

## FCC PART 15.247

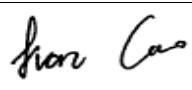
## TEST REPORT

For

### Snap-on Incorporated

2801 80th St, Kenosha, Wisconsin United States 53143

**FCC ID: 2ACXBCTBTSP861**

|                                        |                                                                                                                                                                                                                                                       |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Report Type:</b><br>Original Report | <b>Product Name:</b><br>BLUETOOTH SPEAKER                                                                                                                                                                                                             |
| <b>Report Number:</b> RXM200106051-00B |                                                                                                                                                                                                                                                       |
| <b>Report Date:</b> 2020-02-04         |                                                                                                                                                                                                                                                       |
| <b>Reviewed By:</b>                    | Ivan Cao<br>Assistant Manager<br>                                                                                                                                |
| <b>Test Laboratory:</b>                | Bay Area Compliance Laboratories Corp. (Dongguan)<br>No.69 Pulongcun, Puxinhu Industry Area,<br>Tangxia, Dongguan, Guangdong, China<br>Tel: +86-769-86858888<br>Fax: +86-769-86858891<br><a href="http://www.baclcorp.com.cn">www.baclcorp.com.cn</a> |

## **TABLE OF CONTENTS**

|                                                                                             |           |
|---------------------------------------------------------------------------------------------|-----------|
| <b>GENERAL INFORMATION.....</b>                                                             | <b>4</b>  |
| PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT) .....                                    | 4         |
| OBJECTIVE .....                                                                             | 4         |
| RELATED SUBMITTAL(S)/GRANT(S).....                                                          | 4         |
| TEST METHODOLOGY .....                                                                      | 4         |
| MEASUREMENT UNCERTAINTY .....                                                               | 5         |
| TEST FACILITY .....                                                                         | 5         |
| DECLARATIONS.....                                                                           | 5         |
| <b>SYSTEM TEST CONFIGURATION.....</b>                                                       | <b>6</b>  |
| DESCRIPTION OF TEST CONFIGURATION .....                                                     | 6         |
| EUT EXERCISE SOFTWARE .....                                                                 | 6         |
| EQUIPMENT MODIFICATIONS .....                                                               | 6         |
| BLOCK DIAGRAM OF TEST SETUP .....                                                           | 7         |
| <b>SUMMARY OF TEST RESULTS .....</b>                                                        | <b>8</b>  |
| <b>FCC §15.247 (i) &amp; §1.1310 &amp; §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE).....</b> | <b>9</b>  |
| APPLICABLE STANDARD .....                                                                   | 9         |
| <b>FCC §15.203 - ANTENNA REQUIREMENT.....</b>                                               | <b>10</b> |
| APPLICABLE STANDARD .....                                                                   | 10        |
| ANTENNA CONNECTOR CONSTRUCTION .....                                                        | 10        |
| <b>FCC §15.209, §15.205 &amp; §15.247(d) - SPURIOUS EMISSIONS.....</b>                      | <b>11</b> |
| APPLICABLE STANDARD .....                                                                   | 11        |
| EUT SETUP .....                                                                             | 11        |
| EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP .....                                           | 12        |
| TEST PROCEDURE .....                                                                        | 12        |
| TEST EQUIPMENT LIST AND DETAILS.....                                                        | 12        |
| CORRECTED AMPLITUDE & MARGIN CALCULATION .....                                              | 13        |
| TEST DATA .....                                                                             | 13        |
| <b>FCC §15.247(a) (1) - CHANNEL SEPARATION TEST .....</b>                                   | <b>19</b> |
| APPLICABLE STANDARD .....                                                                   | 19        |
| TEST EQUIPMENT LIST AND DETAILS.....                                                        | 19        |
| TEST PROCEDURE .....                                                                        | 19        |
| TEST DATA .....                                                                             | 19        |
| <b>FCC §15.247(a) (1) – 20 dB BANDWIDTH TESTING .....</b>                                   | <b>25</b> |
| APPLICABLE STANDARD .....                                                                   | 25        |
| TEST PROCEDURE .....                                                                        | 25        |
| TEST EQUIPMENT LIST AND DETAILS.....                                                        | 25        |
| TEST DATA .....                                                                             | 25        |
| <b>FCC §15.247(a) (1) (iii) - QUANTITY OF HOPPING CHANNEL TEST .....</b>                    | <b>31</b> |
| APPLICABLE STANDARD .....                                                                   | 31        |
| TEST PROCEDURE .....                                                                        | 31        |
| TEST EQUIPMENT LIST AND DETAILS.....                                                        | 31        |
| TEST DATA .....                                                                             | 31        |
| <b>FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....</b>                       | <b>34</b> |

|                                                                 |           |
|-----------------------------------------------------------------|-----------|
| APPLICABLE STANDARD .....                                       | 34        |
| TEST PROCEDURE .....                                            | 34        |
| TEST EQUIPMENT LIST AND DETAILS.....                            | 34        |
| TEST DATA .....                                                 | 34        |
| <b>FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT .....</b> | <b>40</b> |
| APPLICABLE STANDARD .....                                       | 40        |
| TEST PROCEDURE .....                                            | 40        |
| TEST EQUIPMENT LIST AND DETAILS.....                            | 40        |
| TEST DATA .....                                                 | 40        |
| <b>FCC §15.247(d) - BAND EDGES TESTING .....</b>                | <b>42</b> |
| APPLICABLE STANDARD .....                                       | 42        |
| TEST PROCEDURE .....                                            | 42        |
| TEST EQUIPMENT LIST AND DETAILS.....                            | 42        |
| TEST DATA .....                                                 | 43        |

## GENERAL INFORMATION

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

|                                          |                             |
|------------------------------------------|-----------------------------|
| <b>EUT Name:</b>                         | BLUETOOTH SPEAKER           |
| <b>EUT Model:</b>                        | CTBTSP861R                  |
| <b>Multiple Model:</b>                   | CTBTSP861X                  |
| <b>Operation Frequency:</b>              | 2402-2480 MHz               |
| <b>Maximum Output Power (Conducted):</b> | 2.47dBm                     |
| <b>Modulation Type:</b>                  | GFSK, $\pi/4$ -DQPSK, 8DPSK |
| <b>Rated Input Voltage:</b>              | DC 14.4V from Battery       |
| <b>Serial Number:</b>                    | RXM200106051-RF-S1          |
| <b>EUT Received Date:</b>                | 2020.01.06                  |
| <b>EUT Received Status:</b>              | Good                        |

*Note: The series product, models CTBTSP861R, CTBTSP861X are electrically identical, The difference between them please refer to the declaration letter for details. We selected CTBTSP861R for fully test.*

### Objective

This report is prepared on behalf of *Snap-on Incorporated* 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, 15.209 and 15.247 rules.

### Related Submittal(s)/Grant(s)

No Related submittal

### 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                                                                                                              |
| Power Spectral Density, conducted | ±0.61 dB                                                                                                             |
| 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.

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 must not be used by the customer to claim product certification, approval, or endorsement by A2LA, or any agency of the U.S. Government.

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.

### EUT Exercise Software

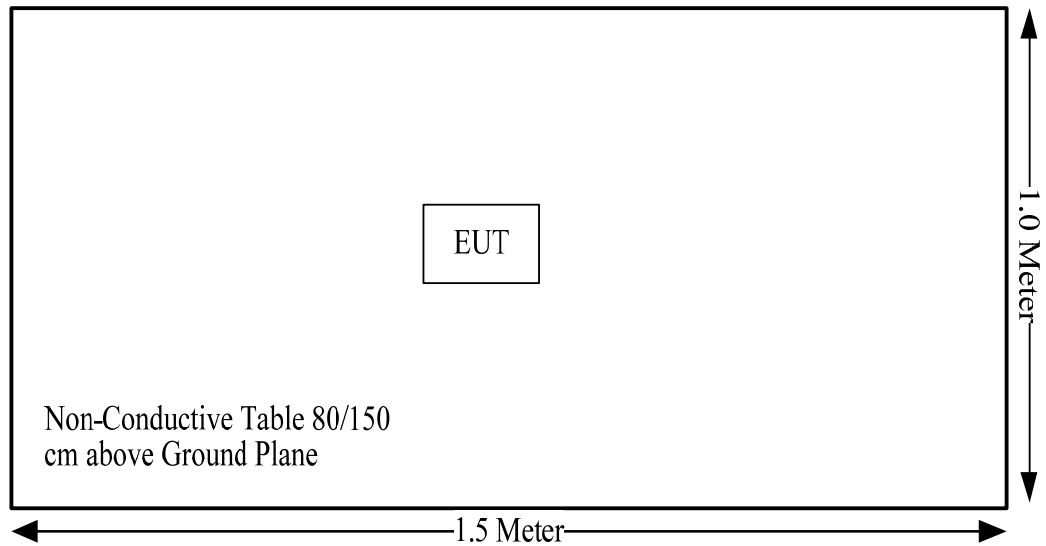
The software: 'BK RF Test\_V1.8.exe' was used during test, which was provided by manufacturer. The maximum power level was configured by the software as below table:

| Mode           | Packet type | Channel | Frequency (MHz) | Packet length | Power Level |
|----------------|-------------|---------|-----------------|---------------|-------------|
| GFSK           | DH1         | Low     | 2402            | 27            | 3           |
|                |             | Middle  | 2441            | 27            | 3           |
|                |             | High    | 2480            | 27            | 3           |
|                | DH3         | Low     | 2402            | 27            | 3           |
|                |             | Middle  | 2441            | 183           | 3           |
|                |             | High    | 2480            | 183           | 3           |
|                | DH5         | Low     | 2402            | 339           | 3           |
|                |             | Middle  | 2441            | 339           | 3           |
|                |             | High    | 2480            | 339           | 3           |
| $\pi/4$ -DQPSK | 2DH1        | Low     | 2402            | 54            | 3           |
|                |             | Middle  | 2441            | 54            | 3           |
|                |             | High    | 2480            | 54            | 3           |
|                | 2DH3        | Low     | 2402            | 367           | 3           |
|                |             | Middle  | 2441            | 367           | 3           |
|                |             | High    | 2480            | 367           | 3           |
|                | 2DH5        | Low     | 2402            | 679           | 3           |
|                |             | Middle  | 2441            | 679           | 3           |
|                |             | High    | 2480            | 679           | 3           |
| 8DPSK          | 3DH1        | Low     | 2402            | 83            | 3           |
|                |             | Middle  | 2441            | 83            | 3           |
|                |             | High    | 2480            | 83            | 3           |
|                | 3DH3        | Low     | 2402            | 552           | 3           |
|                |             | Middle  | 2441            | 552           | 3           |
|                |             | High    | 2480            | 552           | 3           |
|                | 3DH5        | Low     | 2402            | 1021          | 3           |
|                |             | Middle  | 2441            | 1021          | 3           |
|                |             | High    | 2480            | 1021          | 3           |

### Equipment Modifications

No modification was made to the EUT.

### Block Diagram of Test Setup



**SUMMARY OF TEST RESULTS**

| FCC Rules                          | Description of Test                | Result         |
|------------------------------------|------------------------------------|----------------|
| FCC§15.247 (i) & §1.1310 & §2.1091 | Maximum Permissible Exposure (MPE) | Compliance     |
| FCC §15.203                        | Antenna requirement                | Compliance     |
| FCC §15.207(a)                     | AC line conducted emissions        | Not Applicable |
| FCC §15.205, §15.209, §15.247(d)   | Spurious emissions                 | Compliance     |
| FCC §15.247(a)(1)                  | Channel separation                 | Compliance     |
| FCC §15.247(a)(1)                  | 20 dB bandwidth                    | Compliance     |
| FCC §15.247(a)(1)(iii)             | Quantity of hopping channel test   | Compliance     |
| FCC §15.247(a)(1)(iii)             | Time of occupancy (dwell time)     | Compliance     |
| FCC §15.247(b)(1)                  | Peak output power measurement      | Compliance     |
| FCC §15.247(d)                     | Band edges                         | Compliance     |

Not Applicable: the device was powered by battery when use.

## FCC §15.247 (i) & §1.1310 & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

### Applicable Standard

According to subpart 15.247(i) and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

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

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

According to §1.1310 and §2.1091 RF exposure is calculated.

### Calculation formula:

Prediction of power density at the distance of the applicable MPE limit

$S = PG/4\pi R^2$  = power density (in appropriate units, e.g. mW/cm<sup>2</sup>);

P = power input to the antenna (in appropriate units, e.g., mW);

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

### Calculated Data:

| Frequency (MHz) | Antenna Gain |           | Conducted output power including Tune-up Tolerance |      | Evaluation Distance (cm) | Power Density (mW/cm <sup>2</sup> ) | MPE Limit (mW/cm <sup>2</sup> ) |
|-----------------|--------------|-----------|----------------------------------------------------|------|--------------------------|-------------------------------------|---------------------------------|
|                 | (dBi)        | (numeric) | (dBm)                                              | (mW) |                          |                                     |                                 |
| 2402-2480       | 2            | 1.58      | 3                                                  | 2.00 | 20.00                    | 0.0006                              | 1.0                             |

**Result:** The device meet FCC MPE at 20 cm distance

## **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 use of a standard antenna jack or electrical connector is prohibited.

### **Antenna 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 |
|--------------|-----------------------|-------------------------------|
| PCB          | 50                    | 2.0 dBi/2.4~2.5GHz            |

**Result:** Compliance.

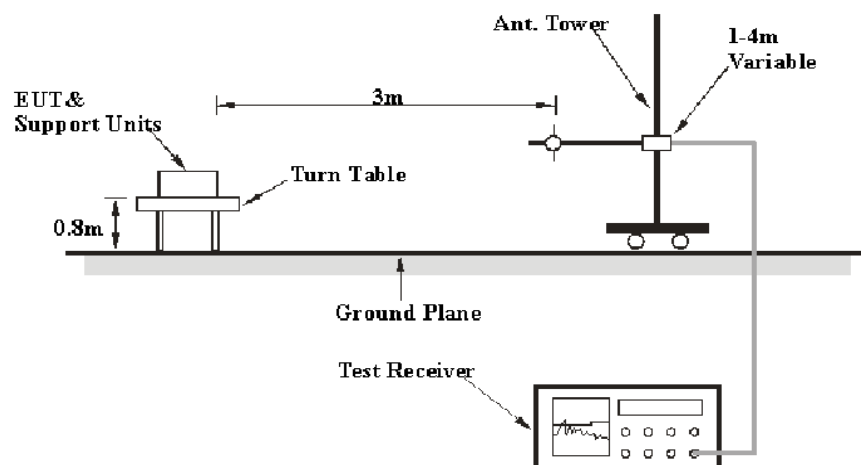
## FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

### Applicable Standard

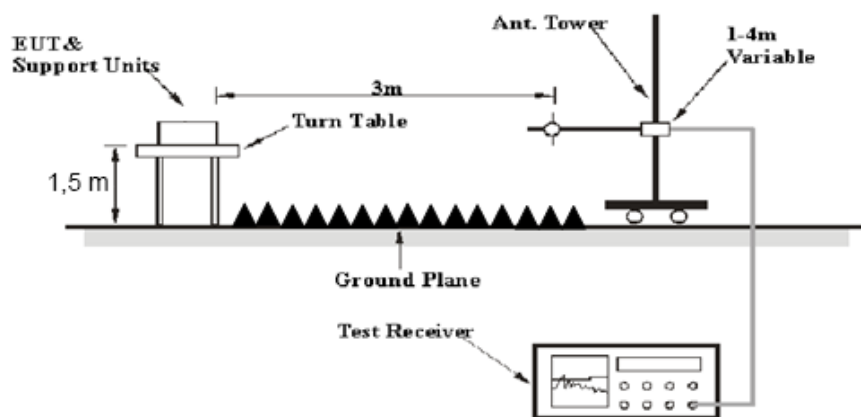
FCC §15.247 (d); §15.209; §15.205;

### EUT Setup

#### Below 1GHz:



#### Above 1GHz:



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

## Test Equipment List and Details

| Manufacturer          | Description       | Model                  | Serial Number      | Calibration Date | Calibration Due Date |
|-----------------------|-------------------|------------------------|--------------------|------------------|----------------------|
| Radiation Below 1GHz  |                   |                        |                    |                  |                      |
| R&S                   | EMI Test Receiver | ESR3                   | 102453             | 2019-09-12       | 2020-09-12           |
| 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           |
| Radiation Above 1GHz  |                   |                        |                    |                  |                      |
| Agilent               | Spectrum Analyzer | E4440A                 | SG43360054         | 2019-05-09       | 2020-05-09           |
| 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           |
| Unknown               | Coaxial Cable     | C-SJSJ-50              | C-0800-01          | 2019-09-05       | 2020-09-05           |
| Unknown               | Coaxial Cable     | C-NJNJ-50              | C-0200-02          | 2019-09-05       | 2020-09-05           |
| Ducommun Technologies | Horn Antenna      | ARH-4223-02            | 1007726-01<br>1304 | 2019-11-18       | 2022-11-18           |
| MITEQ                 | Amplifier         | AFS42-00101800-25-S-42 | 2001271            | 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).

## 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 Data

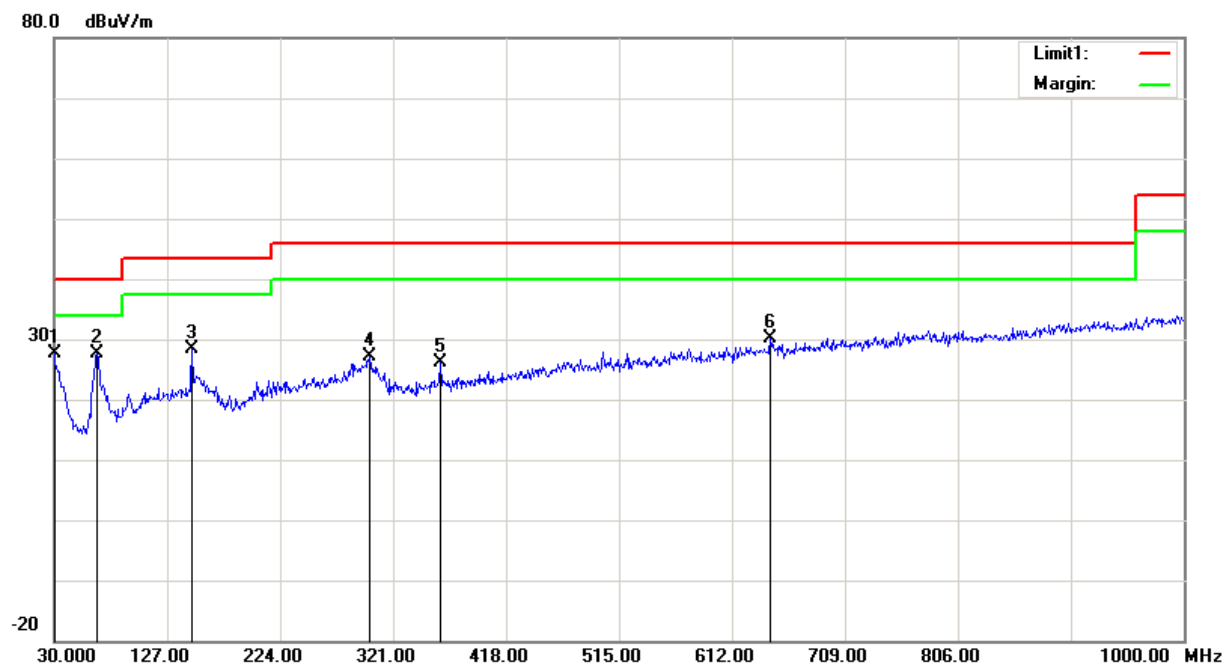
### Environmental Conditions

| Test Items         | Radiation Below 1GHz | Radiation Above 1GHz |
|--------------------|----------------------|----------------------|
| Temperature:       | 21.9 °C              | 21.9 °C              |
| Relative Humidity: | 39 %                 | 39 %                 |
| ATM Pressure:      | 101.1 kPa            | 101.1 kPa            |
| Tester:            | Davy Wang            | Felix Wang           |
| Test Date:         | 2020-01-17           | 2020-01-21           |

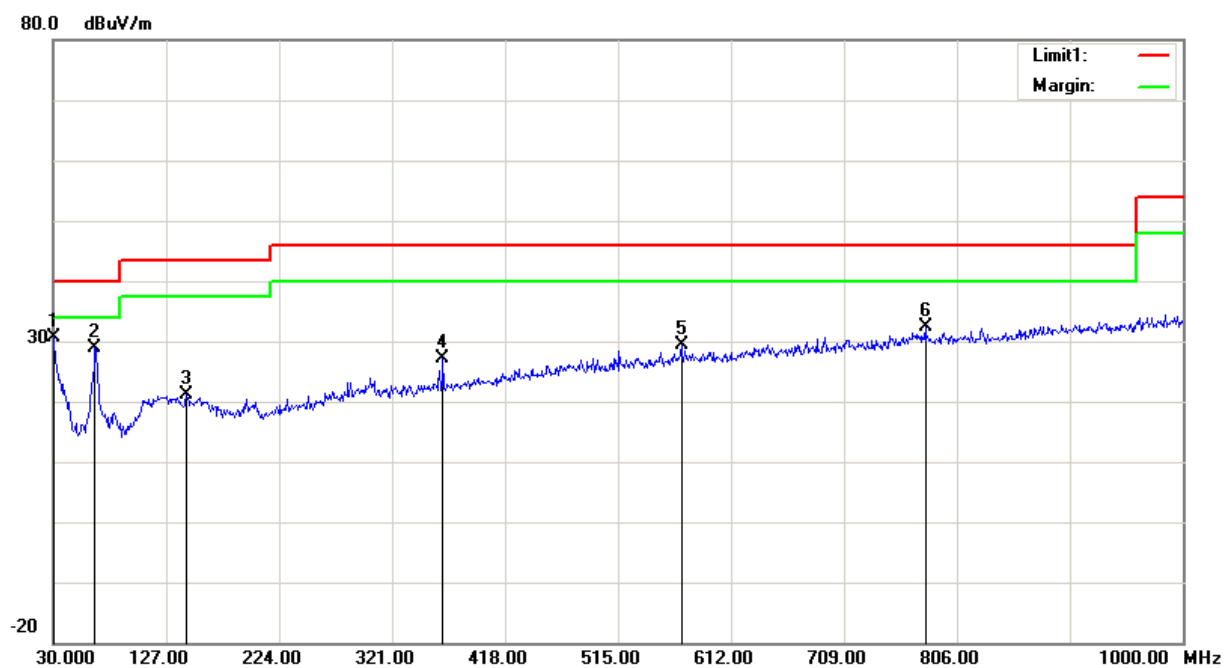
*Test Mode: Transmitting*

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

## Horizontal:



| Frequency (MHz) | Receiver Reading (dB $\mu$ V) | Remark | Correction Factor (dB/m) | Cord. Amp. (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
|-----------------|-------------------------------|--------|--------------------------|---------------------------|----------------------|-------------|
| 30.0000         | 25.95                         | peak   | 1.72                     | 27.67                     | 40.00                | 12.33       |
| 66.8600         | 39.00                         | peak   | -11.46                   | 27.54                     | 40.00                | 12.46       |
| 148.3400        | 34.44                         | peak   | -6.05                    | 28.39                     | 43.50                | 15.11       |
| 300.6300        | 30.84                         | peak   | -3.79                    | 27.05                     | 46.00                | 18.95       |
| 361.7400        | 28.86                         | peak   | -2.80                    | 26.06                     | 46.00                | 19.94       |
| 644.9800        | 28.02                         | peak   | 2.16                     | 30.18                     | 46.00                | 15.82       |

**Vertical:**

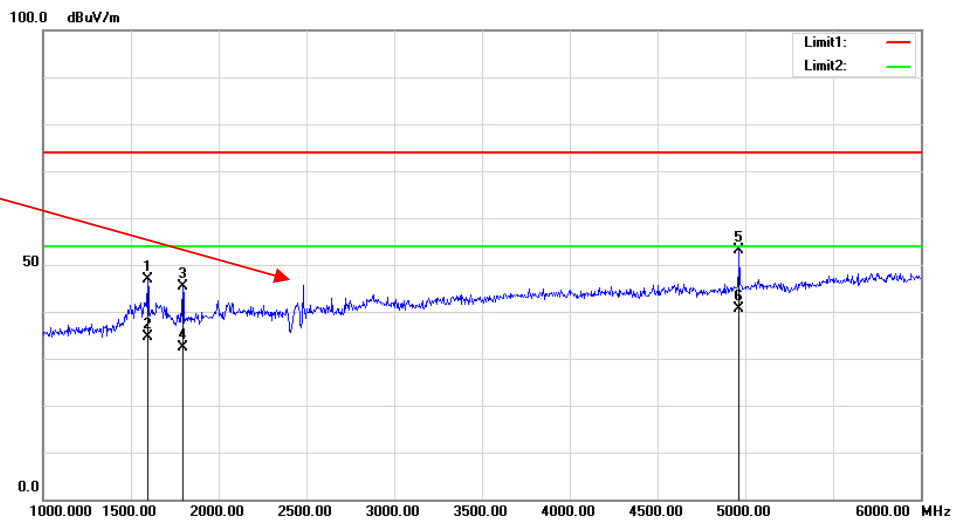
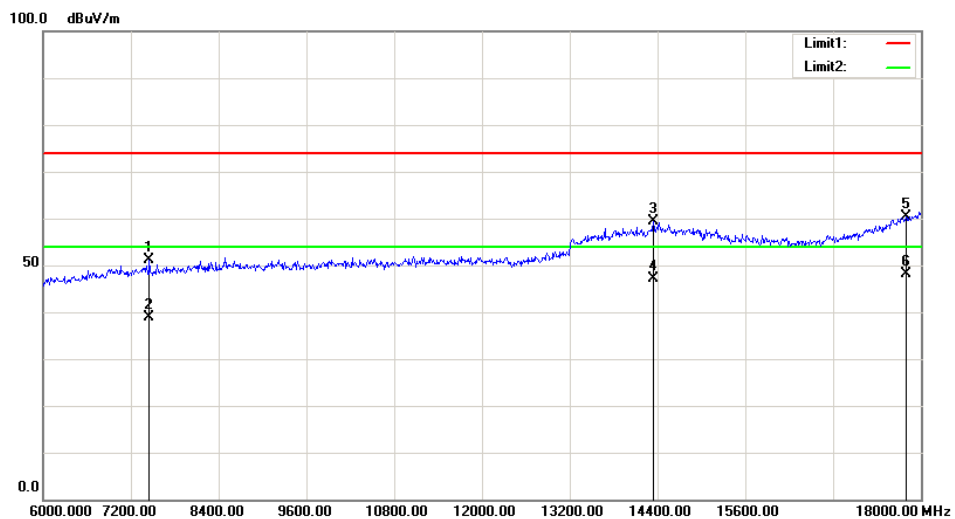
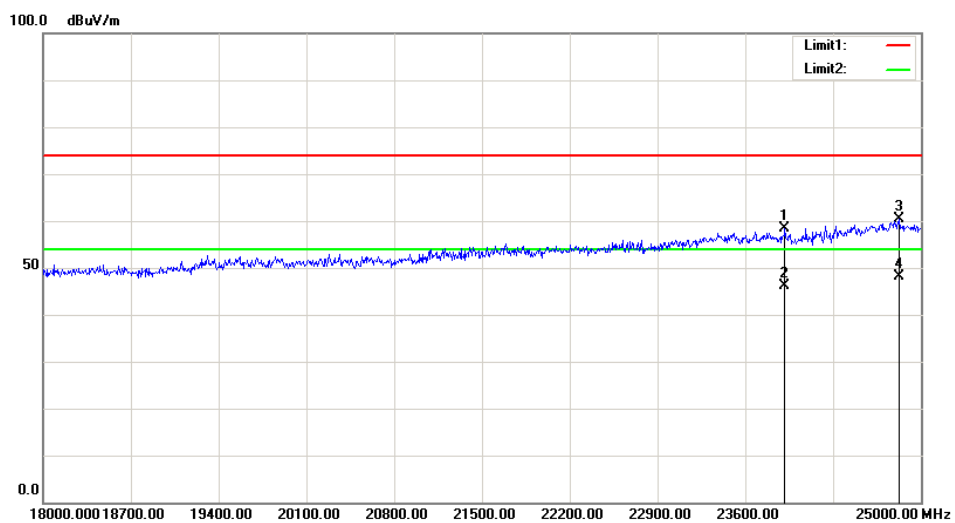
| Frequency (MHz) | Receiver Reading (dB $\mu$ V) | Remark | Correction Factor (dB/m) | Cord. Amp. (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
|-----------------|-------------------------------|--------|--------------------------|---------------------------|----------------------|-------------|
| 30.0000         | 29.00                         | peak   | 1.72                     | 30.72                     | 40.00                | 9.28        |
| 65.8900         | 40.48                         | peak   | -11.60                   | 28.88                     | 40.00                | 11.12       |
| 144.4600        | 27.12                         | peak   | -5.98                    | 21.14                     | 43.50                | 22.36       |
| 364.6500        | 29.83                         | peak   | -2.82                    | 27.01                     | 46.00                | 18.99       |
| 569.3200        | 28.32                         | peak   | 0.99                     | 29.31                     | 46.00                | 16.69       |
| 778.8400        | 27.96                         | peak   | 4.36                     | 32.32                     | 46.00                | 13.68       |

**2)1GHz-25GHz:***BDR Mode(GFSK) was the worst:*

| Frequency<br>(MHz)       | Receiver          |        | Rx Antenna     |                  | Cable<br>loss<br>(dB) | Amplifier<br>Gain<br>(dB) | Corrected<br>Amplitude<br>(dBμV/m) | Limit<br>(dBμV/m) | Margin<br>(dB) |
|--------------------------|-------------------|--------|----------------|------------------|-----------------------|---------------------------|------------------------------------|-------------------|----------------|
|                          | Reading<br>(dBμV) | Remark | Polar<br>(H/V) | Factor<br>(dB/m) |                       |                           |                                    |                   |                |
| Low Channel: 2402 MHz    |                   |        |                |                  |                       |                           |                                    |                   |                |
| 2390.00                  | 26.21             | PK     | H              | 28.08            | 1.80                  | 0.00                      | 56.09                              | 74.00             | 17.91          |
| 2390.00                  | 13.27             | AV     | H              | 28.08            | 1.80                  | 0.00                      | 43.15                              | 54.00             | 10.85          |
| 4804.00                  | 40.07             | PK     | H              | 32.91            | 3.17                  | 25.60                     | 50.55                              | 74.00             | 23.45          |
| 4804.00                  | 27.96             | AV     | H              | 32.91            | 3.17                  | 25.60                     | 38.44                              | 54.00             | 15.56          |
| 7206.00                  | 36.04             | PK     | H              | 35.74            | 4.82                  | 25.60                     | 51.00                              | 74.00             | 23.00          |
| 7206.00                  | 23.96             | AV     | H              | 35.74            | 4.82                  | 25.60                     | 38.92                              | 54.00             | 15.08          |
| Middle Channel: 2441 MHz |                   |        |                |                  |                       |                           |                                    |                   |                |
| 4882.00                  | 40.61             | PK     | H              | 33.06            | 3.27                  | 25.66                     | 51.28                              | 74.00             | 22.72          |
| 4882.00                  | 27.89             | AV     | H              | 33.06            | 3.27                  | 25.66                     | 38.56                              | 54.00             | 15.44          |
| 7323.00                  | 36.03             | PK     | H              | 36.04            | 4.62                  | 25.73                     | 50.96                              | 74.00             | 23.04          |
| 7323.00                  | 23.67             | AV     | H              | 36.04            | 4.62                  | 25.73                     | 38.60                              | 54.00             | 15.40          |
| High Channel: 2480 MHz   |                   |        |                |                  |                       |                           |                                    |                   |                |
| 2483.50                  | 28.44             | PK     | H              | 28.27            | 1.84                  | 0.00                      | 58.55                              | 74.00             | 15.45          |
| 2483.50                  | 13.85             | AV     | H              | 28.27            | 1.84                  | 0.00                      | 43.96                              | 54.00             | 10.04          |
| 4960.00                  | 42.19             | PK     | H              | 33.22            | 3.23                  | 25.63                     | 53.01                              | 74.00             | 20.99          |
| 4960.00                  | 29.70             | AV     | H              | 33.22            | 3.23                  | 25.63                     | 40.52                              | 54.00             | 13.48          |
| 7440.00                  | 35.65             | PK     | H              | 36.34            | 4.41                  | 25.85                     | 50.55                              | 74.00             | 23.45          |
| 7440.00                  | 22.68             | AV     | H              | 36.34            | 4.41                  | 25.85                     | 37.58                              | 54.00             | 16.42          |

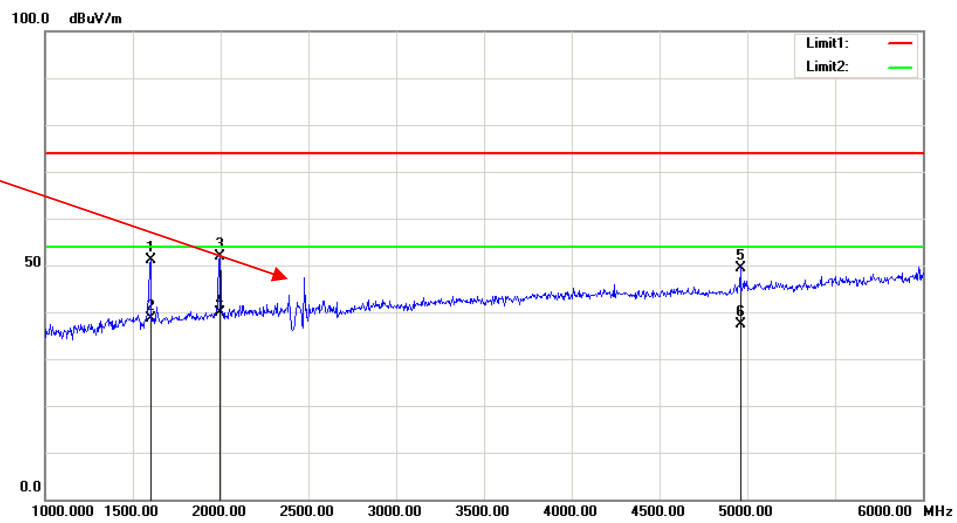
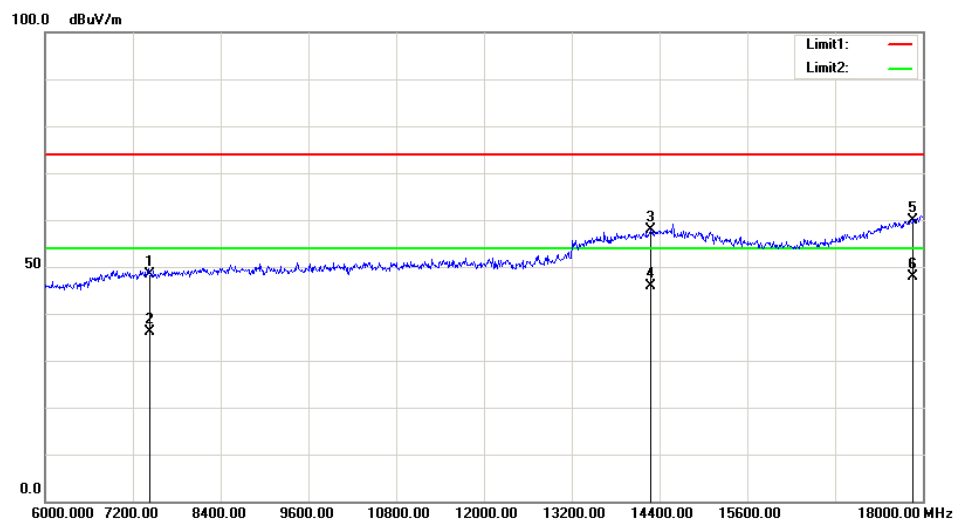
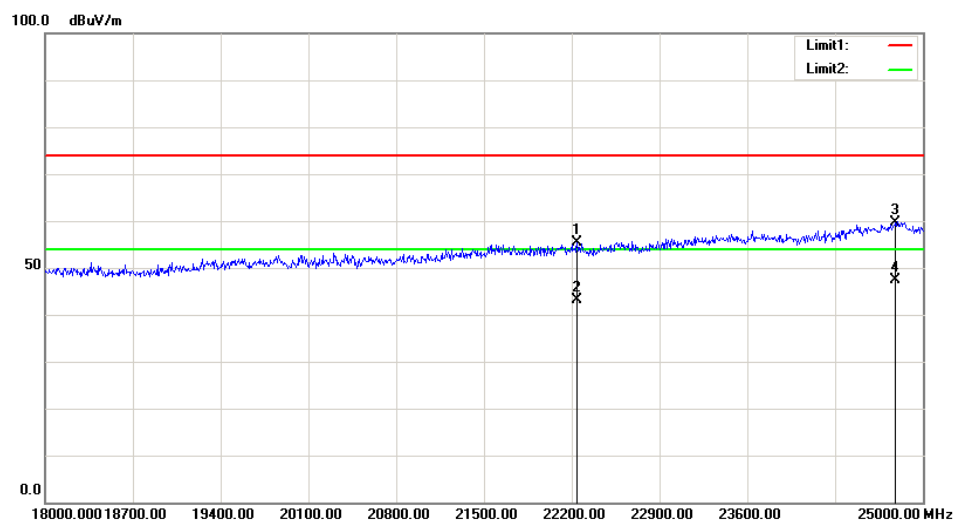
**Worst plots (GFSK High channel was the worst)**  
**Horizontal**

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 | FSV40       | 101474        | 2020-01-09       | 2021-01-09           |
| 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 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>       | 24.1°C     |
| <b>Relative Humidity:</b> | 60 %       |
| <b>ATM Pressure:</b>      | 101.8 kPa  |
| <b>Tester:</b>            | Fay Hu     |
| <b>Test Date:</b>         | 2020-01-17 |

**Test Result:** Compliance.

Please refer to following tables and plots

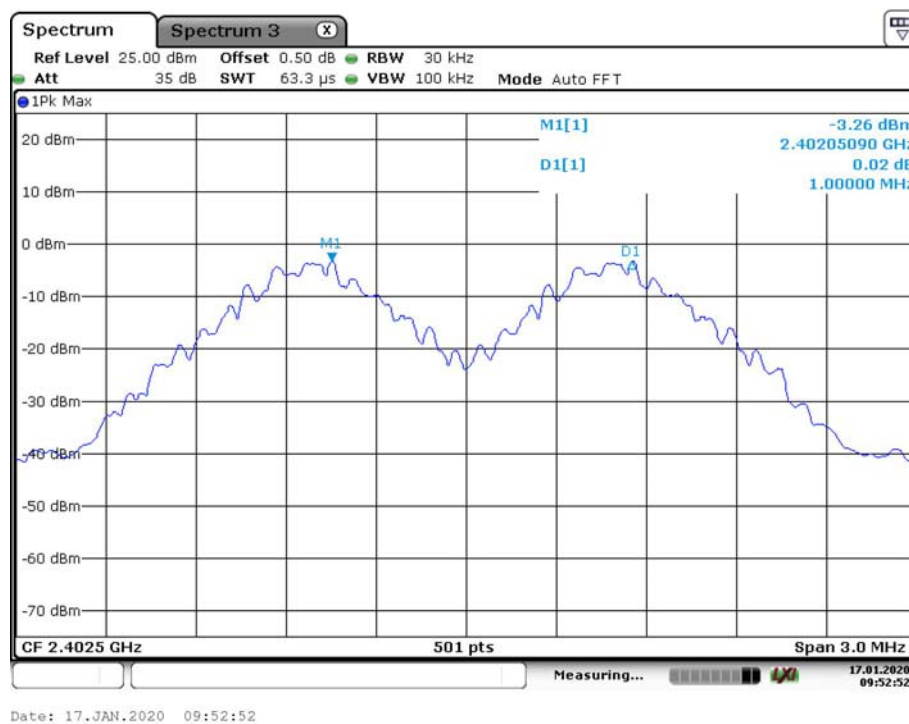
Test Mode: Transmitting

| 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                    | 0.69        |
| EDR ( $\pi/4$ -DQPSK) | Low     | 2402            | 1.000                    | 0.90        |
|                       | Middle  | 2441            | 1.000                    | 0.90        |
|                       | High    | 2480            | 1.000                    | 0.90        |
| EDR (8DPSK)           | Low     | 2402            | 1.000                    | 0.90        |
|                       | Middle  | 2441            | 1.000                    | 0.90        |
|                       | High    | 2480            | 1.000                    | 0.90        |

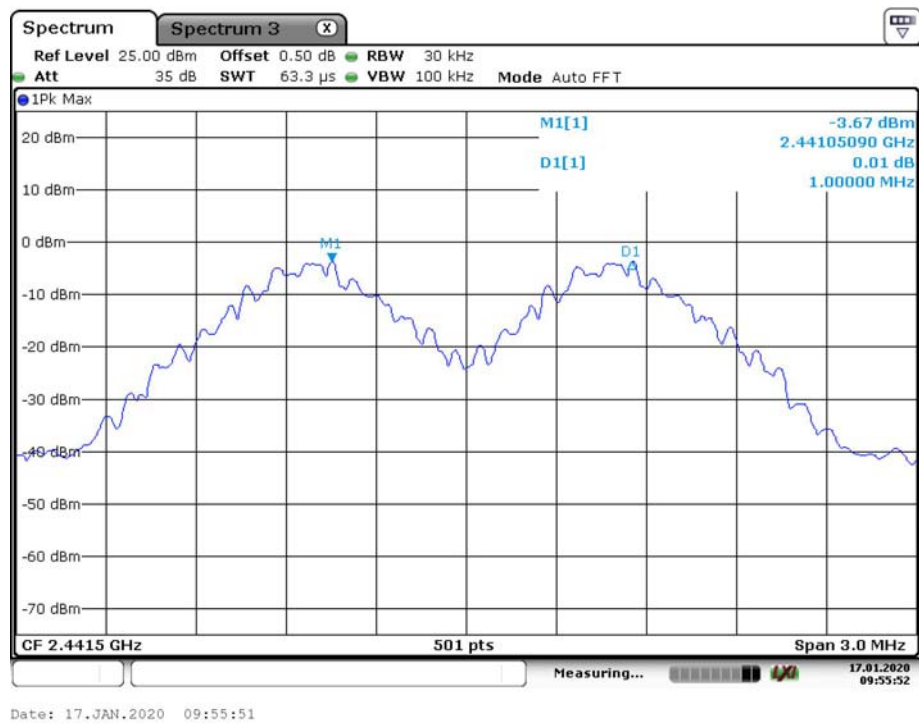
Note: Limit =  $(2/3) \times 20\text{dB bandwidth}$

BDR Mode (GFSK):

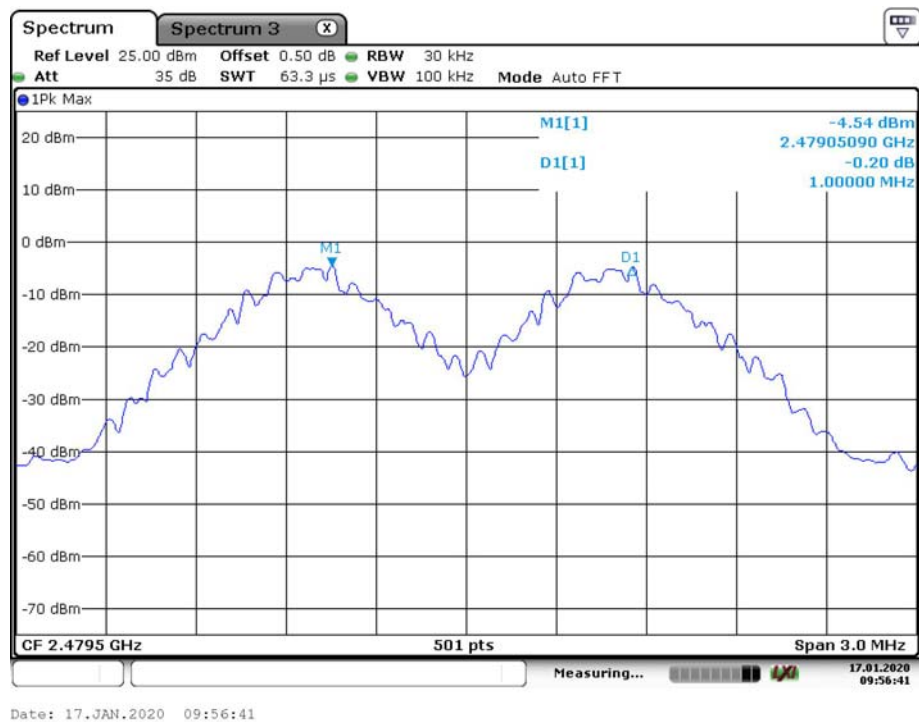
### Low Channel



## Middle Channel

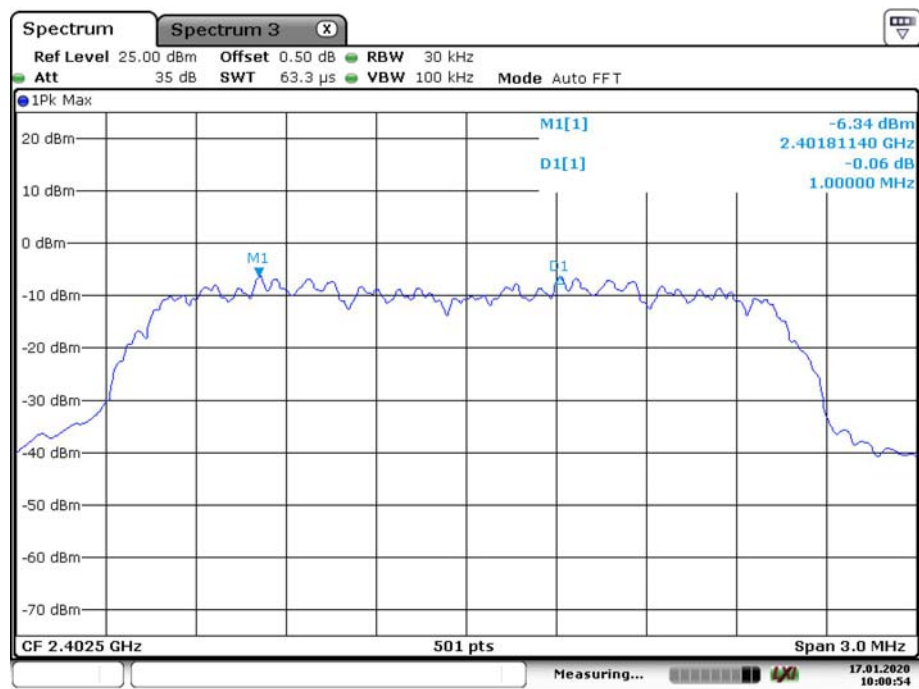


## High Channel



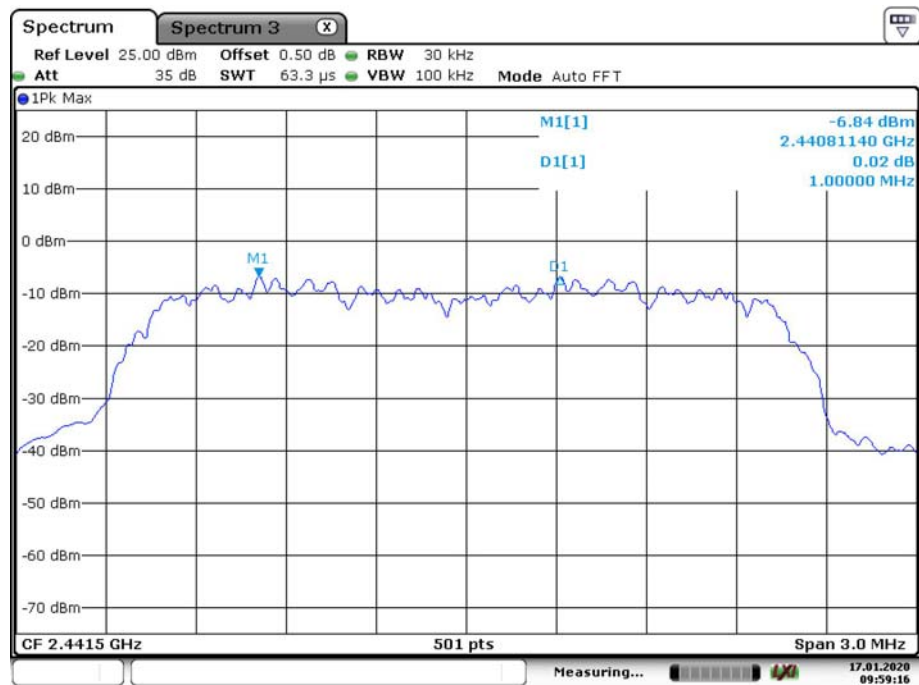
EDR Mode ( $\pi/4$ -DQPSK):

### Low Channel



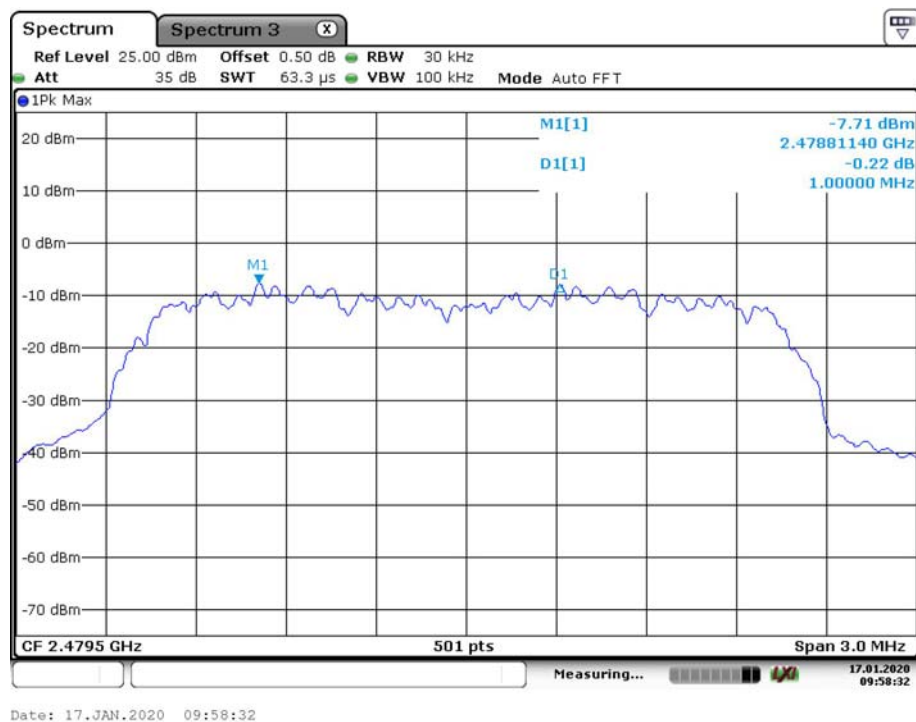
Date: 17.JAN.2020 10:00:54

### Middle Channel



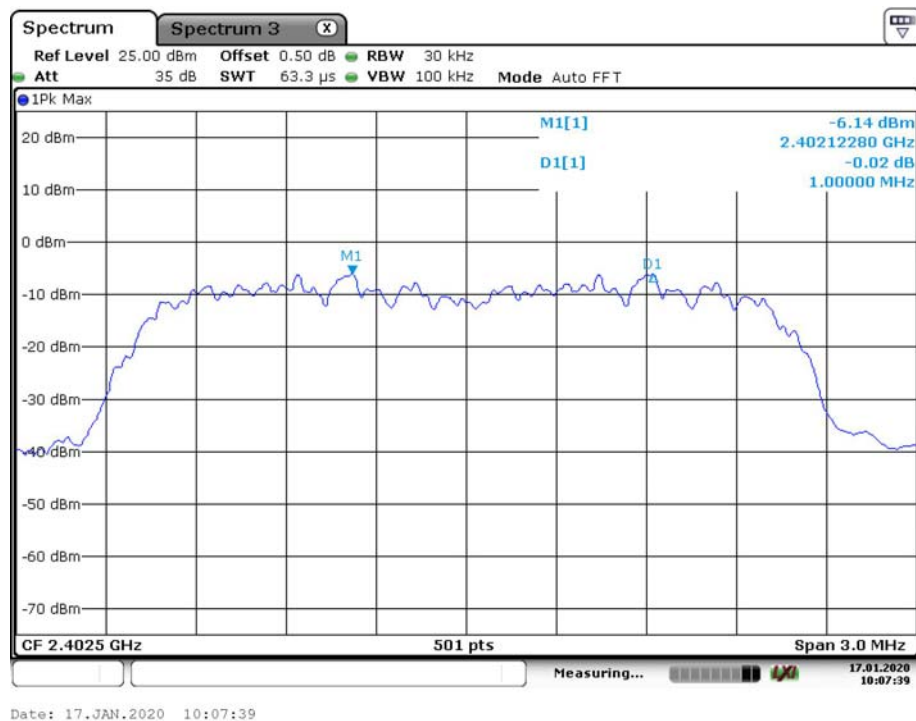
Date: 17.JAN.2020 09:59:16

### High Channel

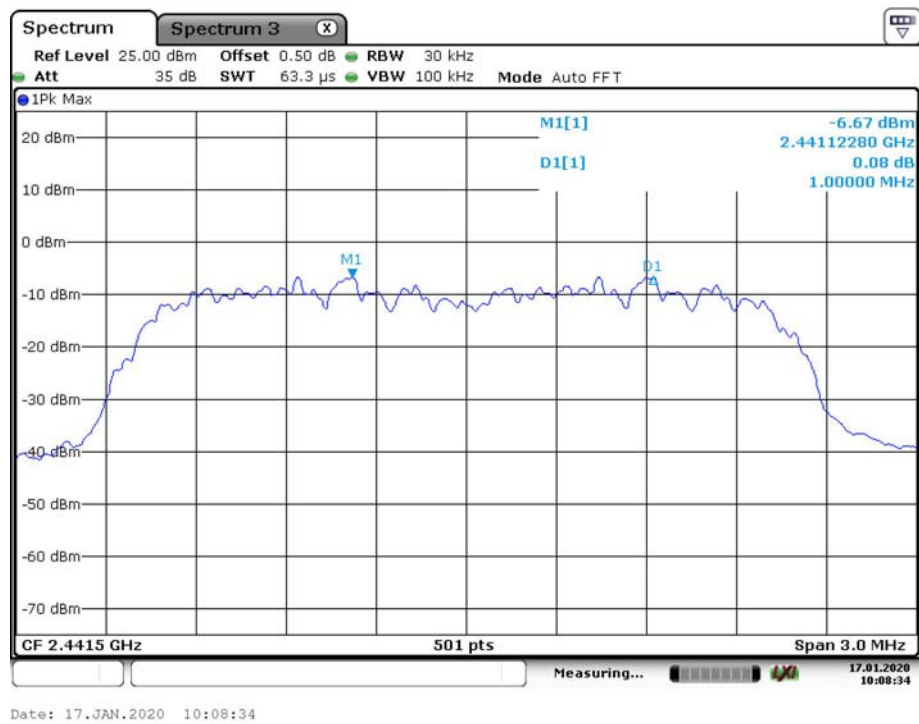


EDR Mode (8DPSK):

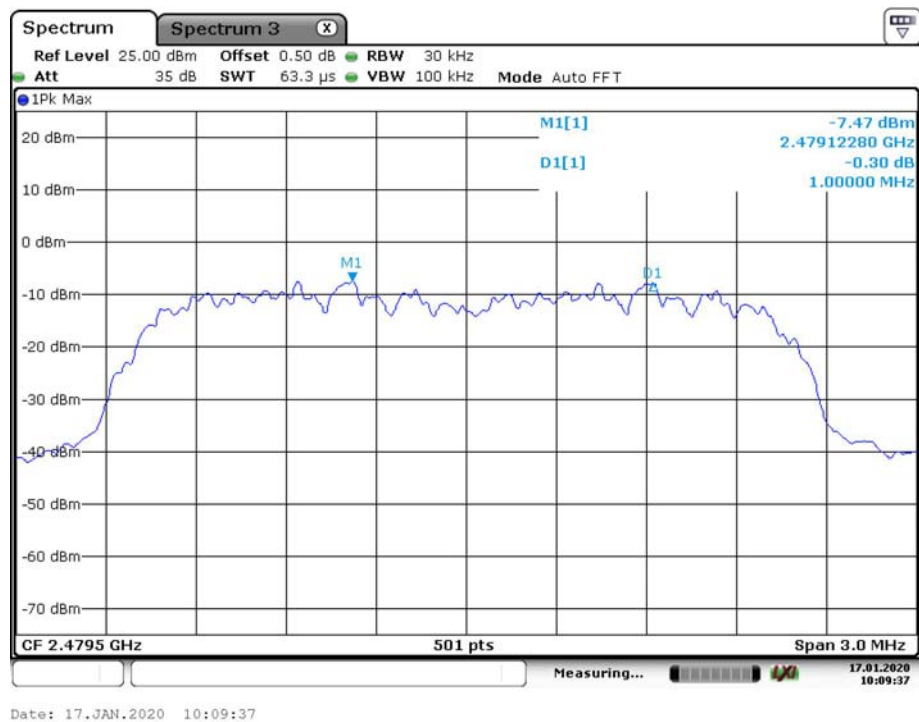
### Low Channel



## Middle Channel



## High Channel



**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 | FSV40       | 101474        | 2020-01-09       | 2021-01-09           |
| 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**

|                           |            |
|---------------------------|------------|
| <b>Temperature:</b>       | 24.1°C     |
| <b>Relative Humidity:</b> | 60 %       |
| <b>ATM Pressure:</b>      | 101.8 kPa  |
| <b>Tester:</b>            | Fay Hu     |
| <b>Test Date:</b>         | 2020-01-17 |

**Test Result:** Compliance.

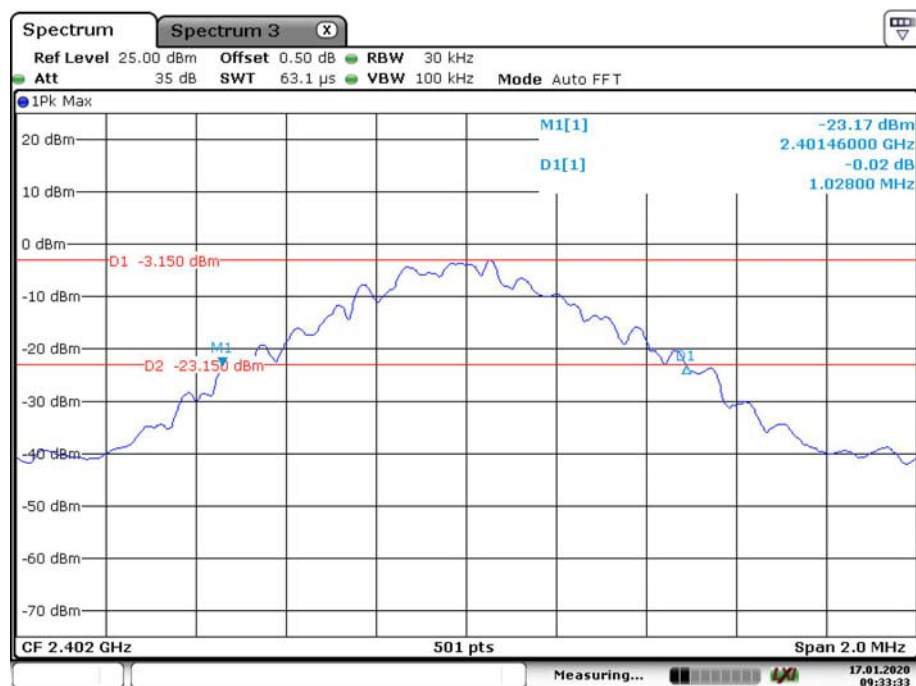
Please refer to following tables and plots

Test Mode: Transmitting

| Mode                       | Channel | Frequency (MHz) | 20 dB Bandwidth (MHz) |
|----------------------------|---------|-----------------|-----------------------|
| BDR Mode (GFSK)            | Low     | 2402            | 1.028                 |
|                            | Middle  | 2441            | 1.028                 |
|                            | High    | 2480            | 1.028                 |
| EDR Mode ( $\pi/4$ -DQPSK) | Low     | 2402            | 1.356                 |
|                            | Middle  | 2441            | 1.356                 |
|                            | High    | 2480            | 1.356                 |
| EDR Mode (8DPSK)           | Low     | 2402            | 1.352                 |
|                            | Middle  | 2441            | 1.348                 |
|                            | High    | 2480            | 1.348                 |

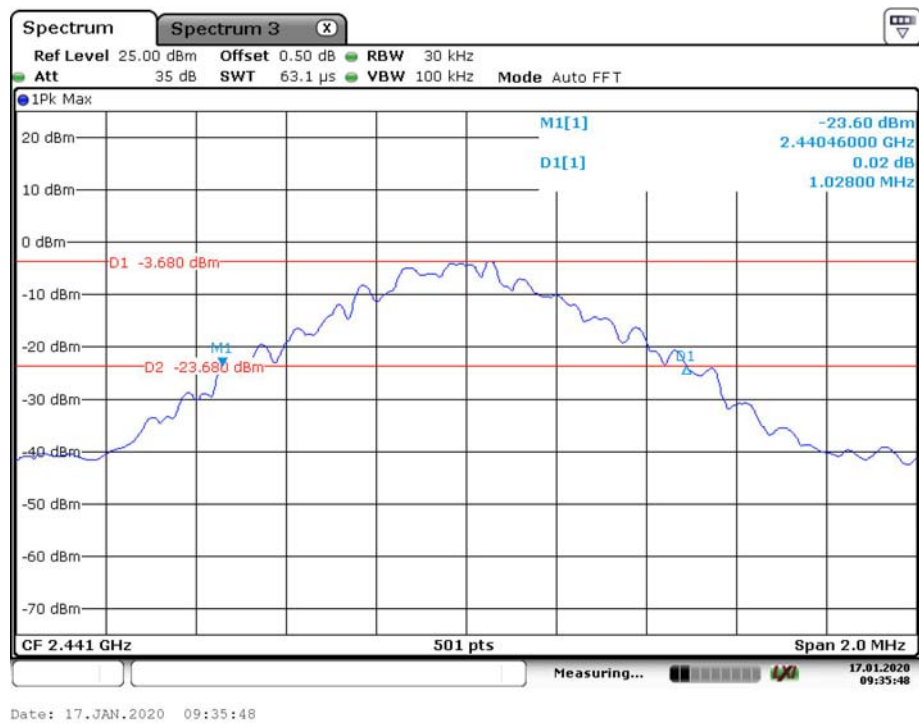
BDR Mode (GFSK):

### Low Channel

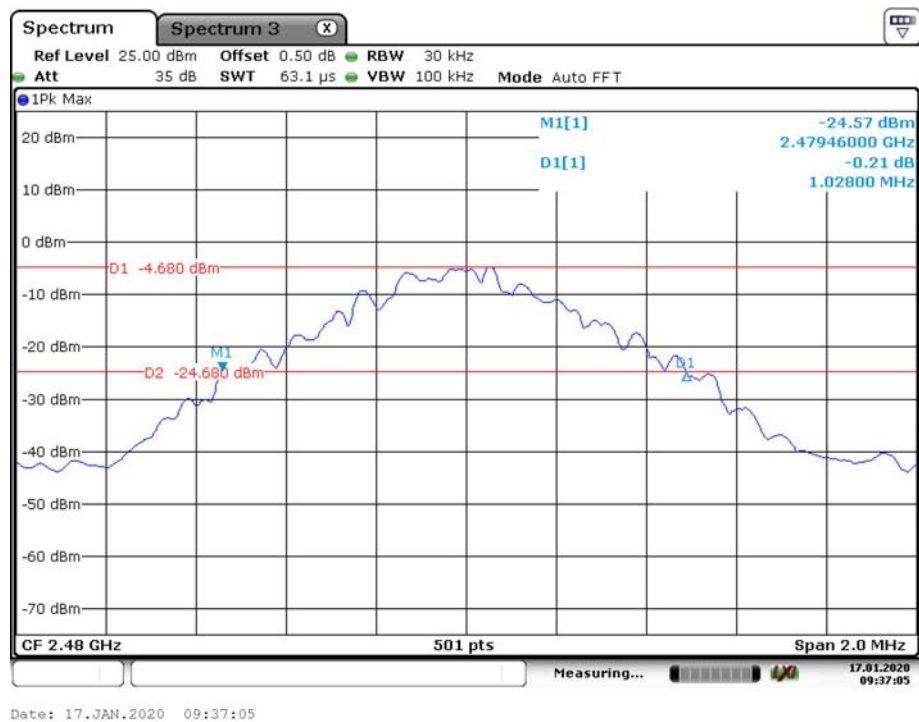


Date: 17.JAN.2020 09:33:33

### Middle Channel

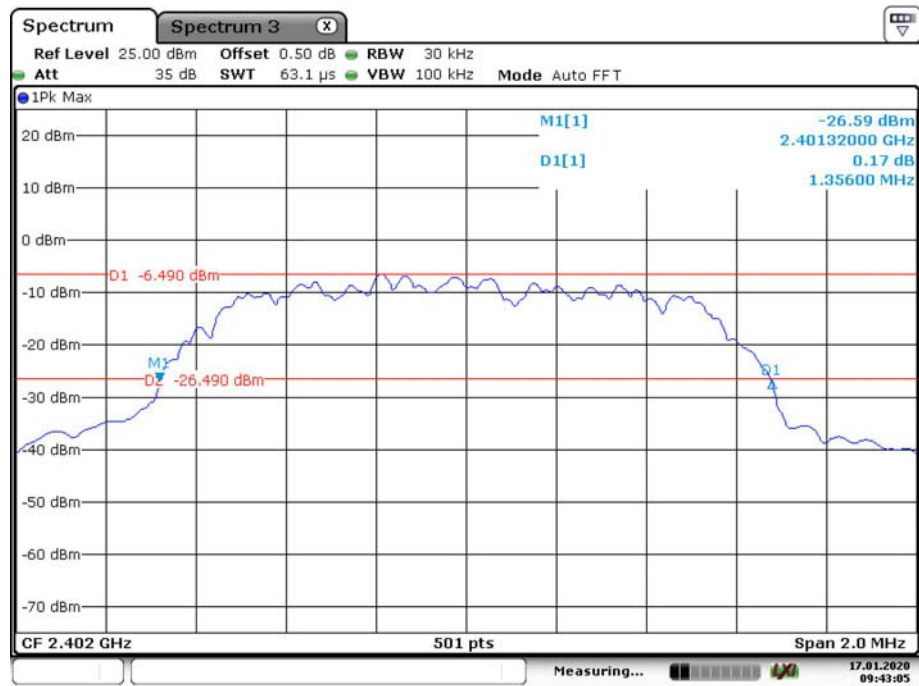


### High Channel



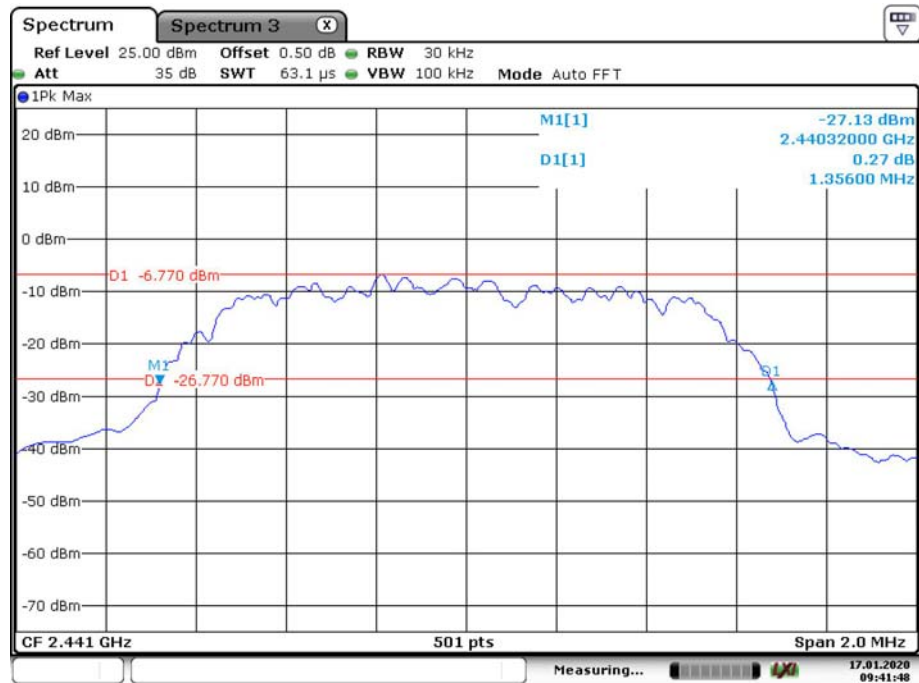
EDR Mode ( $\pi/4$ -DQPSK):

### Low Channel



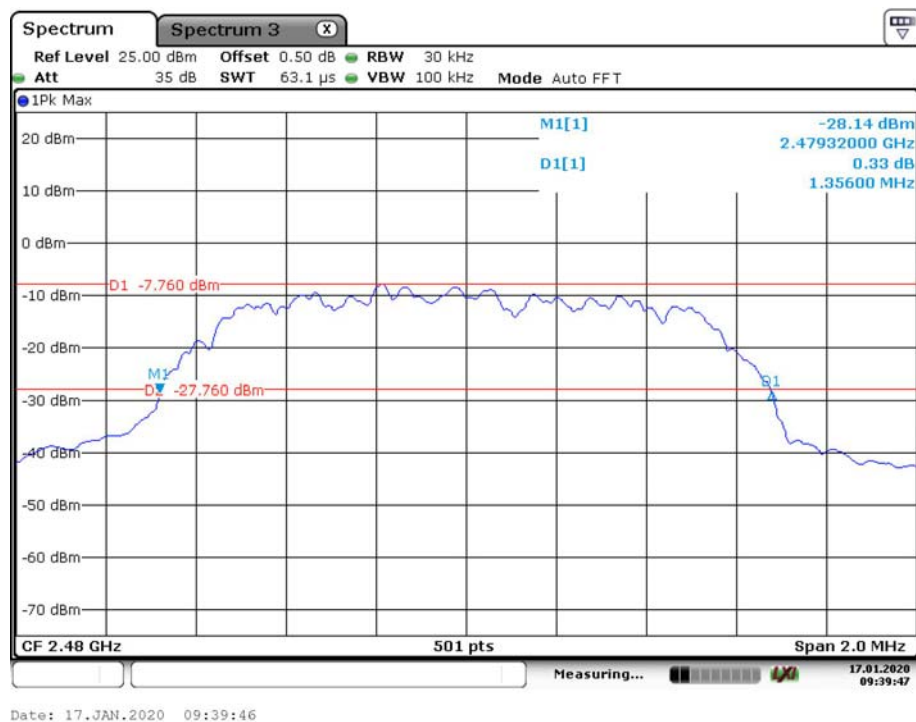
Date: 17.JAN.2020 09:43:05

### Middle Channel



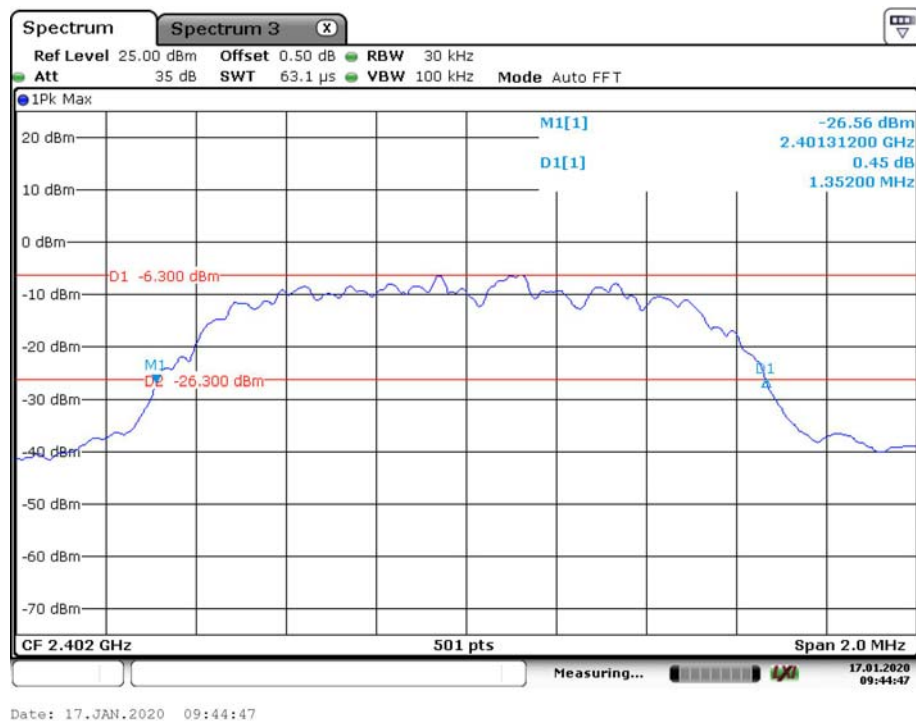
Date: 17.JAN.2020 09:41:48

### High Channel

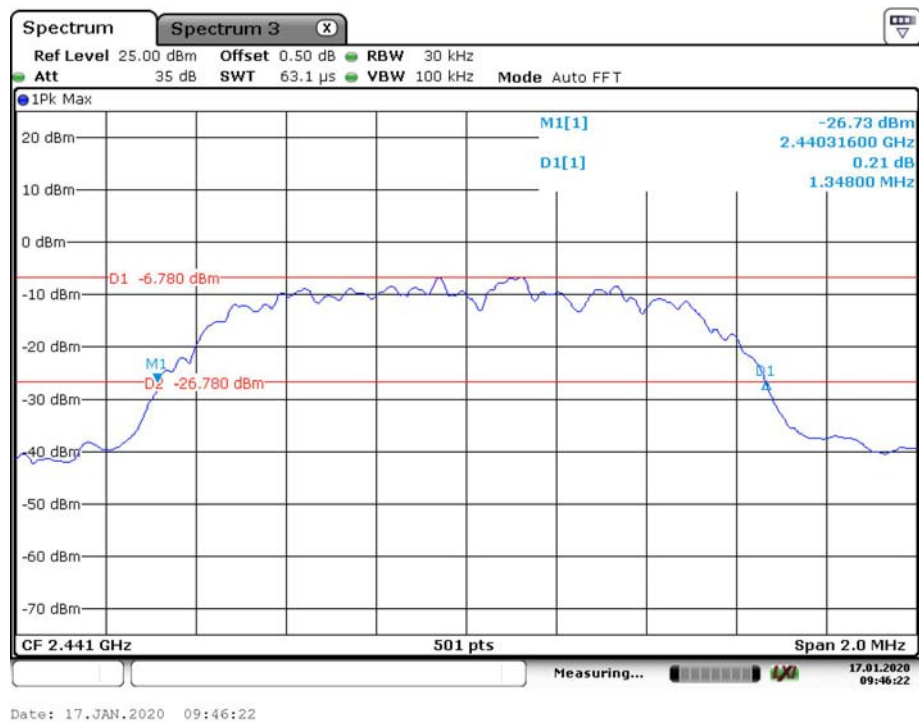


EDR Mode (8DPSK):

### Low Channel



## Middle Channel



## High Channel



**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**

| Manufacturer | Description       | Model       | Serial Number | Calibration Date | Calibration Due Date |
|--------------|-------------------|-------------|---------------|------------------|----------------------|
| R&S          | Spectrum Analyzer | FSV40       | 101474        | 2020-01-09       | 2021-01-09           |
| 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:       | 24.1°C     |
| Relative Humidity: | 60 %       |
| ATM Pressure:      | 101.8 kPa  |
| Tester:            | Fay Hu     |
| Test Date:         | 2020-01-17 |

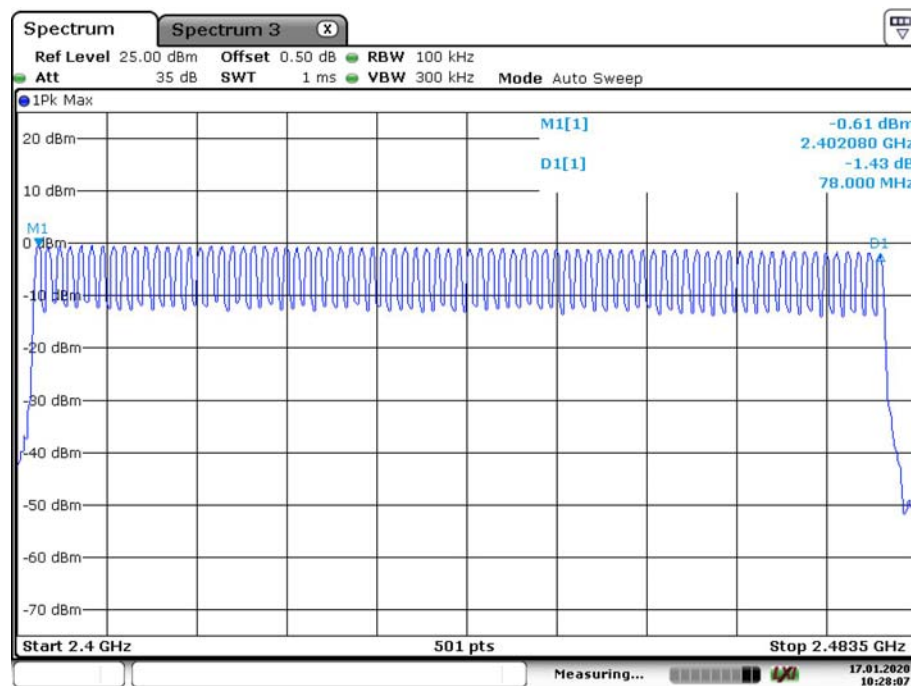
**Test Result:** Compliance.

Please refer to following tables and plots

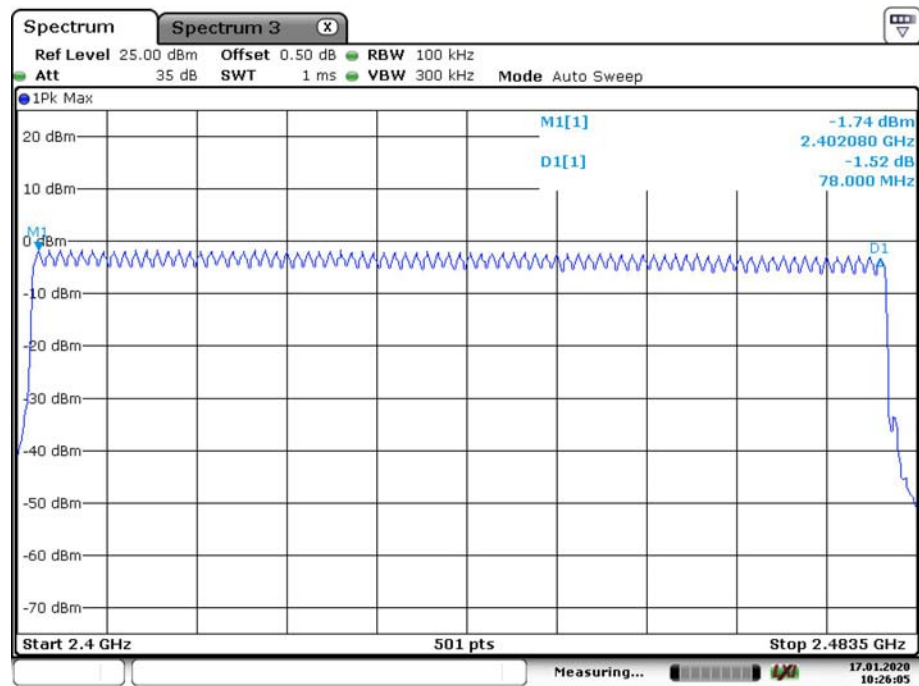
Test Mode: Transmitting

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

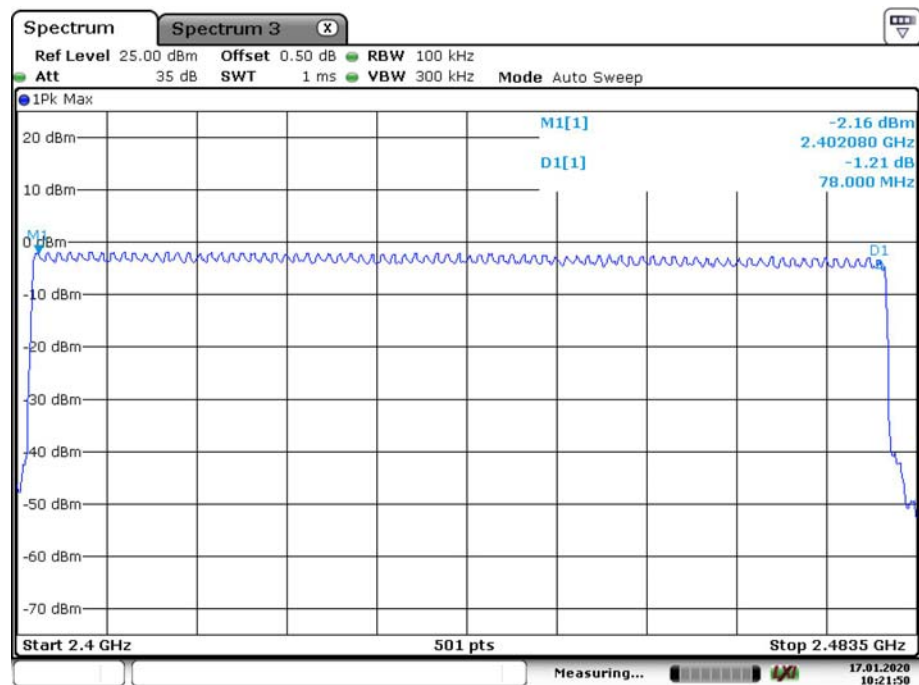
### BDR Mode (GFSK)



Date: 17.JAN.2020 10:28:07

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

Date: 17.JAN.2020 10:26:06

**EDR Mode (8DPSK)**

Date: 17.JAN.2020 10:21:50

**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**

| Manufacturer | Description       | Model       | Serial Number | Calibration Date | Calibration Due Date |
|--------------|-------------------|-------------|---------------|------------------|----------------------|
| R&S          | Spectrum Analyzer | FSV40       | 101474        | 2020-01-09       | 2021-01-09           |
| 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**

|                           |            |
|---------------------------|------------|
| <b>Temperature:</b>       | 24.1°C     |
| <b>Relative Humidity:</b> | 60 %       |
| <b>ATM Pressure:</b>      | 101.8 kPa  |
| <b>Tester:</b>            | Fay Hu     |
| <b>Test Date:</b>         | 2020-01-17 |

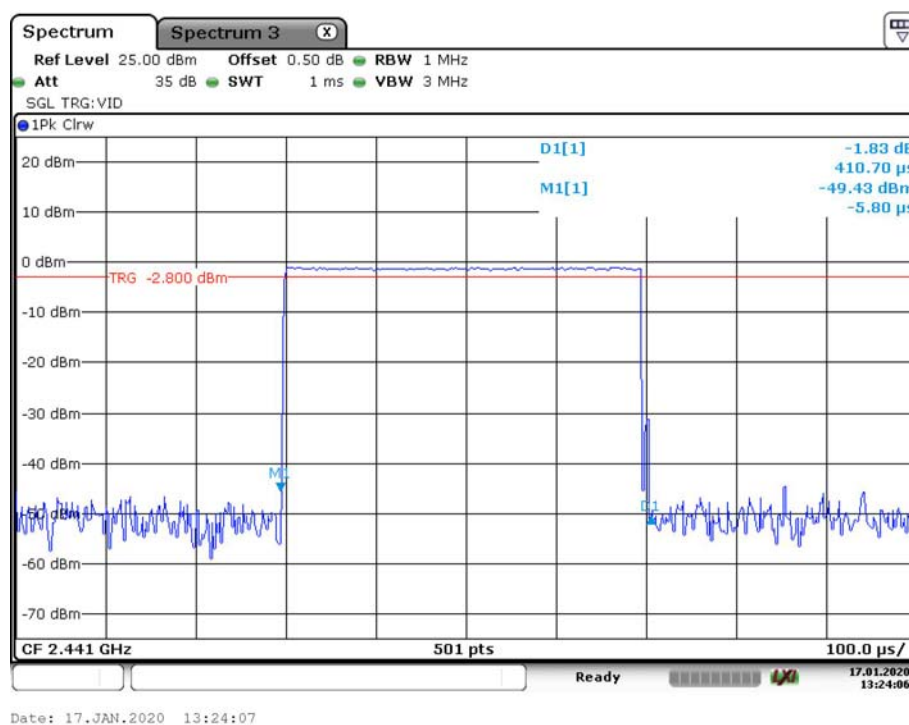
**Test Result:** Compliance.

Please refer to following tables and plots

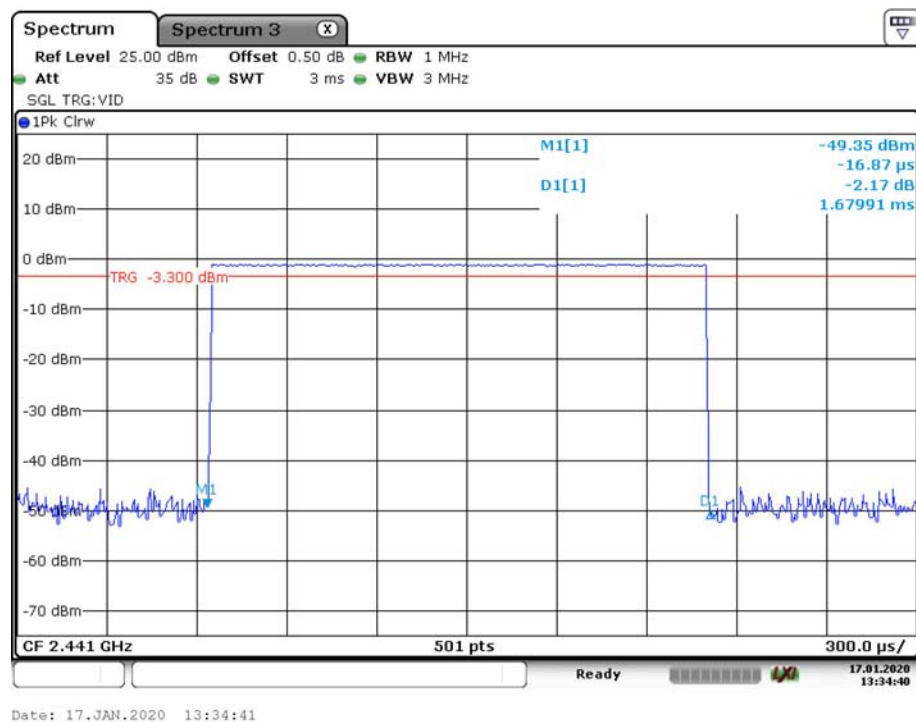
*Test Mode: Transmitting*

| Mode           | Packet type | Channel | Frequency (MHz) | Pulse width (ms) | Result (s) | Limit (s) |
|----------------|-------------|---------|-----------------|------------------|------------|-----------|
| GFSK           | DH1         | Middle  | 2441            | 0.411            | 0.131      | 0.4       |
|                | DH3         | Middle  | 2441            | 1.680            | 0.269      |           |
|                | DH5         | Middle  | 2441            | 2.963            | 0.316      |           |
| $\pi/4$ -DQPSK | 2DH1        | Middle  | 2441            | 0.390            | 0.125      |           |
|                | 2DH3        | Middle  | 2441            | 1.697            | 0.272      |           |
|                | 2DH5        | Middle  | 2441            | 2.981            | 0.318      |           |
| 8DPSK          | 3DH1        | Middle  | 2441            | 0.393            | 0.126      |           |
|                | 3DH3        | Middle  | 2441            | 1.697            | 0.272      |           |
|                | 3DH5        | Middle  | 2441            | 2.968            | 0.317      |           |

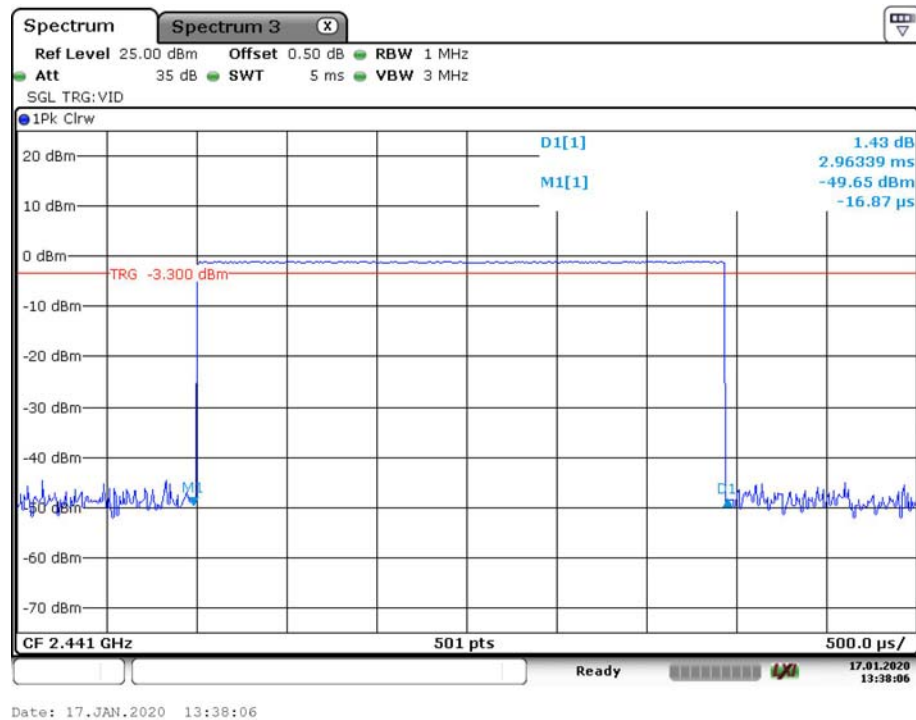
Note:  
 DH1:Dwell time=Pulse time (ms)  $\times$  (1600/2/79)  $\times$  31.6 s  
 DH3:Dwell time=Pulse time (ms)  $\times$  (1600/4/79)  $\times$  31.6 s  
 DH5:Dwell time=Pulse time (ms)  $\times$  (1600/6/79)  $\times$  31.6 s

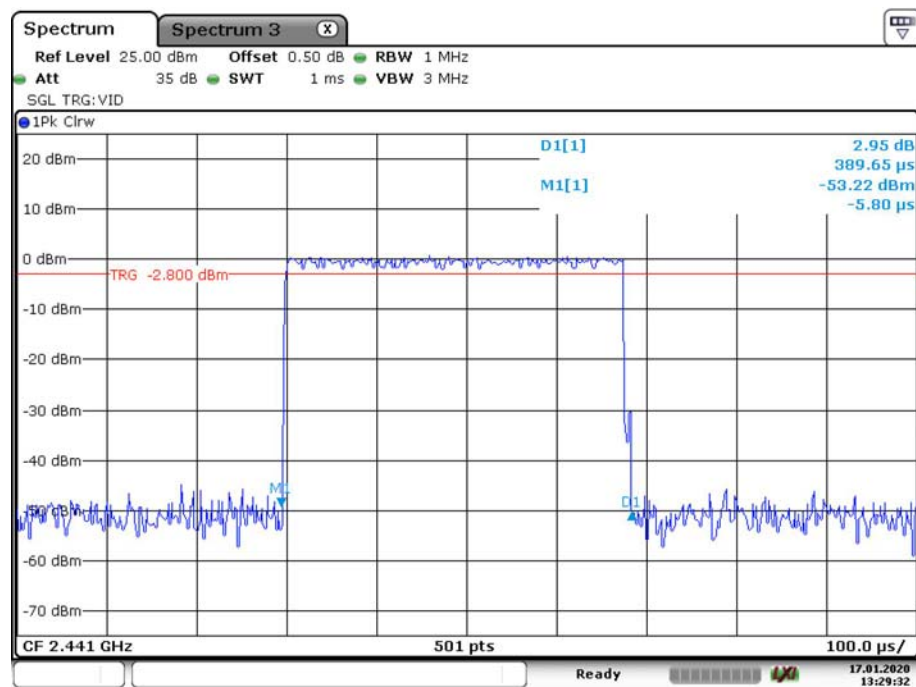
*BDR Mode (GFSK):***DH1: Middle Channel**

### DH3: Middle Channel

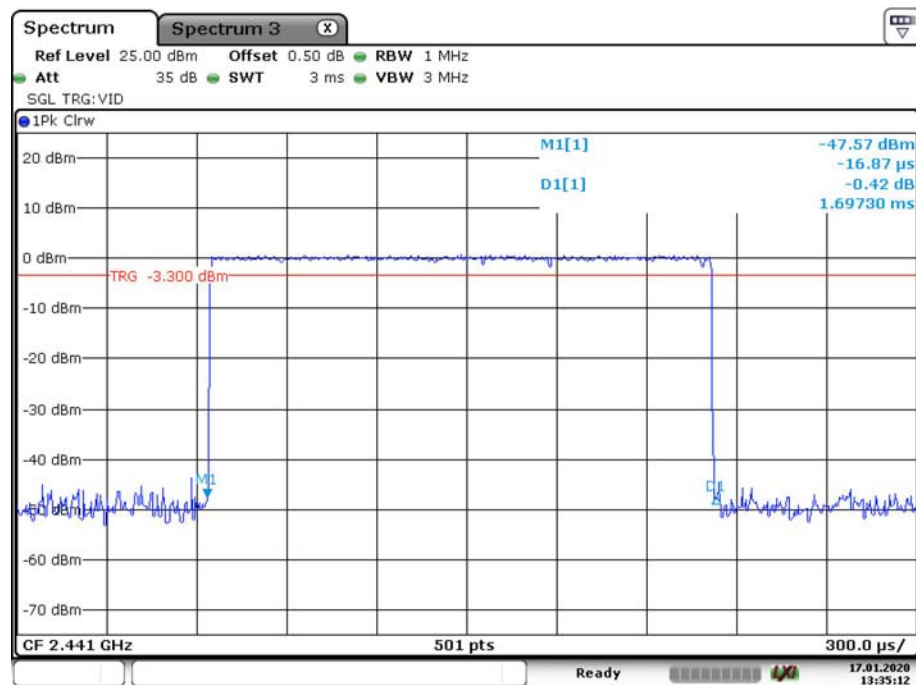


### DH5: Middle Channel



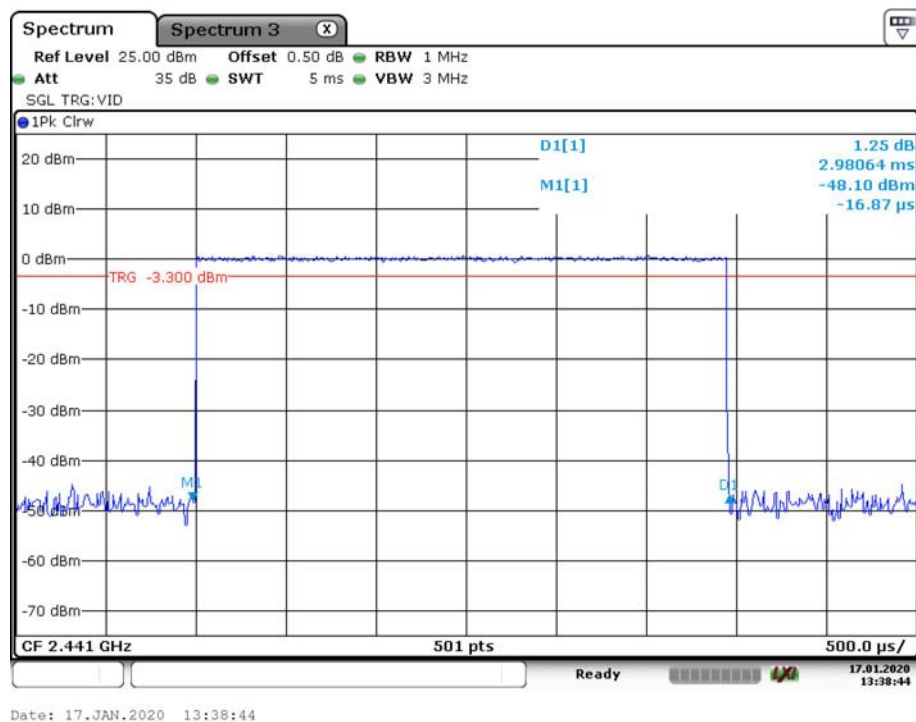
*EDR Mode ( $\pi/4$ -DQPSK):***2DH1: Middle Channel**

Date: 17.JAN.2020 13:29:32

**2DH3: Middle Channel**

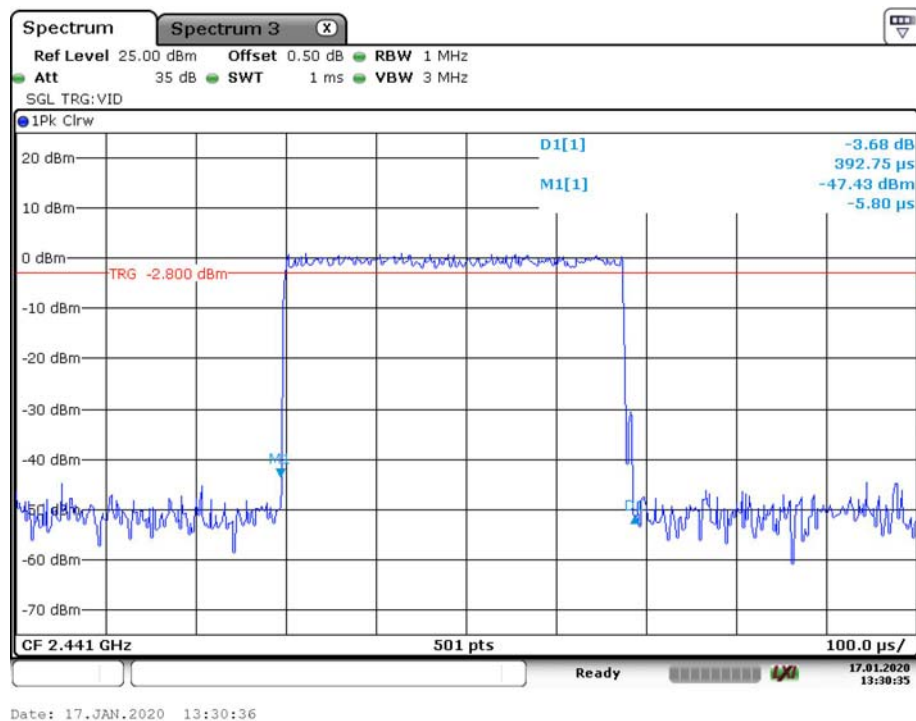
Date: 17.JAN.2020 13:35:12

### 2DH5: Middle Channel

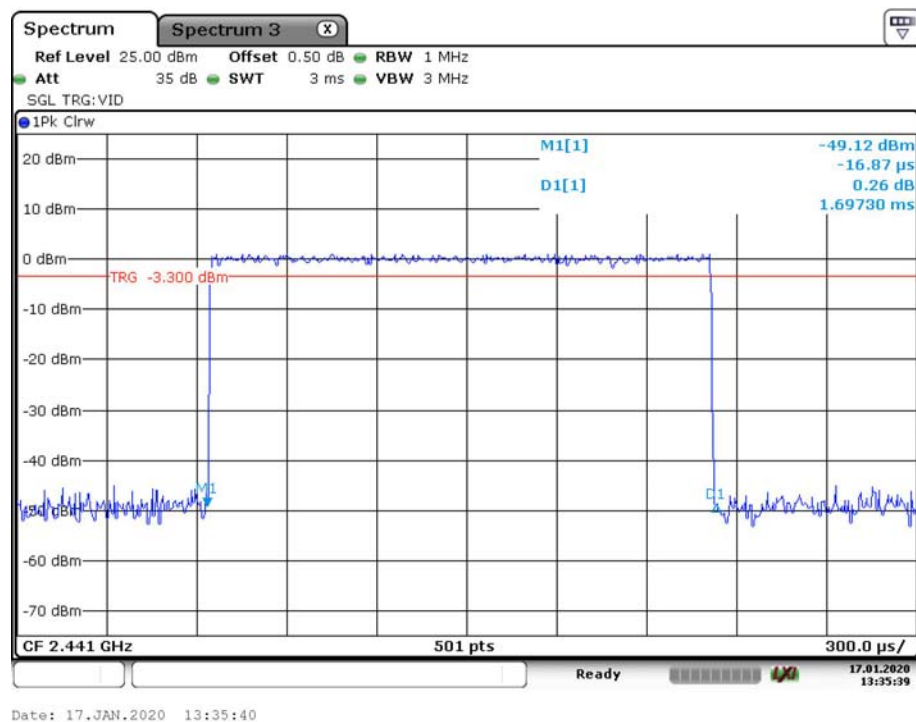


EDR Mode (8DPSK):

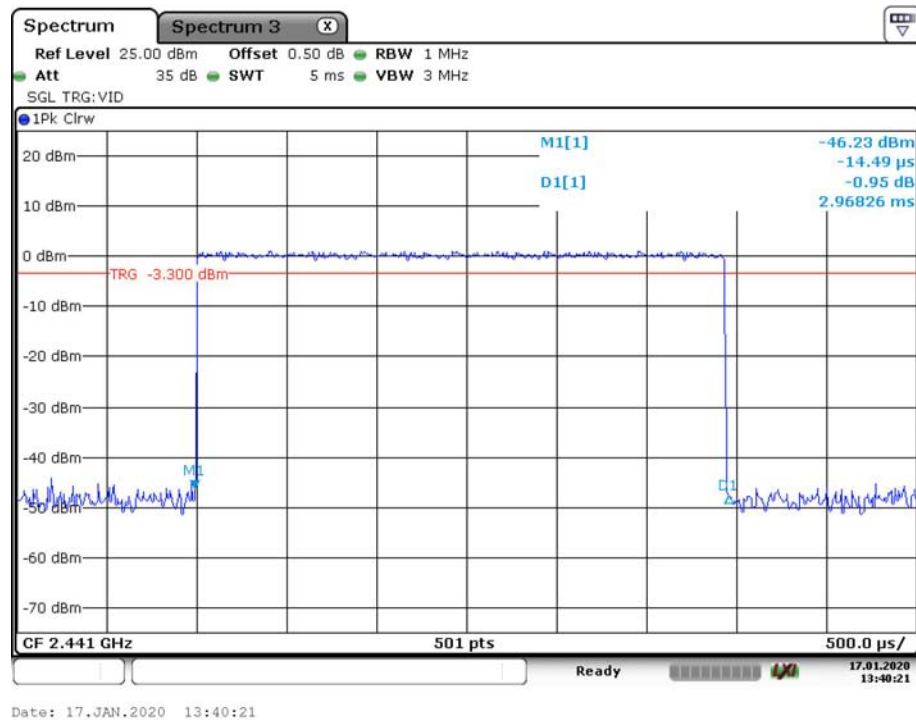
### 3DH1: Middle Channel



### 3DH3: Middle Channel



### 3DH5: Middle Channel



**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 |
|--------------|---------------------------|-------------|---------------|------------------|----------------------|
| Unknown      | Coaxial Cable             | C-SJ00-0010 | C0010/01      | Each Time        | /                    |
| Agilent      | USB Wideband Power Sensor | U2022XA     | MY5417006     | 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:       | 24.1°C     |
| Relative Humidity: | 60 %       |
| ATM Pressure:      | 101.8 kPa  |
| Tester:            | Fay Hu     |
| Test Date:         | 2020-01-17 |

**Test Result:** Compliance.

*Test Mode: Transmitting*

| Mode                       | Frequency (MHz) | Peak Conducted Output power (dBm) | Limit (dBm) |
|----------------------------|-----------------|-----------------------------------|-------------|
| BDR Mode (GFSK)            | 2402            | -0.04                             | 21          |
|                            | 2441            | -0.48                             | 21          |
|                            | 2480            | -1.45                             | 21          |
| EDR Mode ( $\pi/4$ -DQPSK) | 2402            | 2.11                              | 21          |
|                            | 2441            | 1.69                              | 21          |
|                            | 2480            | 0.75                              | 21          |
| EDR Mode (8DPSK)           | 2402            | <b>2.47</b>                       | 21          |
|                            | 2441            | 2.00                              | 21          |
|                            | 2480            | 1.14                              | 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.

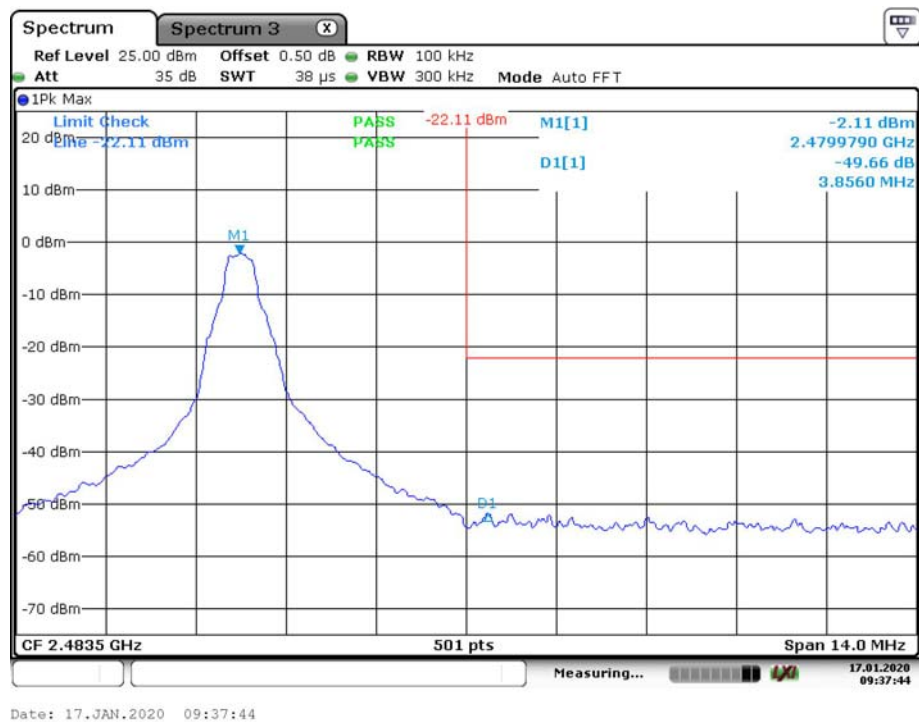
### Test Equipment List and Details

| Manufacturer | Description       | Model       | Serial Number | Calibration Date | Calibration Due Date |
|--------------|-------------------|-------------|---------------|------------------|----------------------|
| R&S          | Spectrum Analyzer | FSV40       | 101474        | 2020-01-09       | 2021-01-09           |
| 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).

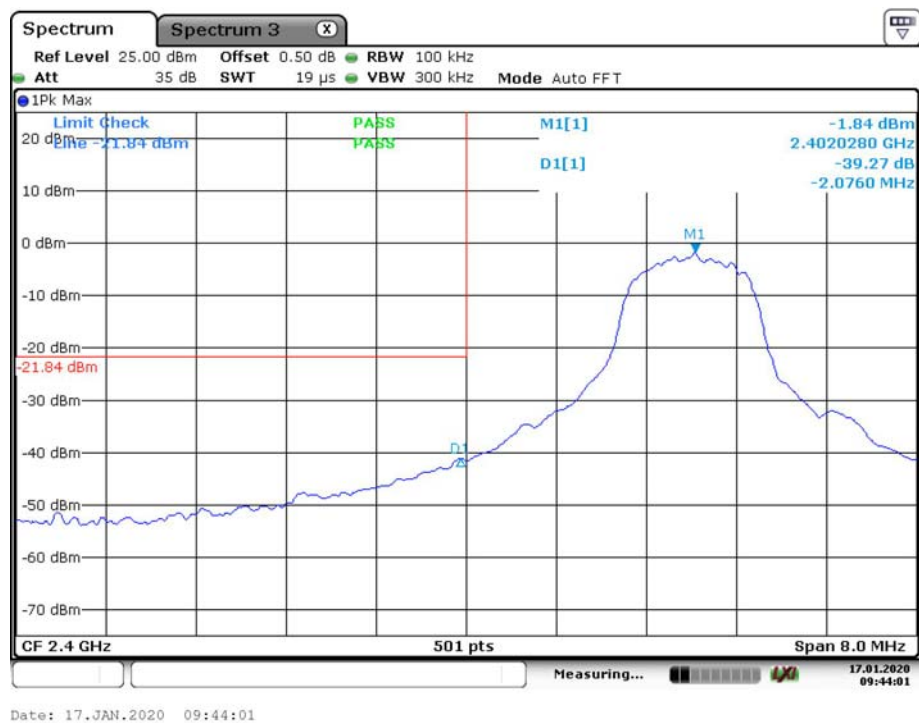


## Band Edge, Right Side

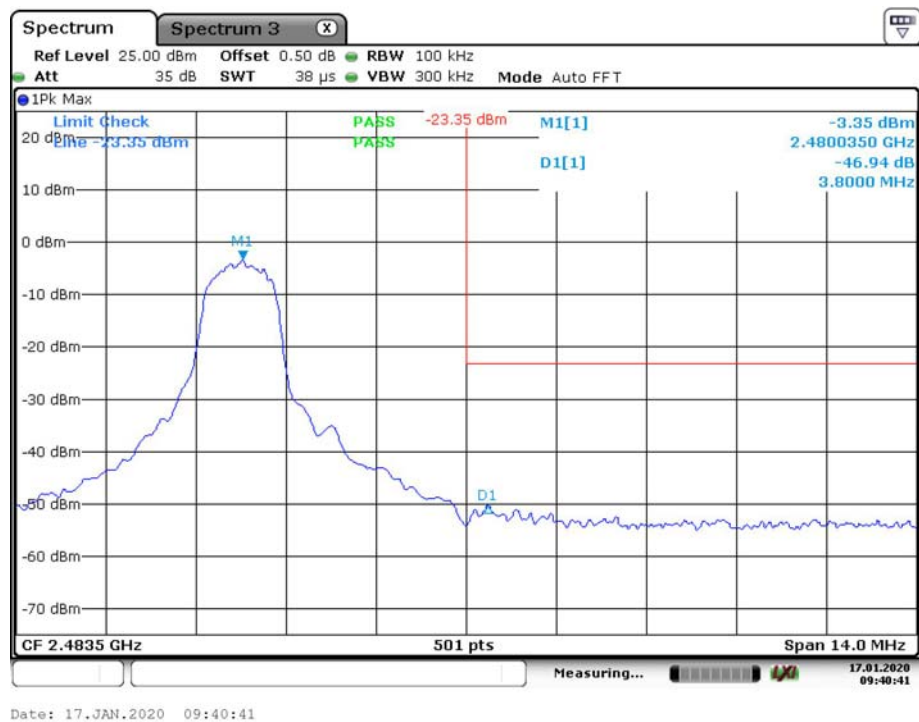


EDR Mode ( $\pi/4$ -DQPSK):

## Band Edge, Left Side

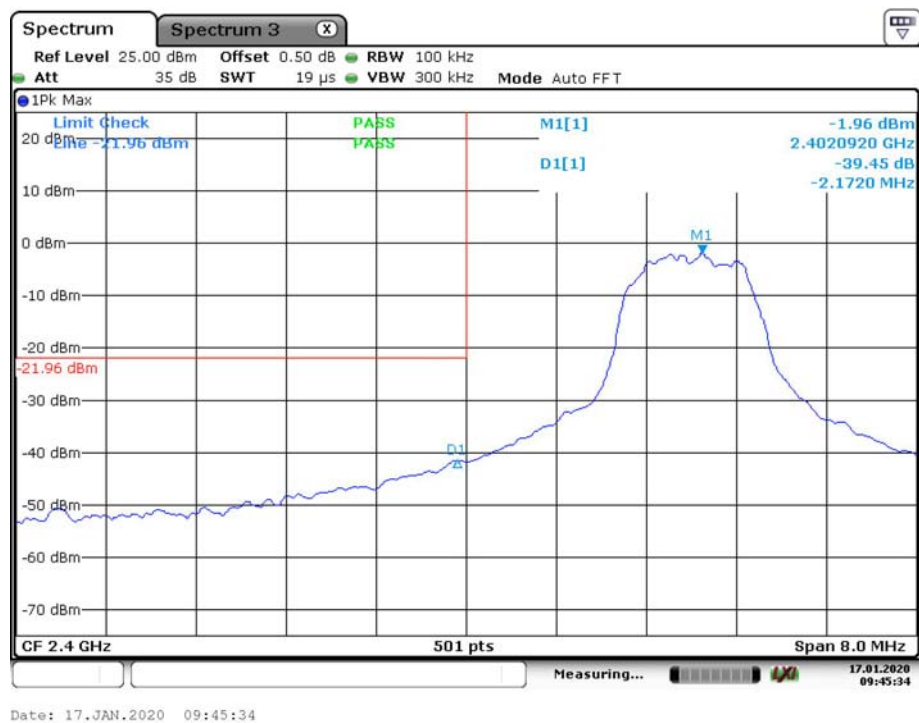


## Band Edge, Right Side

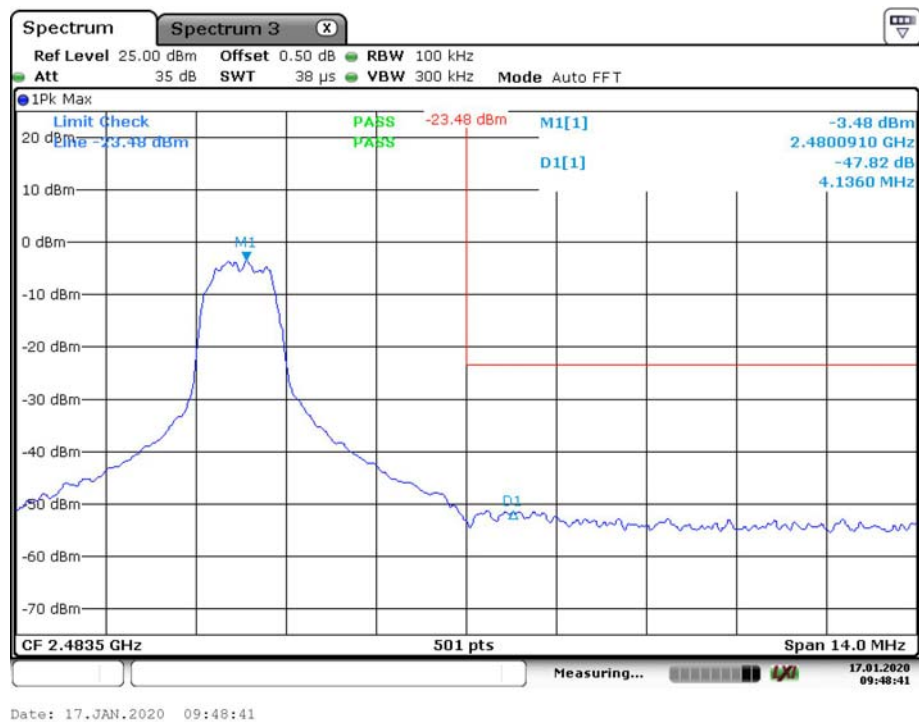


EDR Mode (8DPSK):

## Band Edge, Left Side

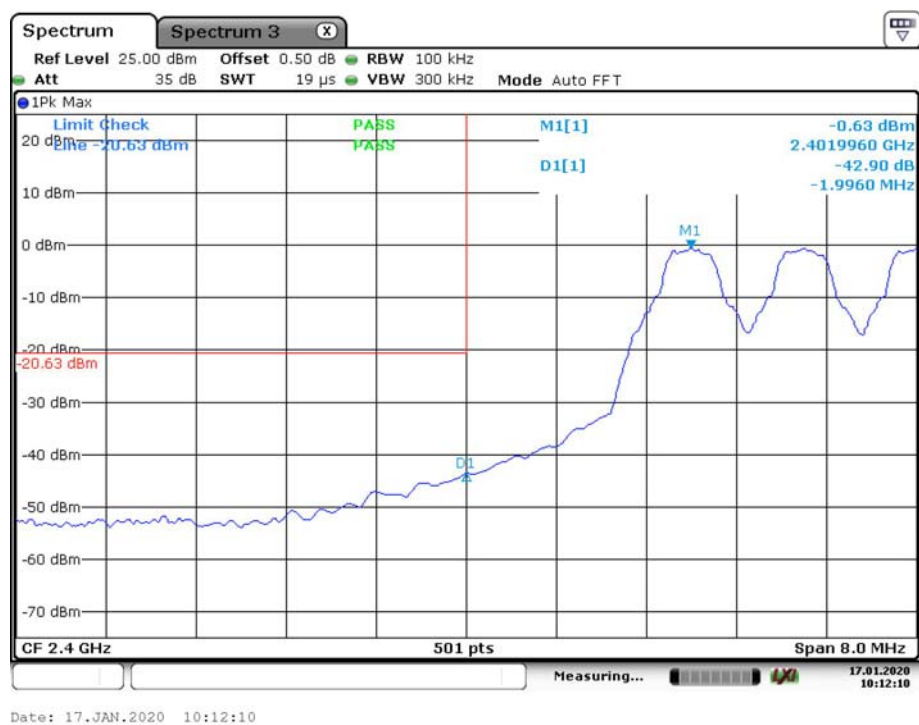


## Band Edge, Right Side

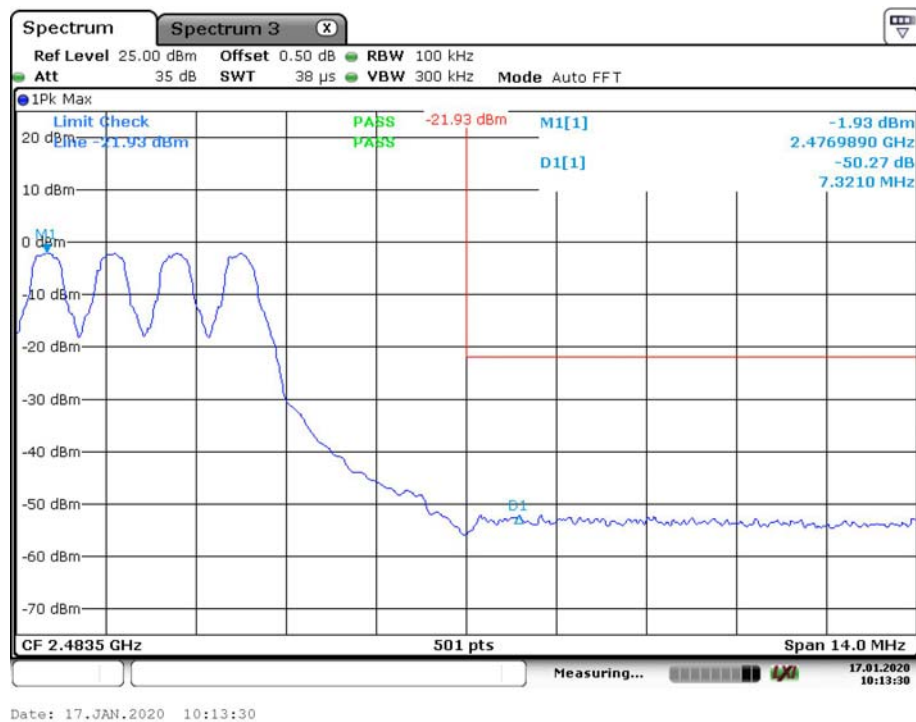


Hopping Mode,  
BDR Mode (GFSK):

## Band Edge, Left Side

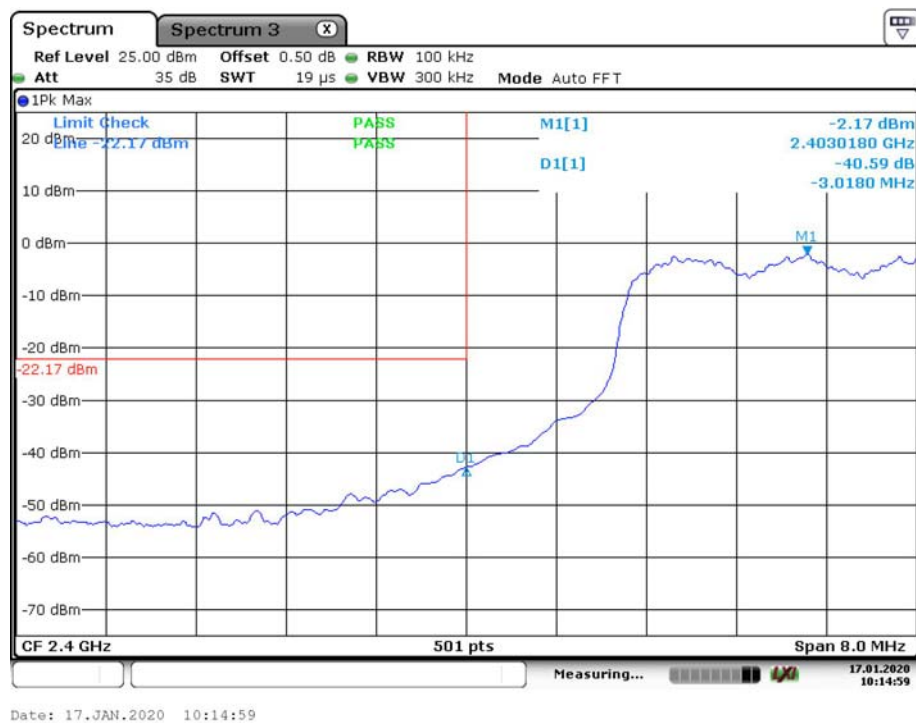


## Band Edge, Right Side

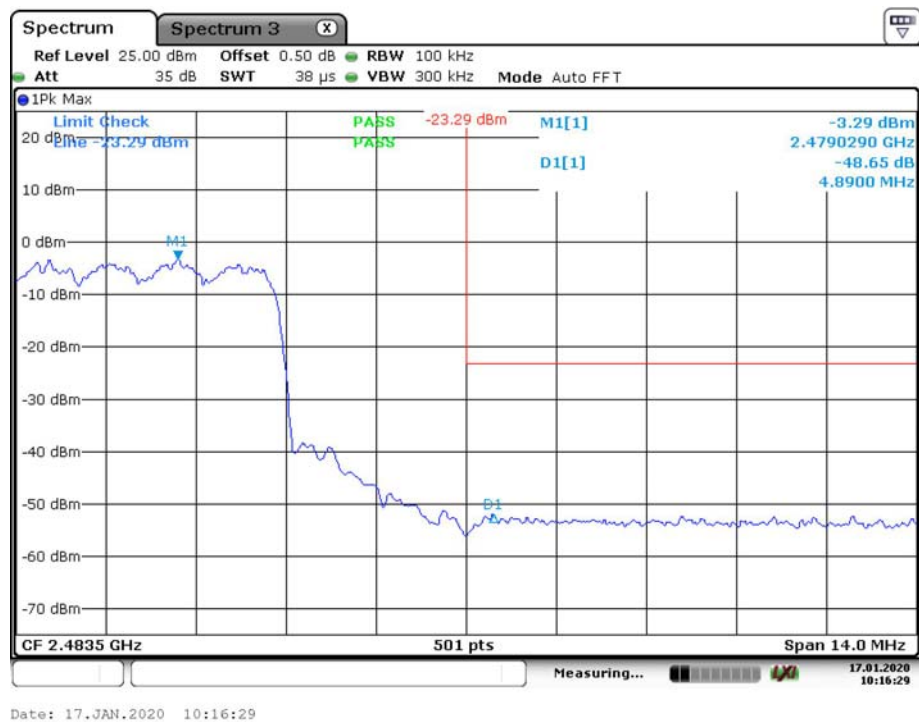


EDR Mode ( $\pi/4$ -DQPSK):

## Band Edge, Left Side

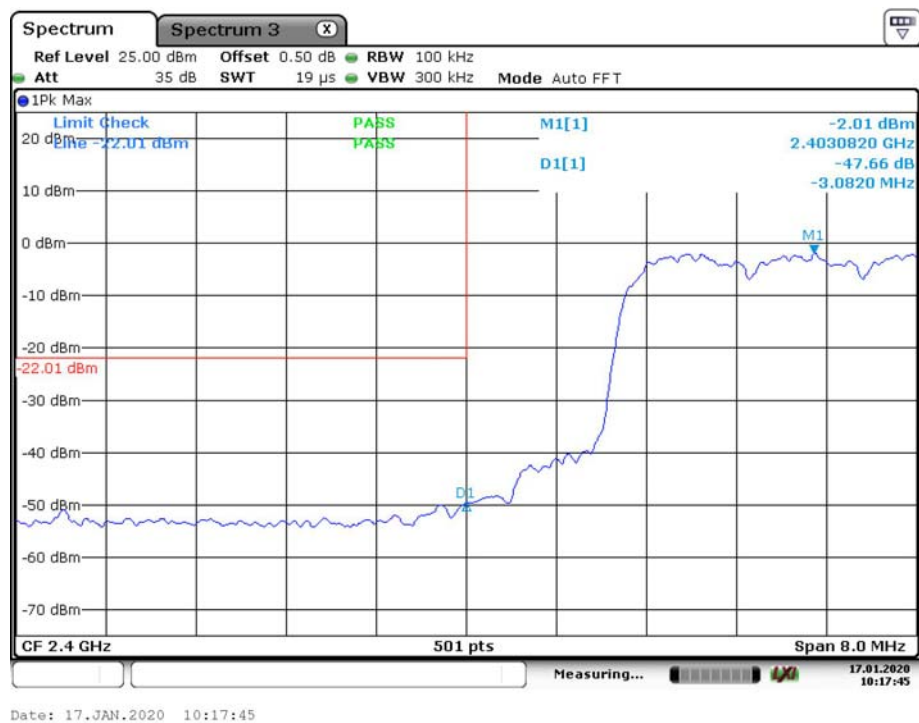


## Band Edge, Right Side

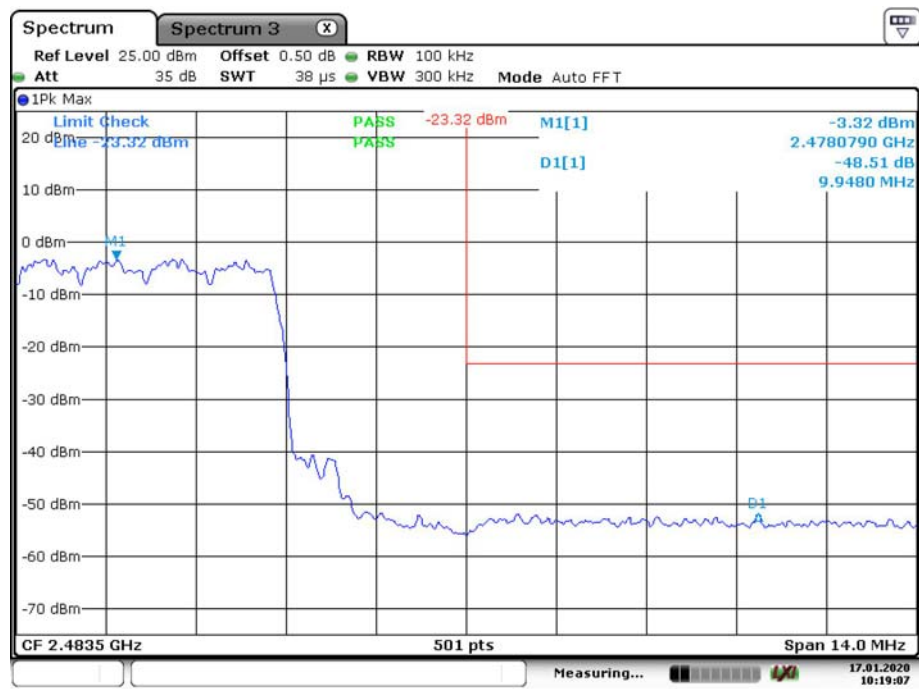


EDR Mode (8DPSK):

## Band Edge, Left Side



### Band Edge, Right Side



Date: 17.JAN.2020 10:19:07

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