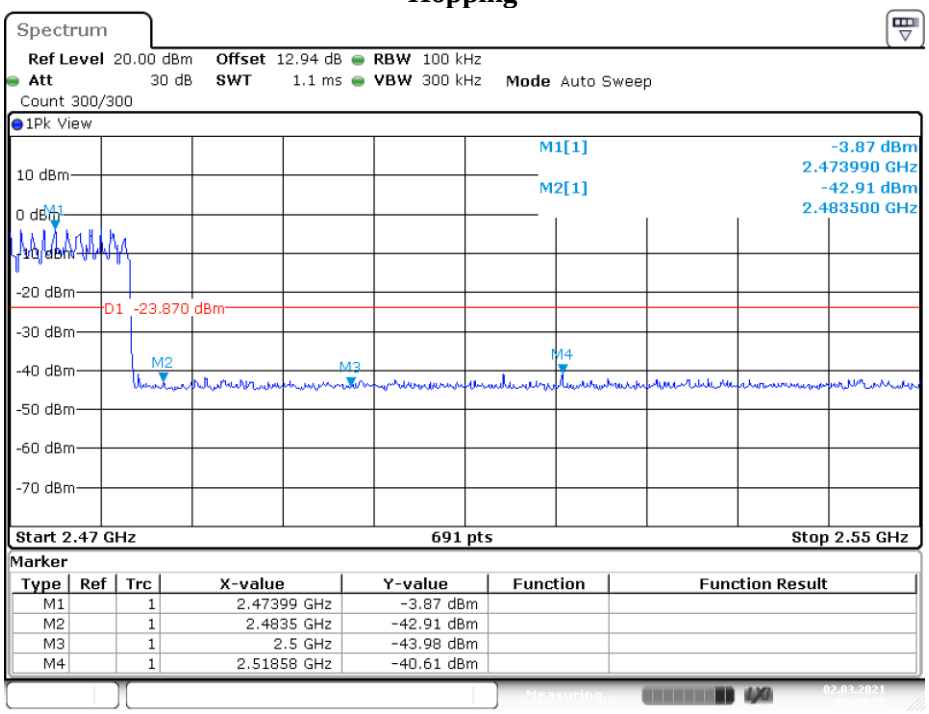
Date: 2.MAR.2021 20:35:05

Single



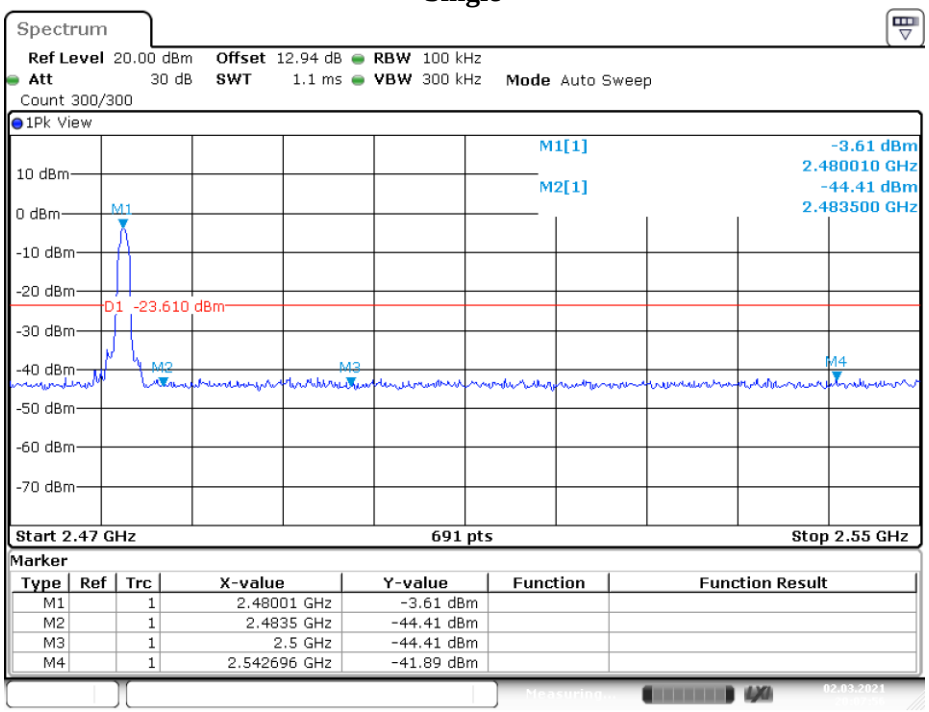
Date: 2.MAR.2021 20:01:49

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



Date: 2.MAR.2021 20:39:28

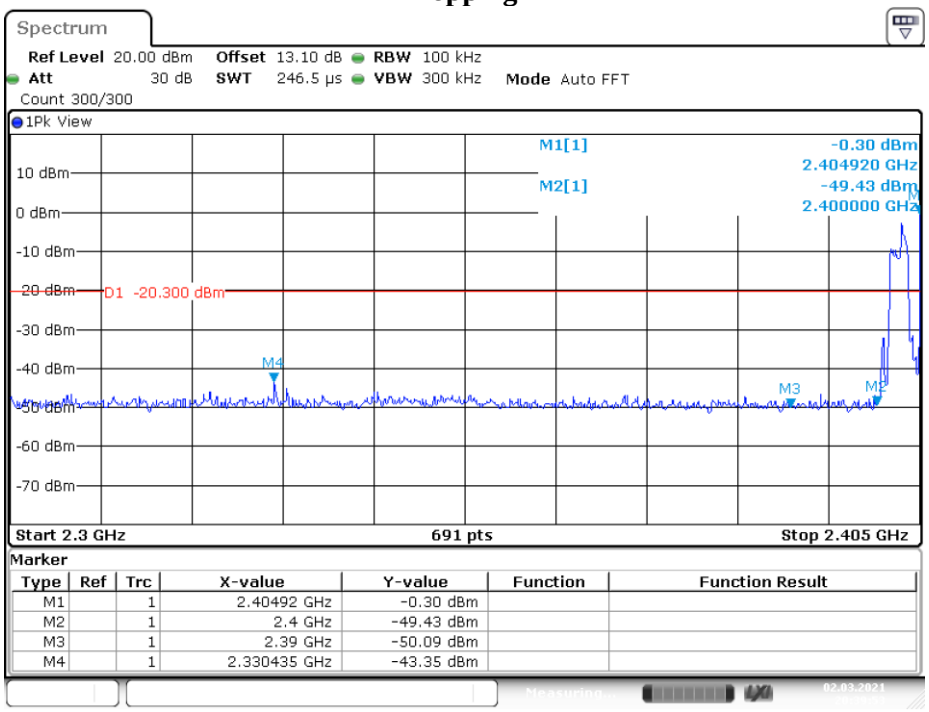
Single



Date: 2.MAR.2021 20:07:57

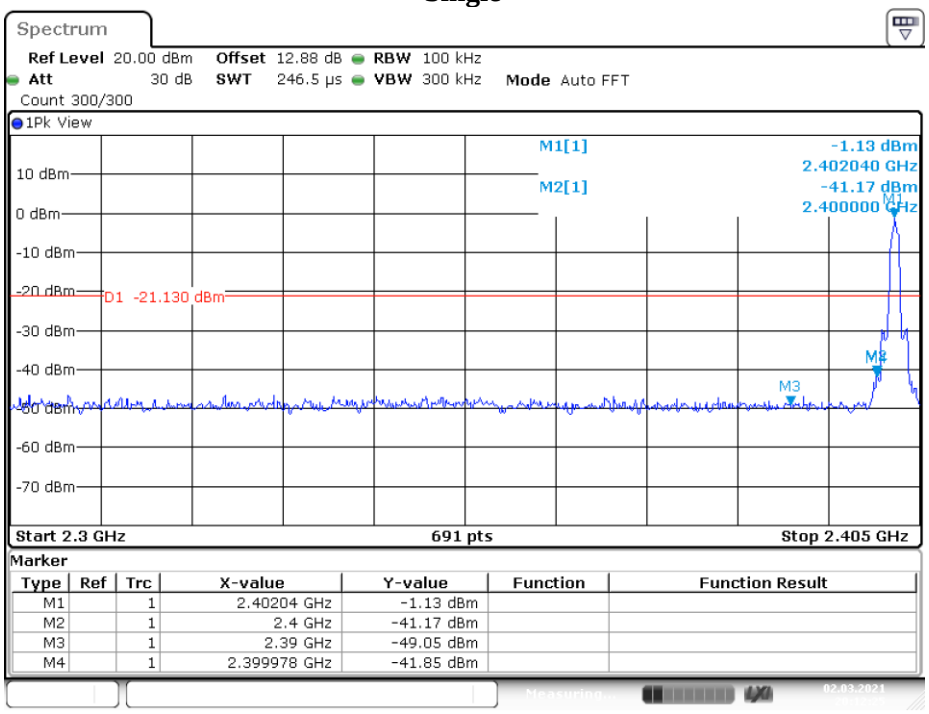
EDR (8DPSK): Band Edge-Left Side

Hopping



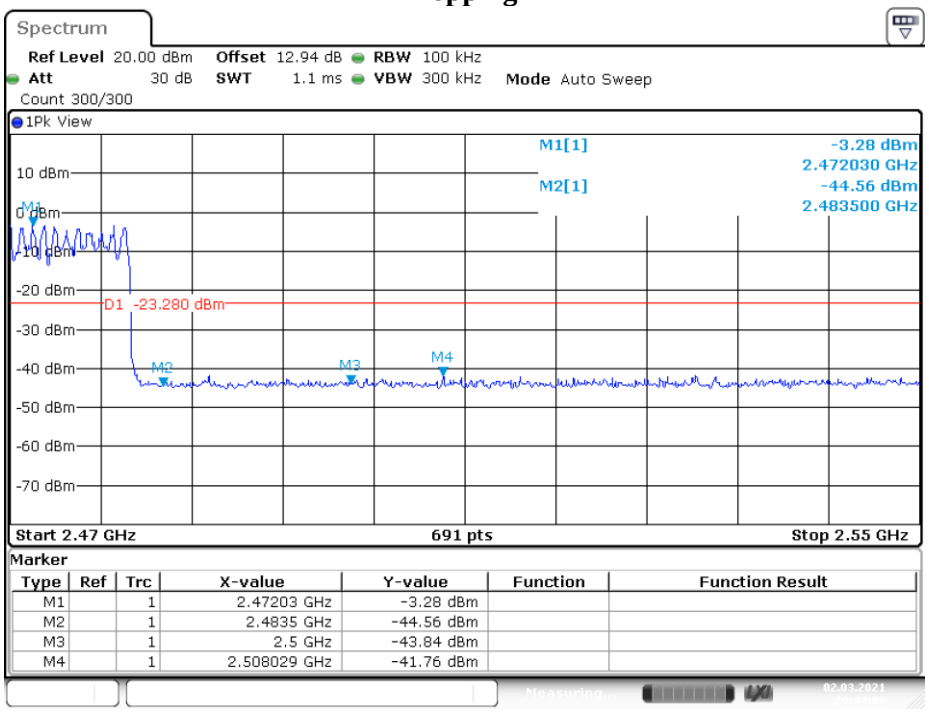
Date: 2.MAR.2021 20:39:54

Single



Date: 2.MAR.2021 20:12:25

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



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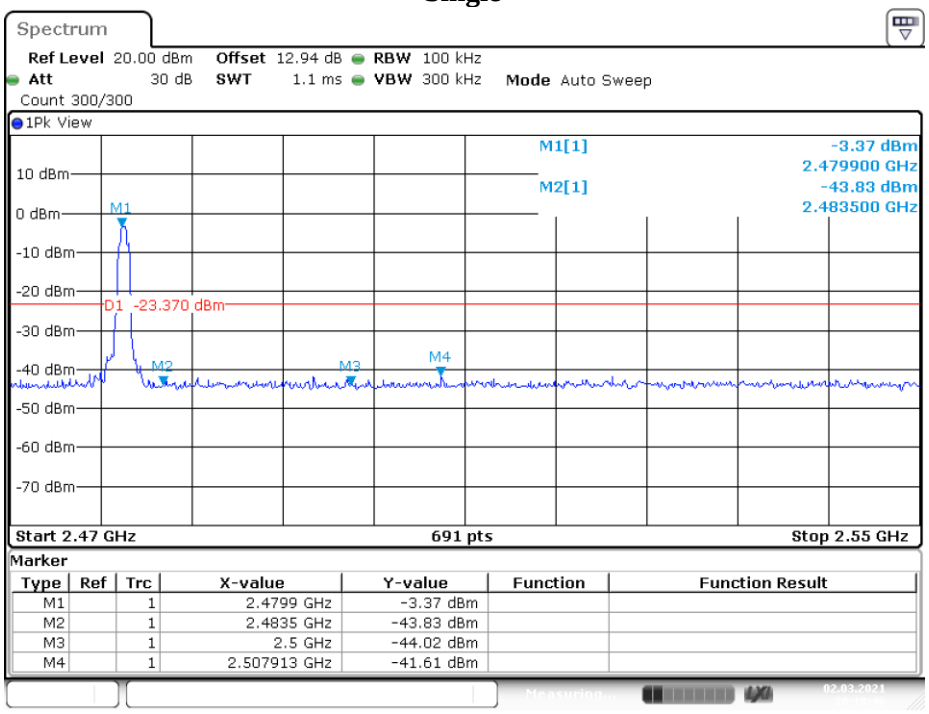
Single



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