



# FCC PART 15.247 TEST REPORT

For

## DGL Group LTD.

195 Raritan Center Parkway, Edison, New Jersey, United States, 08837

**FCC ID: 2AANZTW20**

|   |   |
|---|---|
| <b>Report Type:</b><br>Original Report  | <b>Product Type:</b><br>TRUE WIRELESS EARBUDS &<br>POWER BANK |
| <b>Report Number:</b> RSZ201012839-00   |   |
| <b>Report Date:</b> 2020-11-17  |   |
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## TABLE OF CONTENTS

|   |           |
|---|-----------|
| <b>GENERAL INFORMATION</b> .....  | <b>4</b>  |
| PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT).....                 | 4         |
| OBJECTIVE.....  | 4         |
| TEST METHODOLOGY.....   | 4         |
| MEASUREMENT UNCERTAINTY.....  | 5         |
| TEST FACILITY.....  | 5         |
| <b>SYSTEM TEST CONFIGURATION</b> .....                                  | <b>6</b>  |
| DESCRIPTION OF TEST CONFIGURATION.....                                  | 6         |
| EUT EXERCISE SOFTWARE.....  | 6         |
| SPECIAL ACCESSORIES.....  | 6         |
| EQUIPMENT MODIFICATIONS.....  | 6         |
| SUPPORT EQUIPMENT LIST AND DETAILS.....                                 | 6         |
| EXTERNAL I/O CABLE.....   | 6         |
| BLOCK DIAGRAM OF TEST SETUP.....  | 7         |
| <b>SUMMARY OF TEST RESULTS</b> .....                                    | <b>8</b>  |
| <b>TEST EQUIPMENT LIST</b> .....  | <b>9</b>  |
| <b>FCC§15.247 (i), §1.1307 (b) (1) &amp;§2.1093 – RF EXPOSURE</b> ..... | <b>11</b> |
| APPLICABLE STANDARD.....  | 11        |
| <b>FCC §15.203 – ANTENNA REQUIREMENT</b> .....                          | <b>12</b> |
| APPLICABLE STANDARD.....  | 12        |
| ANTENNA CONNECTOR CONSTRUCTION.....                                     | 12        |
| <b>FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS</b> .....              | <b>13</b> |
| APPLICABLE STANDARD.....  | 13        |
| EUT SETUP.....  | 13        |
| EMI TEST RECEIVER SETUP.....  | 13        |
| TEST PROCEDURE.....   | 13        |
| CORRECTED FACTOR & MARGIN CALCULATION.....                              | 14        |
| TEST DATA.....  | 14        |
| <b>FCC §15.205, §15.209 &amp; §15.247(d) – RADIATED EMISSIONS</b> ..... | <b>17</b> |
| APPLICABLE STANDARD.....  | 17        |
| EUT SETUP.....  | 17        |
| EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP.....                        | 18        |
| TEST PROCEDURE.....   | 18        |
| CORRECTED AMPLITUDE & MARGIN CALCULATION.....                           | 18        |
| TEST DATA.....  | 18        |
| <b>FCC §15.247(a) (1)-CHANNEL SEPARATION TEST</b> .....                 | <b>26</b> |
| APPLICABLE STANDARD.....  | 26        |
| TEST PROCEDURE.....   | 26        |
| TEST DATA.....  | 26        |
| <b>FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH</b> .....              | <b>29</b> |
| APPLICABLE STANDARD.....  | 29        |
| TEST PROCEDURE.....   | 29        |
| TEST DATA.....  | 29        |

**FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST .....35**  
 APPLICABLE STANDARD .....35  
 TEST PROCEDURE .....35  
 TEST DATA .....35

**FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....38**  
 APPLICABLE STANDARD .....38  
 TEST PROCEDURE .....38  
 TEST DATA .....38

**FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT .....39**  
 APPLICABLE STANDARD .....39  
 TEST PROCEDURE .....39  
 TEST DATA .....39

**FCC §15.247(d) - BAND EDGES TESTING .....40**  
 APPLICABLE STANDARD .....40  
 TEST PROCEDURE .....40  
 TEST DATA .....40

**APPENDIX .....47**  
 APPENDIX A: MAXIMUM CONDUCTED PEAK OUTPUT POWER.....47  
 APPENDIX B: TIME OF OCCUPANCY.....51

## GENERAL INFORMATION

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

|                                     |   |
|-------------------------------------|---|
| Product                             | TRUE WIRELESS EARBUDS & POWER BANK                  |
| Tested Model                        | FB-TW20   |
| UPC Number                          | 888255250902  |
| SKU Number                          | 3600164   |
| Frequency Range                     | Bluetooth: 2402~2480MHz                             |
| Maximum conducted Peak output power | Bluetooth: -0.04dBm                                 |
| Modulation Technique                | Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK              |
| Antenna Specification*              | PCB Antenna: 0dBi (It is provided by the applicant) |
| Voltage Range                       | DC 3.7V from battery                                |
| Date of Test                        | 2020-10-18 to 2020-11-17                            |
| Sample number                       | RSZ201012839-RF-S1(Assigned by BA CL, Shenzhen)     |
| Received date                       | 2020-10-12  |
| Sample/EUT Status                   | Good condition                                      |

### Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

### Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For Radiated Emissions testing, please refer to DA 00-705 Released March 30, 2000, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

## Measurement Uncertainty

| Parameter                          |            | Uncertainty |
|------------------------------------|------------|-------------|
| Occupied Channel Bandwidth         |            | ±5%         |
| RF Output Power with Power meter   |            | ±0.73dB     |
| RF conducted test with spectrum    |            | ±1.6dB      |
| AC Power Lines Conducted Emissions |            | ±1.95dB     |
| Emissions,<br>Radiated             | Below 1GHz | ±4.75dB     |
|                                    | Above 1GHz | ±4.88dB     |
| Temperature                        |            | ±1°C        |
| Humidity                           |            | ±6%         |
| Supply voltages                    |            | ±0.4%       |

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

## Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

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

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

The system was configured for testing in an engineering mode.

### EUT Exercise Software

“BT tool”\* software was use to the EUT tested and power level is 5\*. The software and power level was provided by the applicant.

### Special Accessories

No special accessory.

### Equipment Modifications

No modification was made to the EUT tested.

### Support Equipment List and Details

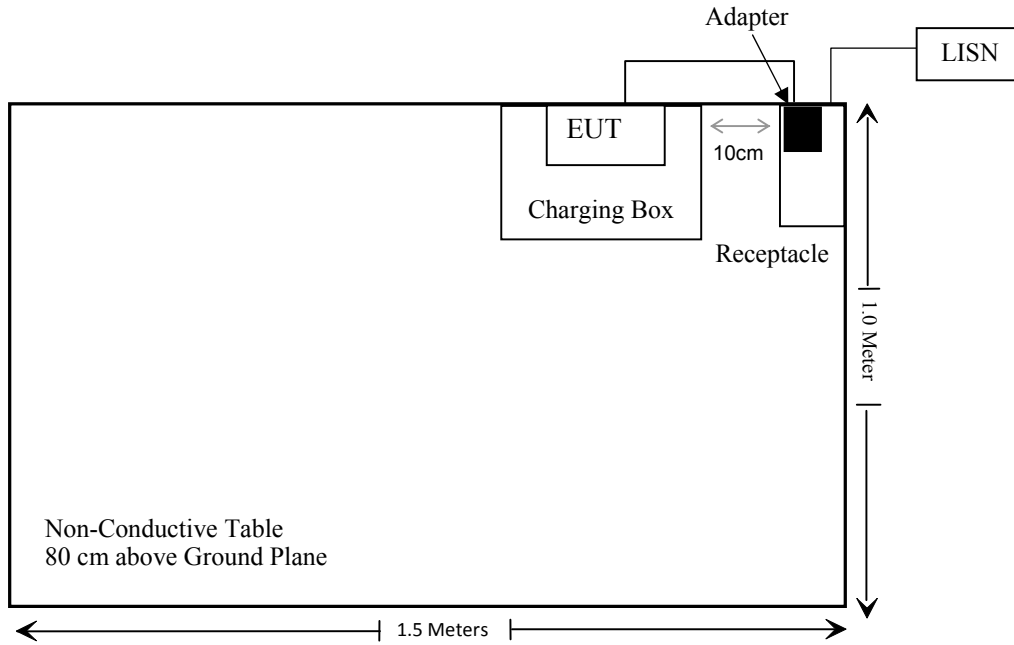
| Manufacturer                             | Description | Model     | Serial Number |
|--|-------------|-----------|---------------|
| Dongguan Aohai Power Technology Co.,Ltd. | Adapter     | A8-501000 | A1906034835   |

### External I/O Cable

| Cable Description                 | Length (m) | From Port    | To      |
|-----------------------------------|------------|--------------|---------|
| Un-shielding Detachable USB Cable | 0.2        | Charging Box | Adapter |

### Block Diagram of Test Setup

For conducted emission:



**SUMMARY OF TEST RESULTS**

| FCC Rules                             | Description of Test              | Result     |
|---------------------------------------|----------------------------------|------------|
| §15.247 (i), §1.1307 (b) (1)& §2.1093 | RF Exposure                      | Compliance |
| §15.203                               | Antenna Requirement              | Compliance |
| §15.207(a)                            | AC Line Conducted Emissions      | Compliance |
| §15.205, §15.209 & §15.247(d)         | Radiated Emissions               | Compliance |
| §15.247(a)(1)                         | 20 dB Emission 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 |

Note: The left earbud and right earbud have the identical PCB layout and output power, the left earbud was chosen for the full test.



**TEST EQUIPMENT LIST**

| Manufacturer                    | Description        | Model                   | Serial Number          | Calibration Date | Calibration Due Date |
|---------------------------------|--------------------|-------------------------|------------------------|------------------|----------------------|
| <b>Conducted Emissions Test</b> |                    |                         |                        |                  |                      |
| Rohde & Schwarz                 | EMI Test Receiver  | ESCI                    | 101120                 | 2020/08/04       | 2021/08/03           |
| Rohde & Schwarz                 | LISN               | ENV216                  | 101613                 | 2020/08/04       | 2021/08/03           |
| Rohde & Schwarz                 | Transient Limiter  | ESH3Z2                  | DE25985                | 2019/11/29       | 2020/11/28           |
| Unknown                         | CE Cable           | CE Cable                | UF A210B-1-0720-504504 | 2019/11/29       | 2020/11/28           |
| Rohde & Schwarz                 | CE Test software   | EMC 32                  | V8.53.0                | NCR              | NCR                  |
| <b>Radiated Emission Test</b>   |                    |                         |                        |                  |                      |
| R&S                             | EMI Test Receiver  | ESR3                    | 102455                 | 2020/08/04       | 2021/08/03           |
| Sonoma instrument               | Pre-amplifier      | 310 N                   | 186238                 | 2020/08/04       | 2021/08/03           |
| Sunol Sciences                  | Broadband Antenna  | JB1                     | A040904-1              | 2017/12/22       | 2020/12/21           |
| Unknown                         | Cable              | Chamber Cable 4         | EC-007                 | 2019/11/29       | 2020/11/28           |
| Unknown                         | Cable              | Chamber Cable 1         | F-03-EM236             | 2019/11/29       | 2020/11/28           |
| Rohde & Schwarz                 | Auto test software | EMC 32                  | V9.10                  | NCR              | NCR                  |
| Rohde & Schwarz                 | Spectrum Analyzer  | FSV40-N                 | 102259                 | 2020/08/04       | 2021/08/03           |
| COM-POWER                       | Pre-amplifier      | PA-122                  | 181919                 | 2019/11/29       | 2020/11/28           |
| Quinstar                        | Amplifier          | QLW-18405536-J0         | 15964001002            | 2019/11/29       | 2020/11/28           |
| Sunol Sciences                  | Horn Antenna       | DRH-118                 | A052604                | 2017/12/22       | 2020/12/21           |
| Insulted Wire Inc.              | RF Cable           | SPS-2503-3150           | 02222010               | 2019/11/29       | 2020/11/28           |
| Unknown                         | RF Cable           | W1101-EQ1 OUT           | F-19-EM005             | 2019/11/29       | 2020/11/28           |
| SNSD                            | Band Reject filter | BSF2402-2480MN-0898-001 | 2.4G filter            | 2020/04/20       | 2021/04/20           |
| Ducommun Technologies           | Horn antenna       | ARH-4223-02             | 1007726-02<br>1304     | 2017/12/06       | 2020/12/05           |

| Manufacturer             | Description       | Model    | Serial Number | Calibration Date | Calibration Due Date |
|--------------------------|-------------------|----------|---------------|------------------|----------------------|
| <b>RF Conducted Test</b> |                   |          |               |                  |                      |
| Tonscend Corporation     | RF control Unit   | JS0806-2 | 19D8060154    | 2020/08/04       | 2021/08/03           |
| Rohde & Schwarz          | Spectrum Analyzer | FSV40-N  | 102259        | 2020/08/04       | 2021/08/03           |
| Unknown                  | RF Cable          | Unknown  | 2301 276      | 2019/11/29       | 2020/11/28           |
| Rohde & Schwarz          | SPECTRUM ANALYZER | FSU26    | 200120        | 2020/04/03       | 2021/04/02           |
| WEINSCHEL                | 3dB Attenuator    | Unknown  | F-03-EM121    | 2019/11/29       | 2020/11/28           |

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

**FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 – RF EXPOSURE**

**Applicable Standard**

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

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

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

1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

**For worst case:**

| Frequency (MHz) | Maximum Tune-up power |      | Calculated Distance (mm) | Calculated Value | Threshold (1-g SAR) | SAR Test Exclusion |
|-----------------|-----------------------|------|--------------------------|------------------|---------------------|--------------------|
|                 | (dBm)                 | (mW) |                          |                  |                     |                    |
| 2480            | 0.5                   | 1.12 | 5                        | 0.35             | 3.0                 | Yes                |

**Result: No Standalone SAR test is required**

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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, which was permanently attached 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 measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

**EMI Test Receiver Setup**

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

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

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

**Test Procedure**

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

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

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

## Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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

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

## Test Data

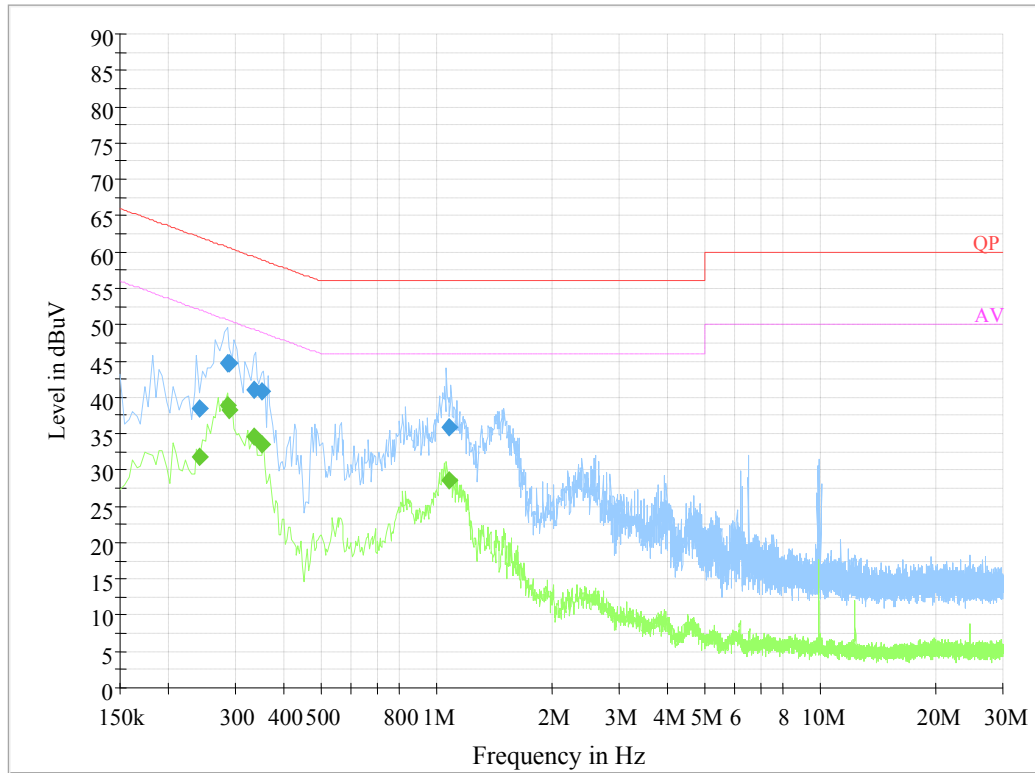
### Environmental Conditions

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 65 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Haiguo Li on 2020-10-22.*

*EUT operation mode: Charging*

**AC 120V/60 Hz, Line**



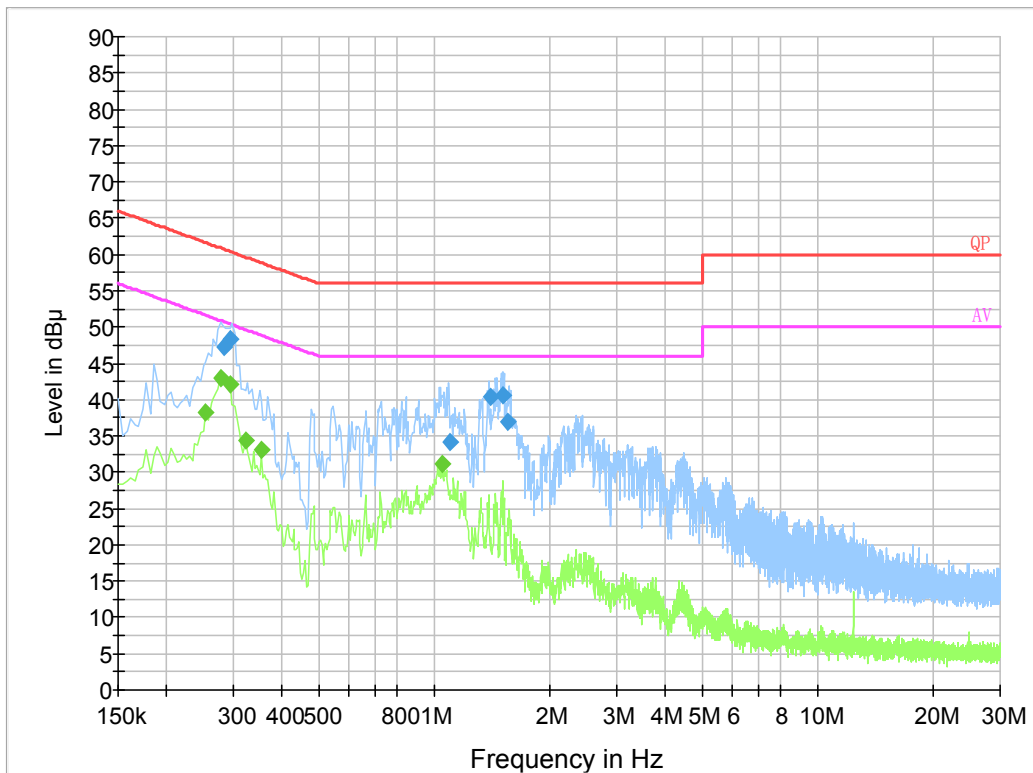
**Final Result 1**

| Frequency (MHz) | QuasiPeak (dB $\mu$ V) | Bandwidth (kHz) | Line | Corr. (dB) | Margin (dB) | Limit (dB $\mu$ V) |
|-----------------|------------------------|-----------------|------|------------|-------------|--------------------|
| 0.241500        | 38.5                   | 9.000           | L1   | 19.8       | 23.5        | 62.0               |
| 0.285500        | 44.7                   | 9.000           | L1   | 19.7       | 16.0        | 60.7               |
| 0.289500        | 44.7                   | 9.000           | L1   | 19.7       | 15.8        | 60.5               |
| 0.336930        | 41.1                   | 9.000           | L1   | 19.8       | 18.2        | 59.3               |
| 0.352690        | 40.8                   | 9.000           | L1   | 19.9       | 18.1        | 58.9               |
| 1.078010        | 35.8                   | 9.000           | L1   | 19.9       | 20.2        | 56.0               |

**Final Result 2**

| Frequency (MHz) | Average (dB $\mu$ V) | Bandwidth (kHz) | Line | Corr. (dB) | Margin (dB) | Limit (dB $\mu$ V) |
|-----------------|----------------------|-----------------|------|------------|-------------|--------------------|
| 0.241500        | 31.9                 | 9.000           | L1   | 19.8       | 20.1        | 52.0               |
| 0.285500        | 38.8                 | 9.000           | L1   | 19.7       | 11.9        | 50.7               |
| 0.289500        | 38.1                 | 9.000           | L1   | 19.7       | 12.4        | 50.5               |
| 0.336930        | 34.7                 | 9.000           | L1   | 19.8       | 14.6        | 49.3               |
| 0.352690        | 33.6                 | 9.000           | L1   | 19.9       | 15.3        | 48.9               |
| 1.078010        | 28.5                 | 9.000           | L1   | 19.9       | 17.5        | 46.0               |

**AC 120V/60 Hz, Neutral**



**Final Result 1**

| Frequency (MHz) | QuasiPeak (dB $\mu$ V) | Bandwidth (kHz) | Line | Corr. (dB) | Margin (dB) | Limit (dB $\mu$ V) |
|-----------------|------------------------|-----------------|------|------------|-------------|--------------------|
| 0.282500        | 47.3                   | 9.000           | N    | 19.7       | 13.4        | 60.7               |
| 0.293500        | 48.4                   | 9.000           | N    | 19.7       | 12.0        | 60.4               |
| 1.101590        | 34.1                   | 9.000           | N    | 19.8       | 21.9        | 56.0               |
| 1.401270        | 40.5                   | 9.000           | N    | 19.8       | 15.5        | 56.0               |
| 1.519350        | 40.7                   | 9.000           | N    | 19.8       | 15.3        | 56.0               |
| 1.562330        | 36.9                   | 9.000           | N    | 19.8       | 19.1        | 56.0               |

**Final Result 2**

| Frequency (MHz) | Average (dB $\mu$ V) | Bandwidth (kHz) | Line | Corr. (dB) | Margin (dB) | Limit (dB $\mu$ V) |
|-----------------|----------------------|-----------------|------|------------|-------------|--------------------|
| 0.254000        | 38.3                 | 9.000           | N    | 19.8       | 13.3        | 51.6               |
| 0.278000        | 42.9                 | 9.000           | N    | 19.7       | 8.0         | 50.9               |
| 0.294000        | 42.0                 | 9.000           | N    | 19.7       | 8.4         | 50.4               |
| 0.322000        | 34.3                 | 9.000           | N    | 19.8       | 15.4        | 49.7               |
| 0.354000        | 33.0                 | 9.000           | N    | 19.9       | 15.9        | 48.9               |
| 1.050000        | 31.2                 | 9.000           | N    | 19.8       | 14.8        | 46.0               |



**FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS**

**Applicable Standard**

FCC §15.205; §15.209; §15.247(d)

**EUT Setup**

**Below 1 GHz:**



**Above 1GHz:**



The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

## EMI Test Receiver & Spectrum Analyzer Setup

During the radiated emission test, according to the DA 00-705 Released March 30, 2000, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

| Frequency Range   | RBW     | Video B/W | IF B/W  | Measurement |
|-------------------|---------|-----------|---------|-------------|
| 30 MHz – 1000 MHz | 100 kHz | 300 kHz   | 120 kHz | QP          |
| Above 1 GHz       | 1 MHz   | 3 MHz     | /       | PK          |
|                   | 1 MHz   | 10 Hz     | /       | Average     |

## Test Procedure

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

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

## Corrected Amplitude & Margin Calculation

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

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

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

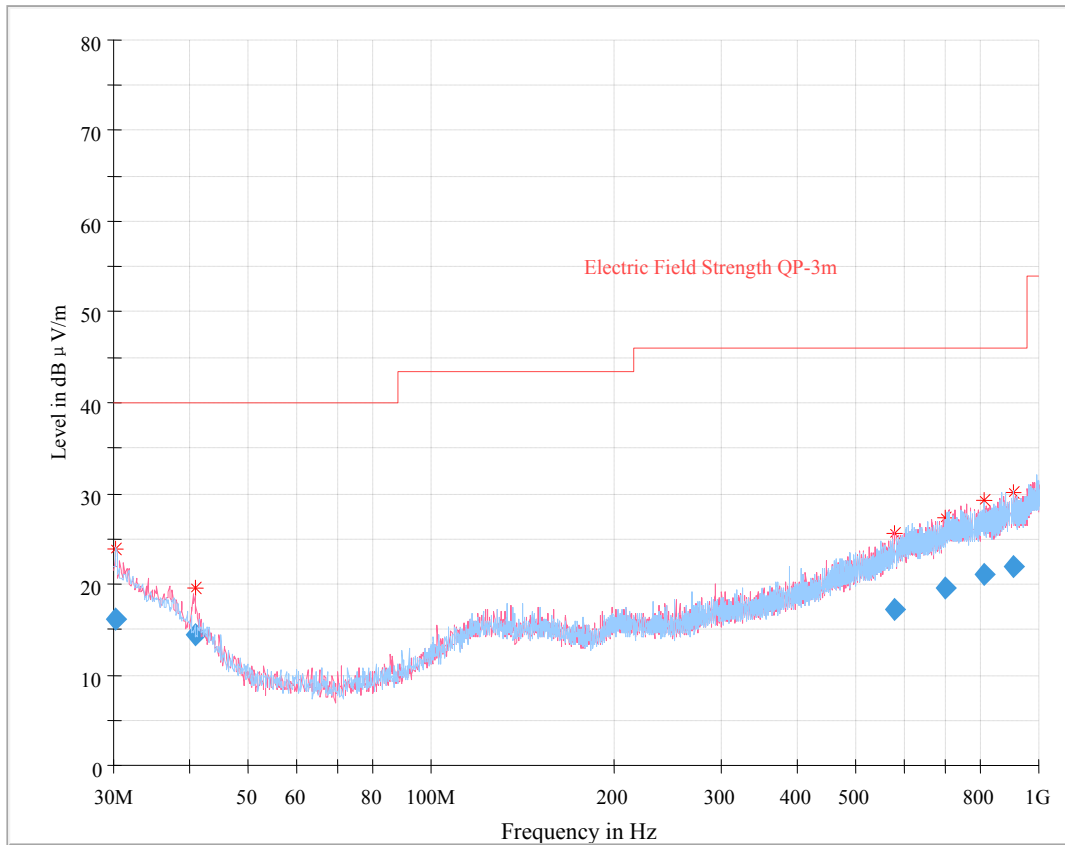
### Environmental Conditions

|                           |                 |
|---------------------------|-----------------|
| <b>Temperature:</b>       | 28~32.2 °C      |
| <b>Relative Humidity:</b> | 55~56 %         |
| <b>ATM Pressure:</b>      | 100.7~101.0 kPa |

*The testing was performed by Charlie Cha on 2020-10-22 for below 1GHz and Alan He on 2020-10-28 for above 1GHz.*

*EUT operation mode: Transmitting*

**30 MHz~1 GHz: (the worst case is 8DPSK Mode, Low channel)**



**Final Result**

| Frequency (MHz) | QuasiPeak (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------------|----------------------|-------------|-------------|-----|---------------|------------|
| 30.226927       | 16.22                    | 40.00                | 23.78       | 386.0       | H   | 198.0         | -4.6       |
| 40.814500       | 14.44                    | 40.00                | 25.56       | 126.0       | V   | 81.0          | -11.1      |
| 578.298875      | 17.19                    | 46.00                | 28.81       | 148.0       | V   | 171.0         | -3.0       |
| 700.844250      | 19.49                    | 46.00                | 26.51       | 246.0       | V   | 272.0         | -1.2       |
| 813.438000      | 20.99                    | 46.00                | 25.01       | 203.0       | H   | 246.0         | 0.0        |
| 908.335125      | 21.97                    | 46.00                | 24.03       | 168.0       | H   | 51.0          | 1.5        |

**1 GHz - 25 GHz:** (Scan with GFSK,  $\pi/4$ -DQPSK, 8DPSK mode, the worst case is 8DPSK Mode)

| Frequency (MHz)           | Receiver             |            | Turntable Degree | Rx Antenna |             | Corrected Factor (dB/m) | Corrected Amplitude (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
|---------------------------|----------------------|------------|------------------|------------|-------------|-------------------------|------------------------------------|----------------------|-------------|
|                           | Reading (dB $\mu$ V) | PK/QP/Ave. |                  | Height (m) | Polar (H/V) |                         |                                    |                      |             |
| Low Channel (2402 MHz)    |                      |            |                  |            |             |                         |                                    |                      |             |
| 2339.42                   | 28.87                | PK         | 100              | 1.8        | H           | 31.64                   | 60.51                              | 74                   | 13.49       |
| 2339.42                   | 13.79                | Ave.       | 100              | 1.8        | H           | 31.64                   | 45.43                              | 54                   | 8.57        |
| 2484.65                   | 28.89                | PK         | 278              | 1.9        | H           | 32.13                   | 61.02                              | 74                   | 12.98       |
| 2484.65                   | 13.82                | Ave.       | 278              | 1.9        | H           | 32.13                   | 45.95                              | 54                   | 8.05        |
| 4804.00                   | 52.17                | PK         | 214              | 1.8        | H           | 5.40                    | 57.57                              | 74                   | 16.43       |
| 4804.00                   | 43.89                | Ave.       | 214              | 1.8        | H           | 5.40                    | 49.29                              | 54                   | 4.71        |
| Middle Channel (2441 MHz) |                      |            |                  |            |             |                         |                                    |                      |             |
| 4882.00                   | 50.19                | PK         | 235              | 1.5        | H           | 6.43                    | 56.62                              | 74                   | 17.38       |
| 4882.00                   | 41.95                | Ave.       | 235              | 1.5        | H           | 6.43                    | 48.38                              | 54                   | 5.62        |
| High Channel (2480 MHz)   |                      |            |                  |            |             |                         |                                    |                      |             |
| 2334.75                   | 28.86                | PK         | 42               | 1.7        | H           | 31.64                   | 60.50                              | 74                   | 13.50       |
| 2334.75                   | 13.78                | Ave.       | 42               | 1.7        | H           | 31.64                   | 45.42                              | 54                   | 8.58        |
| 2486.23                   | 28.92                | PK         | 40               | 2.1        | H           | 32.13                   | 61.05                              | 74                   | 12.95       |
| 2486.23                   | 13.85                | Ave.       | 40               | 2.1        | H           | 32.13                   | 45.98                              | 54                   | 8.02        |
| 4960.00                   | 49.61                | PK         | 321              | 2.0        | H           | 6.95                    | 56.56                              | 74                   | 17.44       |
| 4960.00                   | 41.19                | Ave.       | 321              | 2.0        | H           | 6.95                    | 48.14                              | 54                   | 5.86        |

Note:

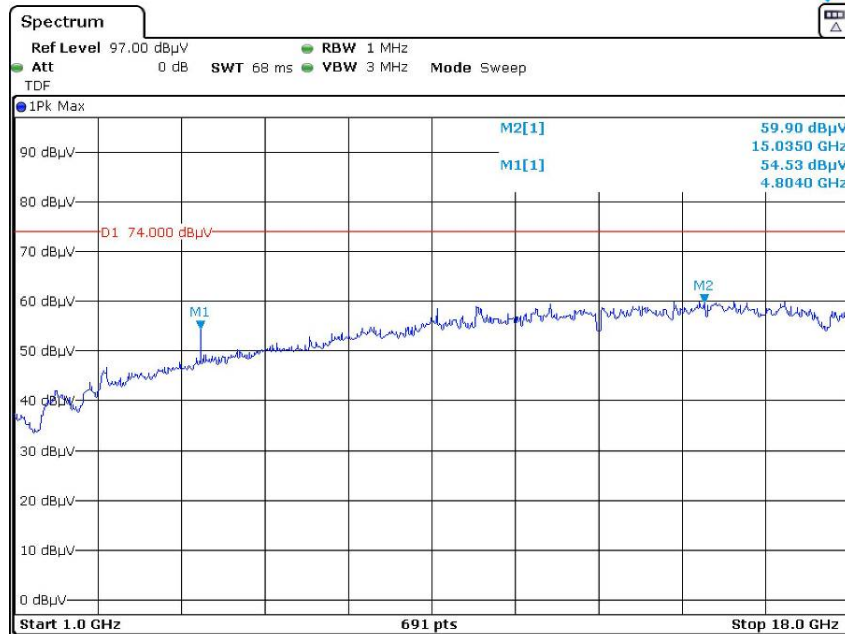
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

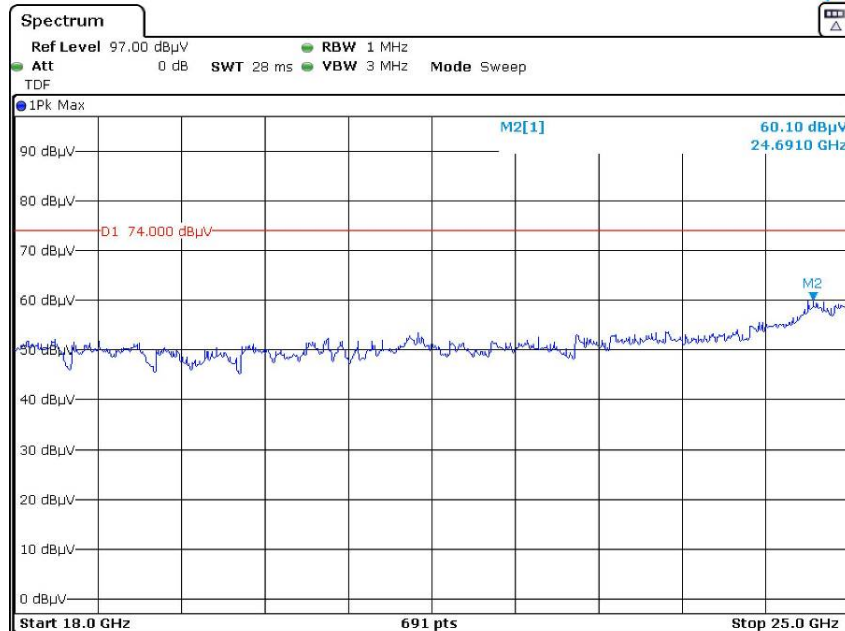
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

**Pre-scan with Low Channel Peak  
Horizontal**

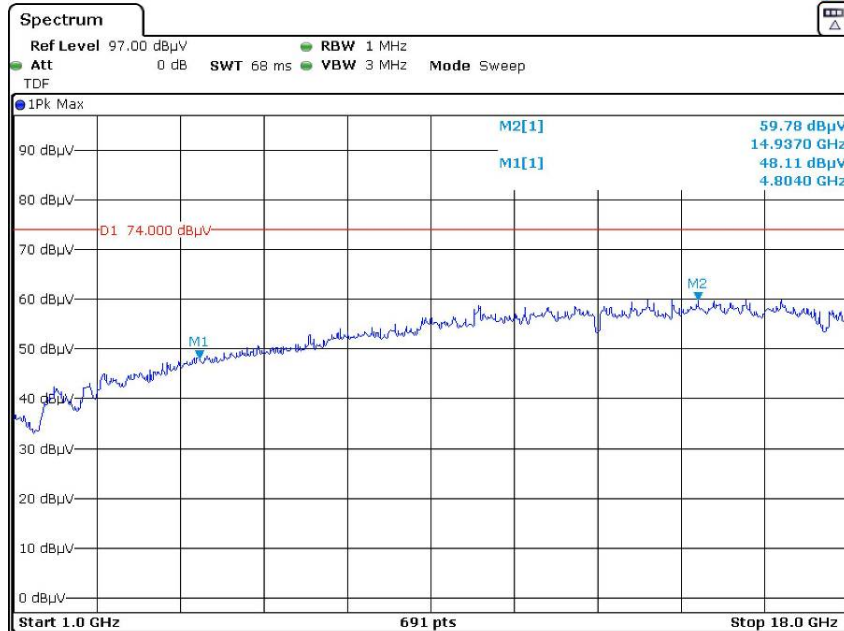


Date: 28.OCT.2020 08:36:12

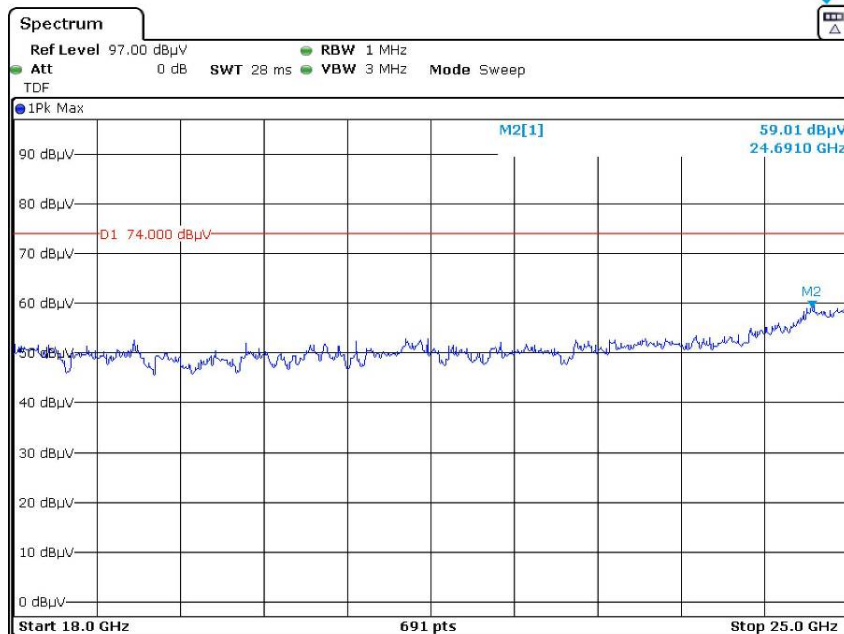


Date: 28.OCT.2020 09:30:21

Vertical

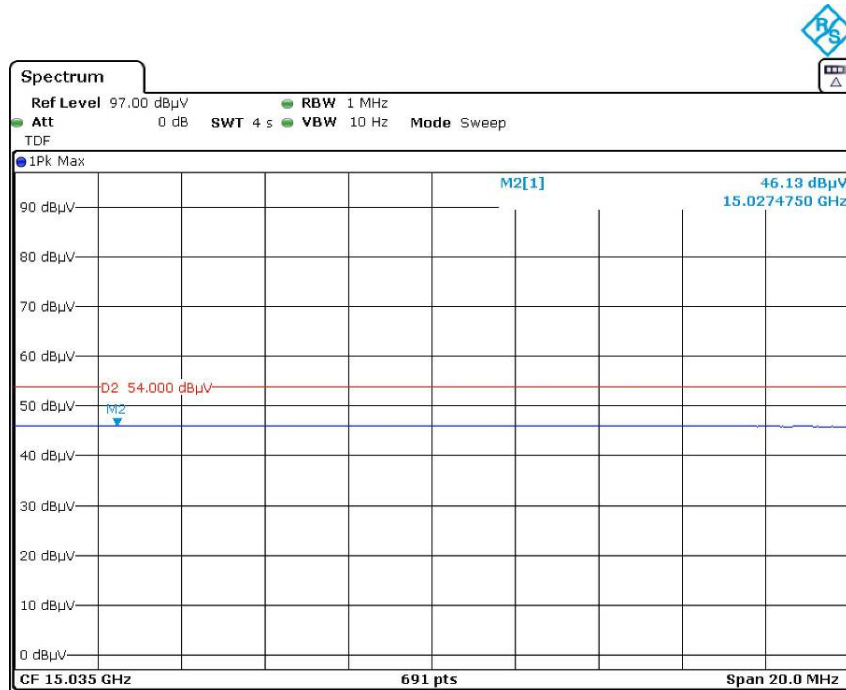


Date: 28.OCT.2020 08:51:03

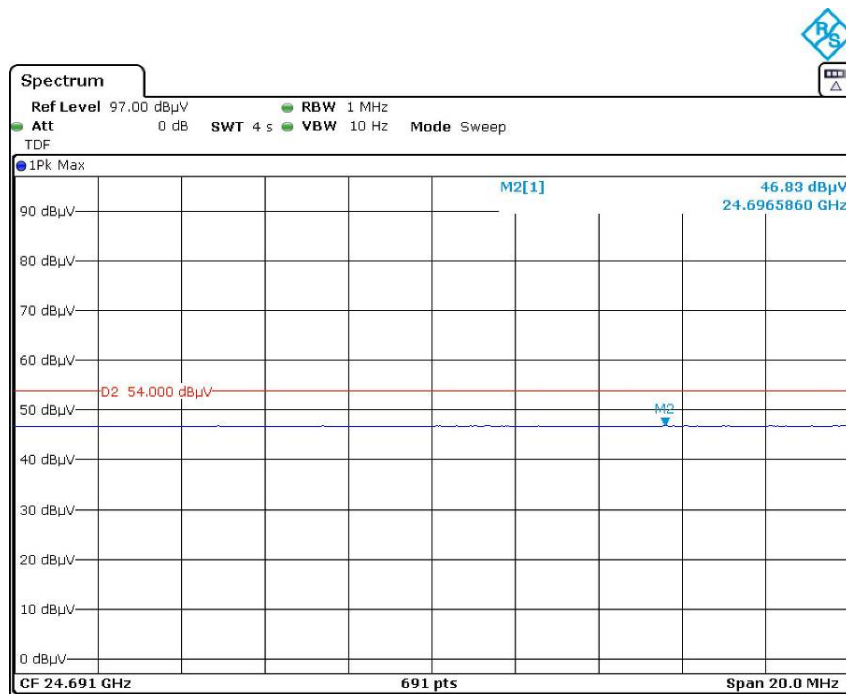


Date: 28.OCT.2020 09:41:13

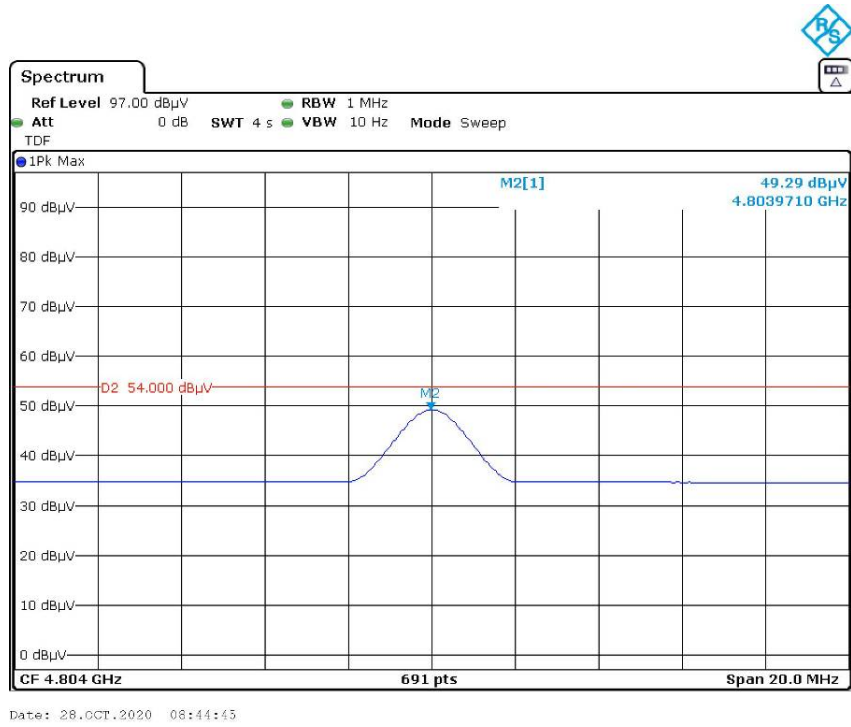
### Pre-scan for Average Horizontal



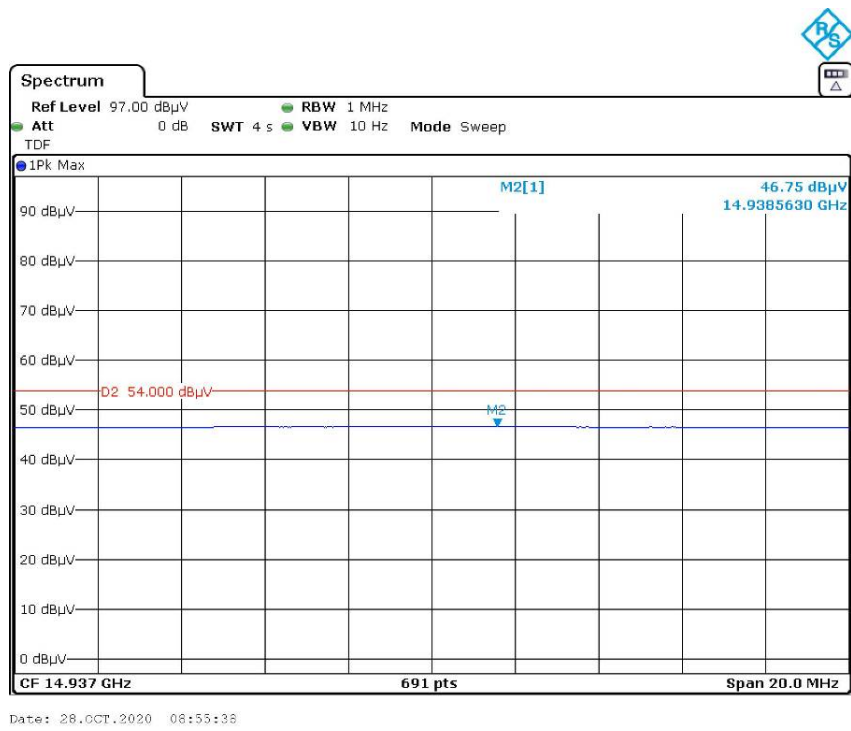
Date: 28.OCT.2020 08:40:40



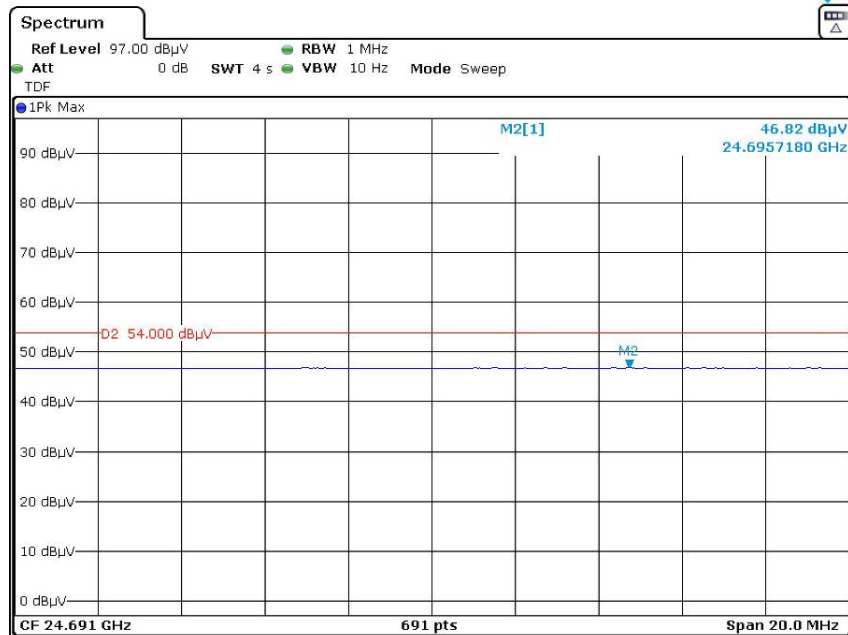
Date: 28.OCT.2020 09:35:43



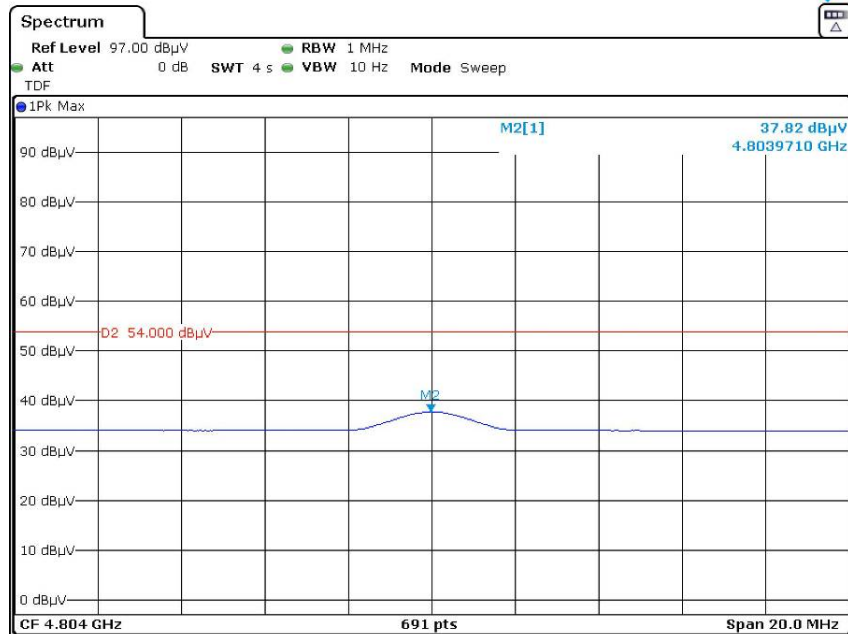
Vertical







Date: 28.OCT.2020 09:46:38



Date: 28.OCT.2020 08:59:12

## 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 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

### Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

### Test Data

#### Environmental Conditions

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 26 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Hailey Yang on 2020-11-17.*

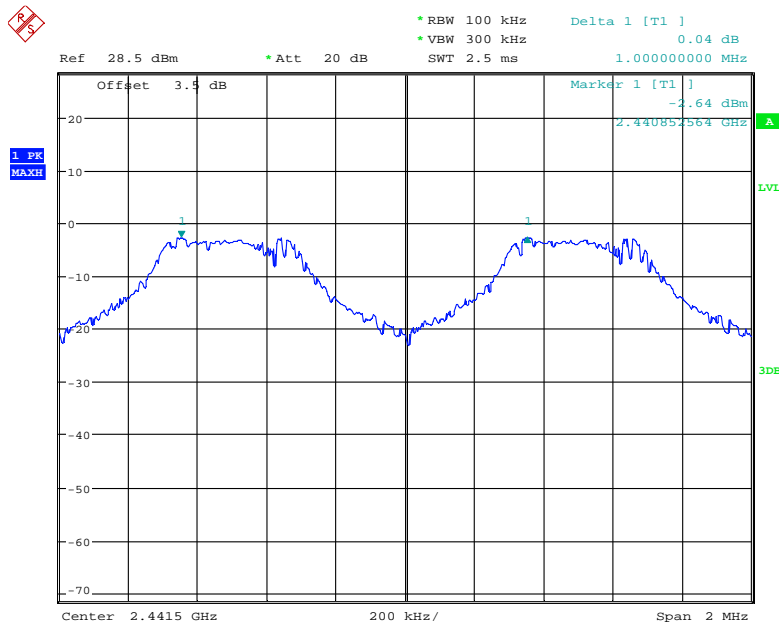
*EUT operation mode: Transmitting*

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

| Test Mode                            | Channel Separation (MHz) | 20 dBc BW (MHz) | Two-thirds of the 20 dB bandwidth (MHz) | Channel Separation Limit            |
|--------------------------------------|--------------------------|-----------------|---|-------------------------------------|
| <b>BDR(GFSK)</b>                     |                          |                 |   |                                     |
| Hopping                              | 1.000                    | 0.929           | 0.619                                   | > two-thirds of the 20 dB bandwidth |
| <b>EDR(<math>\pi/4</math>-DQPSK)</b> |                          |                 |   |                                     |
| Hopping                              | 1.019                    | 1.280           | 0.853                                   | > two-thirds of the 20 dB bandwidth |
| <b>EDR(8DPSK)</b>                    |                          |                 |   |                                     |
| Hopping                              | 1.000                    | 1.242           | 0.828                                   | > two-thirds of the 20 dB bandwidth |

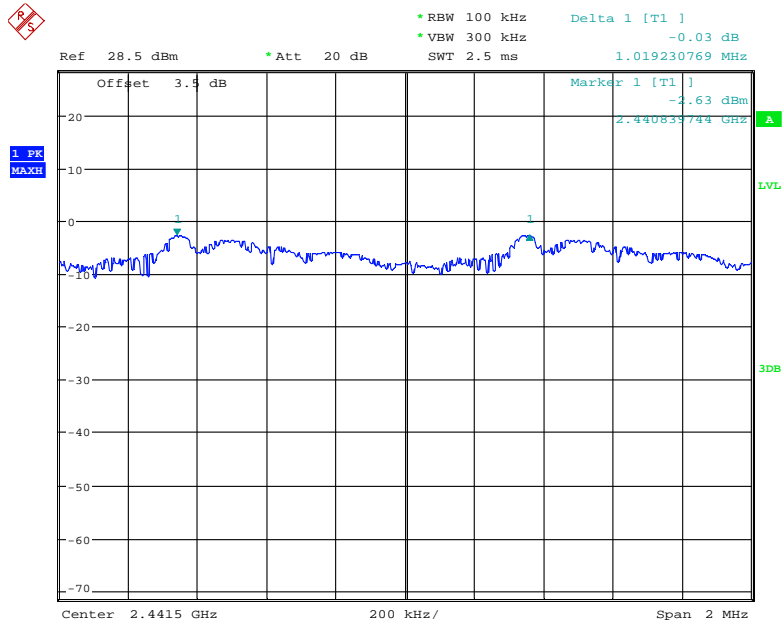
Note: The limit > two-thirds of the 20 dB bandwidth

### BDR (GFSK) Channel



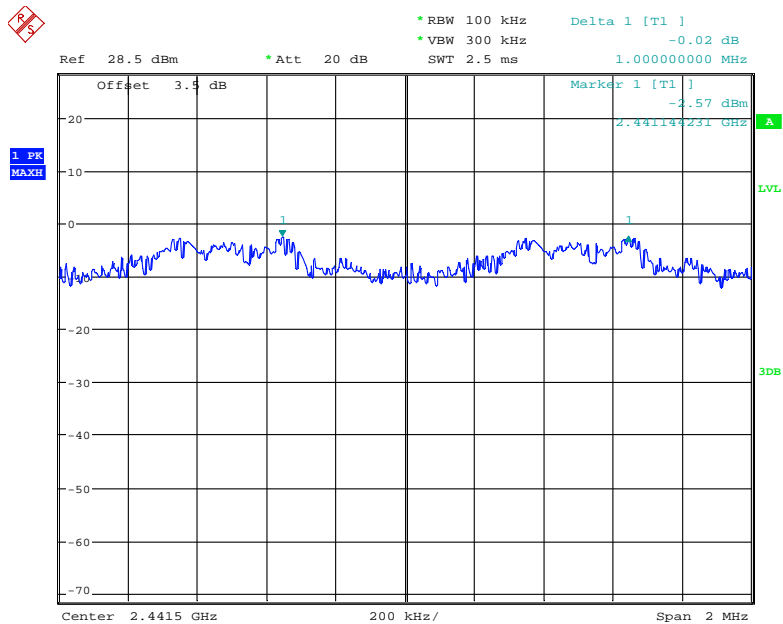
Date: 17.NOV.2020 11:58:21

### EDR ( $\pi/4$ -DQPSK) Channel



Date: 17.NOV.2020 12:01:29

### EDR (8DPSK) Channel



Date: 17.NOV.2020 12:03:29

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

### 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 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. 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 Data

#### Environmental Conditions

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

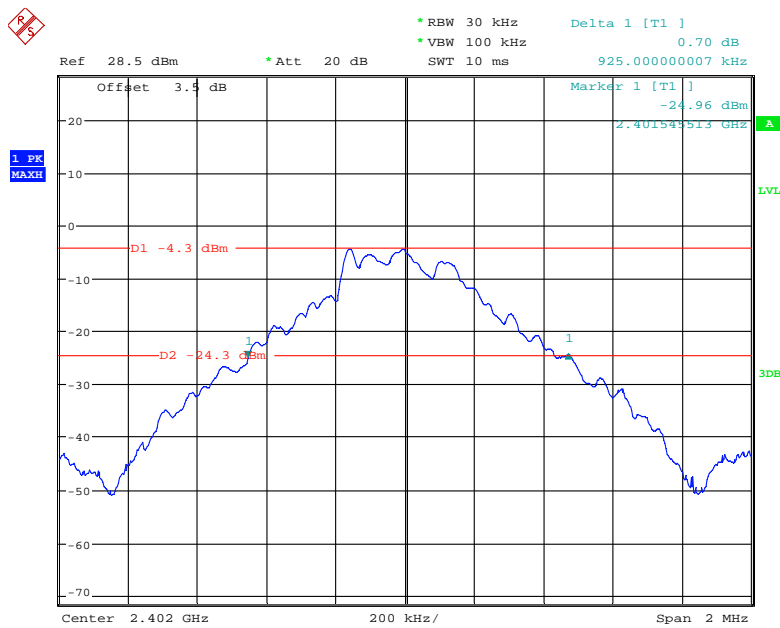
*The testing was performed by Hailey Yang on 2020-11-17.*

*EUT operation mode: Transmitting*

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

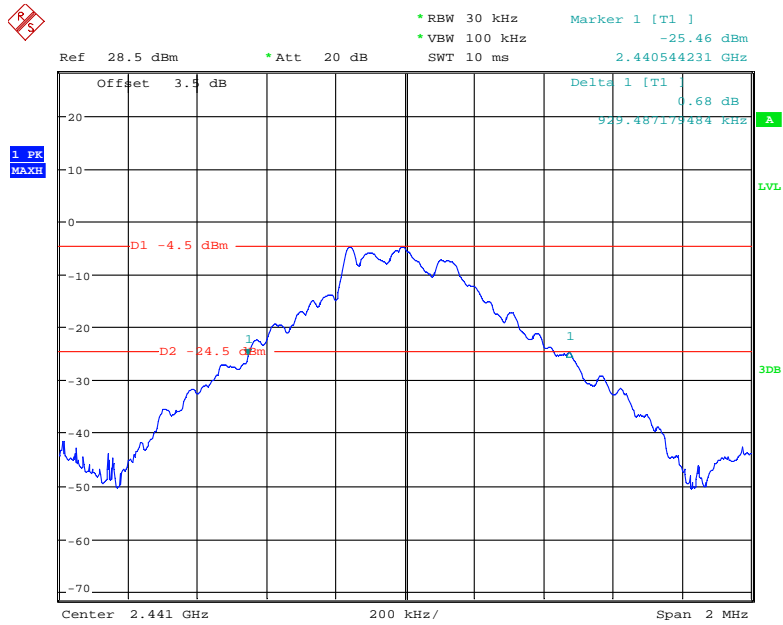
| Mode                                  | Channel | Frequency (MHz) | 20 dB Emission Bandwidth (MHz) |
|---------------------------------------|---------|-----------------|--------------------------------|
| <b>BDR (GFSK)</b>                     | Low     | 2402            | 0.925                          |
|                                       | Middle  | 2441            | 0.929                          |
|                                       | High    | 2480            | 0.926                          |
| <b>EDR (<math>\pi/4</math>-DQPSK)</b> | Low     | 2402            | 1.303                          |
|                                       | Middle  | 2441            | 1.280                          |
|                                       | High    | 2480            | 1.277                          |
| <b>EDR (8DPSK)</b>                    | Low     | 2402            | 1.248                          |
|                                       | Middle  | 2441            | 1.242                          |
|                                       | High    | 2480            | 1.242                          |

**BDR (GFSK): Low Channel**



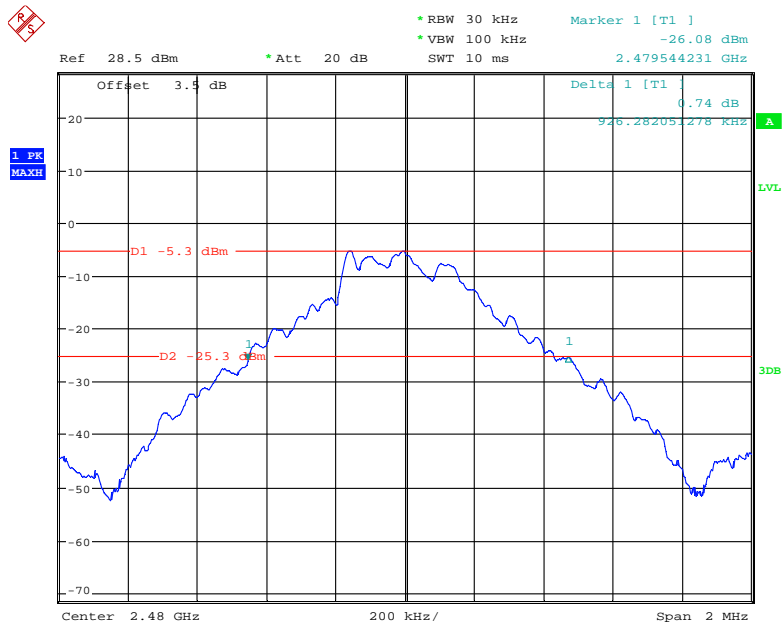
Date: 17.NOV.2020 10:52:04

### BDR (GFSK): Middle Channel



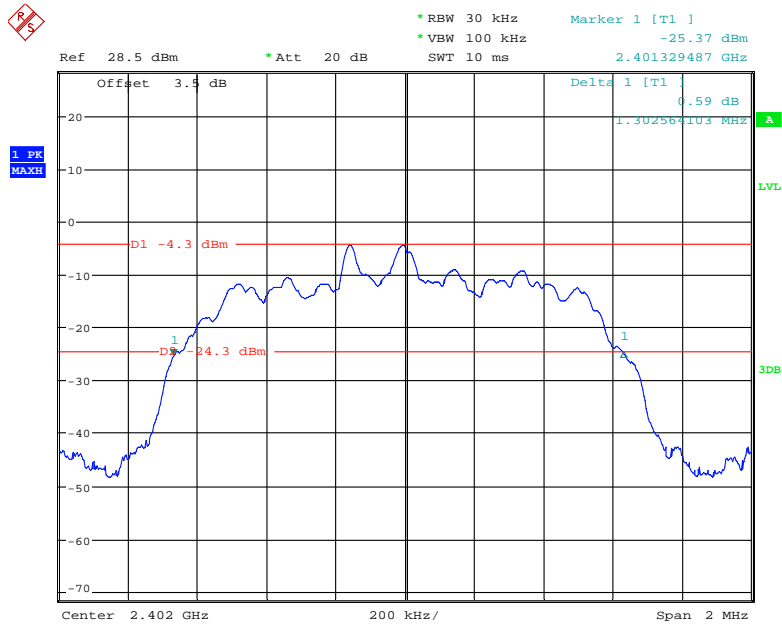
Date: 17.NOV.2020 10:57:04

### BDR (GFSK): High Channel



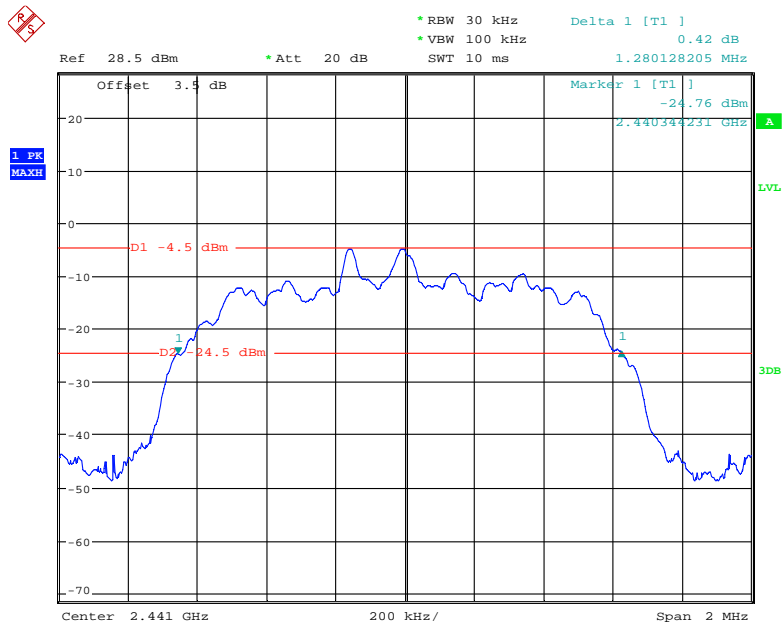
Date: 17.NOV.2020 11:00:16

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



Date: 17.NOV.2020 10:54:20

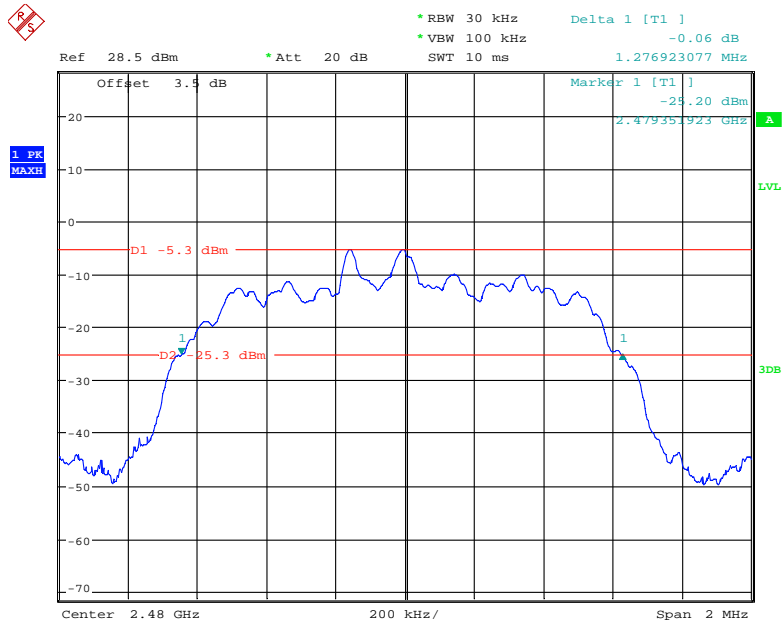
**EDR ( $\pi/4$ -DQPSK): Middle Channel**



Date: 17.NOV.2020 10:57:50

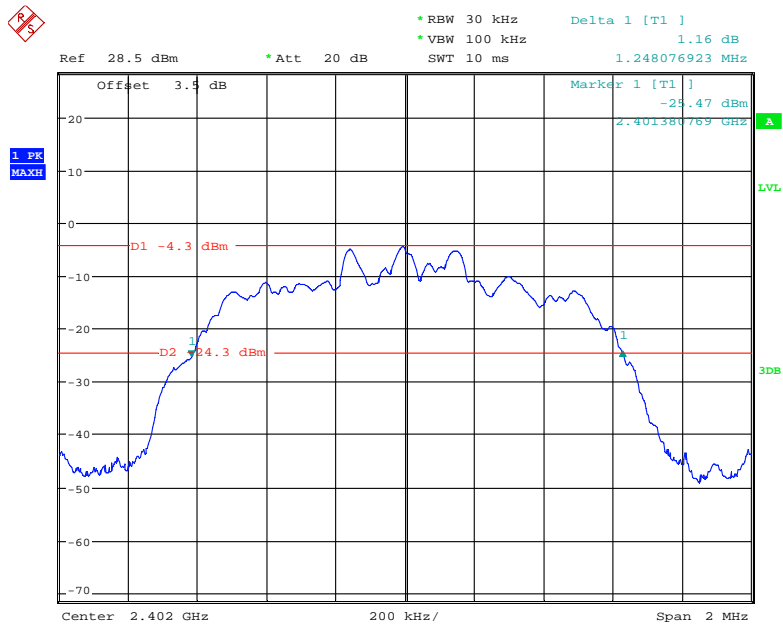


### EDR ( $\pi/4$ -DQPSK): High Channel



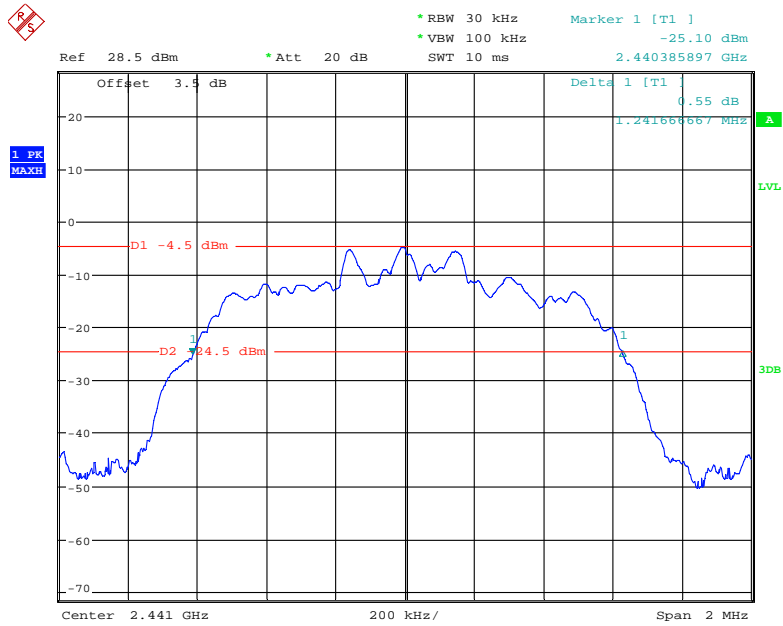
Date: 17.NOV.2020 11:00:57

### EDR (8DPSK): Low Channel



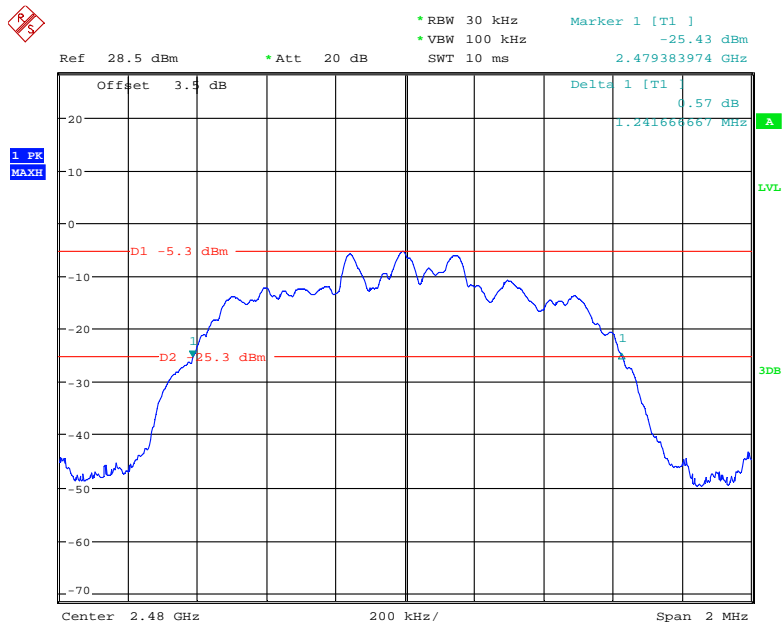
Date: 17.NOV.2020 10:55:06

### EDR (8DPSK): Middle Channel



Date: 17.NOV.2020 10:58:27

### EDR (8DPSK): High Channel



Date: 17.NOV.2020 11:01:33

## 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 Data

#### Environmental Conditions

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 26 °C     |
| <b>Relative Humidity:</b> | 57 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

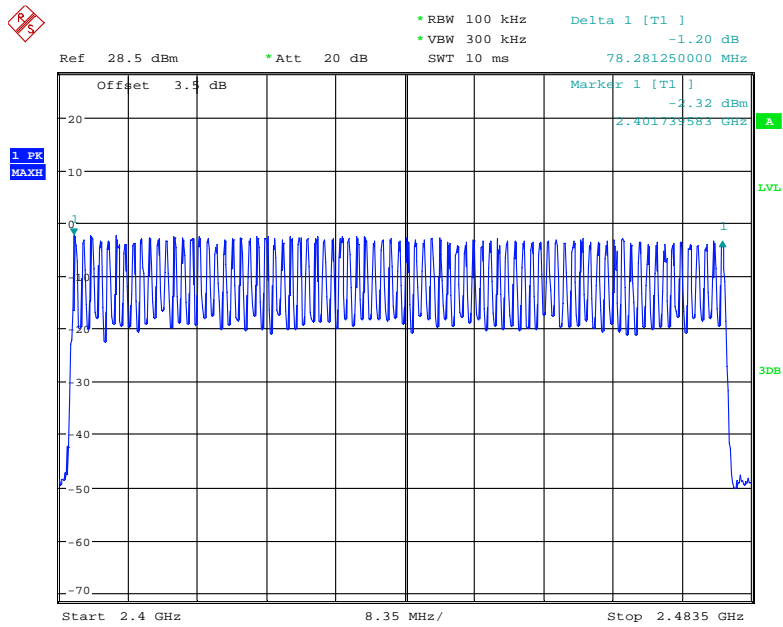
*The testing was performed by Hailey Yang on 2020-11-17.*

*EUT operation mode: Transmitting*

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

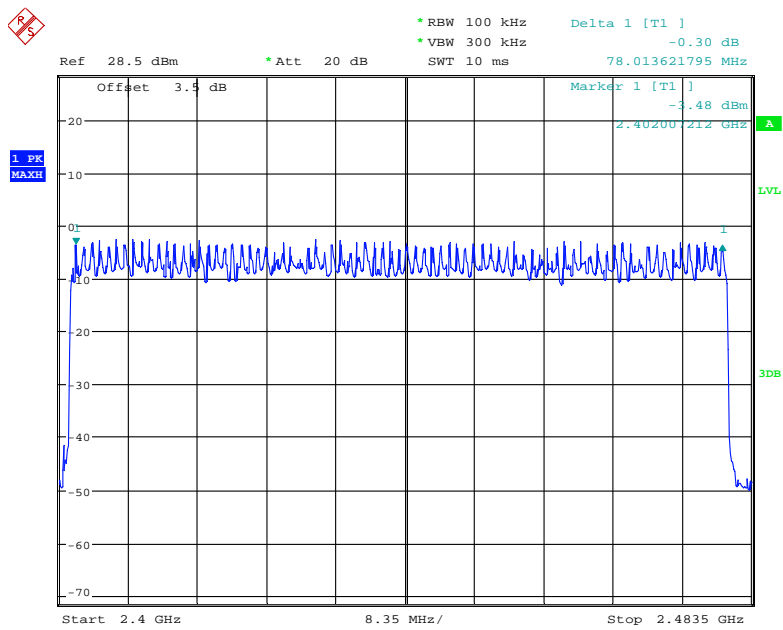
| Mode            | Frequency Range (MHz) | Number of Hopping Channel (CH) | Limit (CH) |
|-----------------|-----------------------|--------------------------------|------------|
| BDR (GFSK)      | 2400-2483.5           | 79                             | ≥15        |
| EDR (π/4-DQPSK) | 2400-2483.5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

### BDR (GFSK): Number of Hopping Channels



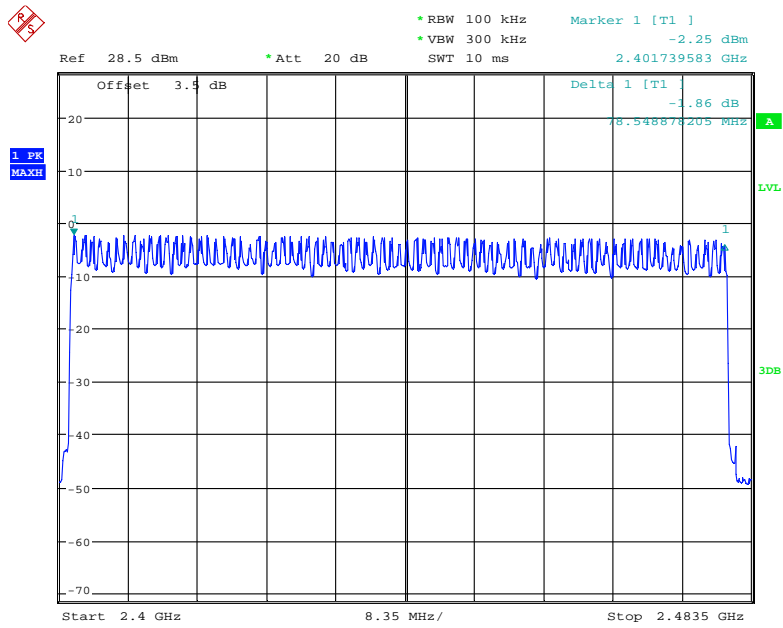
Date: 17.NOV.2020 13:13:05

### EDR ( $\pi/4$ -DQPSK): Number of Hopping Channels



Date: 17.NOV.2020 13:14:32

### EDR (8DPSK): Number of Hopping Channels



Date: 17.NOV.2020 13:10:56

**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**

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW  $\geq 3 \times$ RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

**Test Data****Environmental Conditions**

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 27 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Hailey Yang on 2020-10-18.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

## 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. And 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 Data

#### Environmental Conditions

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 27 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Hailey Yang on 2020-10-23.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

## **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 of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

### **Test Data**

#### **Environmental Conditions**

|                           |           |
|---------------------------|-----------|
| <b>Temperature:</b>       | 25 °C     |
| <b>Relative Humidity:</b> | 56 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

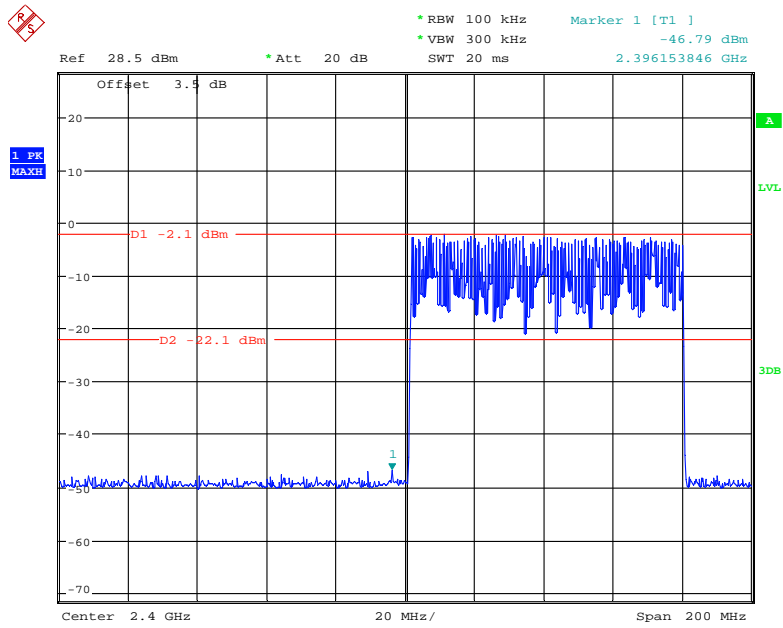
*The testing was performed by Hailey Yang on 2020-11-17.*

*EUT operation mode: Transmitting*

*Test Result: Compliance. Please refer to following plots.*

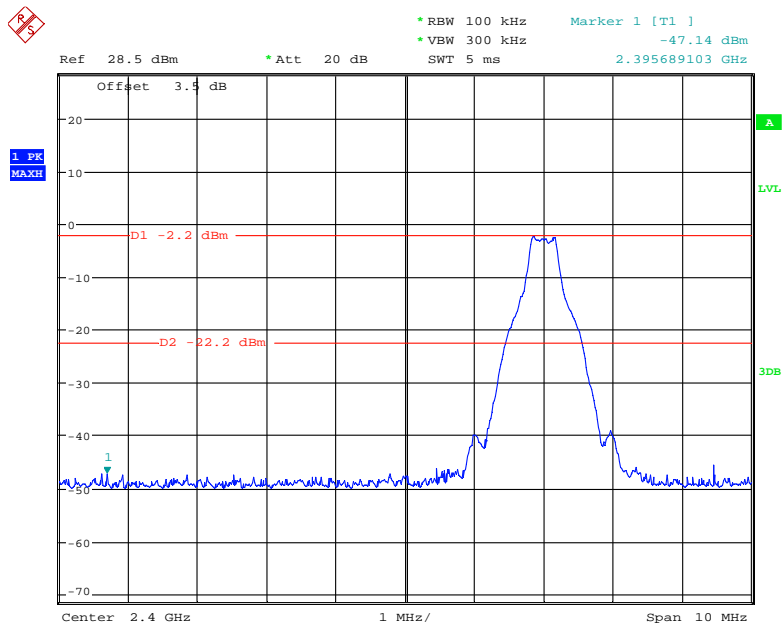


### BDR (GFSK): Band Edge-Left Side Hopping



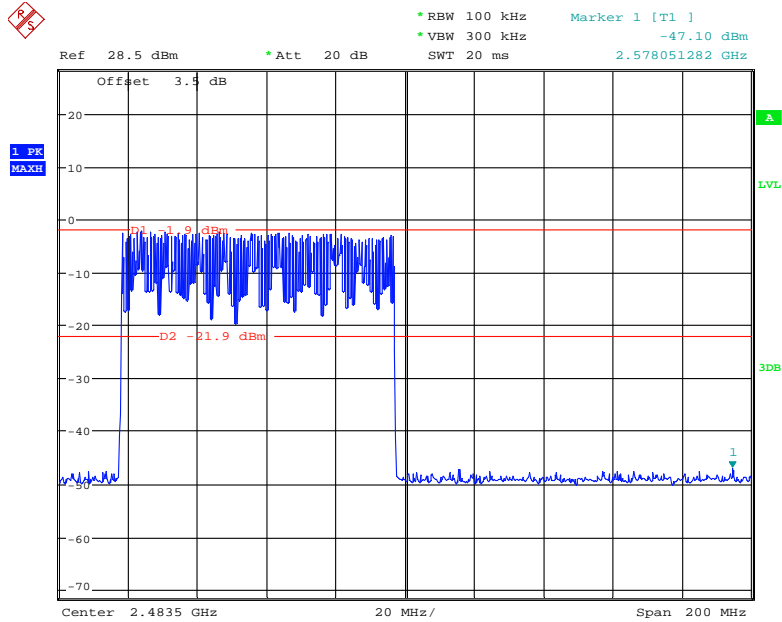
Date: 17.NOV.2020 11:22:46

### Single



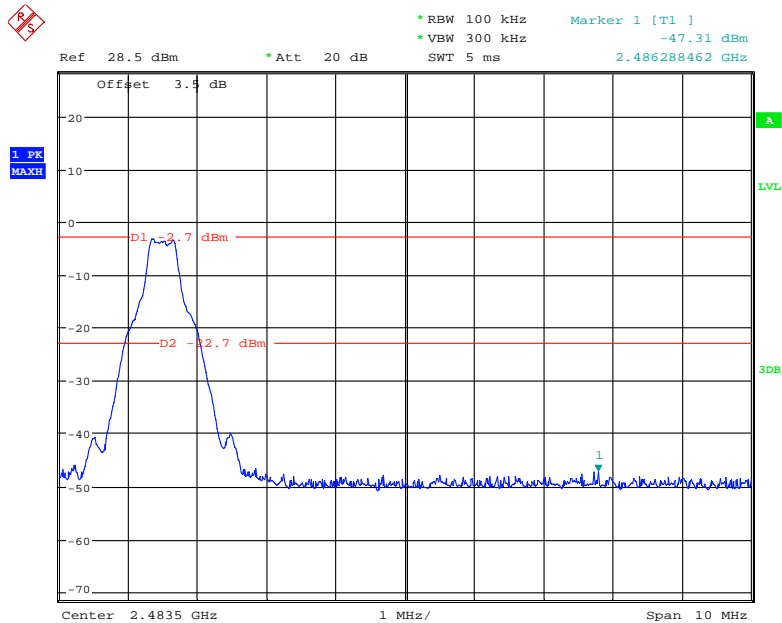
Date: 17.NOV.2020 11:05:15

### BDR (GFSK): Band Edge-Right Side Hopping



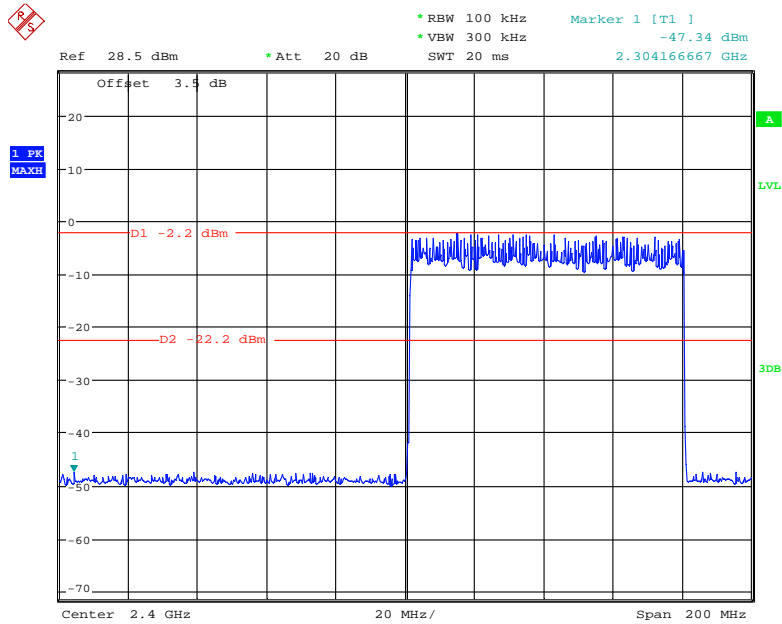
Date: 17.NOV.2020 11:26:38

### Single



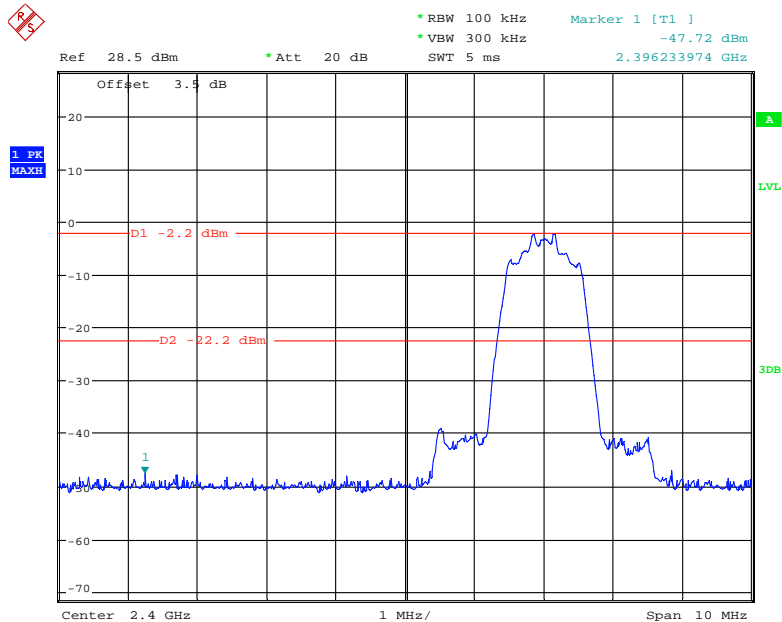
Date: 17.NOV.2020 11:12:52

### EDR ( $\pi/4$ -DQPSK): Band Edge-Left Side Hopping



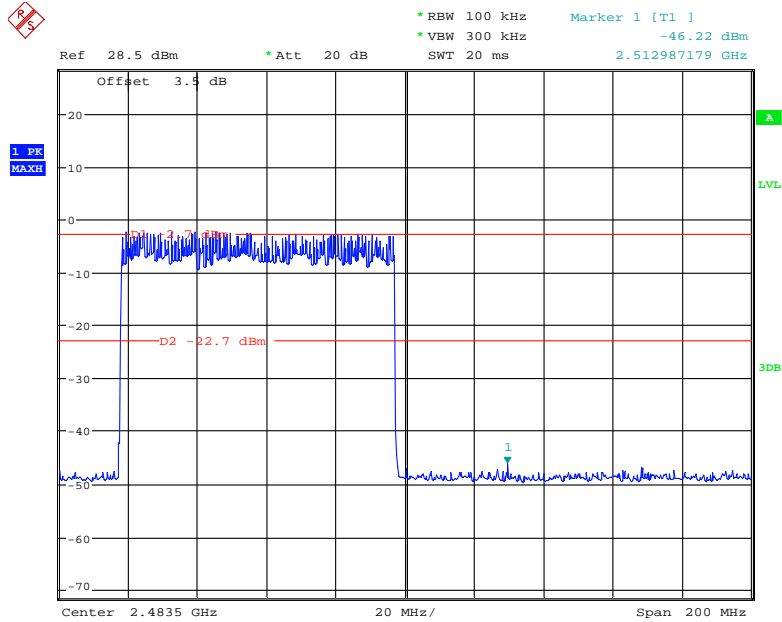
Date: 17.NOV.2020 11:24:08

### Single



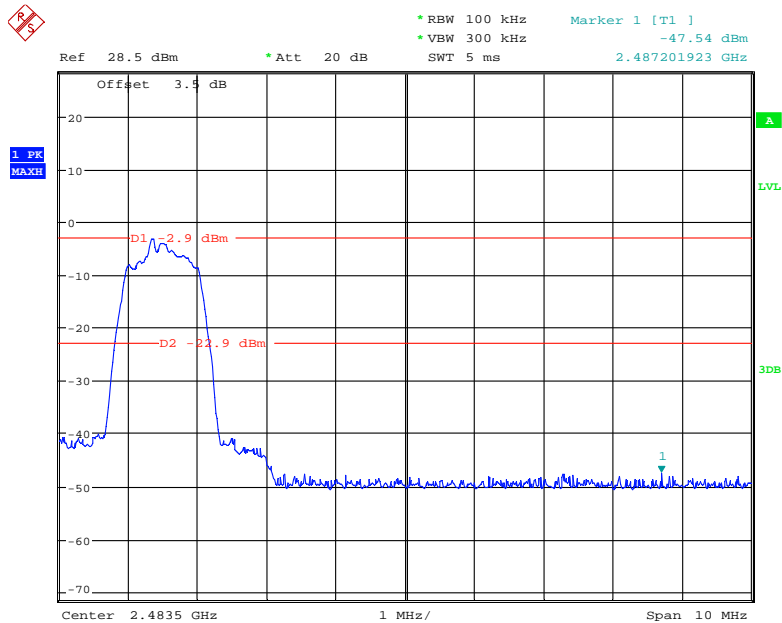
Date: 17.NOV.2020 11:07:13

### EDR ( $\pi/4$ -DQPSK): Band Edge-Right Side Hopping



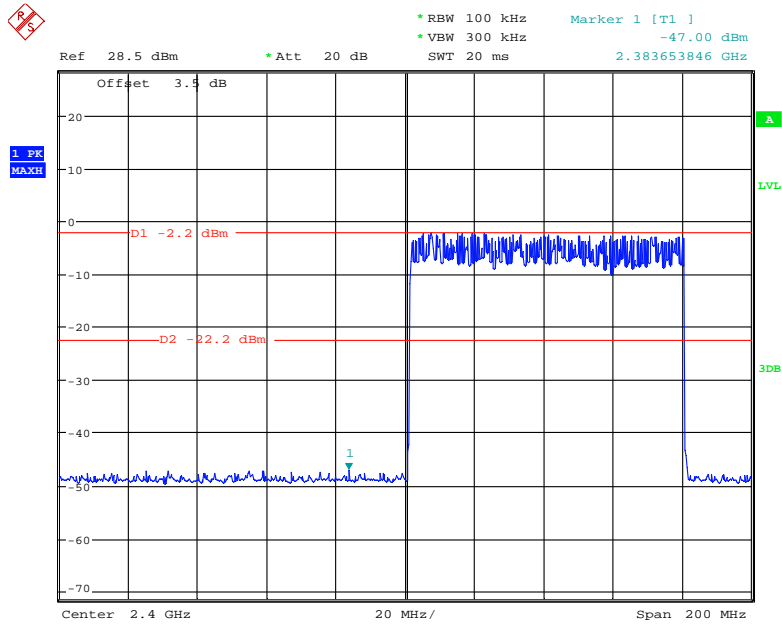
Date: 17.NOV.2020 13:25:22

### Single



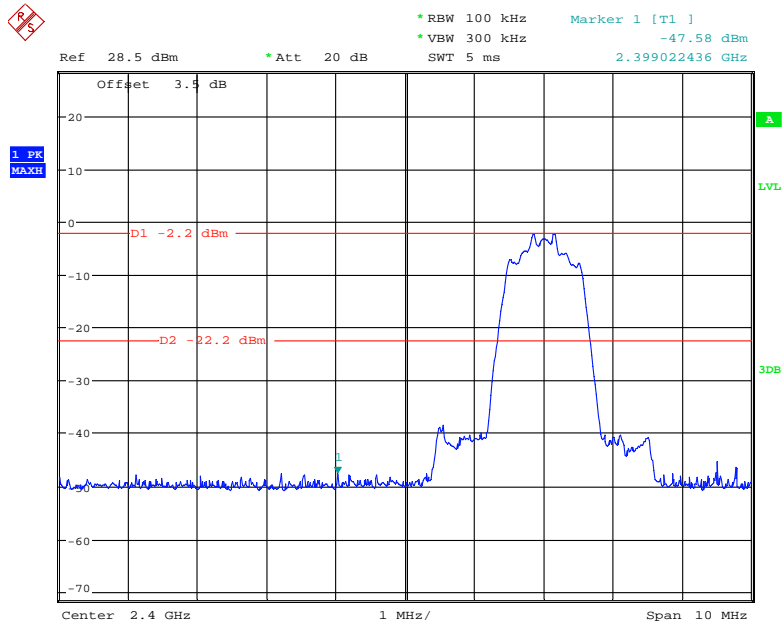
Date: 17.NOV.2020 11:14:50

### EDR (8DPSK): Band Edge-Left Side Hopping



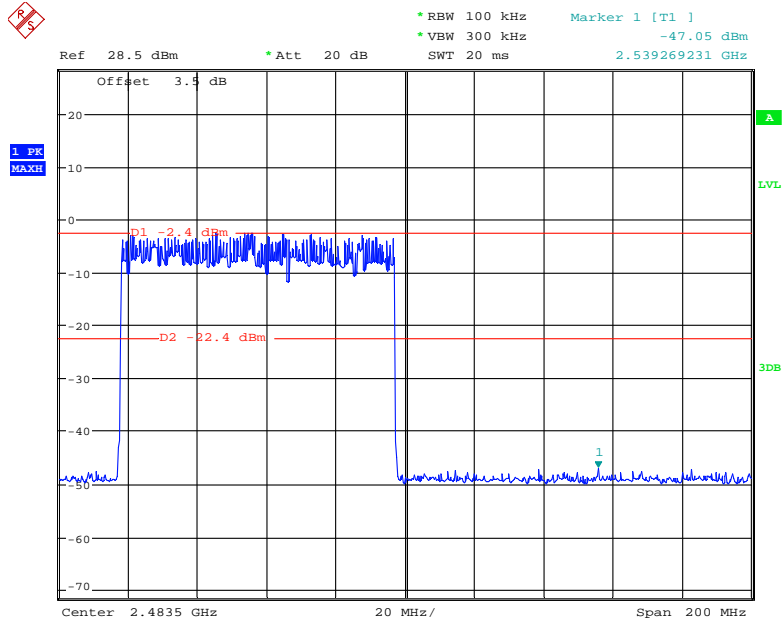
Date: 17.NOV.2020 11:21:16

### Single



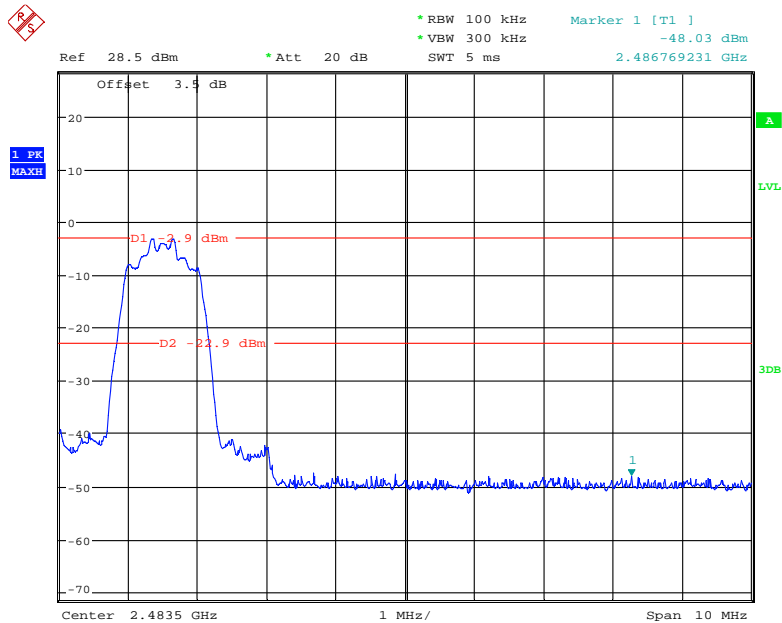
Date: 17.NOV.2020 11:16:56

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



Date: 17.NOV.2020 13:29:54

### Single

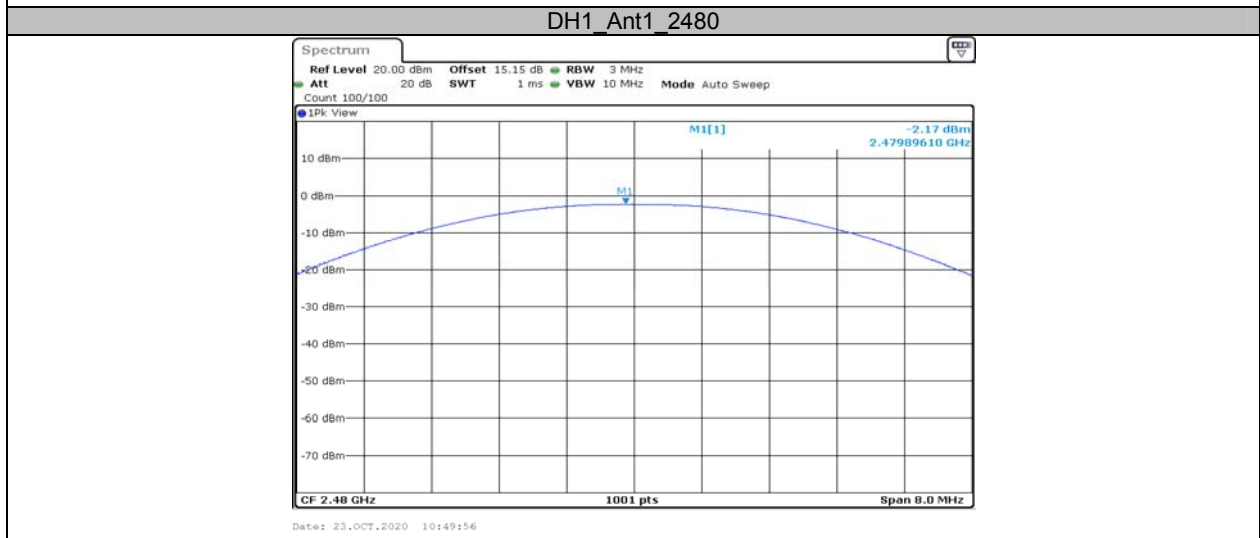
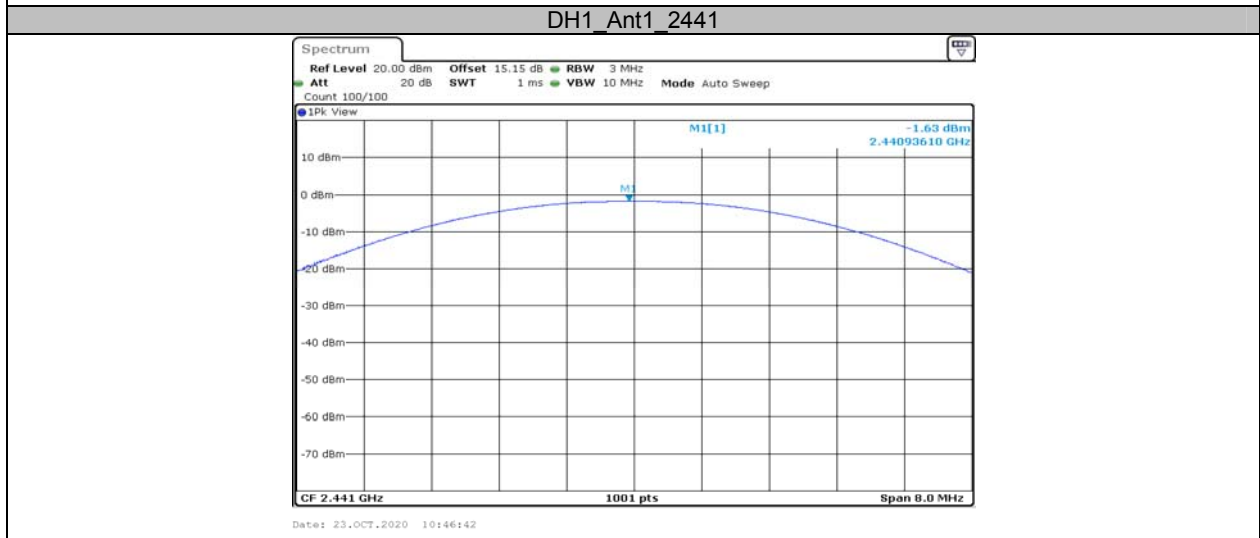
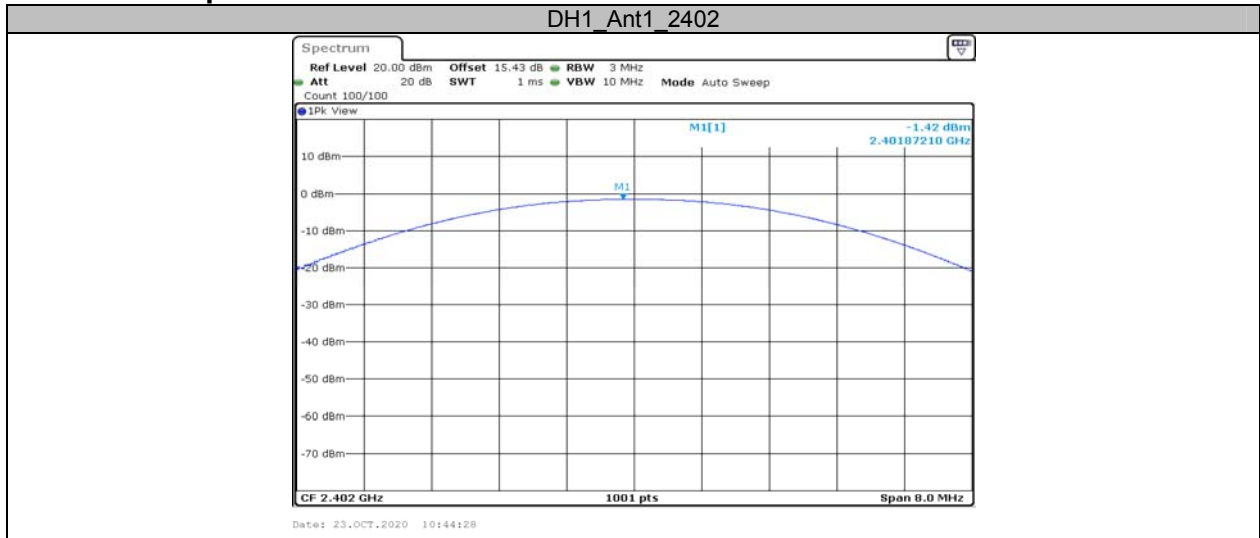


Date: 17.NOV.2020 11:15:44

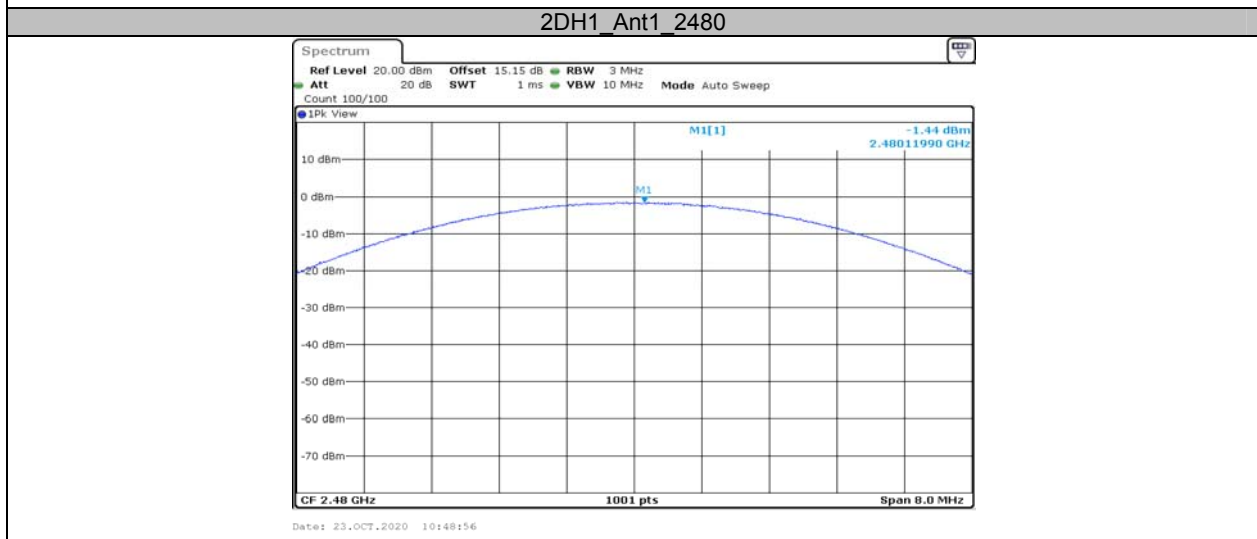
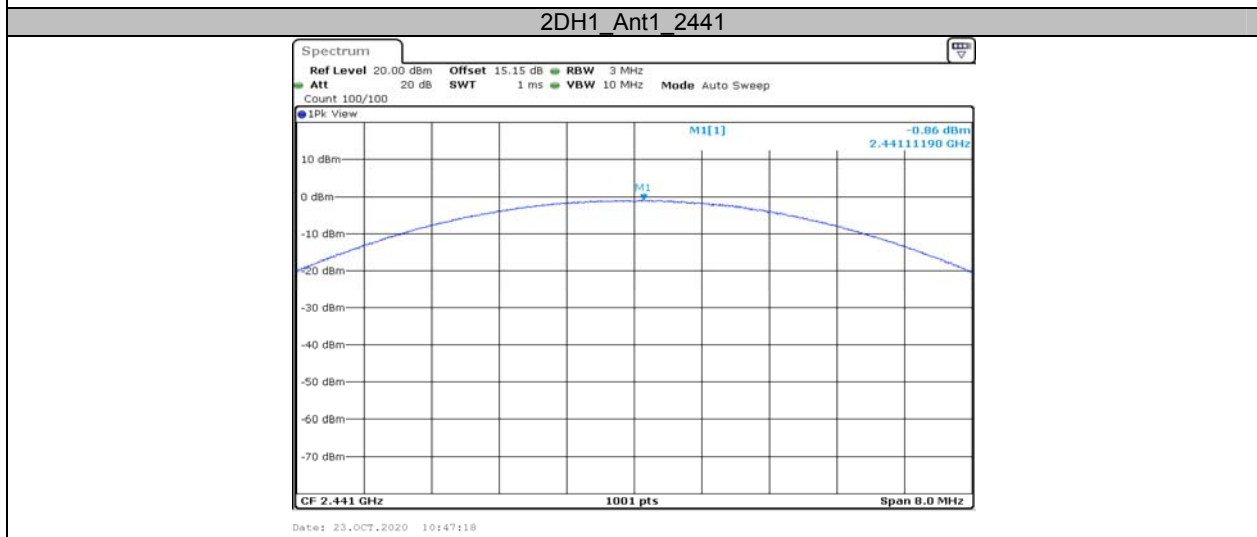
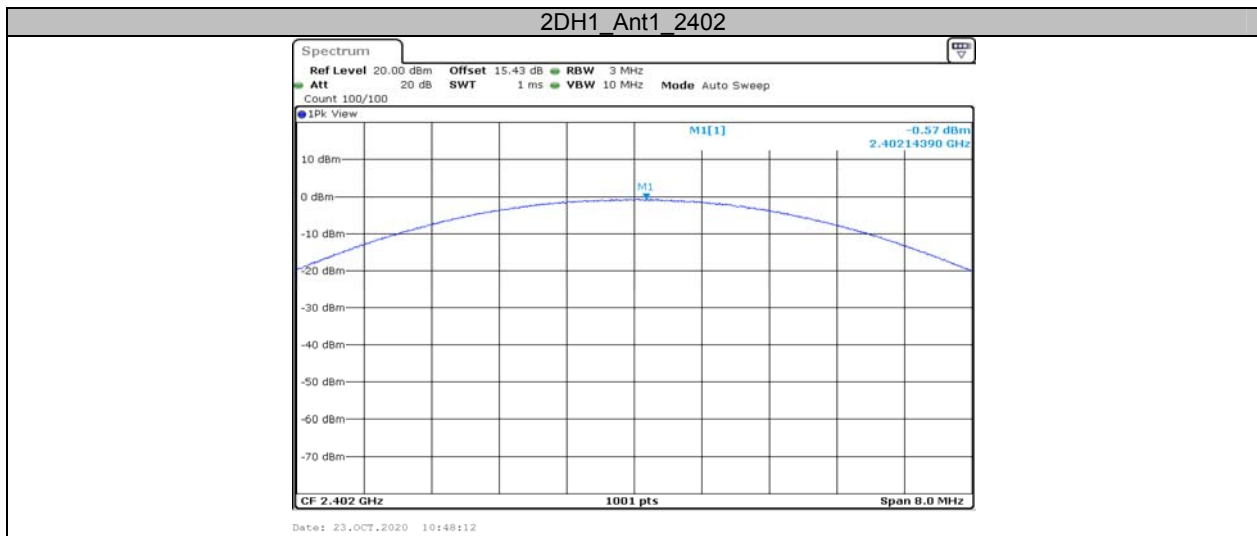
**APPENDIX****Appendix A: Maximum conducted Peak output power  
Test Result**

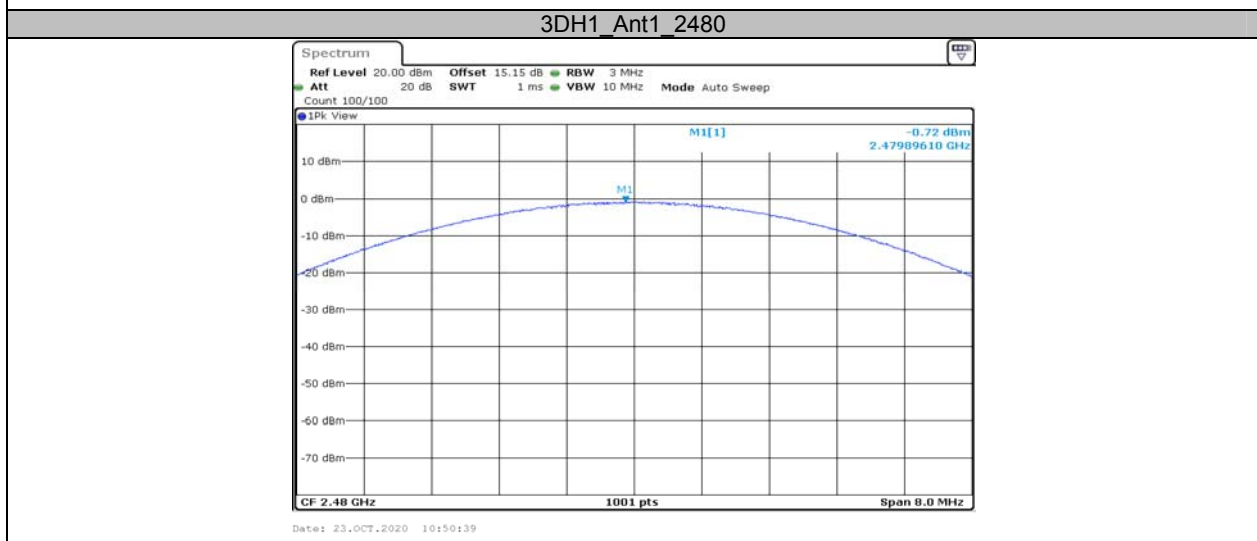
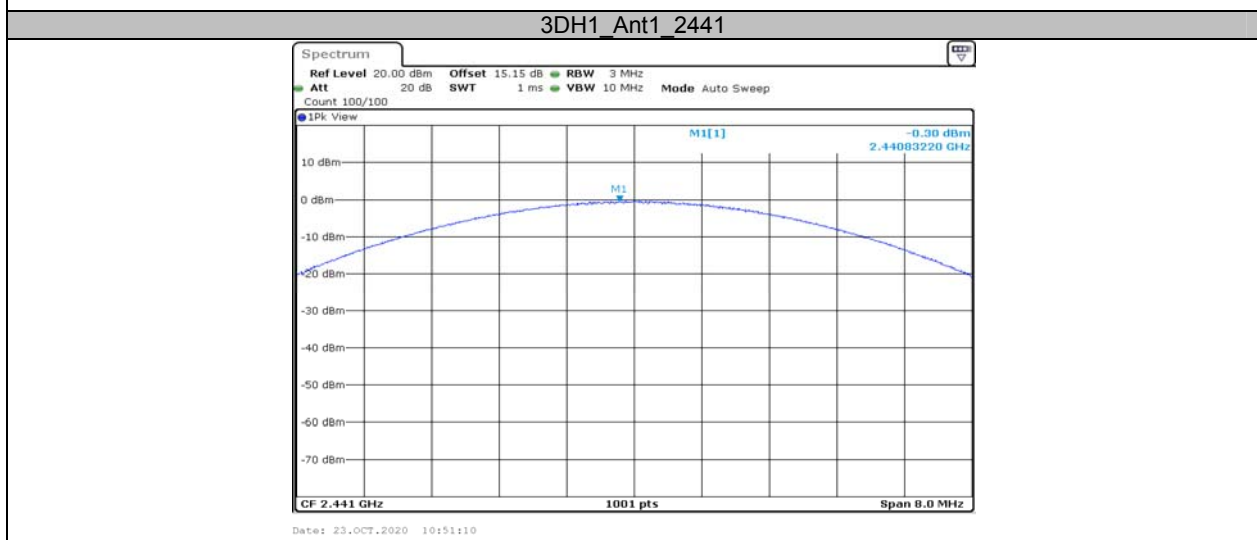
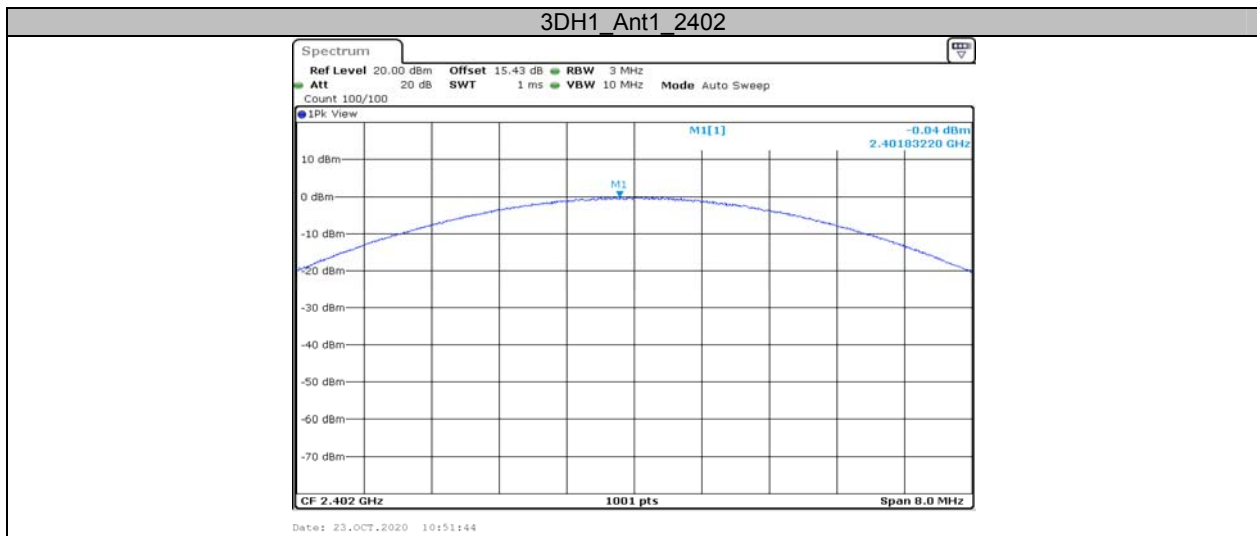
| TestMode | Antenna | Channel | Result[dBm] | Limit[dBm] | Verdict |
|----------|---------|---------|-------------|------------|---------|
| DH1      | Ant1    | 2402    | -1.42       | <=20.97    | PASS    |
|          |         | 2441    | -1.63       | <=20.97    | PASS    |
|          |         | 2480    | -2.17       | <=20.97    | PASS    |
| 2DH1     | Ant1    | 2402    | -0.57       | <=20.97    | PASS    |
|          |         | 2441    | -0.86       | <=20.97    | PASS    |
|          |         | 2480    | -1.44       | <=20.97    | PASS    |
| 3DH1     | Ant1    | 2402    | -0.04       | <=20.97    | PASS    |
|          |         | 2441    | -0.3        | <=20.97    | PASS    |
|          |         | 2480    | -0.72       | <=20.97    | PASS    |

Test Graphs









### Appendix B: Time of occupancy Test Result

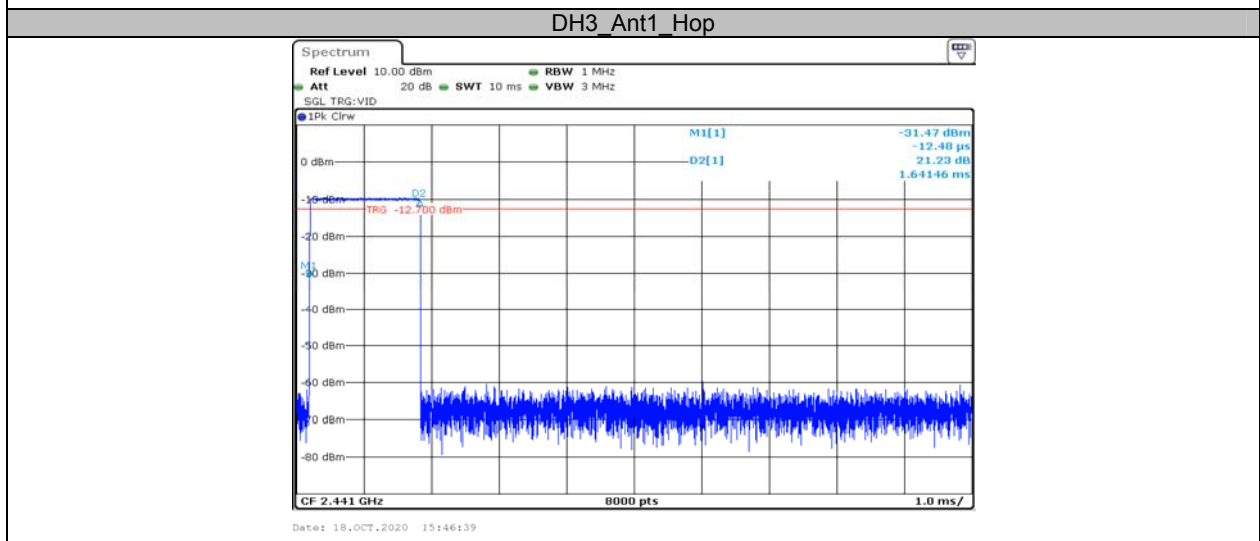
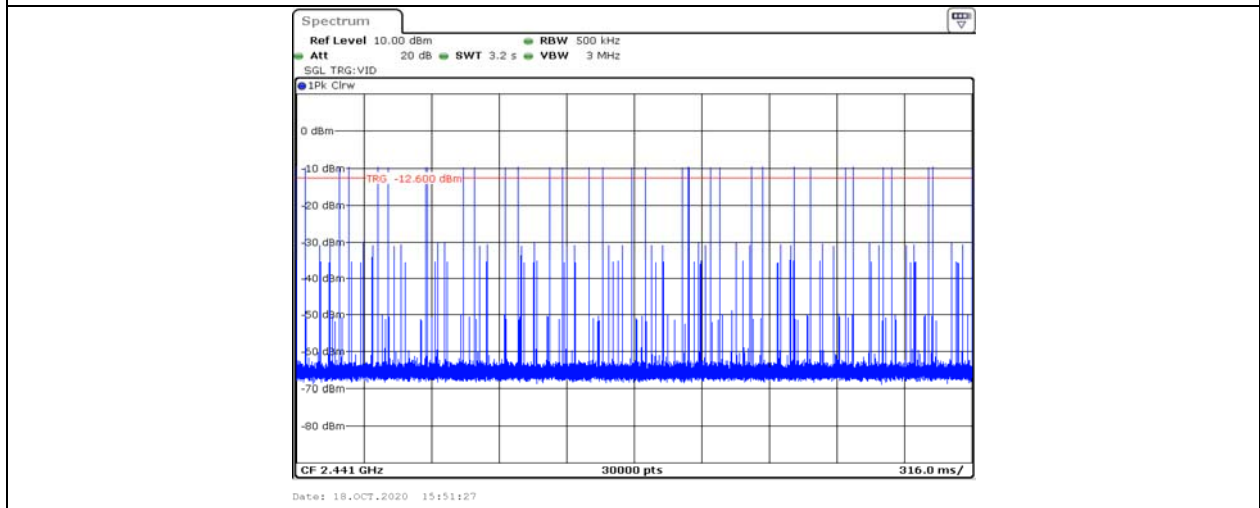
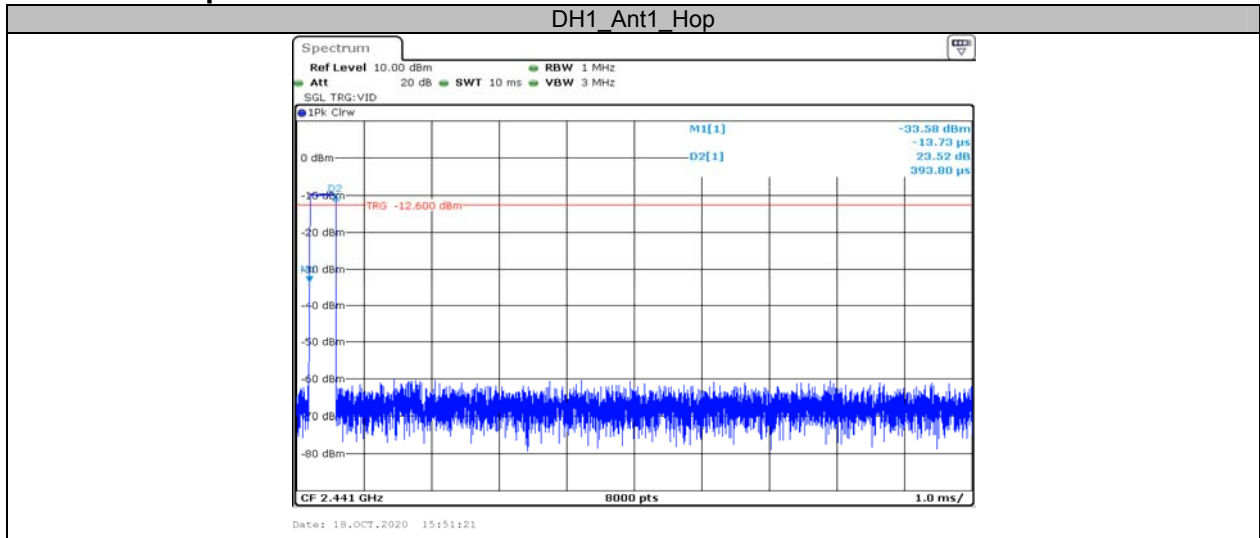
| TestMode | Antenna | Channel | BurstWidth<br>[ms] | TotalHops<br>[Num] | Result[s] | Limit[s] | Verdict |
|----------|---------|---------|--------------------|--------------------|-----------|----------|---------|
| DH1      | Ant1    | Hop     | 0.39               | 320                | 0.126     | <=0.4    | PASS    |
| DH3      | Ant1    | Hop     | 1.64               | 150                | 0.246     | <=0.4    | PASS    |
| DH5      | Ant1    | Hop     | 2.88               | 110                | 0.317     | <=0.4    | PASS    |
| 2DH1     | Ant1    | Hop     | 0.40               | 320                | 0.129     | <=0.4    | PASS    |
| 2DH3     | Ant1    | Hop     | 1.65               | 150                | 0.247     | <=0.4    | PASS    |
| 2DH5     | Ant1    | Hop     | 2.89               | 120                | 0.347     | <=0.4    | PASS    |
| 3DH1     | Ant1    | Hop     | 0.41               | 320                | 0.13      | <=0.4    | PASS    |
| 3DH3     | Ant1    | Hop     | 1.65               | 150                | 0.247     | <=0.4    | PASS    |
| 3DH5     | Ant1    | Hop     | 2.89               | 120                | 0.347     | <=0.4    | PASS    |

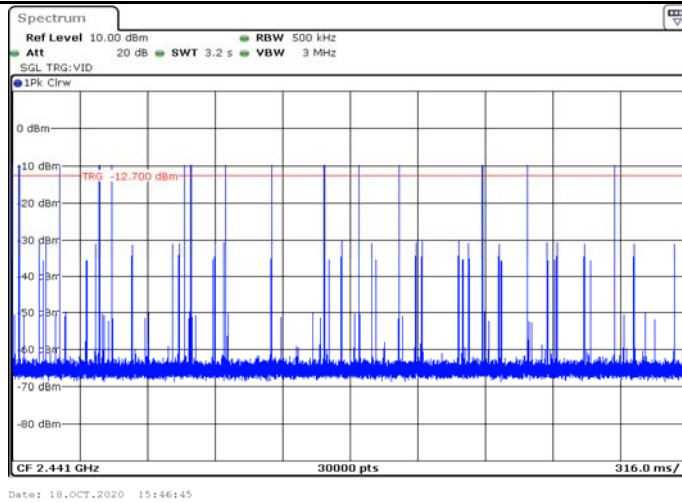
Note 1: A period time= $0.4 \times 79 = 31.6$ (S), Result=BurstWidth\*Totalhops

Note 2: Totalhops=Hopping Number in  $3.16s \times 10$

Note 3: Hopping Number in  $3.16s =$ Total of highest signals in  $3.16s$ (Second high signals were other channel)

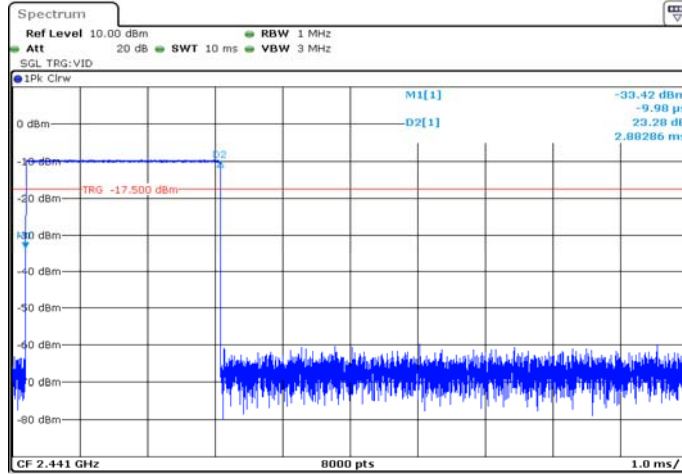
Test Graphs



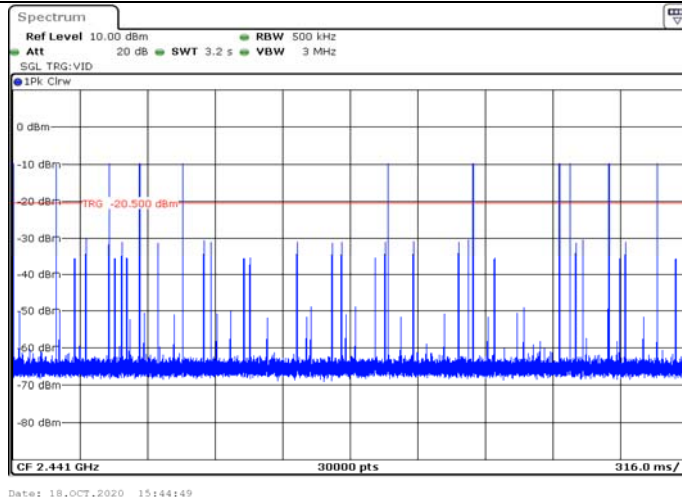


Date: 18.OCT.2020 15:46:45

DH5 Ant1 Hop

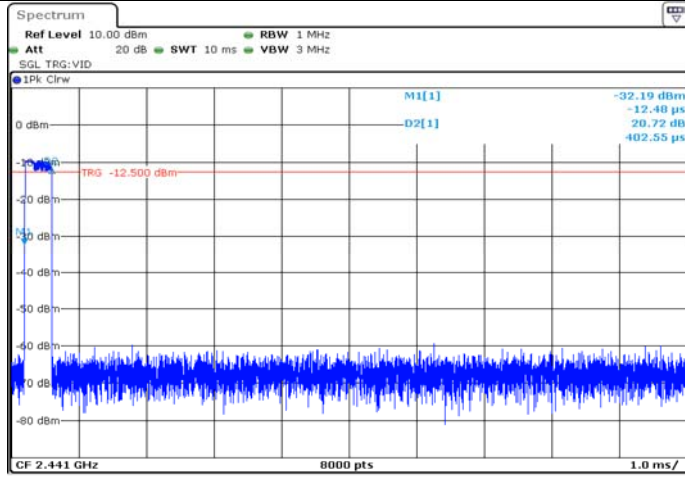


Date: 18.OCT.2020 15:44:44



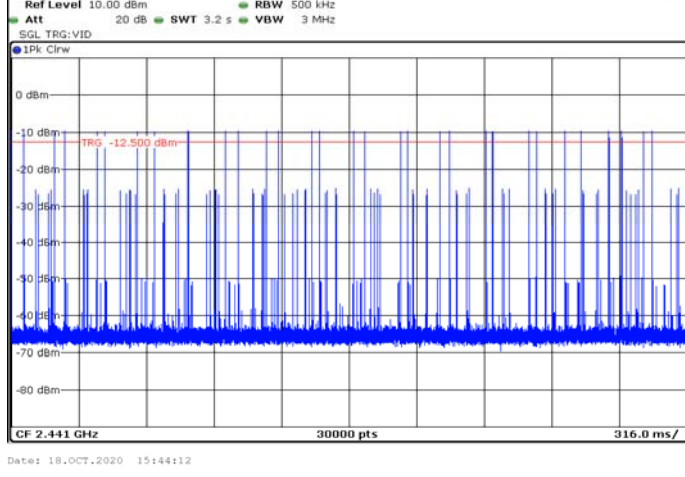
Date: 18.OCT.2020 15:44:49

2DH1\_Ant1\_Hop



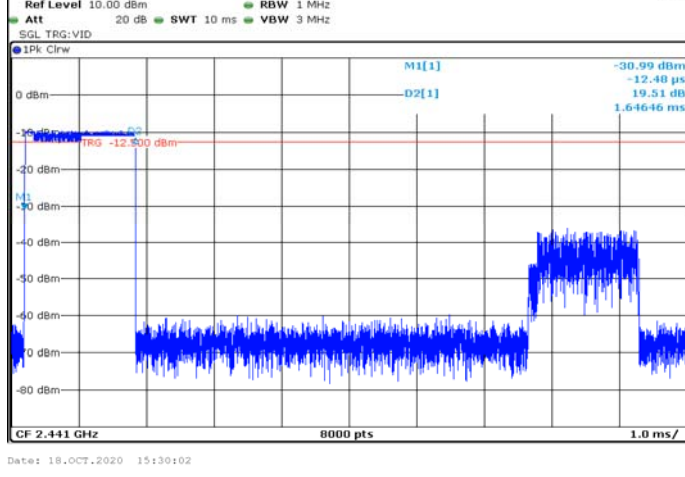
Date: 18.OCT.2020 15:44:07

2DH3\_Ant1\_Hop

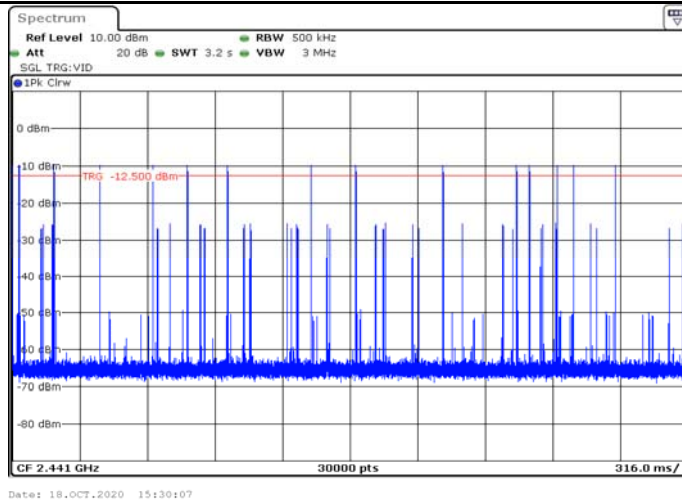


Date: 18.OCT.2020 15:44:12

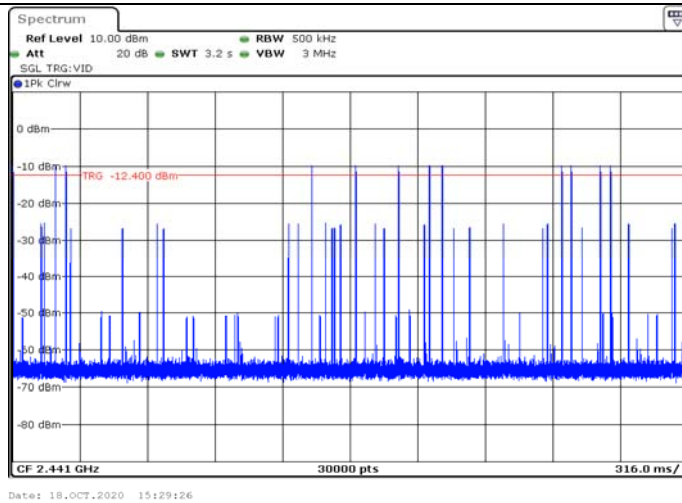
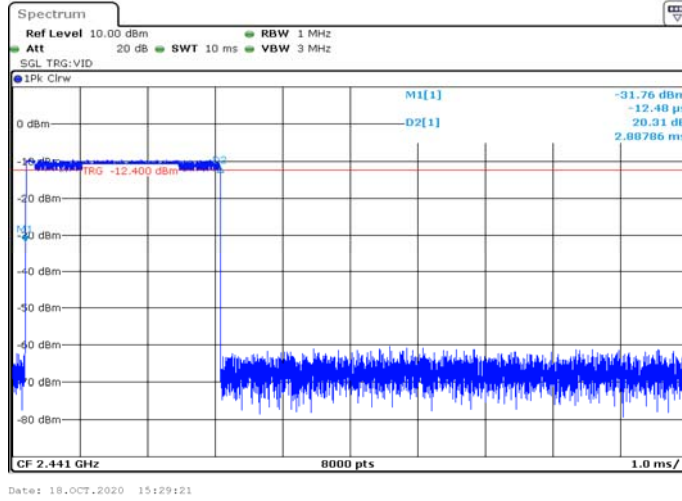
2DH1\_Ant1\_Hop



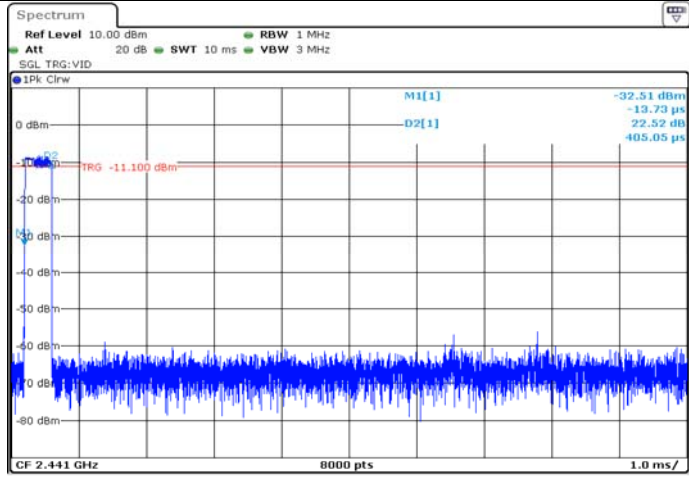
Date: 18.OCT.2020 15:30:02



2DH5 Ant1\_Hop

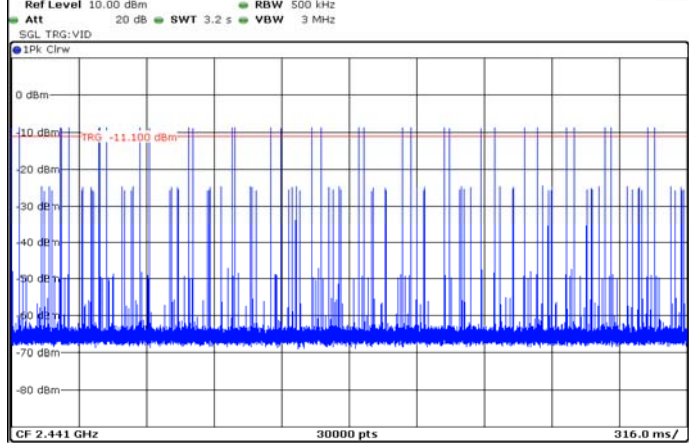


3DH1\_Ant1\_Hop



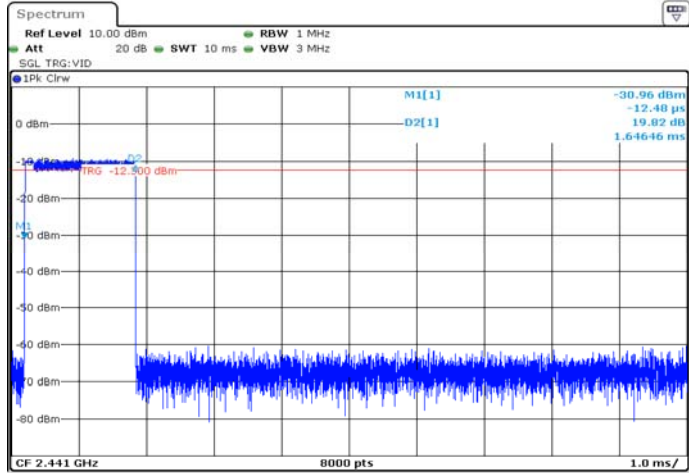
Date: 18.OCT.2020 15:13:02

3DH1\_Ant1\_Hop



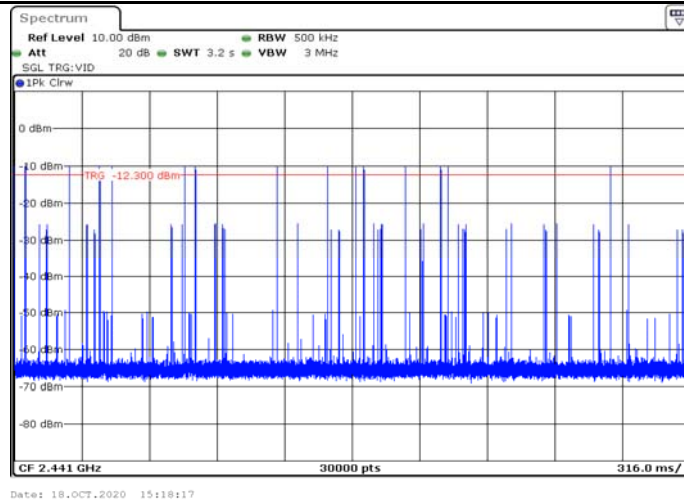
Date: 18.OCT.2020 15:13:08

3DH3\_Ant1\_Hop

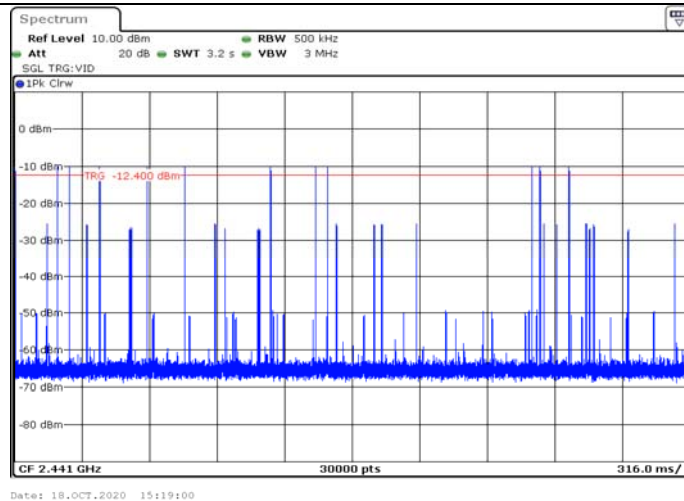
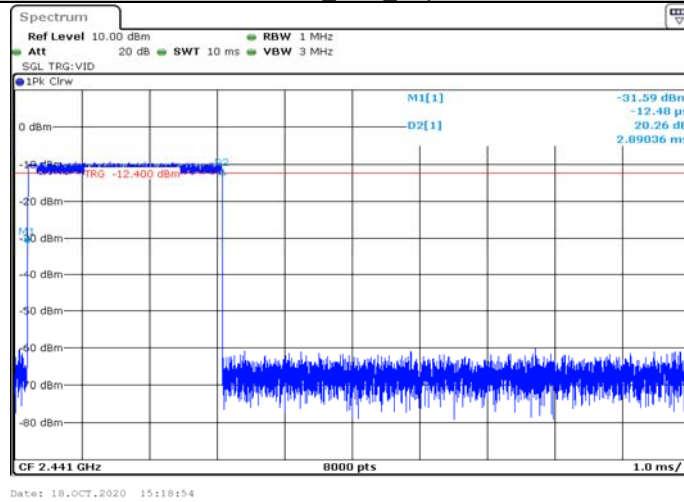


Date: 18.OCT.2020 15:18:11





3DH5 Ant1\_Hop



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