

## FCC PART 15.247 TEST REPORT

For

### ORAIMO TECHNOLOGY LIMITED

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**FCC ID: 2AXYP-OEB-E104D-L**

|                                                                                                                                                                                                                                                                                                                         |                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| <b>Report Type:</b><br>Original Report                                                                                                                                                                                                                                                                                  | <b>Product Type:</b><br>Wireless Earphone |
| <b>Report Number:</b> SZ1210810-33632E-RF-00B                                                                                                                                                                                                                                                                           |                                           |
| <b>Report Date:</b> 2021-09-09                                                                                                                                                                                                                                                                                          |                                           |
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## GENERAL INFORMATION

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

|                                     |                                                                                                     |
|-------------------------------------|-----------------------------------------------------------------------------------------------------|
| Product                             | Wireless Earphone                                                                                   |
| Tested Model                        | OEB-E104D                                                                                           |
| Frequency Range                     | Bluetooth: 2402-2480MHz                                                                             |
| Maximum conducted peak output power | Bluetooth: -0.6dBm                                                                                  |
| Modulation Technique                | Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK                                                              |
| Antenna Specification*              | 2.0dBi(provided by the applicant)                                                                   |
| Voltage Range                       | DC 3.7V from battery                                                                                |
| Sample number                       | SZ1210810-33632E-RF-S1(RF Conducted Test)<br>SZ1210810-33632E-RF-S2<br>(Assigned by BACL, Shenzhen) |
| Received date                       | 2021-08-10                                                                                          |
| 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.

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. Each test item follows test standards and with no deviation.

**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 5F(B-West) , 6F, 7F, the 3rd Phase of Wan Li Industrial Building D, Shihua Rd, FuTian Free Trade Zone, Shenzhen, 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.

#### Channel List

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|
| 0       | 2402            | 40      | 2442            |
| 1       | 2403            | 41      | 2443            |
| 2       | 2404            | 42      | 2444            |
| ...     | ...             | ...     | ...             |
| ...     | ...             | 78      | 2480            |
| 39      | 2441            | /       | /               |

EUT was tested with channel 0, 39 and 78

### EUT Exercise Software

“BQB” exercise software was used and the power level is 2\*. 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

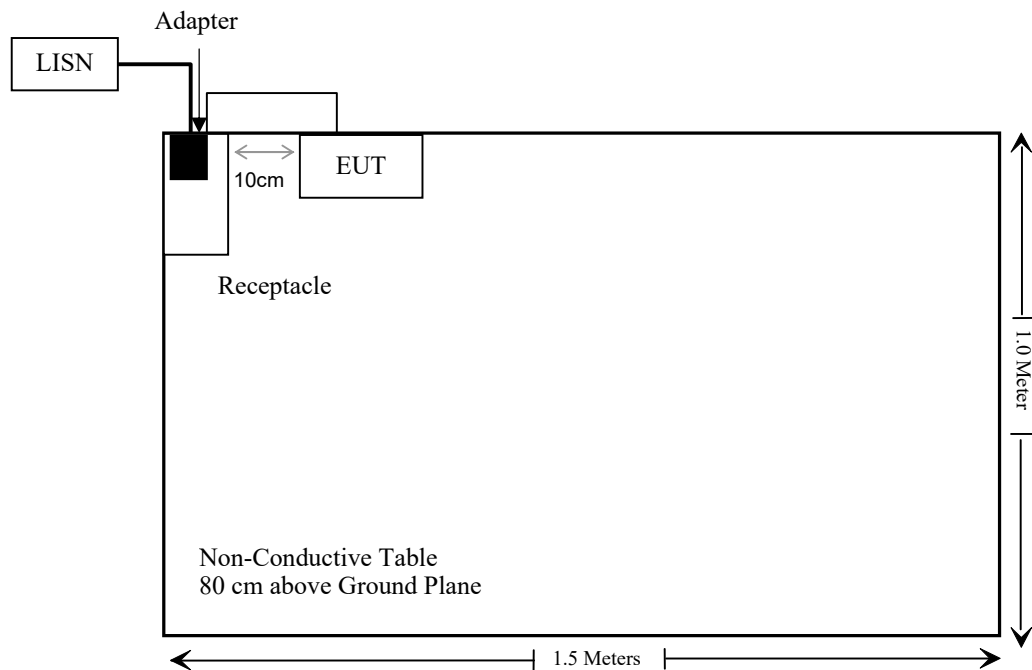
| Manufacturer                             | Description | Model     | Serial Number |
|------------------------------------------|-------------|-----------|---------------|
| Dongguan Aohai Power Technology Co.,Ltd. | Adapter     | A8-501000 | A1906034835   |

### External I/O Cable

| Cable Description                 | Length (m) | From Port | To      |
|-----------------------------------|------------|-----------|---------|
| Un-shielding Detachable USB Cable | 0.2        | EUT       | 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                      | Compliant |
| §15.203                               | Antenna Requirement              | Compliant |
| §15.207(a)                            | AC Line Conducted Emissions      | Compliant |
| §15.205, §15.209 & §15.247(d)         | Radiated Emissions               | Compliant |
| §15.247(a)(1)                         | 20 dB Emission Bandwidth         | Compliant |
| §15.247(a)(1)                         | Channel Separation Test          | Compliant |
| §15.247(a)(1)(iii)                    | Time of Occupancy (Dwell Time)   | Compliant |
| §15.247(a)(1)(iii)                    | Quantity of hopping channel Test | Compliant |
| §15.247(b)(1)                         | Peak Output Power Measurement    | Compliant |
| §15.247(d)                            | Band edges                       | Compliant |

**TEST EQUIPMENT LIST**

| Manufacturer                   | Description                  | Model                   | Serial Number          | Calibration Date | Calibration Due Date |
|--------------------------------|------------------------------|-------------------------|------------------------|------------------|----------------------|
| <b>Conducted Emission Test</b> |                              |                         |                        |                  |                      |
| Rohde & Schwarz                | EMI Test Receiver            | ESCI                    | 101120                 | 2021/07/07       | 2022/07/06           |
| Rohde & Schwarz                | LISN                         | ENV216                  | 101613                 | 2021/07/07       | 2022/07/06           |
| Rohde & Schwarz                | Transient Limiter            | ESH3Z2                  | DE25985                | 2020/11/29       | 2021/11/28           |
| Unknown                        | CE Cable                     | CE Cable                | UF A210B-1-0720-504504 | 2020/11/29       | 2021/11/28           |
| Rohde & Schwarz                | CE Test software             | EMC 32                  | V8.53.0                | NCR              | NCR                  |
| <b>Radiated Emission Test</b>  |                              |                         |                        |                  |                      |
| R&S                            | EMI Test Receiver            | ESR3                    | 102455                 | 2021/07/06       | 2022/07/05           |
| Sonoma instrument              | Pre-amplifier                | 310 N                   | 186238                 | 2021/08/03       | 2022/08/02           |
| Sunol Sciences                 | Broadband Antenna            | JB1                     | A040904-2              | 2020/12/22       | 2023/12/21           |
| Unknown                        | Cable 2                      | RF Cable 2              | F-03-EM197             | 2020/11/29       | 2021/11/28           |
| Unknown                        | Cable                        | Chamber Cable 1         | F-03-EM236             | 2020/11/29       | 2021/11/28           |
| Rohde & Schwarz                | Auto test software           | EMC 32                  | V9.10.00               | NCR              | NCR                  |
| Rohde & Schwarz                | Spectrum Analyzer            | FSV40-N                 | 102259                 | 2021/07/06       | 2022/07/05           |
| COM-POWER                      | Pre-amplifier                | PA-122                  | 181919                 | 2020/11/29       | 2021/11/28           |
| Quinstar                       | Amplifier                    | QLW-18405536-J0         | 15964001002            | 2020/11/28       | 2021/11/27           |
| Sunol Sciences                 | Horn Antenna                 | 3115                    | 9107-3694              | 2021/01/15       | 2024/01/14           |
| Insulated Wire Inc.            | RF Cable                     | SPS-2503-3150           | 02222010               | 2020/11/29       | 2021/11/28           |
| Unknown                        | RF Cable                     | W1101-EQ1 OUT           | F-19-EM005             | 2020/11/29       | 2021/11/28           |
| SNSD                           | Band Reject filter           | BSF2402-2480MN-0898-001 | 2.4G filter            | 2021/04/20       | 2022/04/20           |
| Ducommun Technologies          | Horn antenna                 | ARH-4223-02             | 1007726-021304         | 2020/12/06       | 2023/12/05           |
| <b>RF Conducted Test</b>       |                              |                         |                        |                  |                      |
| Tonscend Corporation           | RF control Unit              | JS0806-2                | 19D8060154             | 2021/07/06       | 2022/07/05           |
| Rohde & Schwarz                | Signal and Spectrum Analyzer | FSV40                   | 101473                 | 2021/07/06       | 2022/07/05           |

\* **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  $\leq 50$  mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot$

$[\sqrt{f(\text{GHz})}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR, where

1.  $f(\text{GHz})$  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<br>(MHz) | Maximum Tune-up<br>power |      | Calculated<br>Distance<br>(mm) | Calculated<br>Value | Threshold<br>(1-g SAR) | SAR Test<br>Exclusion |
|--------------------|--------------------------|------|--------------------------------|---------------------|------------------------|-----------------------|
|                    | (dBm)                    | (mW) |                                |                     |                        |                       |
| 2402-2480          | 0                        | 1    | 5                              | 0.3                 | 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 2.0dBi, fulfill the requirement of this section. Please refer to the EUT photos.

**Result:** Compliant.

## 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 adapter 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

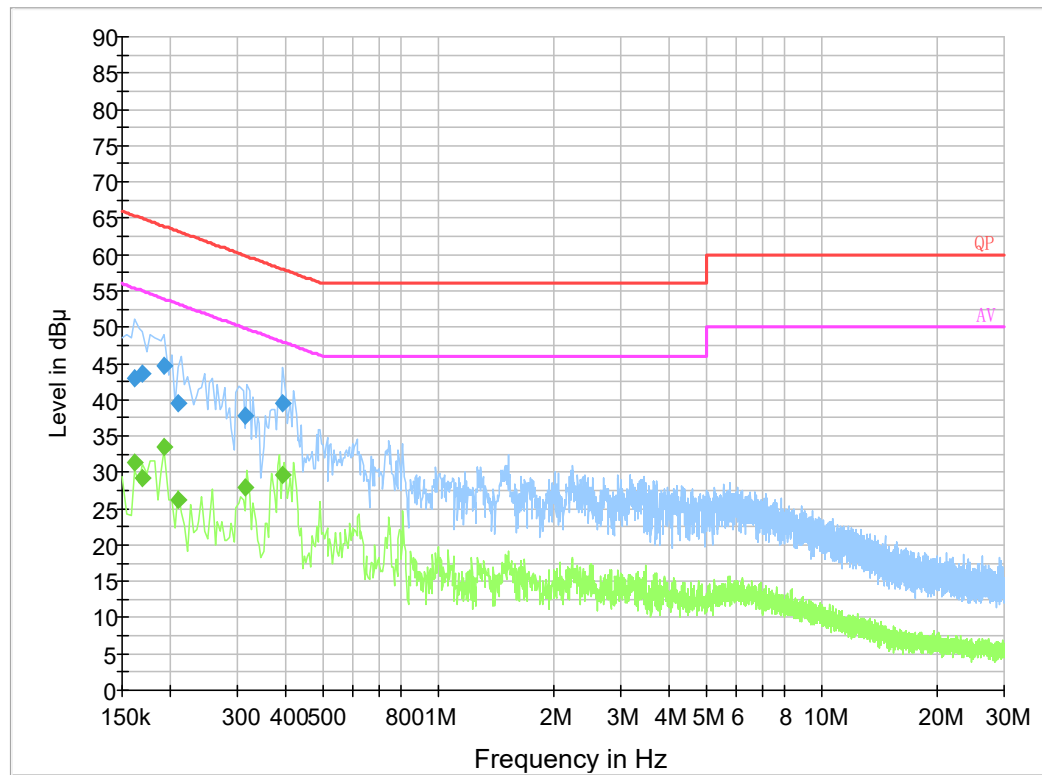
### Environmental Conditions

|                    |           |
|--------------------|-----------|
| Temperature:       | 25 °C     |
| Relative Humidity: | 67 %      |
| ATM Pressure:      | 101.0 kPa |

*The testing was performed by Haiguo Li on 2021-09-09.*

*EUT operation mode: Charging*

## AC 120V/60 Hz, Line

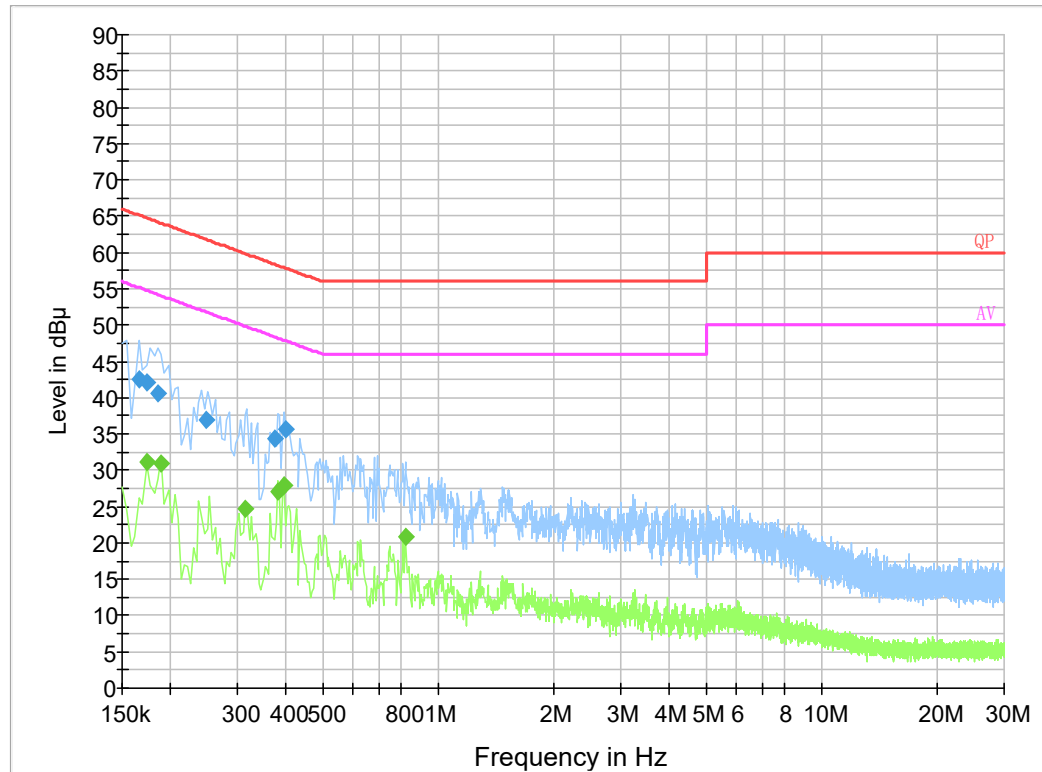


## Final Result 1

| Frequency (MHz) | QuasiPeak (dB μV) | Bandwidth (kHz) | Line | Corr. (dB) | Margin (dB) | Limit (dB μV) |
|-----------------|-------------------|-----------------|------|------------|-------------|---------------|
| 0.161500        | 42.9              | 9.000           | L1   | 19.9       | 22.5        | 65.4          |
| 0.169500        | 43.5              | 9.000           | L1   | 19.9       | 21.5        | 65.0          |
| 0.193500        | 44.6              | 9.000           | L1   | 19.8       | 19.3        | 63.9          |
| 0.209500        | 39.5              | 9.000           | L1   | 19.8       | 23.7        | 63.2          |
| 0.313230        | 37.8              | 9.000           | L1   | 19.8       | 22.1        | 59.9          |
| 0.392090        | 39.5              | 9.000           | L1   | 19.9       | 18.5        | 58.0          |

## Final Result 2

| Frequency (MHz) | Average (dB μV) | Bandwidth (kHz) | Line | Corr. (dB) | Margin (dB) | Limit (dB μV) |
|-----------------|-----------------|-----------------|------|------------|-------------|---------------|
| 0.161500        | 31.4            | 9.000           | L1   | 19.9       | 24.0        | 55.4          |
| 0.169500        | 29.3            | 9.000           | L1   | 19.9       | 25.7        | 55.0          |
| 0.193500        | 33.5            | 9.000           | L1   | 19.8       | 20.4        | 53.9          |
| 0.209500        | 26.1            | 9.000           | L1   | 19.8       | 27.1        | 53.2          |
| 0.313230        | 27.9            | 9.000           | L1   | 19.8       | 22.0        | 49.9          |
| 0.392090        | 29.6            | 9.000           | L1   | 19.9       | 18.4        | 48.0          |

**AC 120V/60 Hz, Neutral****Final Result 1**

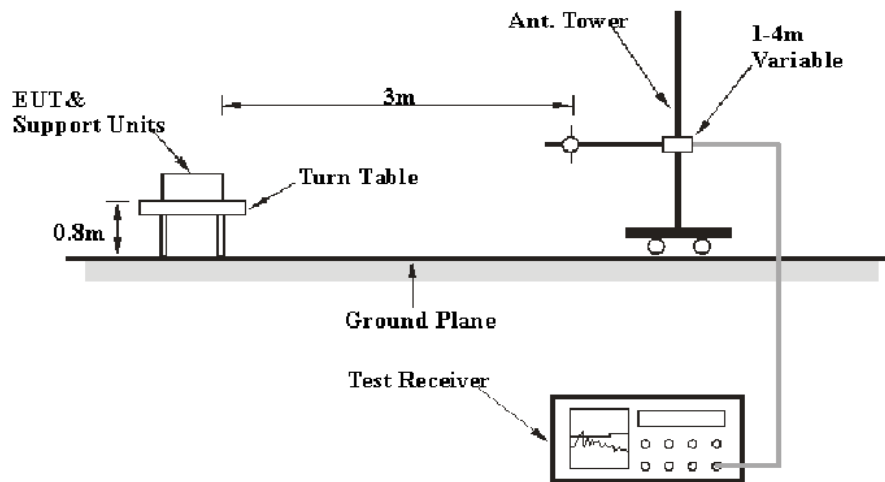
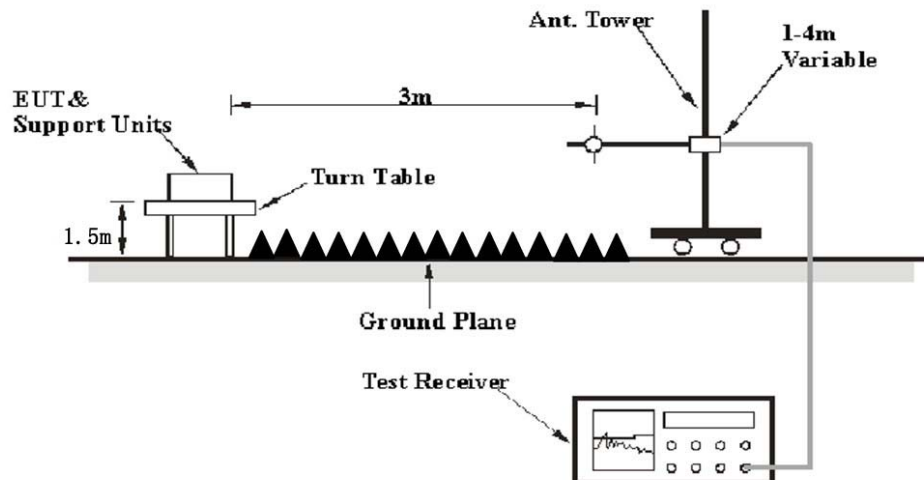
| Frequency (MHz) | QuasiPeak (dB $\mu$ V) | Bandwidth (kHz) | Line | Corr. (dB) | Margin (dB) | Limit (dB $\mu$ V) |
|-----------------|------------------------|-----------------|------|------------|-------------|--------------------|
| 0.165500        | 42.6                   | 9.000           | N    | 19.8       | 22.6        | 65.2               |
| 0.173500        | 42.2                   | 9.000           | N    | 19.8       | 22.6        | 64.8               |
| 0.185500        | 40.5                   | 9.000           | N    | 19.8       | 23.7        | 64.2               |
| 0.249500        | 37.0                   | 9.000           | N    | 19.8       | 24.8        | 61.8               |
| 0.376270        | 34.3                   | 9.000           | N    | 19.8       | 24.1        | 58.4               |
| 0.400030        | 35.6                   | 9.000           | N    | 19.8       | 22.3        | 57.9               |

**Final Result 2**

| Frequency (MHz) | Average (dB $\mu$ V) | Bandwidth (kHz) | Line | Corr. (dB) | Margin (dB) | Limit (dB $\mu$ V) |
|-----------------|----------------------|-----------------|------|------------|-------------|--------------------|
| 0.174000        | 31.1                 | 9.000           | N    | 19.8       | 23.7        | 54.8               |
| 0.190000        | 30.9                 | 9.000           | N    | 19.8       | 23.1        | 54.0               |
| 0.314000        | 24.7                 | 9.000           | N    | 19.7       | 25.2        | 49.9               |
| 0.382000        | 27.1                 | 9.000           | N    | 19.8       | 21.1        | 48.2               |
| 0.398000        | 27.9                 | 9.000           | N    | 19.8       | 20.0        | 47.9               |
| 0.822000        | 20.9                 | 9.000           | N    | 19.8       | 25.1        | 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, 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

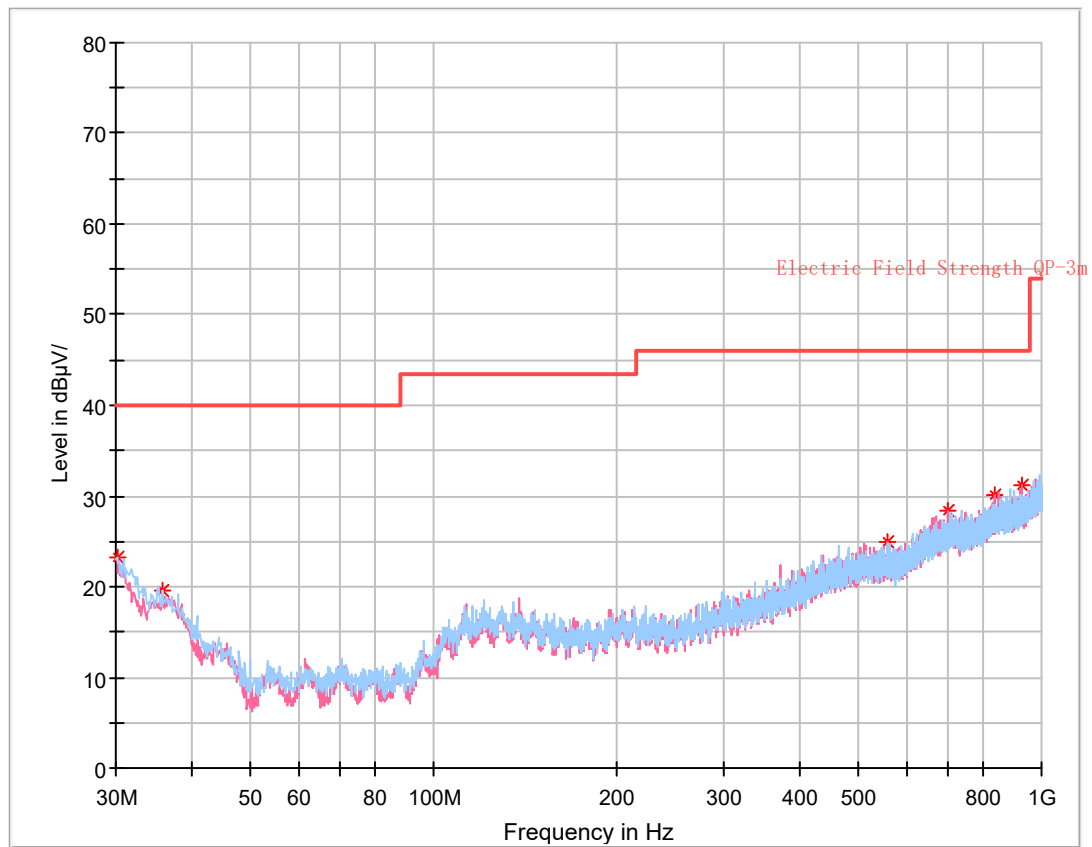
### Environmental Conditions

|                           |                 |
|---------------------------|-----------------|
| <b>Temperature:</b>       | 26~26.8 °C      |
| <b>Relative Humidity:</b> | 51~56 %         |
| <b>ATM Pressure:</b>      | 101.0~101.2 kPa |

*The testing was performed by Cloud Yun on 2021-08-23 for below 1GHz and Bruce Lin on 2021-08-31 for above 1GHz.*

*EUT operation mode: Transmitting*

**30 MHz~1 GHz:** (High channel in 8DPSK was worst case)



### Critical\_Freqs

| Frequency (MHz) | MaxPeak (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|------------------|-------------|-------------|-----|---------------|------------|
| 30.121250       | 23.18              | 40.00            | 16.82       | 200.0       | H   | 323.0         | -3.6       |
| 35.820000       | 19.67              | 40.00            | 20.33       | 100.0       | H   | 132.0         | -7.8       |
| 557.195000      | 25.03              | 46.00            | 20.97       | 100.0       | V   | 323.0         | -4.6       |
| 699.178750      | 28.49              | 46.00            | 17.51       | 300.0       | V   | 323.0         | -1.5       |
| 836.191250      | 30.04              | 46.00            | 15.96       | 300.0       | V   | 300.0         | 0.0        |
| 929.068750      | 31.19              | 46.00            | 14.81       | 200.0       | V   | 248.0         | 1.4        |

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

| Frequency<br>(MHz)      | Receiver          |            | Turntable<br>Degree | Rx Antenna    |                | Corrected<br>Factor<br>(dB/m) | Corrected<br>Amplitude<br>(dBμV/m) | Limit<br>(dBμV/m) | Margin<br>(dB) |
|-------------------------|-------------------|------------|---------------------|---------------|----------------|-------------------------------|------------------------------------|-------------------|----------------|
|                         | Reading<br>(dBμV) | PK/QP/Ave. |                     | Height<br>(m) | Polar<br>(H/V) |                               |                                    |                   |                |
| Low Channel (2402 MHz)  |                   |            |                     |               |                |                               |                                    |                   |                |
| 2389.74                 | 28.95             | PK         | 350                 | 2.3           | H              | 31.87                         | 60.82                              | 74                | 13.18          |
| 2389.74                 | 14.62             | Ave.       | 350                 | 2.3           | H              | 31.87                         | 46.49                              | 54                | 7.51           |
| 2483.88                 | 28.93             | PK         | 92                  | 2.2           | H              | 32.13                         | 61.06                              | 74                | 12.94          |
| 2483.88                 | 14.56             | Ave.       | 92                  | 2.2           | H              | 32.13                         | 46.69                              | 54                | 7.31           |
| 4804.00                 | 51.27             | PK         | 242                 | 1.4           | H              | 6.28                          | 57.55                              | 74                | 16.45          |
| 4804.00                 | 40.24             | Ave.       | 242                 | 1.4           | H              | 6.28                          | 46.52                              | 54                | 7.48           |
| Middle Channel(2441MHz) |                   |            |                     |               |                |                               |                                    |                   |                |
| 4882.00                 | 52.47             | PK         | 31                  | 1.7           | H              | 6.76                          | 59.23                              | 74                | 14.77          |
| 4882.00                 | 39.57             | Ave.       | 31                  | 1.7           | H              | 6.76                          | 46.33                              | 54                | 7.67           |
| High Channel(2480 MHz)  |                   |            |                     |               |                |                               |                                    |                   |                |
| 2389.49                 | 28.96             | PK         | 290                 | 1.7           | H              | 31.87                         | 60.83                              | 74                | 13.17          |
| 2389.49                 | 14.72             | Ave.       | 290                 | 1.7           | H              | 31.87                         | 46.59                              | 54                | 7.41           |
| 2484.12                 | 29.87             | PK         | 61                  | 1.6           | H              | 32.13                         | 62.00                              | 74                | 12.00          |
| 2484.12                 | 14.59             | Ave.       | 61                  | 1.6           | H              | 32.13                         | 46.72                              | 54                | 7.28           |
| 4960.00                 | 53.05             | PK         | 16                  | 1.6           | H              | 6.80                          | 59.85                              | 74                | 14.15          |
| 4960.00                 | 41.29             | Ave.       | 16                  | 1.6           | H              | 6.80                          | 48.09                              | 54                | 5.91           |

Note:

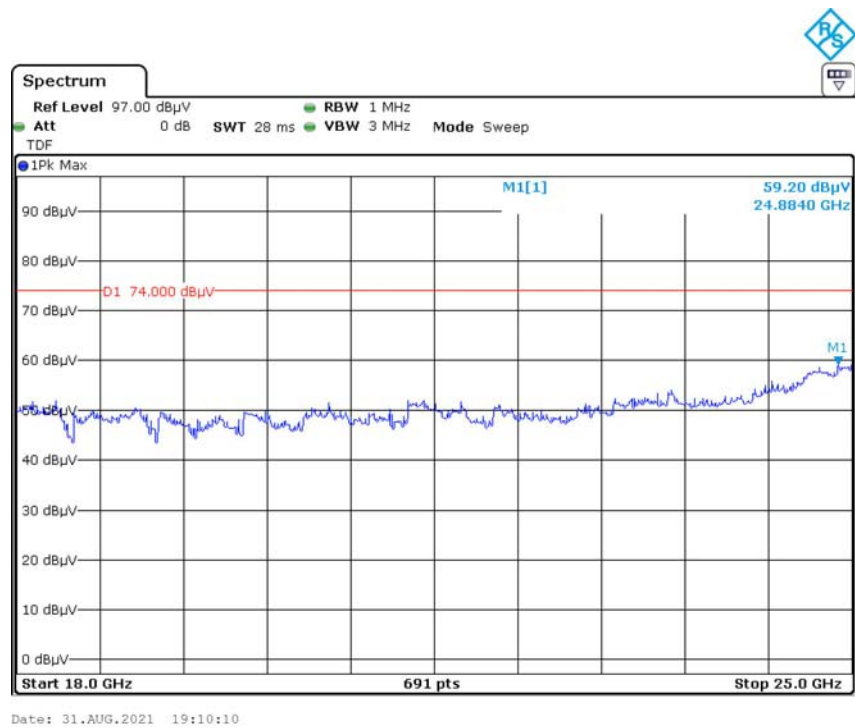
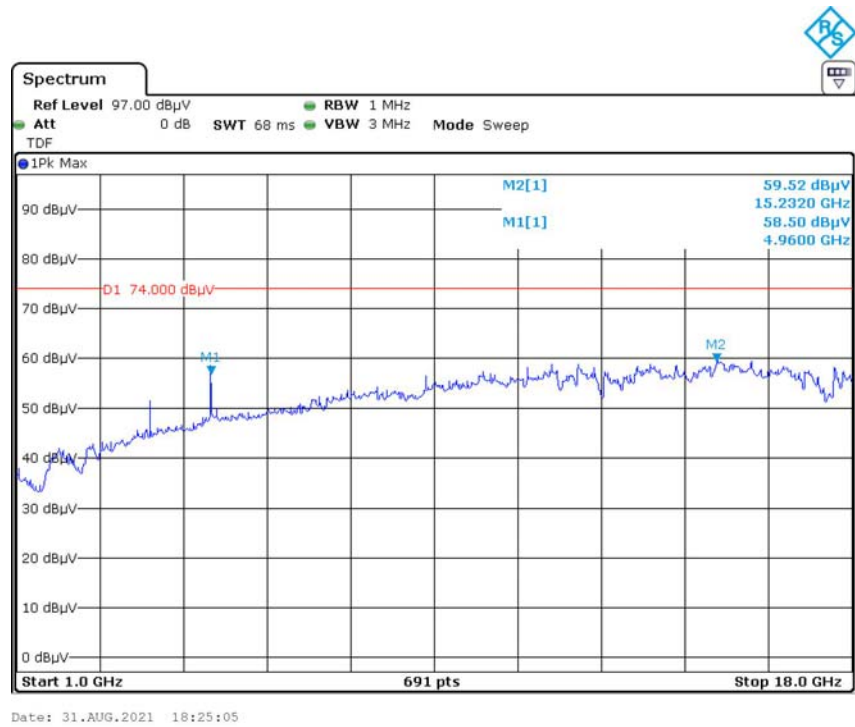
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

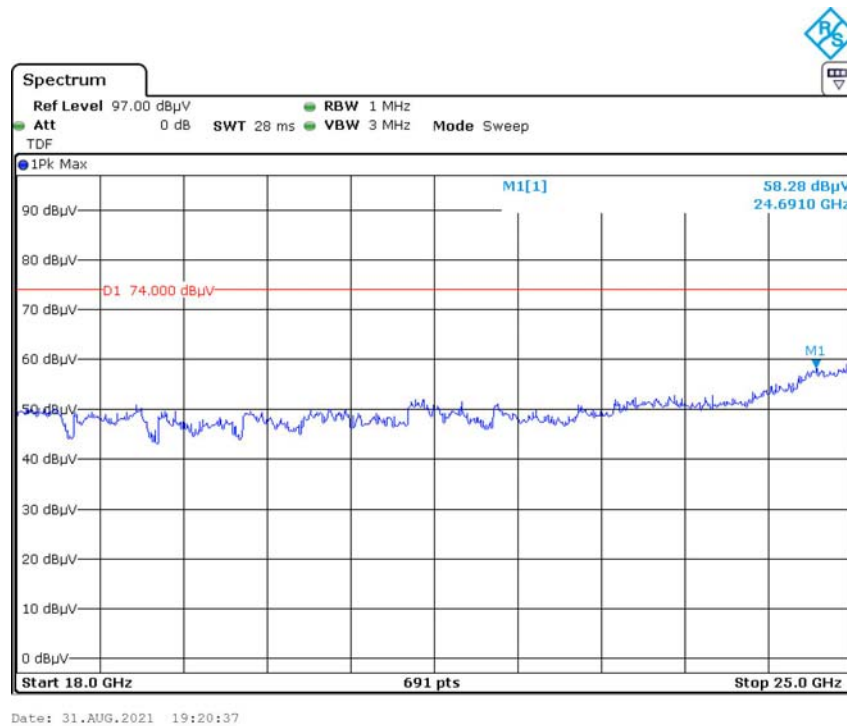
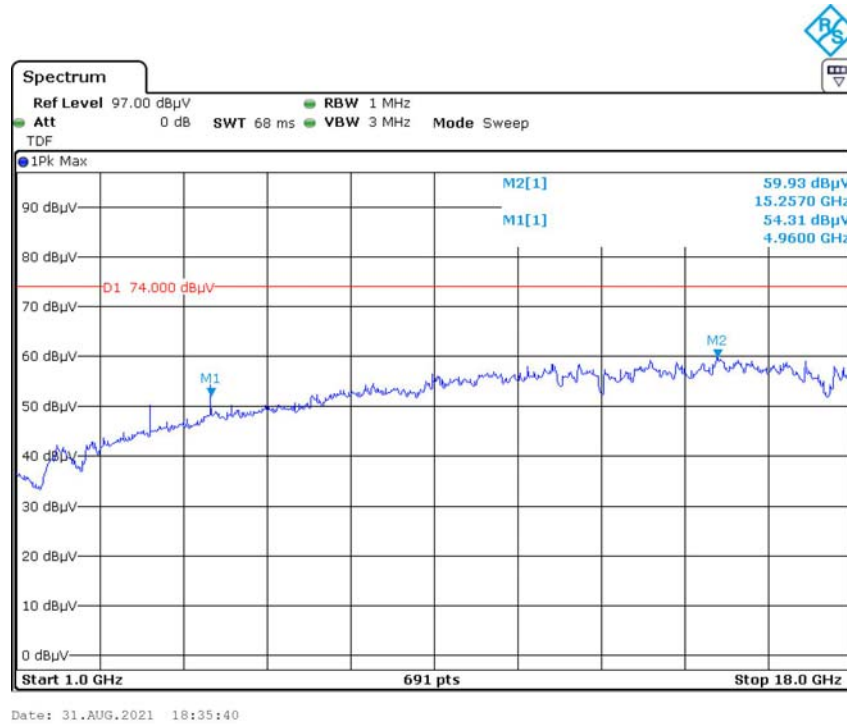
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB below the limit and noiser floor was not recorded.

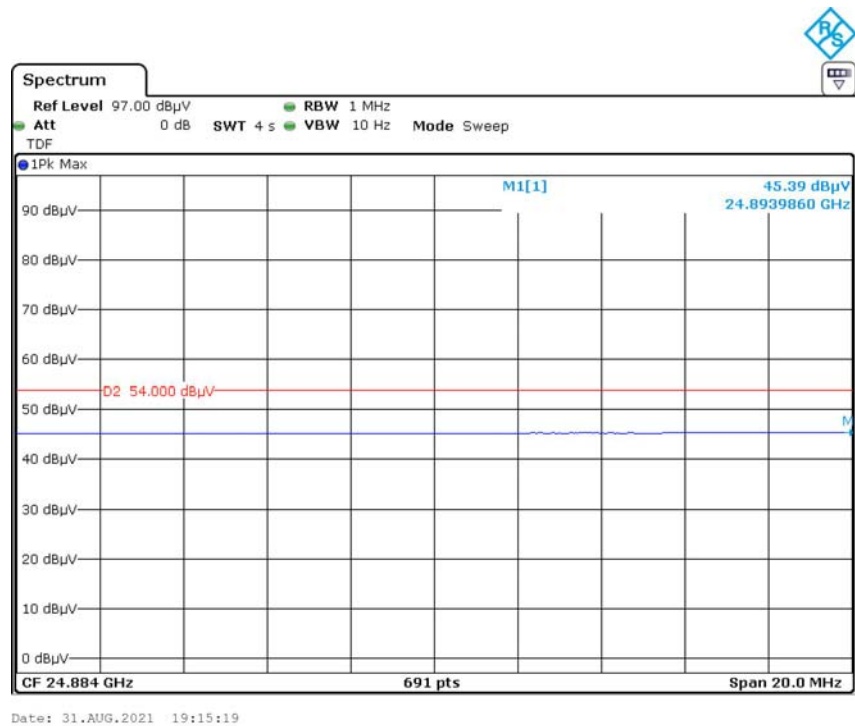
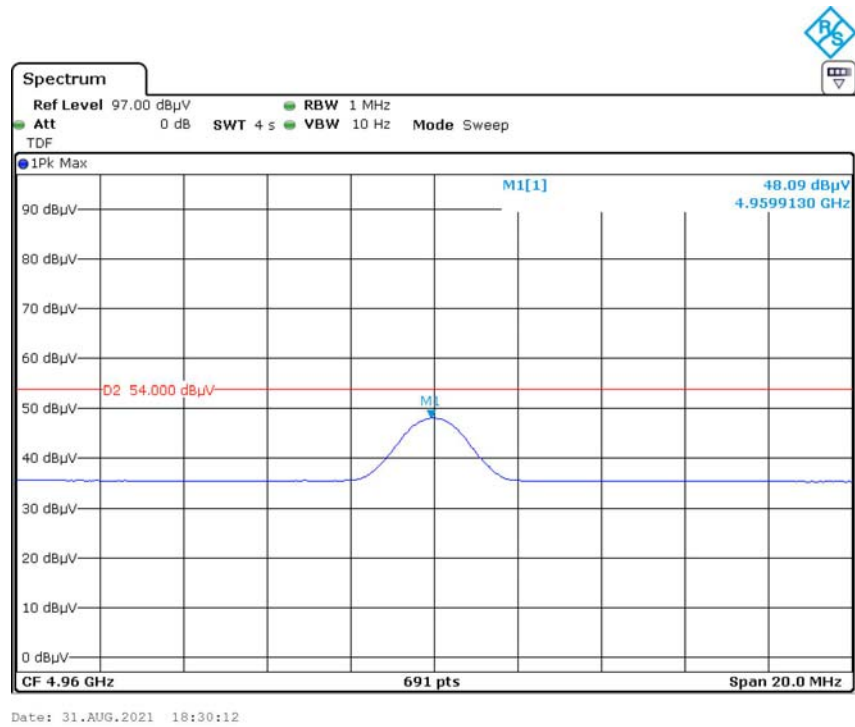
# Pre-scan with High channel Peak Horizontal



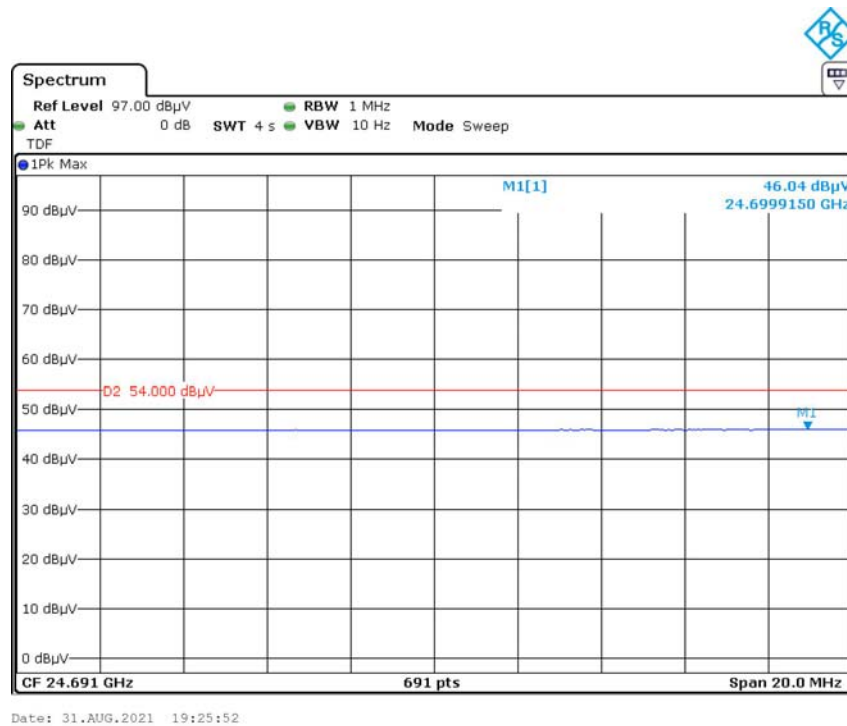
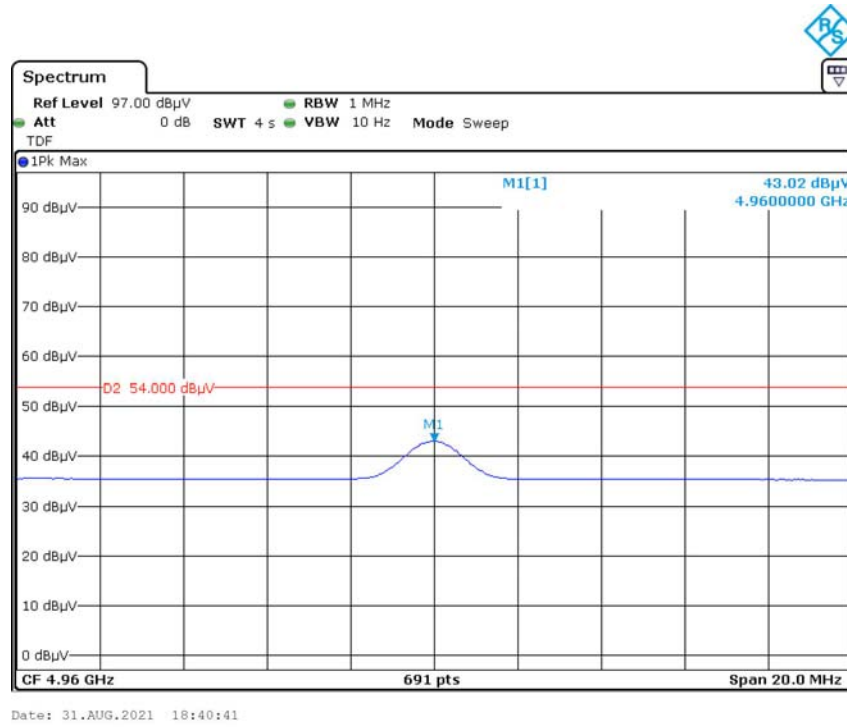
# Vertical



# Average Horizontal



# Vertical



## 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

|                    |           |
|--------------------|-----------|
| Temperature:       | 25 °C     |
| Relative Humidity: | 63 %      |
| ATM Pressure:      | 101.0 kPa |

*The testing was performed by Restar Li on 2021-08-30.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

## 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

|                    |           |
|--------------------|-----------|
| Temperature:       | 25 °C     |
| Relative Humidity: | 63 %      |
| ATM Pressure:      | 101.0 kPa |

*The testing was performed by Restar Li on 2021-08-30.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

**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>       | 25 °C     |
| <b>Relative Humidity:</b> | 63 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Restar Li on 2021-08-30.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

**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>       | 25 °C     |
| <b>Relative Humidity:</b> | 63 %      |
| <b>ATM Pressure:</b>      | 101.0 kPa |

*The testing was performed by Restar Li on 2021-08-30.*

*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

|                    |           |
|--------------------|-----------|
| Temperature:       | 25 °C     |
| Relative Humidity: | 63 %      |
| ATM Pressure:      | 101.0 kPa |

*The testing was performed by Restar Li on 2021-08-30.*

*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

|                    |           |
|--------------------|-----------|
| Temperature:       | 25 °C     |
| Relative Humidity: | 63 %      |
| ATM Pressure:      | 101.0 kPa |

*The testing was performed by Restar Li on 2021-08-30.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

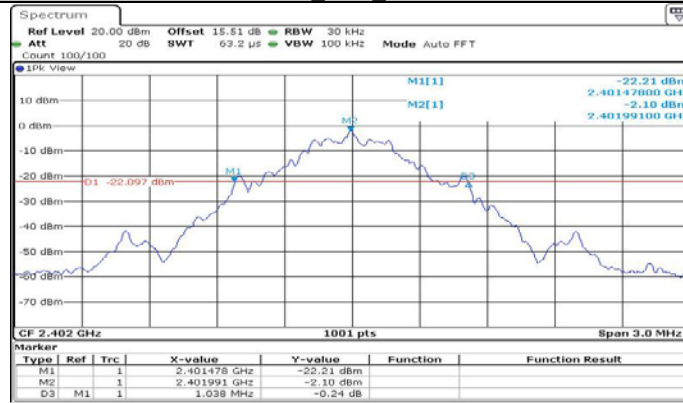
## APPENDIX

### Appendix A: 20dB Emission Bandwidth Test Result

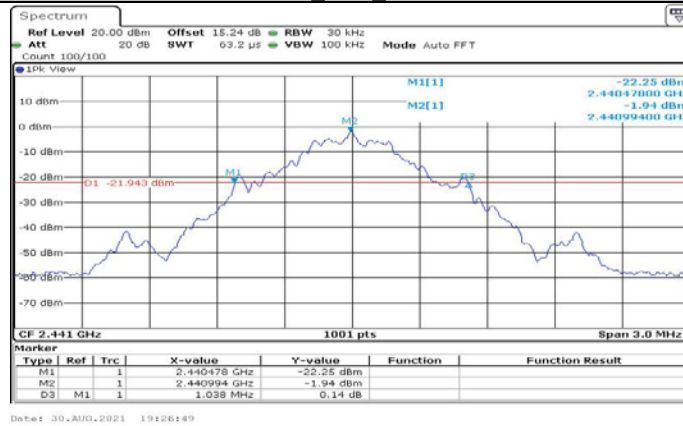
| TestMode | Antenna | Channel | 20db EBW[MHz] | Limit[MHz] | Verdict |
|----------|---------|---------|---------------|------------|---------|
| DH1      | Ant1    | 2402    | 1.038         | ---        | PASS    |
|          |         | 2441    | 1.038         | ---        | PASS    |
|          |         | 2480    | 1.038         | ---        | PASS    |
| 2DH1     | Ant1    | 2402    | 1.179         | ---        | PASS    |
|          |         | 2441    | 1.179         | ---        | PASS    |
|          |         | 2480    | 1.182         | ---        | PASS    |
| 3DH1     | Ant1    | 2402    | 1.176         | ---        | PASS    |
|          |         | 2441    | 1.176         | ---        | PASS    |
|          |         | 2480    | 1.179         | ---        | PASS    |

## Test Graphs

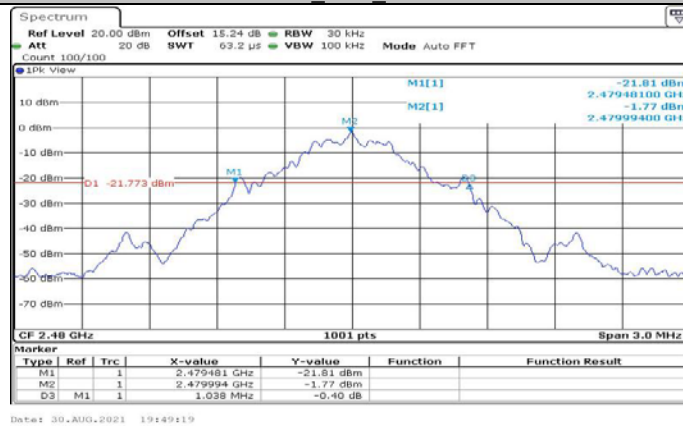
DH1\_Ant1\_2402



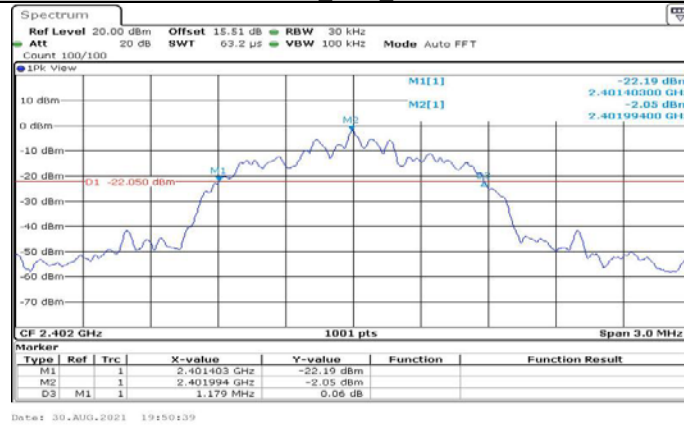
DH1\_Ant1\_2441



DH1\_Ant1\_2480



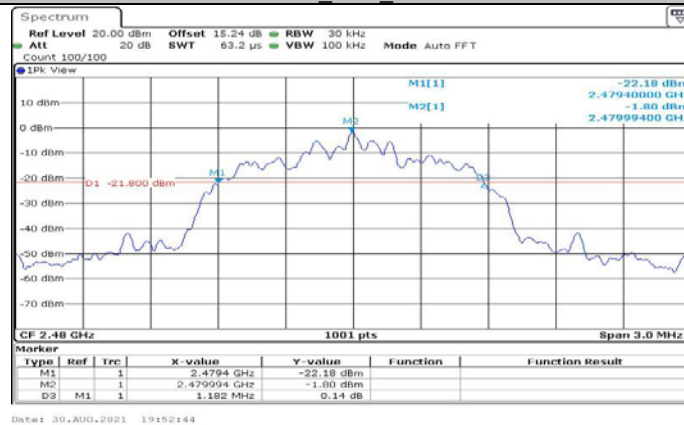
## 2DH1\_Ant1\_2402

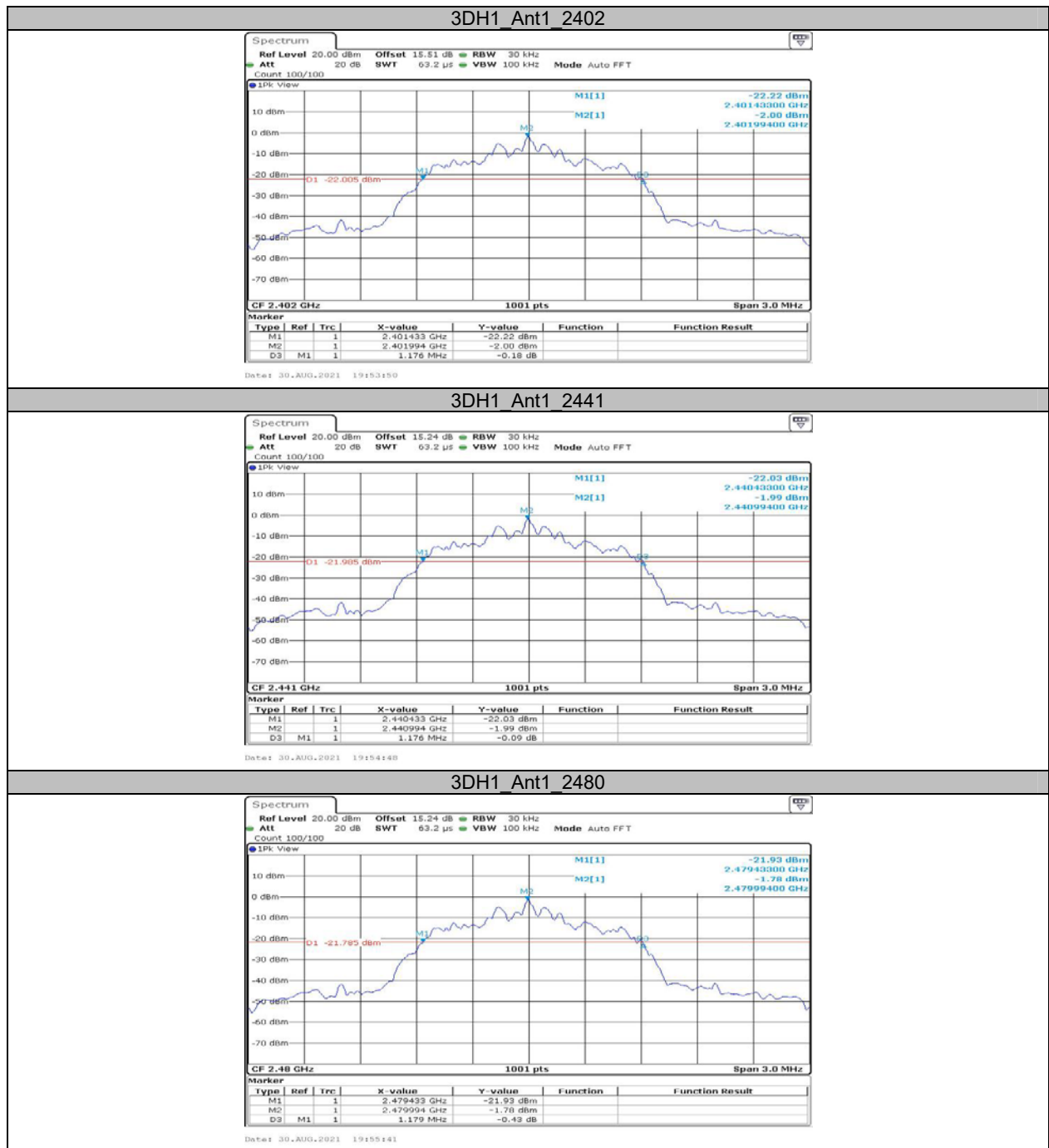


## 2DH1\_Ant1\_2441



## 2DH1\_Ant1\_2480





**Appendix B: Occupied Channel Bandwidth  
Test Result**

| TestMode | Antenna | Channel | OCB [MHz] | Limit[MHz] | Verdict |
|----------|---------|---------|-----------|------------|---------|
| DH1      | Ant1    | 2402    | 0.935     | ---        | PASS    |
|          |         | 2441    | 0.935     | ---        | PASS    |
|          |         | 2480    | 0.932     | ---        | PASS    |
| 2DH1     | Ant1    | 2402    | 1.124     | ---        | PASS    |
|          |         | 2441    | 1.124     | ---        | PASS    |
|          |         | 2480    | 1.124     | ---        | PASS    |
| 3DH1     | Ant1    | 2402    | 1.100     | ---        | PASS    |
|          |         | 2441    | 1.103     | ---        | PASS    |
|          |         | 2480    | 1.106     | ---        | PASS    |

## Test Graphs

DH1\_Ant1\_2402

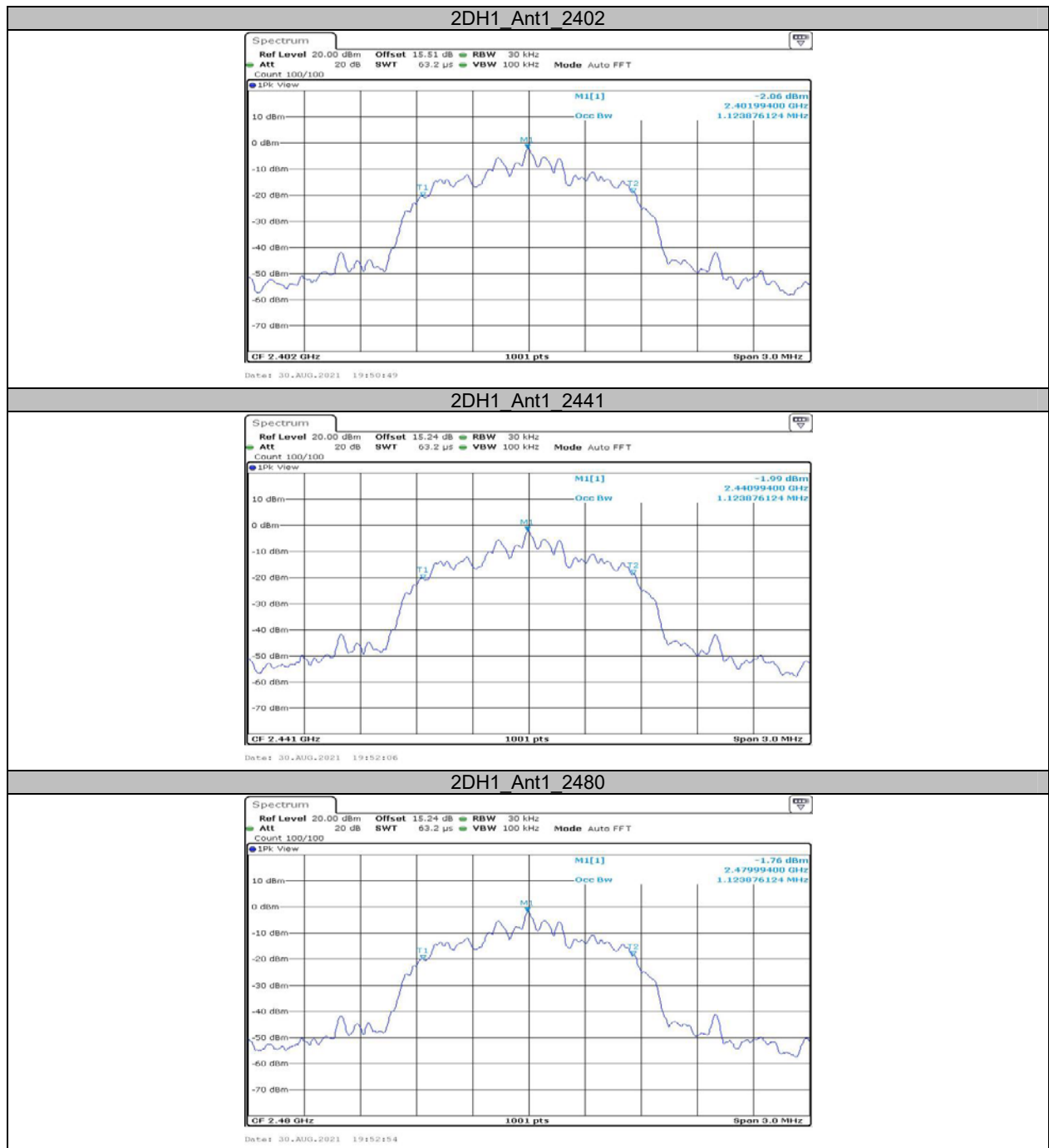


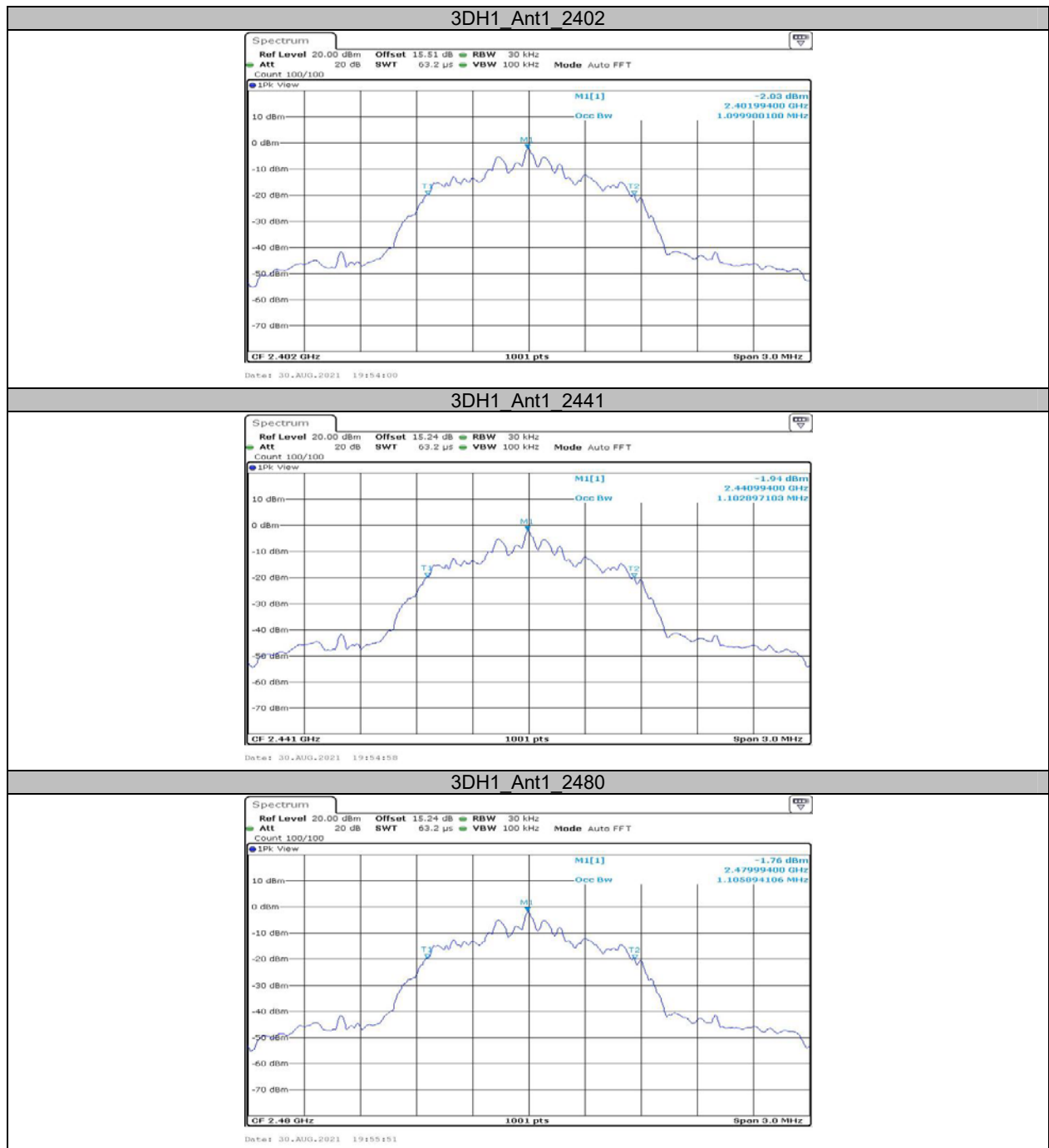
DH1\_Ant1\_2441



DH1\_Ant1\_2480







**Appendix C: Maximum conducted Peak output power  
Test Result**

| TestMode | Antenna | Channel | Result[dBm] | Limit[dBm] | Verdict |
|----------|---------|---------|-------------|------------|---------|
| DH1      | Ant1    | 2402    | -0.90       | ≤20.97     | PASS    |
|          |         | 2441    | -0.84       | ≤20.97     | PASS    |
|          |         | 2480    | -0.64       | ≤20.97     | PASS    |
| 2DH1     | Ant1    | 2402    | -0.85       | ≤20.97     | PASS    |
|          |         | 2441    | -0.82       | ≤20.97     | PASS    |
|          |         | 2480    | -0.64       | ≤20.97     | PASS    |
| 3DH1     | Ant1    | 2402    | -0.86       | ≤20.97     | PASS    |
|          |         | 2441    | -0.81       | ≤20.97     | PASS    |
|          |         | 2480    | -0.60       | ≤20.97     | PASS    |

## Test Graphs

DH1\_Ant1\_2402



DH1\_Ant1\_2441



DH1\_Ant1\_2480



## 2DH1\_Ant1\_2402



## 2DH1\_Ant1\_2441



## 2DH1\_Ant1\_2480



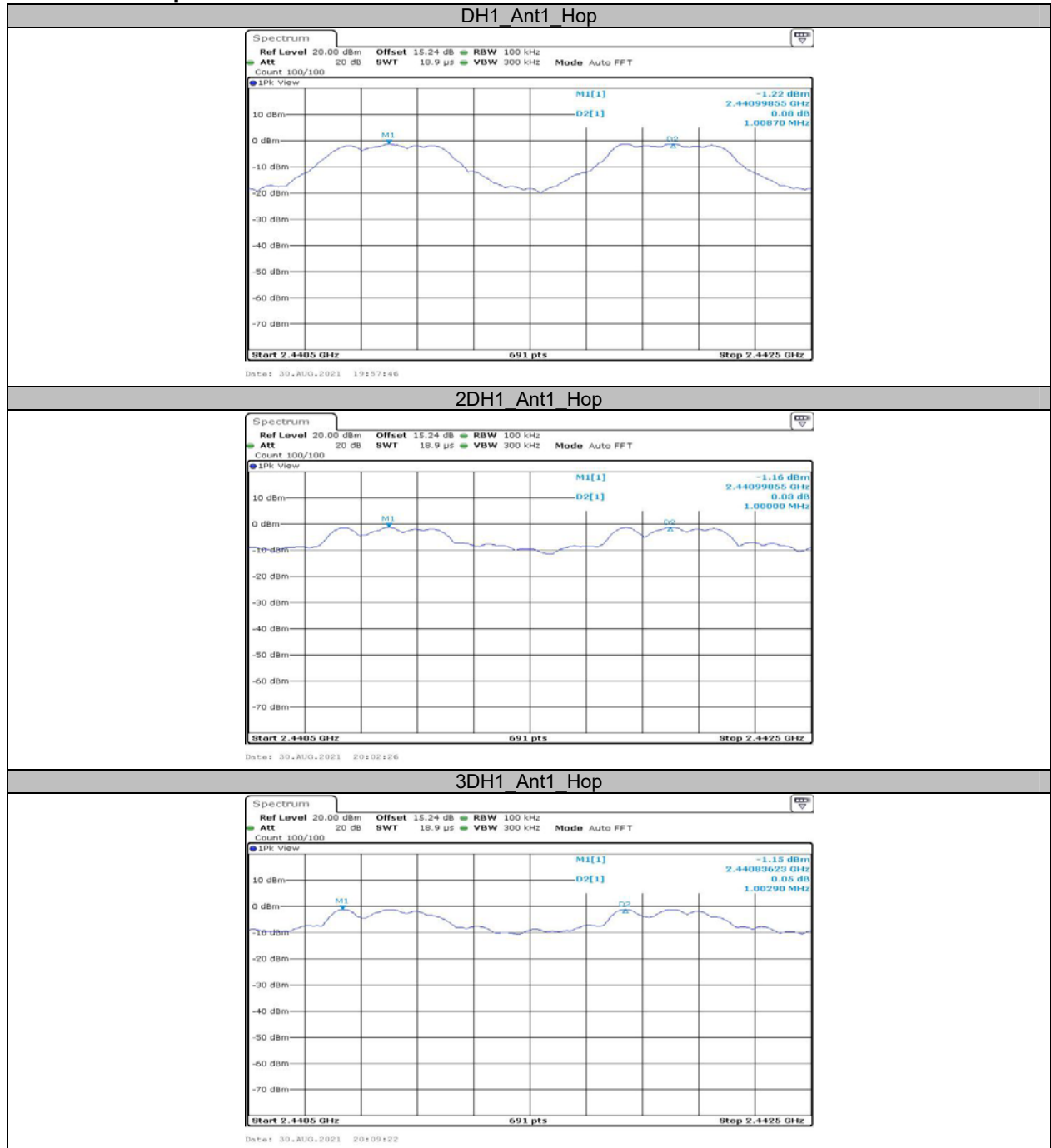


**Appendix D: Carrier frequency separation  
Test Result**

| TestMode | Antenna | Channel | Result[MHz] | Limit[MHz] | Verdict |
|----------|---------|---------|-------------|------------|---------|
| DH1      | Ant1    | Hop     | 1.009       | 0.692      | PASS    |
| 2DH1     | Ant1    | Hop     | 1.000       | 0.788      | PASS    |
| 3DH1     | Ant1    | Hop     | 1.003       | 0.786      | PASS    |

Note: the limit =  $(2/3) * 20\text{dB}$  bandwidth

## Test Graphs



**Appendix E: Time of occupancy  
Test Result**

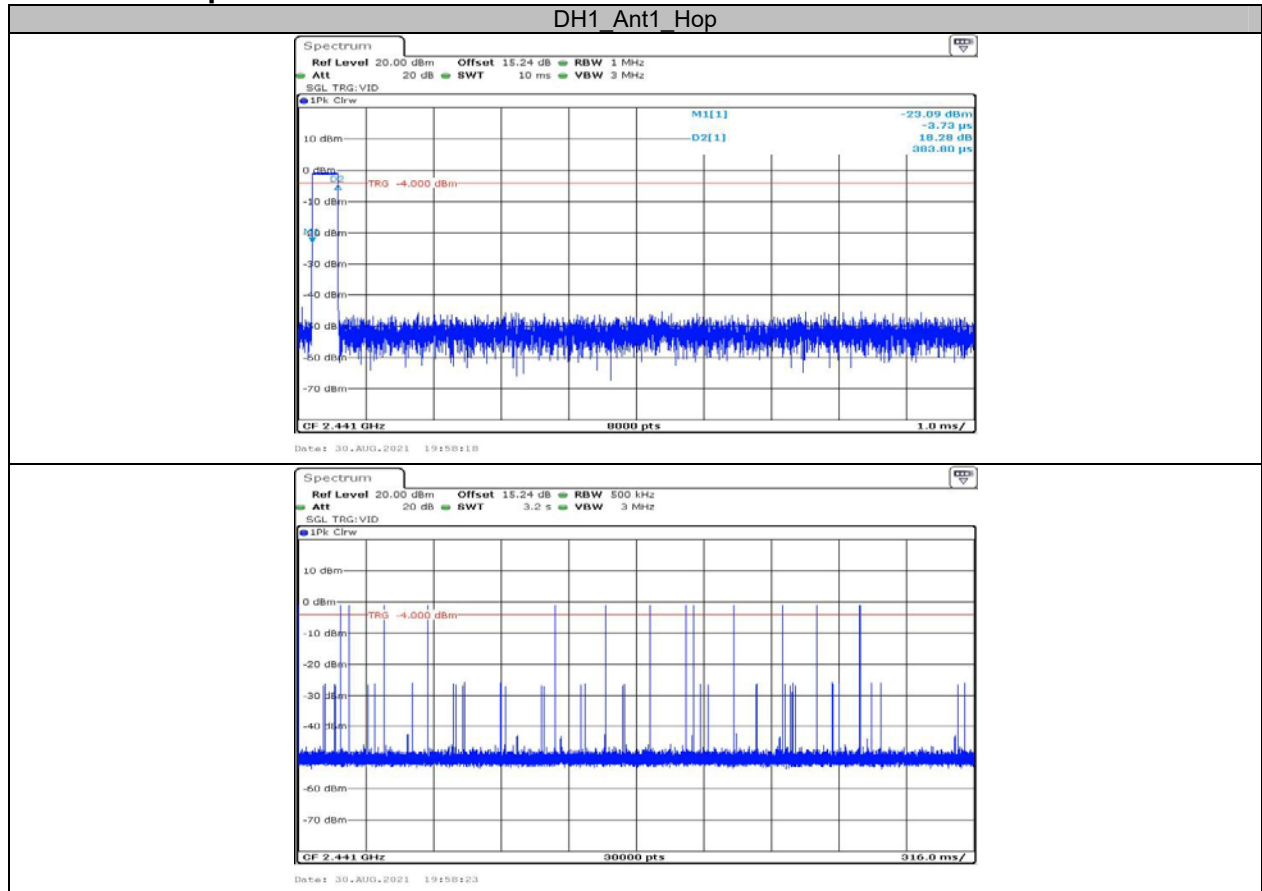
| TestMode | Antenna | Channel | BurstWidth<br>[ms] | TotalHops<br>[Num] | Result[s] | Limit[s] | Verdict |
|----------|---------|---------|--------------------|--------------------|-----------|----------|---------|
| DH1      | Ant1    | Hop     | 0.38               | 150                | 0.057     | ≤0.4     | PASS    |
| DH3      | Ant1    | Hop     | 1.63               | 140                | 0.228     | ≤0.4     | PASS    |
| DH5      | Ant1    | Hop     | 2.87               | 110                | 0.316     | ≤0.4     | PASS    |
| 2DH1     | Ant1    | Hop     | 0.39               | 210                | 0.082     | ≤0.4     | PASS    |
| 2DH3     | Ant1    | Hop     | 1.64               | 120                | 0.197     | ≤0.4     | PASS    |
| 2DH5     | Ant1    | Hop     | 2.88               | 110                | 0.317     | ≤0.4     | PASS    |
| 3DH1     | Ant1    | Hop     | 0.40               | 180                | 0.072     | ≤0.4     | PASS    |
| 3DH3     | Ant1    | Hop     | 1.64               | 110                | 0.180     | ≤0.4     | PASS    |
| 3DH5     | Ant1    | Hop     | 2.88               | 90                 | 0.259     | ≤0.4     | PASS    |

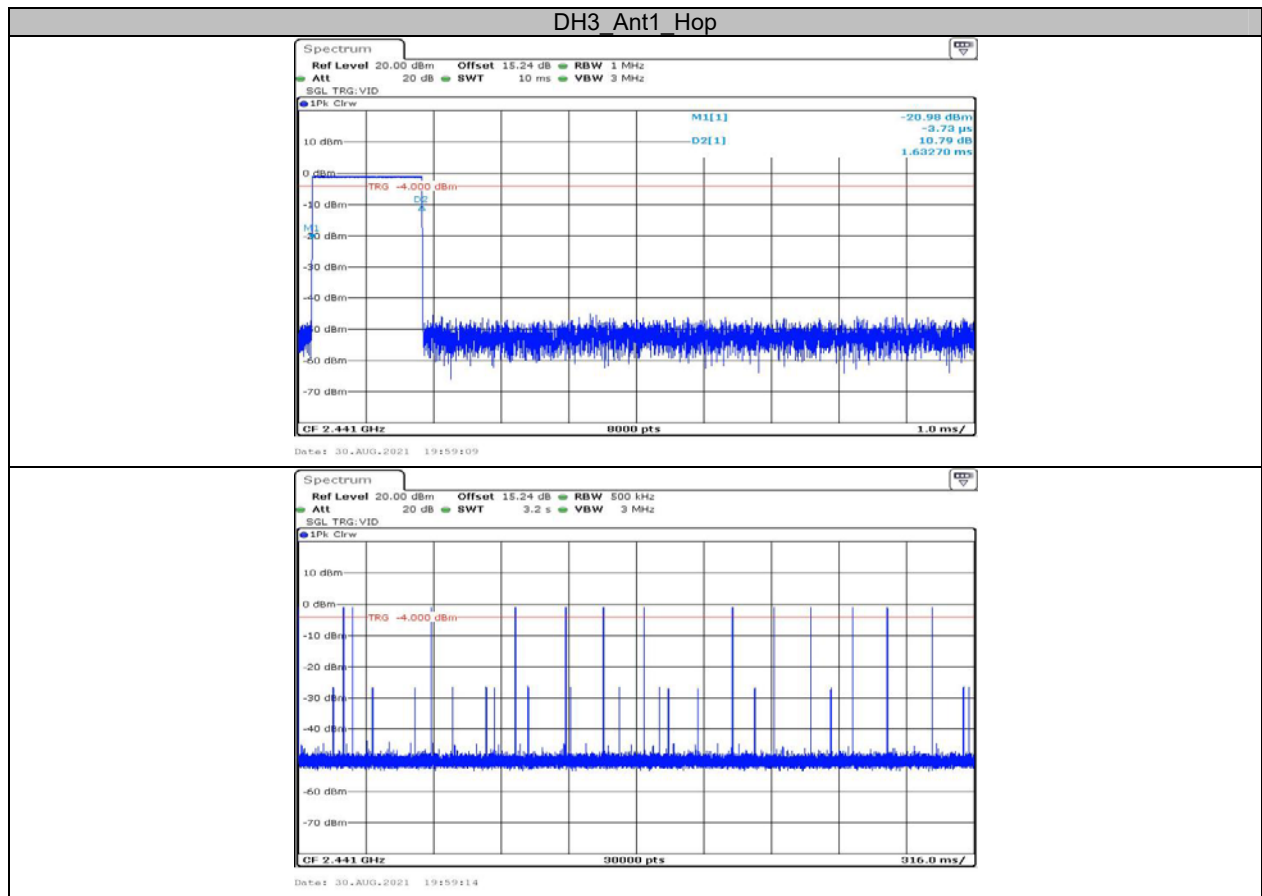
Note 1: A period time= $0.4 \times 79 = 31.6$ (S), Result=BurstWidth\*Totalhops

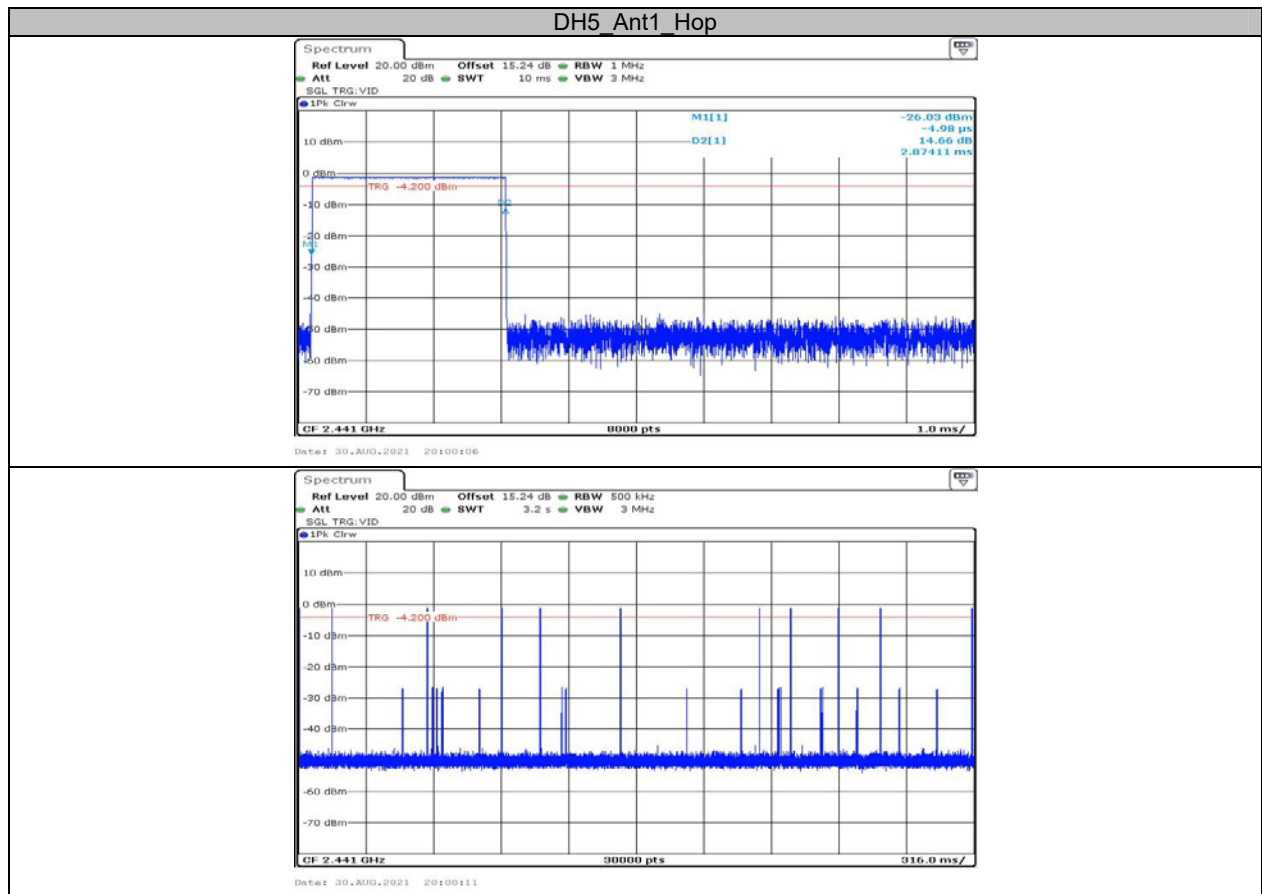
Note 2: Totalhops=Hopping Number in  $3.16s \times 10$

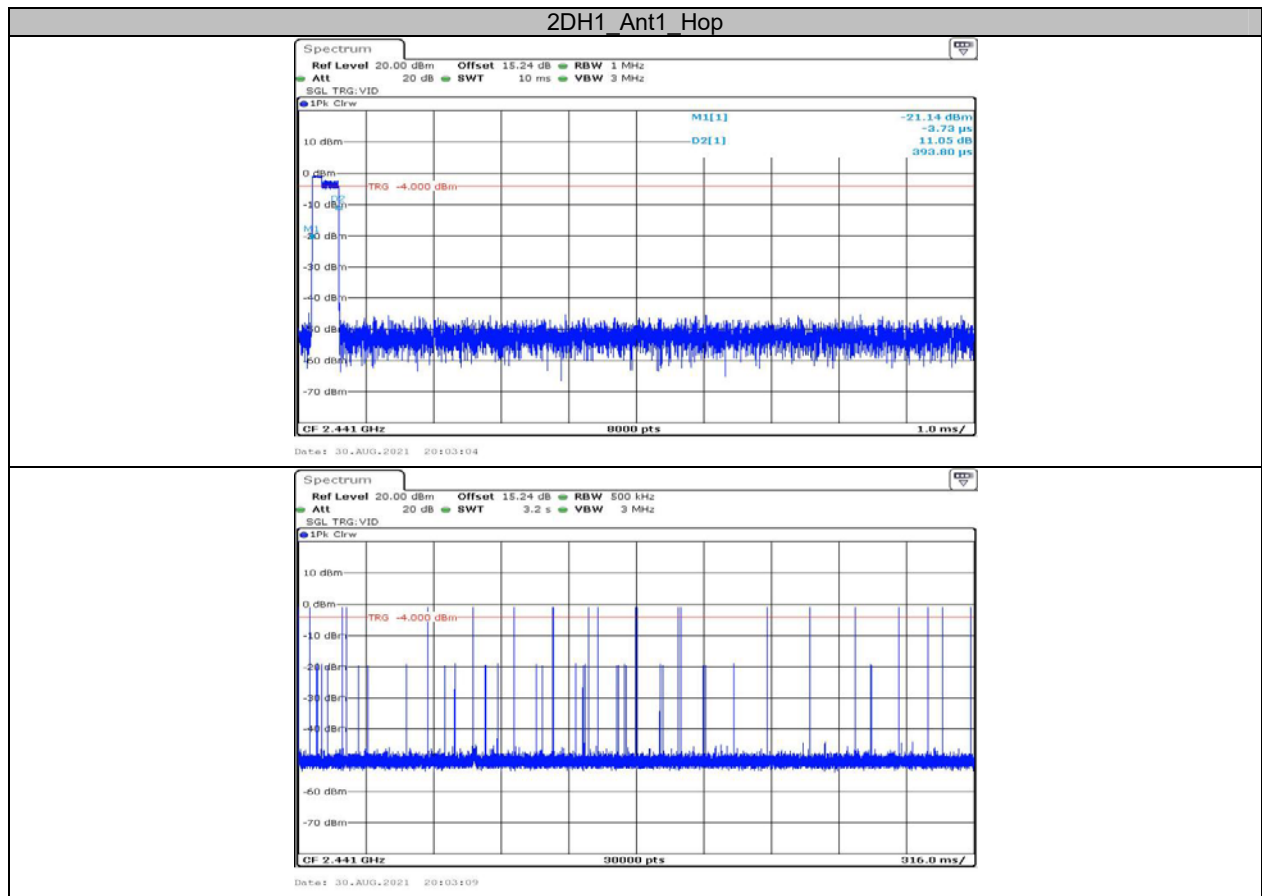
Note 3: Hopping Number in 3.16s=Total of highest signals in 3.16s(Second high signals were other channel)

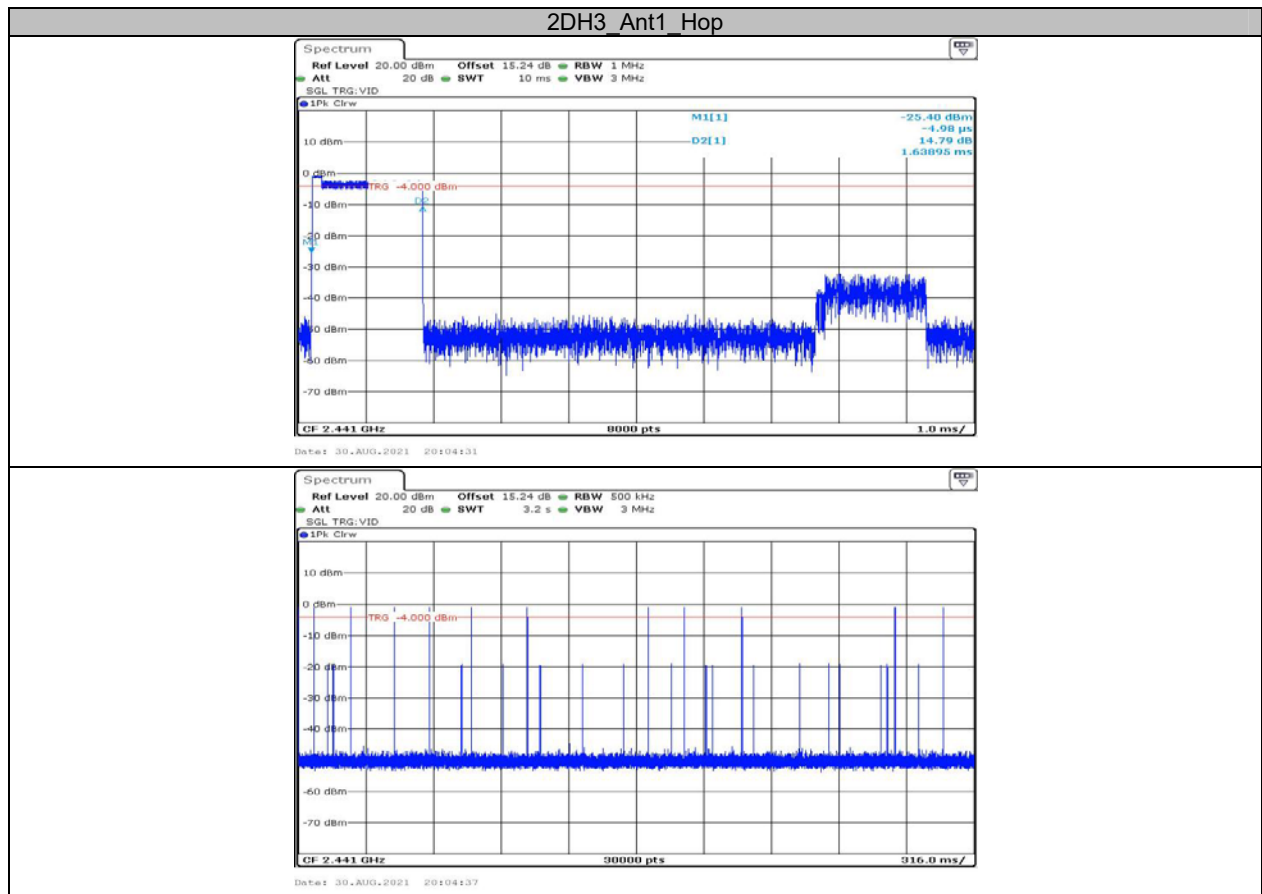
## Test Graphs

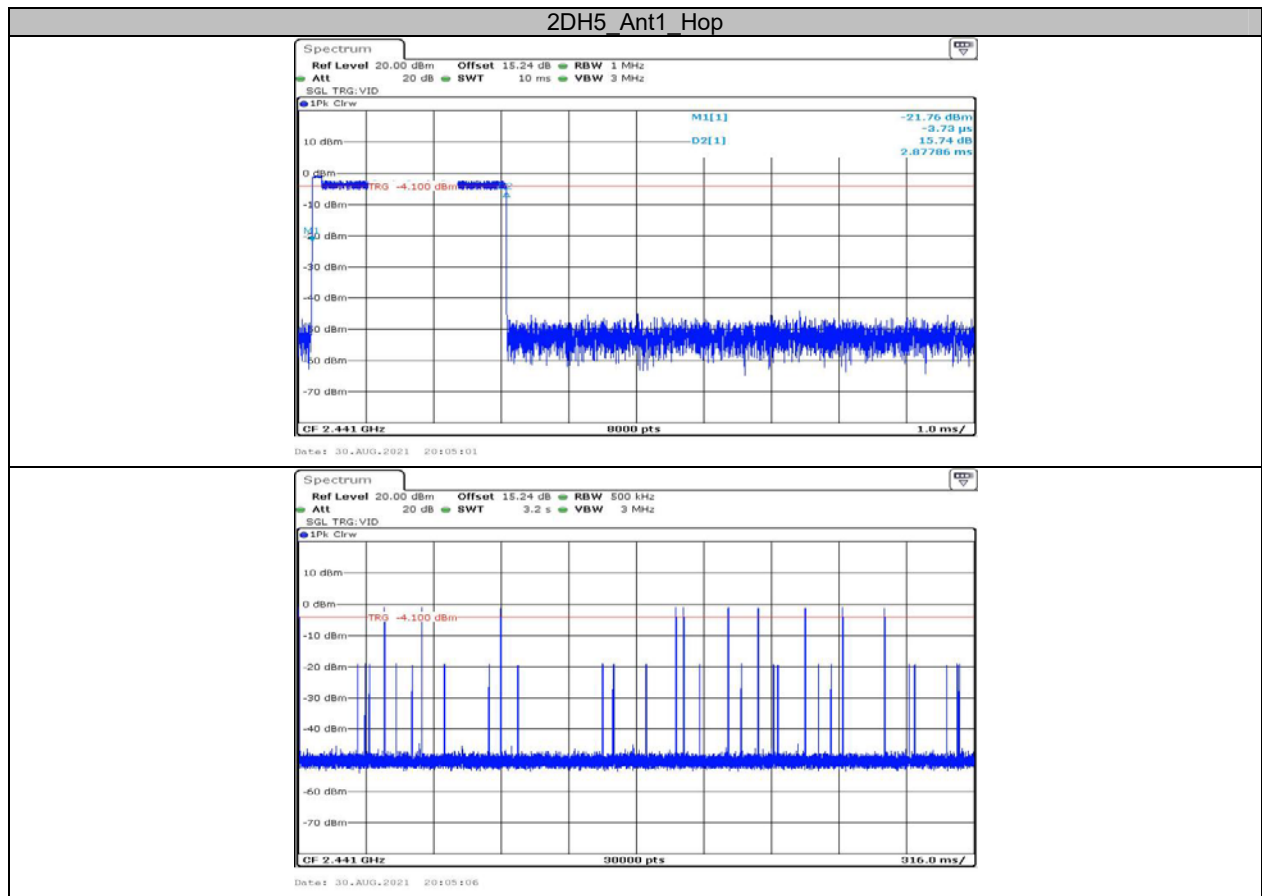


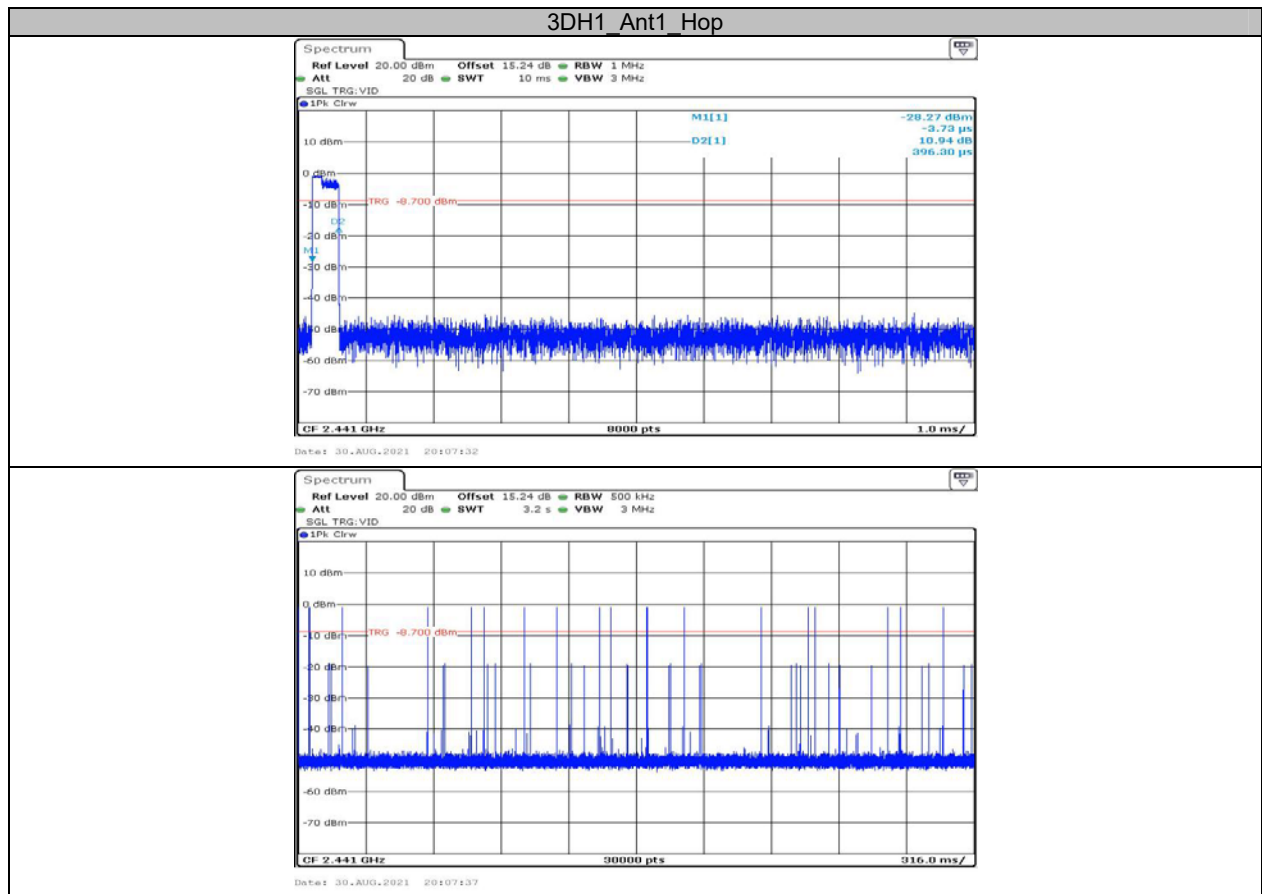


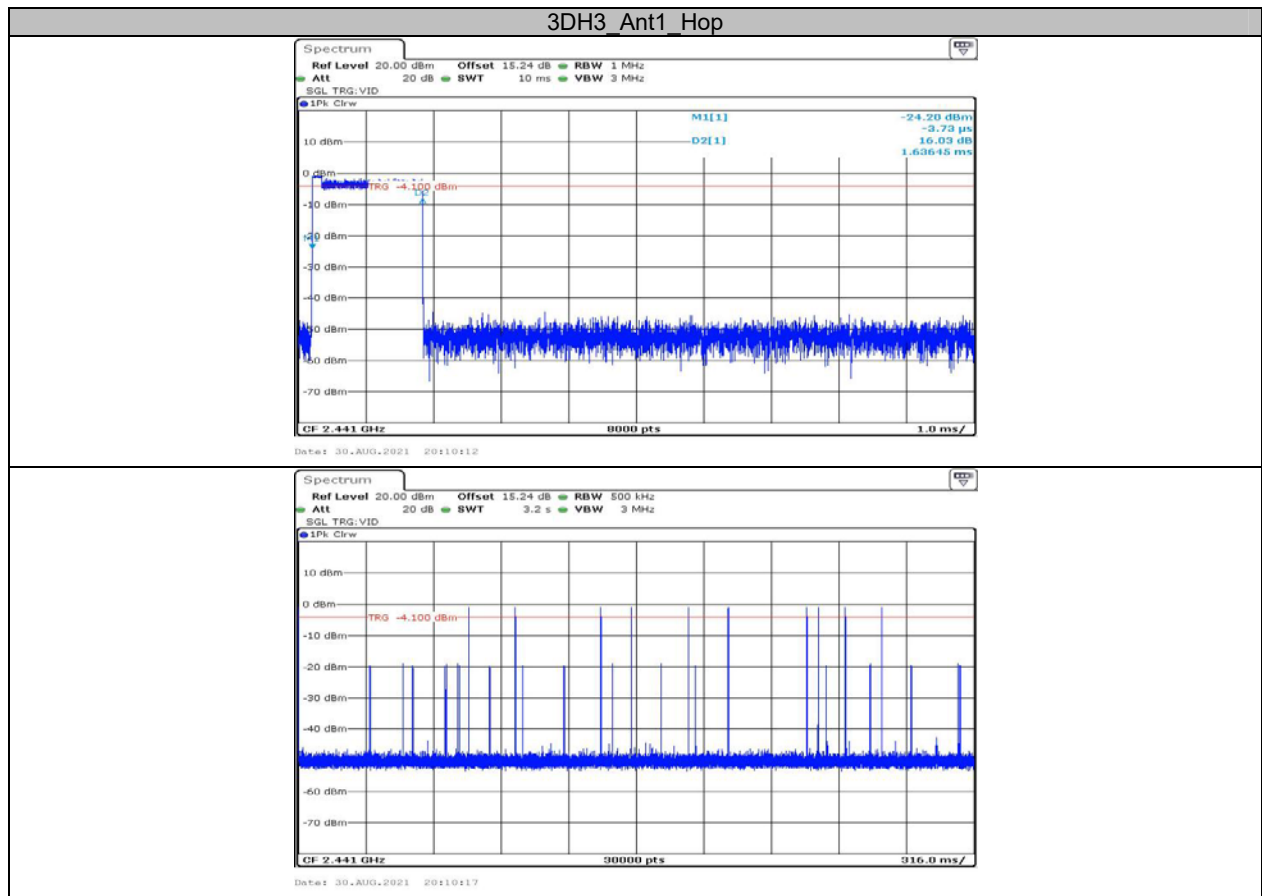


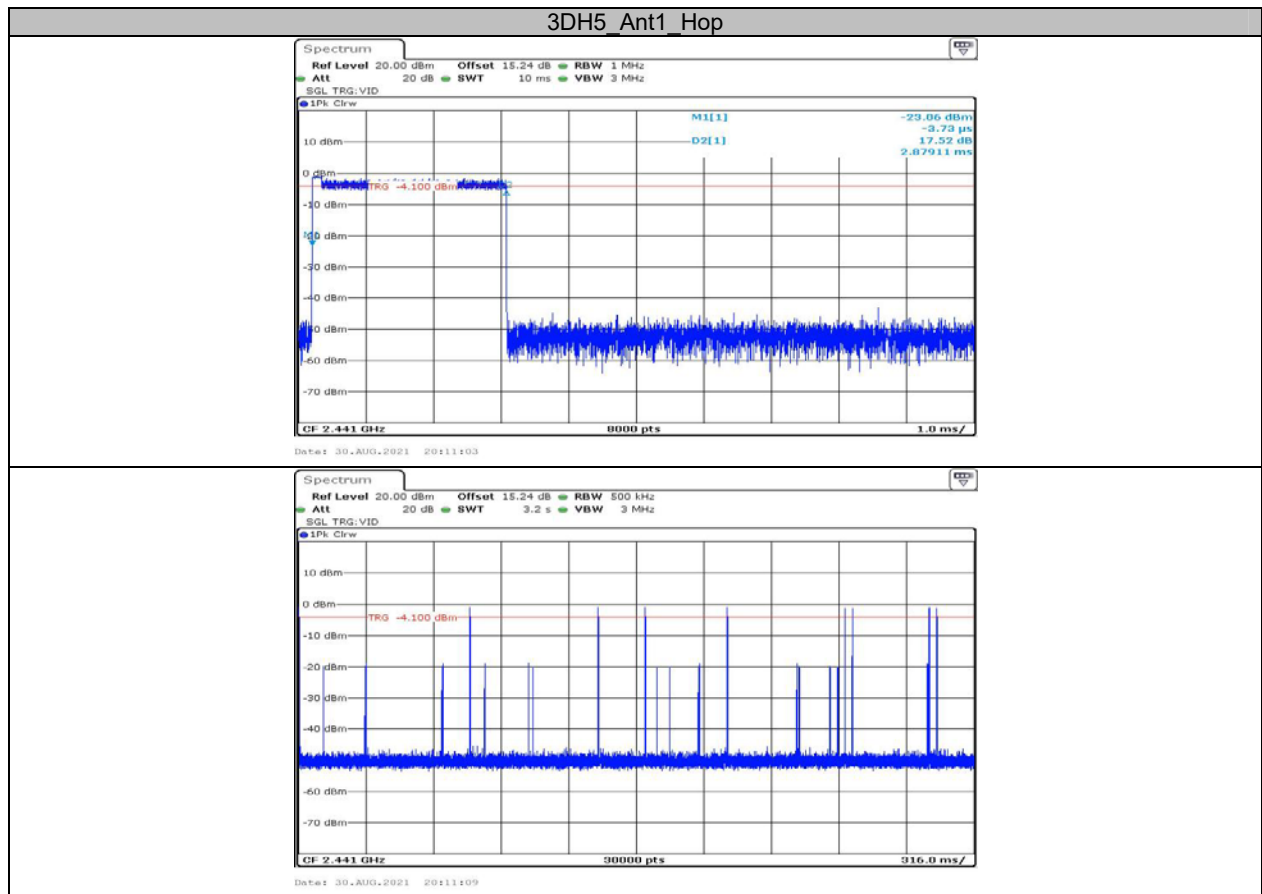








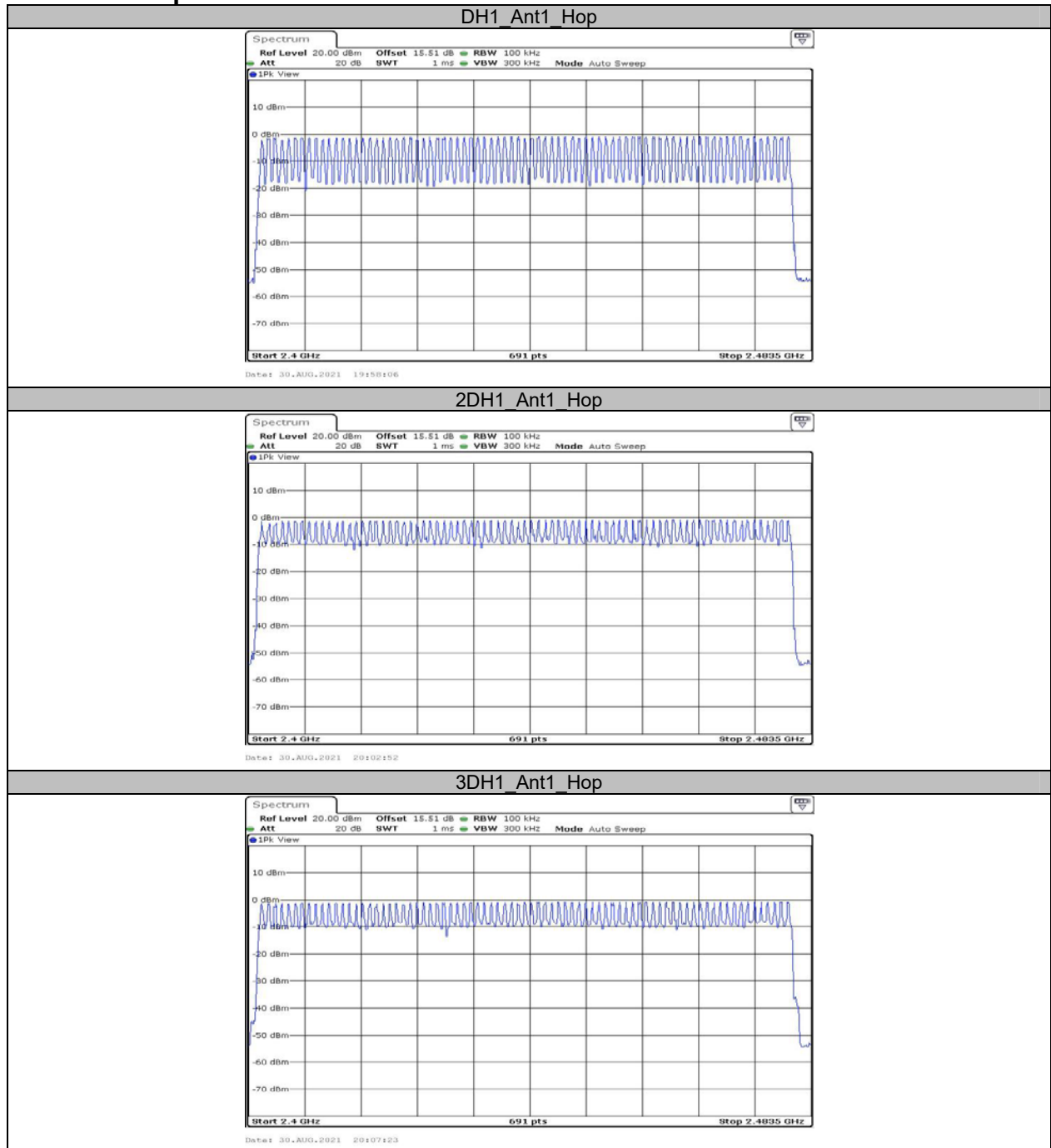




**Appendix F: Number of hopping channels  
Test Result**

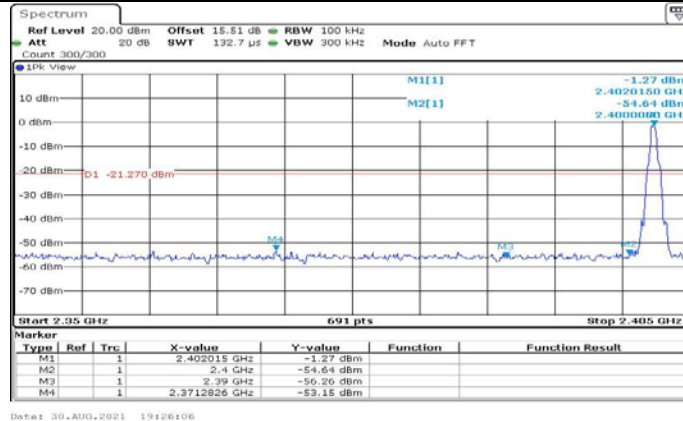
| TestMode | Antenna | Channel | Result[Num] | Limit[Num] | Verdict |
|----------|---------|---------|-------------|------------|---------|
| DH1      | Ant1    | Hop     | 79          | ≥15        | PASS    |
| 2DH1     | Ant1    | Hop     | 79          | ≥15        | PASS    |
| 3DH1     | Ant1    | Hop     | 79          | ≥15        | PASS    |

## Test Graphs

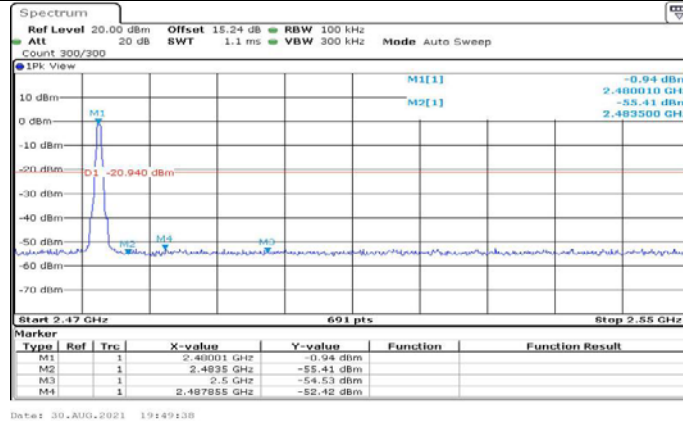


## Appendix G: Band edge measurements Test Graphs

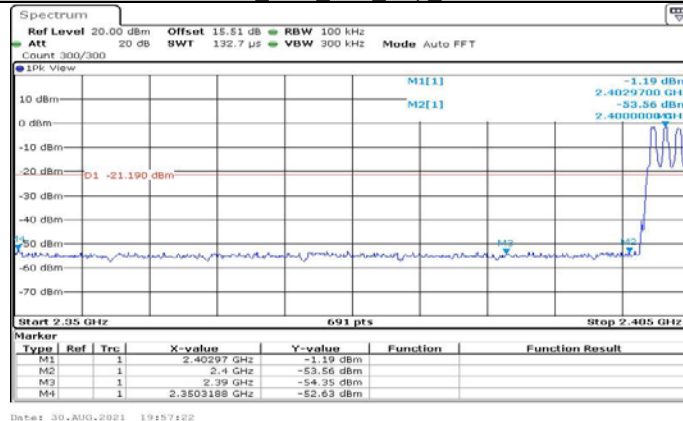
DH1\_Ant1\_Low\_2402

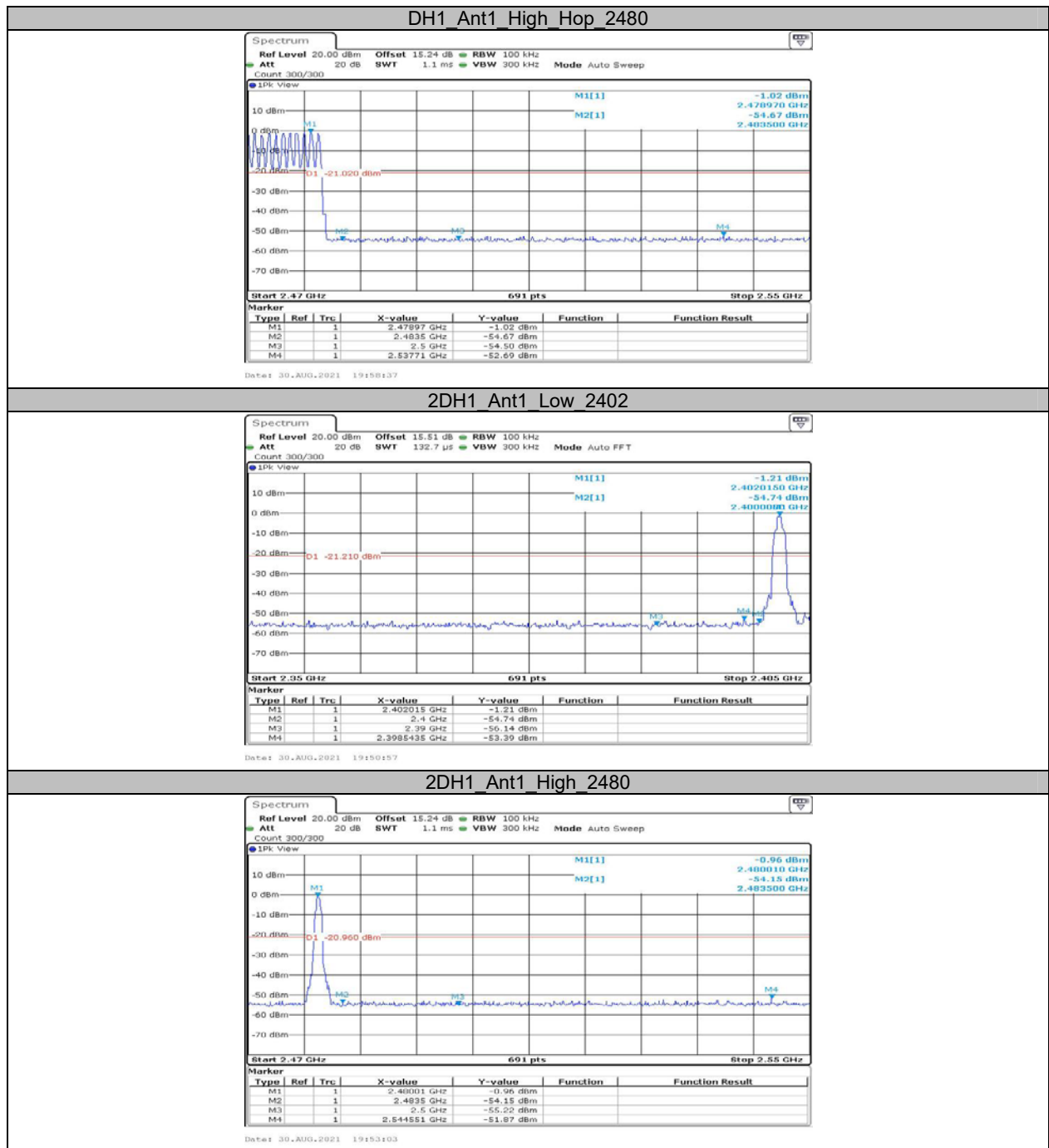


DH1\_Ant1\_High\_2480

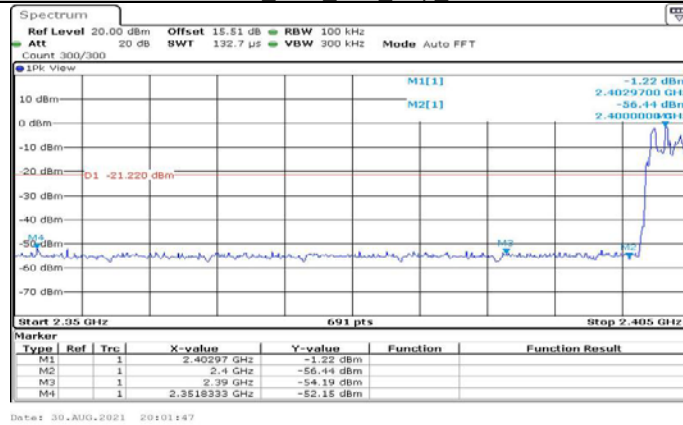


DH1\_Ant1\_Low\_Hop\_2402

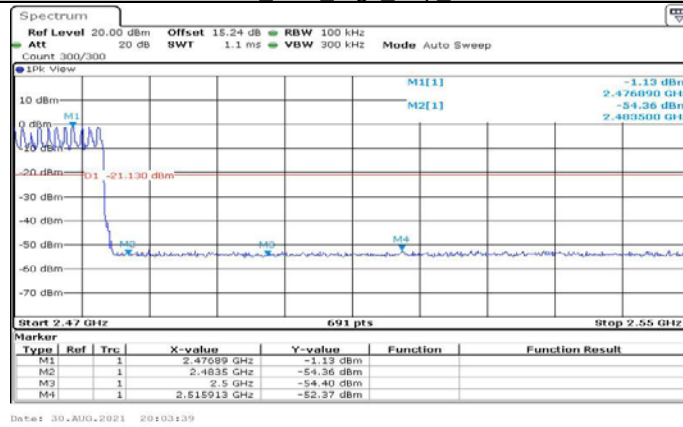




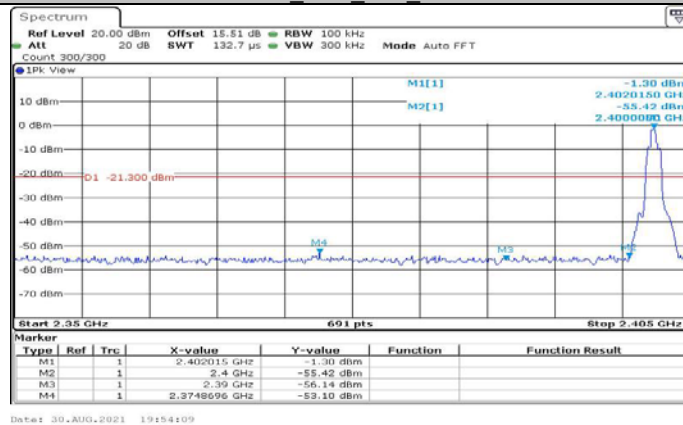
## 2DH1 Ant1 Low Hop 2402

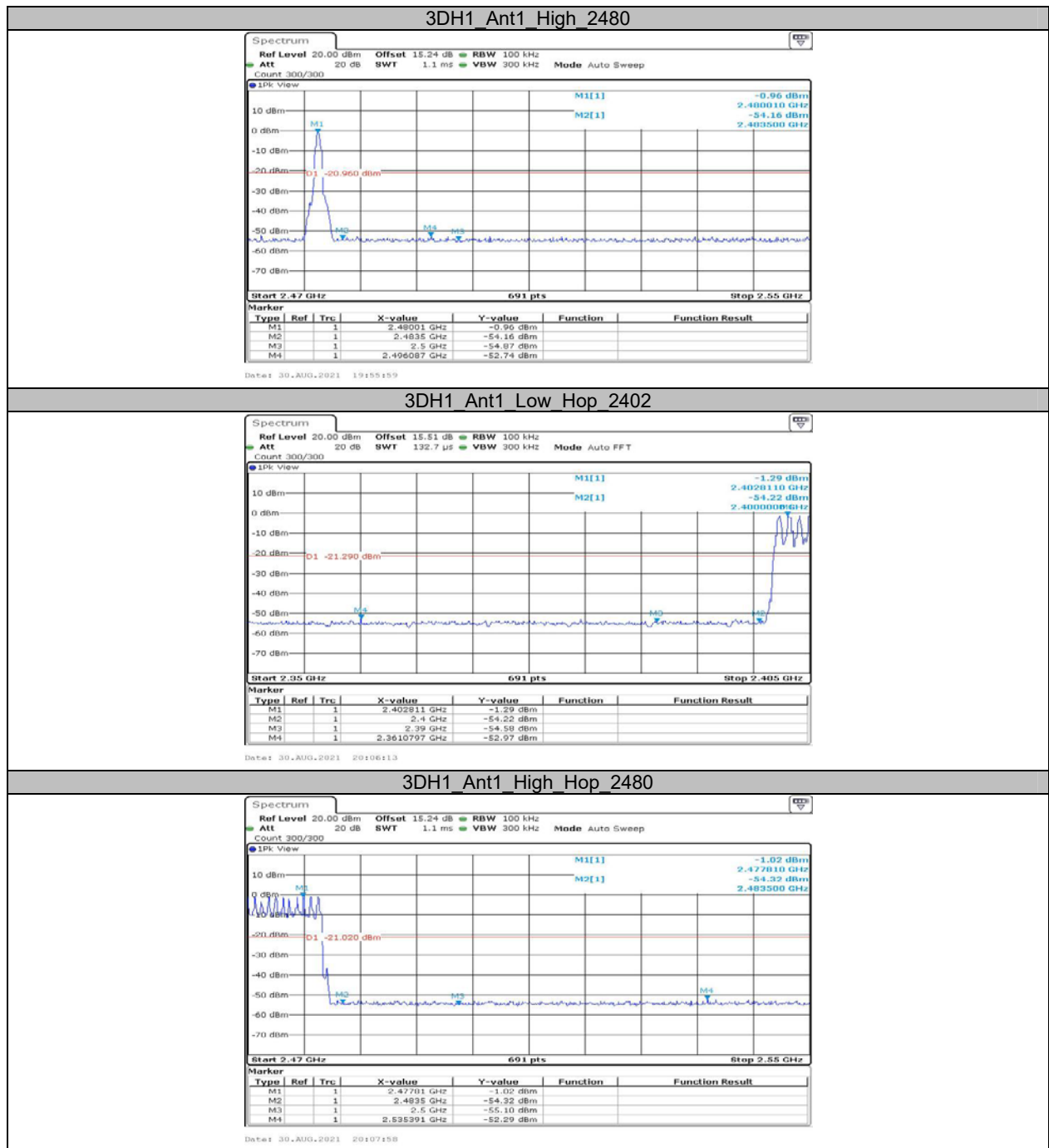


## 2DH1 Ant1 High Hop 2480



## 3DH1 Ant1 Low 2402





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