TESTING LABORATORY
CERTIFICATE #4820.01

FCC PART 15.247

RSS-GEN, ISSUE 5, FEBRUARY 2021 AMENDMENT 2

RSS-247, ISSUE 2, FEBRUARY 2017

TEST REPORT

For

Shenzhen Yingkeda Technology Co., Ltd.

3rd and 4th floors, 88, Xingwang Road, Sigang,Henggang Street,Longgang District, Shenzhen

FCC ID: 2AYLJ-AIR5X
IC: 26843-AIR5X

Report Type:	**Product Name:**
Original Report	AirBuds

Report Number: RSZ210320001-00A

Report Date: 2021-04-06

Reviewed By: Allen Qiao
RF Supervisor

Test Laboratory: Bay Area Compliance Laboratories Corp. (Dongguan)
No.12, Pulong East 1st Road, Tangxia Town, Dongguan, Guangdong, China
Tel: +86-769-86858888
Fax: +86-769-86858891
www.baclcorp.com.cn

TABLE OF CONTENTS

GENERAL INFORMATION **4**
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) 4
OBJECTIVE 4
TEST METHODOLOGY 4
MEASUREMENT UNCERTAINTY 5
TEST FACILITY 5
DECLARATIONS 5
SYSTEM TEST CONFIGURATION **6**
DESCRIPTION OF TEST CONFIGURATION 6
EUT EXERCISE SOFTWARE 6
EQUIPMENT MODIFICATIONS 6
SUPPORT EQUIPMENT LIST AND DETAILS 6
SUPPORT CABLE LIST AND DETAILS 6
BLOCK DIAGRAM OF TEST SETUP 7
SUMMARY OF TEST RESULTS **8**
FCC §15.247 (i) & §1.1310 & §2.1093- RF Exposure **9**
APPLICABLE STANDARD 9
RSS-102 § 2.5.1 EXEMPTION LIMITS FOR ROUTINE EVALUATION – SAR EVALUATION **10**
APPLICABLE STANDARD 10
FCC §15.203 & RSS-GEN CLAUSE 6.8 - ANTENNA REQUIREMENT **11**
APPLICABLE STANDARD 11
ANTENNA INFORMATION AND CONNECTOR CONSTRUCTION 11
FCC §15.209, §15.205 & §15.247(d) & RSS-247 CLAUSE 5.5,RSS -GEN CLAUSE 8.10- SPURIOUS EMISSIONS **12**
APPLICABLE STANDARD 12
EUT SETUP 12
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP 13
TEST PROCEDURE 13
TEST EQUIPMENT LIST AND DETAILS 13
CORRECTED AMPLITUDE & MARGIN CALCULATION 14
TEST DATA 14
FCC §15.247(a) (1)& RSS-247 CLAUSE 5.1 b) - CHANNEL SEPARATION TEST **20**
APPLICABLE STANDARD 20
TEST EQUIPMENT LIST AND DETAILS 20
TEST PROCEDURE 20
TEST DATA 20
RSS-247 CLUASE 5.1&RSS-GEN CLAUSE 6.7 – 20 dB BANDWIDTH AND 99% OCCUPIED BANDWIDTH TESTING **26**
APPLICABLE STANDARD 26
TEST PROCEDURE 27
TEST EQUIPMENT LIST AND DETAILS 27
TEST DATA 27
FCC §15.247(a) (1) (iii)& RSS-247 CLAUSE 5.1 d) - QUANTITY OF HOPPING CHANNEL TEST **38**
APPLICABLE STANDARD 38
TEST PROCEDURE 38
TEST EQUIPMENT LIST AND DETAILS 38

TEST DATA 38
FCC §15.247(a) (1) (iii)& RSS-247 Clause 5.1 d) - TIME OF OCCUPANCY (DWELL TIME) 41
APPLICABLE STANDARD 41
TEST PROCEDURE 41
TEST EQUIPMENT LIST AND DETAILS.....41
TEST DATA 41
FCC §15.247(b) (1), RSS-247 Clause 5.4 b) - PEAK OUTPUT POWER MEASUREMENT 47
APPLICABLE STANDARD 47
TEST PROCEDURE 47
TEST EQUIPMENT LIST AND DETAILS.....47
TEST DATA 47
FCC §15.247(d) & RSS-247 CLAUSE 5.5- BAND EDGES TESTING.....49
APPLICABLE STANDARD 49
TEST PROCEDURE 49
TEST EQUIPMENT LIST AND DETAILS.....50
TEST DATA 50

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	AirBuds
EUT Model:	AirBuds
Multiple Model:	AirBuds Q, AirBuds 2, AirBuds Pro, AirBuds U, Upods 2, Upods 2 Pro
Models Difference:	Refer to the DOS
Operation Frequency:	2402-2480MHz
Maximum Peak Output Power (Conducted):	3.06 dBm
Modulation Type:	GFSK, π/4-DQPSK, 8DPSK
Antenna Gain▲:	-0.45dBi
Rated Input Voltage:	DC 3.7V from battery
Serial Number:	RSZ210320001-RF-S1
EUT Received Date:	2021.03.24
EUT Received Status:	Good

Objective

This report is prepared on behalf of ***Shenzhen Yingkeda Technology Co., Ltd.***in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules and RSS-247, Issue 2, February 2017, RSS-Gen, Issue 5, February 2021 Amendment 2 of the Innovation, Science and Economic Development Canada.

The tests were performed in order to determine the Bluetooth BDR and EDR mode of EUT compliance with FCC Rules Part 15, Subpart C, and section 15.203, 15.205, 15.209 and 15.247 rules and RSS-247, Issue 2, February 2017, RSS-Gen, Issue 5, February 2021 Amendment 2 of the Innovation, Science and Economic Development Canada.

Test Methodology

All measurements detailed in this test report were performed in accordance with ANSI C63.10-2013 "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices" and KDB 558074 D01 15.247 Meas Guidance v05r02. And RSS-247, Issue 2, February 2017, RSS-Gen, Issue 5, February 2021 Amendment 2 of the Innovation, Science and Economic Development Canada.

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Dongguan).

Measurement Uncertainty

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.61dB
Unwanted Emissions, radiated	30M~200MHz: 4.55 dB,200M~1GHz: 5.92 dB,1G~6GHz: 4.98 dB, 6G~18GHz: 5.89 dB,18G~26.5G:5.47 dB,26.5G~40G:5.63 dB
Unwanted Emissions, conducted	±1.5 dB
Temperature	±1℃
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%
AC Power Lines Conducted Emission	3.12 dB (150 kHz to 30 MHz)

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

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.12, Pulong East 1st Road, Tangxia Town, Dongguan, Guangdong, China

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 897218,the FCC Designation No. : CN1220.

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

Declarations

BACL 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 a triangle symbol "▲". Customer model name, addresses, names, trademarks etc. are not considered data.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

This report cannot be reproduced except in full, without prior written approval of the Company.

This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

This report may contain data that are not covered by the accreditation scope and shall be marked with an asterisk "★".

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in engineering mode, which was provided by manufacturer.

EUT Exercise Software

The software "BQB "was used for testing and the maximum power was configured as below, which was provided by the manufacturer▲:

Mode	Channel	Frequency (MHz)	Power Level Setting
GFSK	Low	2402	1
	Middle	2441	1
	High	2480	1
π/4-DQPSK	Low	2402	1
	Middle	2441	1
	High	2480	1
8DPSK	Low	2402	1
	Middle	2441	1
	High	2480	1

Equipment Modifications

No modification was made to the EUT.

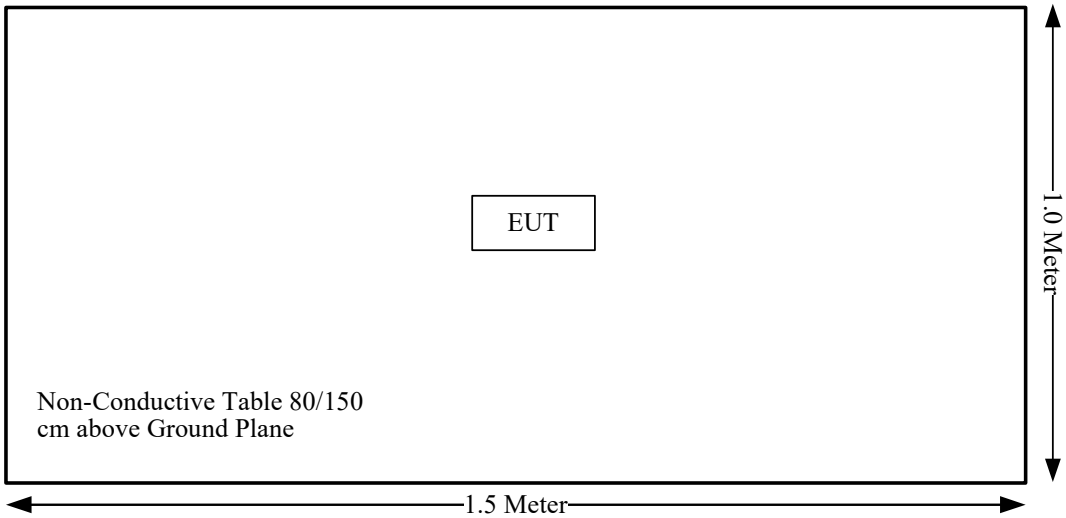
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
/	/	/	/

Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
/	/	/	/	/	/

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
§15.247 (i) & §1.1310 & §2.1093	RF Exposure	Compliance
RSS-102 Clause 2.5.1	Exemption Limits For Routine Evaluation-SAR Evaluation	Compliance
FCC§15.203, RSS-Gen Clause 6.8	Antenna Requirement	Compliance
FCC§15.207 (a), RSS-Gen Clause 8.8	Conducted Emissions	Not Applicant
FCC§15.205, §15.209, FCC §15.247(d), RSS-247 Clause 5.5, RSS-Gen Clause 8.10	Spurious Emissions	Compliance
FCC §15.247 (a)(1), RSS-247 Clause 5.1 b) RSS-Gen Clause 6.7	Emission Bandwidth	Compliance
FCC §15.247(a)(1), RSS-247 Clause 5.1 b)	Channel Separation Test	Compliance
FCC§15.247(a)(1)(iii), RSS-247 Clause 5.1 d)	Time of Occupancy (Dwell Time)	Compliance
FCC§15.247(a)(1)(iii), RSS-247 Clause 5.1 d)	Quantity of hopping channel Test	Compliance
FCC§15.247(b)(1), RSS-247 Clause 5.4 b)	Peak Output Power Measurement	Compliance
FCC§15.247(d) RSS-247 Clause 5.5	Band Edges	Compliance

Note 1: Not Applicant: The device cannot charging when transmitting.
Note 2: The left and right unit have same PCB board and left unit was tested.

FCC §15.247 (i) & §1.1310 & §2.1093- RF Exposure

Applicable Standard

According to§15.247(i) and §1.1310, 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 KDB447498 D01 General RF Exposure Guidance v06:

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

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

Measurement Result

The max conducted power including tune-up tolerance is 3.5 dBm (2.2 mW).
[(max. power of channel, mW)/(min. test separation distance, mm)][√f(GHz)]
=2.2/5*(√2.480) = 0.7< 3.0

Result: Compliance. The stand-alone SAR evaluation is not necessary.

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

Applicable Standard

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. 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.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance[4,5]

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

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

Measurement Result:

The max tune-up conducted power is 3.5 dBm(2.2 mW), Antenna Gain:-0.45 dBi

The exemption power(P) limits for routine evaluation in 2402-2480MHz is:
(2480-2450)/(3500-2450)=(P -4)/(2-4)
=>P=3.94 mW@2480 MHz
> 2.2mW

So the stand-alone SAR evaluation can be exempted.

FCC §15.203 & RSS-GEN CLAUSE 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 RSS-Gen §6.8, 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 Information And Connector Construction

The EUT has one internal antenna arrangement, fulfill the requirement of this section. Please refer to below information and the EUT photos:

Antenna Type	input impedance (Ohm)	Antenna Gain /Frequency Range
FPC	50	-0.45 dBi/2.4~2.5GHz

Result: Compliance.

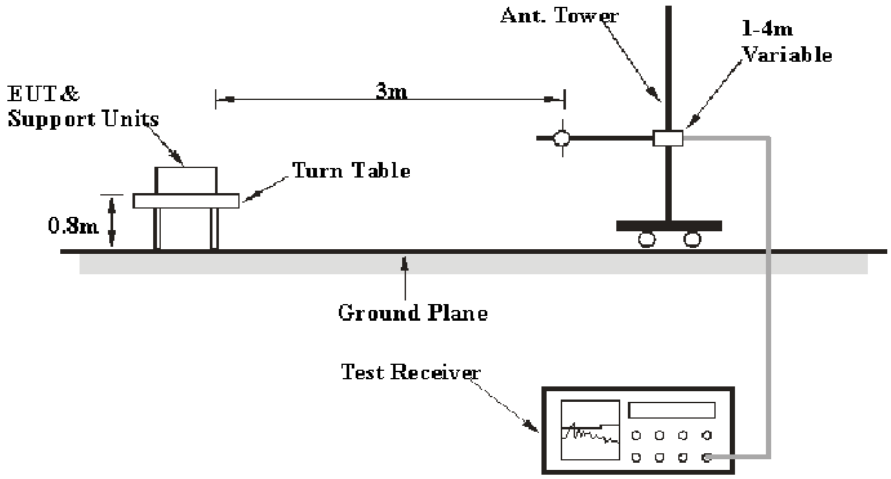
FCC §15.209, §15.205 & §15.247(d) & RSS-247 CLAUSE 5.5,RSS -GEN CLAUSE 8.10- SPURIOUS EMISSIONS

Applicable Standard

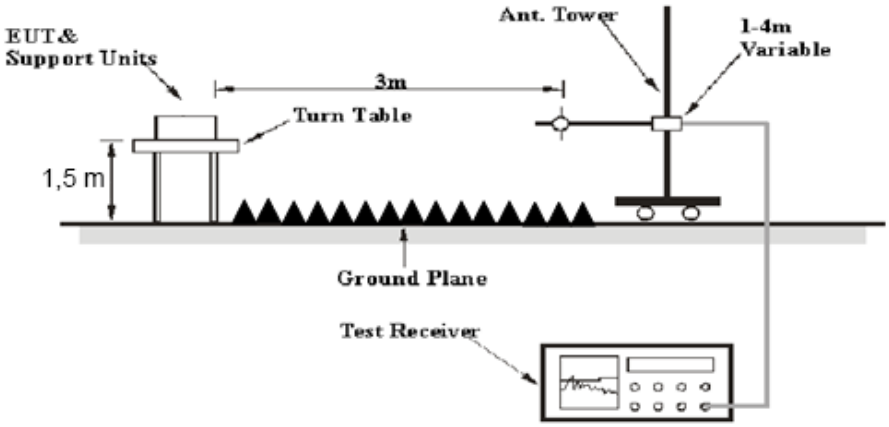
FCC §15.247 (d); §15.209; §15.205; RSS-247 Clause 5.5, RSS-GEN Clause 8.10

EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emission below 1GHz tests were performed in the 3 meters chamber test site A, above 1GHz tests were performed in the 3 meters chamber test site B, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 and the RSS-247 Clause 5.5, RSS-GEN Clause 8.10 limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

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

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

Test Procedure

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

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz - 1 GHz, peak and average detection modes for frequencies above 1 GHz.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiation Below 1GHz					
Sunol Sciences	Antenna	JB3	A060611-1	2020-11-10	2023-11-10
R&S	EMI Test Receiver	ESR3	102453	2020-09-12	2021-09-12
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-01	2020-09-05	2021-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-01	2020-09-05	2021-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-1400-01	2020-05-06	2021-05-06
HP	Amplifier	8447D	2727A05902	2020-09-05	2021-09-05
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Radiation Above 1GHz					
ETS-Lindgren	Horn Antenna	3115	000 527 35	2018-10-12	2021-10-12
Ducommun Technolagies	Horn Antenna	ARH-4223-02	1007726-01 1304	2020-12-05	2023-12-04
Agilent	Spectrum Analyzer	E4440A	SG43360054	2020-07-07	2021-07-07
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2020-09-05	2021-09-05
Unknown	Coaxial Cable	C-2.4J2.4J-50	C-0700-02	2020-06-27	2021-06-27
Mini-Circuit	Amplifier	ZVA-213-S+	54201245	2020-09-05	2021-09-05
Quinstar	Amplifier	QLW-18405536-JO	15964001001	2020-06-27	2021-06-27
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
E-Microwave	Band-stop Filters	OBSF-2400-2483.5-S	OE01601525	2020-06-16	2021-06-16
Mini Circuits	High Pass Filter	VHF-6010+	31118	2020-06-16	2021-06-16

**** Statement of Traceability:*** *Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

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

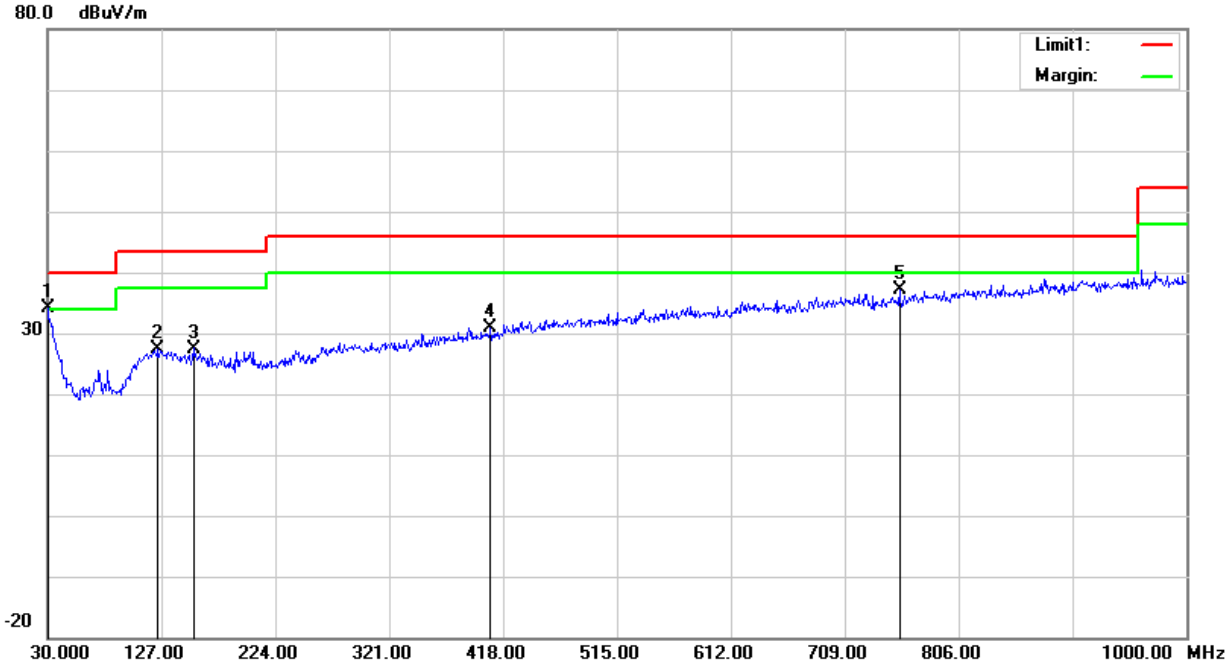
Test Items	Radiation Below 1GHz	Radiation Above 1GHz
Temperature:	22.7°C	27.8°C
Relative Humidity:	65%	56%
ATM Pressure:	100.6 kPa	100.8 kPa
Tester:	Lee Li	Lee Li
Test Date:	2021-03-31	2021-04-01

Test Mode: Transmitting

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

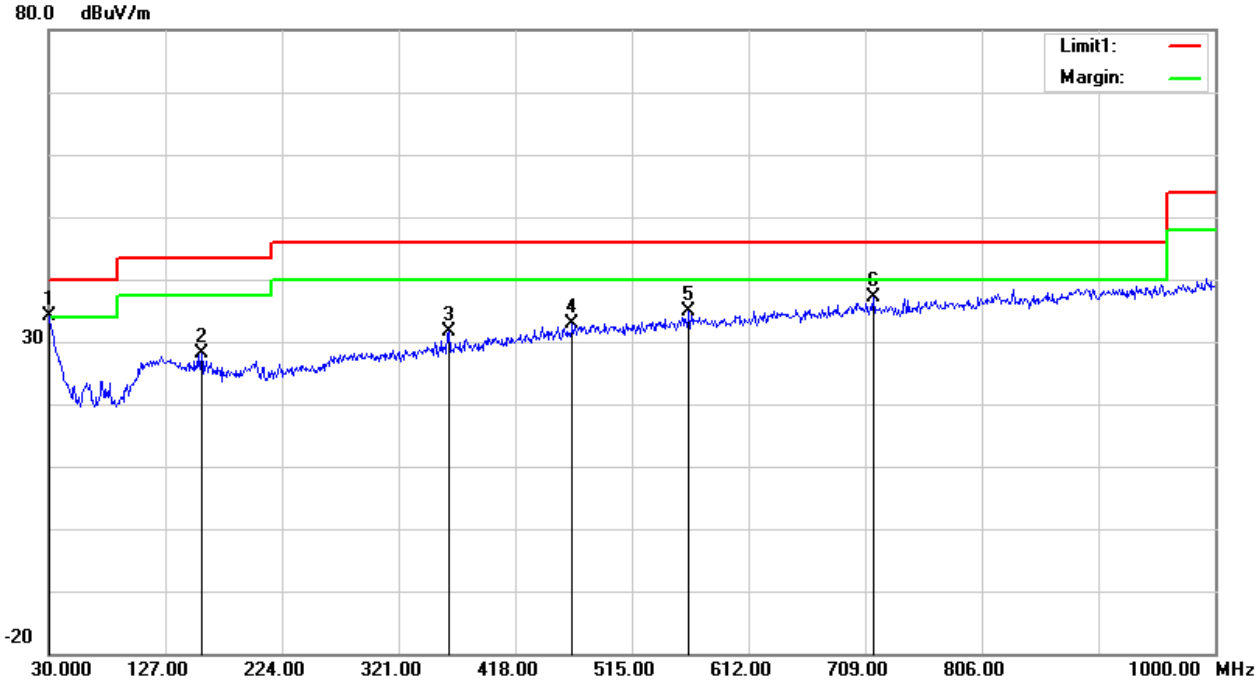
1) 30MHz-1GHz (GFSK high channel was the worst)

Horizontal:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	32.68	peak	1.46	34.14	40.00	5.86
124.0900	32.16	peak	-4.75	27.41	43.50	16.09
154.1600	33.61	peak	-6.11	27.50	43.50	16.00
407.3300	32.93	peak	-1.97	30.96	46.00	15.04
755.5600	33.68	peak	3.35	37.03	46.00	8.97

Vertical:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	32.56	peak	1.46	34.02	40.00	5.98
157.0700	34.08	peak	-5.96	28.12	43.50	15.38
362.7100	34.50	peak	-2.75	31.75	46.00	14.25
465.5300	33.52	peak	-0.60	32.92	46.00	13.08
562.5300	34.39	peak	0.49	34.88	46.00	11.12
715.7900	34.40	peak	2.74	37.14	46.00	8.86

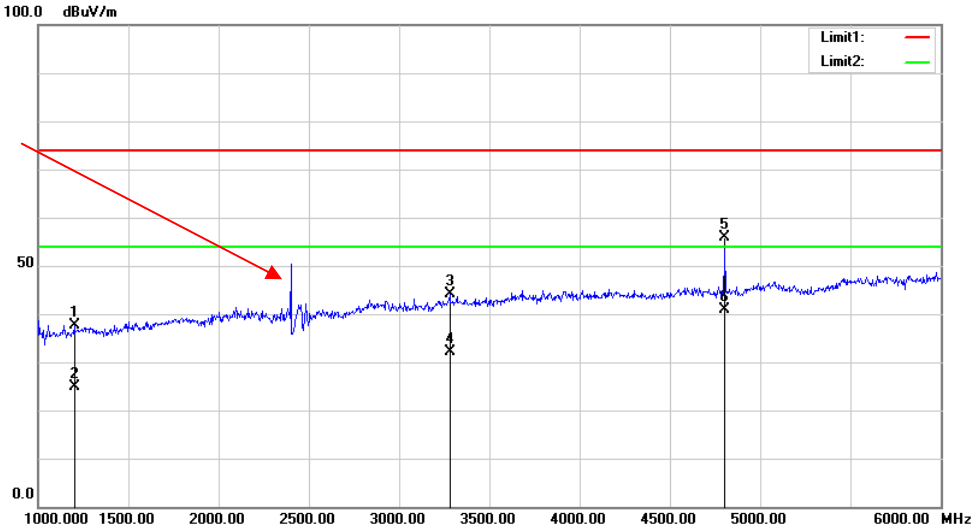
2) 1GHz-25GHz:

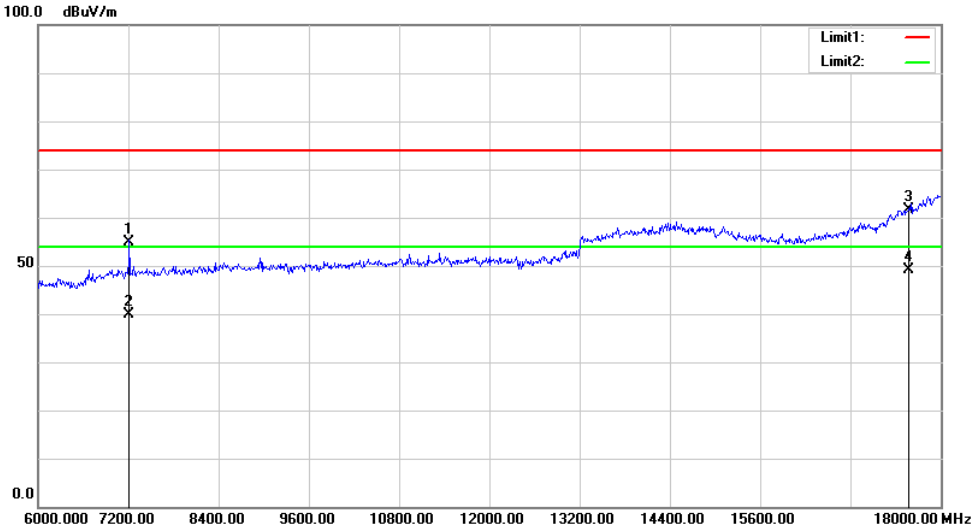
BDR Mode (GFSK was the worst case):

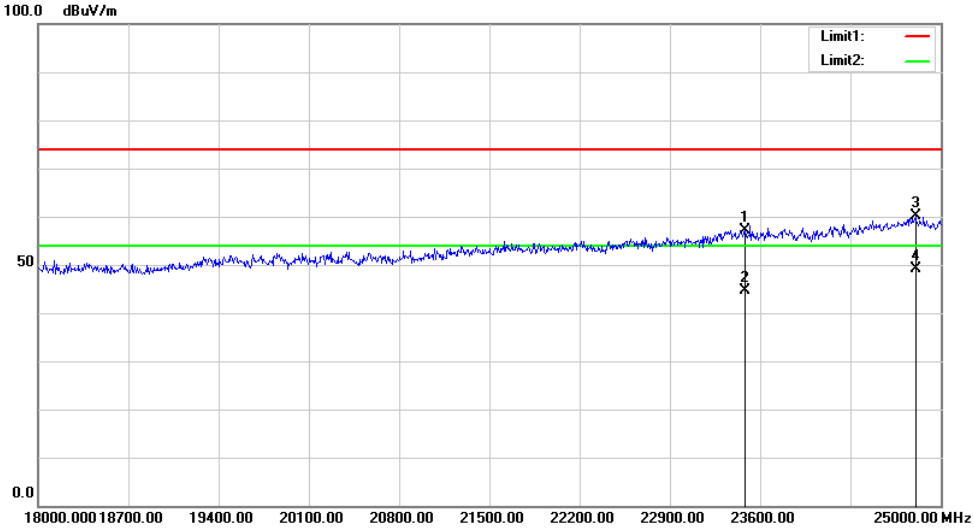
Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2402.00	64.95	PK	H	28.10	1.80	0.00	94.85	N/A	N/A
2402.00	48.26	AV	H	28.10	1.80	0.00	78.16	N/A	N/A
2402.00	61.26	PK	V	28.10	1.80	0.00	91.16	N/A	N/A
2402.00	45.98	AV	V	28.10	1.80	0.00	75.88	N/A	N/A
2390.00	26.13	PK	H	28.08	1.80	0.00	56.01	74.00	17.99
2390.00	13.45	AV	H	28.08	1.80	0.00	43.33	54.00	10.67
4804.00	45.52	PK	H	32.91	3.17	25.60	56.00	74.00	18.00
4804.00	30.50	AV	H	32.91	3.17	25.60	40.98	54.00	13.02
7206.00	39.92	PK	H	35.74	4.82	25.60	54.88	74.00	19.12
7206.00	24.98	AV	H	35.74	4.82	25.60	39.94	54.00	14.06
Middle Channel: 2441 MHz									
2441.00	62.35	PK	H	28.18	1.82	0.00	92.35	N/A	N/A
2441.00	45.61	AV	H	28.18	1.82	0.00	75.61	N/A	N/A
2441.00	58.61	PK	V	28.18	1.82	0.00	88.61	N/A	N/A
2441.00	43.33	AV	V	28.18	1.82	0.00	73.33	N/A	N/A
4882.00	41.52	PK	H	33.06	3.27	25.66	52.19	74.00	21.81
4882.00	26.50	AV	H	33.06	3.27	25.66	37.17	54.00	16.83
7323.00	37.25	PK	H	36.04	4.62	25.73	52.18	74.00	21.82
7323.00	24.91	AV	H	36.04	4.62	25.73	39.84	54.00	14.16
High Channel: 2480 MHz									
2480.00	59.30	PK	H	28.26	1.84	0.00	89.40	N/A	N/A
2480.00	43.35	AV	H	28.26	1.84	0.00	73.45	N/A	N/A
2480.00	54.95	PK	V	28.26	1.84	0.00	85.05	N/A	N/A
2480.00	38.29	AV	V	28.26	1.84	0.00	68.39	N/A	N/A
2483.50	26.08	PK	H	28.27	1.84	0.00	56.19	74.00	17.81
2483.50	13.42	AV	H	28.27	1.84	0.00	43.53	54.00	10.47
4960.00	39.55	PK	H	33.22	3.23	25.63	50.37	74.00	23.63
4960.00	24.88	AV	H	33.22	3.23	25.63	35.70	54.00	18.30
7440.00	36.30	PK	H	36.34	4.41	25.85	51.20	74.00	22.80
7440.00	24.22	AV	H	36.34	4.41	25.85	39.12	54.00	14.88

Worst plots(GFSK High channel)
Horizontal:

Fundamental Test with Band Rejection Filter

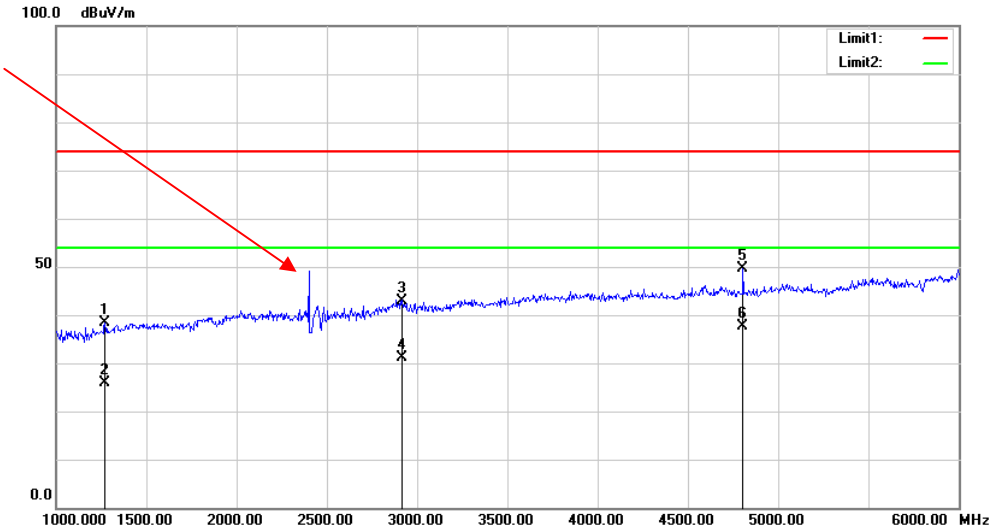


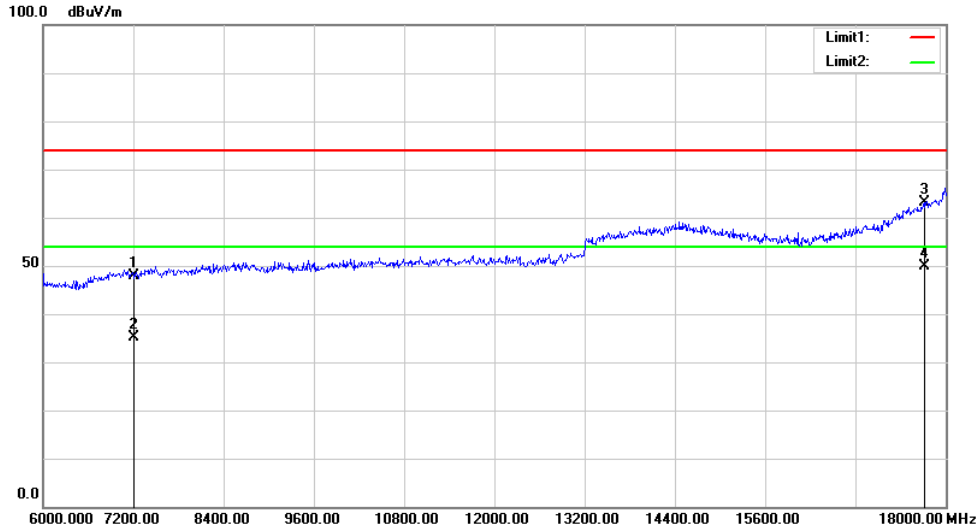


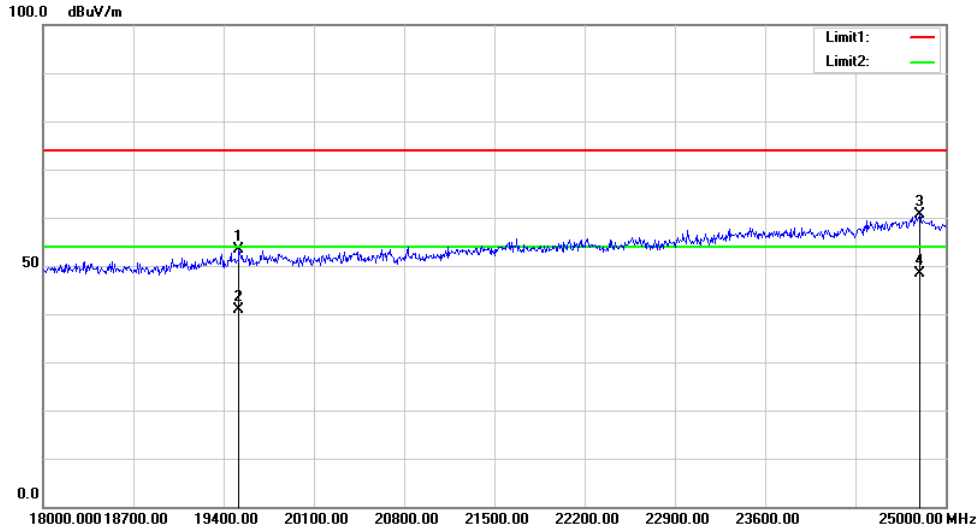


Vertical:

Fundamental Test with Band Rejection Filter







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

Applicable Standard

According to FCC §15.247(a) (1), RSS-247 Clause 5.1 b)

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.50 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSV40	101591	2020-06-29	2021-06-28
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Procedure

1. Set the EUT in transmitting mode, spectrum Bandwidth was set at 30 kHz, maxhold the channel.
2. Set the adjacent channel of the EUT maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	23.9°C
Relative Humidity:	38%
ATM Pressure:	101.1Pa
Tester:	Tiger Mo
Test Date:	2021-03-26

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

Test Mode: Transmitting

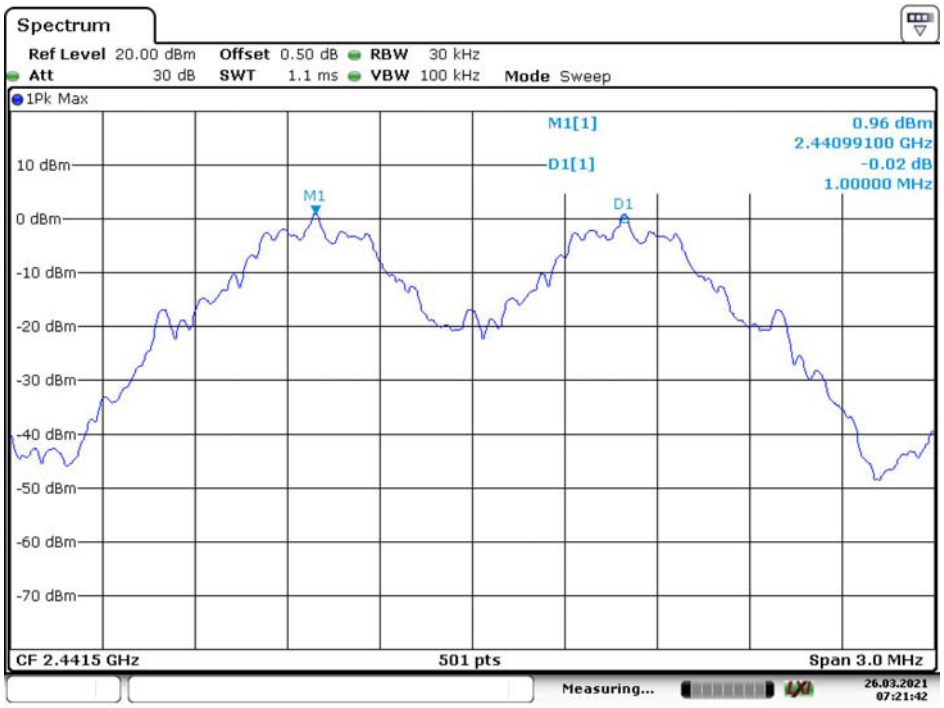
Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
BDR (GFSK)	Low	2402	1.000	0.69
	Middle	2441	1.000	0.69
	High	2480	1.000	0.7
EDR (π/4-DQPSK)	Low	2402	1.000	0.78
	Middle	2441	1.000	0.78
	High	2480	1.000	0.78
EDR (8DPSK)	Low	2402	1.000	0.78
	Middle	2441	1.000	0.78
	High	2480	1.000	0.78

Note: Limit= (2/3) × 20dB bandwidth

BDR Mode (GFSK):

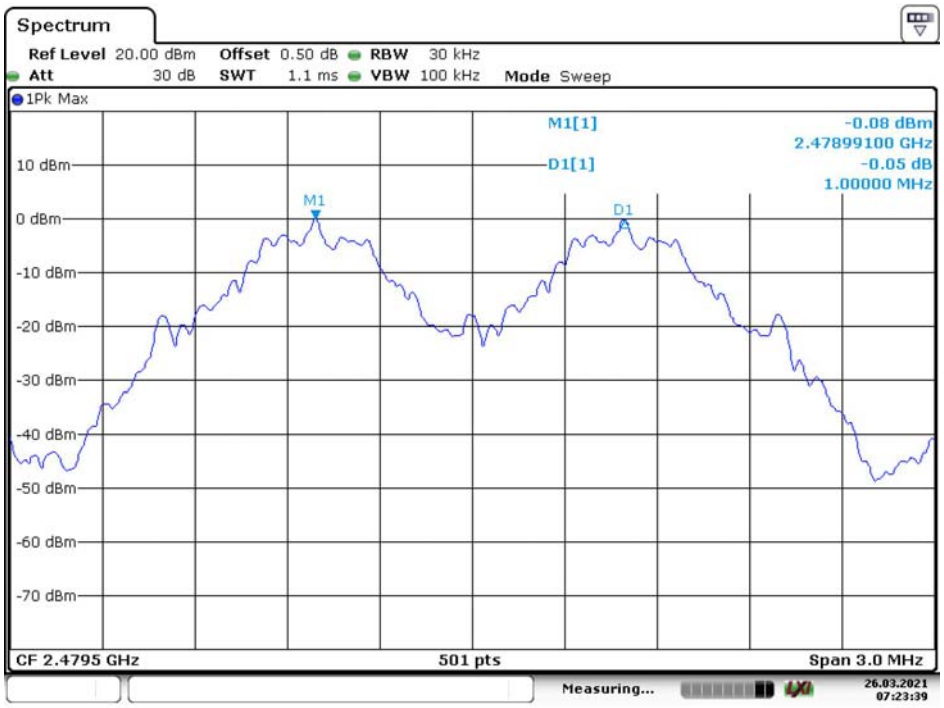
Low Channel

Middle Channel



Date: 26.MAR.2021 07:21:42

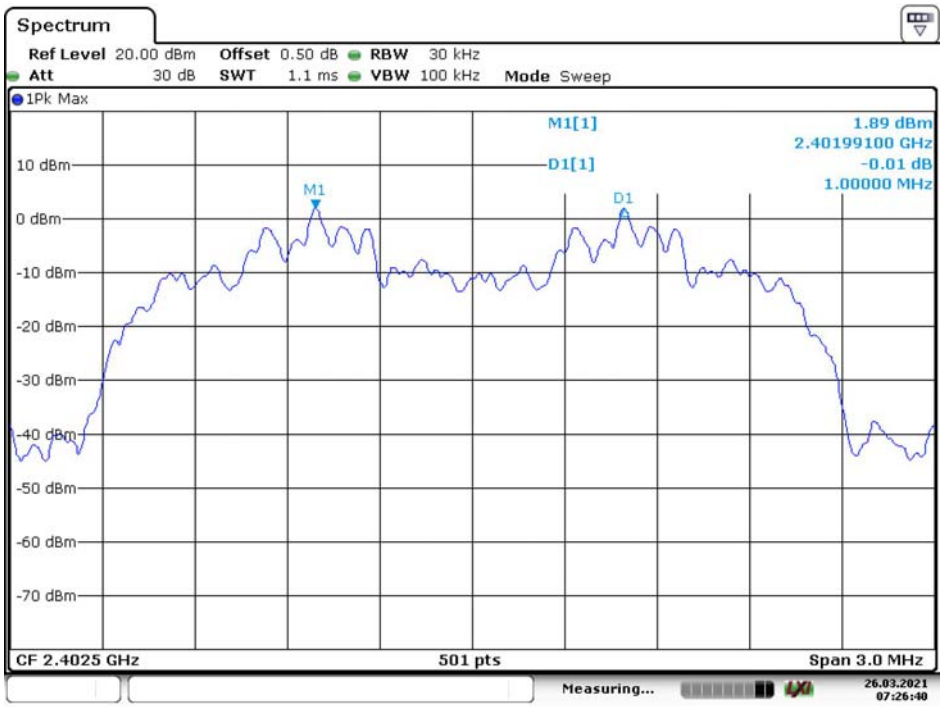
High Channel



Date: 26.MAR.2021 07:23:39

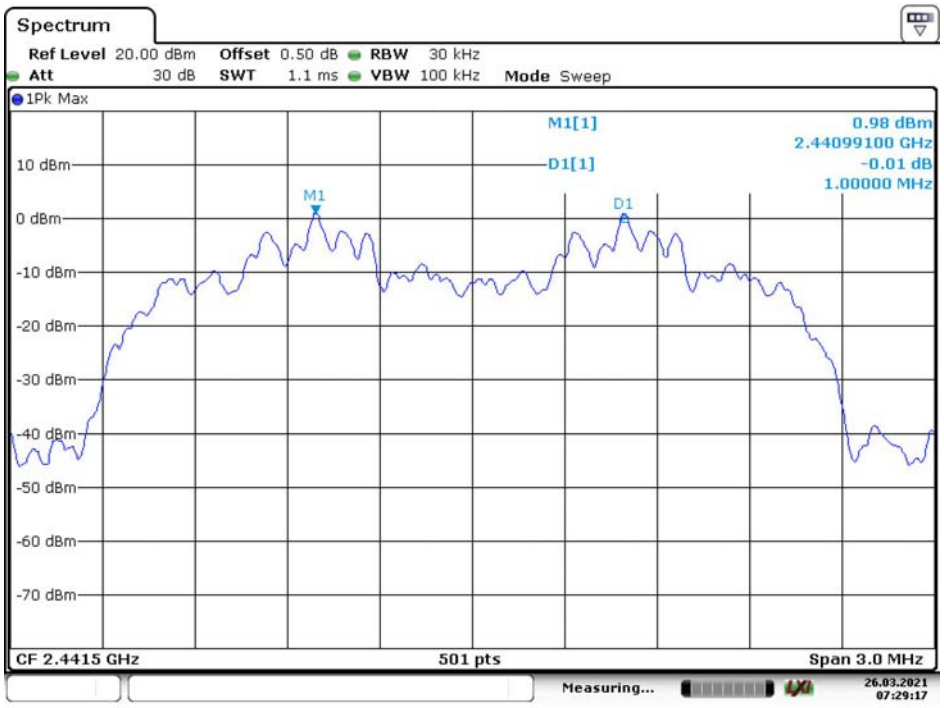
EDR Mode (π/4-DQPSK):

Low Channel



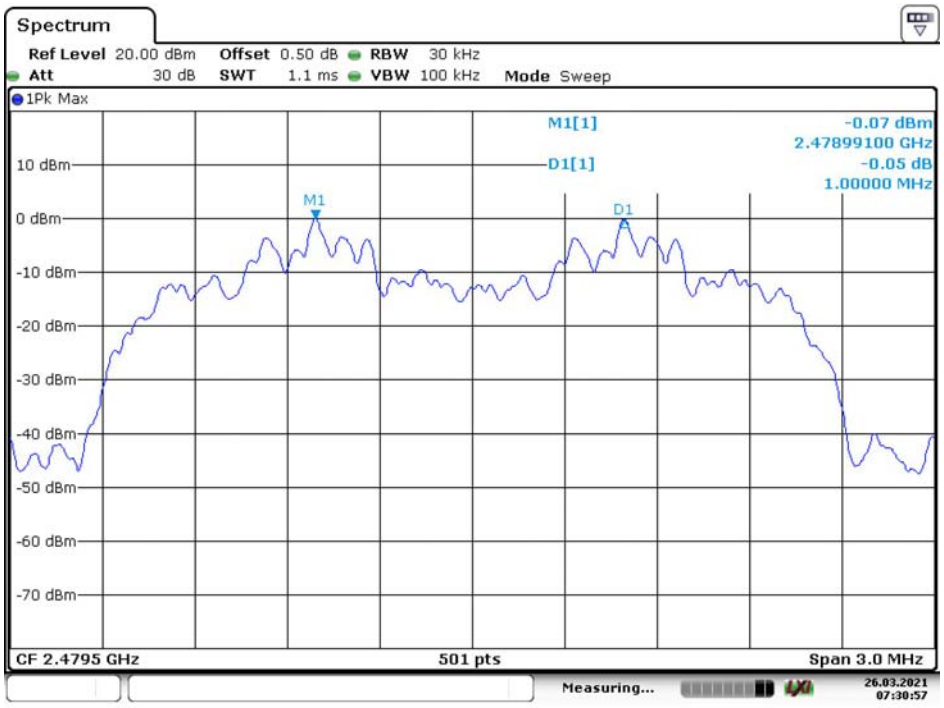
Date: 26.MAR.2021 07:26:40

Middle Channel



Date: 26.MAR.2021 07:29:17

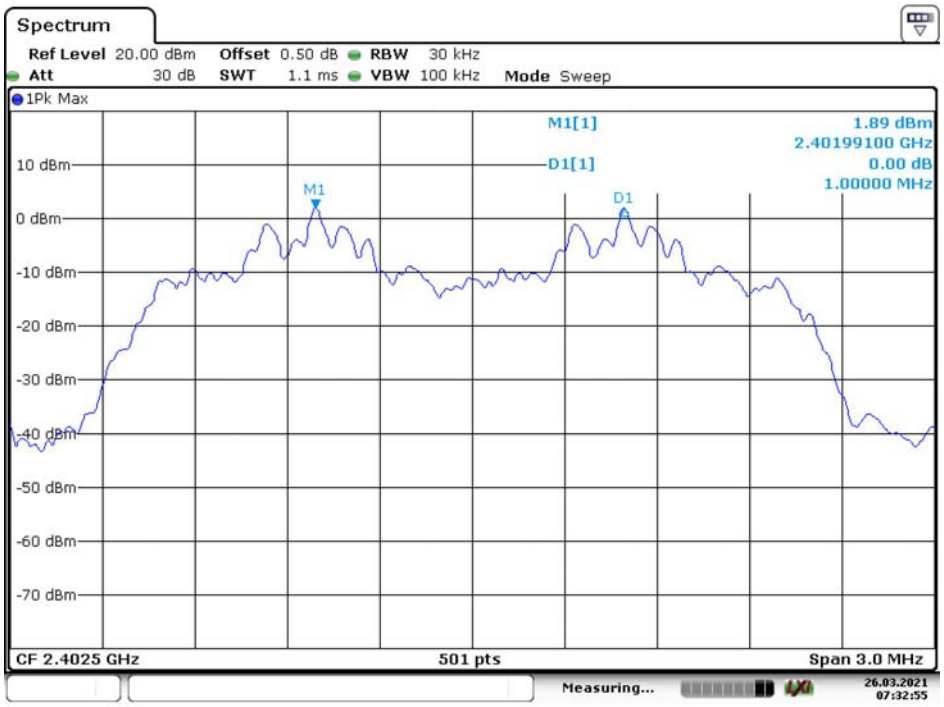
High Channel



Date: 26.MAR.2021 07:30:57

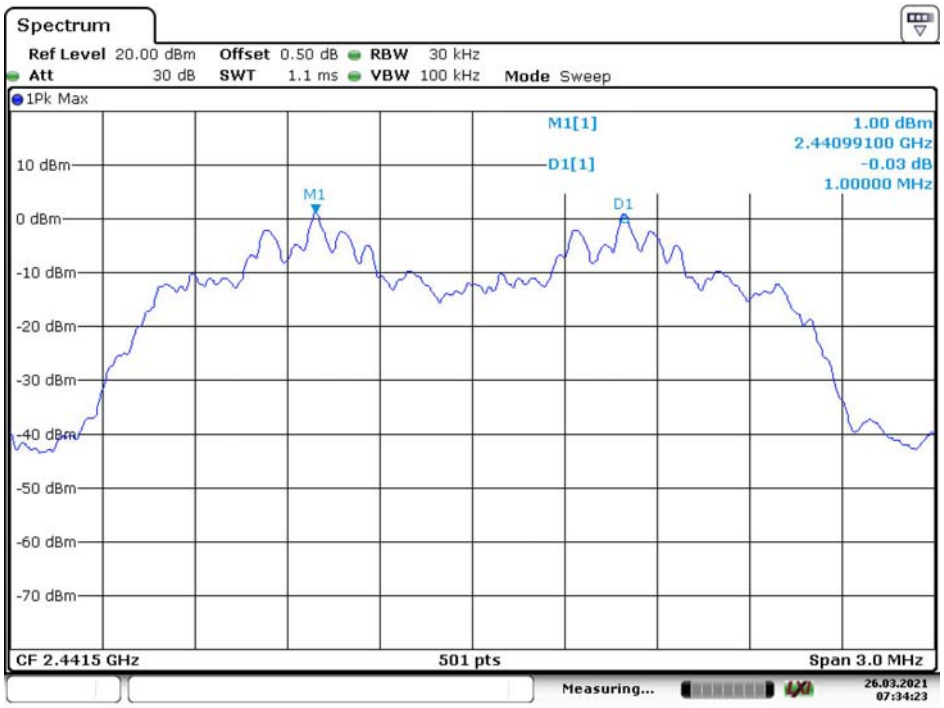
EDR Mode (8DPSK):

Low Channel



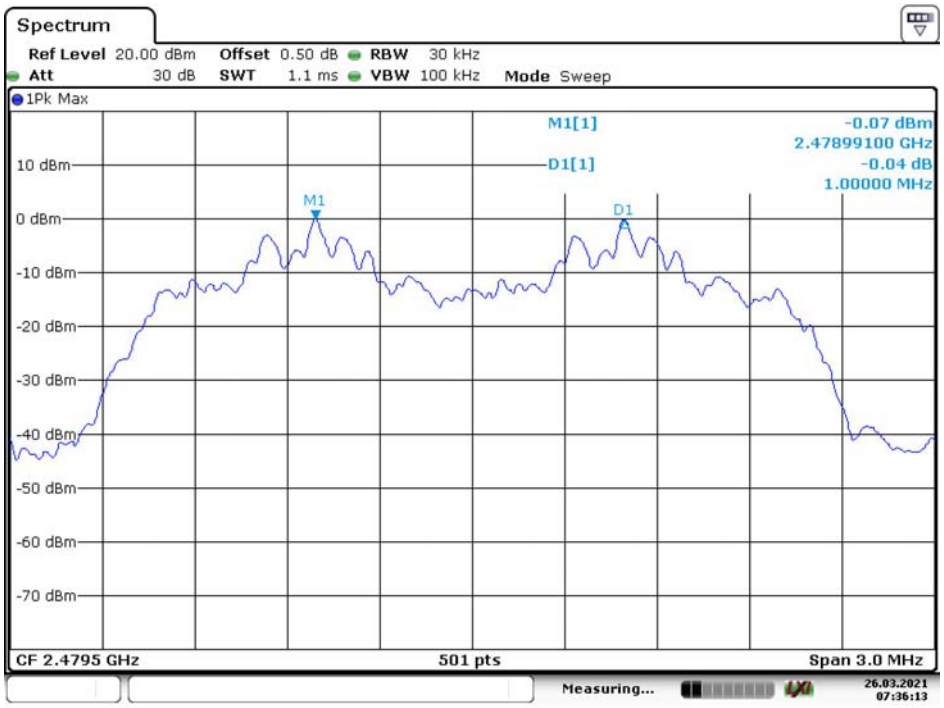
Date: 26.MAR.2021 07:32:55

Middle Channel



Date: 26.MAR.2021 07:34:23

High Channel



Date: 26.MAR.2021 07:36:13

RSS-247 CLUASE 5.1&RSS-GEN CLAUSE 6.7 – 20 dB BANDWIDTH AND 99% OCCUPIED BANDWIDTH TESTING

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 Clause 5.1 b):

b) 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.

According to RSS-Gen Clause 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 "x 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 x 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.

The following conditions shall be observed for measuring the occupied bandwidth and x 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 / x 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 / x 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 Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT on the test table without connection to measurement instrument. Turn on the EUT. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Use Occupied bandwidth test function, measure the 99% Occupied bandwidth.
5. Repeat above procedures until all frequencies measured were complete.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSV40	101591	2020-06-29	2021-06-28
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data

Environmental Conditions

Temperature:	23.9°C
Relative Humidity:	38%
ATM Pressure:	101.1Pa
Tester:	Tiger Mo
Test Date:	2021-03-26

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

Test Mode: Transmitting

Mode	Channel	Frequency (MHz)	20 dB Bandwidth (MHz)	99% occupied Bandwidth (MHz)
BDR Mode (GFSK)	Low	2402	1.040	0.938
	Middle	2441	1.040	0.938
	High	2480	1.044	0.942
EDR Mode (π/4-DQPSK)	Low	2402	1.176	1.114
	Middle	2441	1.176	1.114
	High	2480	1.176	1.114
EDR Mode (8DPSK)	Low	2402	1.168	1.086
	Middle	2441	1.168	1.086
	High	2480	1.168	1.086

20dB Bandwidth:

BDR Mode (GFSK):

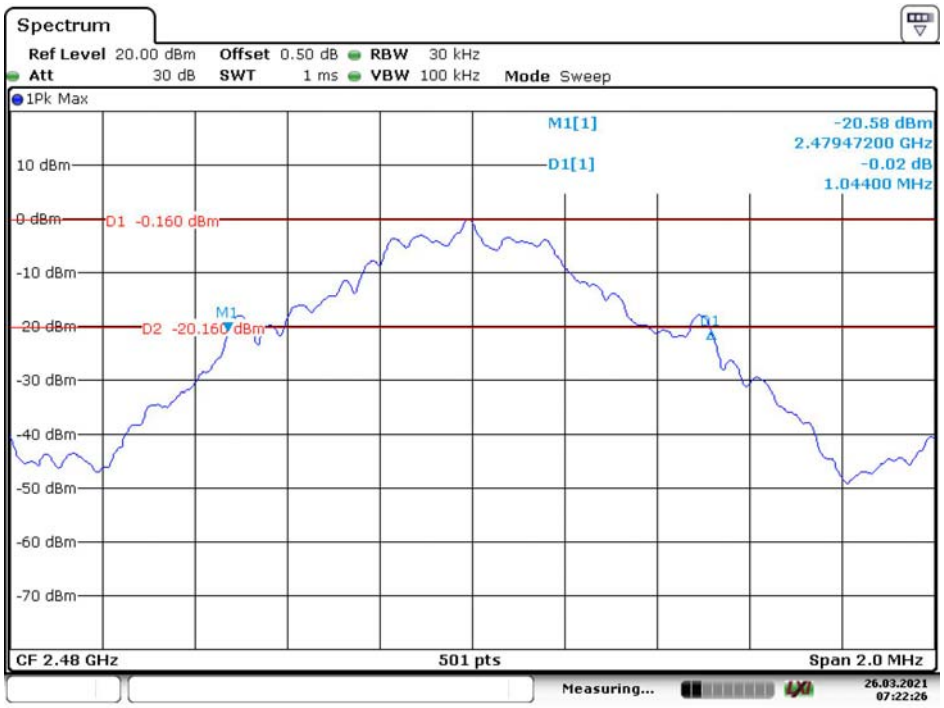
Low Channel

Date: 26.MAR.2021 07:18:40

Middle Channel

Date: 26.MAR.2021 07:20:51

High Channel



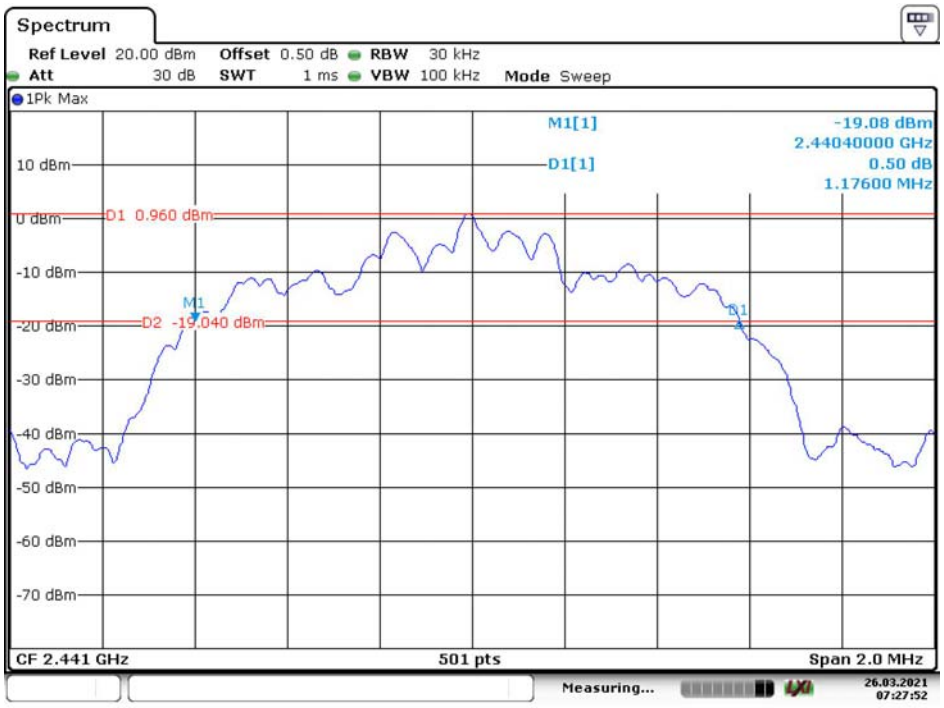
Date: 26.MAR.2021 07:22:26

EDR Mode (π/4-DQPSK):

Low Channel

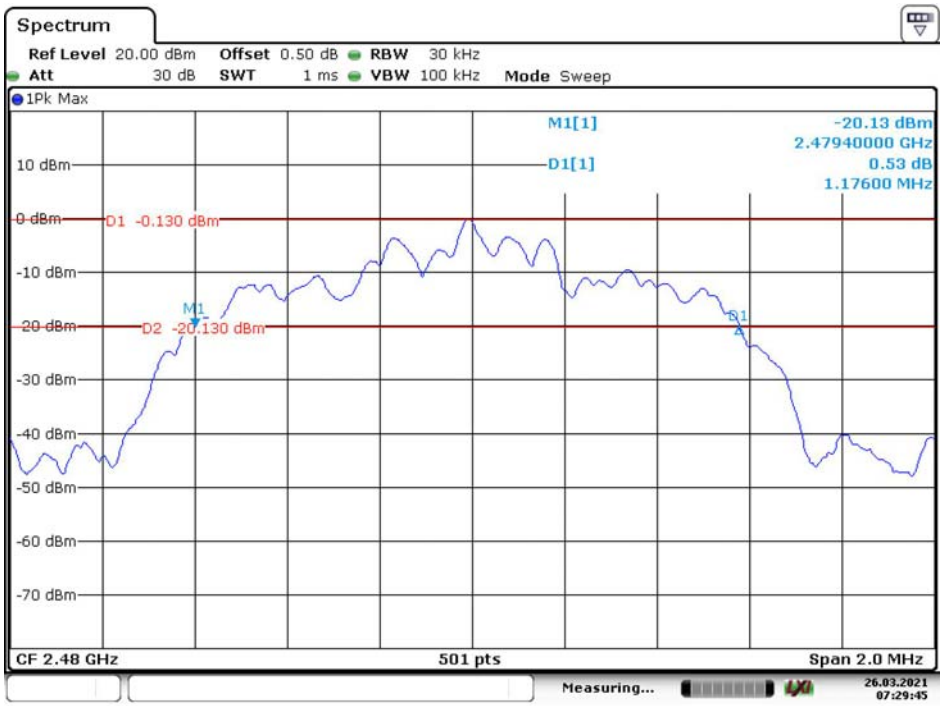
Date: 26.MAR.2021 07:25:19

Middle Channel



Date: 26.MAR.2021 07:27:52

High Channel



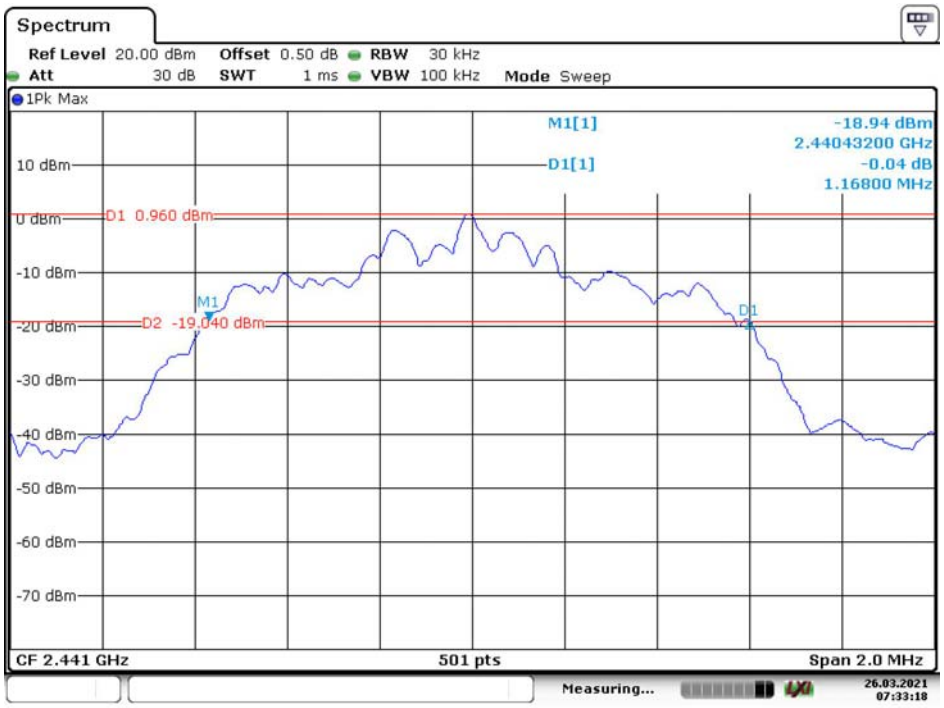
Date: 26.MAR.2021 07:29:45

EDR Mode (8DPSK):

Low Channel

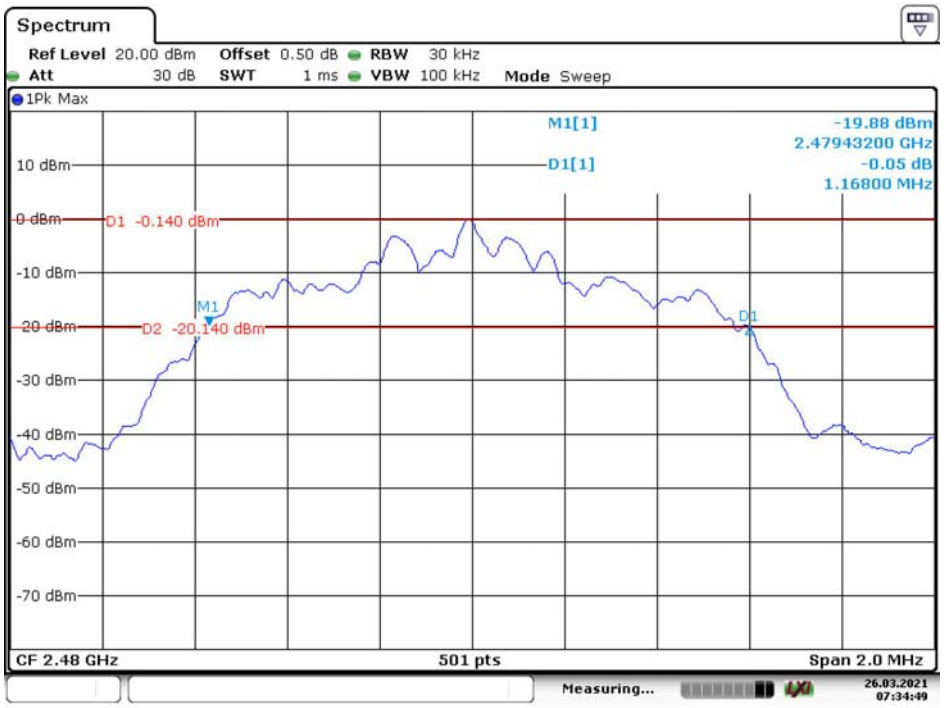
Date: 26.MAR.2021 07:31:40

Middle Channel



Date: 26.MAR.2021 07:33:18

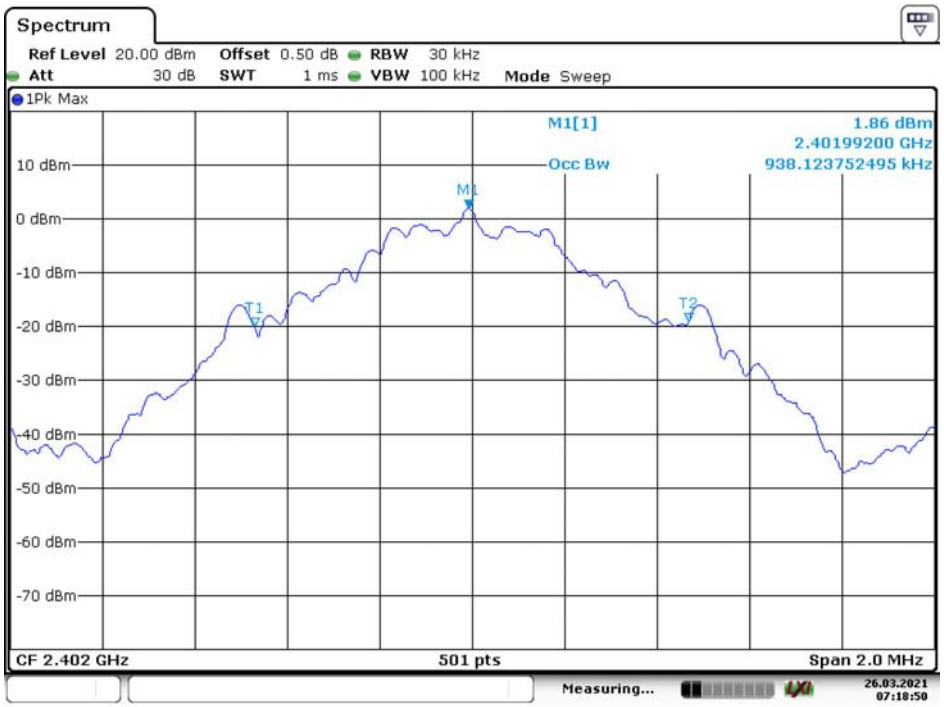
High Channel



Date: 26.MAR.2021 07:34:49

99% Occupied Bandwidth:
BDR Mode (GFSK):

Low Channel



Date: 26.MAR.2021 07:18:50

Middle Channel

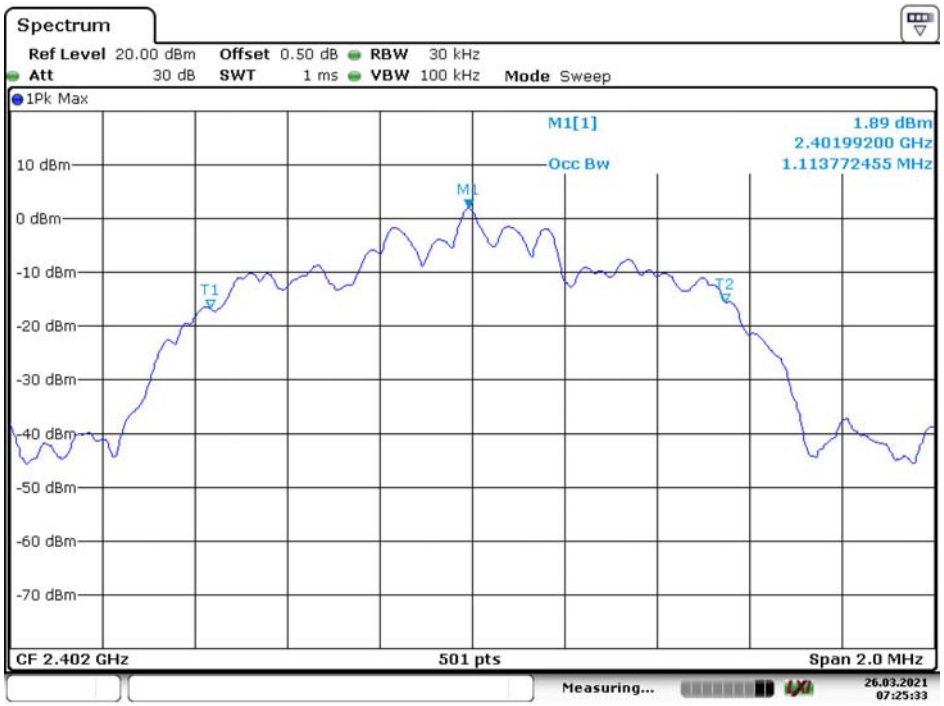
Date: 26.MAR.2021 07:21:05

High Channel

Date: 26.MAR.2021 07:22:39

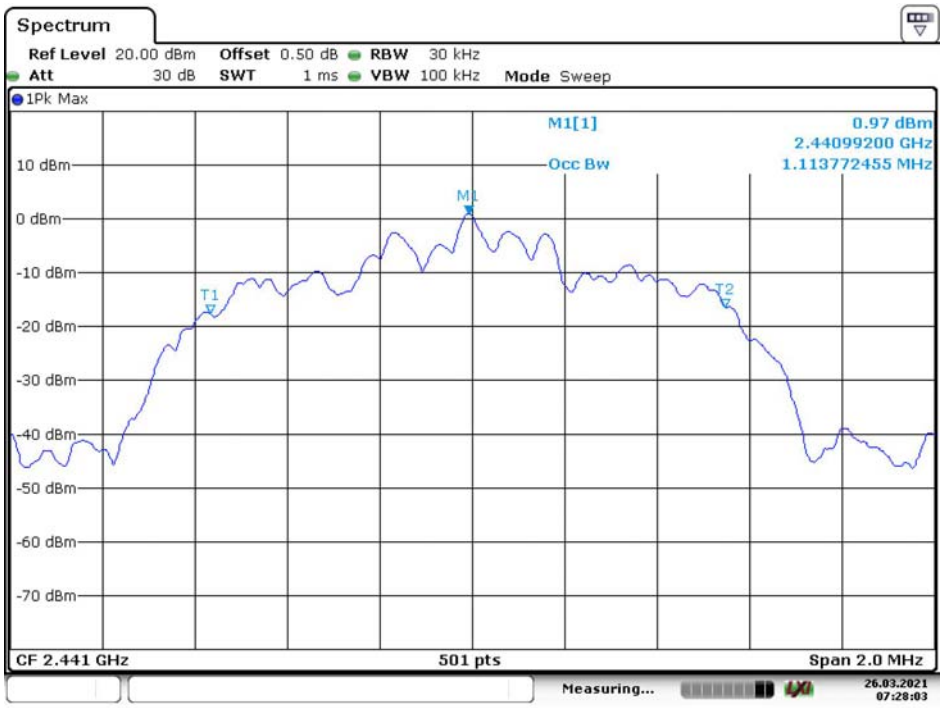
EDR Mode (π/4-DQPSK):

Low Channel



Date: 26.MAR.2021 07:25:32

Middle Channel



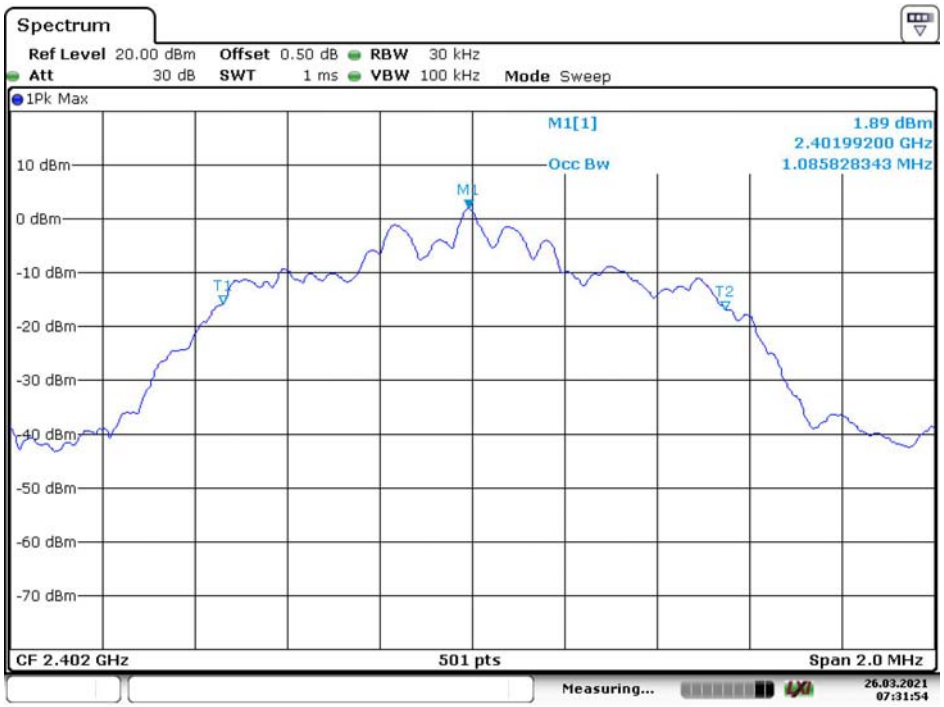
Date: 26.MAR.2021 07:28:03

High Channel

Date: 26.MAR.2021 07:29:59

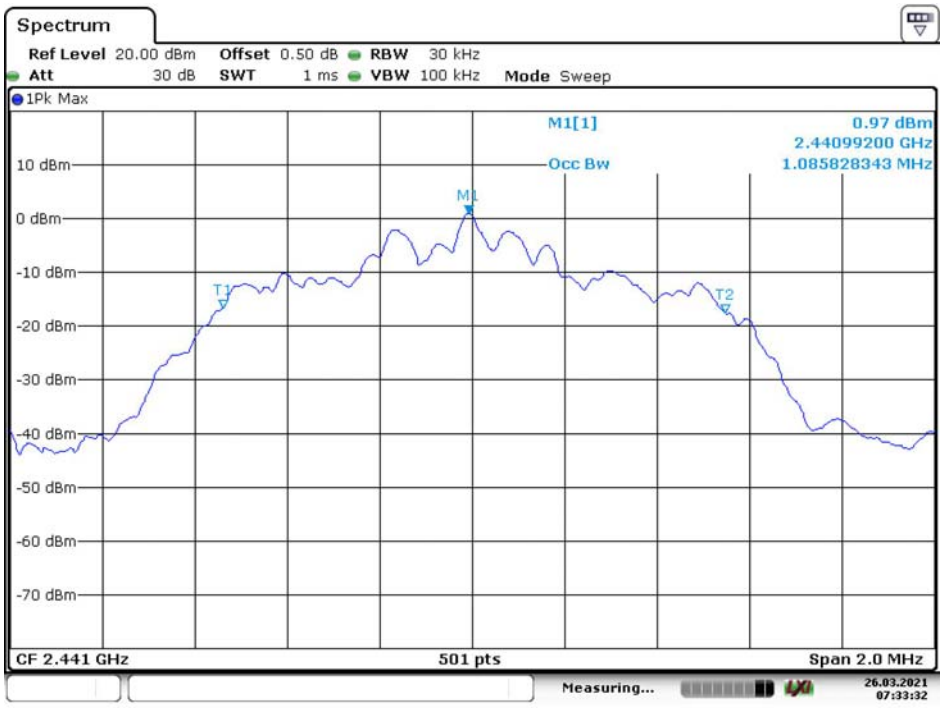
EDR Mode (8DPSK):

Low Channel



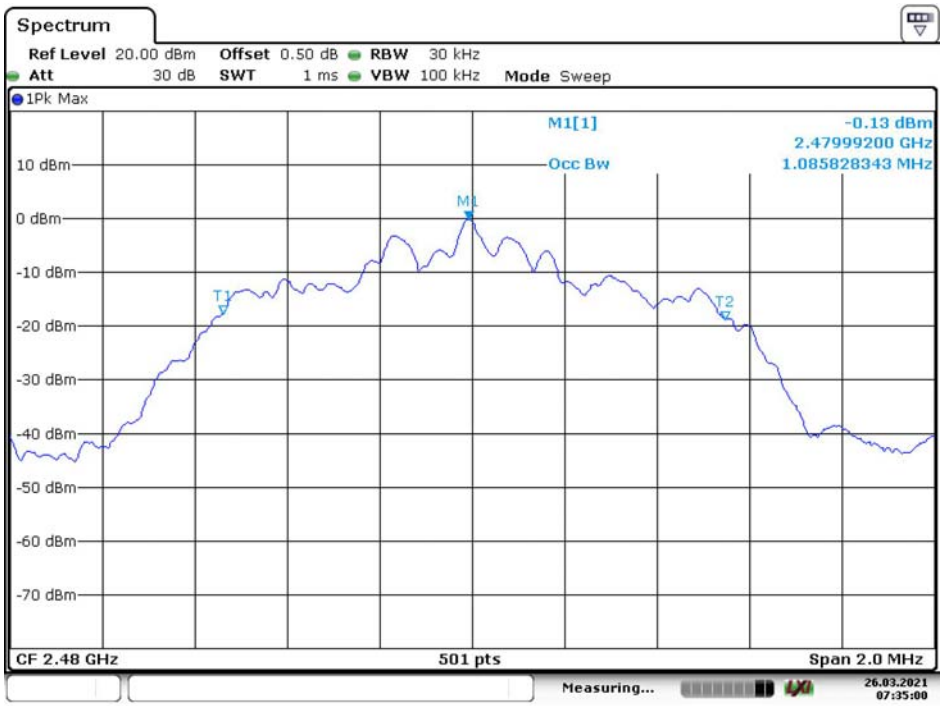
Date: 26.MAR.2021 07:31:54

Middle Channel



Date: 26.MAR.2021 07:33:32

High Channel



Date: 26.MAR.2021 07:35:00

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

Applicable Standard

According to FCC §15.247(a) (1) (iii), RSS-247 Clause 5.1 d)

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

Test Procedure

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

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSV40	101591	2020-06-29	2021-06-28
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data

Environmental Conditions

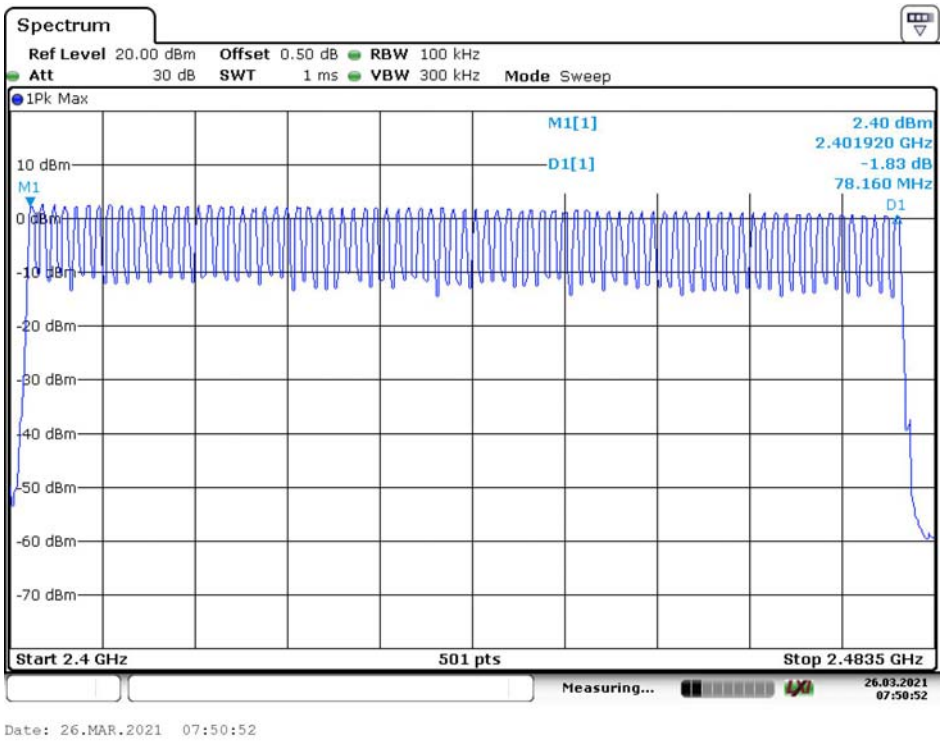
Temperature:	23.9°C
Relative Humidity:	38%
ATM Pressure:	101.1Pa
Tester:	Tiger Mo
Test Date:	2021-03-26

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

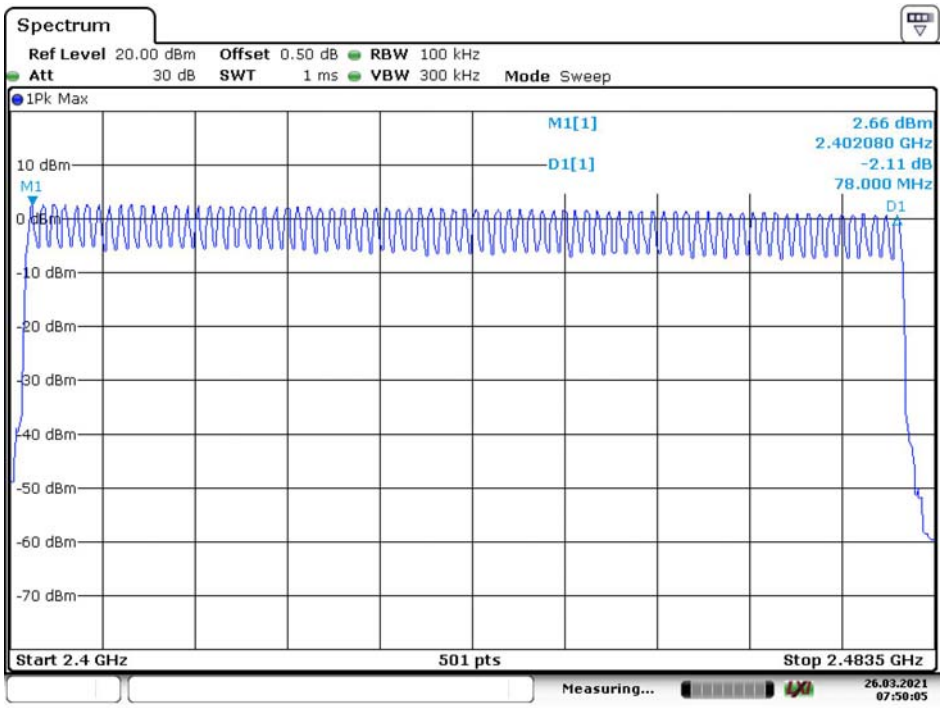
Test Mode: Transmitting

Test mode	Frequency Range (MHz)	Number of Hopping Channel	Limit
GFSK	2400-2483.5	79	≥15
π/4-DQPSK	2400-2483.5	79	≥15
8DPSK	2400-2483.5	79	≥15

GFSK

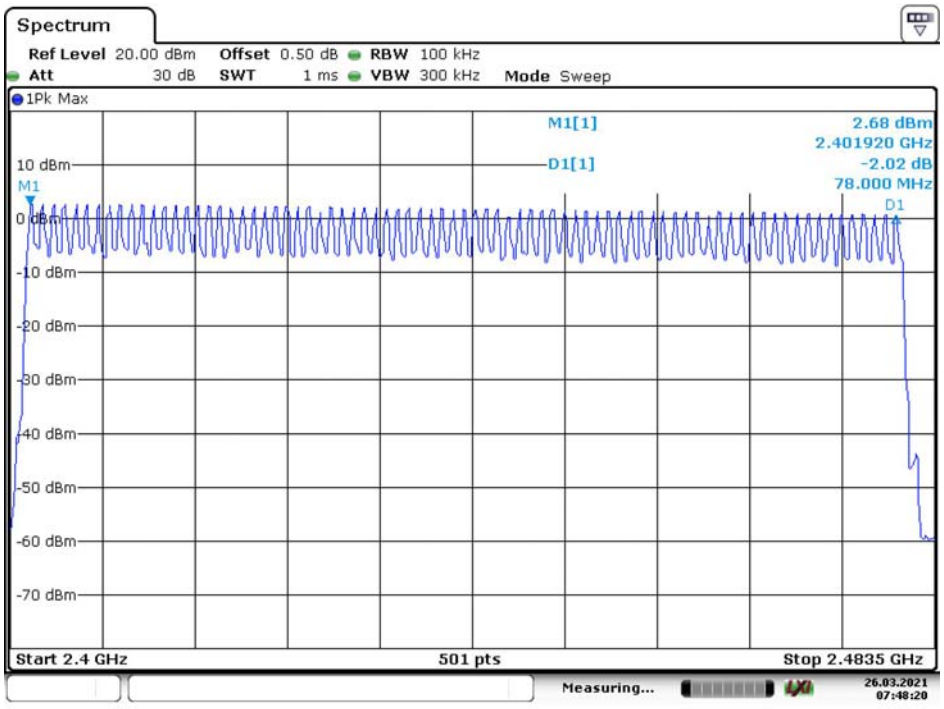


π/4-DQPSK



Date: 26.MAR.2021 07:50:05

8DPSK



Date: 26.MAR.2021 07:48:20

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

Applicable Standard

According to FCC §15.247(a) (1) (iii), RSS-247 Clause 5.1 d)

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

Test Procedure

The EUT was worked in channel hopping; the time of single pulses was tested.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSV40	101591	2020-06-29	2021-06-28
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data

Environmental Conditions

Temperature:	23.9°C
Relative Humidity:	38%
ATM Pressure:	101.1Pa
Tester:	Thesshy Xie
Test Date:	2021-03-26

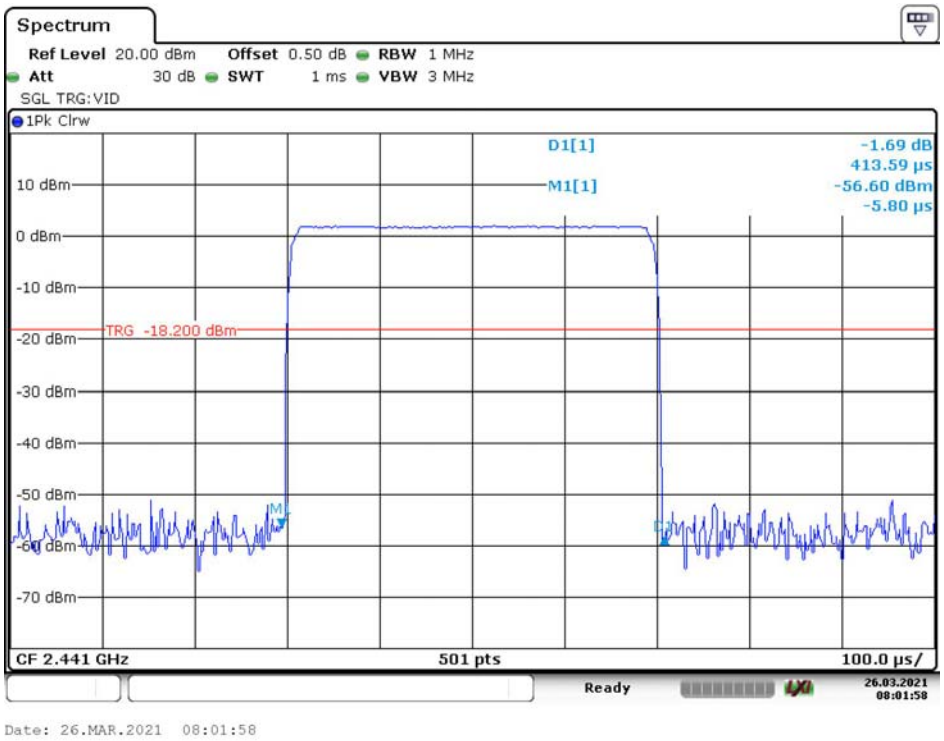
Test Mode: Transmitting

Mode	Packet type	Channel	Frequency (MHz)	Puse width (ms)	Result (s)	Limit (s)
GFSK	DH1	Middle	2441	0.414	0.132	0.4
	DH3	Middle	2441	1.675	0.268	
	DH5	Middle	2441	2.933	0.313	
π/4-DQPSK	2DH1	Middle	2441	0.422	0.135	
	2DH3	Middle	2441	1.687	0.27	
	2DH5	Middle	2441	2.943	0.314	
8DPSK	3DH1	Middle	2441	0.424	0.136	
	3DH3	Middle	2441	1.687	0.27	
	3DH5	Middle	2441	2.943	0.314	

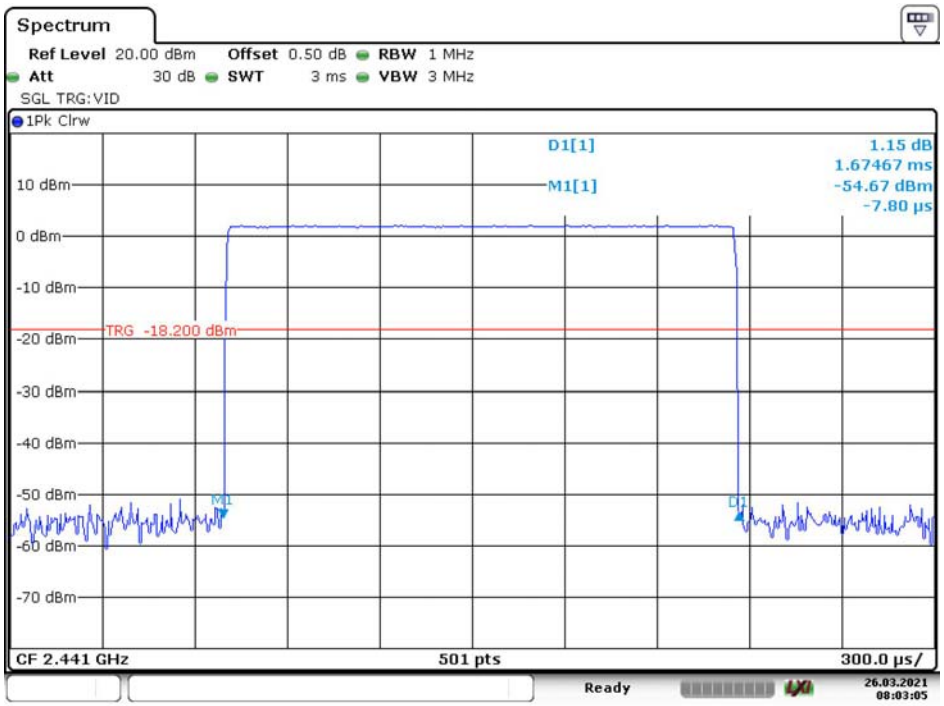
Note:
DH1:Dwell time=Pulse time (ms) × (1600/2/79) ×31.6 s
DH3:Dwell time=Pulse time (ms) × (1600/4/79) ×31.6 s
DH5:Dwell time=Pulse time (ms) × (1600/6/79) ×31.6 s

BDR Mode (GFSK):

DH1: Middle Channel

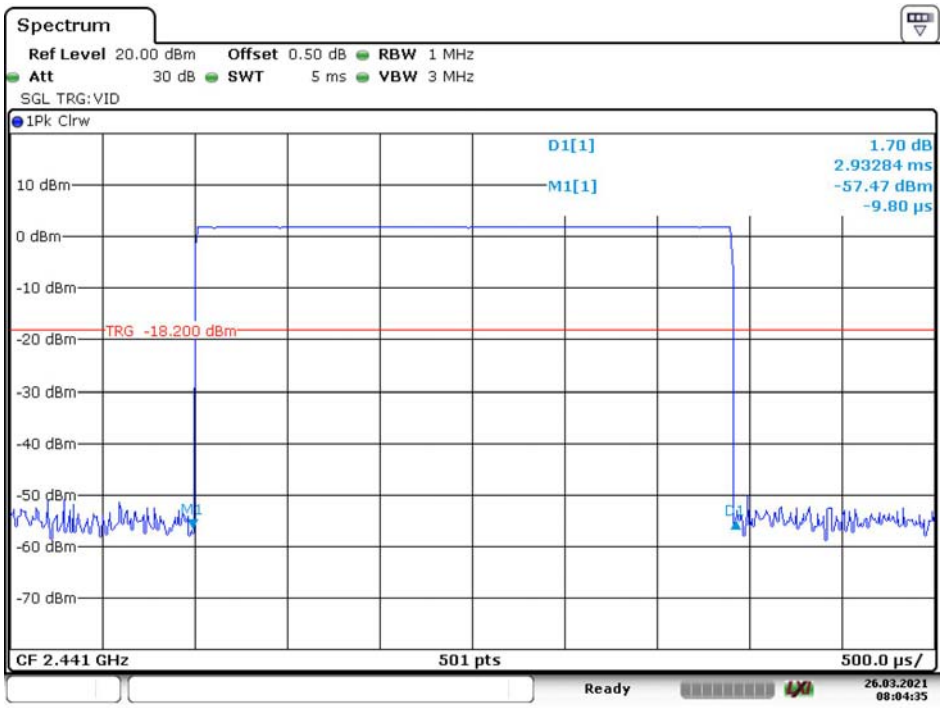


DH3: Middle Channel



Date: 26.MAR.2021 08:03:05

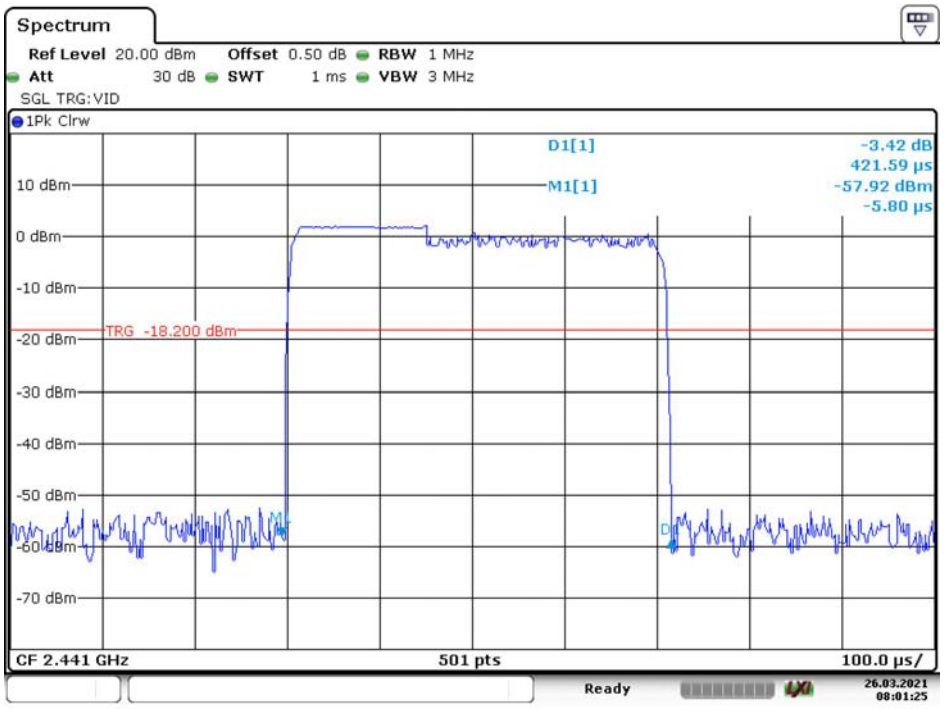
DH5: Middle Channel



Date: 26.MAR.2021 08:04:35

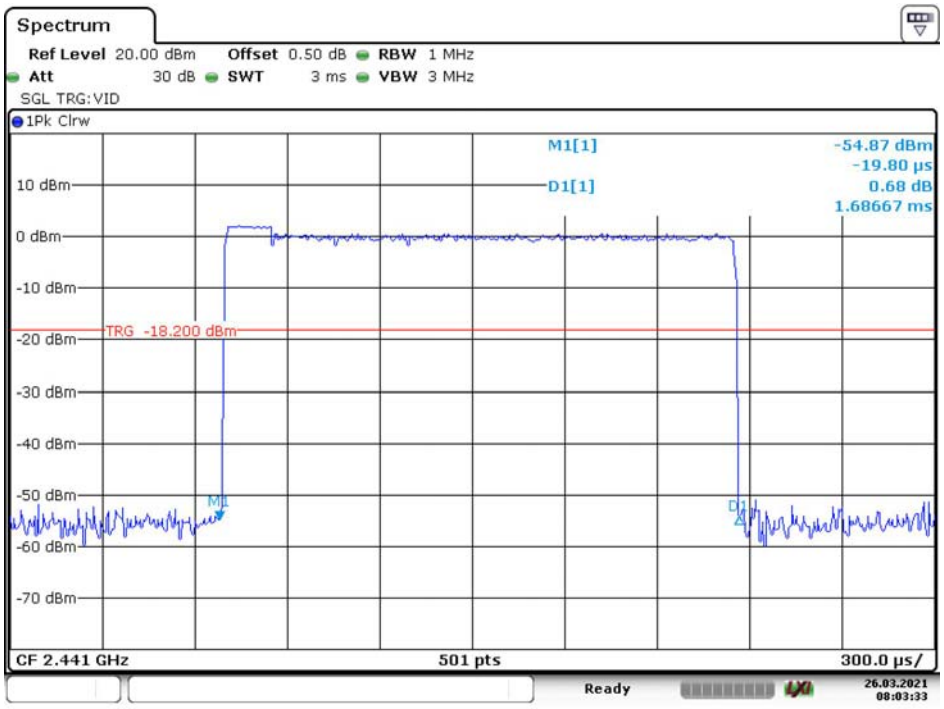
EDR Mode (π/4-DQPSK):

2DH1: Middle Channel



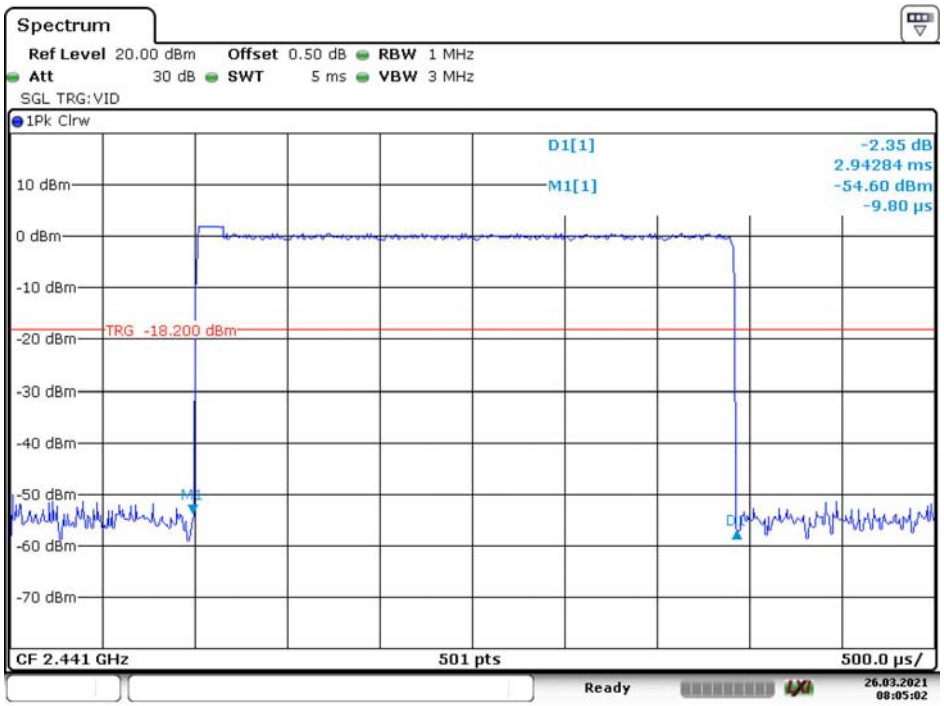
Date: 26.MAR.2021 08:01:25

2DH3: Middle Channel



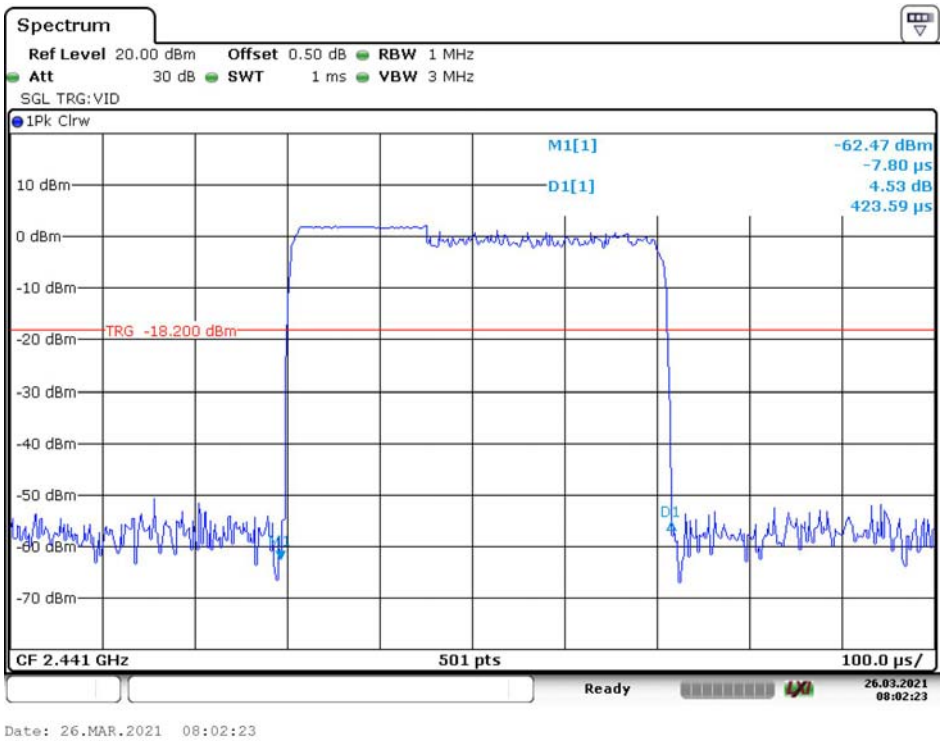
Date: 26.MAR.2021 08:03:33

2DH5: Middle Channel

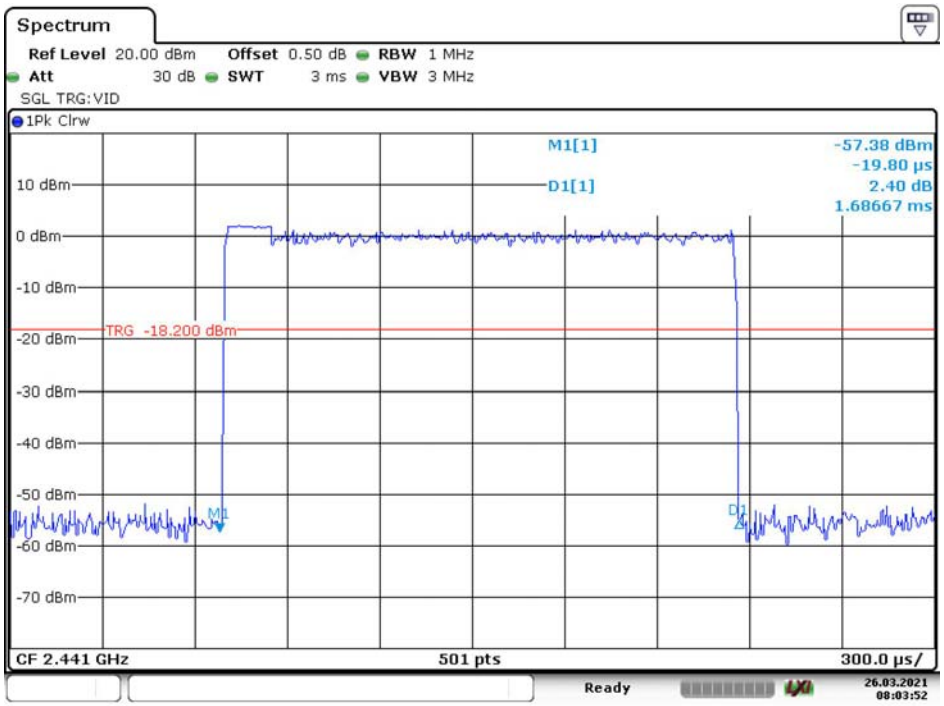


EDR Mode (8DPSK):

3DH1: Middle Channel

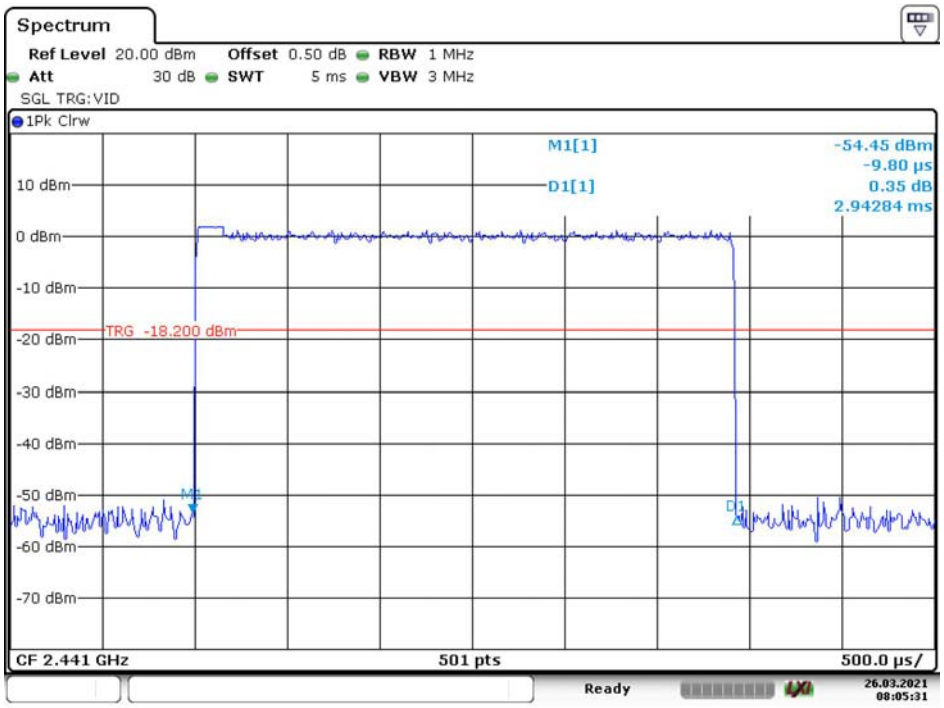


3DH3: Middle Channel



Date: 26.MAR.2021 08:03:52

3DH5: Middle Channel



Date: 26.MAR.2021 08:05:31

FCC §15.247(b) (1), RSS-247 Clause 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.
For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts

According to RSS-247 Clause 5.4 b)

b) For 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, except as provided in section 5.4(e).

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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
E-Microwave	Blocking Control	EMDCB-00036	0E01201047	2020-05-06	2021-05-06
E-Microwave	Coaxial Attenuators	EMCA10-5RN-6	OE01203239	2020-09-06	2021-09-06
Agilent	USB Wideband Power Sensor	U2022XA	MY5417006	2020-09-12	2021-09-12

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data

Environmental Conditions

Temperature:	23.9°C
Relative Humidity:	38%
ATM Pressure:	101.1Pa
Tester:	Thesshy Xie
Test Date:	2021-03-26

Test Result: Compliance.

Test Mode: Transmitting

Mode	Frequency (MHz)	Peak Conducted Output power (dBm)	Peak Conducted Output power Limit (dBm)	EIRP (dBm)	EIRP Limit For ISED (dBm)
BDR Mode (GFSK)	2402	3.06	21	2.61	36
	2441	2.12	21	1.67	36
	2480	1.02	21	0.57	36
EDR Mode (π/4-DQPSK)	2402	3.06	21	2.61	36
	2441	2.11	21	1.66	36
	2480	1.01	21	0.56	36
EDR Mode (8DPSK)	2402	3.05	21	2.60	36
	2441	2.12	21	1.67	36
	2480	1.04	21	0.59	36

Note: The data above was tested in conducted mode, the antenna gain is -0.45 dBi.

FCC §15.247(d) & RSS-247 CLAUSE 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 Clause 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(d), 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/ VBW of spectrum analyzer to 100/300 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSV40	101591	2020-06-29	2021-06-28
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data

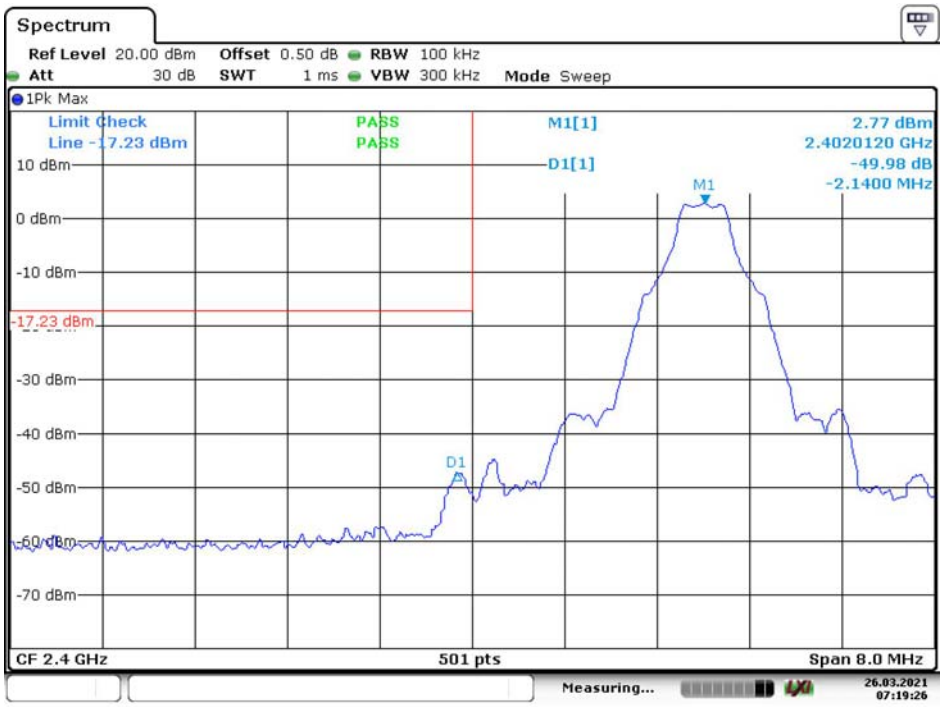
Environmental Conditions

Temperature:	23.9°C
Relative Humidity:	38%
ATM Pressure:	101.1Pa
Tester:	Thesshy Xie
Test Date:	2021-03-26

Test Result: Compliance

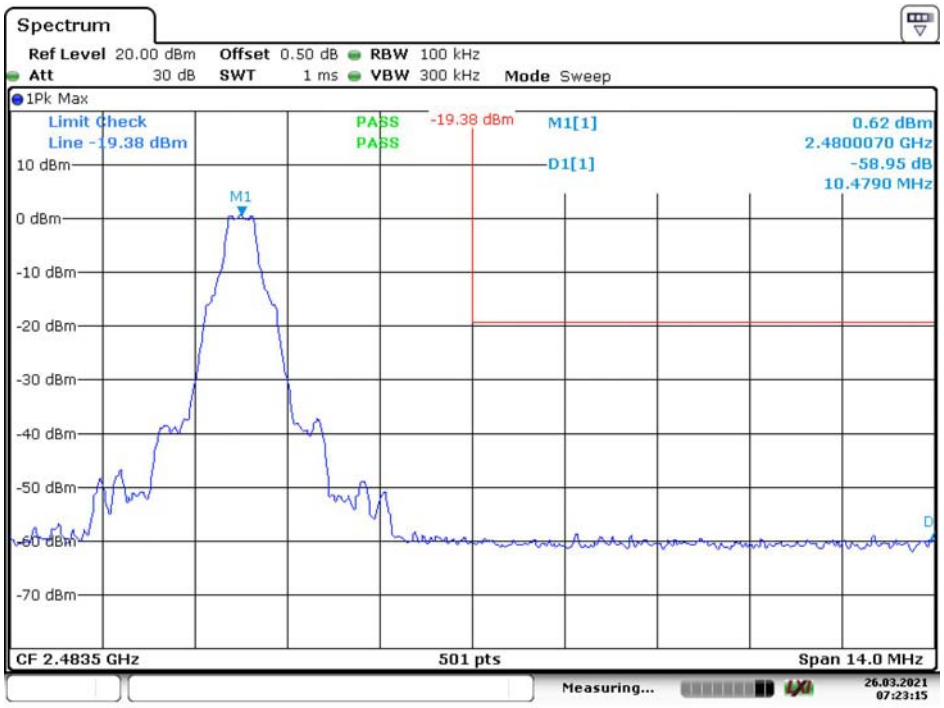
Single mode:
BDR Mode (GFSK):

Band Edge, Left Side



Date: 26.MAR.2021 07:19:26

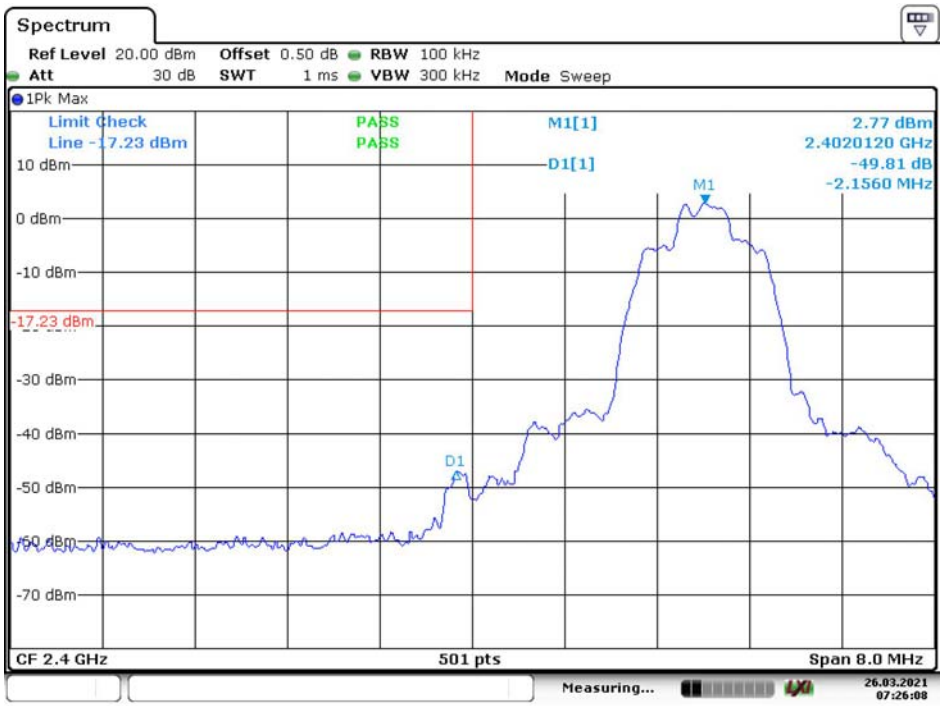
Band Edge, Right Side



Date: 26.MAR.2021 07:23:15

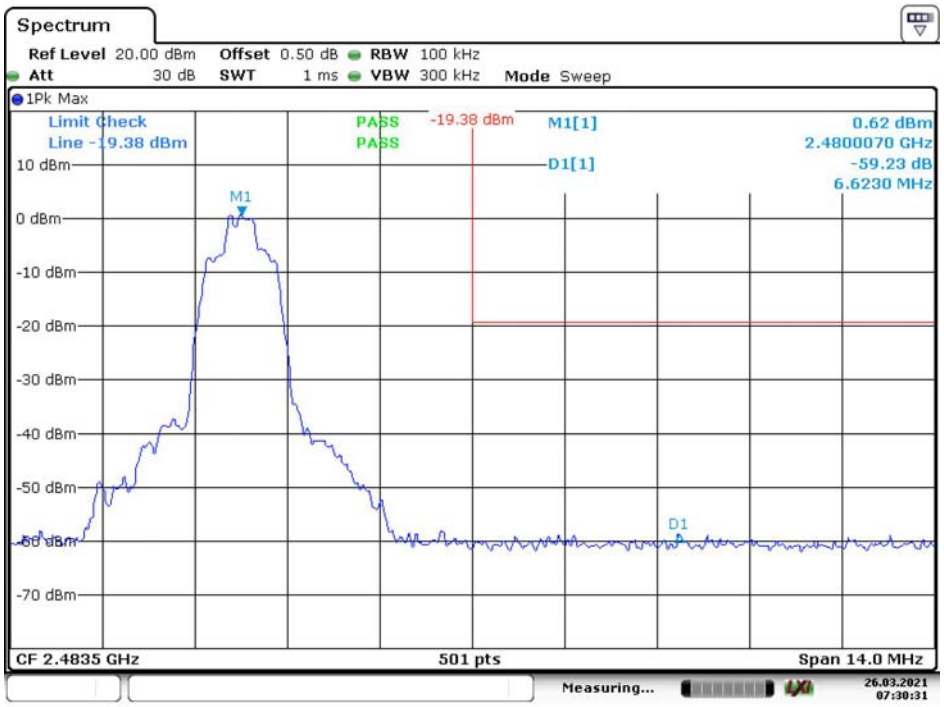
EDR Mode (π/4-DQPSK):

Band Edge, Left Side



Date: 26.MAR.2021 07:26:08

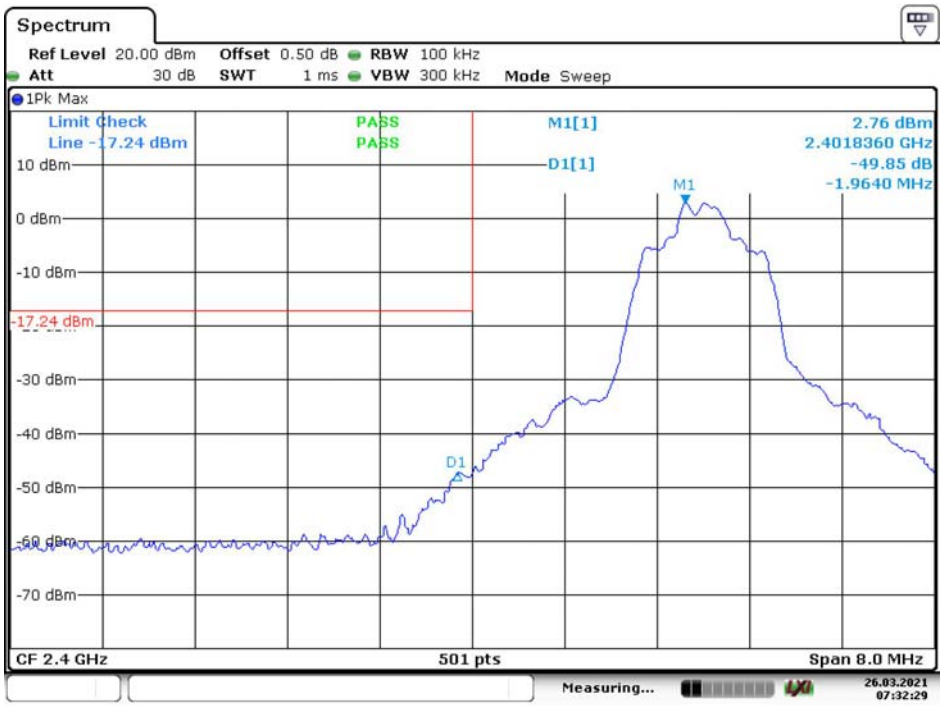
Band Edge, Right Side



Date: 26.MAR.2021 07:30:31

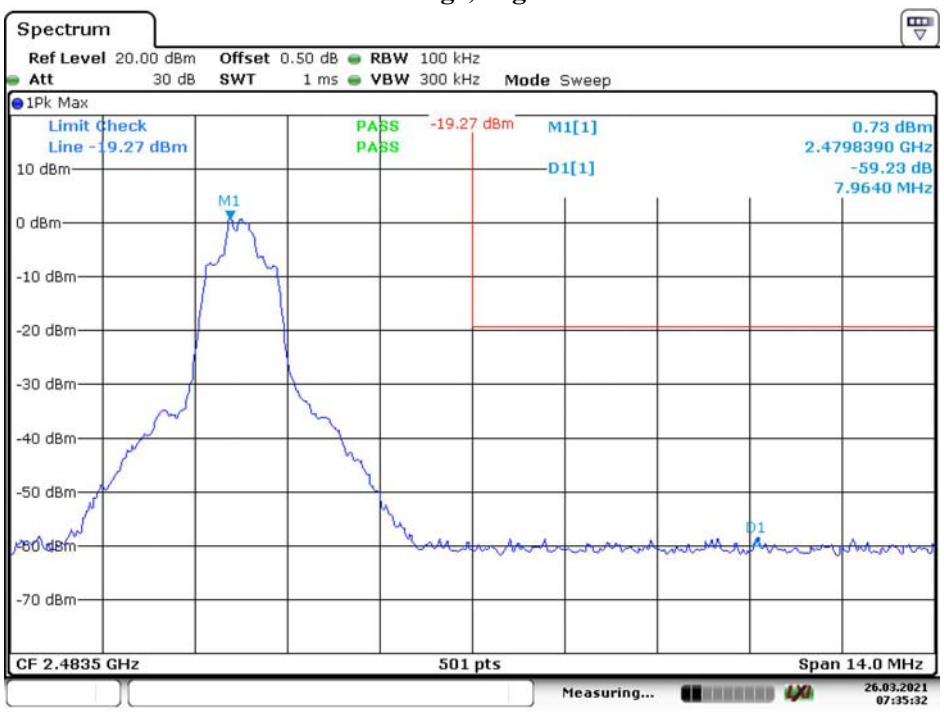
EDR Mode (8DPSK):

Band Edge, Left Side



Date: 26.MAR.2021 07:32:29

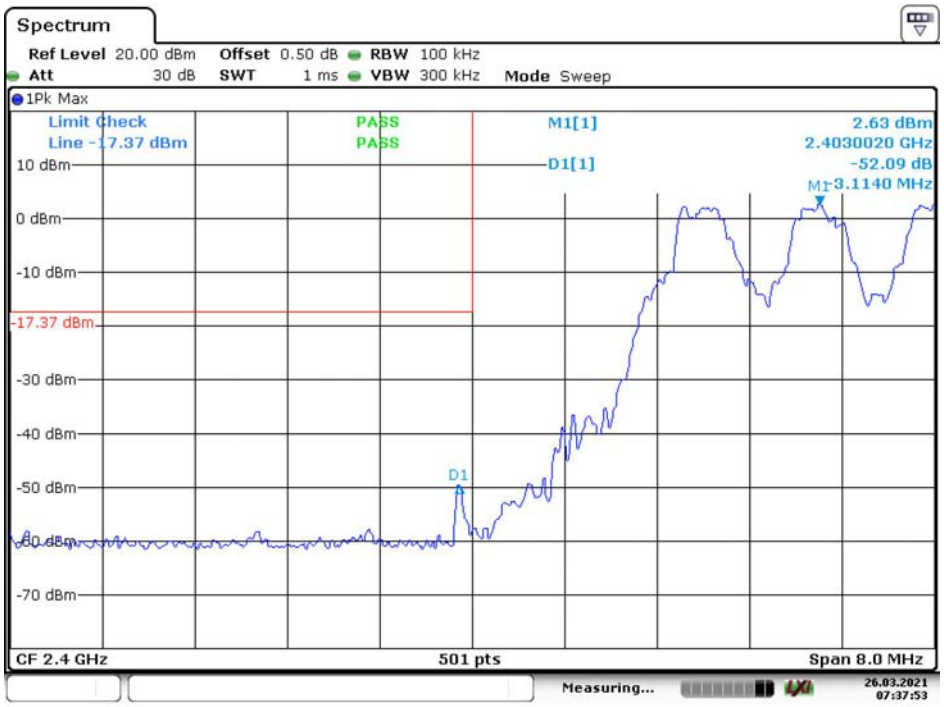
Band Edge, Right Side



Date: 26.MAR.2021 07:35:32

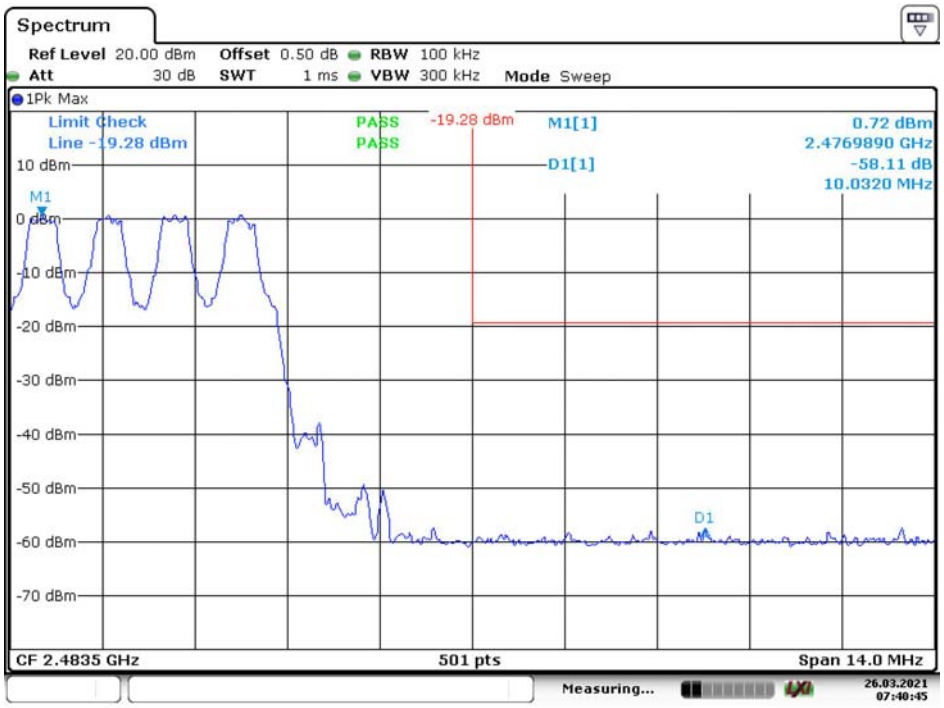
Hopping mode:
BDR Mode (GFSK):

Band Edge, Left Side



Date: 26.MAR.2021 07:37:53

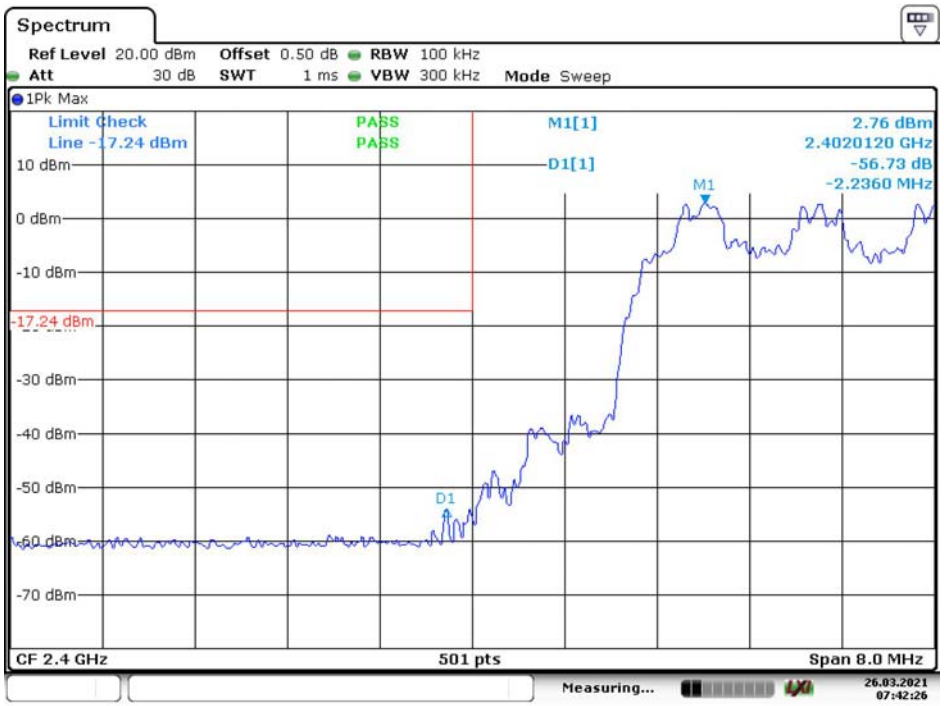
Band Edge, Right Side



Date: 26.MAR.2021 07:40:45

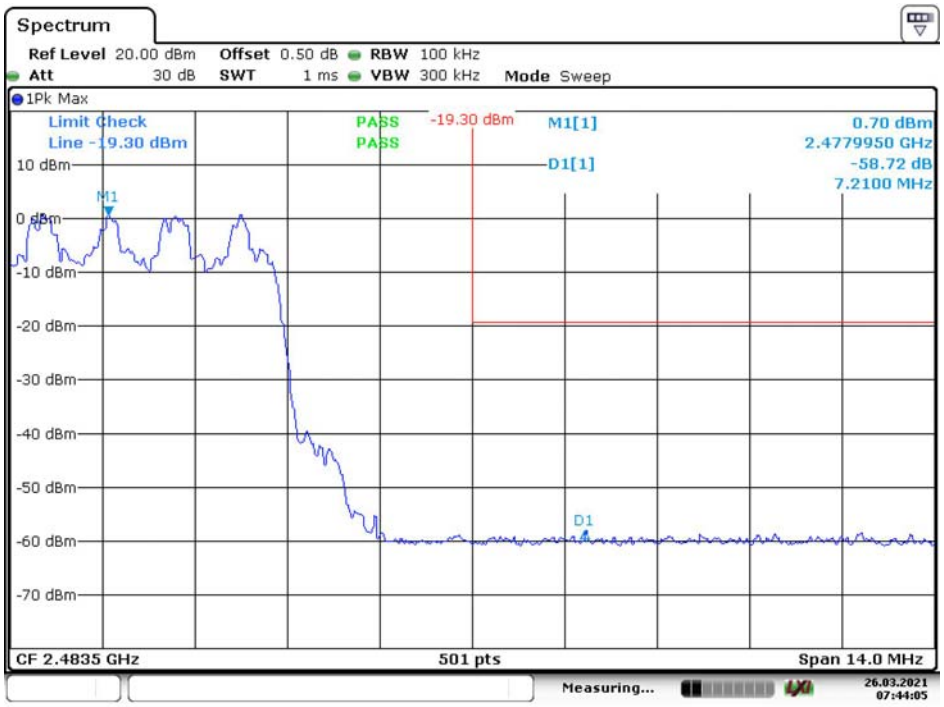
EDR Mode (π/4-DQPSK):

Band Edge, Left Side



Date: 26.MAR.2021 07:42:26

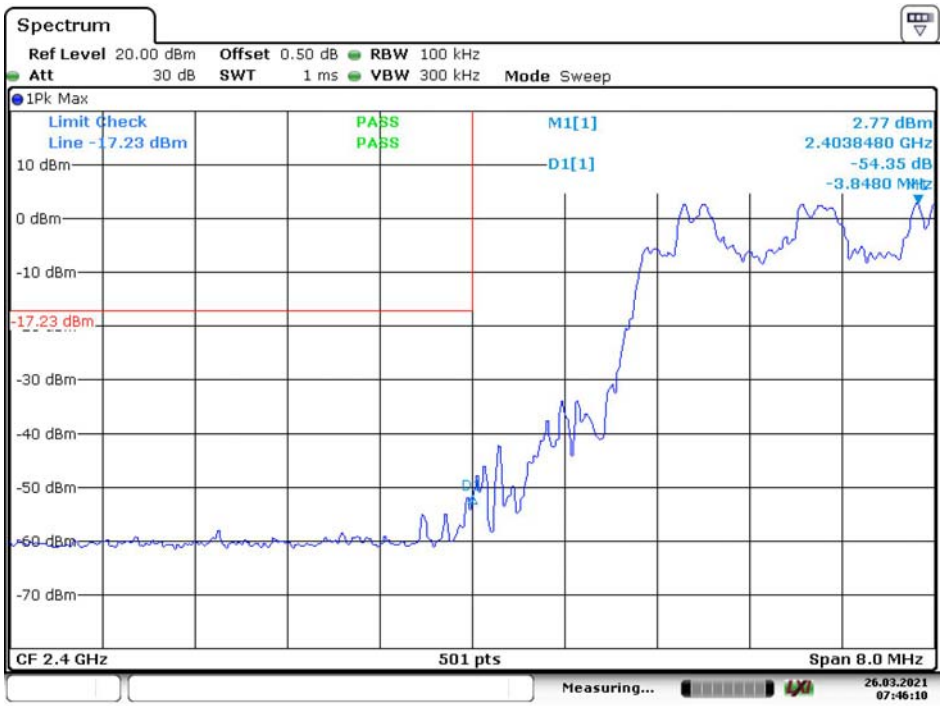
Band Edge, Right Side



Date: 26.MAR.2021 07:44:05

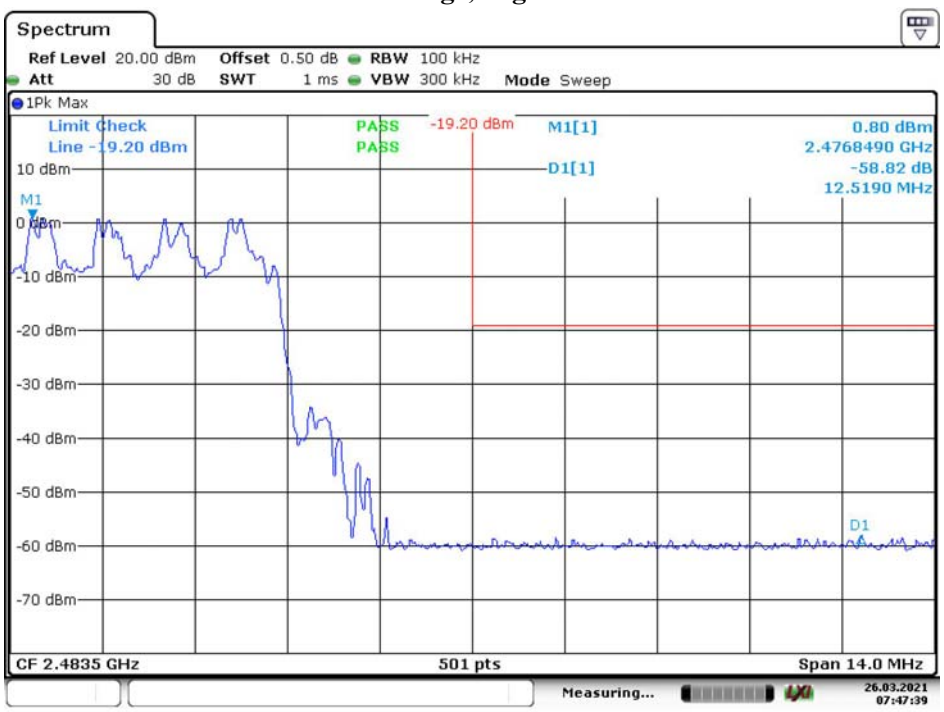
EDR Mode (8DPSK):

Band Edge, Left Side



Date: 26.MAR.2021 07:46:10

Band Edge, Right Side



Date: 26.MAR.2021 07:47:39

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