



TESTING LABORATORY
CERTIFICATE #4820.01



FCC PART 15.247

TEST REPORT

For

Earfun Technology (HK) Limited

FLAT/RM A 9F,SILVERCORP INTERNATIONAL TOWER 707-713 NATHAN ROAD MONGKOK KL,
HONG KONG

FCC ID:2AVIT-TW200L

Report Type: Original Report	Product Name: True Wireless Earbuds
Report Number: <u>RDG200403009-00A</u>	
Report Date: <u>2020-04-23</u>	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	True Wireless Earbuds
EUT Model:	TW200
Operation Frequency:	2402-2480MHz
Maximum Peak Output Power (Conducted):	7.10 dBm
Modulation Type:	GFSK, $\pi/4$ -DQPSK, 8DPSK
Rated Input Voltage:	DC 3.7V from battery or DC 5V from charger base
Serial Number:	Left Earbud: RDG200403009-RF-S2
EUT Received Date:	2020.4.8
EUT Received Status:	Good

Objective

This report is prepared on behalf of *Earfun Technology (HK) Limited* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules.

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, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

Part of system submissions with FCC ID: 2AVIT-TW200R

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.

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 °C
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.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab 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 lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier : CN0022.

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.

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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: 'AB153x_Airoha_Tool_Kit(ATK)_V2.3.7' was used during test, which was provided by manufacturer. The maximum power level was configured by the software as below table:

Test Frequency	2402MHz	2441MHz	2480MHz
GFSK	Default	Default	Default
$\pi/4$ -DQPSK	Default	Default	Default
8DPSK	Default	Default	Default

Equipment Modifications

No modification was made to the EUT.

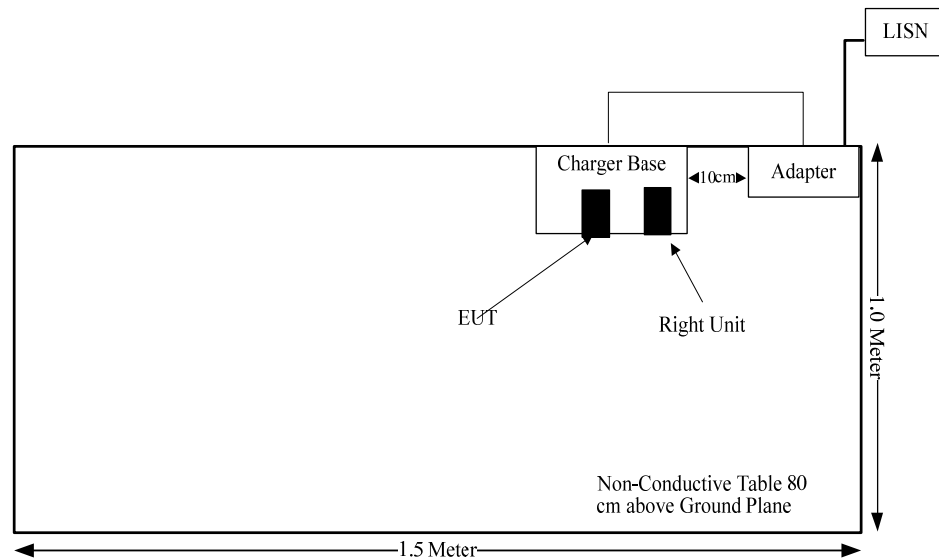
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
Maxwest	Adapter	DCS10-0501000F	0069

Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
USB cable	Yes	No	1	Adapter	Base charger

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
§15.247 (i) & §1.1310 & §2.1093	RF Exposure	Compliance
FCC§15.203	Antenna Requirement	Compliance
FCC§15.207 (a)	Conducted Emissions	Compliance
FCC§15.205, §15.209, FCC §15.247(d)	Spurious Emissions	Compliance
FCC §15.247 (a)(1)	Emission Bandwidth	Compliance
FCC §15.247(a)(1)	Channel Separation Test	Compliance
FCC§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
FCC§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
FCC§15.247(b)(1)	Peak Output Power Measurement	Compliance
FCC§15.247(d)	Band Edges	Compliance

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:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f(\text{GHz})$ 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 8.0 dBm (6.31 mW).

$[(\text{max. power of channel, mW})/(\text{min. test separation distance, mm})][\sqrt{f(\text{GHz})}]$
 $= 6.31/5 \cdot (\sqrt{2.480}) = 2.0 < 3.0$

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

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to FCC§ 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
- b. Antenna must use a unique type of connector to attach to the EUT.
- c. Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

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	1.36 dBi/2.4~2.5GHz

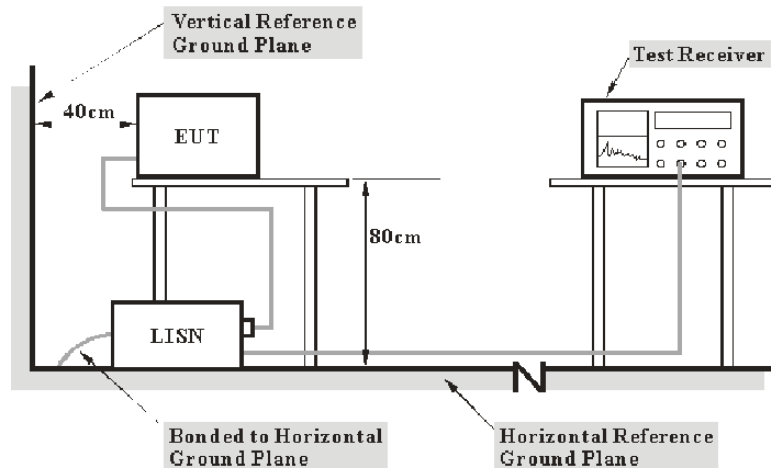
Result: Compliance.

FCC §15.207 (a)– AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207(a).

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

The spacing between the peripherals was 10 cm.

The adapter was connected to the main LISN with a 120 V/60 Hz AC power source.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the first LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the Quasi-peak and average detection mode.

Corrected Amplitude & Margin Calculation

The basic equation is as follows:

$$V_C = V_R + A_C + VDF$$

Herein,

V_C : corrected voltage amplitude

V_R : reading voltage amplitude

A_C : attenuation caused by cable loss

VDF: voltage division factor of AMN or ISN

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

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

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-01	2019-09-05	2020-09-05
R&S	Test Software	EMC32	Version8.53.0	N/A	N/A
R&S	LISN	ENV 216	101614	2019-09-12	2020-09-12
R&S	EMI Test Receiver	ESCI	101121	2019-05-09	2020-05-09

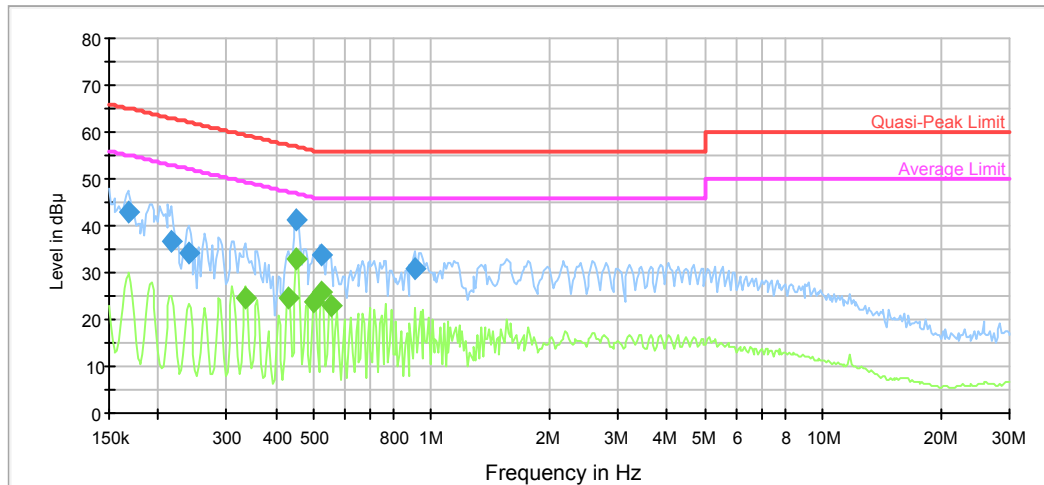
* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data

Environmental Conditions

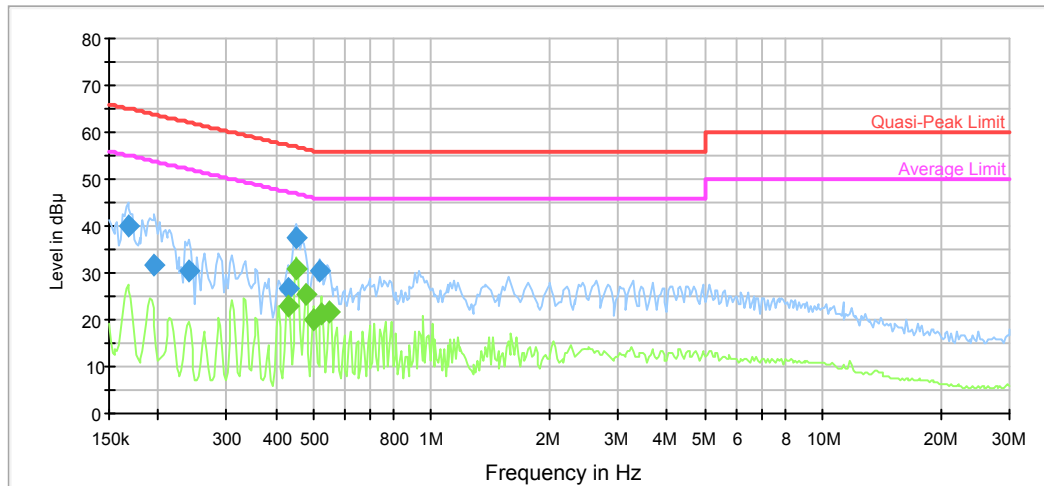
Temperature:	25.8°C
Relative Humidity:	70%
ATM Pressure:	100.8kPa
Test by:	Nayley Lao
Test Date:	2020-04-21

Test Result: Compliance

Test Mode: Charging**AC120V, 60 Hz, Line:**

Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.167350	43.0	9.000	L1	9.7	22.1	65.1
0.216762	36.5	9.000	L1	9.7	26.4	62.9
0.239440	34.4	9.000	L1	9.7	27.7	62.1
0.452652	41.1	9.000	L1	9.7	15.7	56.8
0.525514	33.7	9.000	L1	9.7	22.3	56.0
0.908365	30.8	9.000	L1	9.7	25.2	56.0

Frequency (MHz)	Average (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.335833	24.6	9.000	L1	9.7	24.7	49.3
0.430682	24.5	9.000	L1	9.7	22.7	47.2
0.452652	32.8	9.000	L1	9.7	14.0	46.8
0.500009	23.8	9.000	L1	9.7	22.2	46.0
0.525514	25.7	9.000	L1	9.7	20.3	46.0
0.552321	22.8	9.000	L1	9.7	23.2	46.0

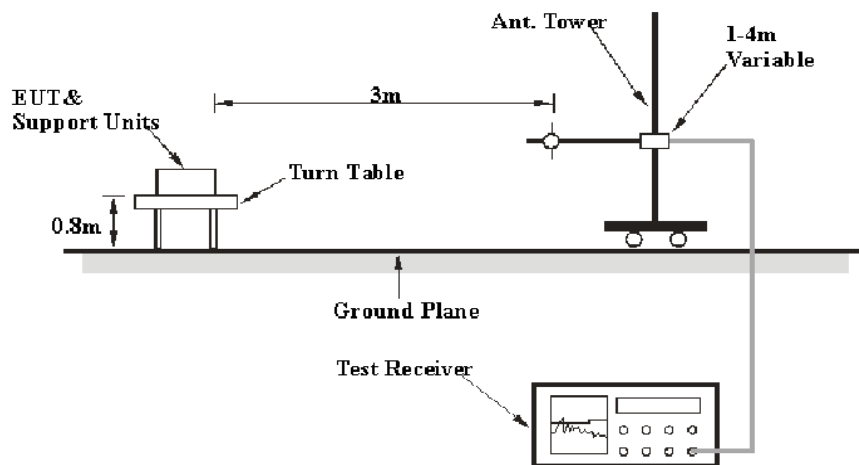
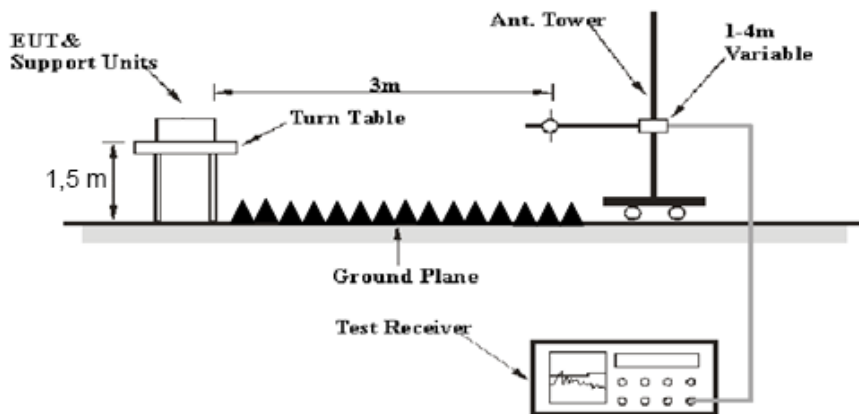
AC120V, 60 Hz, Neutral:

Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.167350	40.1	9.000	N	9.7	25.0	65.1
0.196231	31.5	9.000	N	9.7	32.3	63.8
0.239440	30.5	9.000	N	9.7	31.6	62.1
0.430682	26.8	9.000	N	9.6	30.4	57.2
0.452652	37.4	9.000	N	9.6	19.4	56.8
0.520311	30.3	9.000	N	9.6	25.7	56.0

Frequency (MHz)	Average (dBμV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.430682	22.8	9.000	N	9.6	24.4	47.2
0.452652	30.8	9.000	N	9.6	16.0	46.8
0.475741	25.5	9.000	N	9.6	20.9	46.4
0.500009	20.0	9.000	N	9.6	26.0	46.0
0.525514	21.3	9.000	N	9.6	24.7	46.0
0.546852	21.7	9.000	N	9.6	24.3	46.0

FCC §15.209, §15.205 & §15.247(d)- SPURIOUS EMISSIONS**Applicable Standard**

FCC §15.247 (d); §15.209; §15.205.

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 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

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.

Corrected Amplitude & Margin Calculation

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

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

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

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

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiation Below 1GHz					
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Sunol Sciences	Antenna	JB3	A060611-1	2017-11-10	2020-11-10
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-1400-01	2019-05-06	2020-05-06
HP	Amplifier	8447D	2727A05902	2019-09-05	2020-09-05
R&S	EMI Test Receiver	ESR3	102453	2019-06-26	2020-06-26
Radiation Above 1GHz					
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
ETS-Lindgren	Horn Antenna	3115	000 527 35	2018-10-12	2021-10-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-02 1304	2017-12-06	2020-12-05
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2019-09-05	2020-09-05
Unknown	Coaxial Cable	C-2.4J2.4J-50	C-0700-02	2019-06-27	2020-06-27
Mini-Circuit	Amplifier	ZVA-213-S+	54201245	2019-09-05	2020-09-05
Quinstar	Amplifier	QLW-18405536-JO	15964001001	2019-06-27	2020-06-27
E-Microwave	Band-stop Filters	OBSF-2400-2483.5-S	OE01601525	2019-06-16	2020-06-16
Micro-tronics	High Pass Filter	HPM50111	S/N-G217	2019-06-16	2020-06-16

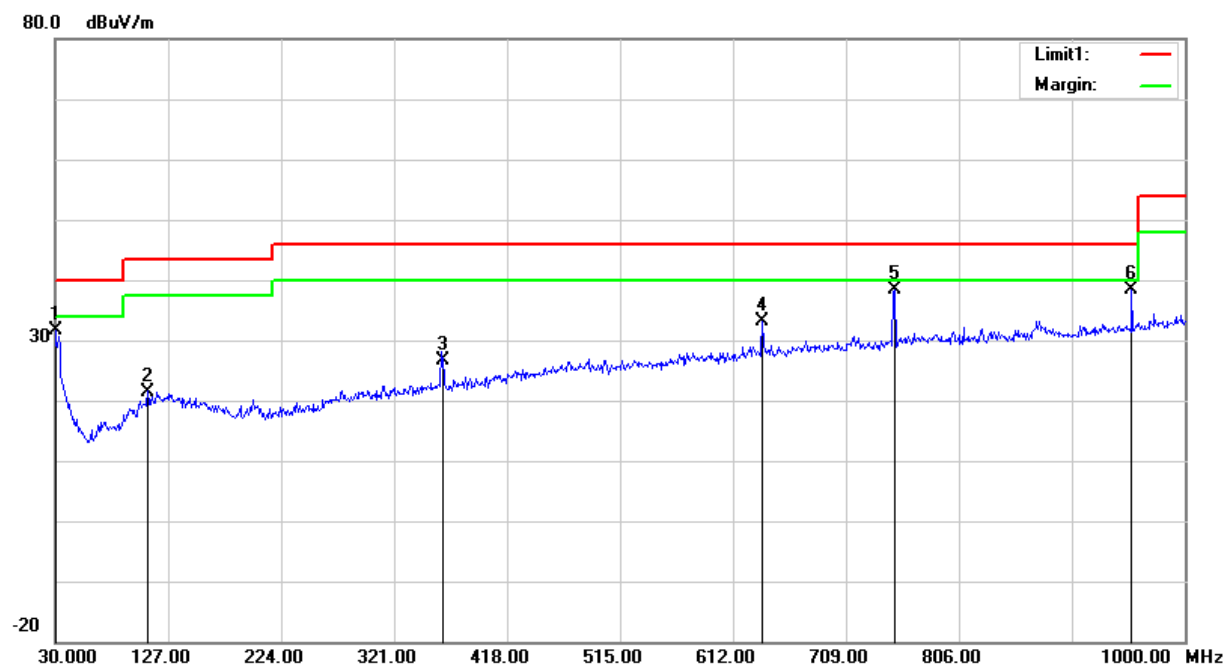
* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

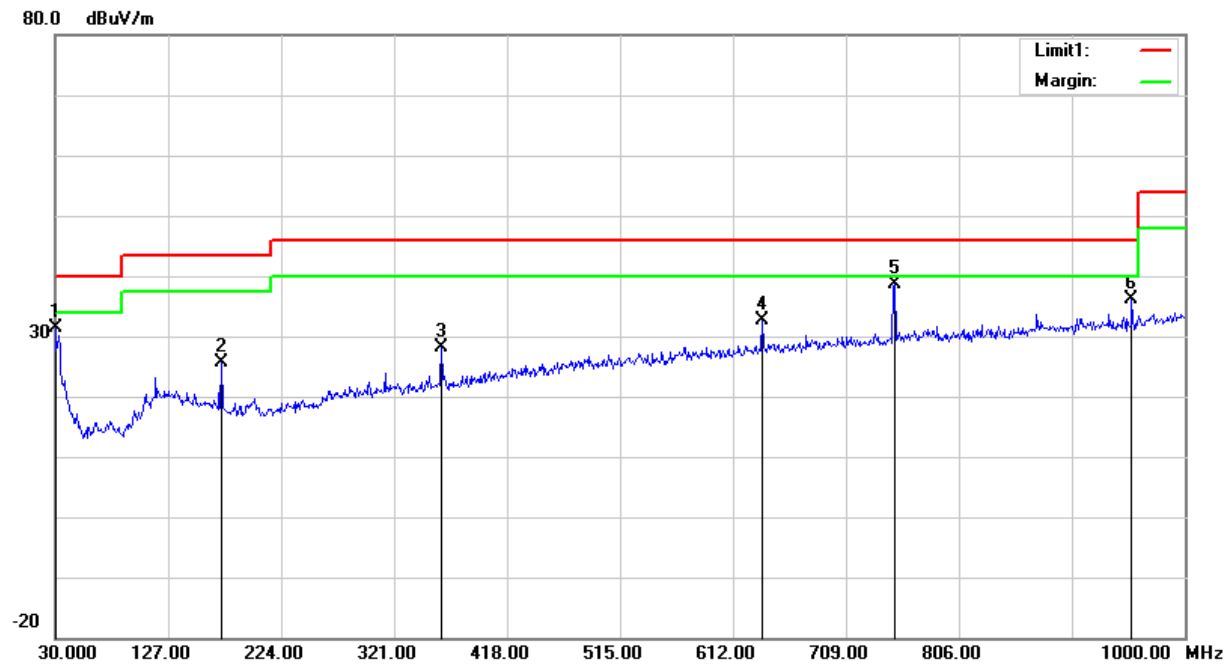
Test Items	Radiation Below 1GHz	Radiation Above 1GHz
Temperature:	26.5°C	26.5°C
Relative Humidity:	66%	66%
ATM Pressure:	101.1kPa	101.1kPa
Tester:	Jalon Liu	Jalon Liu
Test Date:	2020-04-19	2020-04-19

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	29.82	peak	1.72	31.54	40.00	8.46
109.5400	27.96	peak	-6.46	21.50	43.50	22.00
362.7100	29.52	peak	-2.81	26.71	46.00	19.29
637.2200	31.03	peak	2.20	33.23	46.00	12.77
750.7100	34.61	peak	3.66	38.27	46.00	7.73
954.4100	37.45	peak	0.82	38.27	46.00	7.73

Vertical:

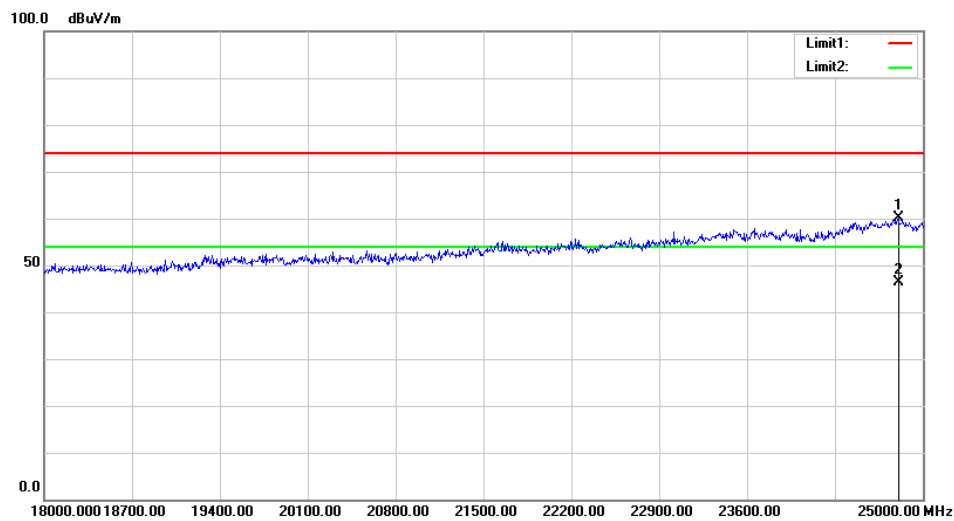
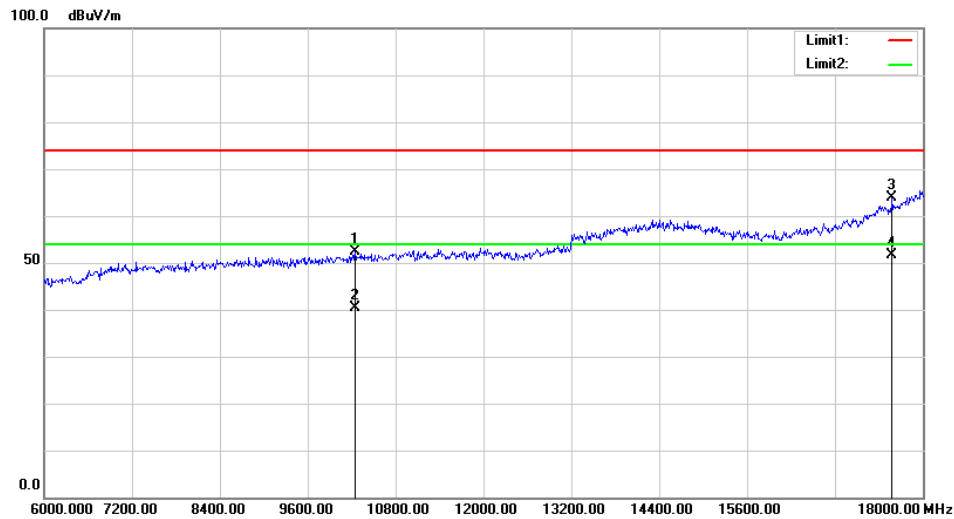
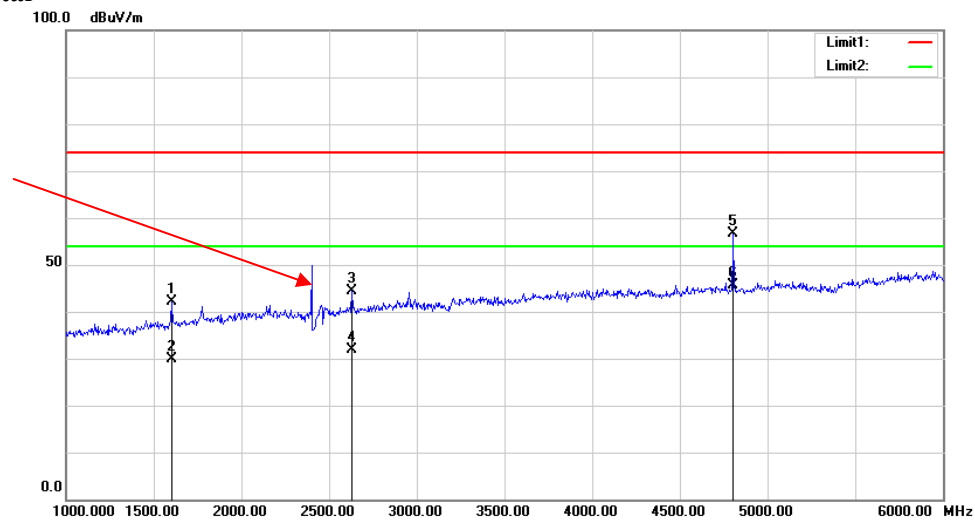
Frequency (MHz)	Receiver Reading (dB μ V)	Detector	Correction Factor (dB/m)	Cord. Amp. (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
30.0000	29.68	peak	1.72	31.40	40.00	8.60
172.5900	32.42	peak	-6.79	25.63	43.50	17.87
361.7400	30.90	peak	-2.80	28.10	46.00	17.90
637.2200	30.53	peak	2.20	32.73	46.00	13.27
750.7100	34.93	peak	3.66	38.59	46.00	7.41
954.4100	35.26	peak	0.82	36.08	46.00	9.92

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									
2390.00	26.39	PK	H	28.08	1.80	0.00	56.27	74.00	17.73
2390.00	13.36	AV	H	28.08	1.80	0.00	43.24	54.00	10.76
4804.00	46.42	PK	H	32.91	3.17	25.60	56.90	74.00	17.10
4804.00	35.42	AV	H	32.91	3.17	25.60	45.90	54.00	8.10
7206.00	37.13	PK	H	35.74	4.82	25.60	52.09	74.00	21.91
7206.00	24.26	AV	H	35.74	4.82	25.60	39.22	54.00	14.78
Middle Channel: 2441 MHz									
4882.00	45.58	PK	H	33.06	3.27	25.66	56.25	74.00	17.75
4882.00	34.41	AV	H	33.06	3.27	25.66	45.08	54.00	8.92
7323.00	36.09	PK	H	36.04	4.62	25.73	51.02	74.00	22.98
7323.00	24.02	AV	H	36.04	4.62	25.73	38.95	54.00	15.05
High Channel: 2480 MHz									
2483.50	27.71	PK	H	28.27	1.84	0.00	57.82	74.00	16.18
2483.50	13.94	AV	H	28.27	1.84	0.00	44.05	54.00	9.95
4960.00	44.17	PK	H	33.22	3.23	25.63	54.99	74.00	19.01
4960.00	32.98	AV	H	33.22	3.23	25.63	43.80	54.00	10.20
7440.00	36.01	PK	H	36.34	4.41	25.85	50.91	74.00	23.09
7440.00	23.72	AV	H	36.34	4.41	25.85	38.62	54.00	15.38

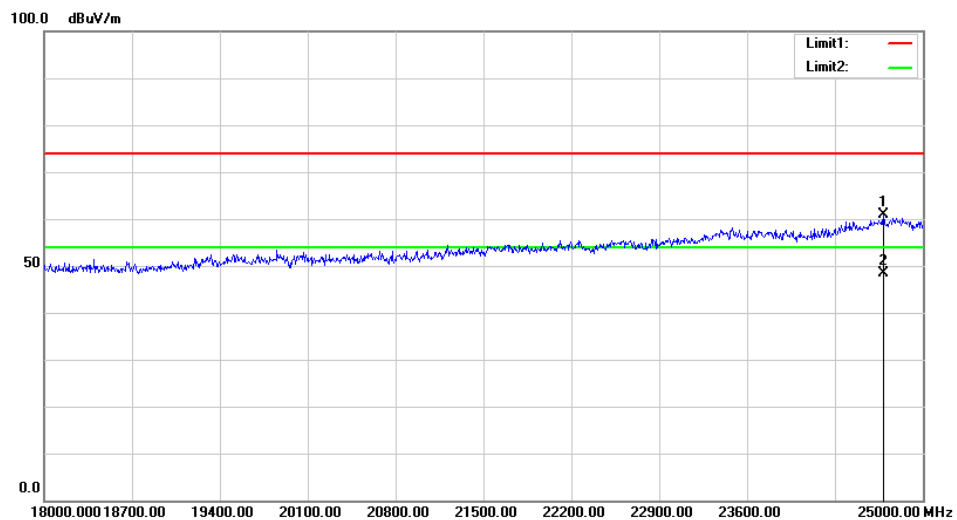
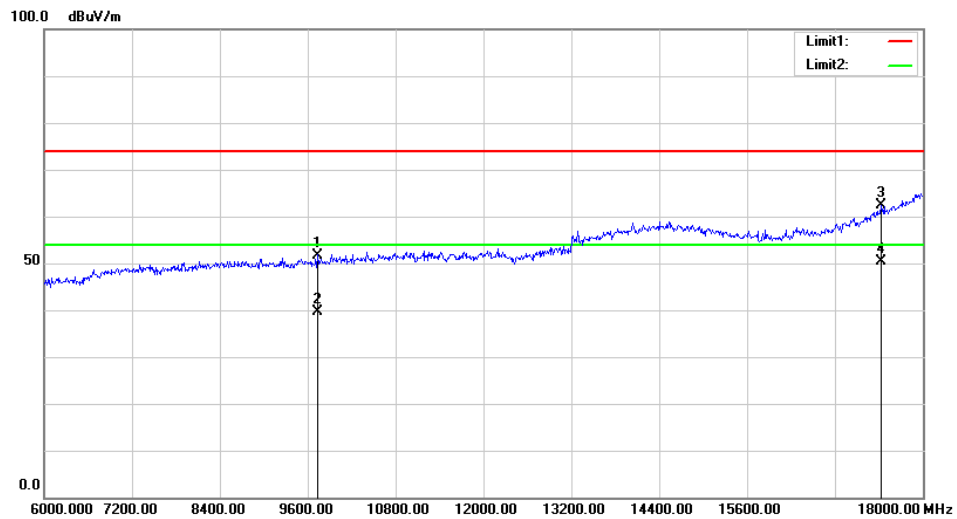
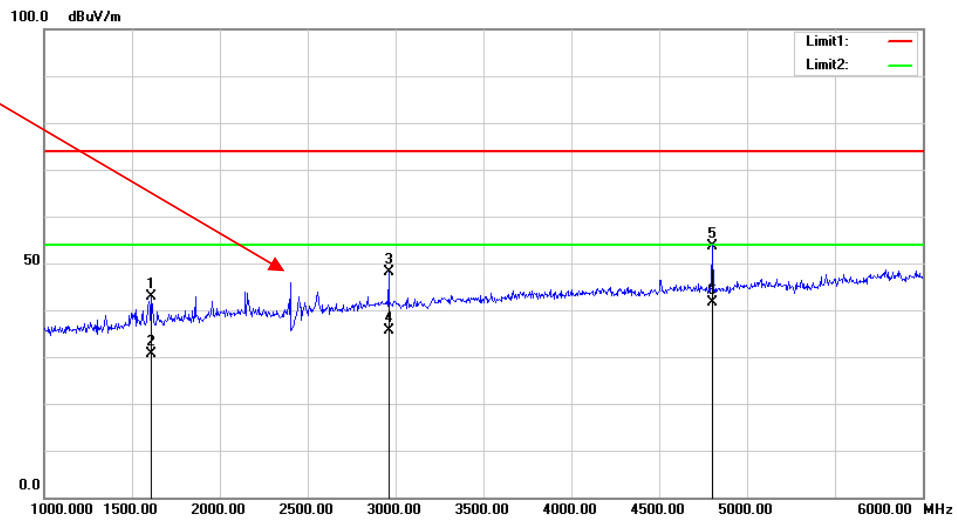
Worst plots(*GFSK Low channel*)
Horizontal

Fundamental
Test with Band
Rejection Filter



Vertical

Fundamental
Test with Band
Rejection Filter



FCC §15.247(a) (1) - CHANNEL SEPARATION TEST**Applicable Standard**

According to FCC §15.247(a) (1).

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 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	FSU 26	200256	2019-05-09	2020-05-09
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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:	52%
ATM Pressure:	101.6 Pa
Tester:	Jay Xie
Test Date:	2020-04-16

Test Result: Compliance.

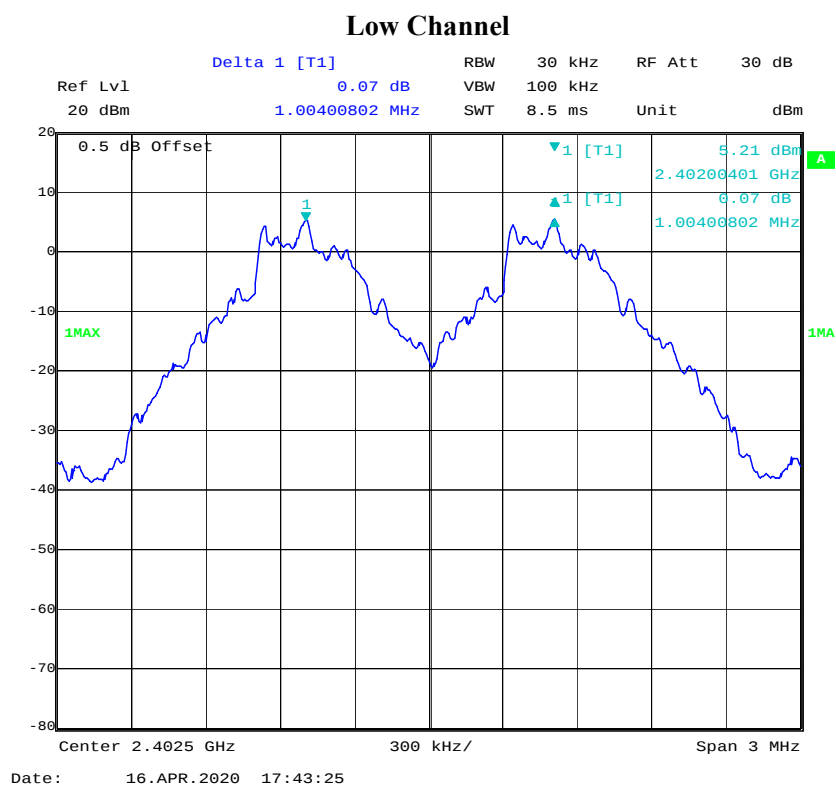
Please refer to following tables and plots

Test Mode: Transmitting

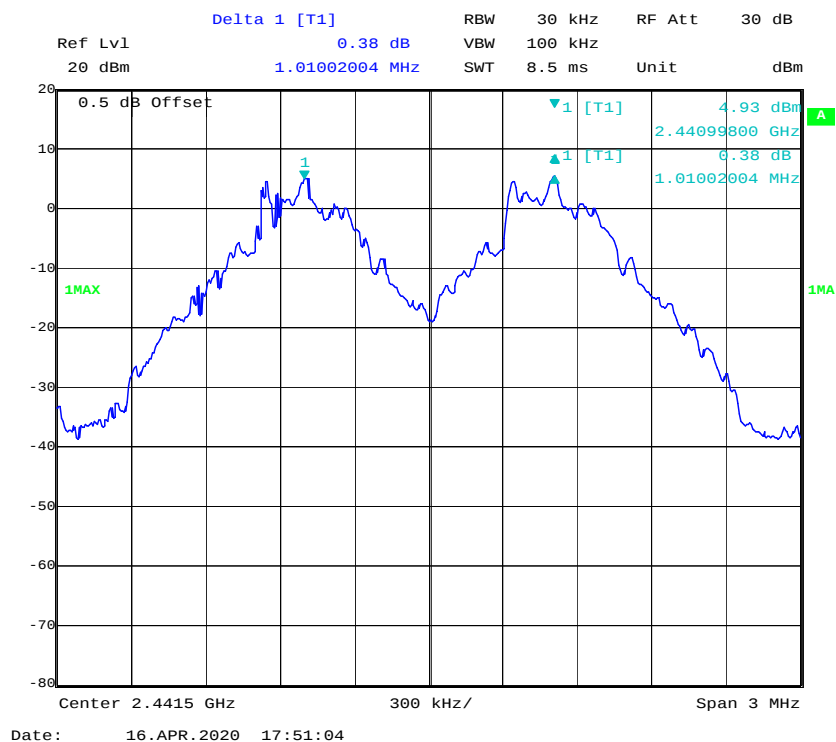
Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
BDR (GFSK)	Low	2402	1.004	0.58
	Middle	2441	1.010	0.57
	High	2480	1.004	0.57
EDR ($\pi/4$ -DQPSK)	Low	2402	0.998	0.81
	Middle	2441	1.004	0.81
	High	2480	0.986	0.81
EDR (8DPSK)	Low	2402	1.004	0.81
	Middle	2441	1.004	0.81
	High	2480	0.998	0.81

Note: Limit= $(2/3) \times 20\text{dB bandwidth}$

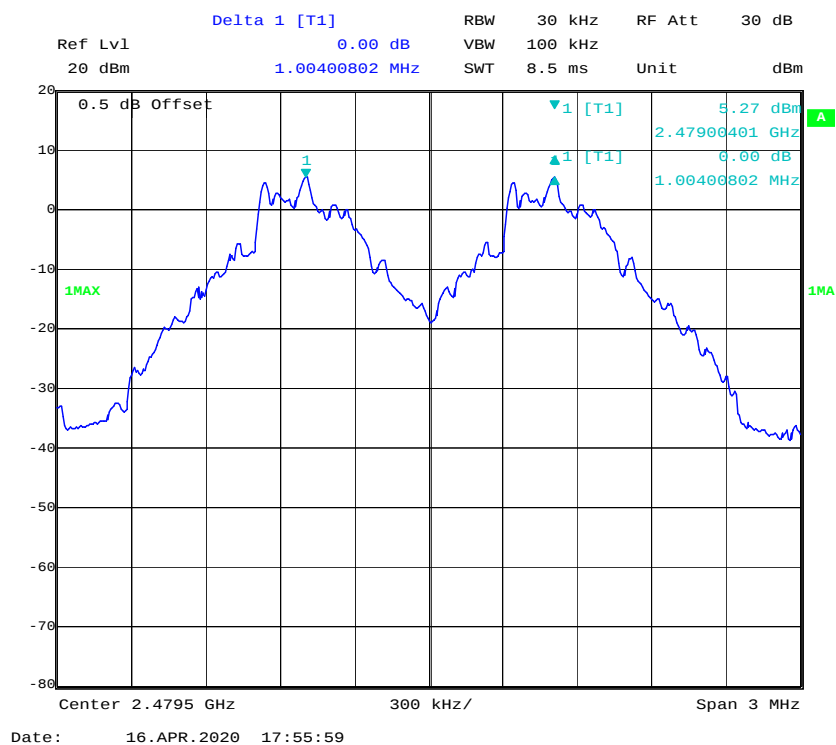
BDR Mode (GFSK):

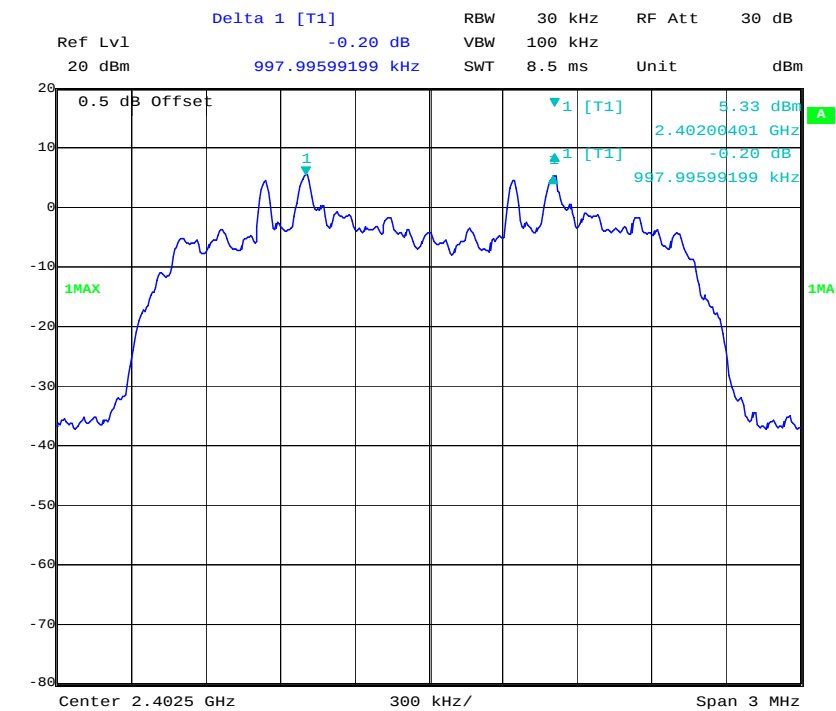


Middle Channel

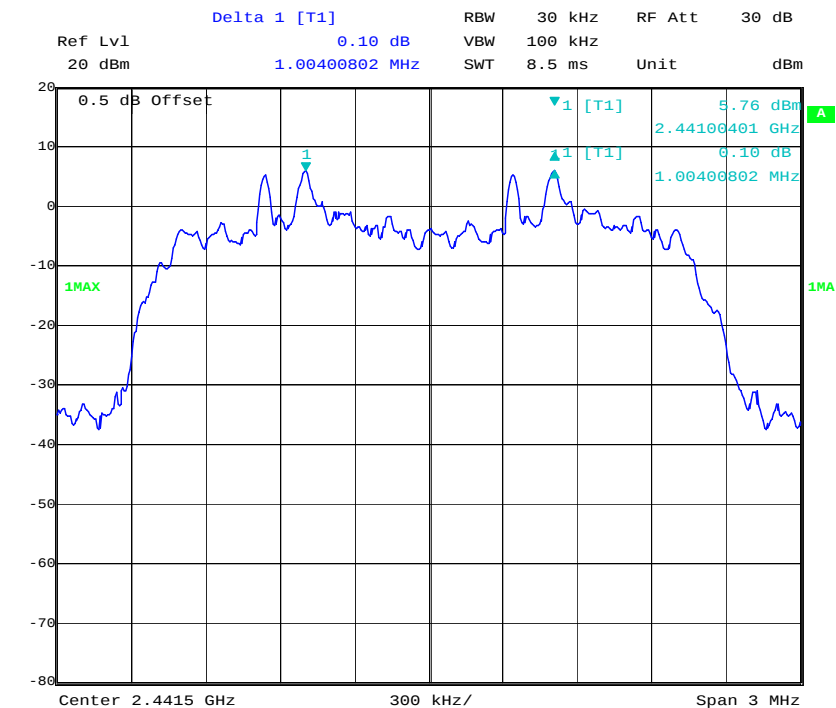


High Channel



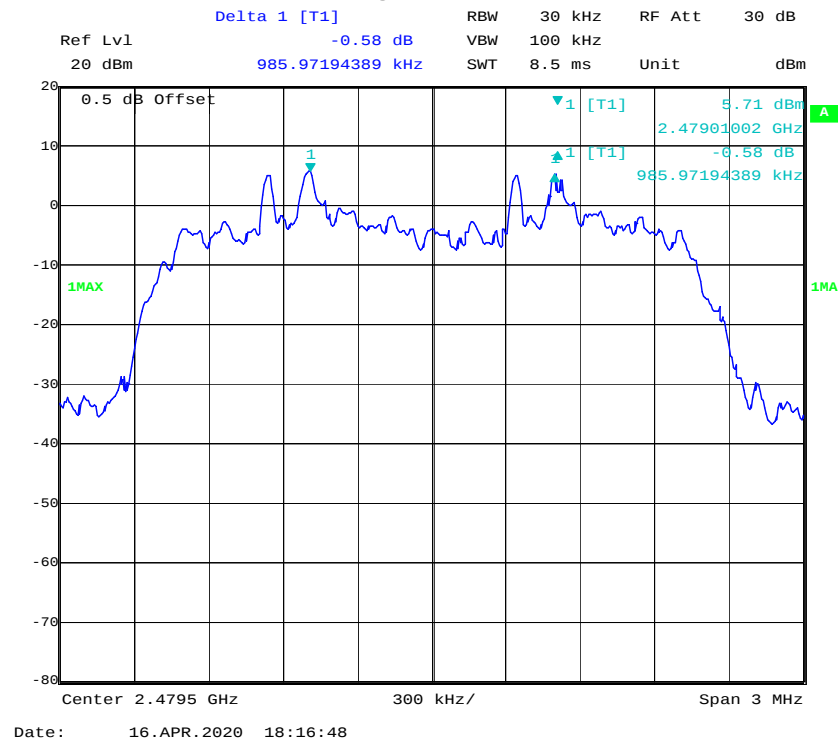
*EDR Mode ($\pi/4$ -DQPSK):***Low Channel**

Date: 16.APR.2020 18:00:33

Middle Channel

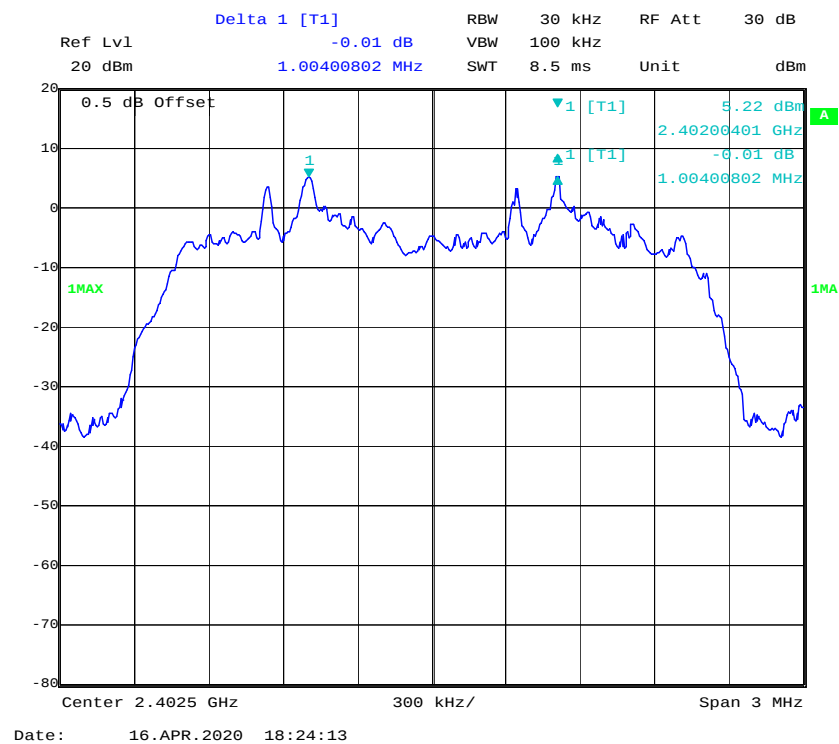
Date: 16.APR.2020 18:13:01

High Channel

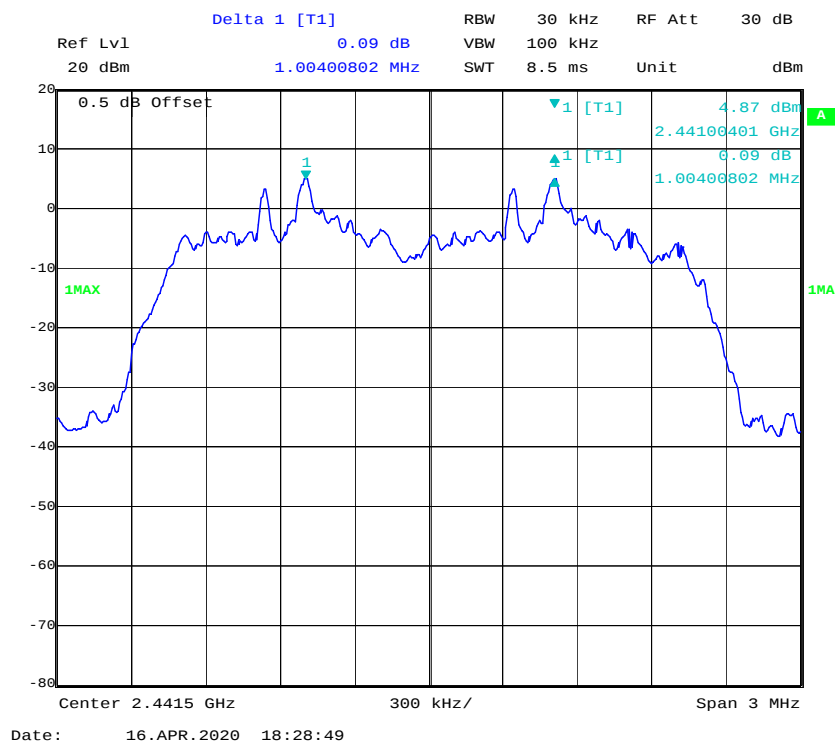


EDR Mode (8DPSK):

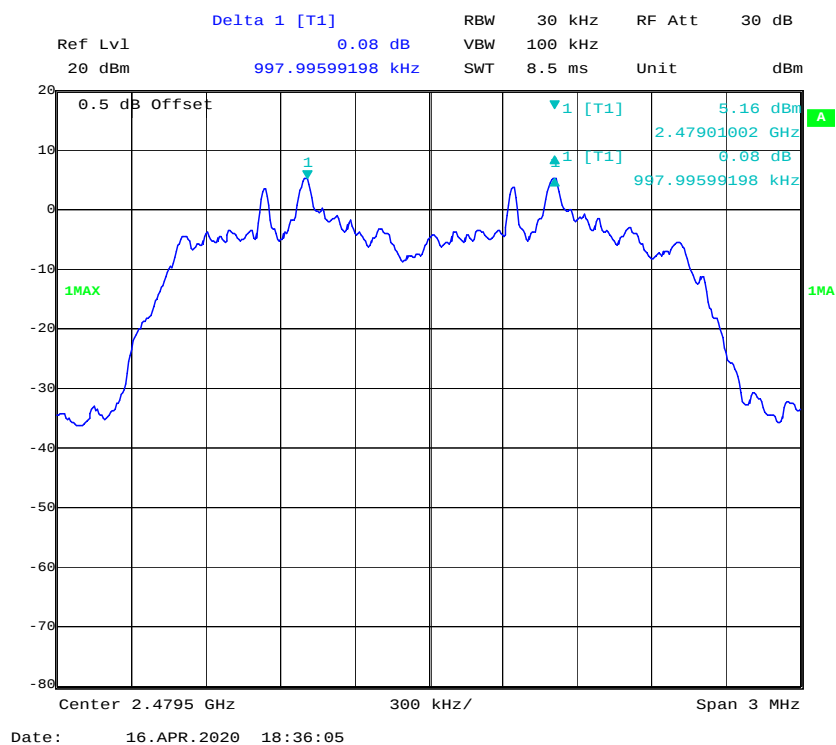
Low Channel



Middle Channel



High Channel



RSS-247 CLUASE 5.1– 20 dB 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.

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	FSU 26	200256	2019-05-09	2020-05-09
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	Each time	N/A
R&S	Spectrum Analyzer	FSP 38	100478	2019-12-10	2020-12-10

* **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:	23.9~26°C
Relative Humidity:	52~69%
ATM Pressure:	100.5~101.6 Pa
Tester:	Jay Xie
Test Date:	2020-04-22

Test Result: Compliance.

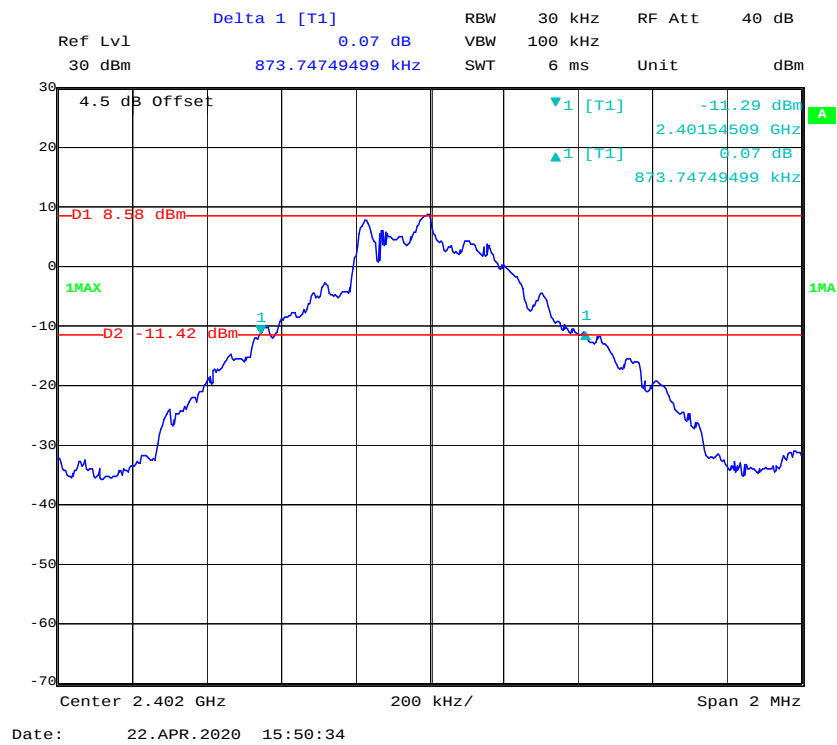
Please refer to following tables and plots

Test Mode: Transmitting

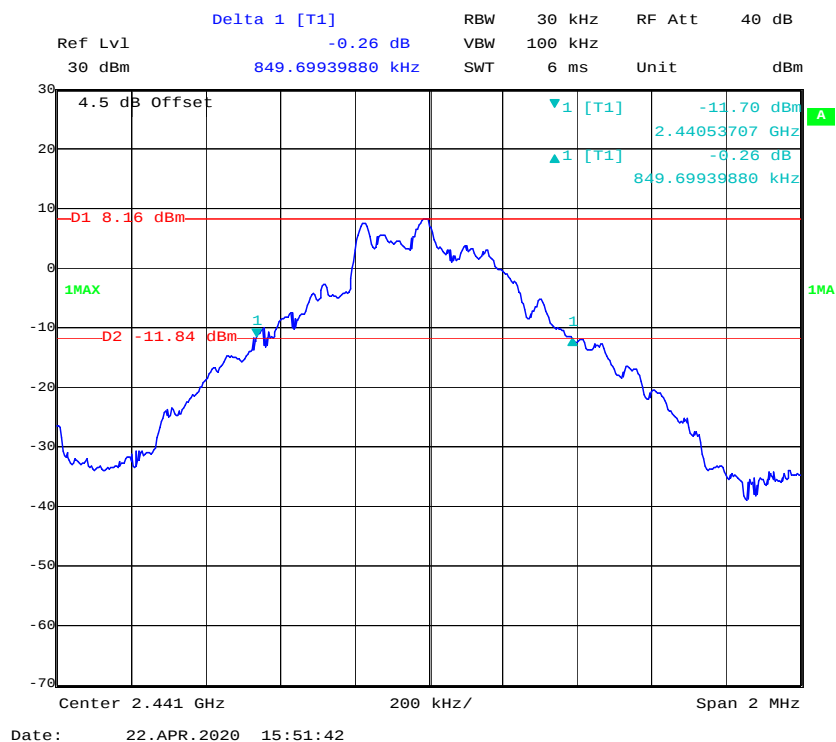
Mode	Channel	Frequency (MHz)	20 dB Bandwidth (MHz)
BDR Mode (GFSK)	Low	2402	0.874
	Middle	2441	0.850
	High	2480	0.854
EDR Mode ($\pi/4$ -DQPSK)	Low	2402	1.218
	Middle	2441	1.222
	High	2480	1.222
EDR Mode (8DPSK)	Low	2402	1.218
	Middle	2441	1.218
	High	2480	1.222

BDR Mode (GFSK):

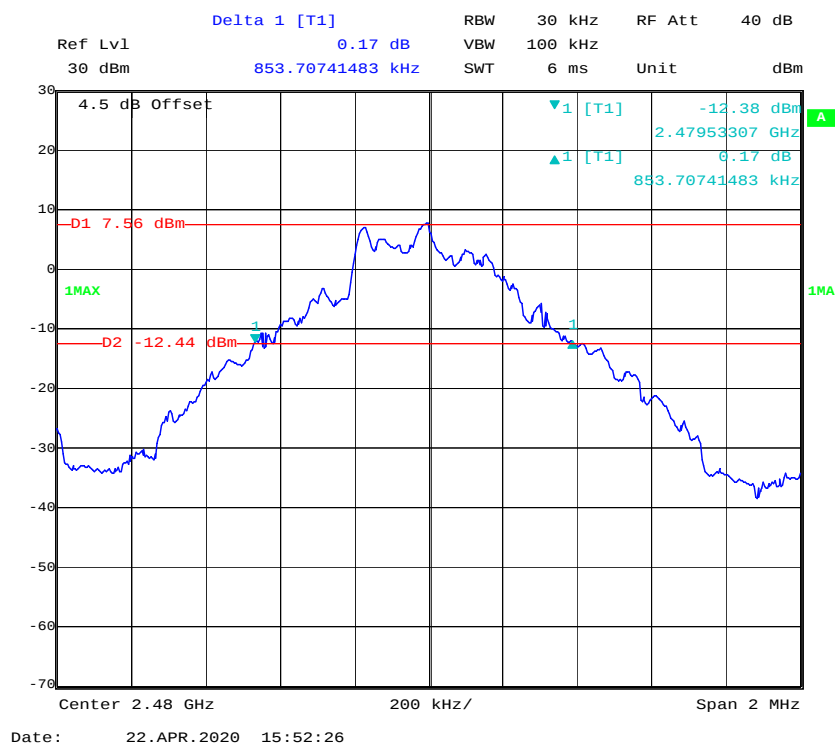
Low Channel



Middle Channel



High Channel

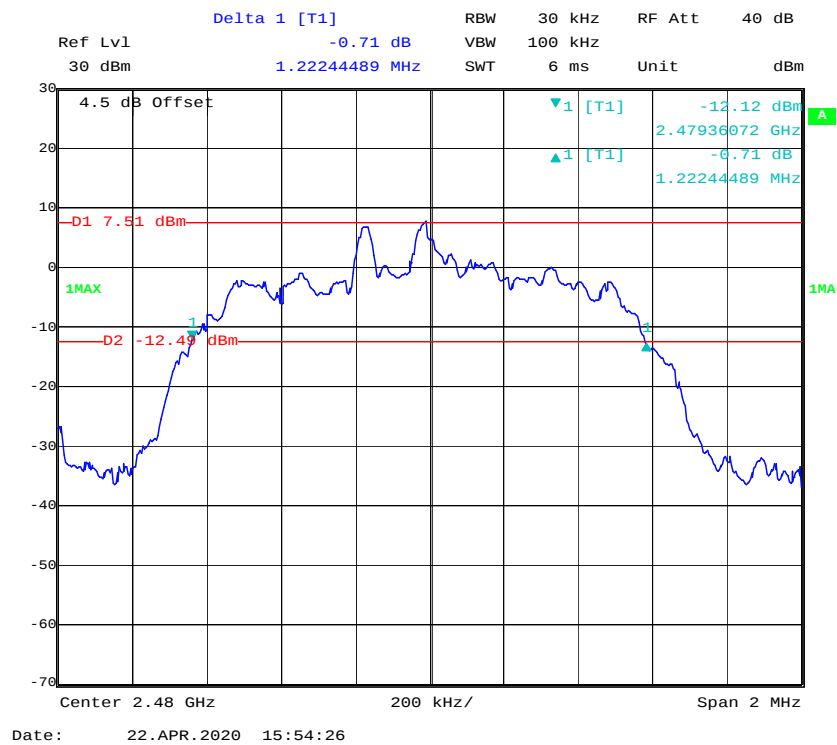


Low Channel



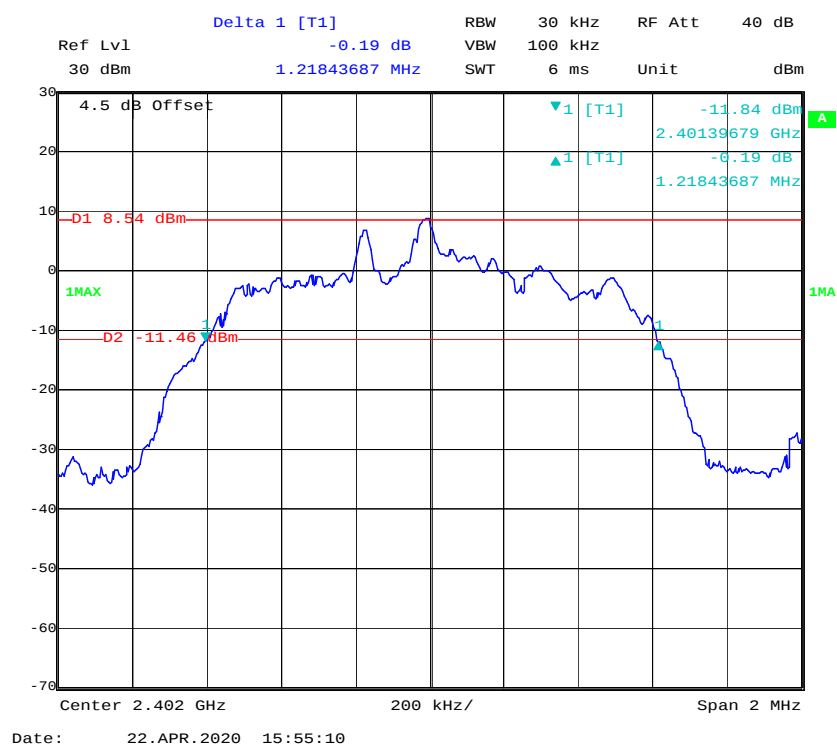
Date: 22.APR.2020 15:53:55

High Channel

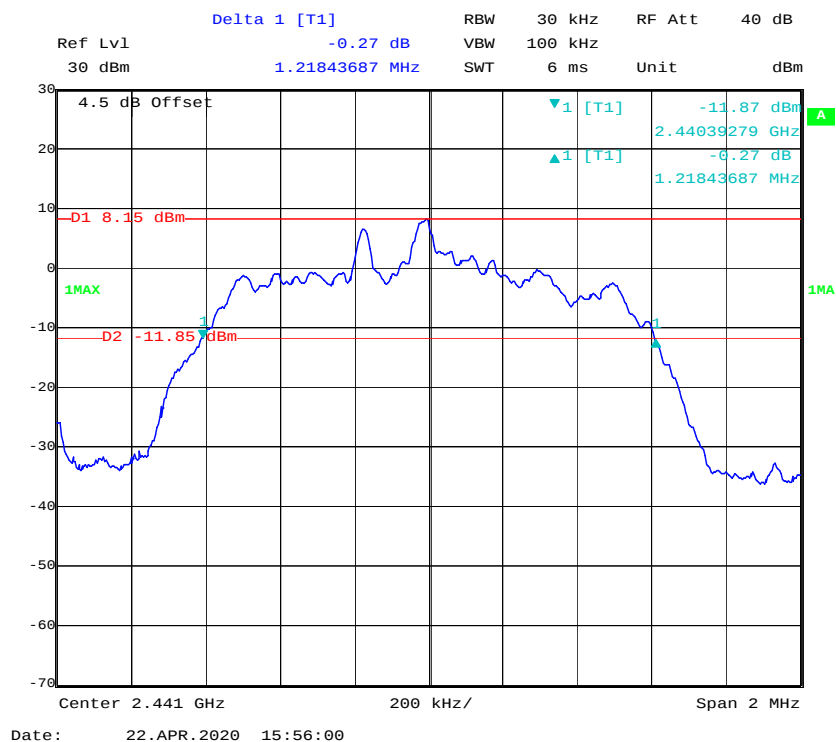


EDR Mode (8DPSK):

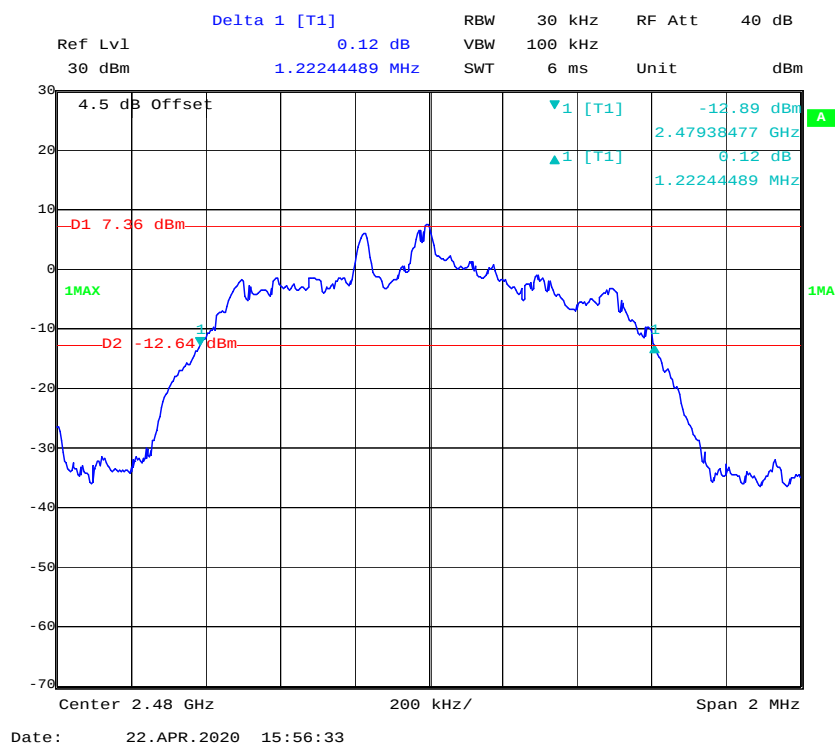
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (1) (iii) - 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.

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	FSU 26	200256	2019-05-09	2020-05-09
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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

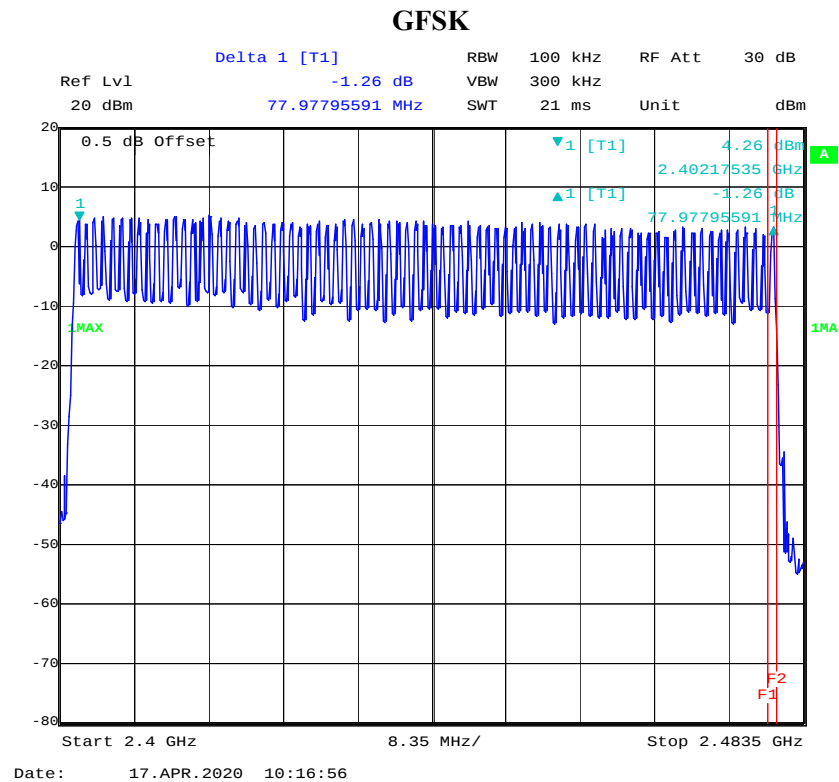
Temperature:	23.9°C
Relative Humidity:	52%
ATM Pressure:	101.6 Pa
Tester:	Jay Xie
Test Date:	2020-04-16~2020-04-17

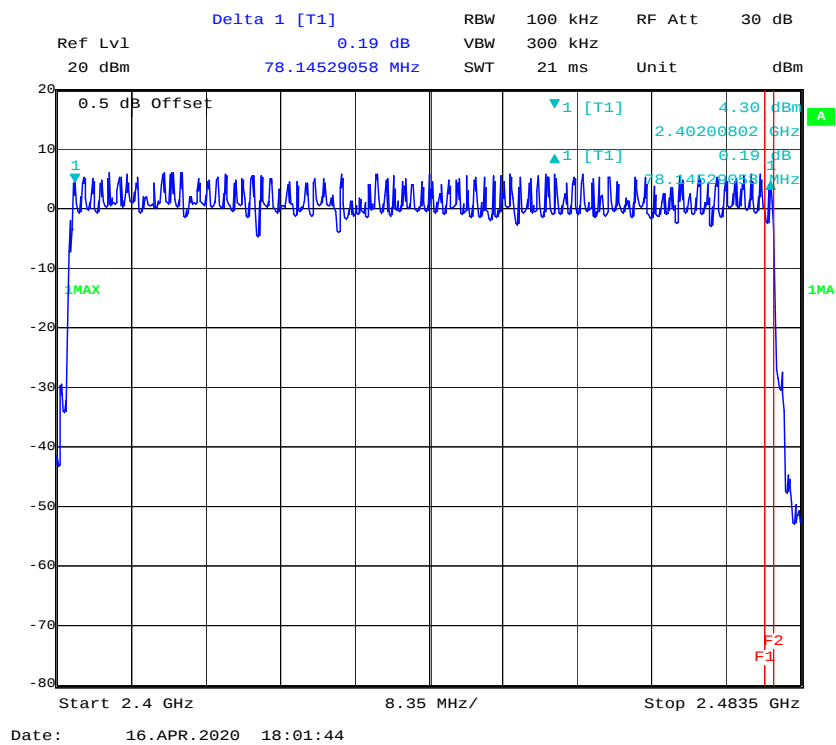
Test Result: Compliance.

Please refer to following tables and plots

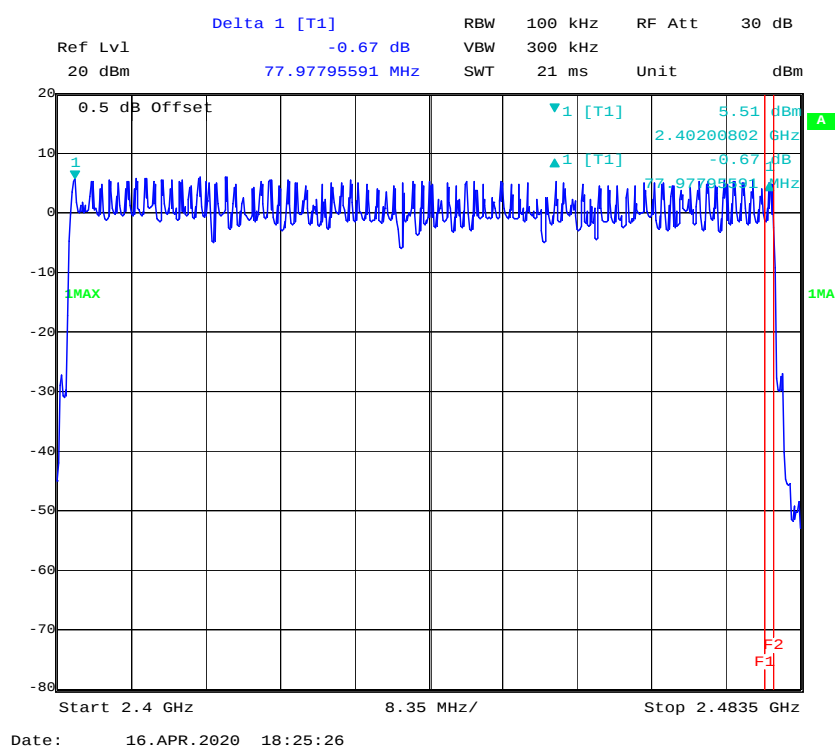
Test Mode: Transmitting

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



$\pi/4$ -DQPSK

8DPSK



FCC §15.247(a) (1) (iii) - 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.

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	FSU 26	200256	2019-05-09	2020-05-09
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	Each time	N/A

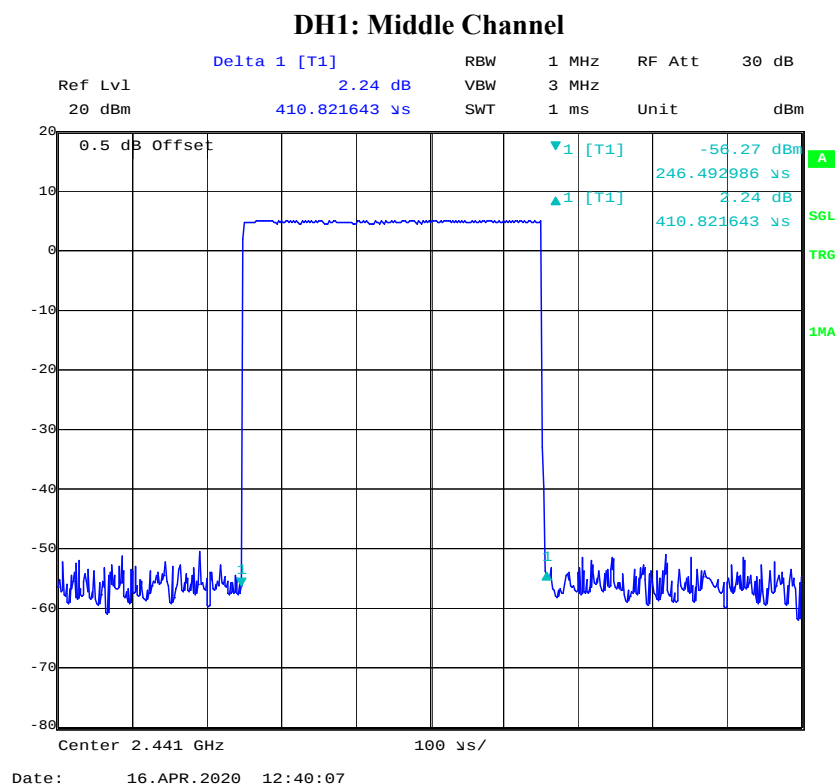
* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

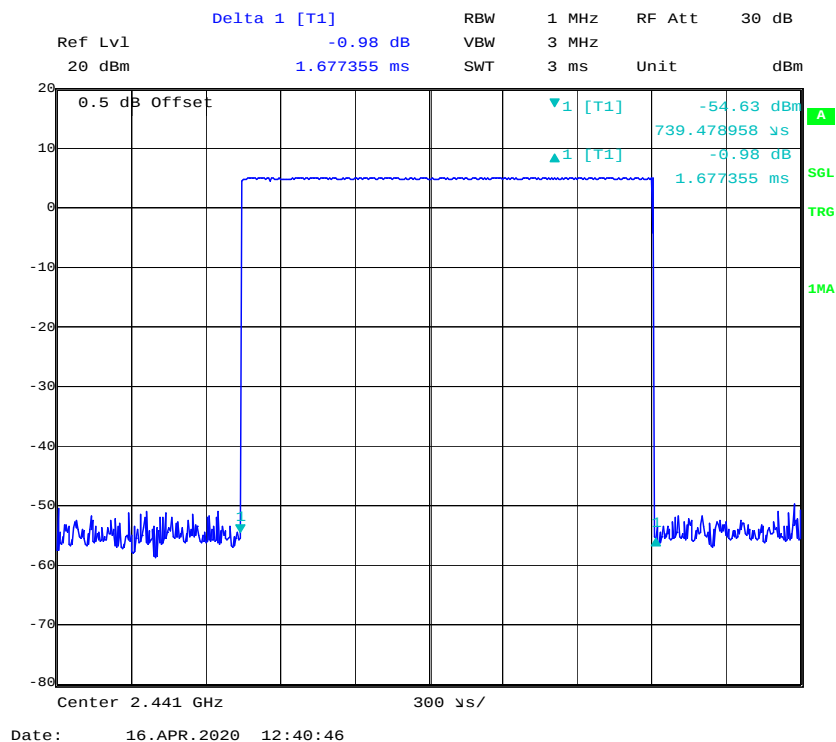
Temperature:	23.9°C
Relative Humidity:	52%
ATM Pressure:	101.6 Pa
Tester:	Jay Xie
Test Date:	2020-04-16

Test Mode: Transmitting

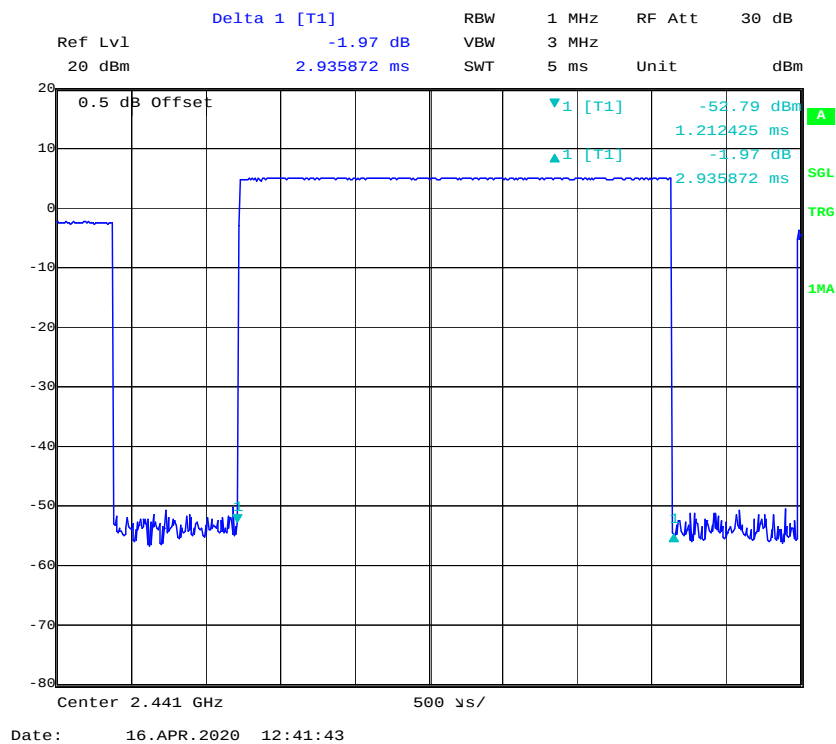
Mode	Packet type	Channel	Frequency (MHz)	Puse width (ms)	Result (s)	Limit (s)
GFSK	DH1	Middle	2441	0.411	0.132	0.4
	DH3	Middle	2441	1.677	0.268	
	DH5	Middle	2441	2.936	0.313	
$\pi/4$ -DQPSK	2DH1	Middle	2441	0.419	0.134	
	2DH3	Middle	2441	1.677	0.268	
	2DH5	Middle	2441	2.946	0.314	
8DPSK	3DH1	Middle	2441	0.419	0.134	
	3DH3	Middle	2441	1.677	0.268	
	3DH5	Middle	2441	2.936	0.313	
Note: DH1:Dwell time=Pulse time (ms) $\times$ (1600/2/79) $\times$ 31.6 s DH3:Dwell time=Pulse time (ms) $\times$ (1600/4/79) $\times$ 31.6 s DH5:Dwell time=Pulse time (ms) $\times$ (1600/6/79) $\times$ 31.6 s						

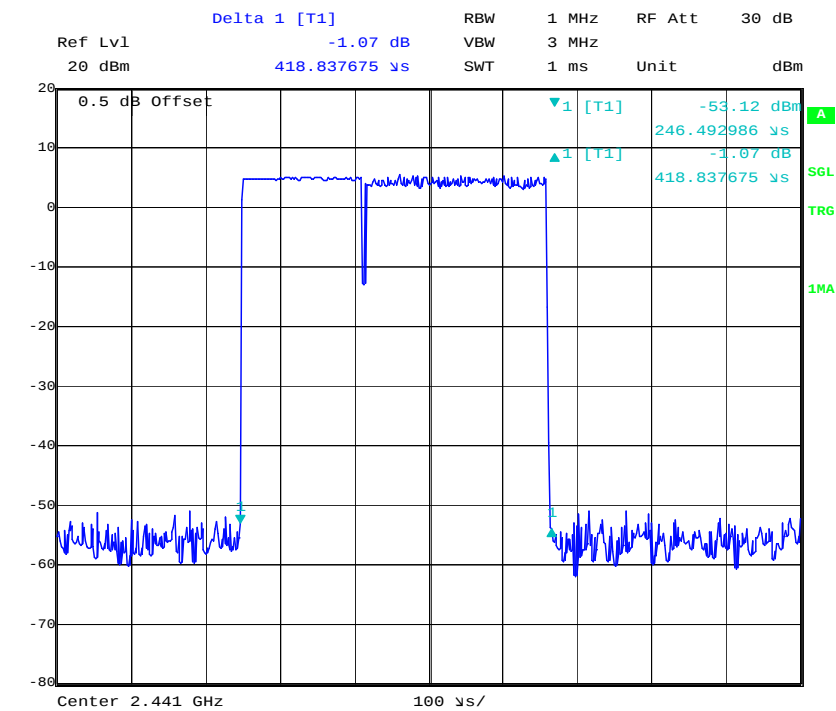
BDR Mode (GFSK):

DH3: Middle Channel

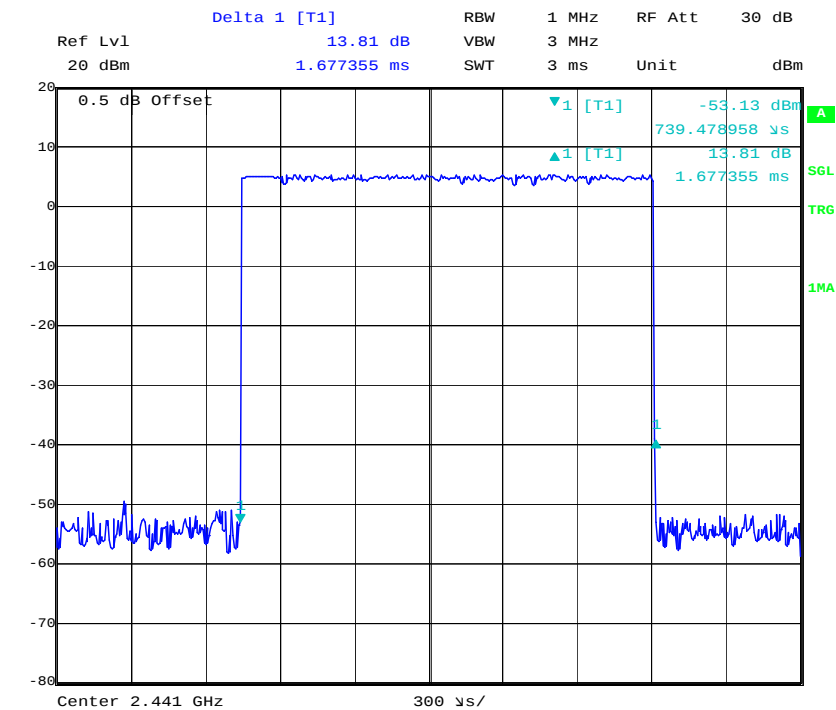


DH5: Middle Channel

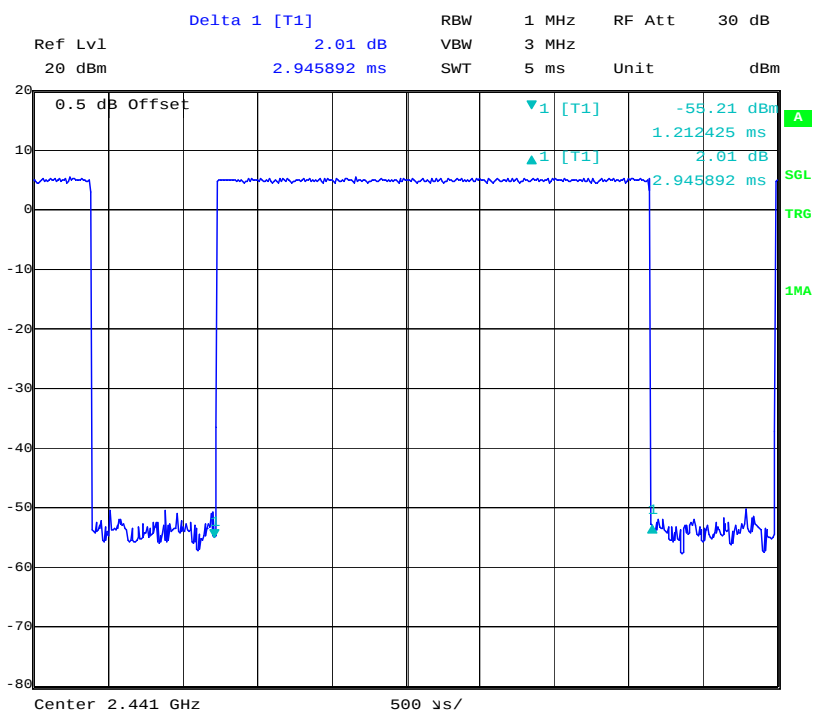


*EDR Mode ($\pi/4$ -DQPSK):***2DH1: Middle Channel**

Date: 16.APR.2020 13:26:49

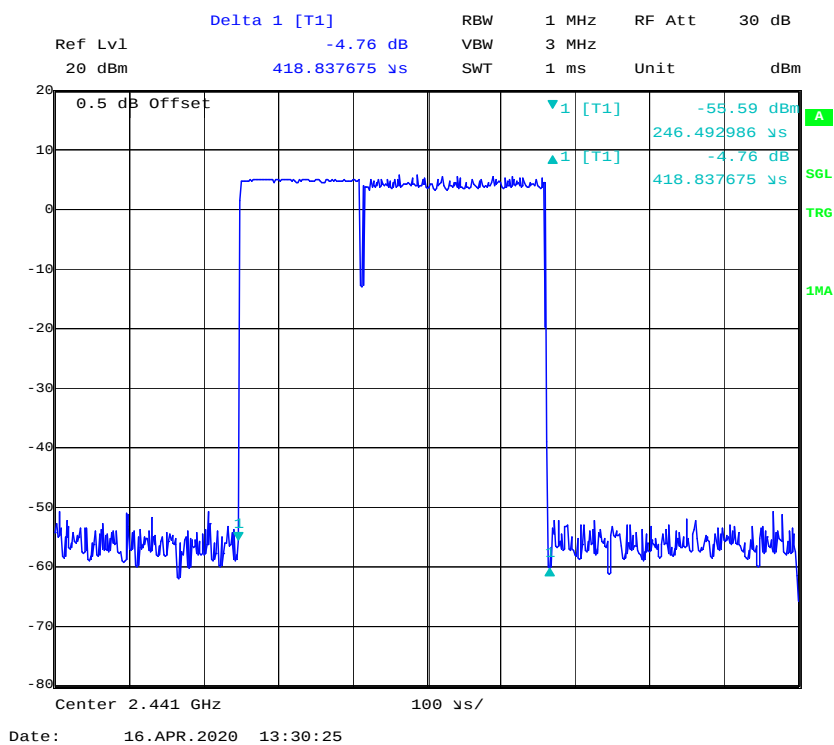
2DH3: Middle Channel

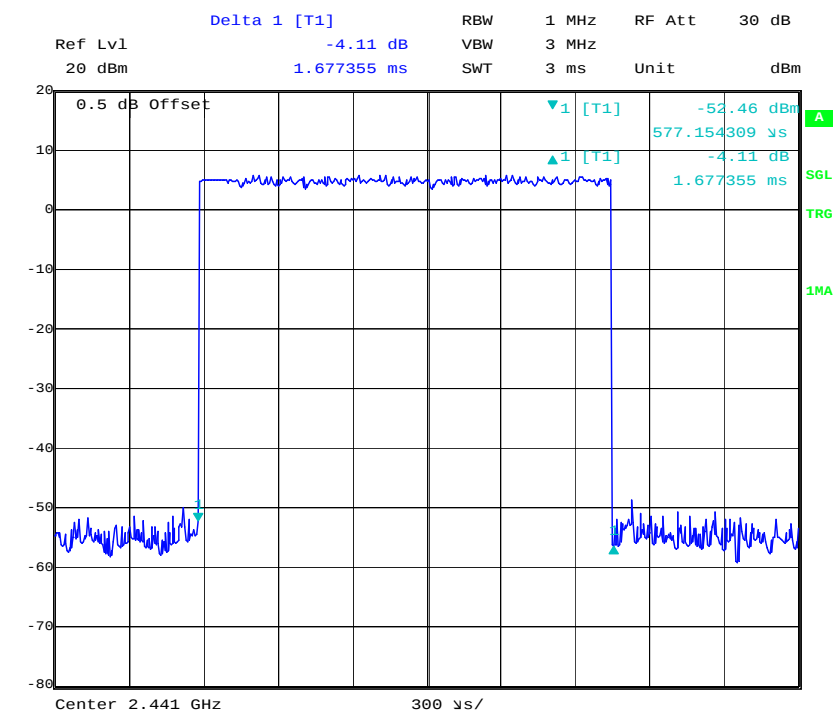
Date: 16.APR.2020 13:38:25

2DH5: Middle Channel

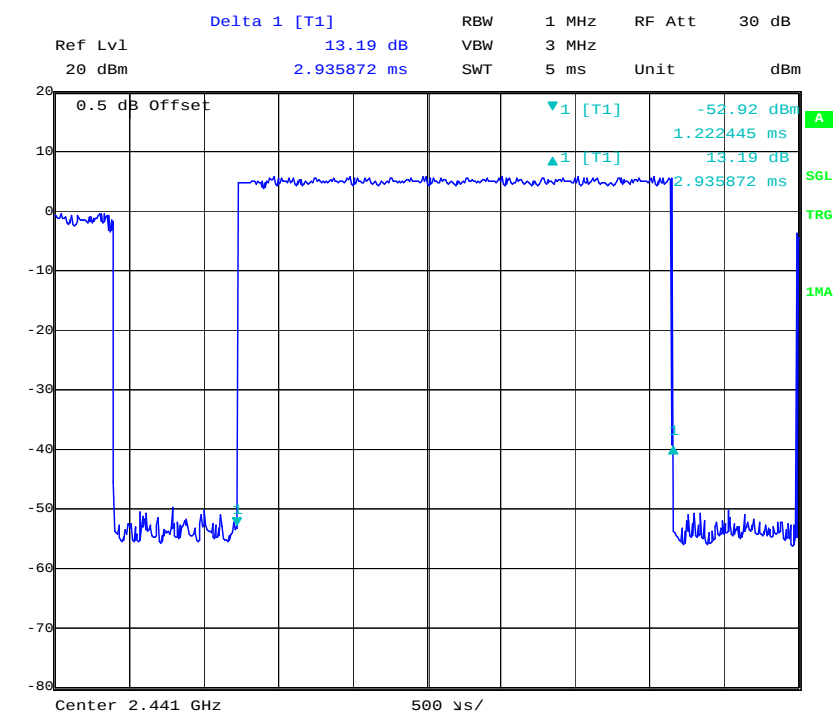
Date: 16.APR.2020 13:29:58

EDR Mode (8DPSK):

3DH1: Middle Channel

3DH3: Middle Channel

Date: 16.APR.2020 13:30:48

3DH5: Middle Channel

Date: 16.APR.2020 13:33:46

FCC §15.247(b) (1) - 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

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
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	Each time	N/A
Agilent	USB Wideband Power Sensor	U2021XA	MY54080014	2019-05-09	2020-05-09

* **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:	52%
ATM Pressure:	101.6 Pa
Tester:	Jay Xie
Test Date:	2020-04-16

Test Result: Compliance.

Test Mode: Transmitting

Mode	Frequency (MHz)	Peak Conducted Output power (dBm)	Limit (dBm)
BDR Mode (GFSK)	2402	5.70	21
	2441	5.70	21
	2480	5.70	21
EDR Mode ($\pi/4$ -DQPSK)	2402	6.38	21
	2441	6.86	21
	2480	6.76	21
EDR Mode (8DPSK)	2402	7.10	21
	2441	6.27	21
	2480	6.38	21

Note: The data above was tested in conducted mode, the antenna gain is 1.36 dBi.

FCC §15.247(d)- 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)).

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	FSU 26	200256	2019-05-09	2020-05-09
Unknown	Coaxial Cable	C-SJ00-0010	C0010/04	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).

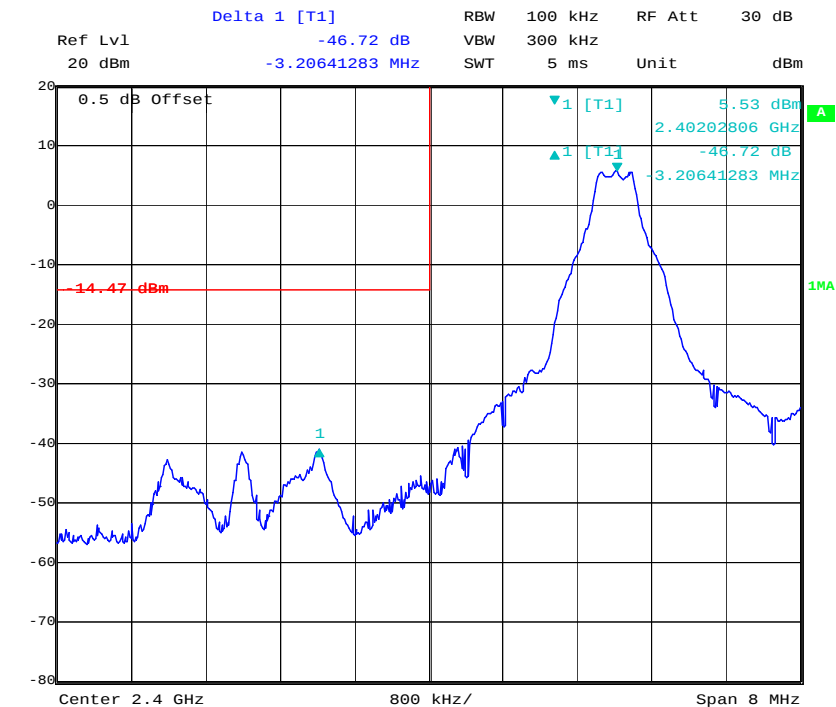
Test Data**Environmental Conditions**

Temperature:	23.9°C
Relative Humidity:	52%
ATM Pressure:	101.6 Pa
Tester:	Jay Xie
Test Date:	2020-04-16

Test Result: Compliance

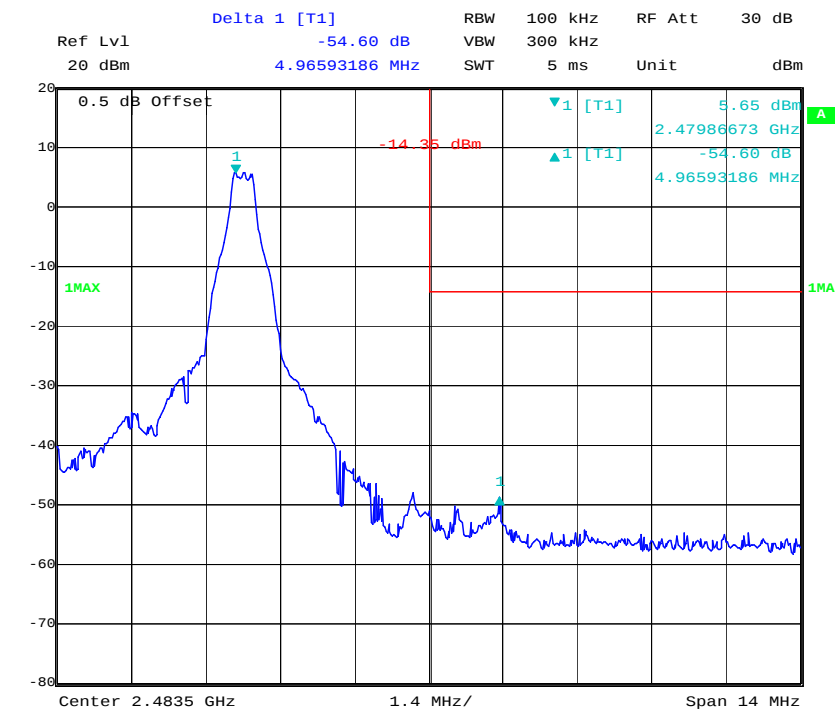
Single mode:
BDR Mode (GFSK):

Band Edge, Left Side

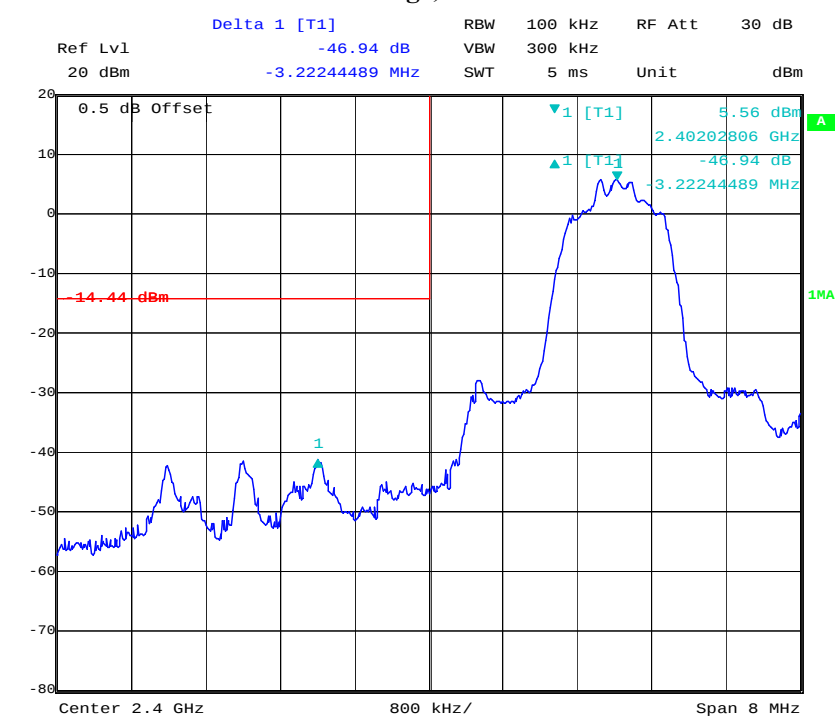
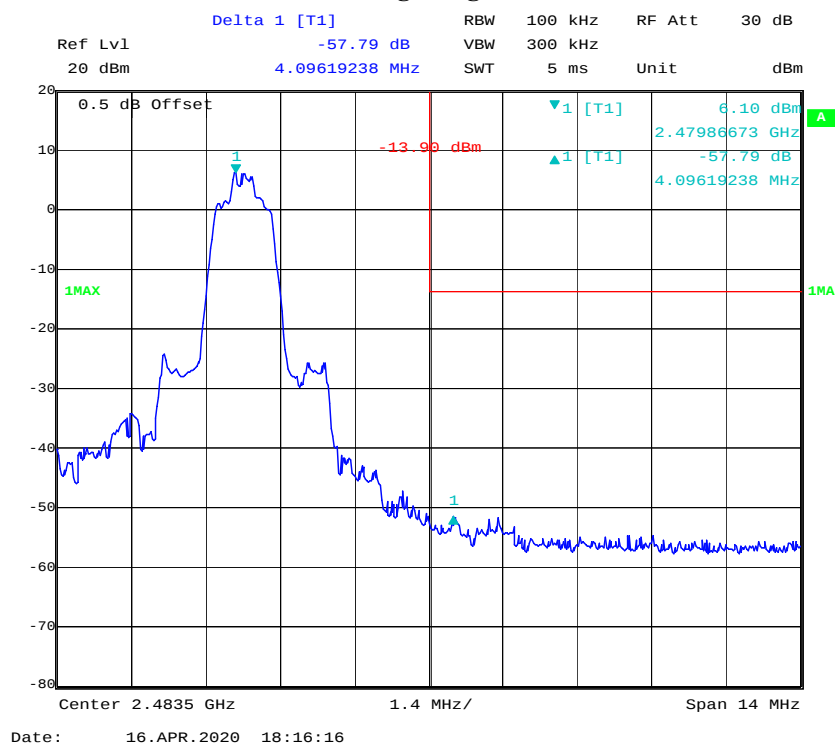


Date: 16.APR.2020 17:42:20

Band Edge, Right Side

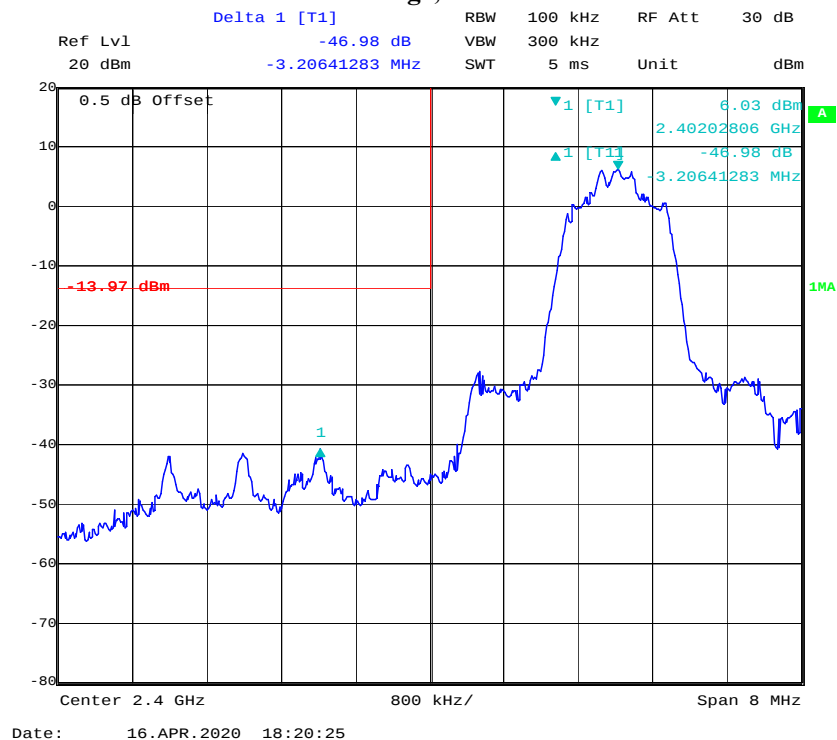


Date: 16.APR.2020 17:55:23

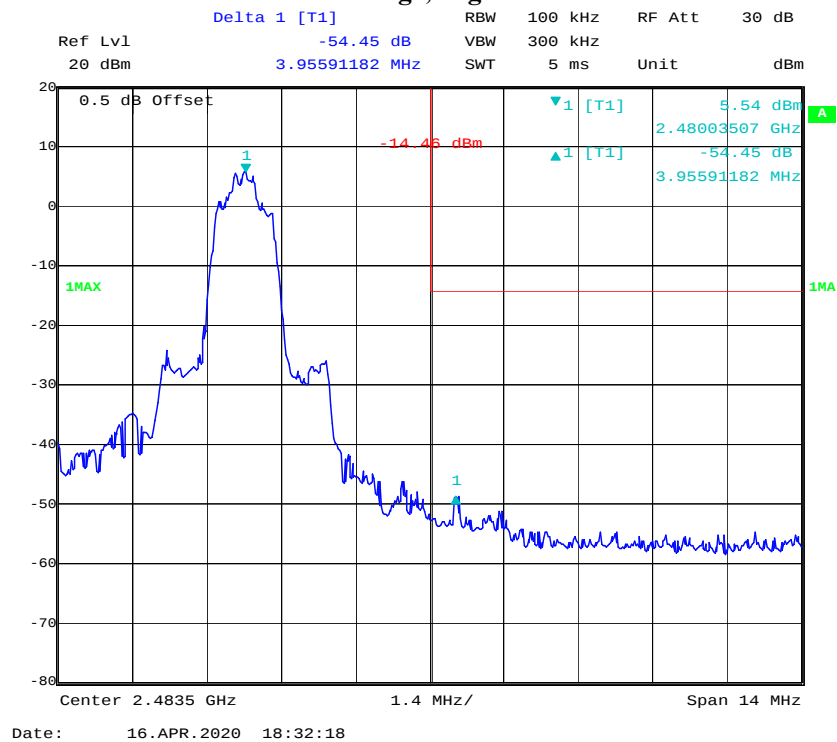
*EDR Mode ($\pi/4$ -DQPSK):***Band Edge, Left Side****Band Edge, Right Side**

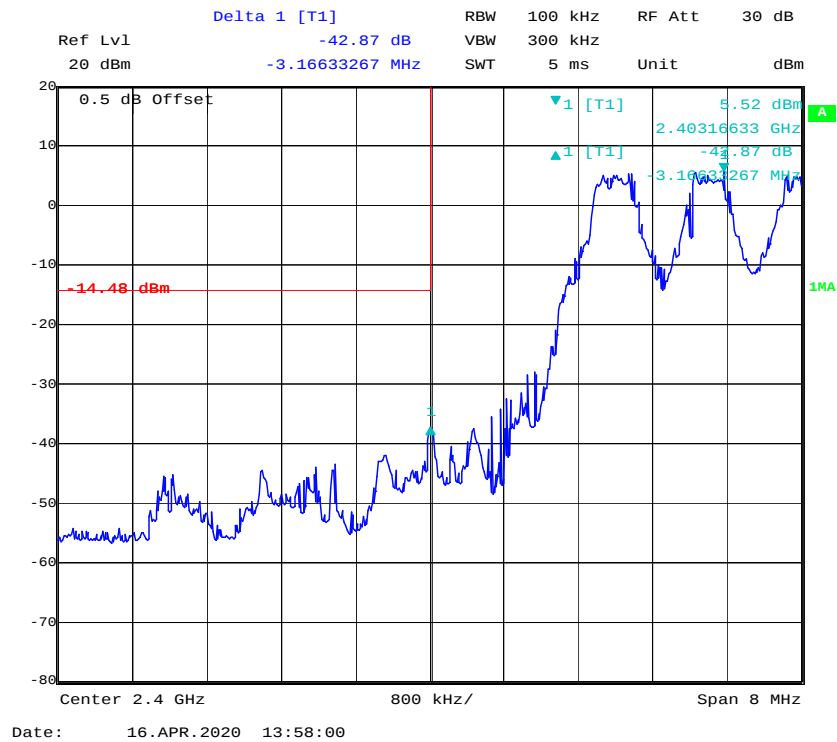
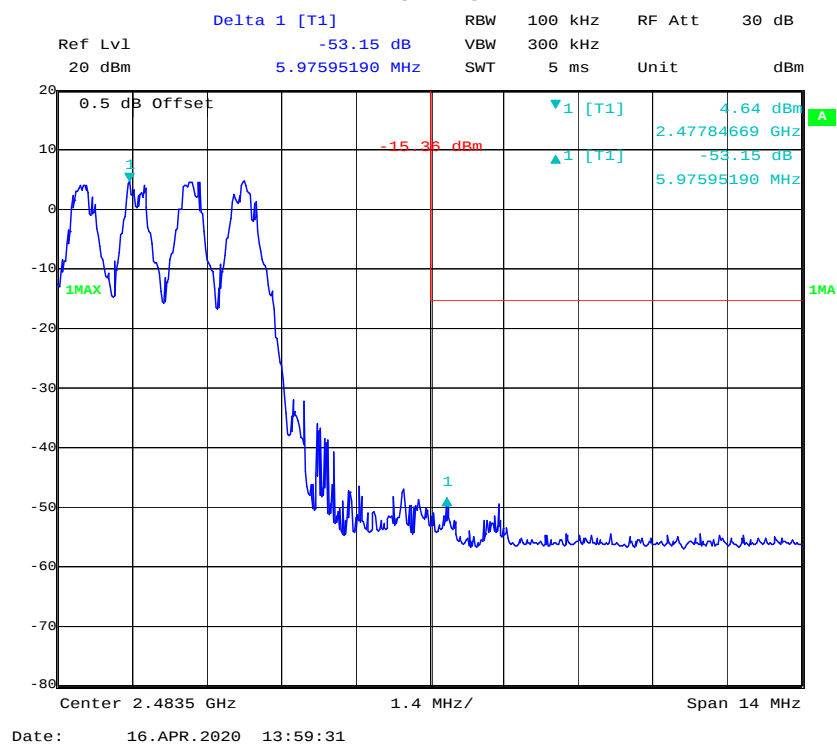
EDR Mode (8DPSK):

Band Edge, Left Side



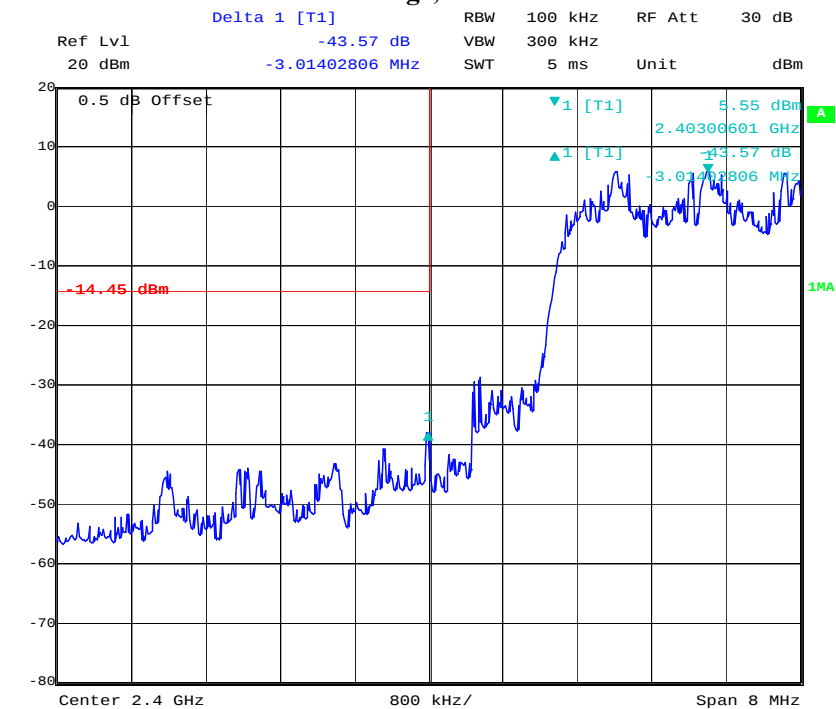
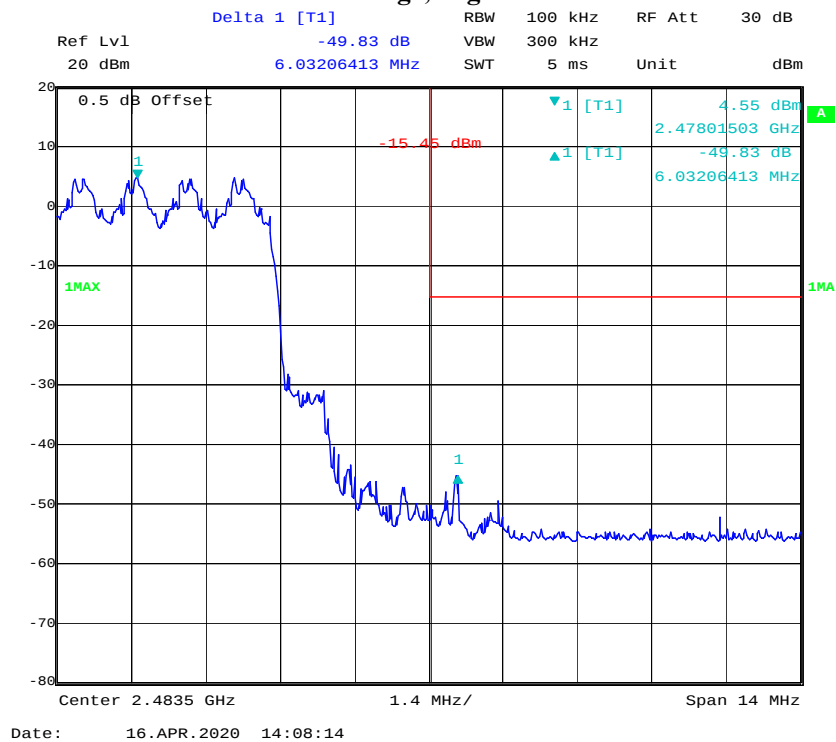
Band Edge, Right Side



*Hopping mode:**BDR Mode (GFSK):***Band Edge, Left Side****Band Edge, Right Side**

Band Edge, Left Side



*EDR Mode (8DPSK):***Band Edge, Left Side****Band Edge, Right Side********* END OF REPORT *******