



TESTING LABORATORY  
CERTIFICATE #4820.01



# FCC PART 15.247 TEST REPORT

For

## freeVoice AG

Industriestrasse 4a CH-8604 Volketswil Switzerland

**FCC ID: 2APKR-FCT170**

<b>Report Type:</b> Original Report	<b>Product Name:</b> freeVoice Connect 170 Bluetooth
<b>Report Number:</b>	RXM190125053-00B
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## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

<b>EUT Name:</b>	freeVoice Connect 170 Bluetooth
<b>EUT Model:</b>	FCT170
<b>Multiple Models:</b>	BT100U,ZUMBTP-410
<b>Operation Frequency:</b>	2402-2480 MHz
<b>Conducted Peak Output Power:</b>	7.89 dBm
<b>Modulation Type:</b>	GFSK, $\pi/4$ -DQPSK, 8DPSK
<b>Rated Input Voltage:</b>	DC5V
<b>External Dimension:</b>	36.5mm(L)*13.8mm(W)*3.2mm(H)
<b>Serial Number:</b>	190125053
<b>EUT Received Date:</b>	2019.03.13

*Note: The series products models BT100U,ZUMBTP-410 are electrically identical with FCT170, we selected FCT170 for fully testing, the details of the difference between them were explained in the attached declaration letter.*

### Objective

This report is prepared on behalf of *freeVoice AG* 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: 2APKR-FBT650B.

### 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".

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)

### Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongun, 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.

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

The system was configured for testing in engineering mode.

### EUT Exercise Software

The software "Blue Test3" was used during testing.

The software: 'Blue Test3 ' was used during test, which was provided by manufacturer. The maximum power level was configured by the software as below table:

Test Software Version	Blue Test3		
Test Frequency	2402MHz	2441MHz	2480MHz
GFSK	50	50	50
$\pi/4$ -DQPSK	50	50	50
8DPSK	50	50	50

### Equipment Modifications

No modification was made to the EUT.

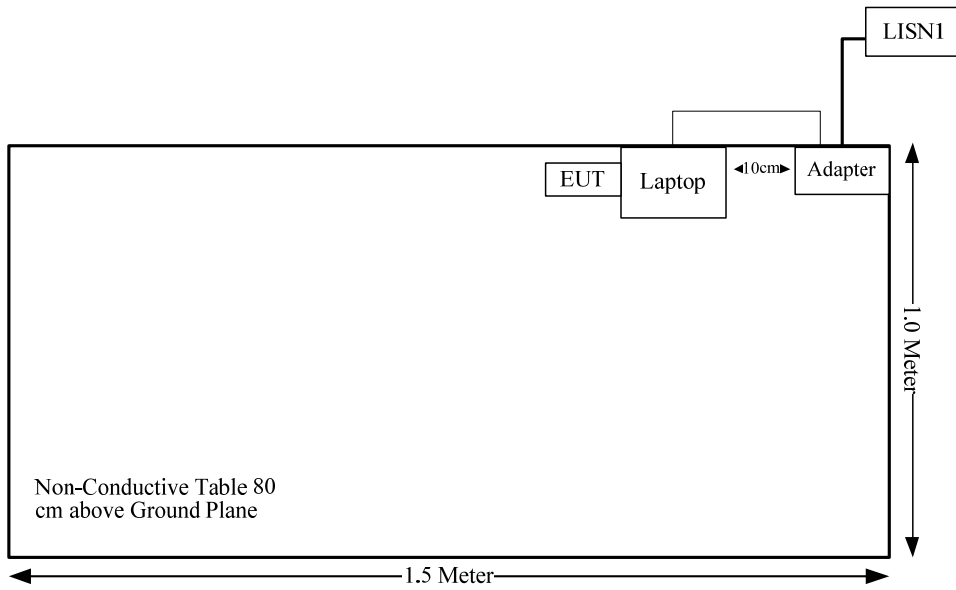
### Local Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
DELL	Laptop	PP11L	QDS-BRCM1017

### Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From	To
Adapter Cable	No	No	1.5	Adapter	Laptop

### Block Diagram of Test Setup



**SUMMARY OF TEST RESULTS**

<b>FCC Rules</b>	<b>Description of Test</b>	<b>Result</b>
§15.247 (i) & §1.1310 & §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(1)	20 dB Bandwidth	Compliance
§15.247(a)(1)	Channel Separation Test	Compliance
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
§15.247(b)(1)	Peak Output Power Measurement	Compliance
§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  $\leq 50$  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  $\leq 7.5$  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  $\leq 50$  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).

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

**So the stand-alone SAR evaluation is not necessary.**

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## **FCC §15.203 - ANTENNA REQUIREMENT**

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### **Applicable Standard**

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

### **Antenna Connector Construction**

The EUT has one internal antenna arrangement, and the antenna gain is 0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

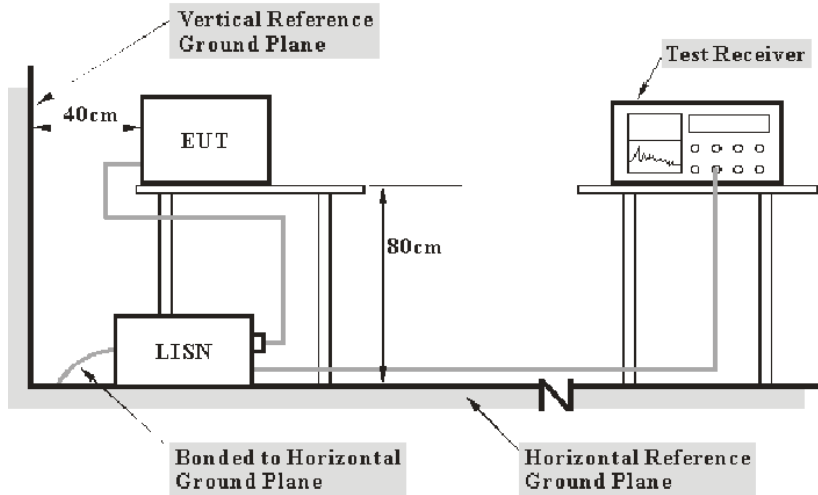
**Result:** Compliance.

**FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS**

**Applicable Standard**

FCC§15.207(a)

**EUT Setup**



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

The 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
R&S	EMI Test Receiver	ESCI	101121	2019-03-23	2020-03-23
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-01	2018-09-05	2019-09-05
R&S	Test Software	EMC32	Version8.53.0	N/A	N/A
R&S	Two-line V-network	ENV 216	101614	2018-12-10	2019-12-10

\* **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

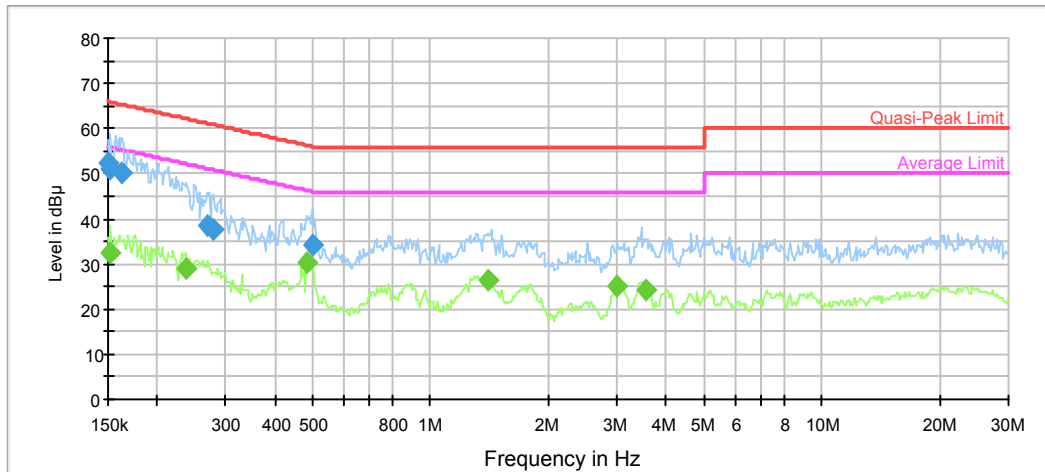
### Environmental Conditions

<b>Temperature:</b>	26.1 °C
<b>Relative Humidity:</b>	57%
<b>ATM Pressure:</b>	100.8kPa

\* The testing was performed by Ade Xiao on 2019-03-19

Test Mode: Transmitting

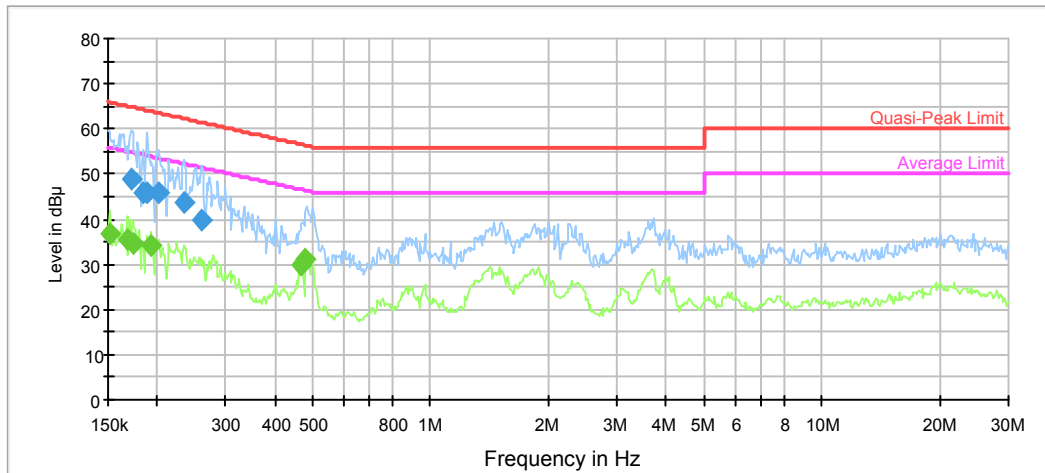
AC120V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.150000	52.4	9.000	L1	11.2	13.6	66.0
0.152410	51.2	9.000	L1	11.1	14.7	65.9
0.162441	50.1	9.000	L1	11.0	15.3	65.3
0.268355	38.6	9.000	L1	10.2	22.6	61.2
0.279263	37.6	9.000	L1	10.2	23.2	60.8
0.499611	34.1	9.000	L1	9.9	22.0	56.0

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.152410	32.5	9.000	L1	11.1	23.4	55.9
0.236234	28.8	9.000	L1	10.4	23.4	52.2
0.483938	30.4	9.000	L1	9.9	15.9	46.3
1.407671	26.3	9.000	L1	9.8	19.7	46.0
3.000901	25.0	9.000	L1	9.8	21.0	46.0
3.547503	24.3	9.000	L1	9.8	21.7	46.0

**AC120V, 60 Hz, Neutral:**



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.171759	49.0	9.000	N	10.9	15.8	64.9
0.184529	45.9	9.000	N	10.7	18.4	64.3
0.188994	45.7	9.000	N	10.7	18.3	64.1
0.203045	45.7	9.000	N	10.6	17.8	63.5
0.234359	43.7	9.000	N	10.4	18.6	62.3
0.259937	39.6	9.000	N	10.3	21.9	61.4

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.152410	36.7	9.000	N	11.1	19.2	55.9
0.167702	35.5	9.000	N	10.9	19.6	55.1
0.173134	34.4	9.000	N	10.9	20.4	54.8
0.193566	34.0	9.000	N	10.7	19.9	53.9
0.468757	30.0	9.000	N	9.9	16.5	46.5
0.480097	31.3	9.000	N	9.9	15.0	46.3

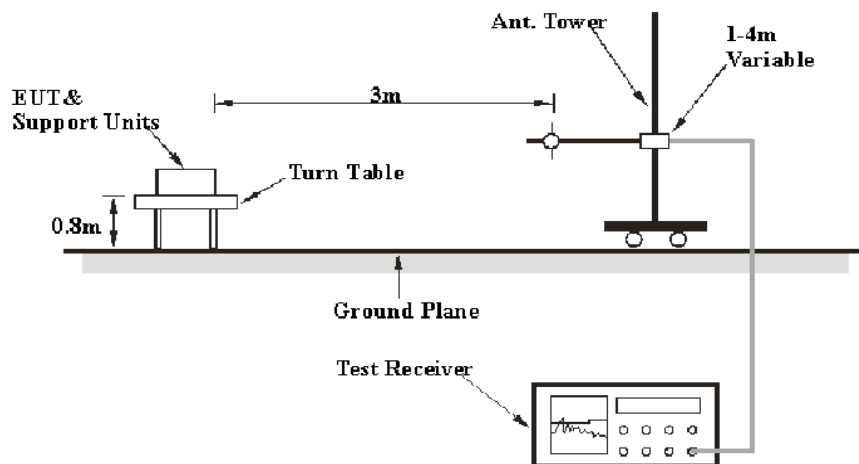
## FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

### Applicable Standard

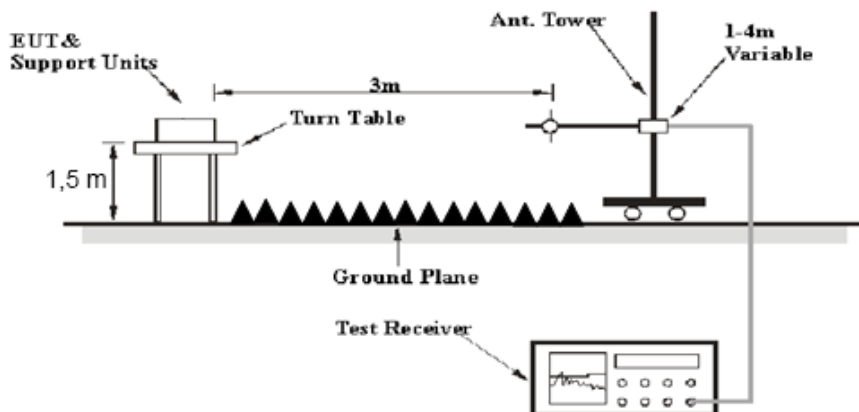
FCC §15.247 (d); §15.209; §15.205;

### EUT Setup

#### Below 1GHz:



#### Above 1GHz:



The radiated emission below 1GHz tests were performed in the 3 meters chamber 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.

According to FCC public notice: DA-00-705, 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.

## 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
R&S	EMI Test Receiver	ESCI	100035	2018-08-03	2019-08-03
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
Sunol Sciences	Antenna	JB3	A060611-3	2017-07-21	2019-07-21
Unknown	Coaxial Cable	C-NJNJ-50	C-1000-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0530-01	2018-09-24	2019-09-24
HP	Amplifier	8447D	2727A05902	2018-09-05	2019-09-05
Agilent	Spectrum Analyzer	E4440A	SG43360054	2018-05-09	2019-05-09
ETS-Lindgren	Horn Antenna	3115	000 527 35	2018-10-12	2021-10-12
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-01 1304	2016-11-18	2019-11-18
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-2.4J2.4J-50	C-0700-02	2018-06-27	2019-06-27
MITEQ	Amplifier	AFS42-00101800- 25-S-42	2001271	2018-09-05	2019-09-05
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**

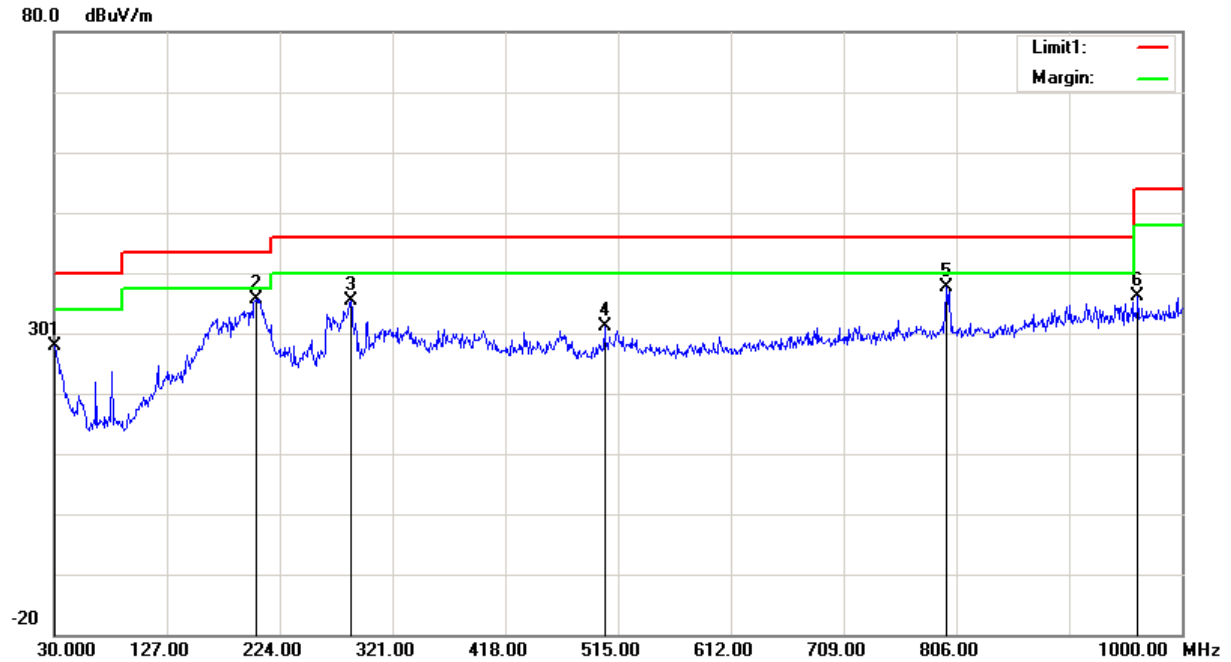
<b>Temperature:</b>	26.1 °C
<b>Relative Humidity:</b>	57%
<b>ATM Pressure:</b>	100.8kPa

\* *The testing was performed by Neil Liao on 2019-3-19*

*Test Mode: Transmitting*

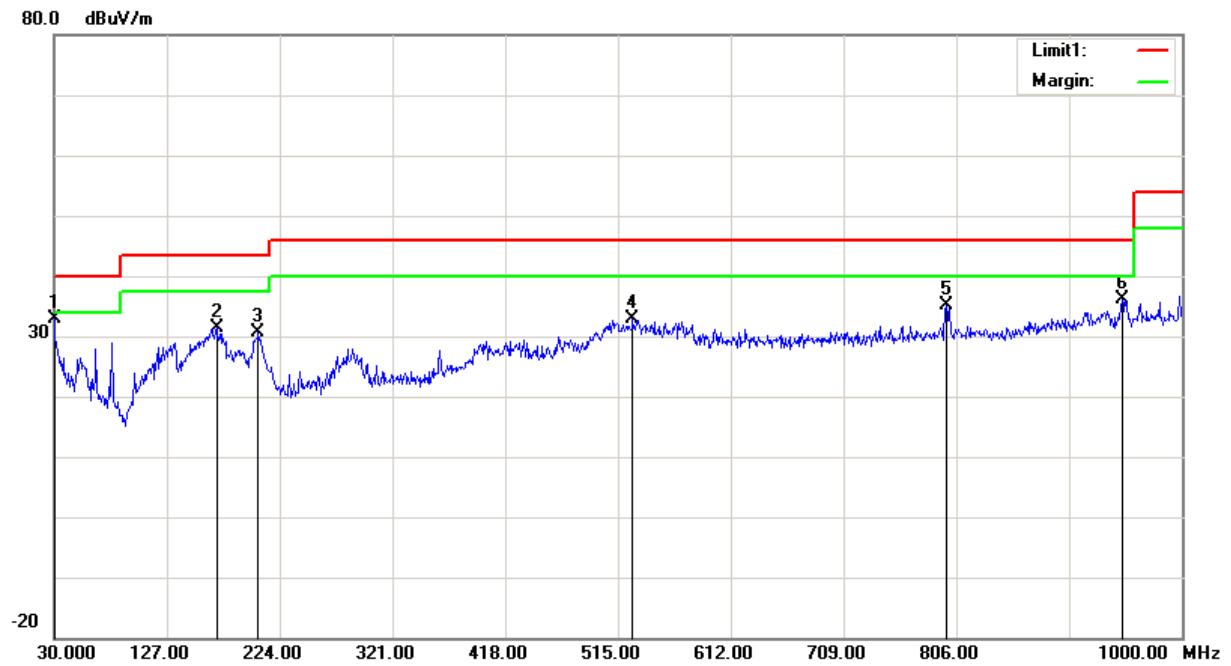
1) 30MHz-1GHz (GFSK High channel was the worst)

Horizontal:



Frequency (MHz)	Receiver Reading (dBμV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBμV/m)	Limit (dBμV/m)	Margin (dB)
30.0000	26.25	peak	1.72	27.97	40.00	12.03
203.6300	42.04	peak	-6.29	35.75	43.50	7.75
285.1100	39.47	peak	-4.03	35.44	46.00	10.56
503.3600	31.50	peak	-0.29	31.21	46.00	14.79
797.2700	33.39	peak	4.34	37.73	46.00	8.27
962.1700	13.24	peak	22.90	36.14	54.00	17.86

**Vertical:**



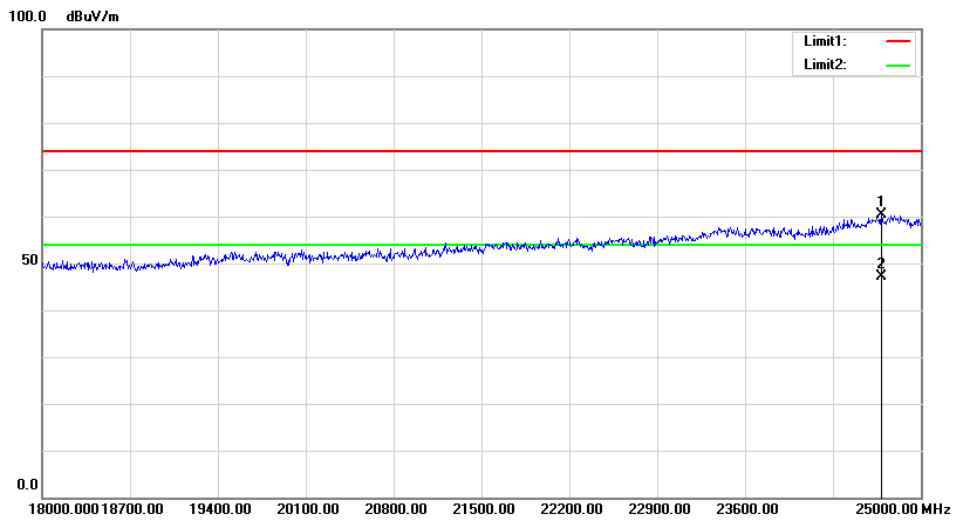
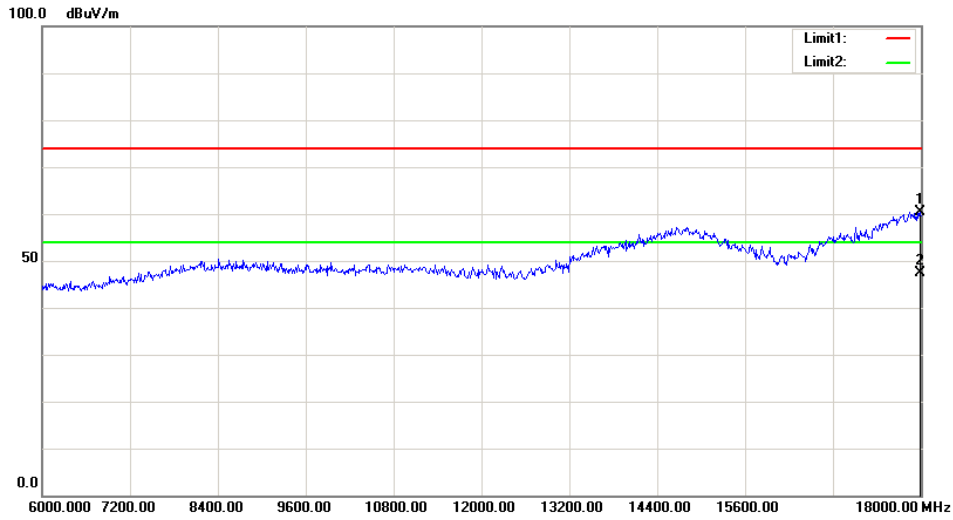
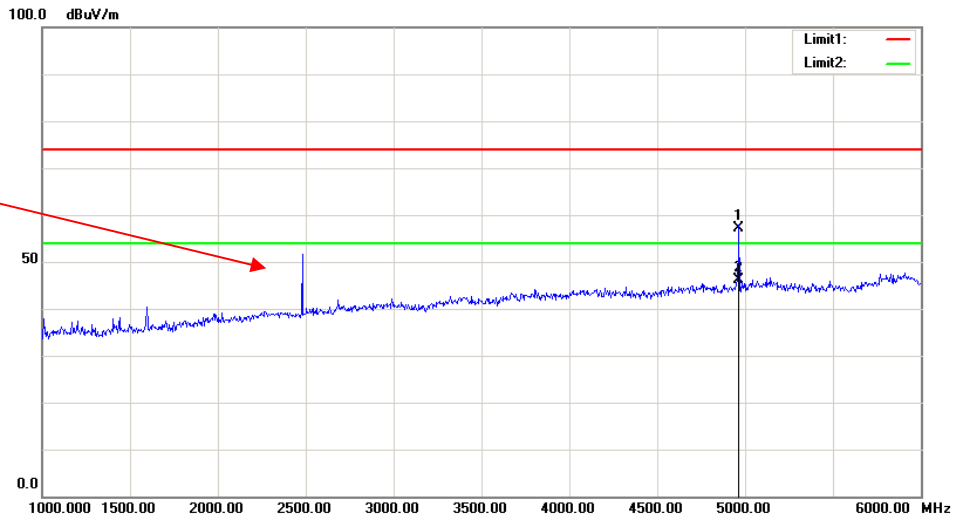
Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	31.04	peak	1.72	32.76	40.00	7.24
169.6800	37.89	peak	-6.57	31.32	43.50	12.18
205.5700	37.44	peak	-6.88	30.56	43.50	12.94
527.6100	32.69	peak	0.29	32.98	46.00	13.02
797.2700	30.81	peak	4.34	35.15	46.00	10.85
948.5900	39.55	peak	-3.35	36.20	46.00	9.80

**2) 1GHz-25GHz(GFSK mode was the worst case)**

Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
	Reading (dB $\mu$ V)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 2402 MHz									
2402.00	69.27	PK	H	28.10	1.80	0.00	99.17	N/A	N/A
2402.00	59.36	AV	H	28.10	1.80	0.00	89.26	N/A	N/A
2402.00	64.72	PK	V	28.10	1.80	0.00	94.62	N/A	N/A
2402.00	54.33	AV	V	28.10	1.80	0.00	84.23	N/A	N/A
2390.00	25.59	PK	H	28.08	1.80	0.00	55.47	74.00	18.53
2390.00	13.41	AV	H	28.08	1.80	0.00	43.29	54.00	10.71
4804.00	55.45	PK	H	32.91	3.17	37.20	54.33	74.00	19.67
4804.00	43.98	AV	H	32.91	3.17	37.20	42.86	54.00	11.14
7206.00	46.19	PK	H	35.74	4.82	37.23	49.52	74.00	24.48
7206.00	32.96	AV	H	35.74	4.82	37.23	36.29	54.00	17.71
Middle Channel: 2441 MHz									
2441.00	69.39	PK	H	28.18	1.82	0.00	99.39	N/A	N/A
2441.00	59.65	AV	H	28.18	1.82	0.00	89.65	N/A	N/A
2441.00	64.97	PK	V	28.18	1.82	0.00	94.97	N/A	N/A
2441.00	54.77	AV	V	28.18	1.82	0.00	84.77	N/A	N/A
4882.00	57.58	PK	H	33.06	3.27	37.21	56.70	74.00	17.30
4882.00	46.63	AV	H	33.06	3.27	37.21	45.75	54.00	8.25
7323.00	45.44	PK	H	36.04	4.62	37.38	48.72	74.00	25.28
7323.00	32.47	AV	H	36.04	4.62	37.38	35.75	54.00	18.25
High Channel: 2480 MHz									
2480.00	67.02	PK	H	28.26	1.84	0.00	97.12	N/A	N/A
2480.00	57.10	AV	H	28.26	1.84	0.00	87.20	N/A	N/A
2480.00	64.74	PK	V	28.26	1.84	0.00	94.84	N/A	N/A
2480.00	54.88	AV	V	28.26	1.84	0.00	84.98	N/A	N/A
2483.50	28.33	PK	H	28.27	1.84	0.00	58.44	74.00	15.56
2483.50	14.38	AV	H	28.27	1.84	0.00	44.49	54.00	9.51
4960.00	57.86	PK	H	33.22	3.23	37.25	57.06	74.00	16.94
4960.00	46.87	AV	H	33.22	3.23	37.25	46.07	54.00	7.93
7440.00	45.50	PK	H	36.34	4.41	37.52	48.73	74.00	25.27
7440.00	33.14	AV	H	36.34	4.41	37.52	36.37	54.00	17.63

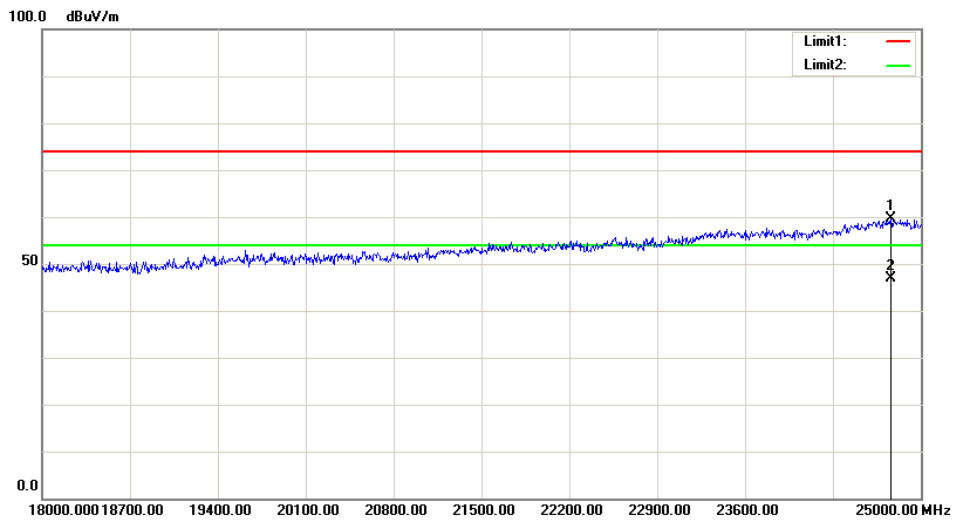
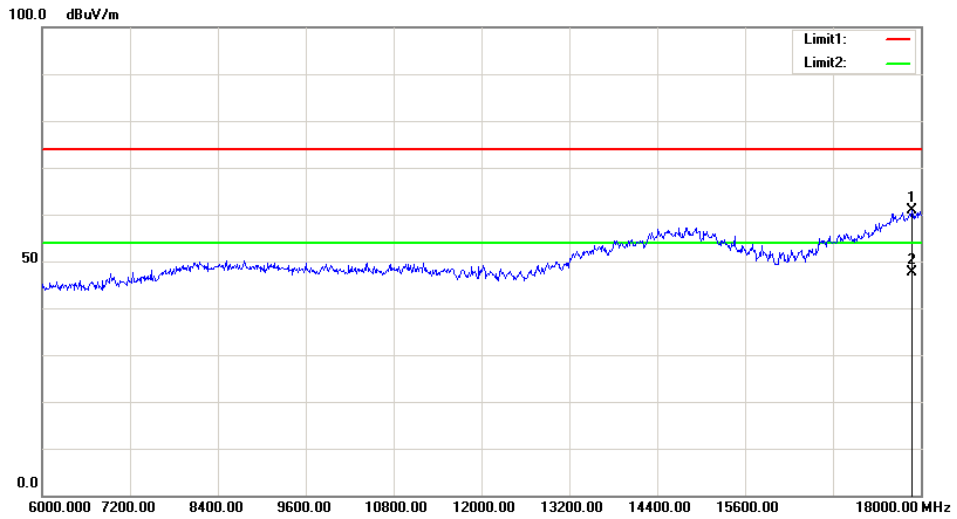
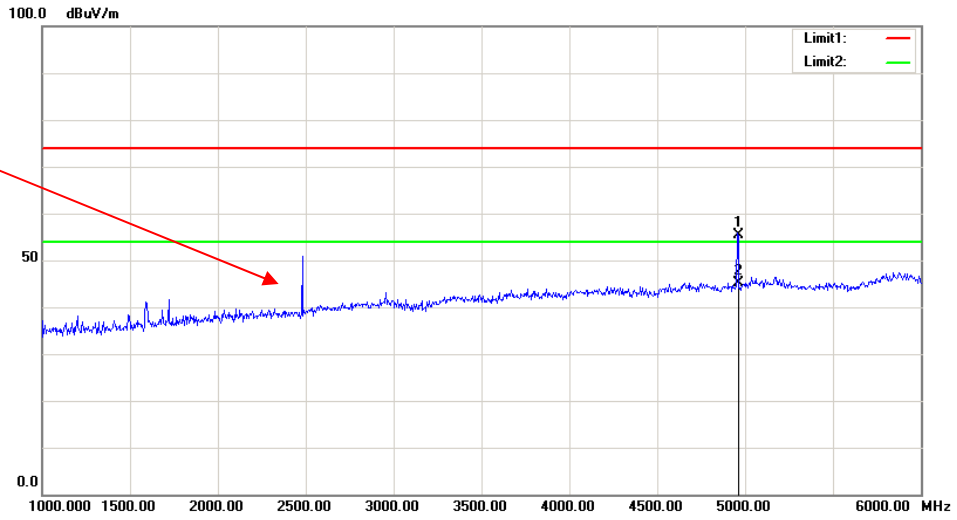
**Worst plots (GFSK High channel)**  
**Horizontal**

Fundamental  
Test with Band  
Rejection Filter



Vertical

Fundamental Test with Band Rejection Filter



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

### Applicable Standard

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	FSP 38	100478	2018-12-10	2019-12-10
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

<b>Temperature:</b>	29.2 °C
<b>Relative Humidity:</b>	61%
<b>ATM Pressure:</b>	100.4 kPa

\* The testing was performed by Elena Lei on 2019-06-29

**Test Result:** Compliance.

Please refer to following tables and plots

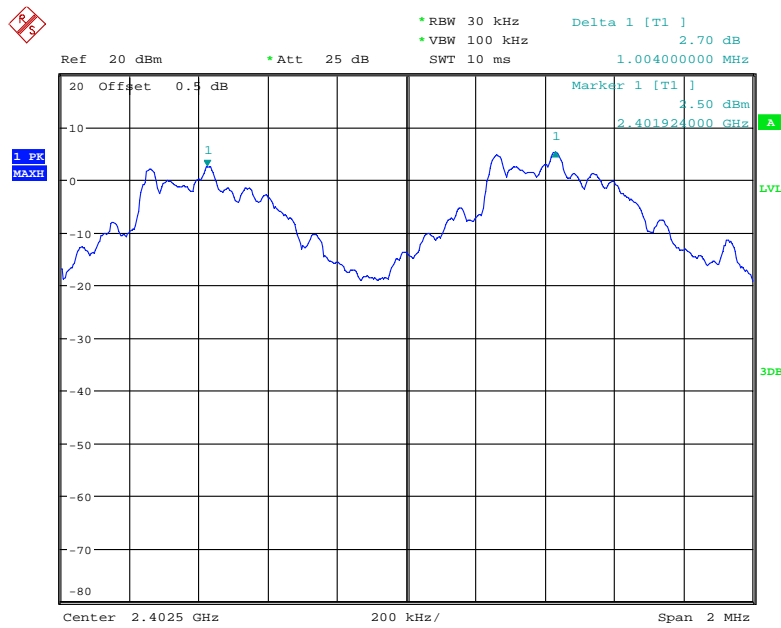
Test Mode: Transmitting

Mode	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
BDR (GFSK)	Low	2402	1.004	0.61
	Middle	2441	1.000	0.61
	High	2480	1.000	0.61
EDR ( $\pi/4$ -DQPSK)	Low	2402	1.004	0.81
	Middle	2441	1.004	0.81
	High	2480	1.000	0.81
EDR (8-DPSK)	Low	2402	1.000	0.79
	Middle	2441	1.004	0.79
	High	2480	1.000	0.79

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

BDR Mode (GFSK):

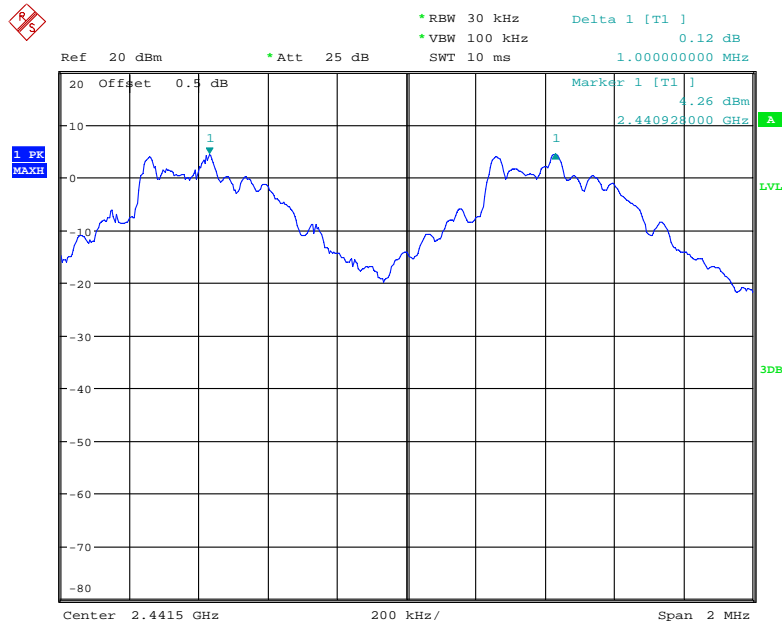
Low Channel



Date: 29.JUN.2019 10:47:20

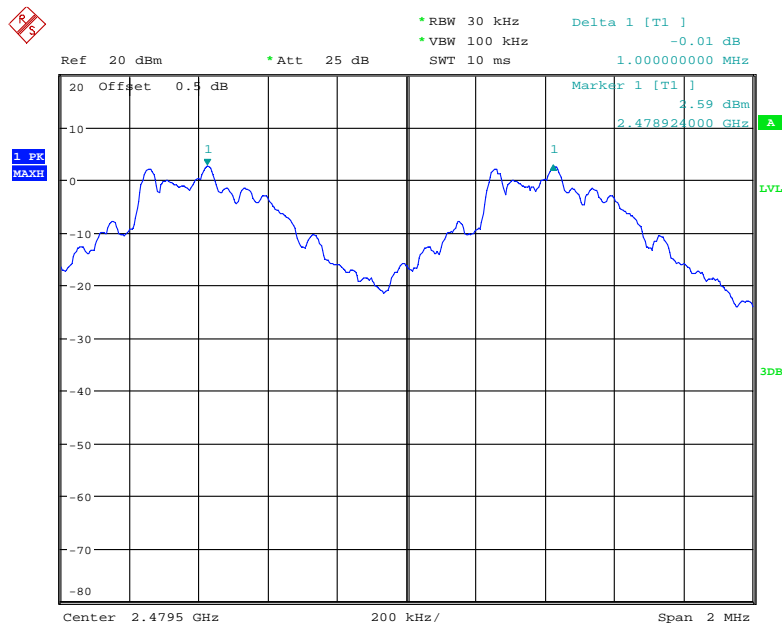


### Middle Channel



Date: 29.JUN.2019 10:48:26

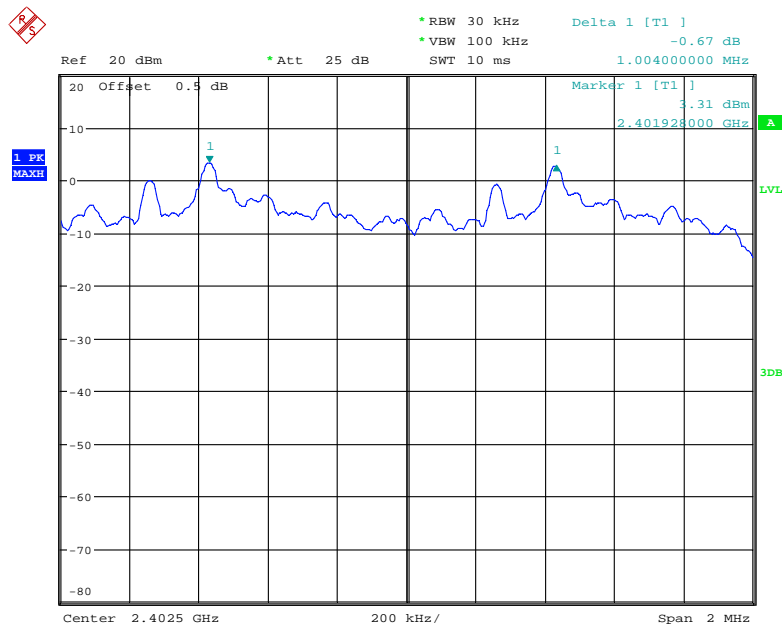
### High Channel



Date: 29.JUN.2019 10:49:01

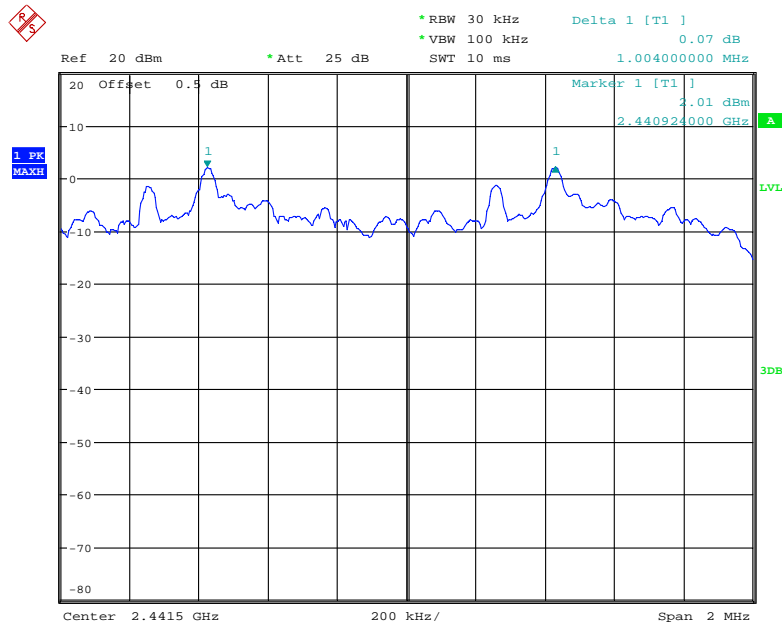
EDR Mode ( $\pi/4$ -DQPSK):

### Low Channel



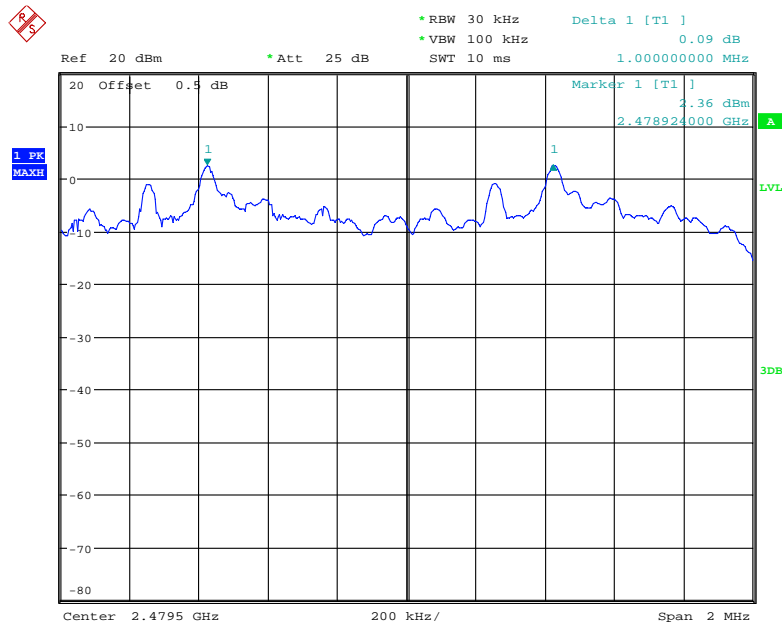
Date: 29.JUN.2019 10:44:35

### Middle Channel



Date: 29.JUN.2019 10:45:04

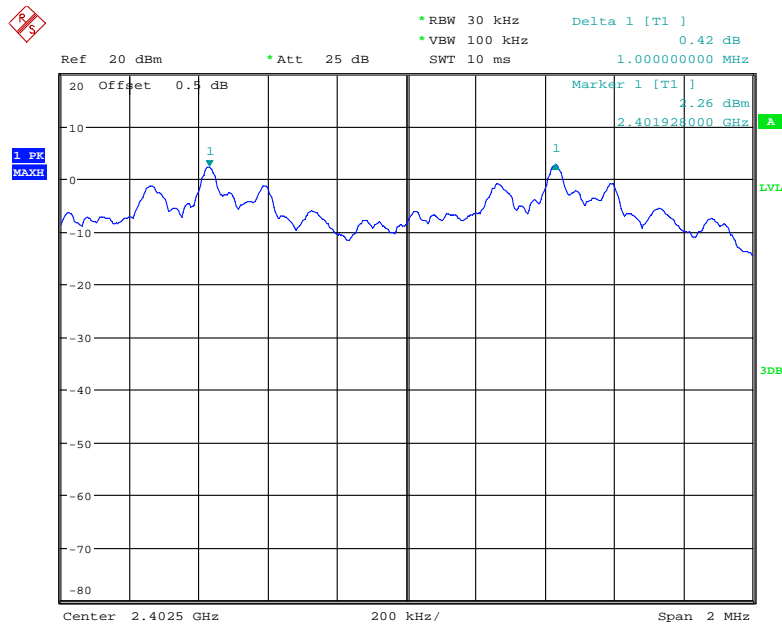
### High Channel



Date: 29.JUN.2019 10:46:25

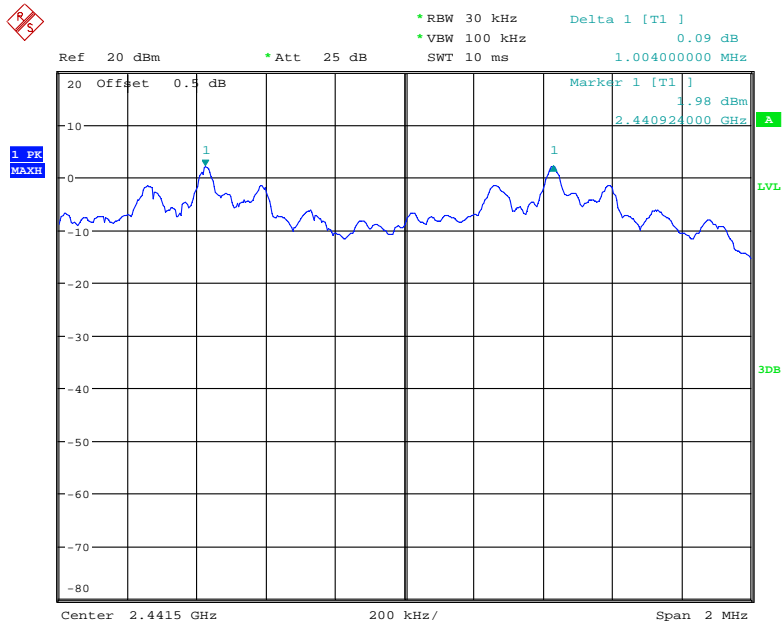
EDR Mode (8-DPSK):

### Low Channel



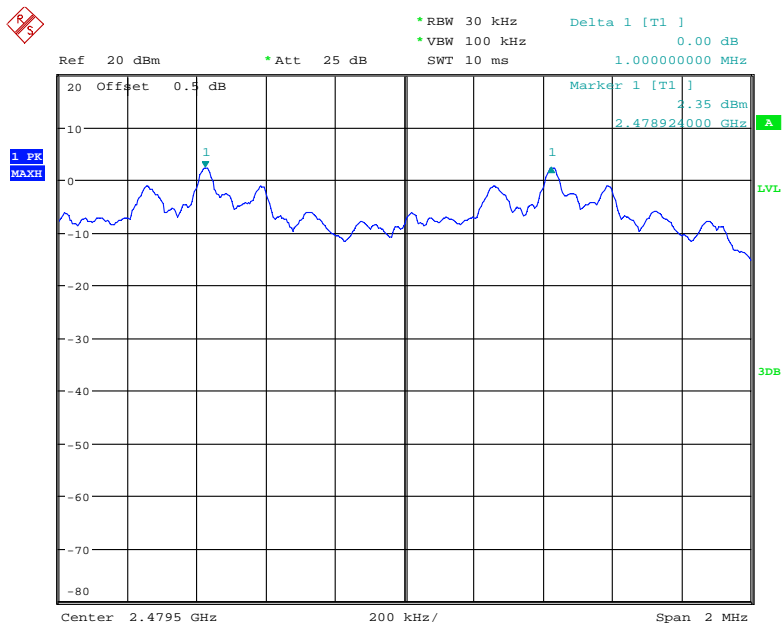
Date: 29.JUN.2019 10:42:12

### Middle Channel



Date: 29.JUN.2019 10:42:46

### High Channel



Date: 29.JUN.2019 10:43:17

## FCC §15.247(a) (1) – 20 dB BANDWIDTH TESTING

### Applicable Standard

Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

### Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT 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. 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	FSP 38	100478	2018-12-10	2019-12-10
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

<b>Temperature:</b>	29.2 °C
<b>Relative Humidity:</b>	61%
<b>ATM Pressure:</b>	100.4 kPa

\* *The testing was performed by Elena Lei on 2019-06-29*

**Test Result:** Compliance.

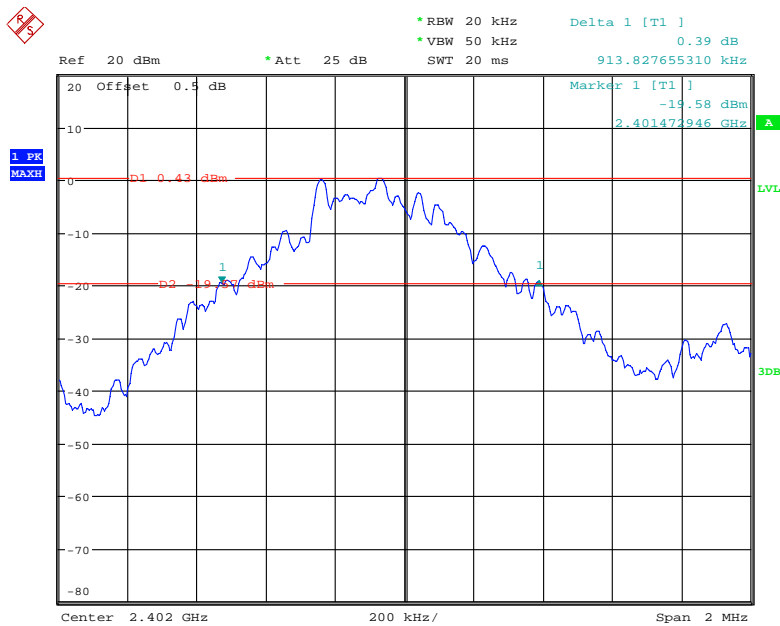
Please refer to following tables and plots

Test Mode: Transmitting

Mode	Channel	Frequency (MHz)	20 dB Bandwidth (MHz)
BDR Mode (GFSK)	Low	2402	0.914
	Middle	2441	0.918
	High	2480	0.918
EDR Mode ( $\pi/4$ -DQPSK)	Low	2402	1.210
	Middle	2441	1.210
	High	2480	1.210
EDR Mode (8-DPSK)	Low	2402	1.190
	Middle	2441	1.190
	High	2480	1.190

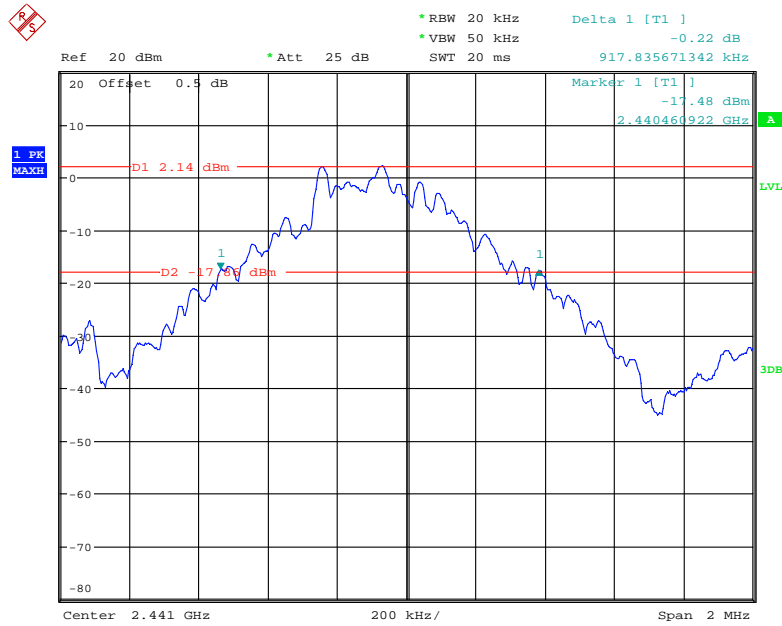
BDR Mode (GFSK):

Low Channel



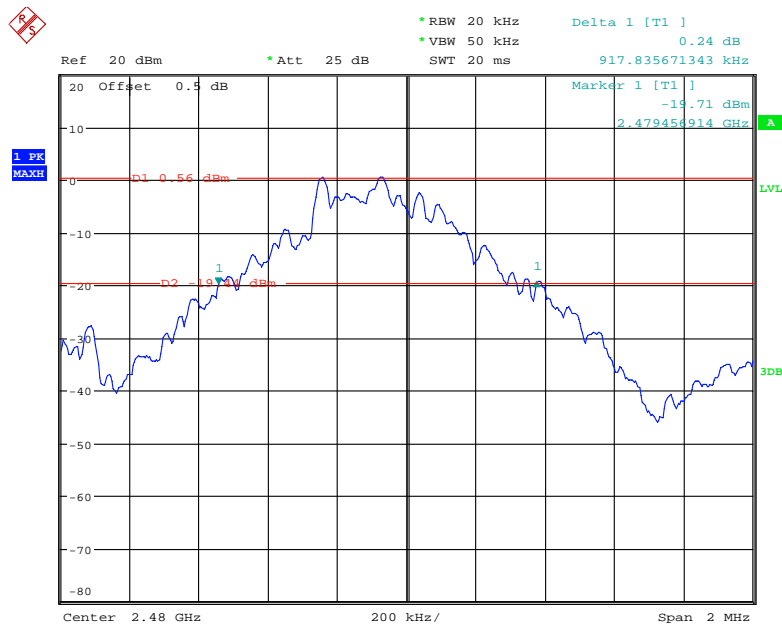
Date: 29.JUN.2019 10:01:32

### Middle Channel



Date: 29.JUN.2019 10:02:49

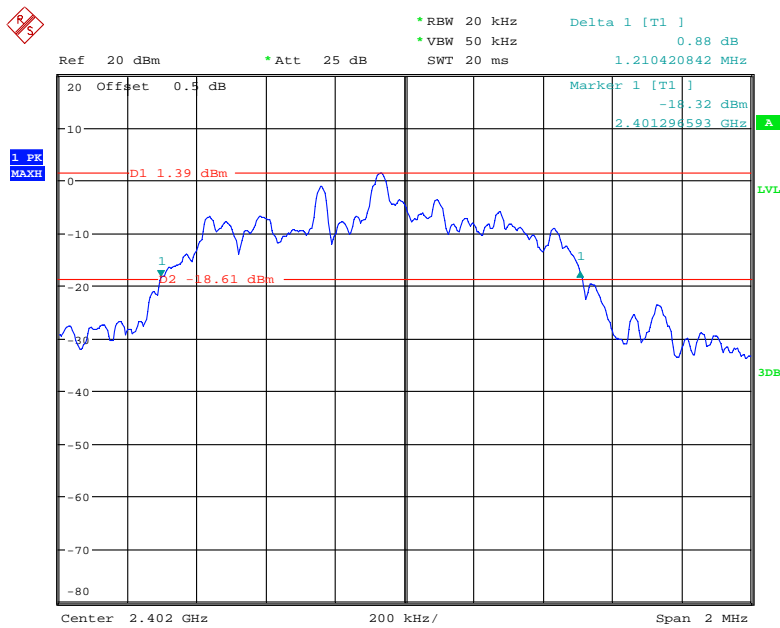
### High Channel



Date: 29.JUN.2019 10:04:50

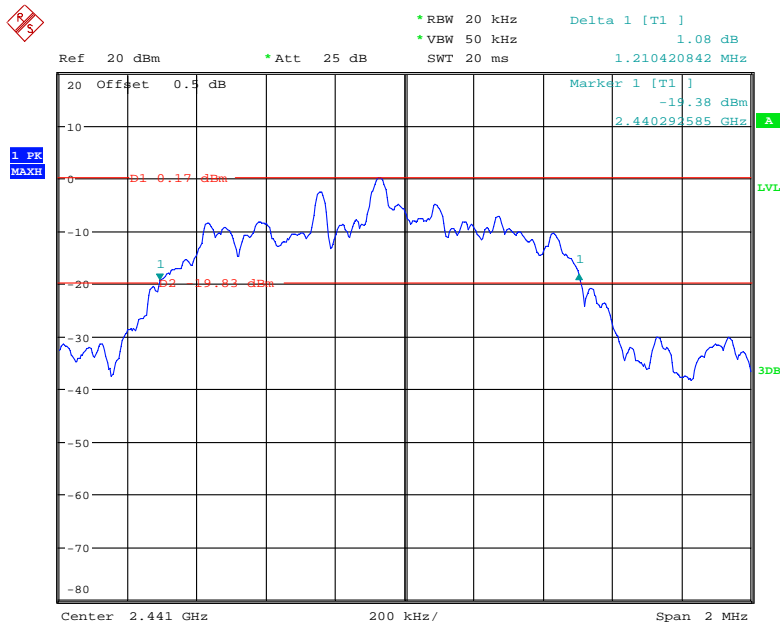
EDR Mode ( $\pi/4$ -DQPSK):

### Low Channel



Date: 29.JUN.2019 10:18:43

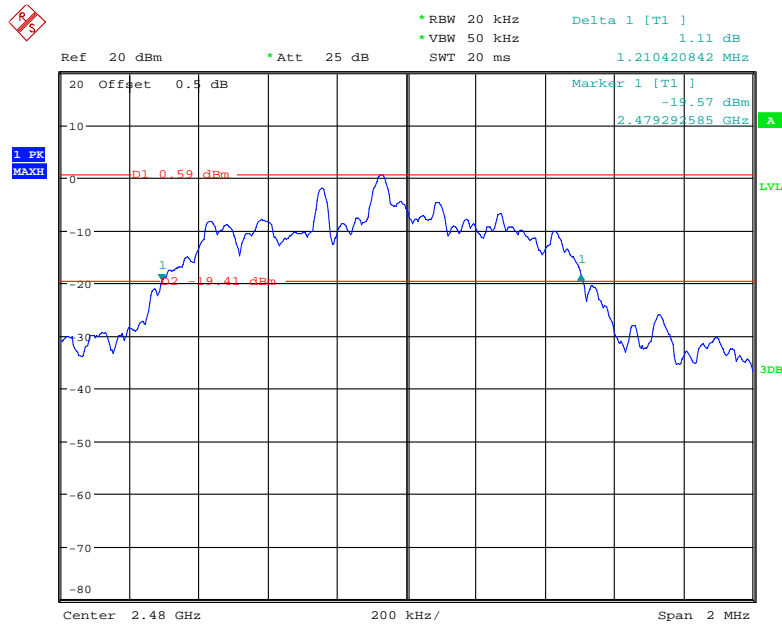
### Middle Channel



Date: 29.JUN.2019 10:22:40



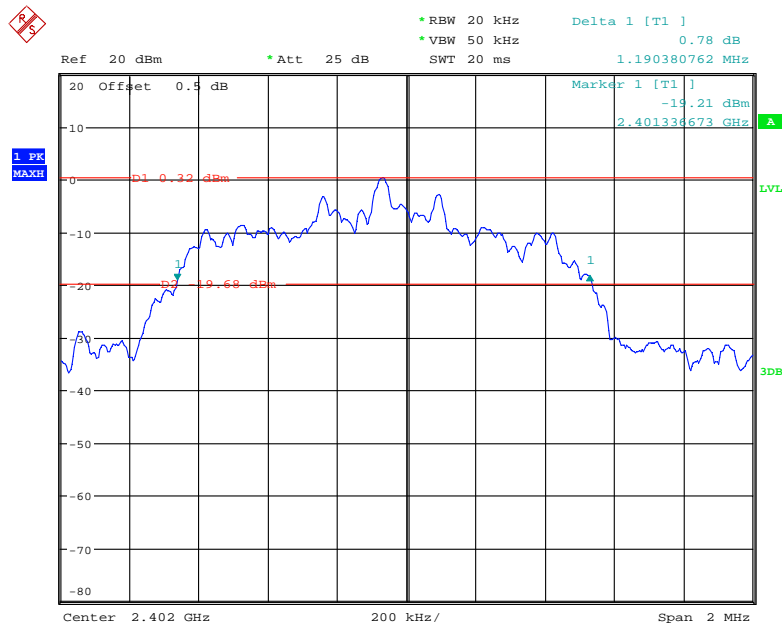
### High Channel



Date: 29.JUN.2019 10:24:02

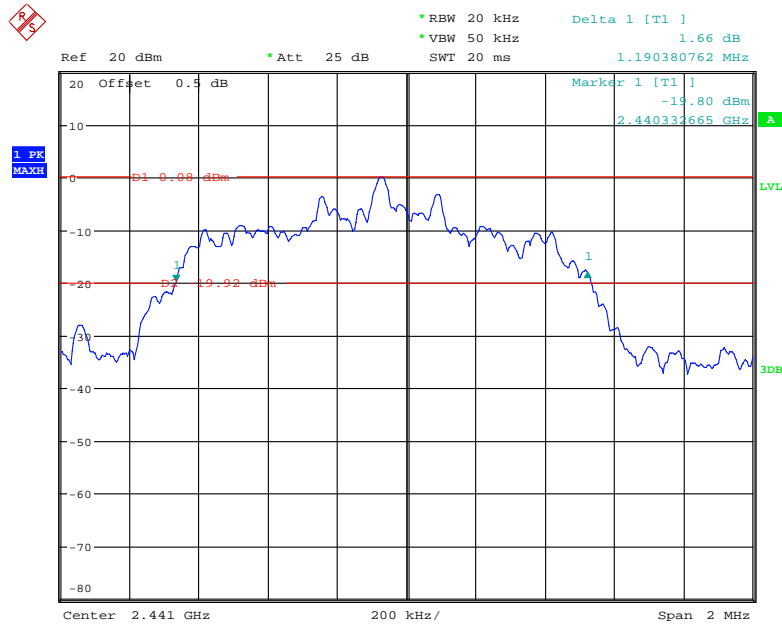
EDR Mode (8-DPSK):

### Low Channel



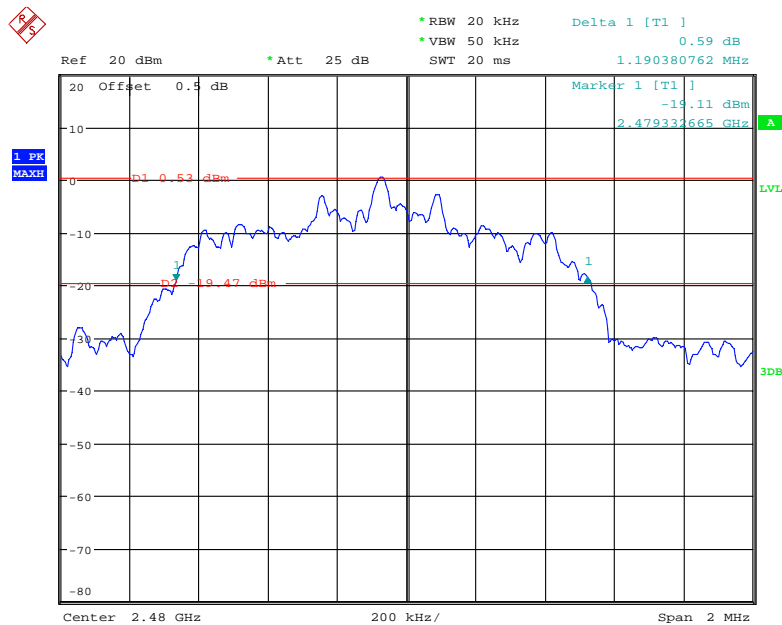
Date: 29.JUN.2019 10:40:15

### Middle Channel



Date: 29.JUN.2019 10:32:04

### High Channel



Date: 29.JUN.2019 10:26:09

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

### **Applicable Standard**

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

### **Test Procedure**

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

### **Test Equipment List and Details**

<b>Manufacturer</b>	<b>Description</b>	<b>Model</b>	<b>Serial Number</b>	<b>Calibration Date</b>	<b>Calibration Due Date</b>
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-10	2019-12-10
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**

<b>Temperature:</b>	29.2 °C
<b>Relative Humidity:</b>	61%
<b>ATM Pressure:</b>	100.4 kPa

\* *The testing was performed by Elena Lei on 2019-06-29*

**Test Result:** Compliance.

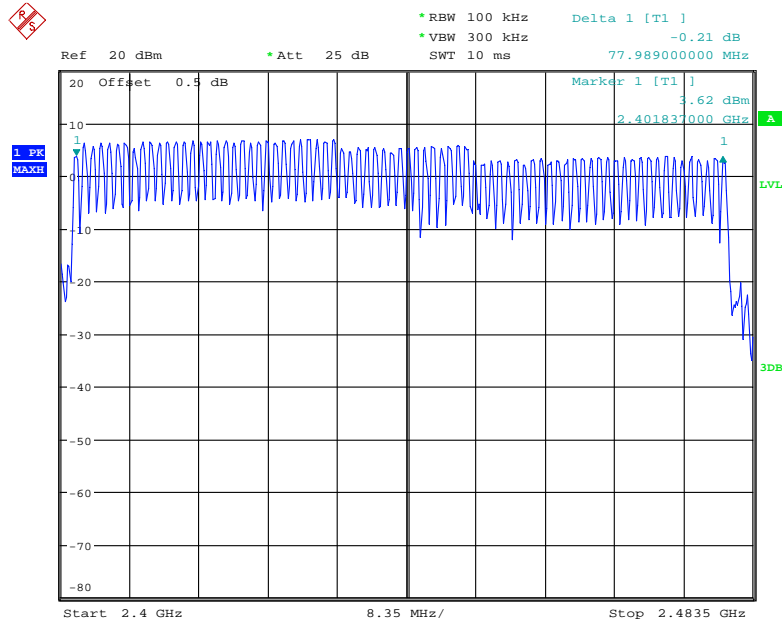
Please refer to following tables and plots

Test Mode: Transmitting

BDR Mode (GFSK):

Frequency Range (MHz)	Number of Hopping Channel	Limit
2400-2483.5	79	≥15

Number of Hopping Channels

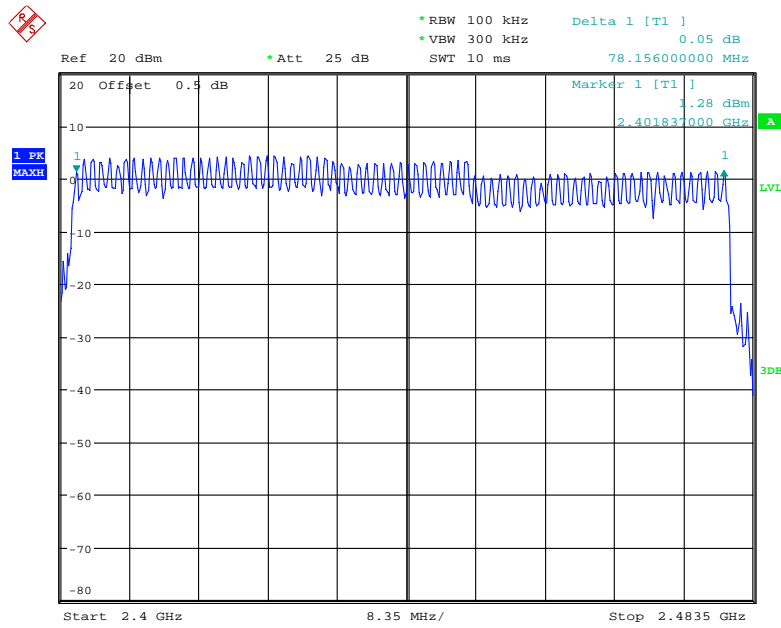


Date: 29.JUN.2019 10:52:34

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

Frequency Range (MHz)	Number of Hopping Channel	Limit
2400-2483.5	79	$\geq 15$

### Number of Hopping Channels

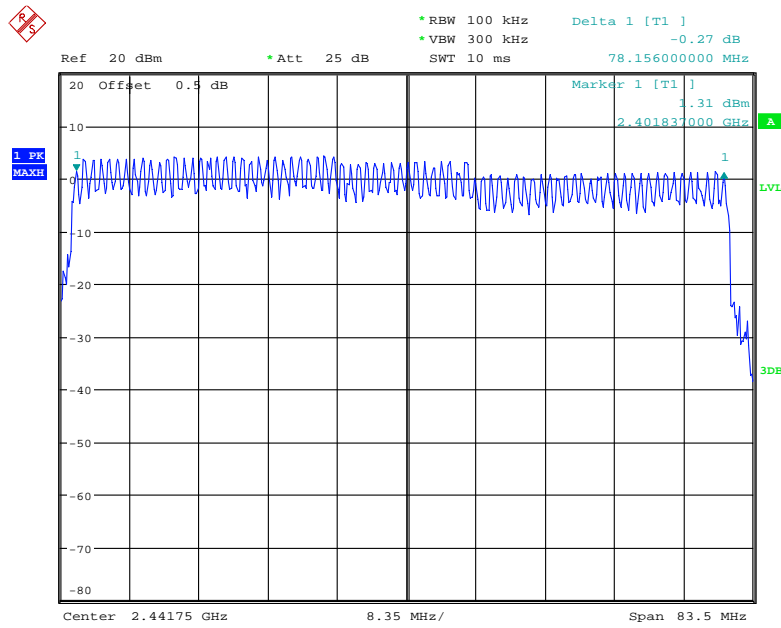


Date: 29.JUN.2019 10:56:46

EDR Mode (8-DPSK):

Frequency Range (MHz)	Number of Hopping Channel	Limit
2400-2483.5	79	≥15

**Number of Hopping Channels**



Date: 29.JUN.2019 11:01:20

## **FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)**

### **Applicable Standard**

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

### **Test Procedure**

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

### **Test Equipment List and Details**

<b>Manufacturer</b>	<b>Description</b>	<b>Model</b>	<b>Serial Number</b>	<b>Calibration Date</b>	<b>Calibration Due Date</b>
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-10	2019-12-10
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**

<b>Temperature:</b>	29.2 °C
<b>Relative Humidity:</b>	61%
<b>ATM Pressure:</b>	100.4 kPa

\* *The testing was performed by Elena Lei on 2019-06-29*

**Test Result:** Compliance.

Please refer to following tables and plots

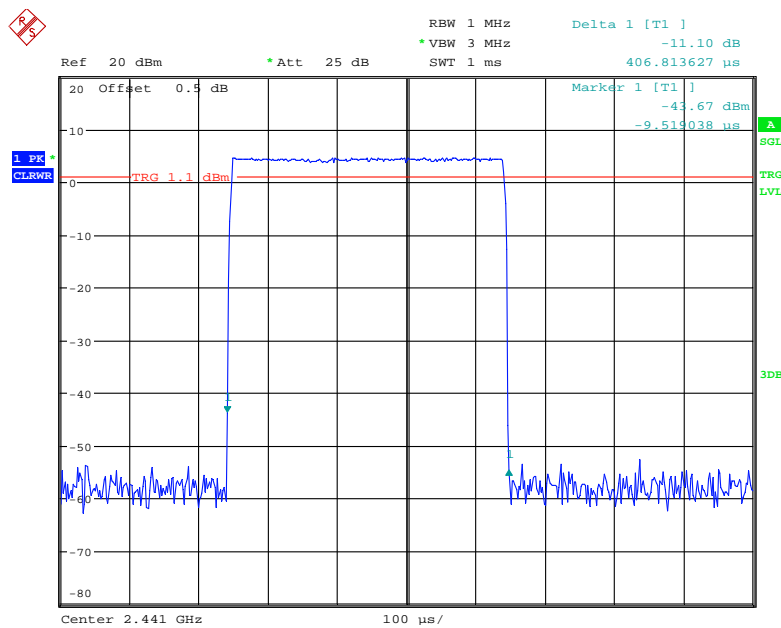
Test Mode: Transmitting

Mode	Packet type	Channel	Frequency (MHz)	Pulse width (ms)	Result (s)	Limit (s)
GFSK	DH1	Middle	2441	0.407	0.130	0.4
	DH3	Middle	2441	1.677	0.268	
	DH5	Middle	2441	2.936	0.313	
π/4-DQPSK	2DH1	Middle	2441	0.423	0.135	
	2DH3	Middle	2441	1.689	0.270	
	2DH5	Middle	2441	2.946	0.314	
8DPSK	3DH1	Middle	2441	0.423	0.135	
	3DH3	Middle	2441	1.689	0.270	
	3DH5	Middle	2441	2.946	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

GFSK:

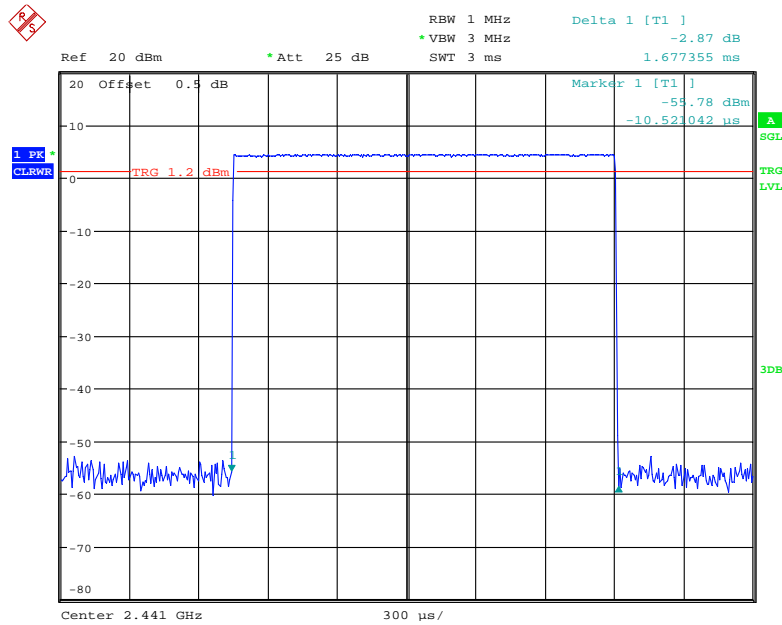
DH1: Middle Channel



Date: 29.JUN.2019 13:50:59

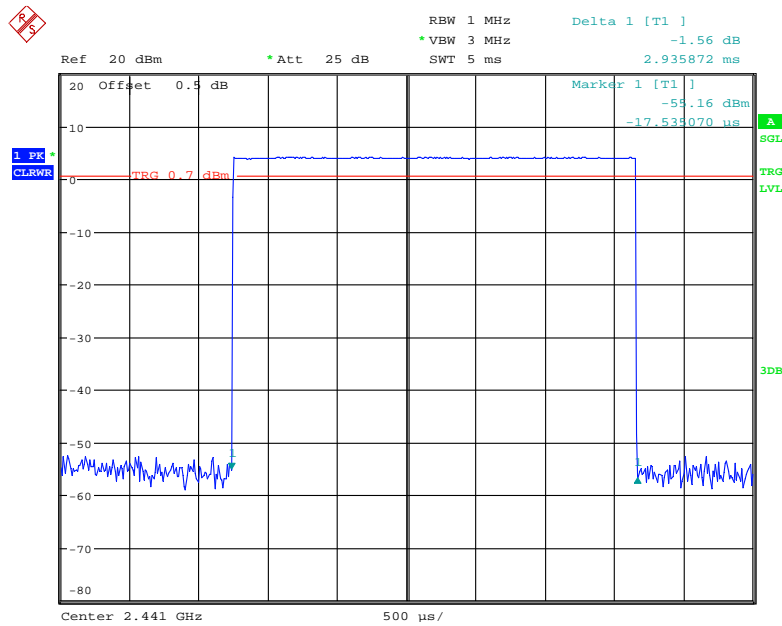


### DH3: Middle Channel



Date: 29.JUN.2019 13:51:23

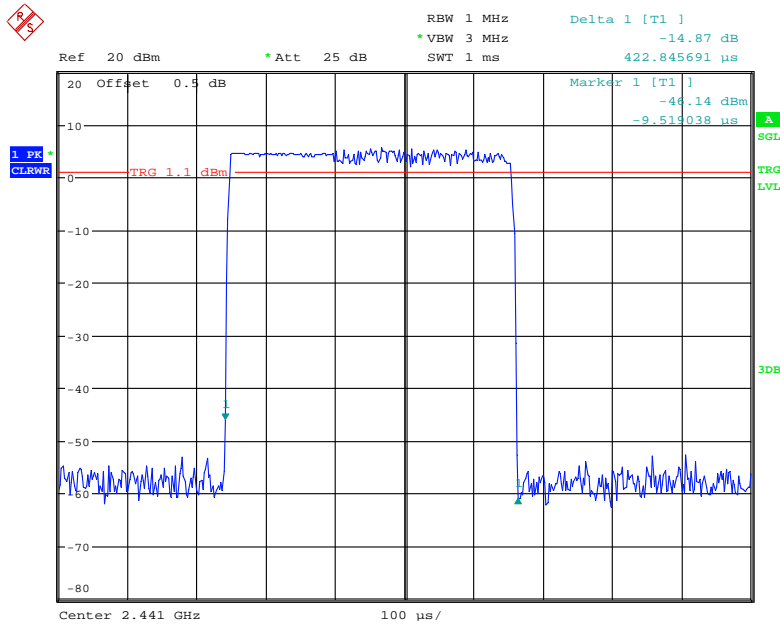
### DH5: Middle Channel



Date: 29.JUN.2019 13:51:42

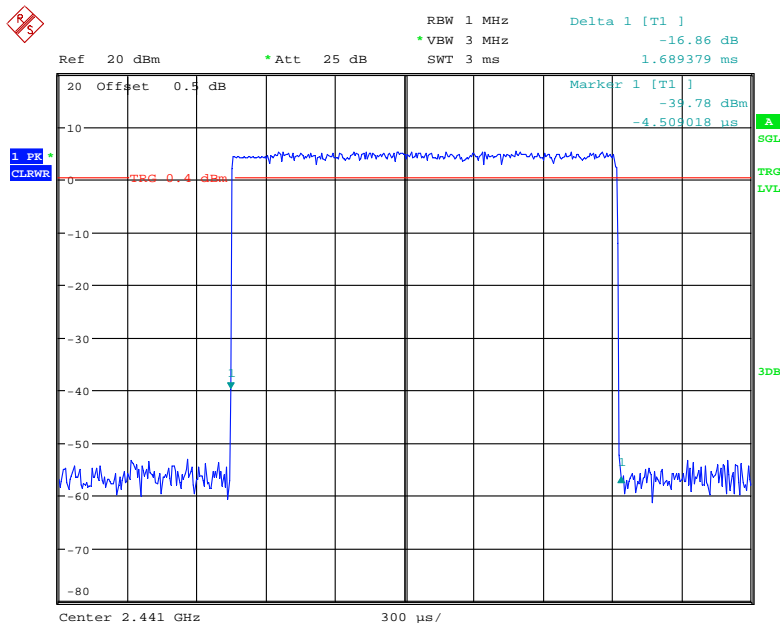
$\pi/4$ -DQPSK:

### 2DH1: Middle Channel



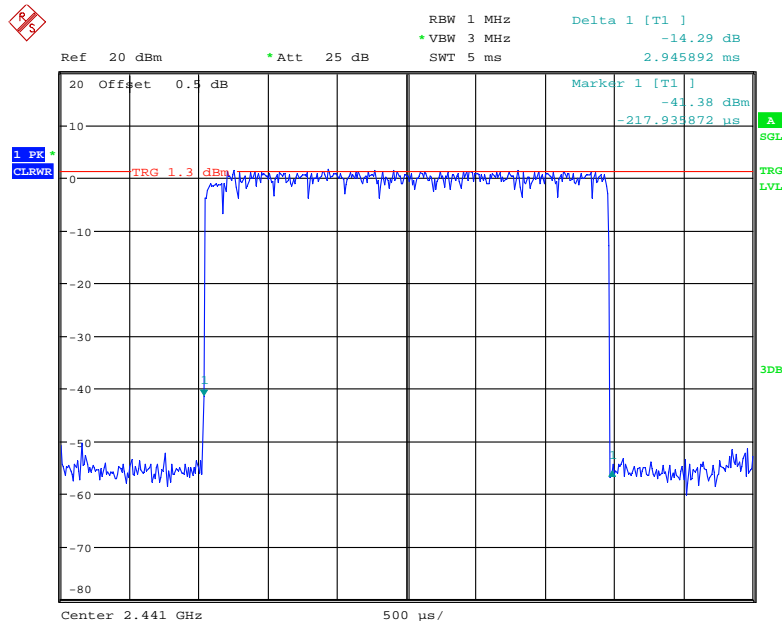
Date: 29.JUN.2019 13:49:31

### 2DH3: Middle Channel



Date: 29.JUN.2019 13:49:48

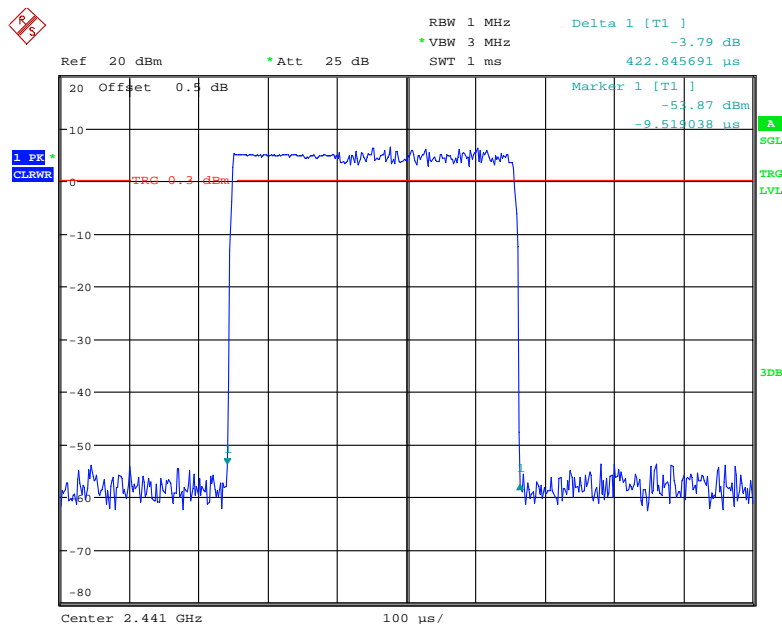
**DH5: Middle Channel**



Date: 29.JUN.2019 13:50:18

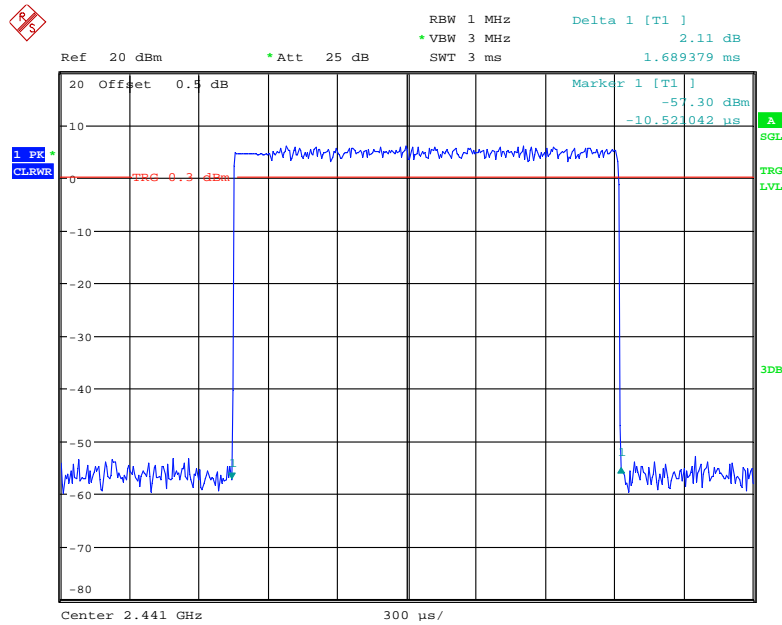
8DPSK:

**3DH1: Middle Channel**



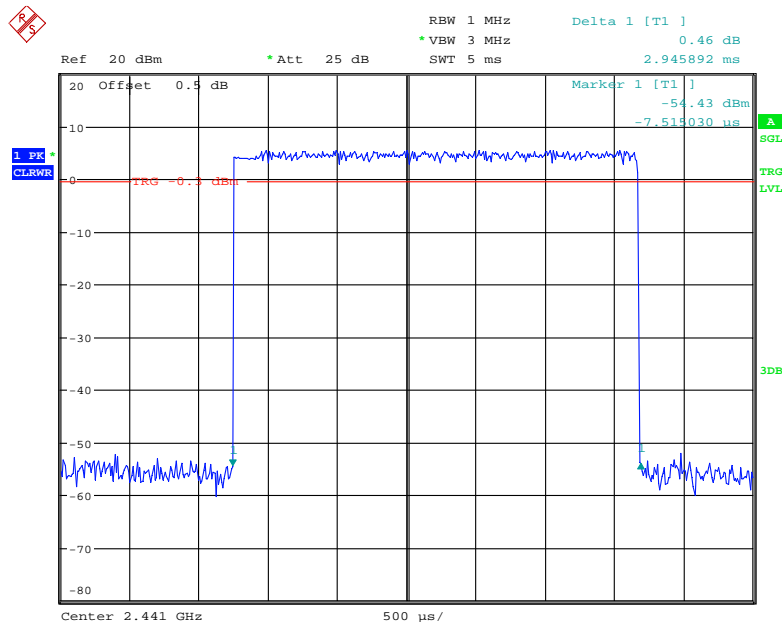
Date: 29.JUN.2019 13:41:25

### 3DH3: Middle Channel



Date: 29.JUN.2019 13:48:19

### 3DH5: Middle Channel



Date: 29.JUN.2019 13:49:03

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

### Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. 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
Agilent	USB Wideband Power Sensor	U2022XA	MY5417006	2018-12-10	2019-12-10
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	/

\* **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:	29.2 °C
Relative Humidity:	61%
ATM Pressure:	100.4 kPa

\* The testing was performed by Elena Lei on 2019-06-29

**Test Result:** Compliance.

*Test Mode: Transmitting*

<b>Mode</b>	<b>Frequency (MHz)</b>	<b>Peak Conducted Output power (dBm)</b>	<b>Limit (dBm)</b>
BDR Mode (GFSK)	2402	5.77	21
	2441	7.89	21
	2480	7.54	21
EDR Mode ( $\pi/4$ -DQPSK)	2402	6.07	21
	2441	6.98	21
	2480	7.15	21
EDR Mode (8-DPSK)	2402	5.72	21
	2441	6.15	21
	2480	6.41	21

Note: The data above was tested in conducted mode.

## **FCC §15.247(d) - BAND EDGES TESTING**

### **Applicable Standard**

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

### **Test Procedure**

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW/ 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**

<b>Manufacturer</b>	<b>Description</b>	<b>Model</b>	<b>Serial Number</b>	<b>Calibration Date</b>	<b>Calibration Due Date</b>
R&S	Spectrum Analyzer	FSP 38	100478	2018-12-10	2019-12-10
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**

<b>Temperature:</b>	29.2 °C
<b>Relative Humidity:</b>	61%
<b>ATM Pressure:</b>	100.4 kPa

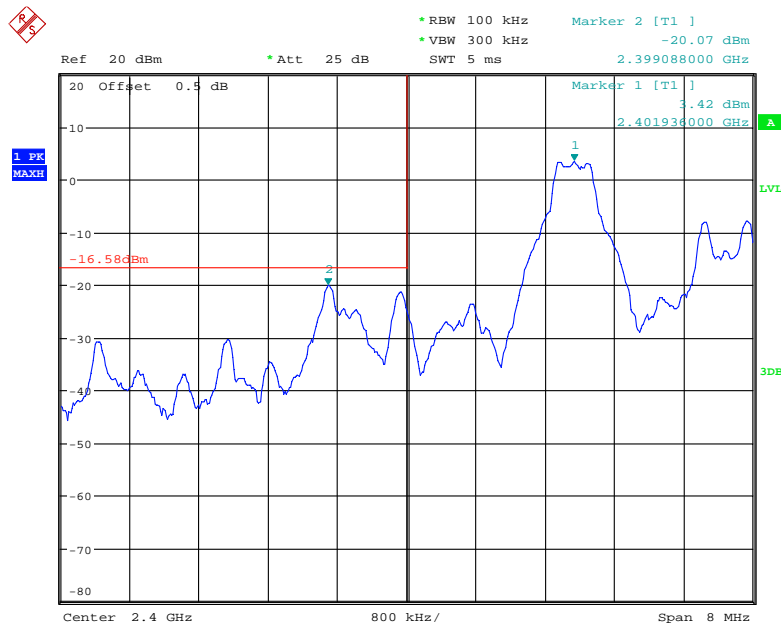
\* The testing was performed by Elena Lei on 2019-06-29

**Test Result:** Compliance

Single mode:

BDR Mode (GFSK):

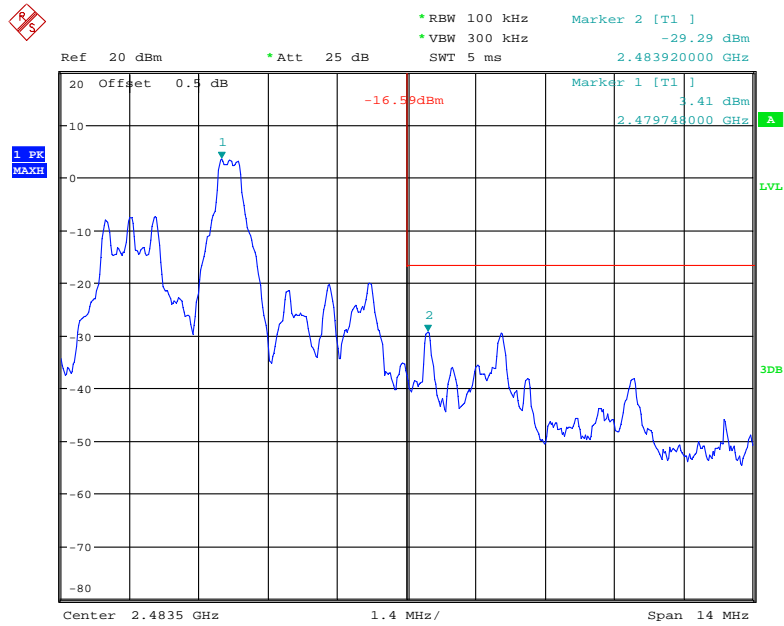
**Band Edge, Left Side**



Date: 29.JUN.2019 13:29:37



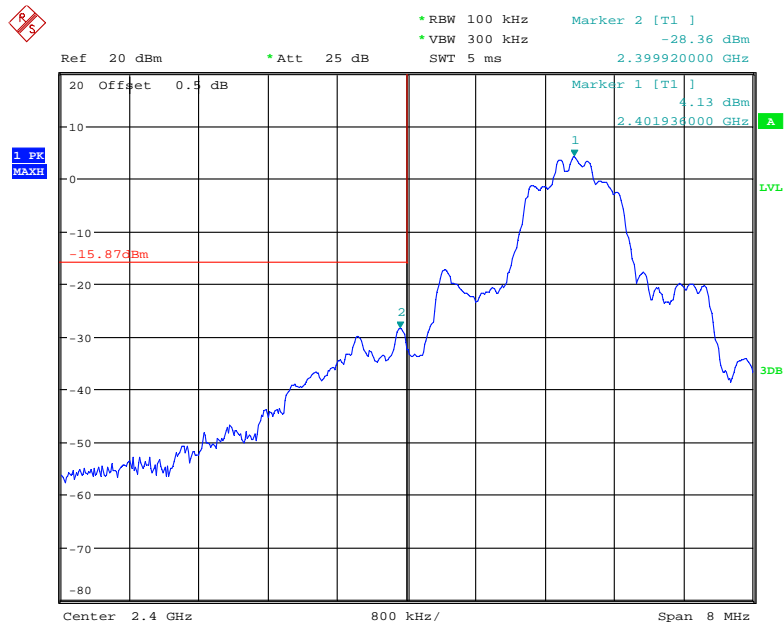
**Band Edge, Right Side**



Date: 29.JUN.2019 13:30:27

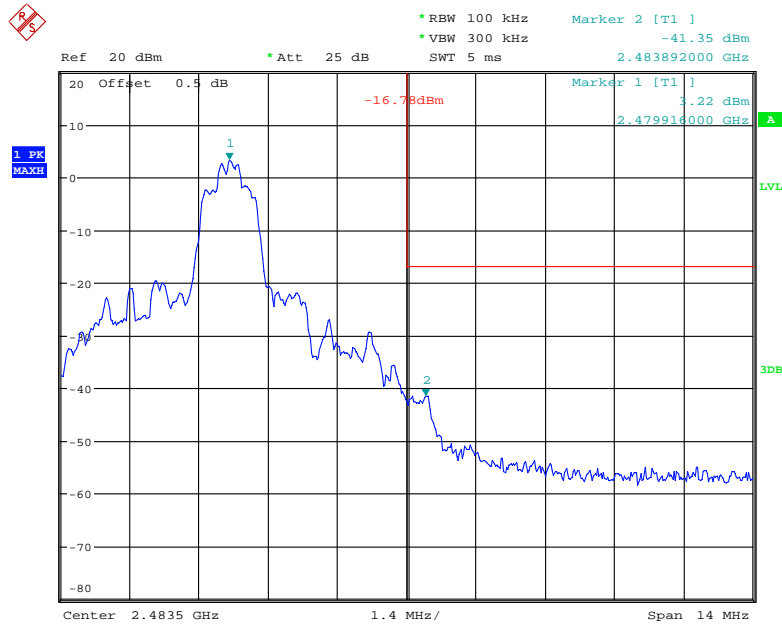
*EDR Mode ( $\pi/4$ -DQPSK):*

**Band Edge, Left Side**



Date: 29.JUN.2019 13:32:09

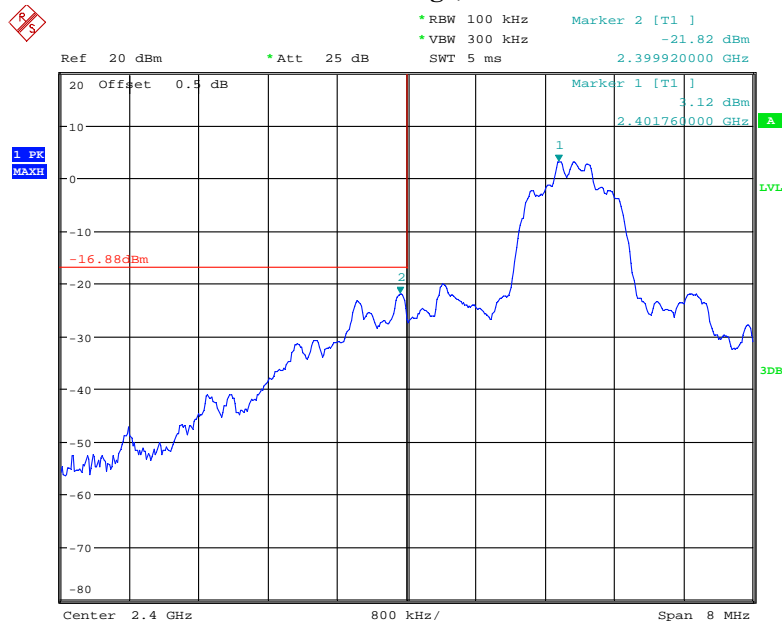
### Band Edge, Right Side



Date: 29.JUN.2019 13:31:32

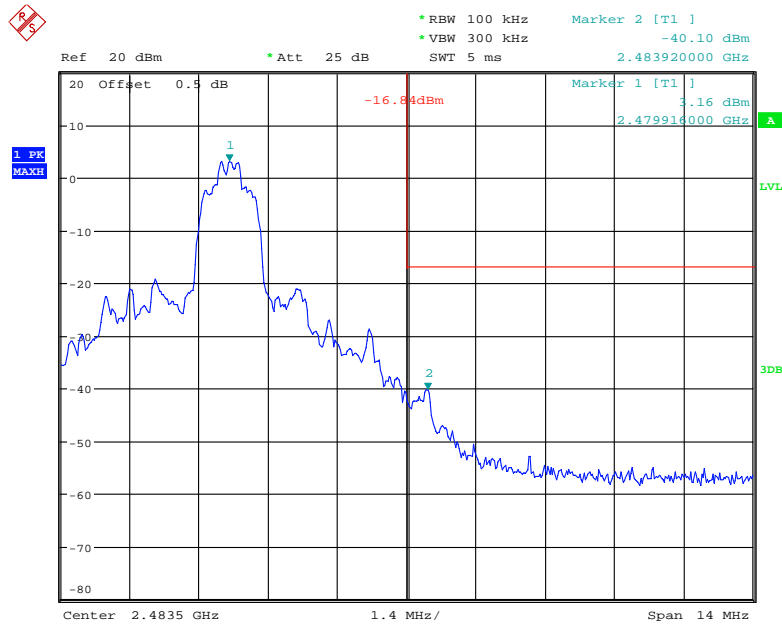
### EDR Mode (8-DPSK):

### Band Edge, Left Side



Date: 29.JUN.2019 13:33:06

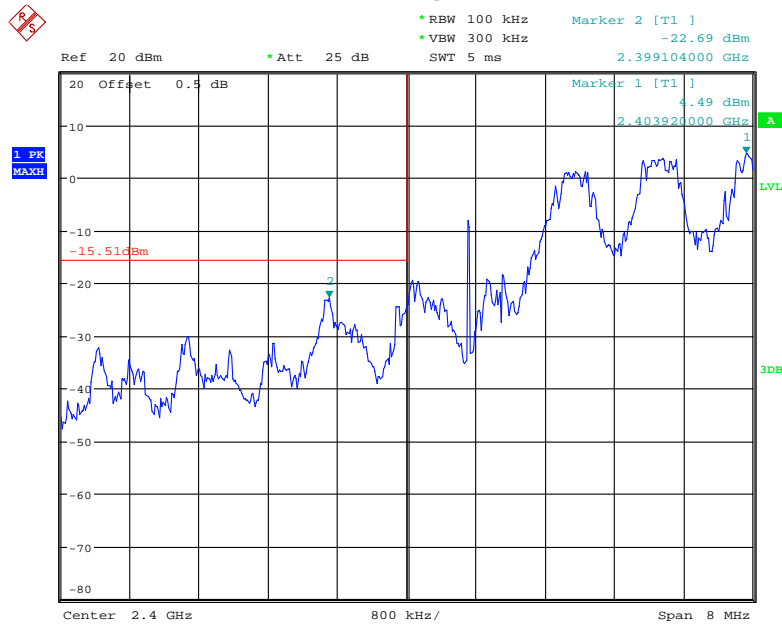
### Band Edge, Right Side



Date: 29.JUN.2019 13:33:45

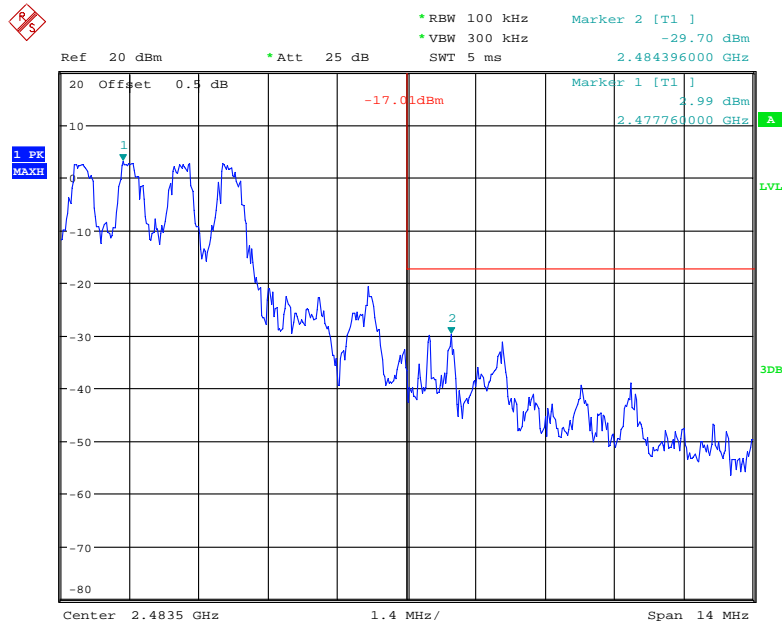
Hopping mode:  
BDR Mode (GFSK):

### Band Edge, Left Side



Date: 29.JUN.2019 11:40:57

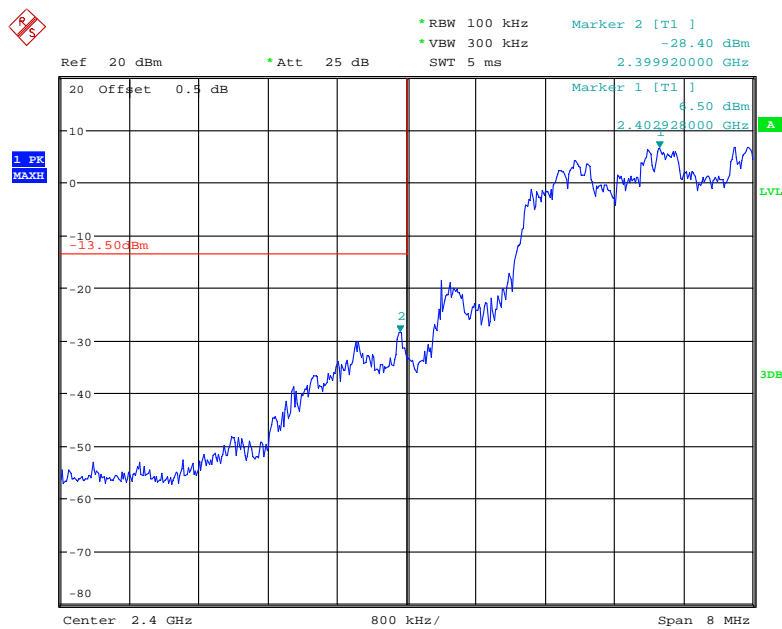
### Band Edge, Right Side



Date: 29.JUN.2019 11:20:05

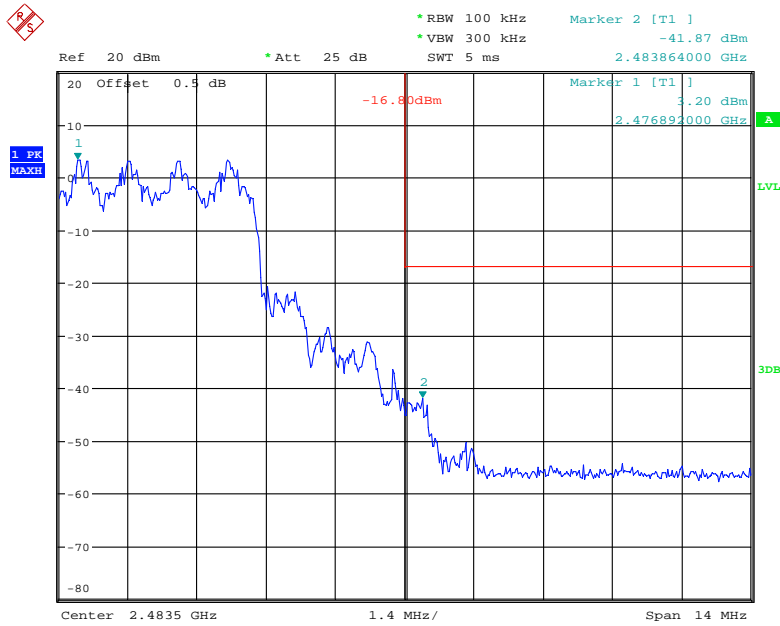
EDR Mode ( $\pi/4$ -DQPSK):

### Band Edge, Left Side



Date: 29.JUN.2019 11:13:03

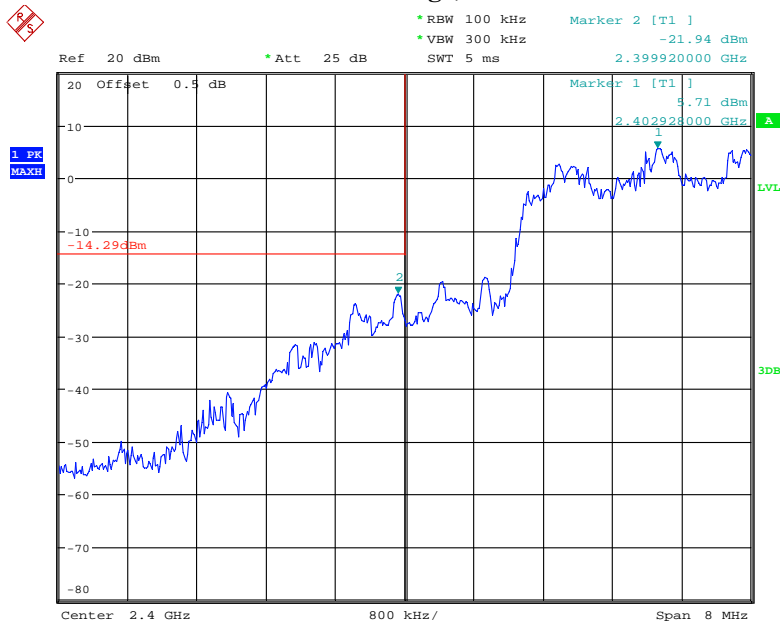
### Band Edge, Right Side



Date: 29.JUN.2019 11:15:55

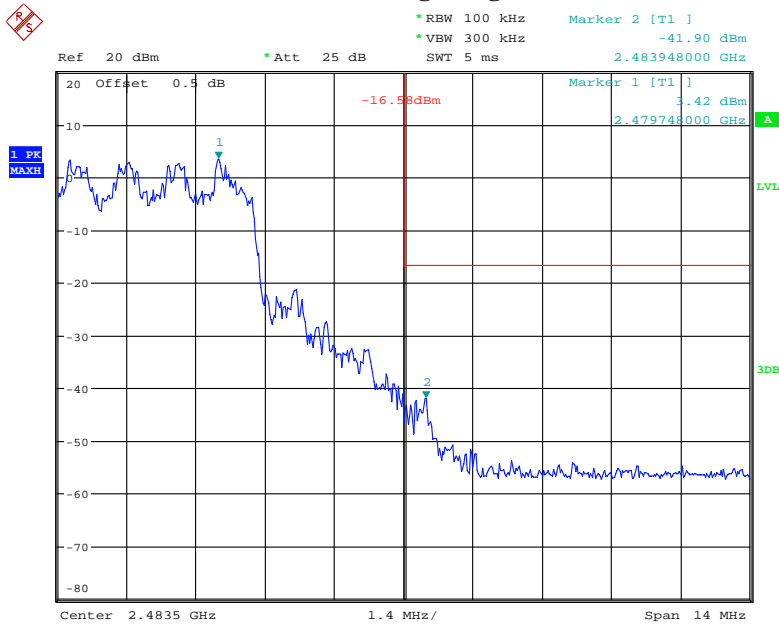
### EDR Mode (8-DPSK):

### Band Edge, Left Side



Date: 29.JUN.2019 11:07:48

### Band Edge, Right Side



Date: 29.JUN.2019 11:10:43

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