# TEST REPORT

| | |
|---|---|
| Report No. | CISRR241220176 |
| Project No. | CISR241220176 |
| FCC ID | 2BFWR-BT801 |
| Applicant | Shenzhen Hatsune Miku E-Commerce Co., ltd. |
| Address | West elevator 607, 6th floor, Building 2, Lijincheng Industrial Park, Yousong Community, Longhua Street, Longhua District, Shenzhen City, Guangdong Province, China |
| Manufacturer | Shenzhen Hatsune Miku E-Commerce Co., ltd. |
| Address | West elevator 607, 6th floor, Building 2, Lijincheng Industrial Park, Yousong Community, Longhua Street, Longhua District, Shenzhen City, Guangdong Province, China |
| Product Name | Computer Speakers |
| Trade Mark | HATSUTEC |
| Model/Type reference | BT801 |
| Listed Model(s) | N/A |
| Standard | 47 CFR Part 15.247 |
| Test date | December 21, 2024 to December 26, 2024 |
| Issue date | December 28, 2024 |
| **Test result** | **Complied** |

**Prepared by: Edward Wang**

**Approved by: Genry Long**

The test results relate only to the tested samples.

The test report should not be reproduced except in full without the written approval of Shenzhen Bangce Testing Technology Co., Ltd.

# Contents

1. REPORT VERSION ..... 3

2. TEST DESCRIPTION ..... 4

3. SUMMARY ..... 5

3.1. Product Description * ..... 5
3.2. Radio Specification Description * ..... 5
3.3. Modification of EUT ..... 5
3.4. Deviation from standards ..... 5
3.5. Testing Site ..... 5

4. TEST CONFIGURATION ..... 7

4.1. Test frequency list ..... 7
4.2. Descriptions of test mode ..... 7
4.3. Support unit used in test configuration ..... 7
4.4. Test sample information ..... 7
4.5. Environmental conditions ..... 7
4.6. Equipment Used during the Test ..... 8

5. TEST RESULTS ..... 10

5.1. Evaluation Results (Evaluation) ..... 10
5.1.1. Antenna Requirement ..... 10
5.2. Radio Spectrum Matter Test Results (RF) ..... 11
5.2.1. Conducted Emission at AC power line ..... 11
5.2.2. Maximum Conducted Output Power ..... 14
5.2.3. Channel Separation ..... 15
5.2.4. Number of Hopping Frequencies ..... 16
5.2.5. Dwell Time ..... 17
5.2.6. Conducted band edge and spurious emission ..... 19
5.2.7. Radiated band edge emission ..... 21
5.2.8. Radiated Spurious Emission (below 1GHz) ..... 27
5.2.9. Radiated Spurious Emission (Above 1GHz) ..... 31

6. TEST SETUP PHOTOS ..... 39

7. EXTERNAL AND INTERNAL PHOTOS ..... 41

7.1. External Photos ..... 41
7.2. Internal Photos ..... 45

8. APPENDIX REPORT ..... 47

# 1. REPORT VERSION

| Version No. | Issue date | Description |
|---|---|---|
| 00 | December 28, 2024 | Original |
| | | |
| | | |

## 2. TEST DESCRIPTION

| No. | Test Item | Standard Requirement | Result |
|---|---|---|---|
| 1 | Antenna Requirement | 47 CFR 15.203 | Pass |
| 2 | Conducted Emission at AC power line | 47 CFR 15.207(a) | Pass |
| 3 | Maximum Conducted Output Power | 47 CFR 15.247(b)(1) | Pass |
| 4 | Channel Separation | 47 CFR 15.247(a)(1) | Pass |
| 5 | Number of Hopping Frequencies | 47 CFR 15.247(a)(1)(iii) | Pass |
| 6 | Dwell Time | 47 CFR 15.247(a)(1)(iii) | Pass |
| 7 | Conducted band edge and spurious emission | 47 CFR 15.247(d), 15.209, 15.205 | Pass |
| 8 | Radiated band edge emission | 47 CFR 15.247(d), 15.209, 15.205 | Pass |
| 9 | Radiated Spurious Emission (below 1GHz) | 47 CFR 15.247(d), 15.209, 15.205 | Pass |
| 10 | Radiated Spurious Emission (Above 1GHz) | 47 CFR 15.247(d), 15.209, 15.205 | Pass |

Note:

– The measurement uncertainty is not included in the test result.

# 3. SUMMARY

## 3.1. Product Description *

| Main unit information: | |
|---|---|
| Product Name: | Computer Speakers |
| Trade Mark: | HATSUTEC |
| Model No.: | BT801 |
| Listed Model(s): | N/A |
| Model difference: | N/A |
| Power supply: | DC 5V |
| Hardware version: | V1.5 |
| Software version: | V1.0 |
| Accessory unit information: | |
| Battery information: | N/A |

## 3.2. Radio Specification Description *

| | |
|---|---|
| Modulation type: | GFSK, π/4 DQPSK, 8DPSK |
| Operation frequency: | 2402MHz to 2480MHz |
| Channel number: | 79 |
| Channel separation: | 1MHz |
| Antenna type: | PCB Antenna |
| Antenna gain: | -0.58 |

Note:

1) *: Since the above information is provided by the applicant relevant results or conclusions of this report are only made for these information , Bangce is not responsible for the authenticity, integrity and results of the information and/or the validity of the conclusion.

## 3.3. Modification of EUT

No modifications are made to the EUT during all test items.

## 3.4. Deviation from standards

None

## 3.5. Testing Site

| | |
|---|---|
| Laboratory Name | Shenzhen Bangce Testing Technology Co., Ltd. |
| Laboratory Location | 101, building 10, Yunli Intelligent Park, Shutianpu community, Matian Street, Guangming District, Shenzhen，Guangdong, China |

| | |
|---|---|
| Contact information | Tel: 86-755-2319 6848, email: service@cis-cn.net<br>Website: http://www.cis-cn.net/ |
| FCC registration number | 736346 |
| FCC designation number | CN1372 |

# 4. TEST CONFIGURATION

## 4.1. Test frequency list

| Lowest Channel (LCH) (MHz) | Middle Channel (MCH) (MHz) | Highest Channel (HCH) (MHz) |
|---|---|---|
| 2402 | 2441 | 2480 |

## 4.2. Descriptions of test mode

| No | Test mode | Description |
|---|---|---|
| TM1 | TX-GFSK (Non-Hopping) | Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation at lowest, middle and highest channel. |
| TM2 | TX-Pi/4DQPSK (Non-Hopping) | Keep the EUT in continuously transmitting mode (non-hopping) with Pi/4DQPSK modulation at lowest, middle and highest channel. |
| TM3 | TX-8DPSK (Non-Hopping) | Keep the EUT in continuously transmitting mode (non-hopping) with 8DPSK modulation at lowest, middle and highest channel. |
| TM4 | TX-GFSK (Hopping) | Keep the EUT in continuously transmitting mode (hopping) with GFSK modulation,. |
| TM5 | TX-Pi/4DQPSK (Hopping) | Keep the EUT in continuously transmitting mode (hopping) with Pi/4DQPSK modulation. |
| TM6 | TX-8DPSK (Hopping) | Keep the EUT in continuously transmitting mode (hopping) with 8DPSK modulation. |
| TM7 | Link mode | Keep the EUT in Bluetooth linking mode with AE. |
| TM8 | Charging mode | Keep the EUT in charging mode with AE. |

## 4.3. Support unit used in test configuration

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application.

The following peripheral devices and interface cables were connected during the measurement:

| Item | Equipment name | Trade Name | Model No. |
|---|---|---|---|
| 1 | Adapter | Guangdong Sangu Technology Co. ltd | SG-0501000AU |
| 2 | Phone | Huawei | NZONE S7 |

## 4.4. Test sample information

| Type | Sample No. |
|---|---|
| Engineer sample | CISR241220176-S01 |
| Normal sample | CISR241220176-S02 |

## 4.5. Environmental conditions

| Type | Requirement |
|---|---|
| Temperature: | 15~35°C |
| Relative Humidity: | 25~75% |
| Air Pressure: | 860~1060mbar |

## 4.6. Equipment Used during the Test

| Conducted Emission at AC power line | | | | | | |
|---|---|---|---|---|---|---|
| Item | Equipment name | Manufacturer | Model | Serial No. | Calibration date | Due date |
| 1 | EMI Test Receiver | Rohde&schwarz | ESCI7 | 100853 | 2024-01-08 | 2025-01-07 |
| 2 | Artificial power network | Schwarzbeck | NSLK8127 | 8127-01096 | 2024-01-08 | 2025-01-07 |
| 3 | 8-wire Impedance Stabilization Network | Schwarzbeck | NTFM 8158 | 8158-00337 | 2024-01-08 | 2025-01-07 |
| 4 | Artificial power network | Schwarzbeck | ENV216 | / | 2024-01-08 | 2025-01-07 |

| Maximum Conducted Output Power<br>Channel Separation<br>Number of Hopping Frequencies<br>Dwell Time<br>Emissions in non-restricted frequency bands | | | | | | |
|---|---|---|---|---|---|---|
| Item | Equipment name | Manufacturer | Model | Serial No. | Calibration date | Due date |
| 1 | MXG RF Signal Generator | Agilent | N5181A | MY50145362 | 2024-01-08 | 2025-01-07 |
| 2 | Spectrum analyzer | R&S | FSV-40N | 102130 | 2024-01-08 | 2025-01-07 |
| 3 | Vector Signal Generator | Agilent | N5182A | MY50142364 | 2024-06-14 | 2025-06-13 |
| 4 | Power Meter | WCS | WCS-PM | WCSPM230405A | 2024-01-08 | 2025-01-07 |

| Emissions in frequency bands (above 1GHz)<br>Band edge emissions (Radiated)<br>Emissions in frequency bands (below 1GHz) | | | | | | |
|---|---|---|---|---|---|---|
| Item | Equipment name | Manufacturer | Model | Serial No. | Calibration date | Due date |
| 1 | EMI Test Receiver | Rohde&schwarz | ESCI7 | 100853 | 2024-01-08 | 2025-01-07 |
| 2 | Amplifier | Tonscend | TAP9K3G40 | AP23A8060270 | 2024-01-08 | 2025-01-07 |
| 3 | Prime amplifier | Tonscend | TAP01018050 | AP23A8060280 | 2024-01-08 | 2025-01-07 |
| 4 | 9*6*6 anechoic chamber | SKET | 9.3*6.3*6 | N/A | 2024-09-02 | 2027-09-01 |
| 5 | Spectrum analyzer | Agilent | N9020A | MY50530263 | 2024-01-08 | 2025-01-07 |
| 6 | Spectrum analyzer | R&S | FSV-40N | 102130 | 2024-01-08 | 2025-01-07 |
| 7 | Bilog Antenna | Schwarzbeck | VULB 9163 | 1463 | 2023-01-09 | 2025-01-08 |
| 8 | Horn Antenna | SCHWARZBECK | BBHA 9120 D | 2487 | 2023-01-09 | 2025-01-08 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | Active Loop Antenna | SCHWARZBECK | FMZB 1519B | / | 2023-01-09 | 2025-01-08 |
| 10 | RF Cable | Tonscend | Cable 1 | / | 2024-01-08 | 2025-01-07 |
| 11 | RF Cable | Tonscend | Cable 2 | / | 2024-01-08 | 2025-01-07 |
| 12 | RF Cable | SKET | Cable 3 | / | 2024-01-08 | 2025-01-07 |
| 13 | L.I.S.N.#1 | Schwarzbeck | NSLK8127 | / | 2024-01-08 | 2025-01-07 |
| 14 | L.I.S.N.#2 | ROHDE&SCHWARZ | ENV216 | / | 2024-01-08 | 2025-01-07 |
| 15 | Horn Antenna | SCHWARZBECK | BBHA9170 | 1130 | 2023-01-09 | 2025-01-08 |
| 16 | Preamplifier | Tonscend | TAP18040048 | AP21C806126 | 2024-01-08 | 2025-01-07 |
| 17 | Variable-frequency power source | Pinhong | PH1110 | / | 2024-01-08 | 2025-01-07 |
| 18 | 6dB Attenuator | SKET | DC-6G | / | / | / |
| 19 | Antenna tower | SKT | Bk-4AT-BS | AT2021040101-V1 | 2024-06-14 | 2025-06-13 |

# 5. TEST RESULTS

## 5.1. Evaluation Results (Evaluation)

### 5.1.1. Antenna Requirement

| | |
|---|---|
| Test Requirement: | Refer to 47 CFR Part 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. |

#### 5.1.1.1. Test Result

Pass

#### 5.1.1.2. Conclusion:

| |
|---|
| The EUT antenna is PCB Antenna(-0.58), the directional gain of the antenna less than 6dBi. It comply with the standard requirement. In case of replacement of broken antenna the same antenna type must be used.Antenna structure please refer to the EUT internal photographs antenna photo. |

## 5.2. Radio Spectrum Matter Test Results (RF)

### 5.2.1. Conducted Emission at AC power line

| | |
|---|---|
| Test Requirement: | Refer to 47 CFR 15.207(a), Except as shown in paragraphs (b)and (c)of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). |
| Test Limit: | |

| Frequency of emission (MHz) | Conducted limit (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

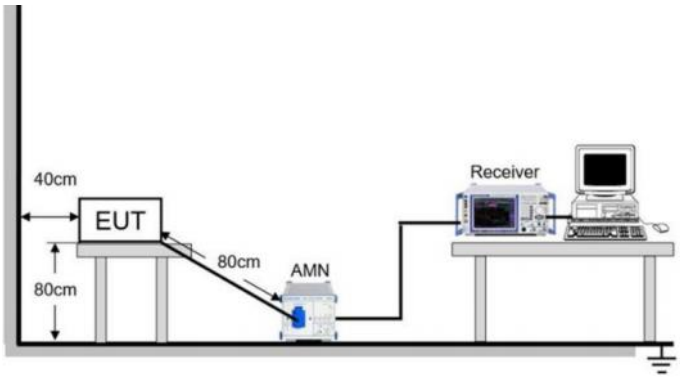
*Decreases with the logarithm of the frequency.

| | |
|---|---|
| Test Method: | ANSI C63.10-2020 section 6.2 |
| Procedure: | 1. The EUT was setup according to ANSI C63.10 requirements.<br>2. The EUT was placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above the conducting ground plane. The vertical conducting plane was located 40 cm to the rear of the EUT. All other surfaces of EUT were at least 80 cm from any other grounded conducting surface.<br>3. The EUT and simulators are connected to the main power through a line impedances stabilization network (LISN). The LISN provides a 50 ohm /50uH coupling impedance for the measuring equipment.<br>4. The peripheral devices are also connected to the main power through a LISN. (Refer to the block diagram of the test setup and photographs)<br>5. Each current-carrying conductor of the EUT power cord, except the ground (safety) conductor, was individually connected through a LISN to the input power source.<br>6. The excess length of the power cord between the EUT and the LISN receptacle were folded back and forth at the center of the lead to form a bundle not exceeding 40 cm in length.<br>7. Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9 kHz.<br>8. During the above scans, the emissions were maximized by cable manipulation. |

#### 5.2.1.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 22.8 °C | Humidity: | 55.2 % | Atmospheric Pressure: | 103 kPa |
| Pre test mode: | TM8 | | | | |
| Final test mode: | TM8 | | | | |

#### 5.2.1.2. Test Setup Diagram

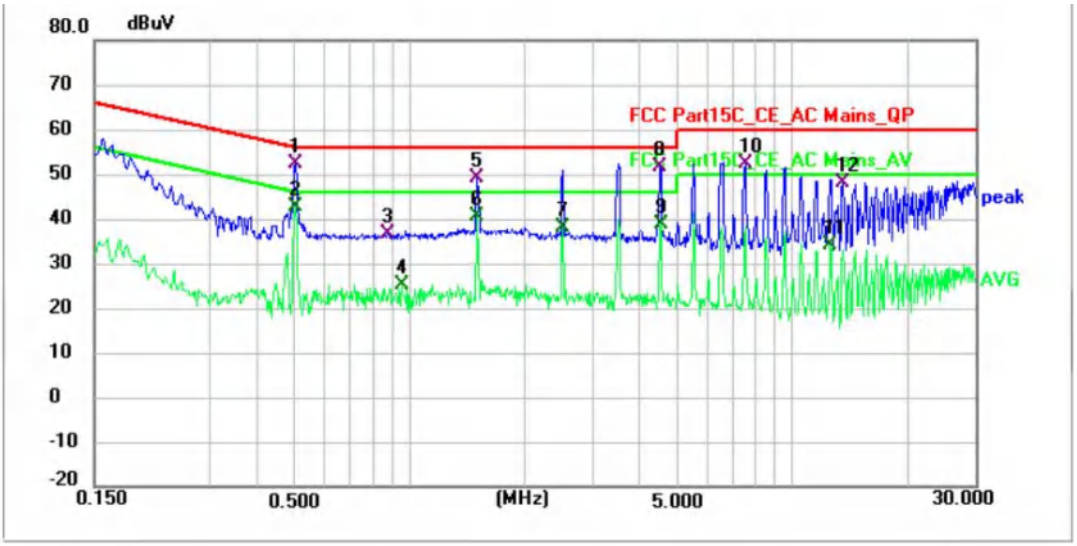


### 5.2.1.3. Test Result

Pass

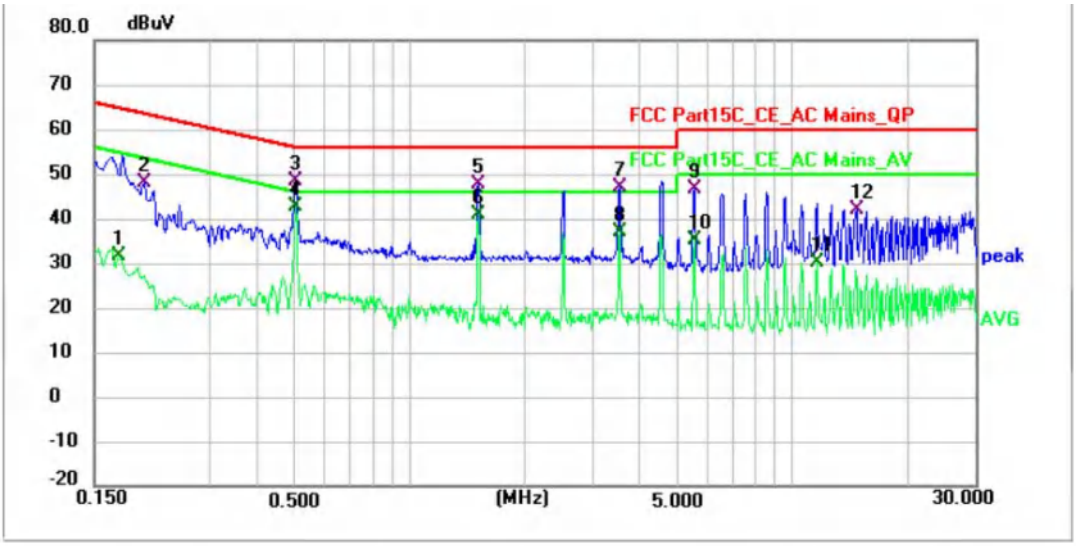
### 5.2.1.4. Test Data

Mode8 / Line: Line




| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 0.506 | 51.98 | 0.37 | 52.35 | 56.00 | -3.65 | QP |
| 2 * | 0.506 | 42.48 | 0.37 | 42.85 | 46.00 | -3.15 | AVG |
| 3 | 0.878 | 36.17 | 0.42 | 36.59 | 56.00 | -19.41 | QP |
| 4 | 0.954 | 24.82 | 0.43 | 25.25 | 46.00 | -20.75 | AVG |
| 5 | 1.510 | 48.50 | 0.57 | 49.07 | 56.00 | -6.93 | QP |
| 6 | 1.510 | 40.00 | 0.57 | 40.57 | 46.00 | -5.43 | AVG |
| 7 | 2.514 | 37.36 | 0.84 | 38.20 | 46.00 | -7.80 | AVG |
| 8 | 4.522 | 50.05 | 1.58 | 51.63 | 56.00 | -4.37 | QP |
| 9 | 4.530 | 37.15 | 1.58 | 38.73 | 46.00 | -7.27 | AVG |
| 10 | 7.550 | 49.51 | 2.90 | 52.41 | 60.00 | -7.59 | QP |
| 11 | 12.562 | 29.22 | 4.95 | 34.17 | 50.00 | -15.83 | AVG |
| 12 | 13.586 | 42.54 | 5.48 | 48.02 | 60.00 | -11.98 | QP |

## Mode8 / Line: Neutral




| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 0.174 | 31.13 | 0.32 | 31.45 | 54.77 | -23.32 | AVG |
| 2 | 0.202 | 47.87 | 0.32 | 48.19 | 63.53 | -15.34 | QP |
| 3 | 0.502 | 48.10 | 0.38 | 48.48 | 56.00 | -7.52 | QP |
| 4 * | 0.506 | 42.45 | 0.38 | 42.83 | 46.00 | -3.17 | AVG |
| 5 | 1.518 | 46.94 | 0.57 | 47.51 | 56.00 | -8.49 | QP |
| 6 | 1.518 | 40.46 | 0.57 | 41.03 | 46.00 | -4.97 | AVG |
| 7 | 3.538 | 45.59 | 1.21 | 46.80 | 56.00 | -9.20 | QP |
| 8 | 3.538 | 35.65 | 1.21 | 36.86 | 46.00 | -9.14 | AVG |
| 9 | 5.542 | 44.63 | 2.06 | 46.69 | 60.00 | -13.31 | QP |
| 10 | 5.542 | 33.17 | 2.06 | 35.23 | 50.00 | -14.77 | AVG |
| 11 | 11.586 | 26.07 | 4.27 | 30.34 | 50.00 | -19.66 | AVG |
| 12 | 14.686 | 36.40 | 5.58 | 41.98 | 60.00 | -18.02 | QP |

Note:
1). Result = Reading +Correct (Insertion Loss + Cable Loss + Attenuator Factor)
2). Margin = Result - Limit

## 5.2.2. Maximum Conducted Output Power

| | |
|---|---|
| Test Requirement: | 47 CFR 15.247(b)(1) |
| Test Limit: | Refer to 47 CFR 15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts. |
| Test Method: | ANSI C63.10-2020, section 7.8.5 |
| Procedure: | This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. Frequency hopping shall be disabled for this test. Use the following spectrum analyzer settings:<br>a) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.<br>b) RBW > 20 dB bandwidth of the emission being measured.<br>c) VBW ≥ RBW.<br>d) Sweep: No faster than coupled (auto) time.<br>e) Detector function: Peak.<br>f) Trace: Max-hold.<br>g) Allow trace to stabilize.<br>h) Use the marker-to-peak function to set the marker to the peak of the emission.<br>i) The indicated level is the peak output power, after any corrections for external attenuators and cables.<br>j) A spectral plot of the test results and setup description shall be included in the test report.<br>NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer. |

### 5.2.2.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 22.4 °C | Humidity: | 55.6 % | Atmospheric Pressure: | 102 kPa |
| Pre test mode: | TM1, TM2, TM3 | | | | |
| Final test mode: | TM1, TM2, TM3 | | | | |

### 5.2.2.2. Test Setup Diagram

### 5.2.2.3. Test Result

Pass

### 5.2.2.4. Test Data

Please Refer to Appendix for Details.

### 5.2.3. Channel Separation

| | |
|---|---|
| Test Requirement: | 47 CFR 15.247(a)(1) |
| Test Limit: | Refer to 47 CFR 15.247(a)(1), 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. |
| Test Method: | ANSI C63.10-2020, section 7.8.2 |
| Procedure: | The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:<br>a) Span: Wide enough to capture the peaks of two adjacent channels.<br>b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.<br>c) Video (or average) bandwidth (VBW) ≥ RBW.<br>d) Sweep: No faster than coupled (auto) time.<br>e) Detector function: Peak.<br>f) Trace: Max-hold.<br>g) Allow the trace to stabilize.<br><br>Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A spectral plot of the data shall be included in the test report. |

#### 5.2.3.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 22.4 °C | Humidity: | 55.6 % | Atmospheric Pressure: | 102 kPa |
| Pre test mode: | TM4, TM5, TM6 | | | | |
| Final test mode: | TM4, TM5, TM6 | | | | |

#### 5.2.3.2. Test Setup Diagram

#### 5.2.3.3. Test Result

Pass

#### 5.2.3.4. Test Data

Please Refer to Appendix for Details.

## 5.2.4. Number of Hopping Frequencies

| | |
|---|---|
| Test Requirement: | 47 CFR 15.247(a)(1)(iii) |
| Test Limit: | Refer to 47 CFR 15.247(a)(1)(iii), Fequency 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 Method: | ANSI C63.10-2020, section 7.8.3 |
| Procedure: | The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:<br>a) Span: The frequency band of operation. Depending on the number of channels the device supports, it could be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.<br>b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.<br>c) VBW ≥ RBW.<br>d) Sweep: No faster than coupled (auto) time.<br>e) Detector function: Peak.<br>f) Trace: Max-hold.<br>g) Allow the trace to stabilize.<br><br>It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A spectral plot of the data shall be included in the test report. |

### 5.2.4.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 22.4 °C | Humidity: | 55.6 % | Atmospheric Pressure: | 102 kPa |
| Pre test mode: | TM4, TM5, TM6 | | | | |
| Final test mode: | TM4, TM5, TM6 | | | | |

### 5.2.4.2. Test Setup Diagram

### 5.2.4.3. Test Result

Pass

### 5.2.4.4. Test Data

Please Refer to Appendix for Details.

### 5.2.5. Dwell Time

| | |
|---|---|
| Test Requirement: | 47 CFR 15.247(a)(1)(iii) |
| Test Limit: | Refer to 47 CFR 15.247(a)(1)(iii), Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used. |
| Test Method: | ANSI C63.10-2020, section 7.8.4 |
| Procedure: | The dwell time per hop on a channel is the time from the start of the first transmission to the end of the last transmission for that hop. If the device has a single transmission per hop then the dwell time is the duration of that transmission. If the device has a multiple transmissions per hop then the dwell time is measured from the start of the first transmission to the end of the last transmission.<br><br>The time of occupancy is the total time that the device dwells on a channel over an observation period specified in the regulatory requirement. To determine the time of occupancy the spectrum analyzer will be configured to measure both the dwell time per hop and the number of times the device transmits on a specific channel in a given period.<br><br>The EUT shall have its hopping function enabled. Compliance with the requirements shall be made with the minimum and with the maximum number of channels enabled. If the dwell time per channel does not vary with the number of channels than compliance with the requirements may be based on the minimum number of channels. If the device supports different dwell times per channel (example Bluetooth devices can dwell on a channel for 1, 3 or 5 time slots) then measurements can be limited to the longest dwell time with the minimum number of channels.<br><br>Use the following spectrum analyzer settings to determine the dwell time per hop:<br><br>a) Span: Zero span, centered on a hopping channel.<br>b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected transmission time per hop.<br>c) Sweep time: Set so that the start of the first transmission and end of the last transmission for the hop are clearly captured. Setting the sweep time to be slightly longer than the hopping period per channel (hopping period = 1/hopping rate) should achieve this.<br>d) Use a video trigger, where possible with a trigger delay, so that the start of the transmission is clearly observed. The trigger level might need adjustment to reduce the chance of triggering when the system hops on an adjacent channel.<br>e) Detector function: Peak.<br>f) Trace: Clear-write, single sweep.<br>g) Place markers at the start of the first transmission on the channel and at the end of the last transmission. The dwell time per hop is the time between these two markers.<br><br>To determine the number of hops on a channel in the regulatory observation period repeat the measurement using a longer sweep time. When the device uses a single hopping sequence the period of measurement should be sufficient to capture at least 2 hops. When the device uses a dynamic hopping sequence, or the sequence varies, the period of measurement may need to capture multiple hops to better determine the average time of occupancy. Count the number of hops on the channel across the sweep time.<br><br>The average number of hops on the same channel within the regulatory observation period is calculated from the number of hops on the channel divided by the spectrum analyzer sweep time multiplied by the regulatory observation period. For example, if three hops are counted with an analyzer sweep time of 500 ms and |

| | |
|---|---|
| | the regulatory observation period is 10 s, then the number of hops in that ten seconds is 3 / 0.5 × 10, or 60 hops.<br><br>The average time of occupancy is calculated by multiplying the dwell time per hop by the number of hops in the observation period. |

### 5.2.5.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 22.4 °C | Humidity: | 55.6 % | Atmospheric Pressure: | 102 kPa |
| Pre test mode: | TM4, TM5, TM6 | | | | |
| Final test mode: | TM4, TM5, TM6 | | | | |

### 5.2.5.2. Test Setup Diagram

### 5.2.5.3. Test Result

Pass

### 5.2.5.4. Test Data

Please Refer to Appendix for Details.

## 5.2.6. Conducted band edge and spurious emission

| | |
|---|---|
| Test Requirement: | 47 CFR 15.247(d), 15.209, 15.205 |
| Test Limit: | Refer to 47 CFR 15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. |
| Test Method: | ANSI C63.10-2020 section 7.8.7 |
| Procedure: | 7.8.7.1 General considerations<br>To demonstrate compliance with the relative out-of-band emissions requirements conducted spurious emissions shall be measured for the transmit frequencies, per 5.5 and 5.6, and at the maximum transmit powers. Frequency hopping shall be disabled for this test with the exception of measurements at the allocated band-edges which shall be repeated with hopping enabled.<br><br>Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between the unlicensed wireless device output and the spectrum analyzer. The frequency range of testing shall span 30 MHz to 10 times the operating frequency and this may be done in a single sweep or, to aid resolution, across a number of sweeps. The resolution bandwidth shall be 100 kHz, video bandwidth 300 kHz, and a coupled sweep time with a peak detector.<br><br>The limit is based on the highest in-band level across all channels measured using the same instrument settings (resolution bandwidth of 100 kHz, video bandwidth of 300 kHz, and a coupled sweep time with a peak detector). To help clearly demonstrate compliance a display line may be set at the required offset (typically 20 dB) below the highest in-band level. Where the highest in-band level is not clearly identified in the out-of-band measurements a separate spectral plot showing the in-band level shall be provided.<br><br>When conducted measurements cannot be made (for example a device with integrated, non-removable antenna) radiated measurements shall be used. The reference level for determining the limit shall be established by maximizing the field strength from the highest power channel and measuring using the resolution and video bandwidth settings and peak detector as described above. The field strength limit for spurious emissions outside of restricted-bands shall then be set at the required offset (typically 20 dB) below the highest in-band level. Radiated measurements will follow the standards measurement procedures described in Clause 6 with the exception that the resolution bandwidth shall be 100 kHz, video bandwidth 300 kHz, and a coupled sweep time with a peak detector. Note that use of wider measurement bandwidths are acceptable for measuring the spurious emissions provided that the peak detector is used and that the measured value of spurious emissions are compared to the highest in-band level measured with the 100 kHz / 300 kHz bandwidth settings to determine compliance.<br><br>7.8.7.2 Band-edges<br>Compliance with a relative limit at the band-edges (e.g., −20 dBc) shall be made on the lowest and on the highest channels with frequency hopping disabled and repeated with frequency hopping enabled. For the latter test the hopping sequence shall include the lowest and highest channels.<br><br>For measurements with the hopping disabled the analyzer screen shall clearly show compliance with the requirement within 10 MHz of the allocated band-edge. |

| | |
|---|---|
| | For measurements with the hopping enabled the analyzer screen shall clearly show compliance with the requirement within 10 MHz of both of the allocated band-edges. This could require separate spectral plots for each band-edge. |

### 5.2.6.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 22.4 °C | Humidity: | 55.6 % | Atmospheric Pressure: | 102 kPa |
| Pre test mode: | TM1, TM2, TM3, TM4, TM5, TM6 | | | | |
| Final test mode: | TM1, TM2, TM3, TM4, TM5, TM6 | | | | |

### 5.2.6.2. Test Setup Diagram

### 5.2.6.3. Test Result

Pass

### 5.2.6.4. Test Data

Please Refer to Appendix for Details.

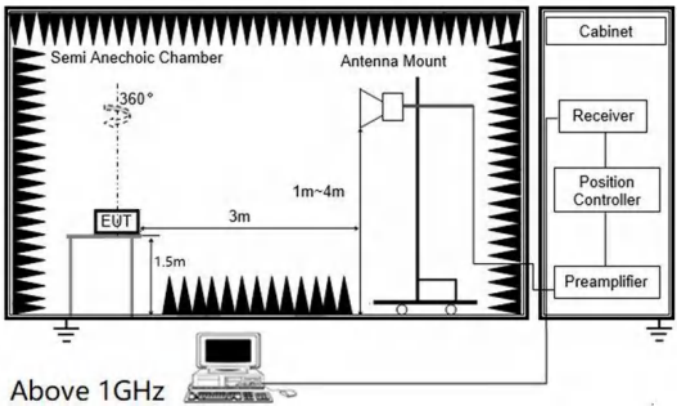
## 5.2.7. Radiated band edge emission

<table>
<tr><td>Test Requirement:</td><td>Refer to 47 CFR 15.247(d), 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)).`</td></tr>
<tr><td>Test Limit:</td><td>
<table>
<tr><th>Frequency (MHz)</th><th>Field strength (microvolts/meter)</th><th>Measurement distance (meters)</th></tr>
<tr><td>0.009-0.490</td><td>2400/F(kHz)</td><td>300</td></tr>
<tr><td>0.490-1.705</td><td>24000/F(kHz)</td><td>30</td></tr>
<tr><td>1.705-30.0</td><td>30</td><td>30</td></tr>
<tr><td>30-88</td><td>100 **</td><td>3</td></tr>
<tr><td>88-216</td><td>150 **</td><td>3</td></tr>
<tr><td>216-960</td><td>200 **</td><td>3</td></tr>
<tr><td>Above 960</td><td>500</td><td>3</td></tr>
</table>
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.<br>In the emission table above, the tighter limit applies at the band edges.<br>The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
</td></tr>
<tr><td>Test Method:</td><td>ANSI C63.10-2020 section 6.10</td></tr>
<tr><td>Procedure:</td><td>1. EUT was setup and tested according to ANSI C63.10 .<br>2. The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level.<br>3. The EUT waspositioned such that the distance from antenna to the EUT was 3 meters.<br>4. The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. Thisis repeated for both horizontal and vertical polarization of the antenna. In order to find themaximum emission, all of the interface cables were manipulated according to ANSI C63.10 on radiated measurement.<br>5. Use the following spectrum analyzer settings:<br>a) Span shall wide enough to fully capture the emission being measured<br>b) Set RBW=1MHz, VBW=3MHz for >1GHz, Sweep time=auto, Detector=peak, Trace=max hold for Peak measurement<br>For average measurement: use duty cycle correction factor method (DCCF), Averager level = Peak level + DCCF</td></tr>
</table>

### 5.2.7.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 23 °C | Humidity: | 56.8 % | Atmospheric Pressure: | 103 kPa |
| Pre test mode: | TM1, TM2, TM3 | | | | |
| Final test mode: | TM1, TM2, TM3 | | | | |

### 5.2.7.2. Test Setup Diagram



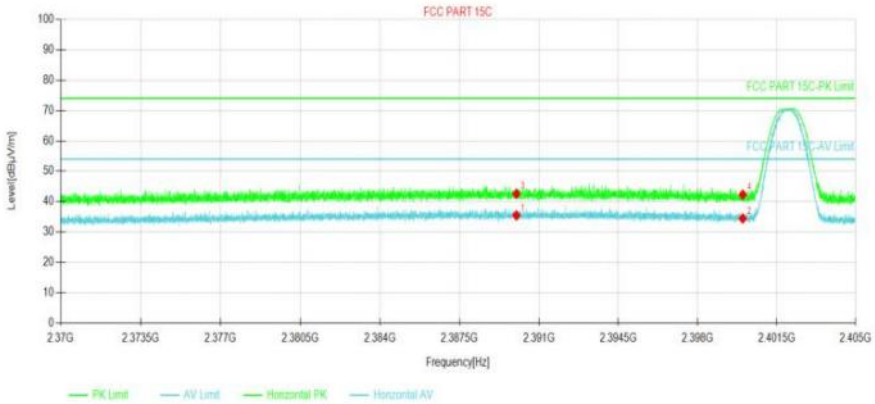

### 5.2.7.3. Test Result

Pass

### 5.2.7.4. Test Data

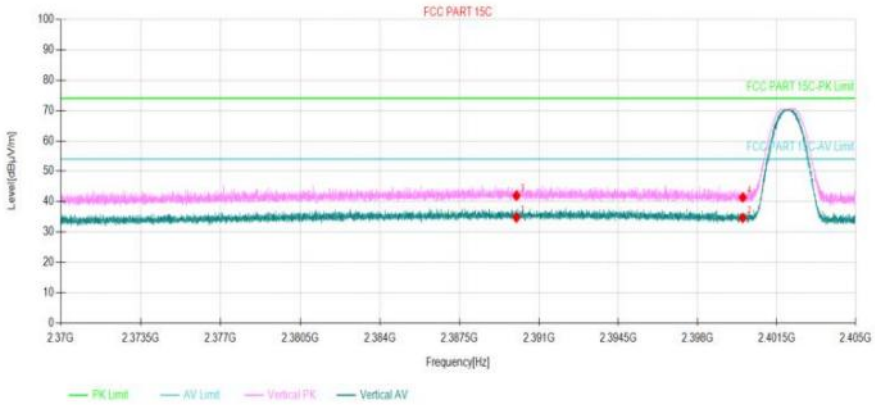
Have pre-scan all test mode, found GFSK-DH5 which it was worst case, so only show the worst case’s data on this report.

Mode1 / Polarization: Horizontal / CH: L



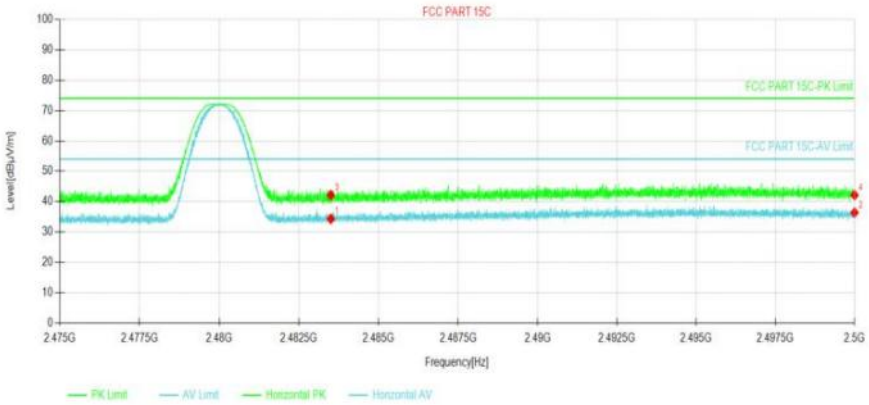

| Suspected Data List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
| 1 | 2390.00 | 28.92 | 35.48 | 6.56 | 54.00 | 18.52 | Horizontal | PASS |
| 2 | 2400.00 | 27.85 | 34.46 | 6.61 | 54.00 | 19.54 | Horizontal | PASS |
| 3 | 2390.00 | 35.99 | 42.55 | 6.56 | 74.00 | 31.45 | Horizontal | PASS |
| 4 | 2400.00 | 35.71 | 42.32 | 6.61 | 74.00 | 31.68 | Horizontal | PASS |

## Mode1 / Polarization: Vertical / CH: L



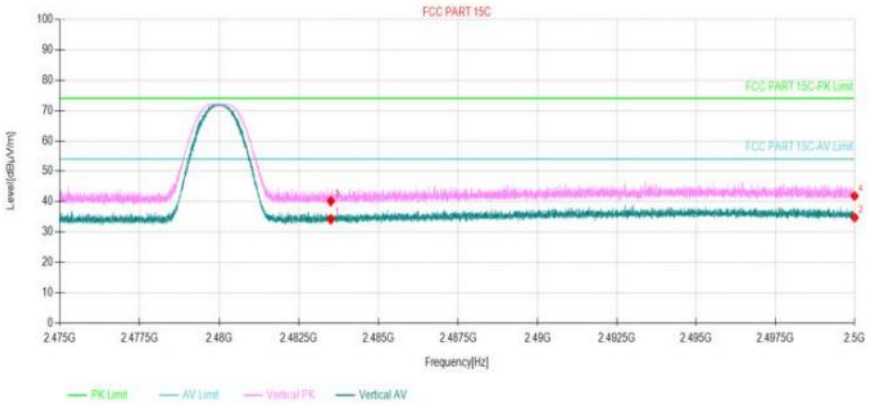

| Suspected Data List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
| 1 | 2390.00 | 28.20 | 34.76 | 6.56 | 54.00 | 19.24 | Vertical | PASS |
| 2 | 2400.00 | 28.06 | 34.67 | 6.61 | 54.00 | 19.33 | Vertical | PASS |
| 3 | 2390.00 | 35.41 | 41.97 | 6.56 | 74.00 | 32.03 | Vertical | PASS |
| 4 | 2400.00 | 34.80 | 41.41 | 6.61 | 74.00 | 32.59 | Vertical | PASS |

## Mode1 / Polarization: Horizontal / CH: H




| Suspected Data List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
| 1 | 2483.5 | 27.77 | 34.33 | 6.56 | 54.00 | 19.67 | Horizontal | PASS |
| 2 | 2500 | 29.86 | 36.41 | 6.55 | 54.00 | 17.59 | Horizontal | PASS |
| 3 | 2483.5 | 35.62 | 42.18 | 6.56 | 74.00 | 31.82 | Horizontal | PASS |
| 4 | 2500 | 35.60 | 42.15 | 6.55 | 74.00 | 31.85 | Horizontal | PASS |

## Mode1 / Polarization: Vertical / CH: H




| Suspected Data List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
| 1 | 2483.5 | 27.64 | 34.20 | 6.56 | 54.00 | 19.80 | Vertical | PASS |
| 2 | 2500 | 28.24 | 34.79 | 6.55 | 54.00 | 19.21 | Vertical | PASS |
| 3 | 2483.5 | 33.60 | 40.16 | 6.56 | 74.00 | 33.84 | Vertical | PASS |
| 4 | 2500 | 35.31 | 41.86 | 6.55 | 74.00 | 32.14 | Vertical | PASS |

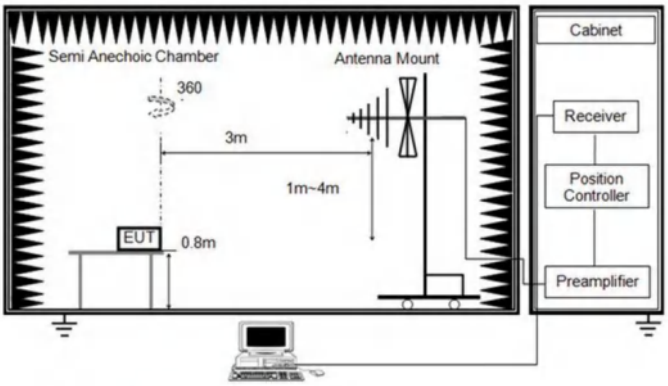
## 5.2.8. Radiated Spurious Emission (below 1GHz)

<table>
<tr><td>Test Requirement:</td><td>Refer to 47 CFR 15.247(d), 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)).`</td></tr>
<tr><td>Test Limit:</td><td>
<table>
<tr><td>Frequency (MHz)</td><td>Field strength (microvolts/meter)</td><td>Measurement distance (meters)</td></tr>
<tr><td>0.009-0.490</td><td>2400/F(kHz)</td><td>300</td></tr>
<tr><td>0.490-1.705</td><td>24000/F(kHz)</td><td>30</td></tr>
<tr><td>1.705-30.0</td><td>30</td><td>30</td></tr>
<tr><td>30-88</td><td>100 **</td><td>3</td></tr>
<tr><td>88-216</td><td>150 **</td><td>3</td></tr>
<tr><td>216-960</td><td>200 **</td><td>3</td></tr>
<tr><td>Above 960</td><td>500</td><td>3</td></tr>
</table>
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.<br>In the emission table above, the tighter limit applies at the band edges.<br>The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
</td></tr>
<tr><td>Test Method:</td><td>ANSI C63.10-2020 section 6.6.4</td></tr>
<tr><td>Procedure:</td><td>1. The EUT was setup and tested according to ANSI C63.10.<br>2. The EUT is placed on a turn table which is 0.8 meter above ground for below 1 GHz, and 1.5 m for above 1 GHz. The turn table is rotated 360 degrees to determine the position of the maximum emission level.<br>3. The EUT was set 3 meters from the receiving antenna, which was mounted on the top of a variable height antenna tower.<br>4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.<br>5. Set to the maximum power setting and enable the EUT transmit continuously.<br>6. Use the following spectrum analyzer settings<br>a) Span shall wide enough to fully capture the emission being measured;<br>b) RBW=120 kHz, VBW=300 kHz, Sweep=auto, Detector function=peak, Trace=max hold;<br>If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.</td></tr>
</table>

### 5.2.8.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 23 °C | Humidity: | 56.8 % | Atmospheric Pressure: | 103 kPa |
| Pre test mode: | TM1, TM2, TM3, TM4, TM5, TM6,TM7,TM8 | | | | |
| Final test mode: | TM1, TM2, TM3, TM4, TM5, TM6,TM7,TM8 | | | | |

### 5.2.8.2. Test Setup Diagram




Below 1 GHz and above 30 MHz

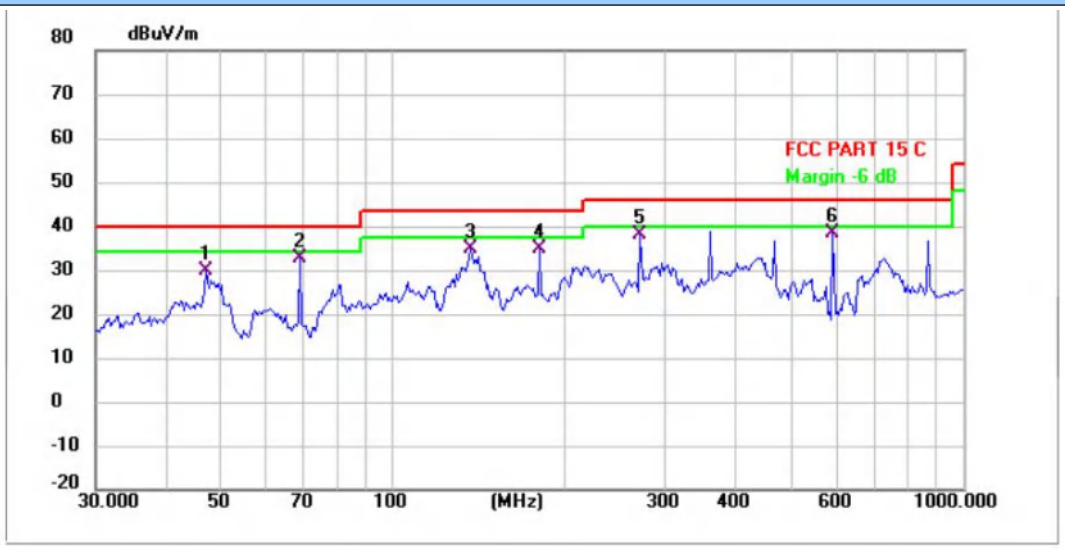
### 5.2.8.3. Test Result

Pass

### 5.2.8.4. Test Data

Have pre-scan all test channel, found CH00(GFSK DH5) mode which it was worst case, so only show the worst case's data on this report.

Mode1 / Polarization: Horizontal / CH: L




| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB/m) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 46.995 | 58.97 | -29.24 | 29.73 | 40.00 | -10.27 | QP |
| 2 * | 68.631 | 65.26 | -32.70 | 32.56 | 40.00 | -7.44 | QP |
| 3 | 136.460 | 69.07 | -34.17 | 34.90 | 43.50 | -8.60 | QP |
| 4 | 180.649 | 66.28 | -31.63 | 34.65 | 43.50 | -8.85 | QP |
| 5 | 271.325 | 66.17 | -28.23 | 37.94 | 46.00 | -8.06 | QP |
| 6 | 590.974 | 58.11 | -19.58 | 38.53 | 46.00 | -7.47 | QP |

Mode1 / Polarization: Vertical / CH: L

| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB/m) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 42.302 | 59.12 | -30.11 | 29.01 | 40.00 | -10.99 | QP |
| 2 | 49.359 | 55.69 | -29.14 | 26.55 | 40.00 | -13.45 | QP |
| 3 | 122.834 | 56.11 | -32.47 | 23.64 | 43.50 | -19.86 | QP |
| 4 * | 275.157 | 64.19 | -28.12 | 36.07 | 46.00 | -9.93 | QP |
| 5 | 419.108 | 60.28 | -24.35 | 35.93 | 46.00 | -10.07 | QP |
| 6 | 704.226 | 49.57 | -16.92 | 32.65 | 46.00 | -13.35 | QP |

Note:
1) For 9 kHz ~ 30 MHz Measurement
The EUT was pre-scanned this frequency band, found the radiated level 20dB lower than the limit, so don't show data on this report.
2) Level= Reading + Factor; Factor =Antenna Factor+ Cable Loss- Preamp Factor
3) Margin = Limit – Level

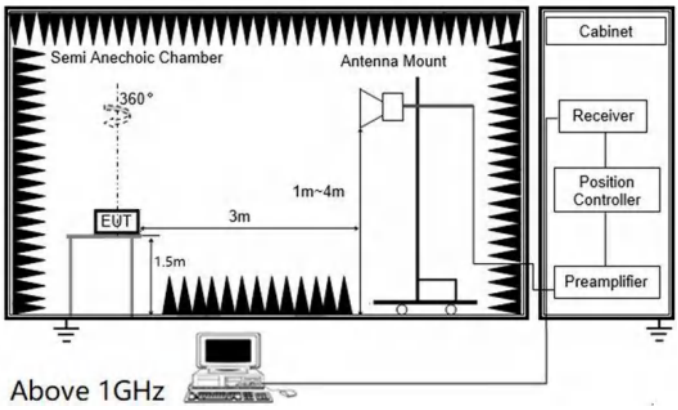
## 5.2.9. Radiated Spurious Emission (Above 1GHz)

<table>
<tr><td>Test Requirement:</td><td>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)).`</td></tr>
<tr><td>Test Limit:</td><td>
<table>
<tr><td>Frequency (MHz)</td><td>Field strength (microvolts/meter)</td><td>Measurement distance (meters)</td></tr>
<tr><td>0.009-0.490</td><td>2400/F(kHz)</td><td>300</td></tr>
<tr><td>0.490-1.705</td><td>24000/F(kHz)</td><td>30</td></tr>
<tr><td>1.705-30.0</td><td>30</td><td>30</td></tr>
<tr><td>30-88</td><td>100 **</td><td>3</td></tr>
<tr><td>88-216</td><td>150 **</td><td>3</td></tr>
<tr><td>216-960</td><td>200 **</td><td>3</td></tr>
<tr><td>Above 960</td><td>500</td><td>3</td></tr>
</table>
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.<br>In the emission table above, the tighter limit applies at the band edges.<br>The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
</td></tr>
<tr><td>Test Method:</td><td>ANSI C63.10-2020 section 6.6.4</td></tr>
<tr><td>Procedure:</td><td>1. The EUT was setup and tested according to ANSI C63.10.<br>2. The EUT is placed on a turn table which is 0.8 meter above ground for below 1 GHz, and 1.5 m for above 1 GHz. The turn table is rotated 360 degrees to determine the position of the maximum emission level.<br>3. The EUT was set 3 meters from the receiving antenna, which was mounted on the top of a variable height antenna tower.<br>4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.<br>5. Set to the maximum power setting and enable the EUT transmit continuously.<br>6. Use the following spectrum analyzer settings<br>a) Span shall wide enough to fully capture the emission being measured;<br>b) Set RBW=1MHz, VBW=3MHz for >1GHz, Sweep time=auto, Detector=peak, Trace=max hold for Peak measurement<br>For average measurement: use duty cycle correction factor method (DCCF)Averager level = Peak level + DCCF</td></tr>
</table>

### 5.2.9.1. E.U.T. Operation

| Operating Environment: | | | | | |
|---|---|---|---|---|---|
| Temperature: | 23 °C | Humidity: | 56.8 % | Atmospheric Pressure: | 103 kPa |
| Pre test mode: | TM1, TM2, TM3, TM4, TM5, TM6,TM7,TM8 | | | | |
| Final test mode: | TM1, TM2, TM3, TM4, TM5, TM6,TM7,TM8 | | | | |

### 5.2.9.2. Test Setup Diagram




### 5.2.9.3. Test Result

Pass

### 5.2.9.4. Test Data

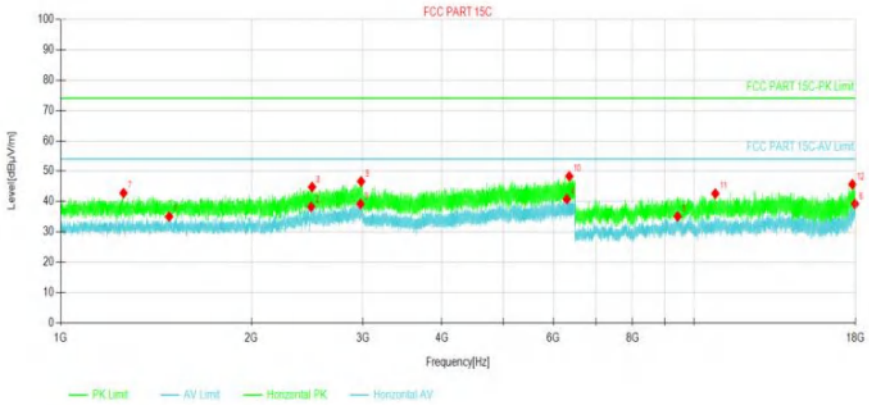
Note:

1. In order to prevent the amplifier from saturating, we add a band-stop filter that filters out the main frequency.

2.18GHz-25GHz is the background of the site, there is no radiated spurious.

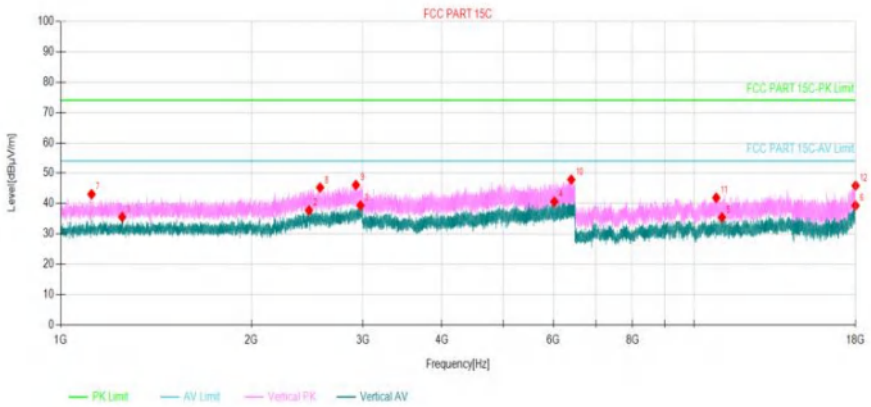
3.Have pre-scan all test mode, found GFSK-DH5 which it was worst case, so only show the worst case’s data on this report.

Mode1 / Polarization: Horizontal / CH: L




| Suspected Data List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
| 1 | 1483.4 | 31.86 | 35.04 | 3.18 | 54.00 | 18.96 | Horizontal | PASS |
| 2 | 2486.2 | 30.61 | 38.25 | 7.64 | 54.00 | 15.75 | Horizontal | PASS |
| 3 | 2974.4 | 29.46 | 39.21 | 9.75 | 54.00 | 14.79 | Horizontal | PASS |
| 4 | 6298.05 | 34.93 | 40.81 | 5.88 | 54.00 | 13.19 | Horizontal | PASS |
| 5 | 9426.75 | 32.02 | 35.09 | 3.07 | 54.00 | 18.91 | Horizontal | PASS |
| 6 | 17964.3 | 25.95 | 39.25 | 13.30 | 54.00 | 14.75 | Horizontal | PASS |
| 7 | 1256.8 | 40.66 | 42.79 | 2.13 | 74.00 | 31.21 | Horizontal | PASS |
| 8 | 2494.2 | 37.08 | 44.78 | 7.70 | 74.00 | 29.22 | Horizontal | PASS |
| 9 | 2981.4 | 36.83 | 46.64 | 9.81 | 74.00 | 27.36 | Horizontal | PASS |
| 10 | 6356.15 | 42.11 | 48.35 | 6.24 | 74.00 | 25.65 | Horizontal | PASS |
| 11 | 10807.9 | 37.74 | 42.62 | 4.88 | 74.00 | 31.38 | Horizontal | PASS |
| 12 | 17795.3 | 32.61 | 45.68 | 13.07 | 74.00 | 28.32 | Horizontal | PASS |

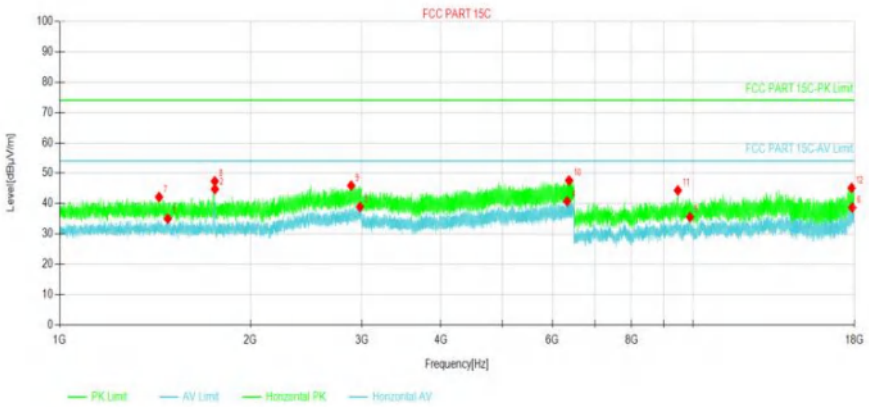
## Mode1 / Polarization: Vertical / CH: L




**Suspected Data List**

| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
|---|---|---|---|---|---|---|---|---|
| 1 | 1251 | 33.47 | 35.56 | 2.09 | 54.00 | 18.44 | Vertical | PASS |
| 2 | 2467.4 | 30.28 | 37.78 | 7.50 | 54.00 | 16.22 | Vertical | PASS |
| 3 | 2974.8 | 29.61 | 39.37 | 9.76 | 54.00 | 14.63 | Vertical | PASS |
| 4 | 6020.15 | 35.32 | 40.61 | 5.29 | 54.00 | 13.39 | Vertical | PASS |
| 5 | 11073.5 | 30.67 | 35.42 | 4.75 | 54.00 | 18.58 | Vertical | PASS |
| 6 | 17998.8 | 25.82 | 39.34 | 13.52 | 54.00 | 14.66 | Vertical | PASS |
| 7 | 1118.6 | 41.86 | 43.08 | 1.22 | 74.00 | 30.92 | Vertical | PASS |
| 8 | 2568.6 | 37.86 | 45.27 | 7.41 | 74.00 | 28.73 | Vertical | PASS |
| 9 | 2925.6 | 36.78 | 46.12 | 9.34 | 74.00 | 27.88 | Vertical | PASS |
| 10 | 6402 | 41.37 | 47.90 | 6.53 | 74.00 | 26.10 | Vertical | PASS |
| 11 | 10844.7 | 37.09 | 41.92 | 4.83 | 74.00 | 32.08 | Vertical | PASS |
| 12 | 18000 | 32.37 | 45.90 | 13.53 | 74.00 | 28.10 | Vertical | PASS |

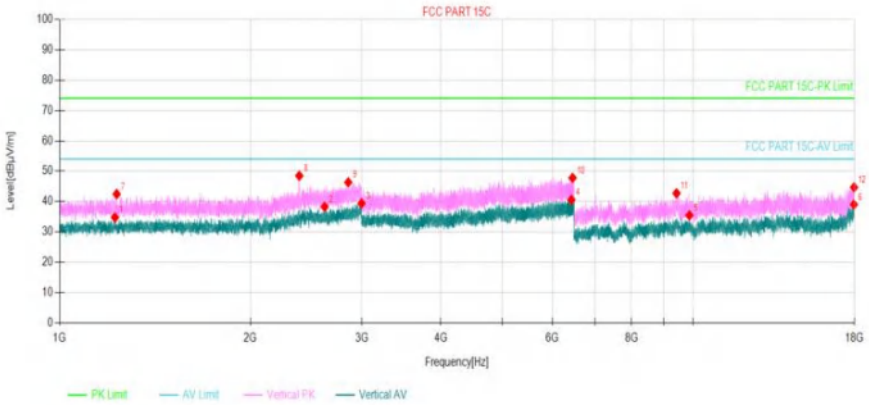
## Mode1 / Polarization: Horizontal / CH: M




**Suspected Data List**

| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
|---|---|---|---|---|---|---|---|---|
| 1 | 1481.8 | 31.83 | 35.01 | 3.18 | 54.00 | 18.99 | Horizontal | PASS |
| 2 | 1758.6 | 41.14 | 44.76 | 3.62 | 54.00 | 9.24 | Horizontal | PASS |
| 3 | 2980.4 | 29.11 | 38.91 | 9.80 | 54.00 | 15.09 | Horizontal | PASS |
| 4 | 6329.2 | 34.66 | 40.73 | 6.07 | 54.00 | 13.27 | Horizontal | PASS |
| 5 | 9894.8 | 32.09 | 35.54 | 3.45 | 54.00 | 18.46 | Horizontal | PASS |
| 6 | 17853.9 | 25.69 | 38.69 | 13.00 | 54.00 | 15.31 | Horizontal | PASS |
| 7 | 1435.6 | 39.11 | 42.15 | 3.04 | 74.00 | 31.85 | Horizontal | PASS |
| 8 | 1757.6 | 43.74 | 47.36 | 3.62 | 74.00 | 26.64 | Horizontal | PASS |
| 9 | 2886 | 36.88 | 45.90 | 9.02 | 74.00 | 28.10 | Horizontal | PASS |
| 10 | 6373.65 | 41.24 | 47.60 | 6.36 | 74.00 | 26.40 | Horizontal | PASS |
| 11 | 9465.85 | 41.22 | 44.35 | 3.13 | 74.00 | 29.65 | Horizontal | PASS |
| 12 | 17811.4 | 32.05 | 45.16 | 13.11 | 74.00 | 28.84 | Horizontal | PASS |

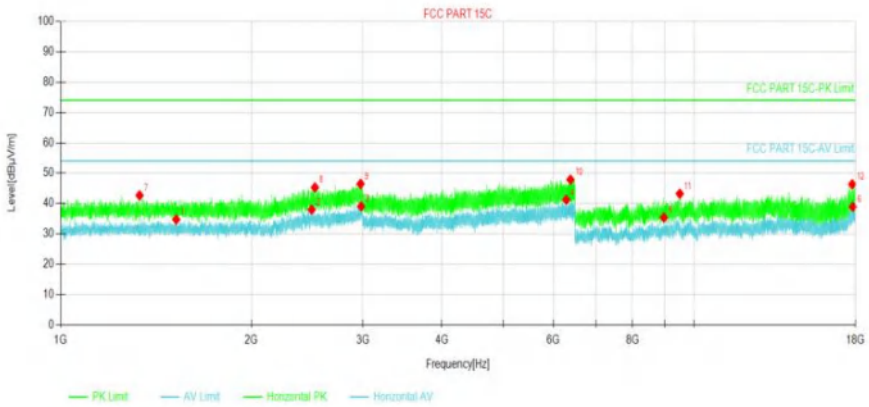
## Mode1 / Polarization: Vertical / CH: M




**Suspected Data List**

| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
|---|---|---|---|---|---|---|---|---|
| 1 | 1222.6 | 32.86 | 34.77 | 1.91 | 54.00 | 19.23 | Vertical | PASS |
| 2 | 2620.6 | 30.89 | 38.26 | 7.37 | 54.00 | 15.74 | Vertical | PASS |
| 3 | 2996.2 | 29.46 | 39.40 | 9.94 | 54.00 | 14.60 | Vertical | PASS |
| 4 | 6426.5 | 34.05 | 40.58 | 6.53 | 54.00 | 13.42 | Vertical | PASS |
| 5 | 9871.8 | 32.06 | 35.46 | 3.40 | 54.00 | 18.54 | Vertical | PASS |
| 6 | 17955.1 | 25.76 | 39.01 | 13.25 | 54.00 | 14.99 | Vertical | PASS |
| 7 | 1230.4 | 40.52 | 42.48 | 1.96 | 74.00 | 31.52 | Vertical | PASS |
| 8 | 2390 | 41.56 | 48.50 | 6.94 | 74.00 | 25.50 | Vertical | PASS |
| 9 | 2855.8 | 37.52 | 46.34 | 8.82 | 74.00 | 27.66 | Vertical | PASS |
| 10 | 6455.55 | 41.26 | 47.79 | 6.53 | 74.00 | 26.21 | Vertical | PASS |
| 11 | 9421 | 39.66 | 42.73 | 3.07 | 74.00 | 31.27 | Vertical | PASS |
| 12 | 17965.5 | 31.37 | 44.68 | 13.31 | 74.00 | 29.32 | Vertical | PASS |

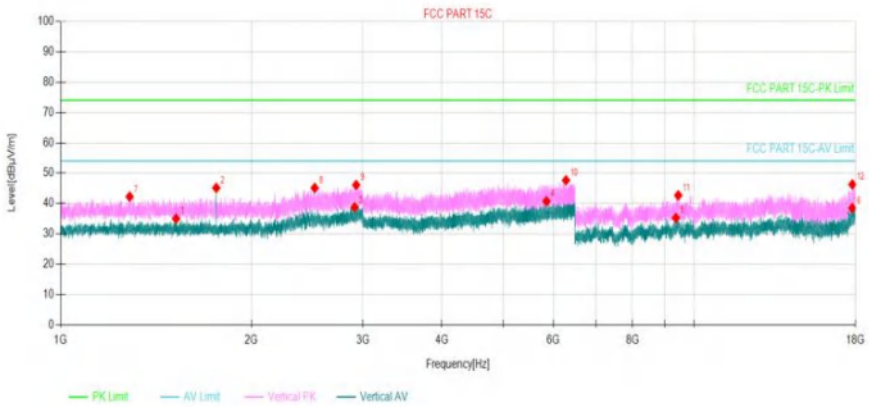
## Mode1 / Polarization: Horizontal / CH: H




**Suspected Data List**

| NO. | Freq. [MHz] | Reading [dBμV/m] | Level [dBμV/m] | Factor [dB] | Limit [dBμV/m] | Margin [dB] | Polarity | Verdict |
|---|---|---|---|---|---|---|---|---|
| 1 | 1522.4 | 31.52 | 34.75 | 3.23 | 54.00 | 19.25 | Horizontal | PASS |
| 2 | 2490.8 | 30.34 | 38.01 | 7.67 | 54.00 | 15.99 | Horizontal | PASS |
| 3 | 2981.4 | 29.27 | 39.08 | 9.81 | 54.00 | 14.92 | Horizontal | PASS |
| 4 | 6287.55 | 35.38 | 41.23 | 5.85 | 54.00 | 12.77 | Horizontal | PASS |
| 5 | 8966.75 | 33.45 | 35.38 | 1.93 | 54.00 | 18.62 | Horizontal | PASS |
| 6 | 17821.7 | 25.87 | 38.95 | 13.08 | 54.00 | 15.05 | Horizontal | PASS |
| 7 | 1332.2 | 40.12 | 42.69 | 2.57 | 74.00 | 31.31 | Horizontal | PASS |
| 8 | 2520.8 | 37.66 | 45.30 | 7.64 | 74.00 | 28.70 | Horizontal | PASS |
| 9 | 2975.6 | 36.73 | 46.49 | 9.76 | 74.00 | 27.51 | Horizontal | PASS |
| 10 | 6384.15 | 41.44 | 47.87 | 6.43 | 74.00 | 26.13 | Horizontal | PASS |
| 11 | 9499.2 | 40.08 | 43.25 | 3.17 | 74.00 | 30.75 | Horizontal | PASS |
| 12 | 17776.9 | 33.54 | 46.36 | 12.82 | 74.00 | 27.64 | Horizontal | PASS |

## Mode1 / Polarization: Vertical / CH: H




**Suspected Data List**

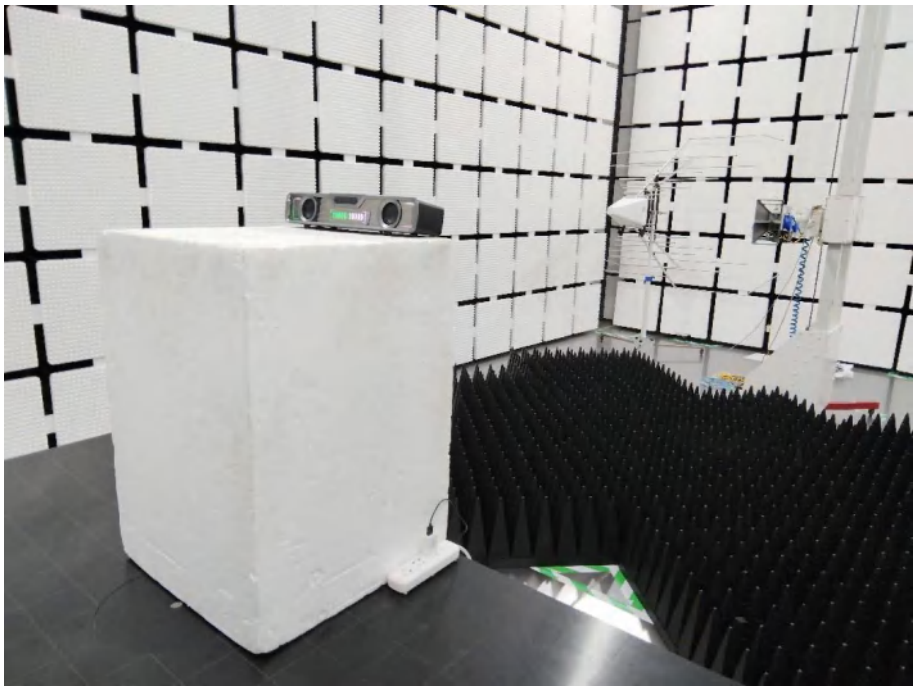
| NO. | Freq. [MHz] | Reading [dBµV/m] | Level [dBµV/m] | Factor [dB] | Limit [dBµV/m] | Margin [dB] | Polarity | Verdict |
|---|---|---|---|---|---|---|---|---|
| 1 | 1521 | 31.78 | 35.01 | 3.23 | 54.00 | 18.99 | Vertical | PASS |
| 2 | 1760.6 | 41.55 | 45.17 | 3.62 | 54.00 | 8.83 | Vertical | PASS |
| 3 | 2912 | 29.55 | 38.77 | 9.22 | 54.00 | 15.23 | Vertical | PASS |
| 4 | 5849.7 | 36.07 | 40.78 | 4.71 | 54.00 | 13.22 | Vertical | PASS |
| 5 | 9366.95 | 32.38 | 35.27 | 2.89 | 54.00 | 18.73 | Vertical | PASS |
| 6 | 17781.5 | 25.60 | 38.48 | 12.88 | 54.00 | 15.52 | Vertical | PASS |
| 7 | 1285 | 39.96 | 42.27 | 2.31 | 74.00 | 31.73 | Vertical | PASS |
| 8 | 2518.8 | 37.50 | 45.15 | 7.65 | 74.00 | 28.85 | Vertical | PASS |
| 9 | 2928.6 | 36.75 | 46.11 | 9.36 | 74.00 | 27.89 | Vertical | PASS |
| 10 | 6280.9 | 41.84 | 47.67 | 5.83 | 74.00 | 26.33 | Vertical | PASS |
| 11 | 9447.45 | 39.61 | 42.71 | 3.10 | 74.00 | 31.29 | Vertical | PASS |
| 12 | 17791.8 | 33.28 | 46.30 | 13.02 | 74.00 | 27.70 | Vertical | PASS |

Note:
1) Level= Reading + Factor; Factor =Antenna Factor+ Cable Loss- Preamp Factor
2) Margin = Limit – Level
3) Average measurement was not performed if peak level is lower than average limit (54dBuV/m) for above 1GHz.

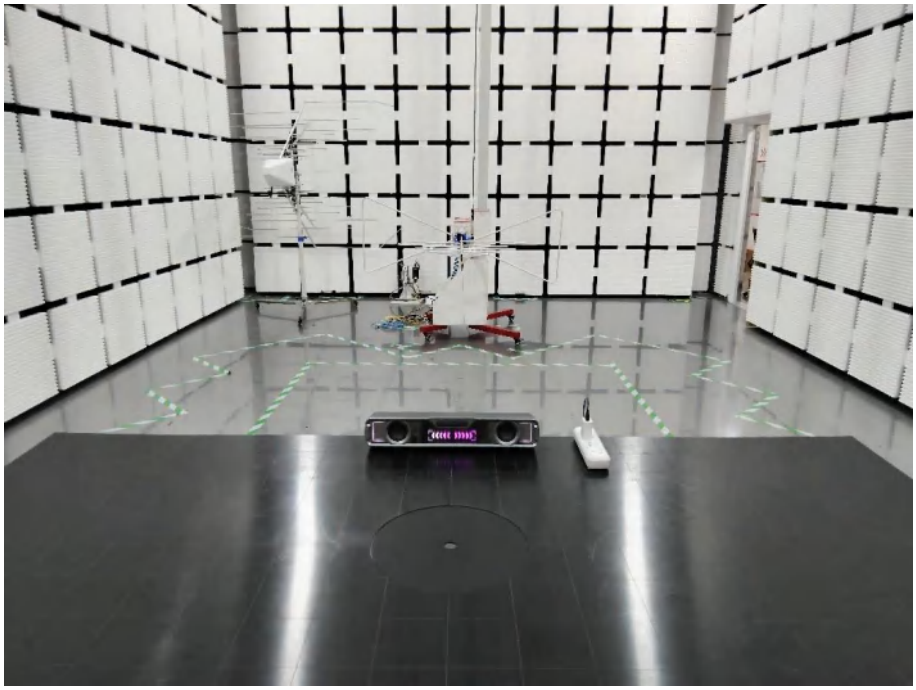
# 6. TEST SETUP PHOTOS

Conducted Emission at AC power line

Radiated band edge emission
Radiated Spurious Emission (Above 1GHz)

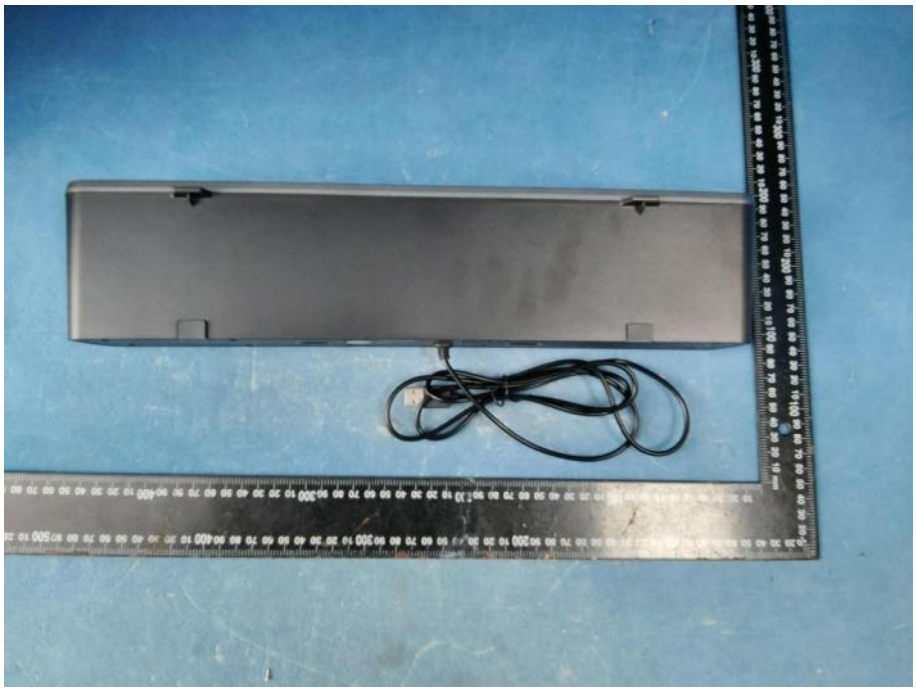


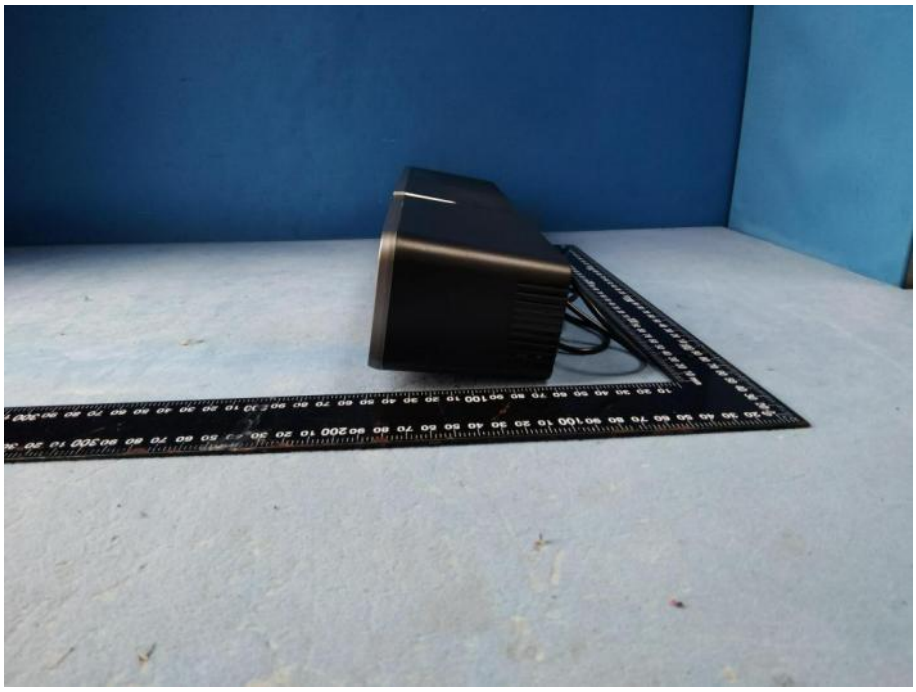
Radiated Spurious Emission (below 1GHz)



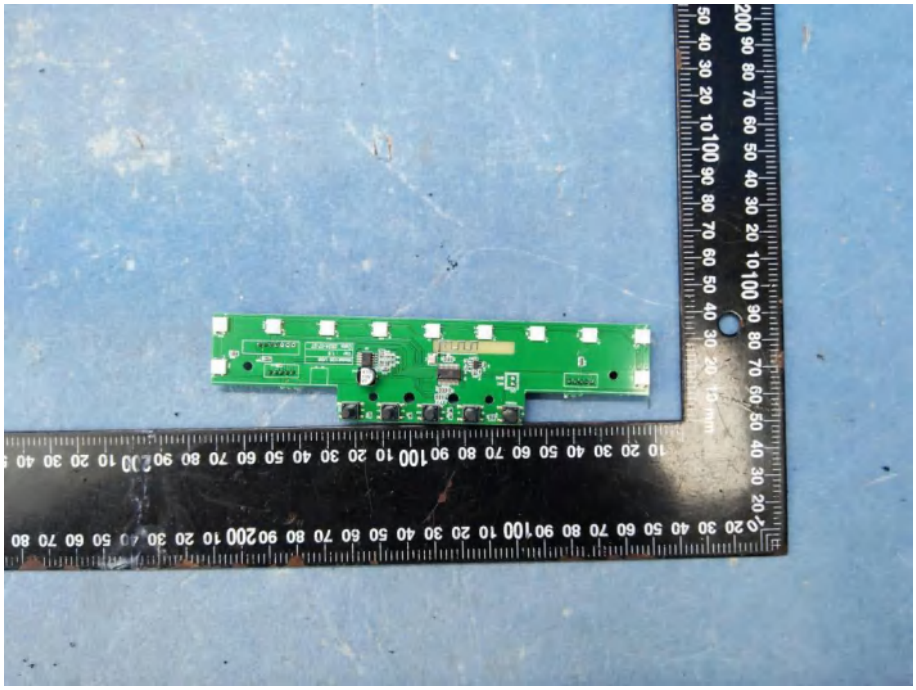
# 7. EXTERNAL AND INTERNAL PHOTOS

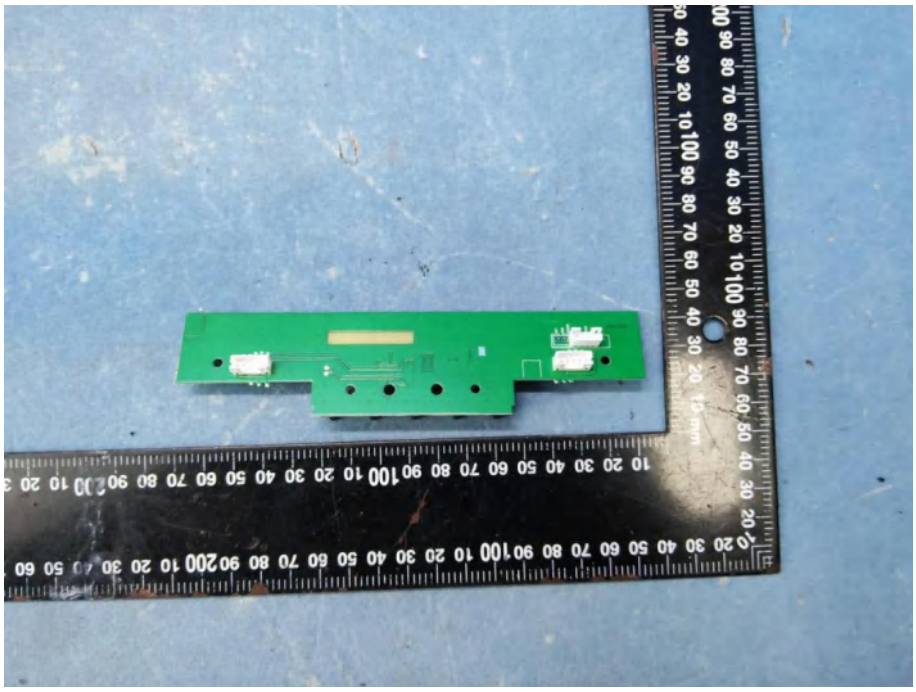
## 7.1. External Photos

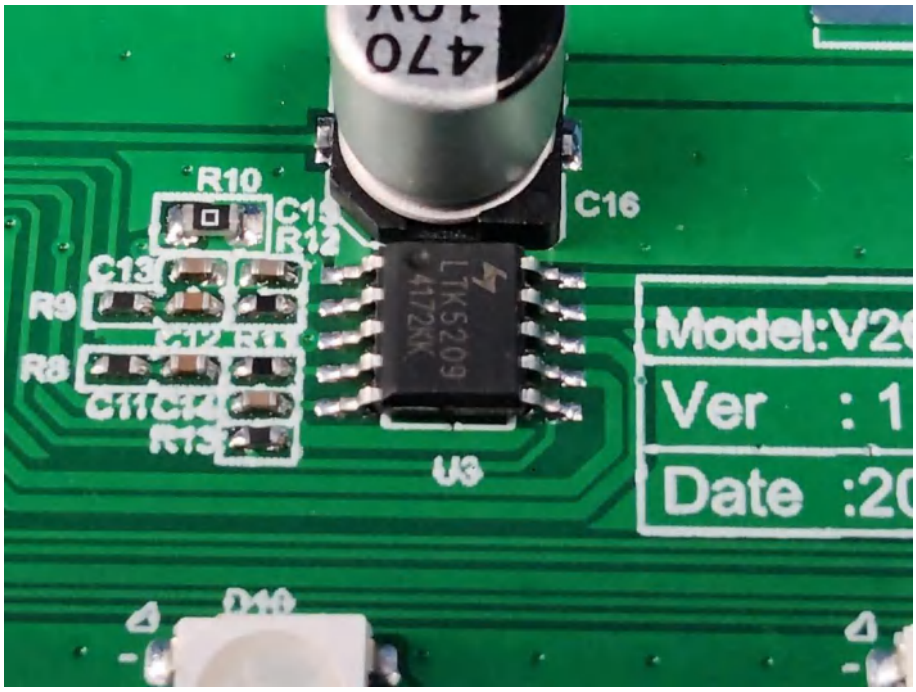


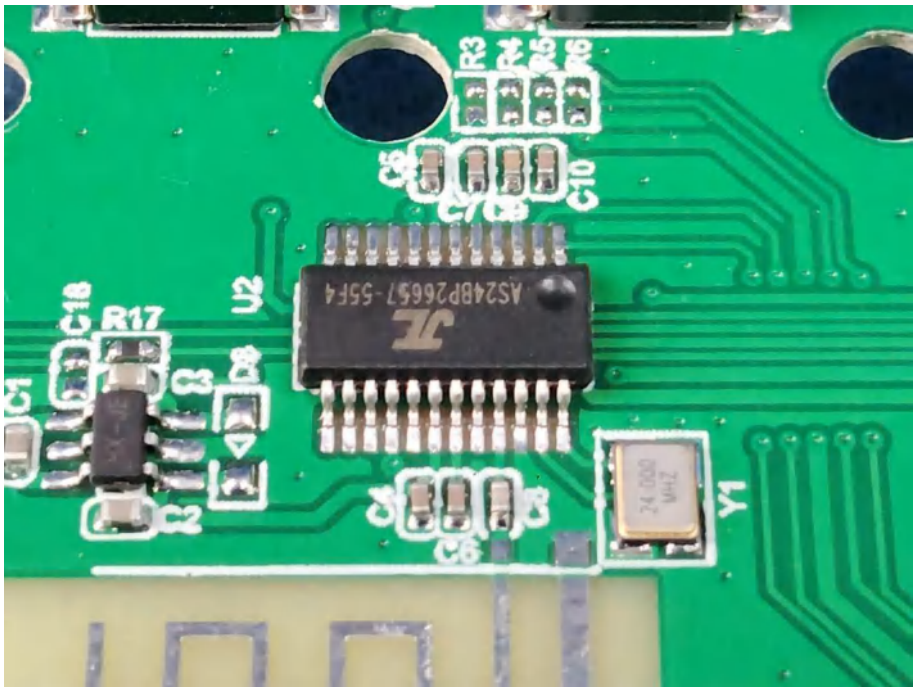


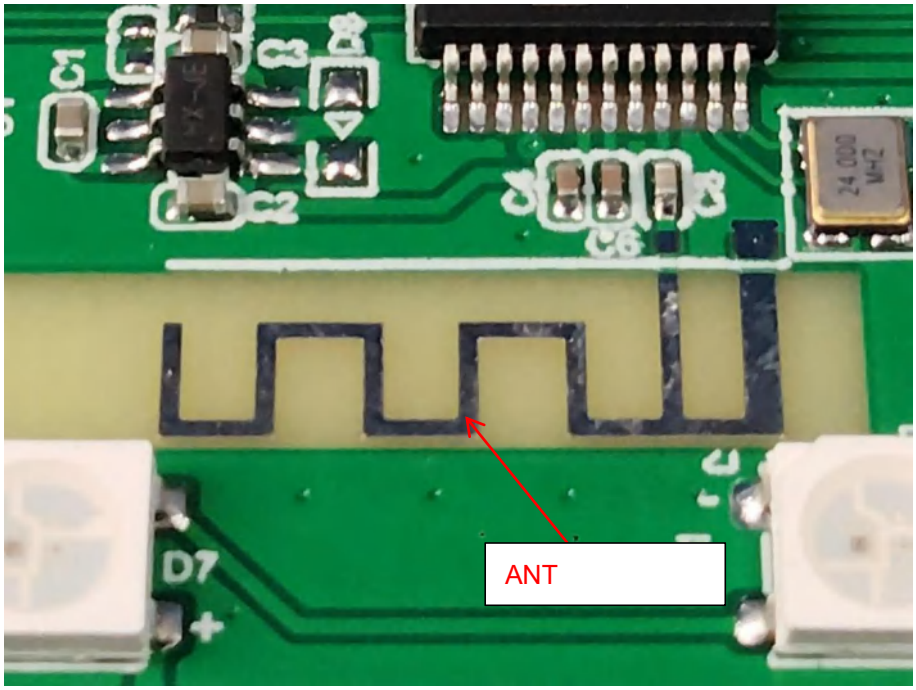
## 7.2. Internal Photos






470
R10
C16
C13
R9
R8
LTK5209
4172KK
U3
Model:V2
Ver : 1
Date :2




## 8. Appendix Report

# Appendix Report

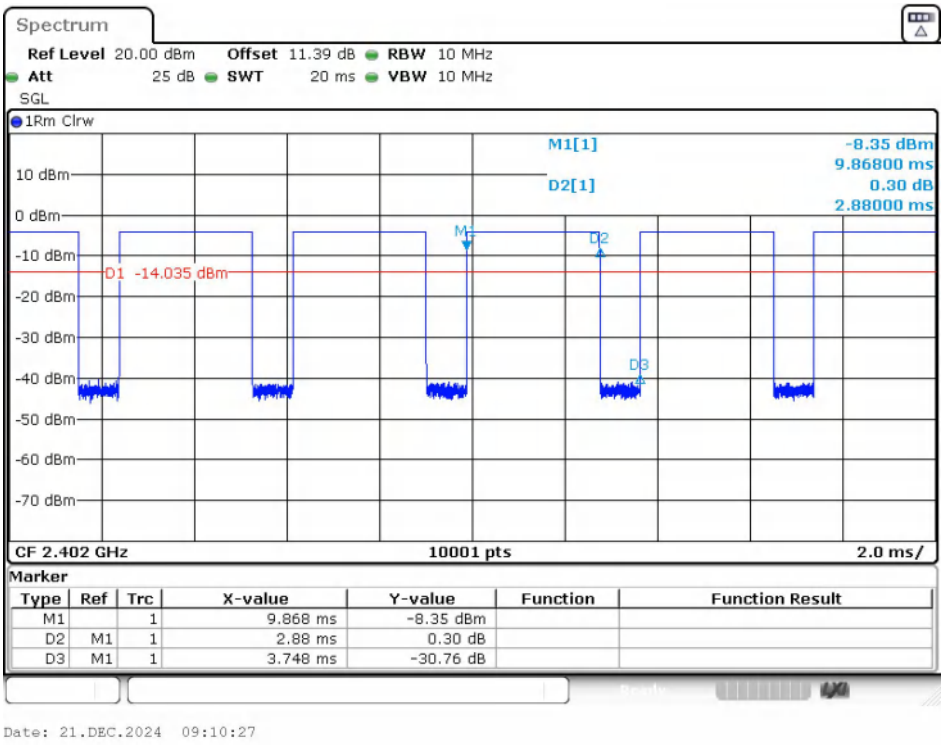
| | |
|---|---|
| CISR241220176 | CISRR241220176 |
| Test Engineer: | Mark Fu |
| Supervised by: | Rory Huang |

# 1) Duty Cycle

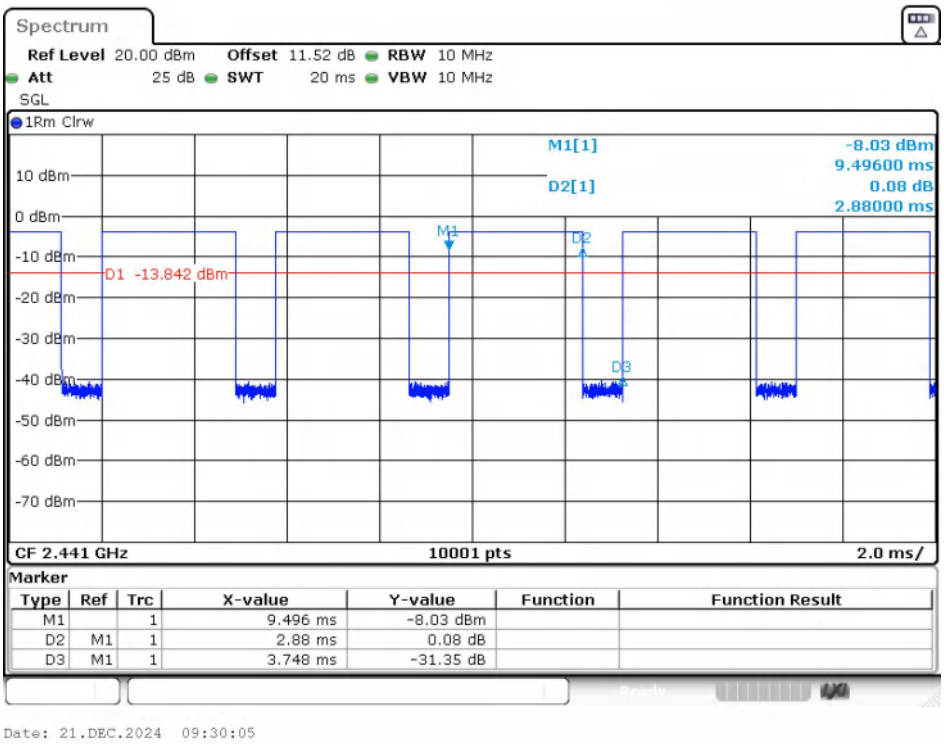
**Test Result**

| Modulation | Packets | Channel | On Time (ms) | Period (ms) | Duty Cycle (%) | Duty Cycle (linear) | Duty Cycle Factor (dB) | 1/T |
|---|---|---|---|---|---|---|---|---|
| GFSK | DH5 | 0 | 2.880 | 3.748 | 76.84 | 0.7684 | 1.1441 | 0.3472 |
| | | 39 | 2.880 | 3.748 | 76.84 | 0.7684 | 1.1441 | 0.3472 |
| | | 78 | 2.880 | 3.748 | 76.84 | 0.7684 | 1.1441 | 0.3472 |
| π/4DQPSK | 2-DH5 | 0 | 2.886 | 3.748 | 77.00 | 0.7700 | 1.1351 | 0.3465 |
| | | 39 | 2.886 | 3.748 | 77.00 | 0.7700 | 1.1351 | 0.3465 |
| | | 78 | 2.886 | 3.748 | 77.00 | 0.7700 | 1.1351 | 0.3465 |
| 8DPSK | 3-DH5 | 0 | 2.886 | 3.748 | 77.00 | 0.7700 | 1.1351 | 0.3465 |
| | | 39 | 2.886 | 3.748 | 77.00 | 0.7700 | 1.1351 | 0.3465 |
| | | 78 | 2.886 | 3.748 | 77.00 | 0.7700 | 1.1351 | 0.3465 |

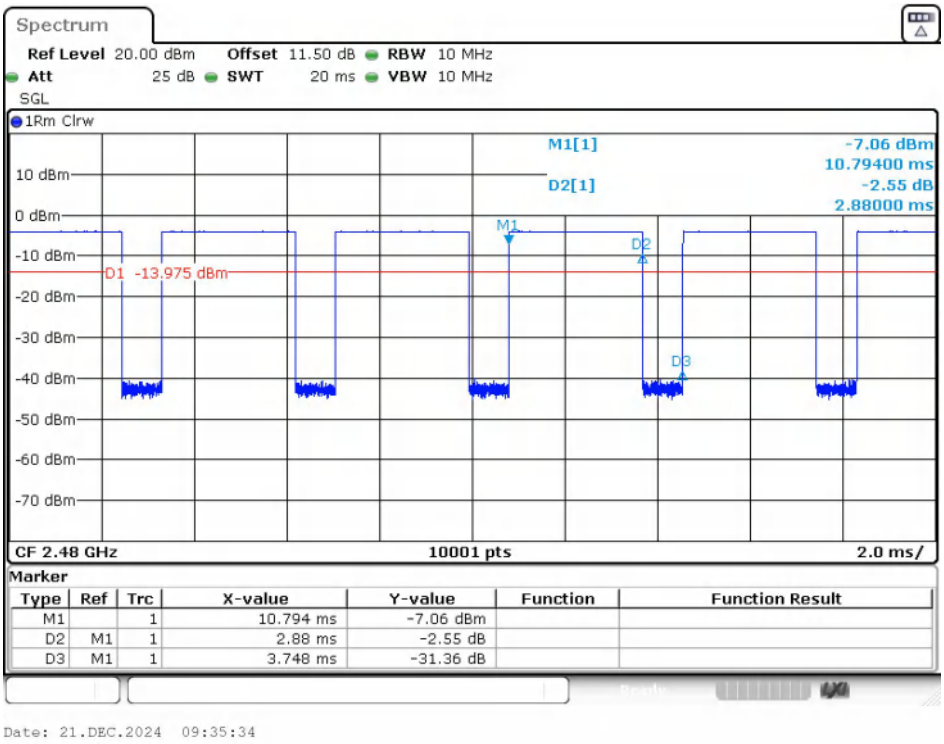
**Test Graphs**



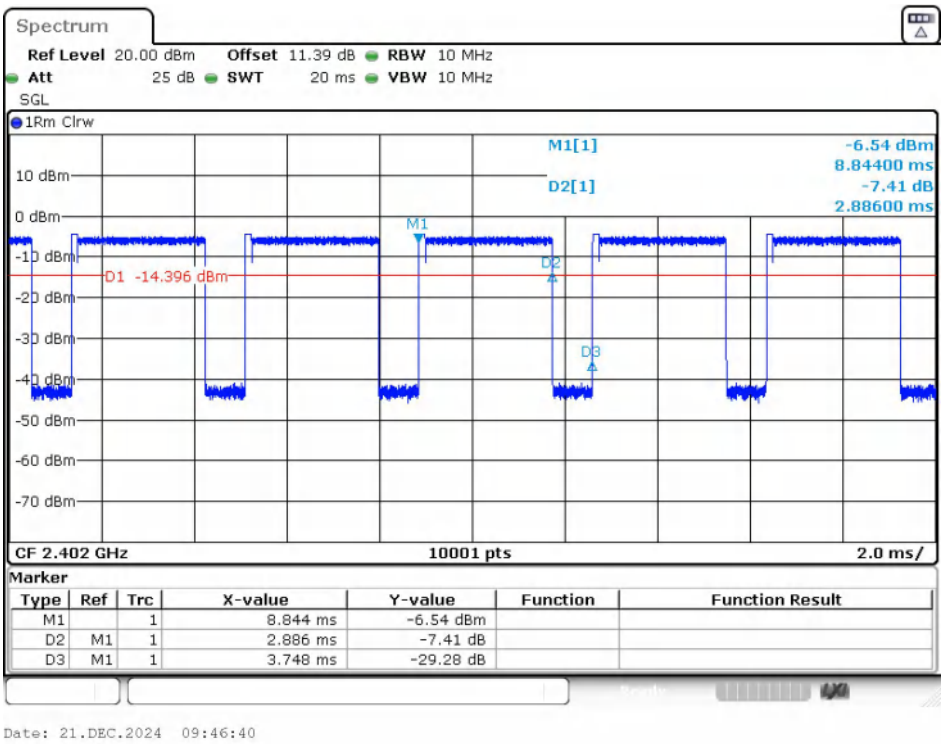

GFSK(DH5)_Channel 0



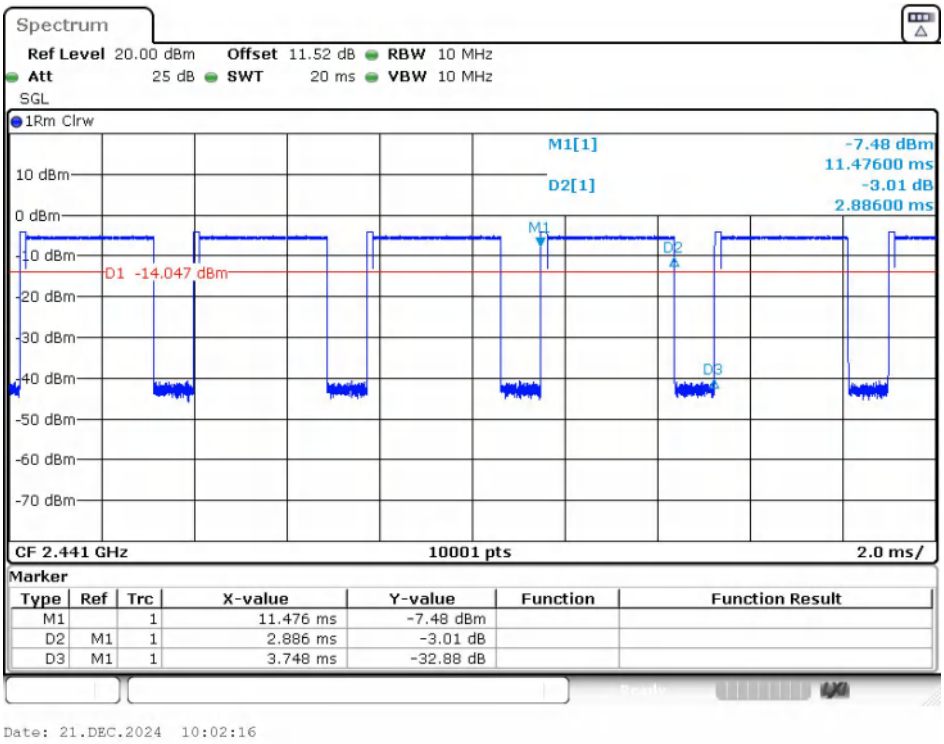

GFSK(DH5)_Channel 39



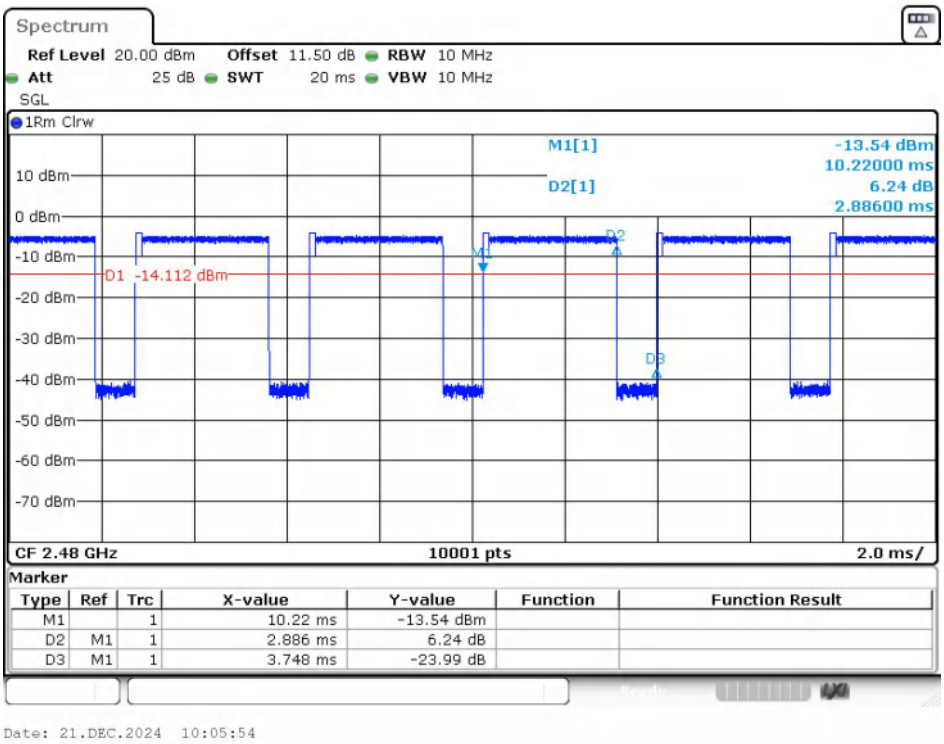

GFSK(DH5)_Channel 78



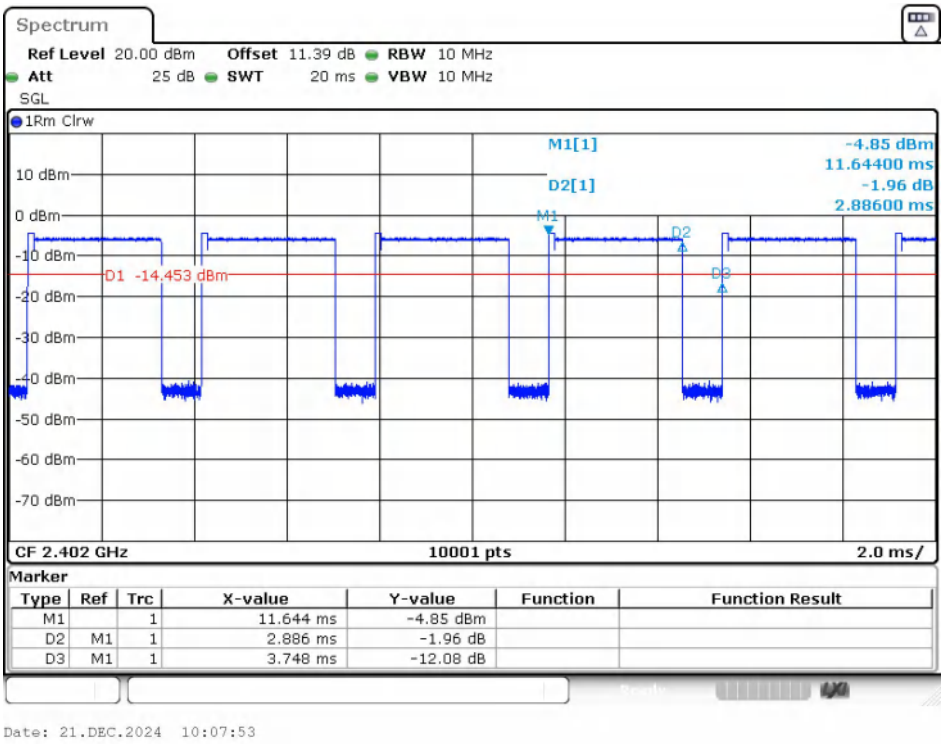

π/4DQPSK(2-DH5)_Channel 0



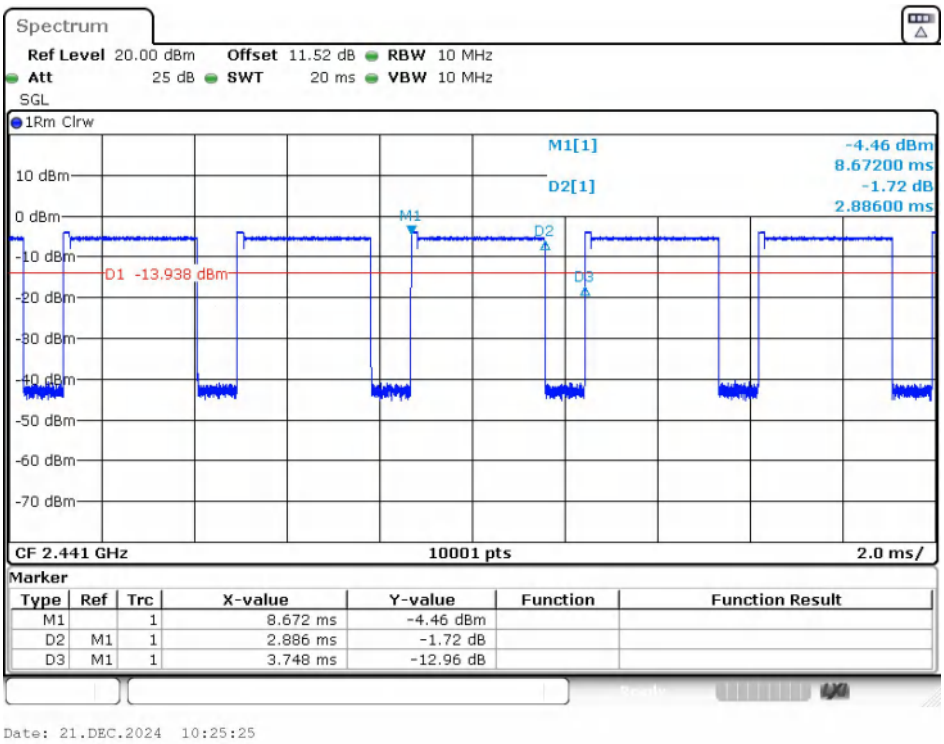

π/4DQPSK(2-DH5)_Channel 39



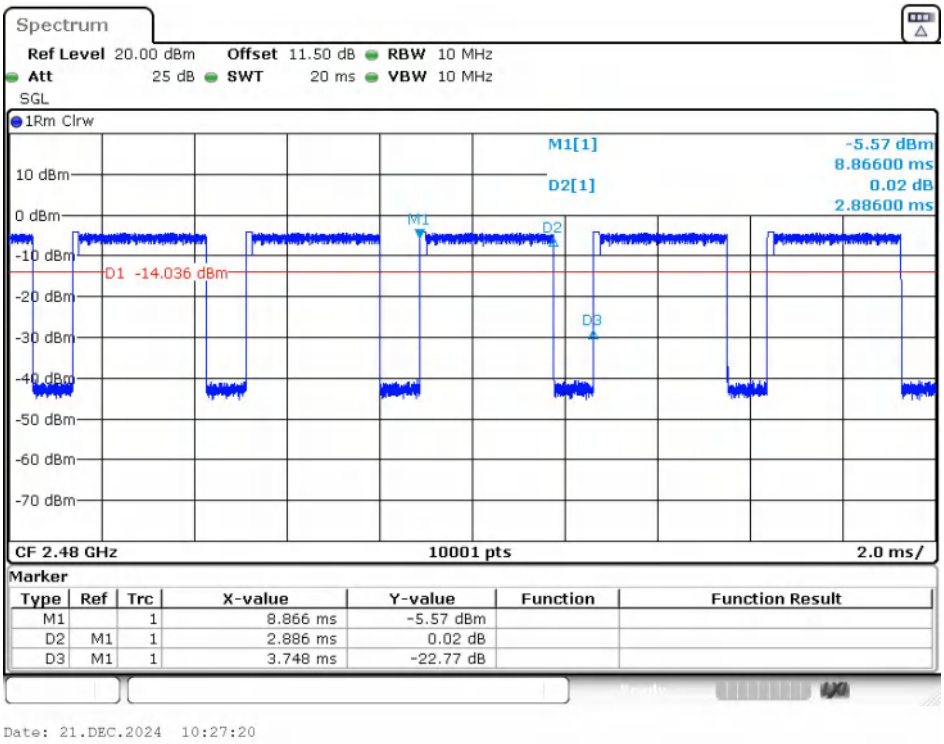

π/4DQPSK(2-DH5)_Channel 78




8DPSK(3-DH5)_Channel 0




**8DPSK(3-DH5)_Channel 39**



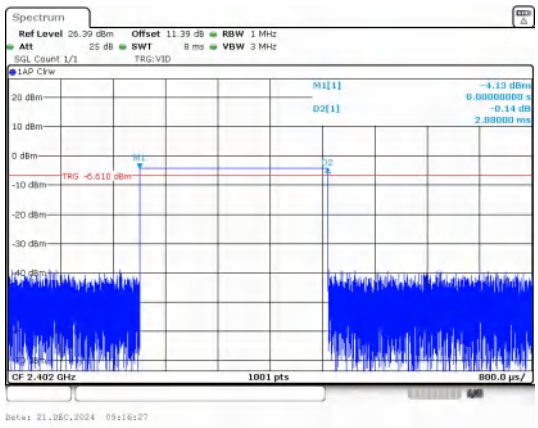

**8DPSK(3-DH5)_Channel 78**

# 2) Dwell Time

**Test Result**

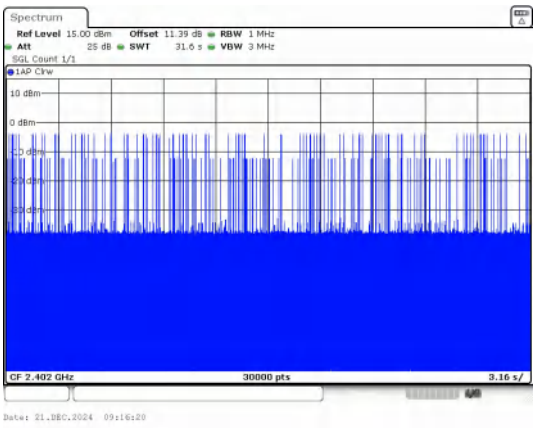
| Modulation | Packet | Channel | Pulse Width (ms) | Number of Pulses in 31.6 seconds | Dwell Time (ms) | Limit (ms) | Result |
|---|---|---|---|---|---|---|---|
| GFSK | DH5 | CH0 (2402MHz) | 2.880 | 101 | 290.88 | < 400 | PASS |
| π/4DQPSK | 2-DH5 | | 2.888 | 111 | 320.57 | | PASS |
| 8DPSK | 3-DH5 | | 2.888 | 100 | 288.8 | | PASS |

**Test Graphs**



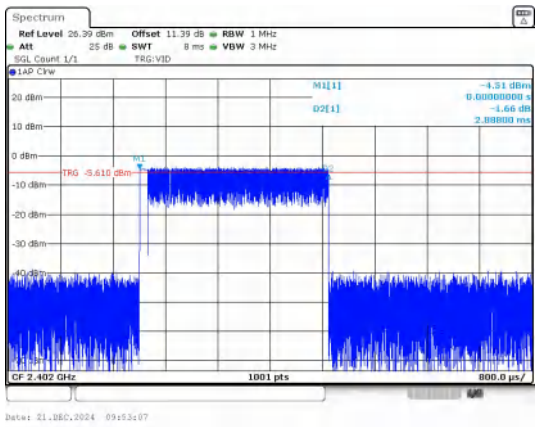

Pulse Width

GFSK_DH5



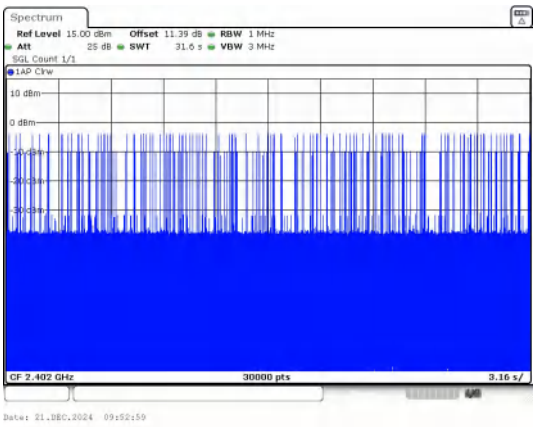

Number of Pulses in 31.6 seconds

GFSK_DH5



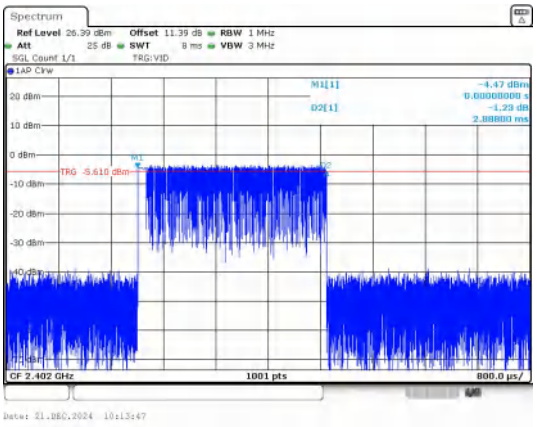
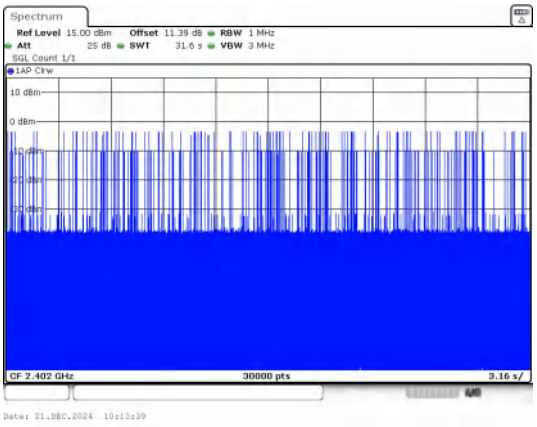

Pulse Width

π/4DQPSK_2-DH5




Number of Pulses in 31.6 seconds

π/4DQPSK_2-DH5

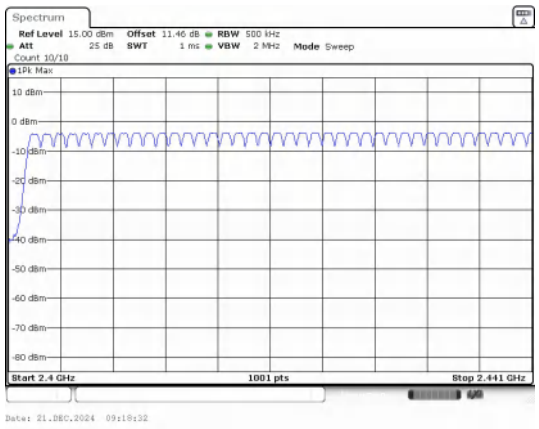
| | |
|---|---|
|  |  |
| **Pulse Width**<br>**8DPSK_3-DH5** | **Number of Pulses in 31.6 seconds**<br>**8DPSK_3-DH5** |

# 3) Number Of Hopping Channel

**Test Result**

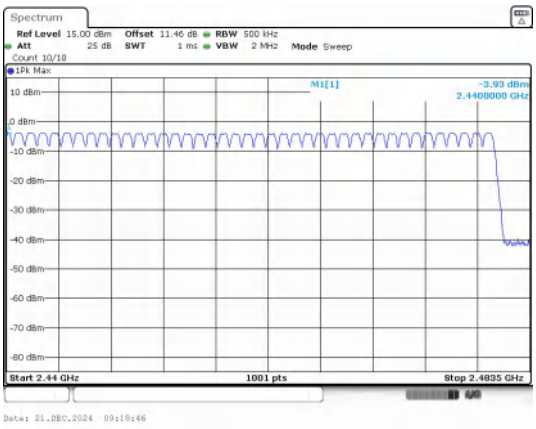
| Modulation | Packet | Number of Hopping Channel | Limit | Result |
|---|---|---|---|---|
| GFSK | DH5 | 79 | 15 | PASS |
| π/4DQPSK | 2-DH5 | 79 | 15 | PASS |
| 8DPSK | 3-DH5 | 79 | 15 | PASS |

**Test Graphs**



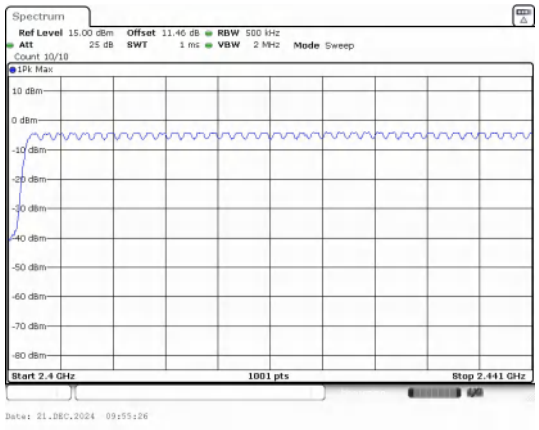

Low End Spectrum Channel Hopping Plot

GFSK



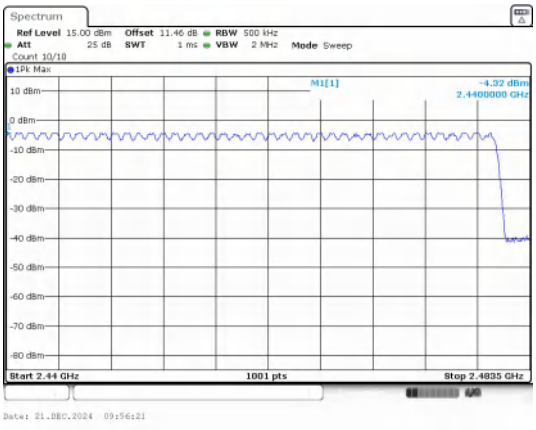

High End Spectrum Channel Hopping Plot

GFSK



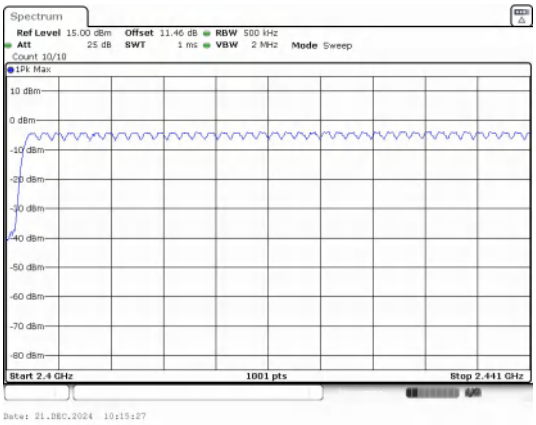

Low End Spectrum Channel Hopping Plot

π/4DQPSK



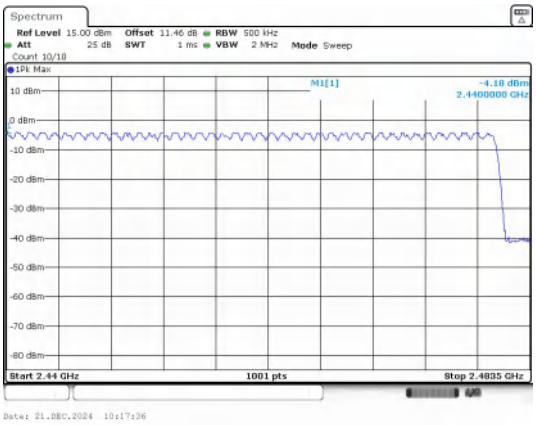

High End Spectrum Channel Hopping Plot

π/4DQPSK




Low End Spectrum Channel Hopping Plot

8DPSK




High End Spectrum Channel Hopping Plot

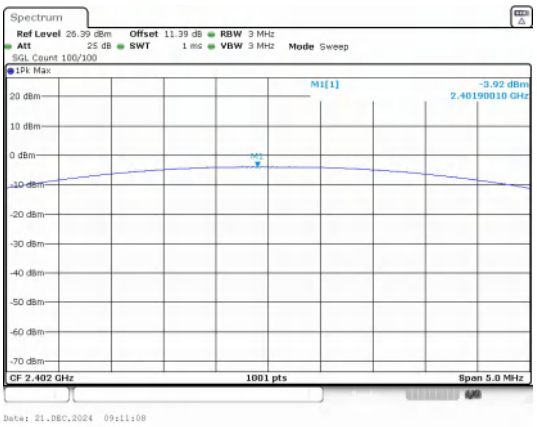
8DPSK

# 4) Conducted Output Power

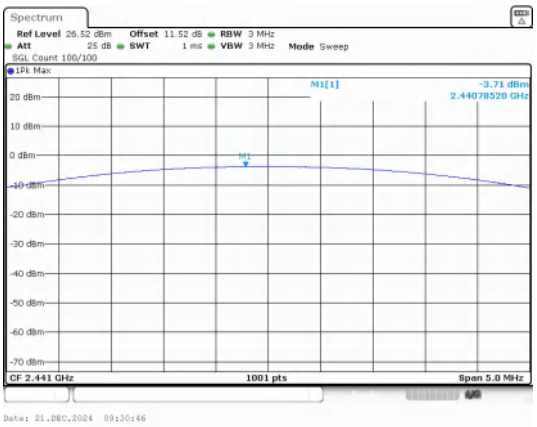
**Test Result**

| Modulation | Packet Type | Channel | Peak Output Power (dBm) | Peak Output Power (mW) | Limit (dBm) | Result |
|---|---|---|---|---|---|---|
| GFSK | DH5 | 0 | -3.92 | 0.41 | ≤30 | PASS |
| | | 39 | -3.71 | 0.43 | | PASS |
| | | 78 | -3.84 | 0.41 | | PASS |
| π/4DQPSK | 2-DH5 | 0 | -3.38 | 0.46 | ≤20.97 | PASS |
| | | 39 | -3.02 | 0.50 | | PASS |
| | | 78 | -3.09 | 0.49 | | PASS |
| 8DPSK | 3-DH5 | 0 | -2.88 | 0.52 | | PASS |
| | | 39 | -2.43 | 0.57 | | PASS |
| | | 78 | -2.53 | 0.56 | | PASS |

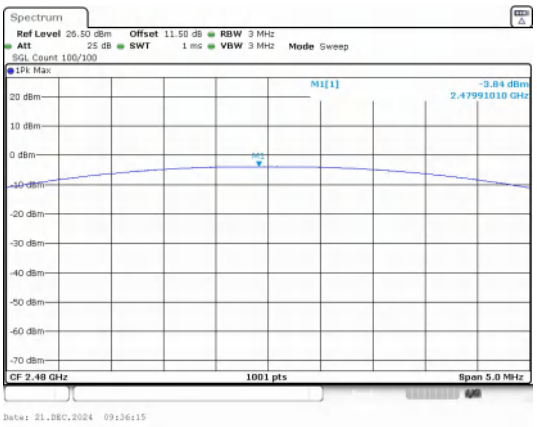
**Test Graphs**



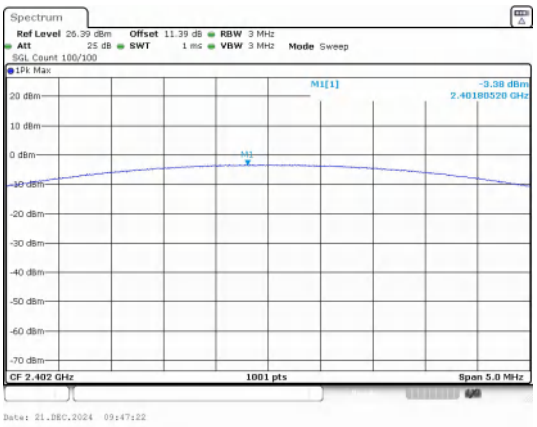

Peak Output Power
GFSK_Channel 0



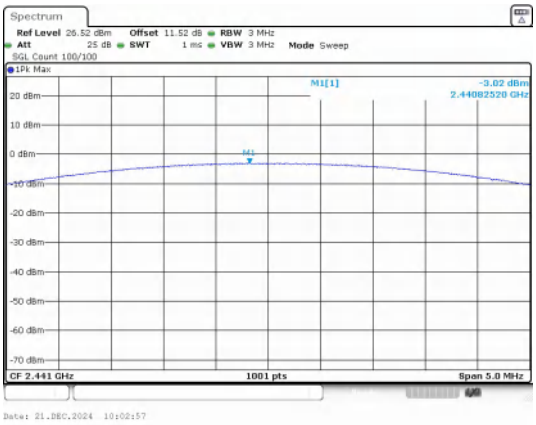

Peak Output Power
GFSK_Channel 39




Peak Output Power
GFSK_Channel 78

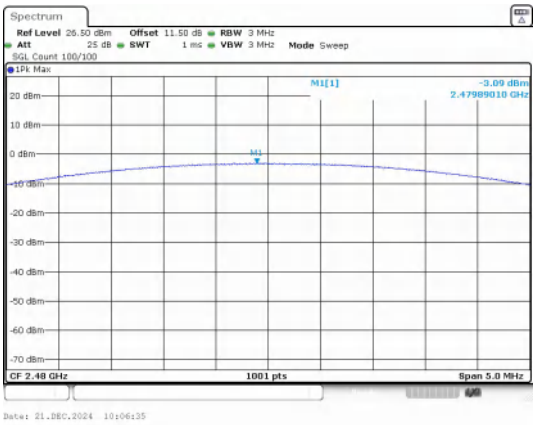



Peak Output Power
π/4DQPSK_Channel 0



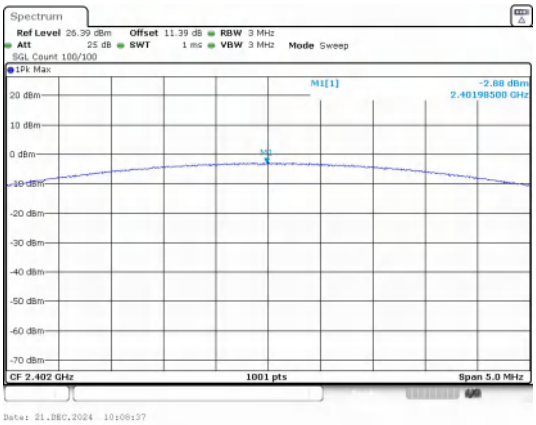

**Peak Output Power**

**π/4DQPSK_Channel 39**



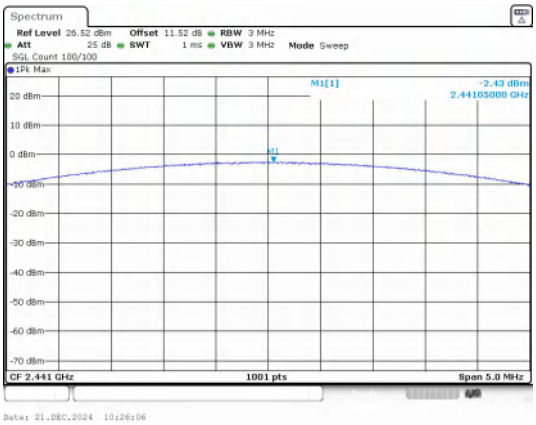

**Peak Output Power**

**π/4DQPSK_Channel 78**



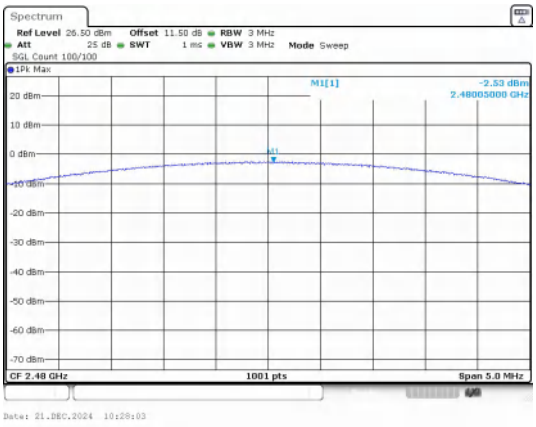

**Peak Output Power**

**8DPSK_Channel 0**




**Peak Output Power**

**8DPSK_Channel 39**




**Peak Output Power**

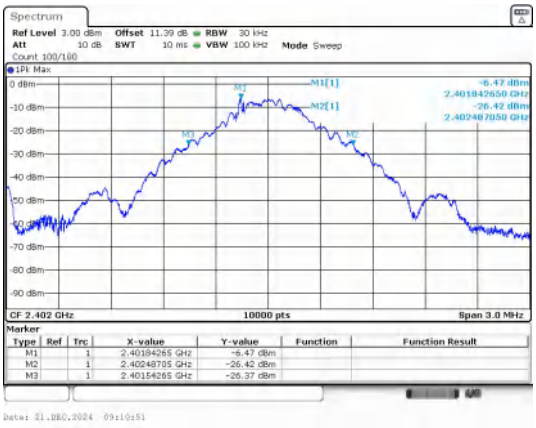
**8DPSK_Channel 78**

# 5) 20dB Bandwidth

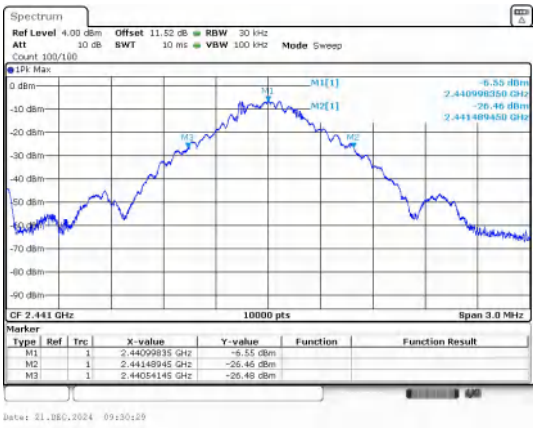
### Test Result

| Modulation | Channel | Center Frequency (MHz) | 20 dB Bandwidth (MHz) |
|---|---|---|---|
| GFSK | 0 | 2402 MHz | 0.9500 |
| | 39 | 2441 MHz | 0.9500 |
| | 78 | 2480 MHz | 0.9500 |
| π/4DQPSK | 0 | 2402 MHz | 1.290 |
| | 39 | 2441 MHz | 1.310 |
| | 78 | 2480 MHz | 1.280 |
| 8DPSK | 0 | 2402 MHz | 1.290 |
| | 39 | 2441 MHz | 1.290 |
| | 78 | 2480 MHz | 1.290 |

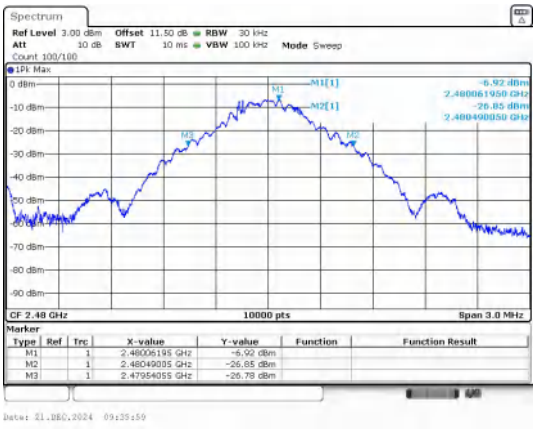
### Test Graphs



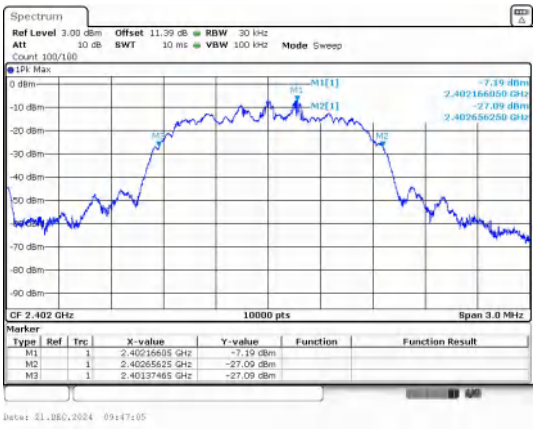

GFSK_DH5_Channel 0



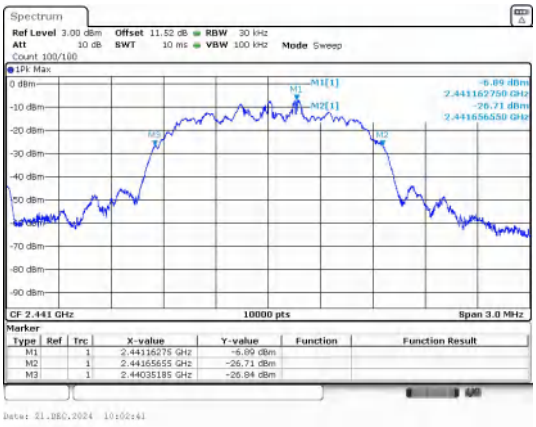

GFSK_DH5_Channel 39



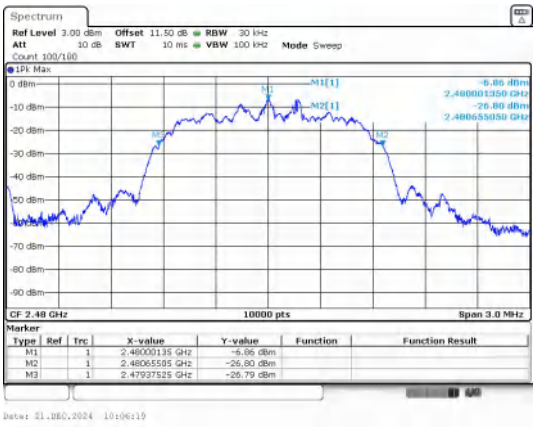

GFSK_DH5_Channel 78



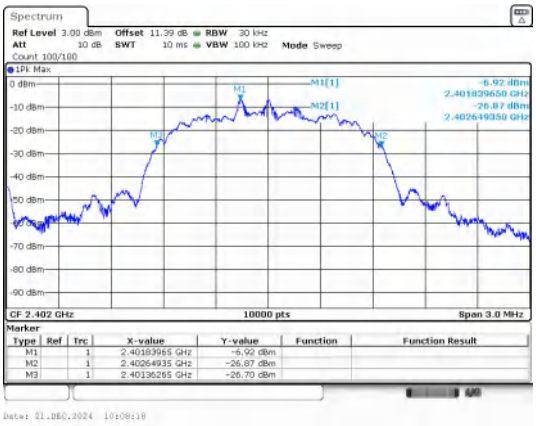

π/4DQPSK_2-DH5_Channel 0



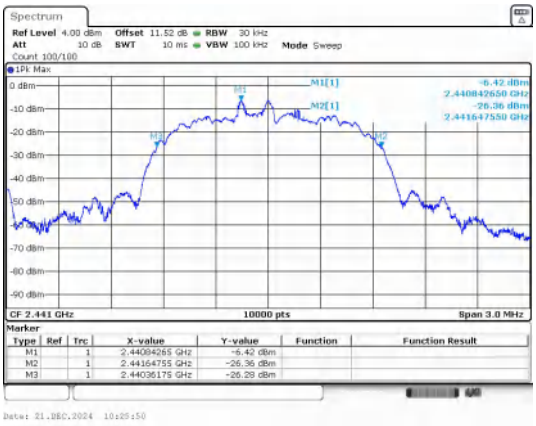

π/4DQPSK_2-DH5_Channel 39



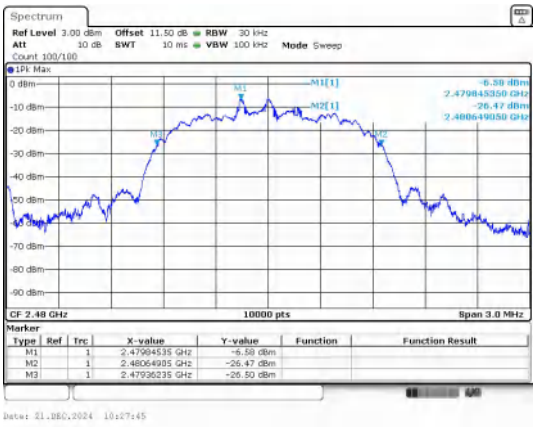

π/4DQPSK_2-DH5_Channel 78




8DPSK_3-DH5_Channel 0




8DPSK_3-DH5_Channel 39



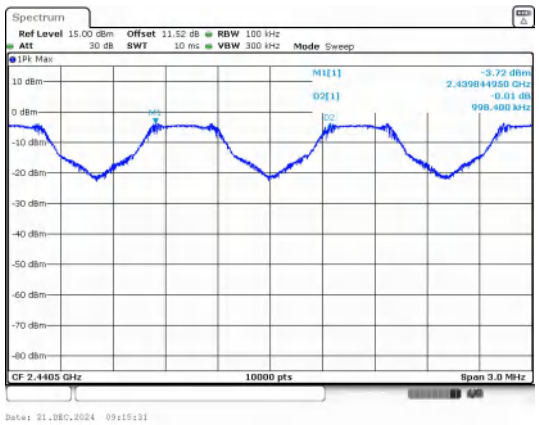

8DPSK_3-DH5_Channel 78

# 6) Carrier Frequencies Separation

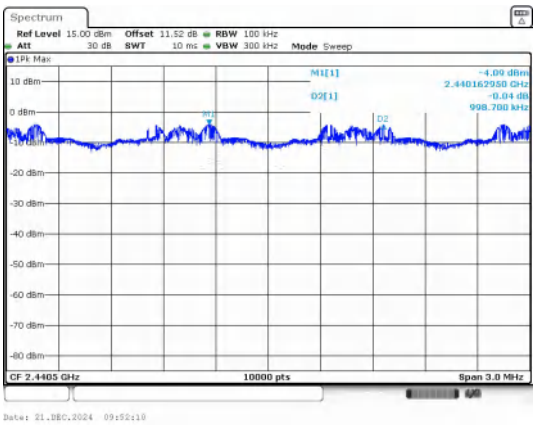
**Test Result**

| Modulation | Packet | Left Center frequency (MHz) | Right Center frequency (MHz) | Hopping Frequency Separation (MHz) | Limit (MHz) | Result |
|---|---|---|---|---|---|---|
| GFSK | DH5 | 2439.845 | 2440.8434 | 0.9984 | 0.95 | PASS |
| π/4DQPSK | 2-DH5 | 2440.1629 | 2441.1617 | 0.9987 | 0.86 | PASS |
| 8DPSK | 3-DH5 | 2439.8443 | 2440.8583 | 1.0140 | 0.86 | PASS |

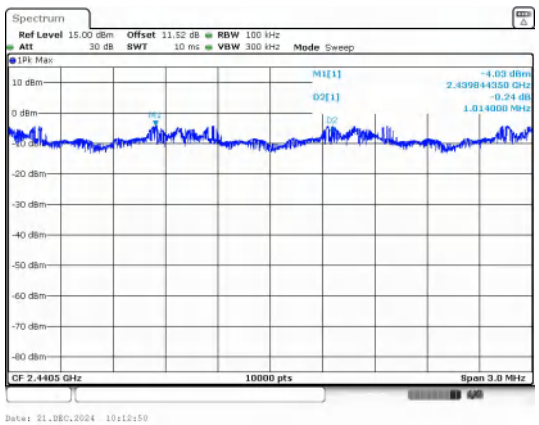
**Test Graphs**




GFSK




π/4DQPSK




8DPSK

# 7) Conducted Out Of Band Emission

**Test Result**

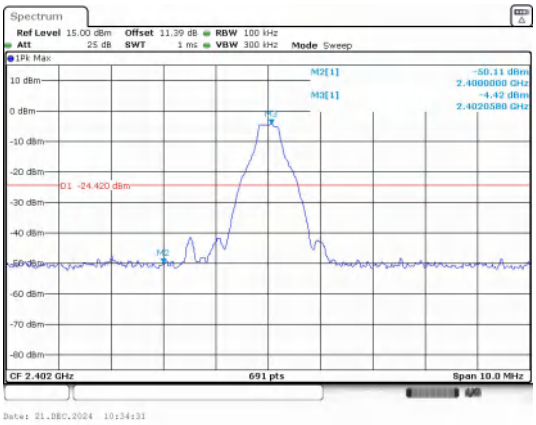
Non-Hopping

| Modulation | Packet | Channel | OOB Emission Frequency (MHz) | OOB Emission Level (dBm) | Limit (dBm) | Over Limit (dB) | Result |
|---|---|---|---|---|---|---|---|
| GFSK | DH5 | 0 | 2399.00 | -47.607 | -24.42 | -23.187 | PASS |
| | | | 2400.00 | -50.110 | -24.42 | -25.690 | PASS |
| | | | 9602.20 | -51.402 | -24.42 | -26.982 | PASS |
| | | 39 | 2300.19 | -41.977 | -23.96 | -18.017 | PASS |
| | | 78 | 2483.50 | -48.820 | -24.0 | -24.820 | PASS |
| | | | 4960.33 | -49.045 | -24.0 | -25.045 | PASS |
| π/4DQPSK | 2-DH5 | 0 | 1886.50 | -48.209 | -24.46 | -23.749 | PASS |
| | | | 2399.00 | -48.929 | -24.46 | -24.469 | PASS |
| | | | 2400.00 | -49.330 | -24.46 | -24.870 | PASS |
| | | 39 | 1784.14 | -41.942 | -24.08 | -17.862 | PASS |
| | | 78 | 911.86 | -47.455 | -24.19 | -23.265 | PASS |
| | | | 2483.50 | -48.780 | -24.19 | -24.590 | PASS |
| 8DPSK | 3-DH5 | 0 | 2399.00 | -48.641 | -24.43 | -24.211 | PASS |
| | | | 2400.00 | -51.830 | -24.43 | -27.400 | PASS |
| | | | 9602.20 | -51.533 | -24.43 | -27.103 | PASS |
| | | 39 | 2633.95 | -46.709 | -24.15 | -22.559 | PASS |
| | | 78 | 1764.17 | -41.958 | -24.12 | -17.838 | PASS |
| | | | 2483.50 | -49.780 | -24.12 | -25.660 | PASS |

Hopping

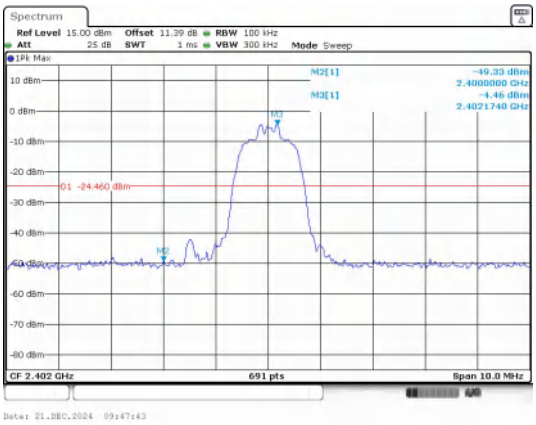
| Modulation | Packet | Channel | OOB Emission Frequency (MHz) | OOB Emission Level (dBm) | Limit (dBm) | Over Limit (dB) | Result |
|---|---|---|---|---|---|---|---|
| GFSK | DH5 | Hopping | 2395.51 | -47.339 | -24.23 | -23.109 | PASS |
| | | | 2400.00 | -48.770 | -24.23 | -24.540 | PASS |
| | | | 2483.50 | -48.010 | -23.91 | -24.100 | PASS |
| π/4DQPSK | 2-DH5 | | 2395.24 | -47.753 | -24.56 | -23.193 | PASS |
| | | | 2400.00 | -49.730 | -24.56 | -25.170 | PASS |
| | | | 2483.50 | -49.300 | -25.15 | -24.150 | PASS |
| 8DPSK | 3-DH5 | | 2398.87 | -46.851 | -24.45 | -22.401 | PASS |
| | | | 2400.00 | -50.040 | -24.45 | -25.590 | PASS |
| | | | 2483.50 | -50.030 | -25.92 | -24.110 | PASS |

**Test Graphs**



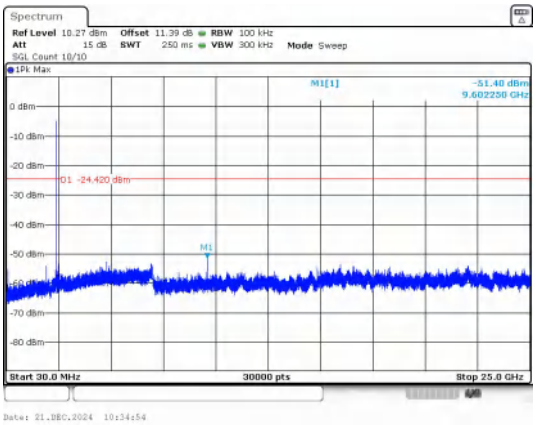

**Out Of Band Emission**

**GFSK_DH5_Channel 0**



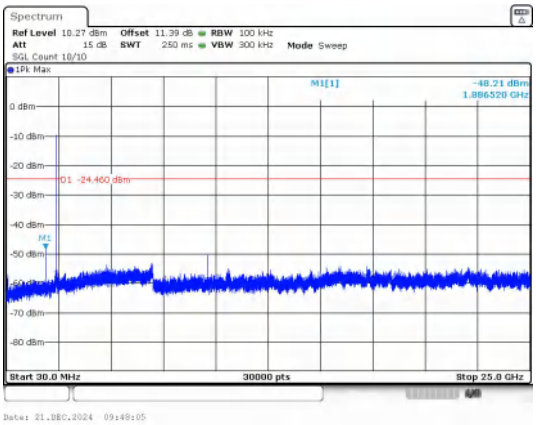

**Out Of Band Emission**

**π/4DQPSK_2-DH5_Channel 0**



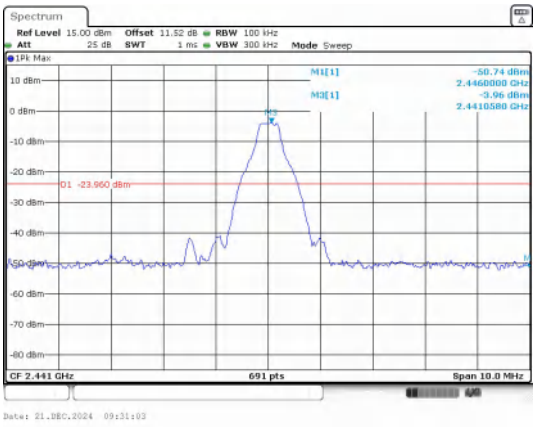

**30.0 MHz - 25000.0 MHz**

**GFSK_DH5_Channel 0**



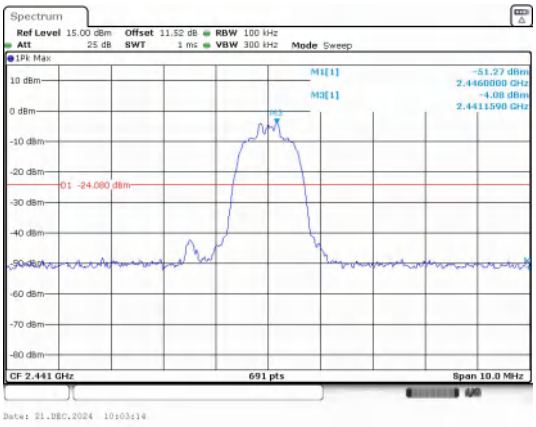

**30.0 MHz - 25000.0 MHz**

**π/4DQPSK_2-DH5_Channel 0**



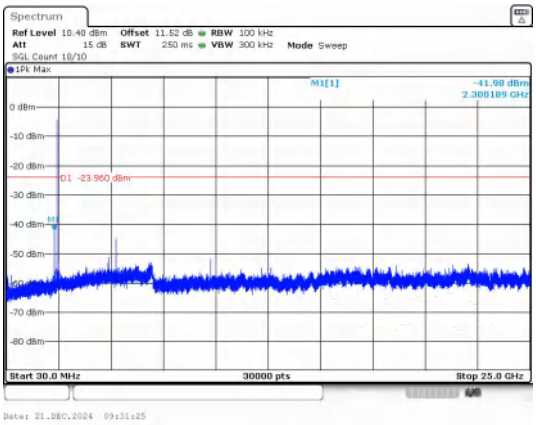

**Out Of Band Emission**

**GFSK_DH5_Channel 39**



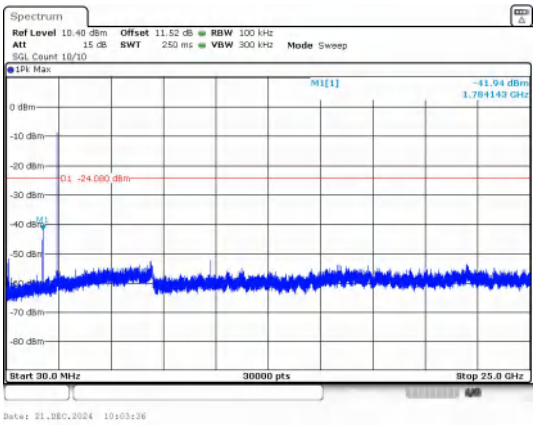

**Out Of Band Emission**

**π/4DQPSK_2-DH5_Channel 39**



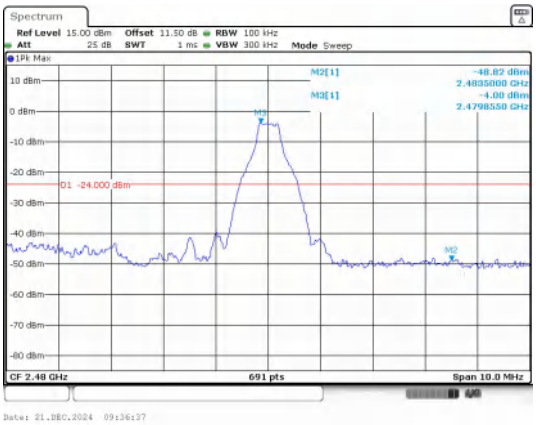

30.0 MHz - 25000.0 MHz

GFSK_DH5_Channel 39



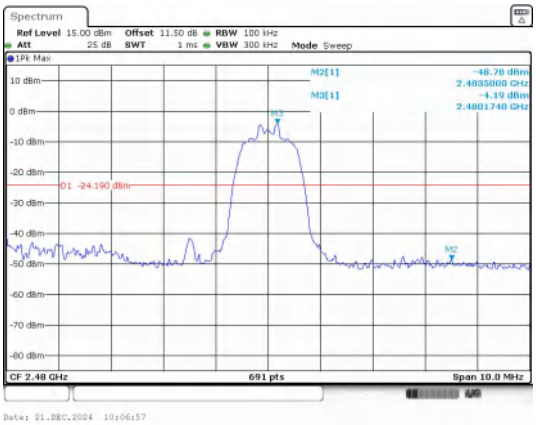

30.0 MHz - 25000.0 MHz

π/4DQPSK_2-DH5_Channel 39



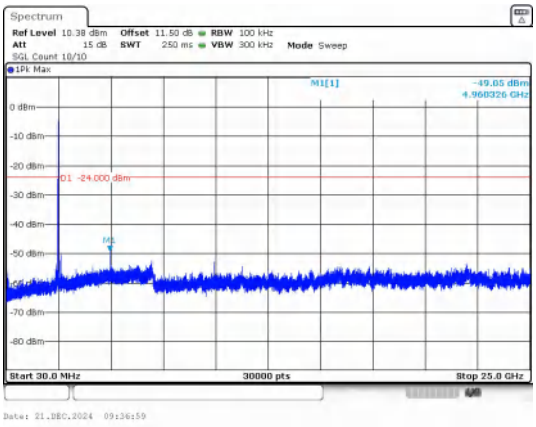

Out Of Band Emission

GFSK_DH5_Channel 78



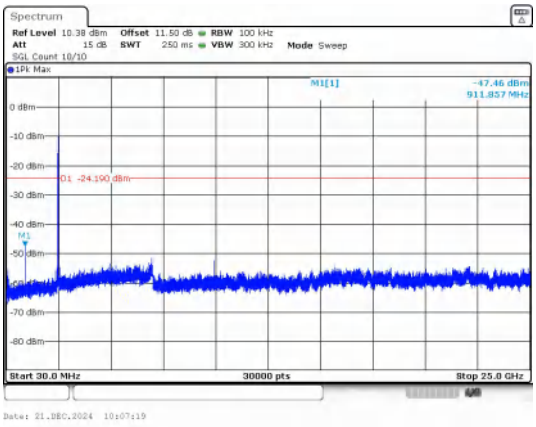

Out Of Band Emission

π/4DQPSK_2-DH5_Channel 78



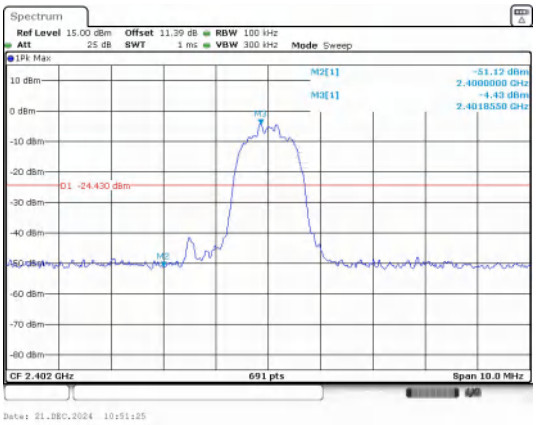

30.0 MHz - 25000.0 MHz

GFSK_DH5_Channel 78



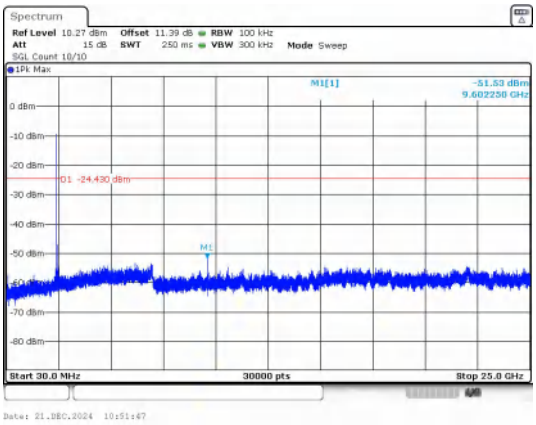

30.0 MHz - 25000.0 MHz

π/4DQPSK_2-DH5_Channel 78



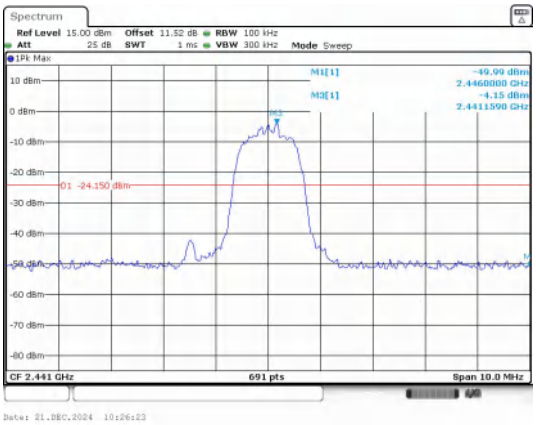

**Out Of Band Emission**

**8DPSK_3-DH5_Channel 0**



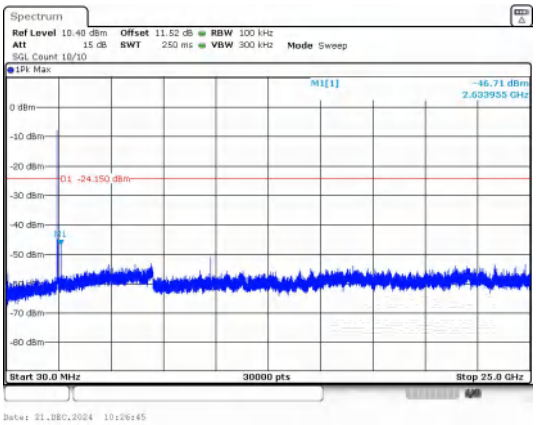

**30.0 MHz - 25000.0 MHz**

**8DPSK_3-DH5_Channel 0**



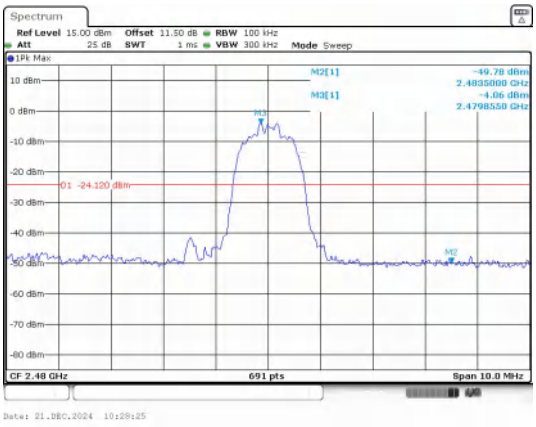

**Out Of Band Emission**

**8DPSK_3-DH5_Channel 39**



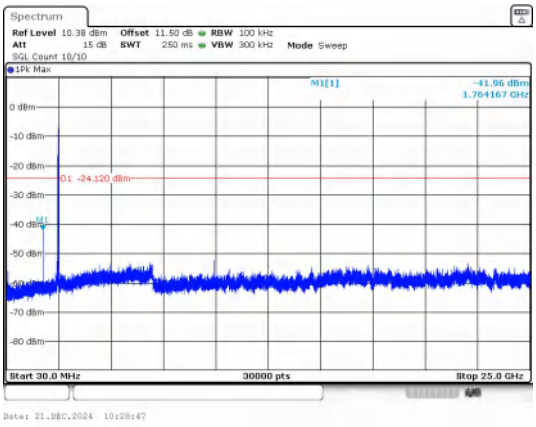

**30.0 MHz - 25000.0 MHz**

**8DPSK_3-DH5_Channel 39**



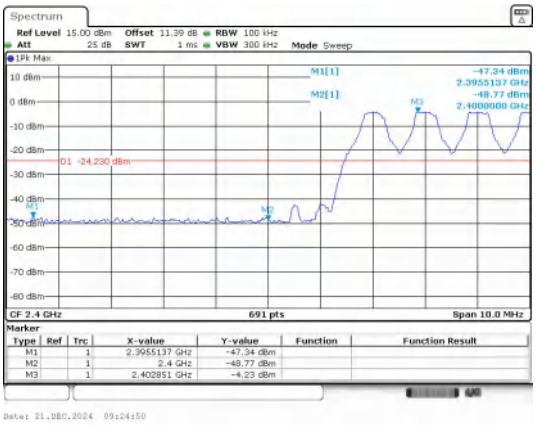

**Out Of Band Emission**

**8DPSK_3-DH5_Channel 78**



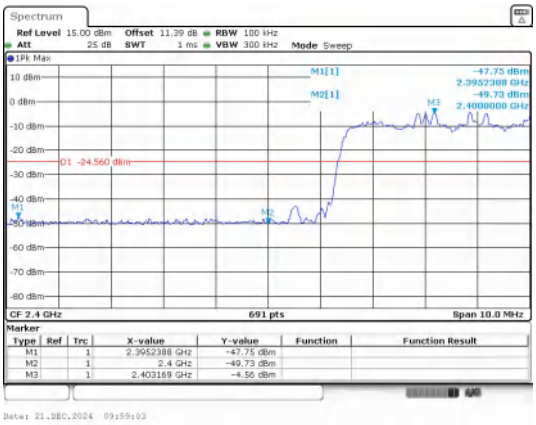

**30.0 MHz - 25000.0 MHz**

**8DPSK_3-DH5_Channel 78**



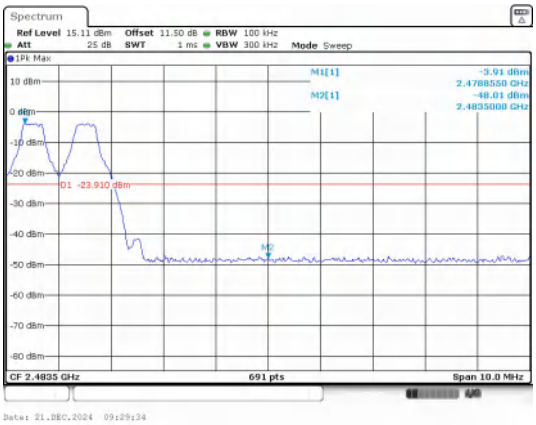

**Out Of Band Emission(Left)**

**GFSK_DH5_Channel Hopping**



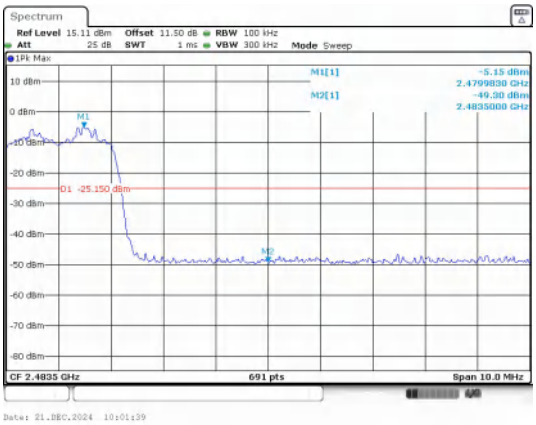

**Out Of Band Emission(Left)**

**π/4DQPSK_2-DH5_Channel Hopping**



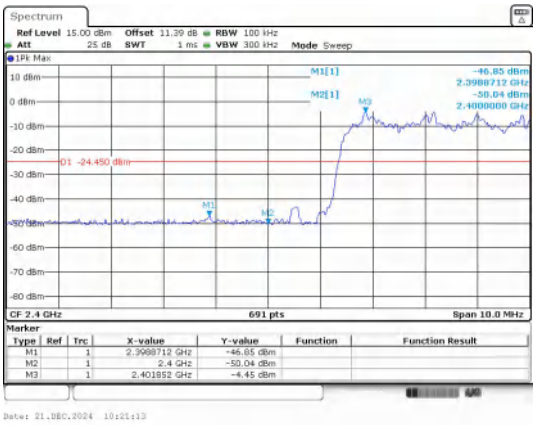

**Out Of Band Emission(Right)**

**GFSK_DH5_Channel Hopping**



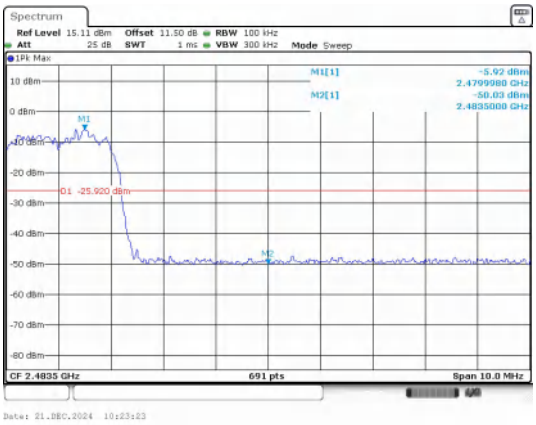

**Out Of Band Emission(Right)**

**π/4DQPSK_2-DH5_Channel Hopping**




**Out Of Band Emission(Left)**

**8DPSK_3-DH5_Channel Hopping**




**Out Of Band Emission(Right)**

**8DPSK_3-DH5_Channel Hopping**

------End of the report-----