

TEST REPORT

Applicant Name: Southern Telecom Inc.
Address: 5601 1st Ave, 2nd Floor, Brooklyn, New York, 11220, United States
Report Number: 2401S68918-RF-00
FCC ID: 2ABV4-WTRSPK

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type: HELLO KITTY XL WATER SPK
Model No.: HKXLWTRSPK-FB
Multiple Model(s) No.: N/A
Trade Mark: HELLO KITTY
Date Received: 2024/04/07
Issue Date: 2024/05/21

| | |
|--------------|-------|
| Test Result: | Pass▲ |
|--------------|-------|

▲ In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:jojo. Guojojo Guo
RF Engineer**Approved By:**Nancy WangNancy Wang
RF Supervisor

Note: The information marked # is provided by the applicant, the laboratory is not responsible for its authenticity and this information can affect the validity of the result in the test report. Customer model name, addresses, names, trademarks etc. are included.

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DOCUMENT REVISION HISTORY

| Revision Number | Report Number | Description of Revision | Date of Revision |
|-----------------|------------------|-------------------------|------------------|
| 0 | 2401S68918-RF-00 | Original Report | 2024/05/21 |

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

| | |
|------------------------------------|---|
| Product | HELLO KITTY XL WATER SPK |
| Tested Model | HKXLWTRSPK-FB |
| Multiple Model(s) | N/A |
| Frequency Range | Bluetooth: 2402~2480MHz |
| Transmit Peak Power | 0.51dBm |
| Modulation Technique | Bluetooth: GFSK, π/4-DQPSK, 8DPSK |
| Antenna Specification [#] | -0.58dBi (provided by the applicant) |
| Voltage Range | DC 5V from USB port |
| Sample serial number | OSEB118528-3 for Conducted and Radiated Emissions Test OSEB118528-2 for RF Conducted Test (Assigned by BACL, Shenzhen) |
| Sample/EUT Status | Good condition |
| Adapter Information | N/A |

Objective

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

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.207, 15.205, 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, conducted | | 0.72 dB(k=2, 95% level of confidence) |
| AC Power Lines Conducted Emissions | 9kHz-150kHz | 3.94dB(k=2, 95% level of confidence) |
| | 150kHz-30MHz | 3.84dB(k=2, 95% level of confidence) |
| Radiated Emissions | 9kHz - 30MHz | 3.30dB(k=2, 95% level of confidence) |
| | 30MHz~200MHz (Horizontal) | 4.48dB(k=2, 95% level of confidence) |
| | 30MHz~200MHz (Vertical) | 4.55dB(k=2, 95% level of confidence) |
| | 200MHz~1000MHz (Horizontal) | 4.85dB(k=2, 95% level of confidence) |
| | 200MHz~1000MHz (Vertical) | 5.05dB(k=2, 95% level of confidence) |
| | 1GHz - 6GHz | 5.35dB(k=2, 95% level of confidence) |
| | 6GHz - 18GHz | 5.44dB(k=2, 95% level of confidence) |
| | 18GHz - 40GHz | 5.16dB(k=2, 95% level of confidence) |
| Temperature | | ±1°C |
| Humidity | | ±1% |
| 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 lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 715558, the FCC Designation No. : CN5045.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

| Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|
| 0 | 2402 | 40 | 2442 |
| 1 | 2403 | 41 | 2443 |
| 2 | 2404 | 42 | 2444 |
| ... | ... | ... | ... |
| ... | ... | ... | ... |
| 36 | 2438 | 75 | 2477 |
| 37 | 2439 | 76 | 2478 |
| 38 | 2440 | 77 | 2479 |
| 39 | 2441 | 78 | 2480 |

EUT was tested with Channel 0, 39 and 78.

EUT Exercise Software

“bt-tool v1.1.0”[#] exercise software was used and the power level is 4[#]. 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

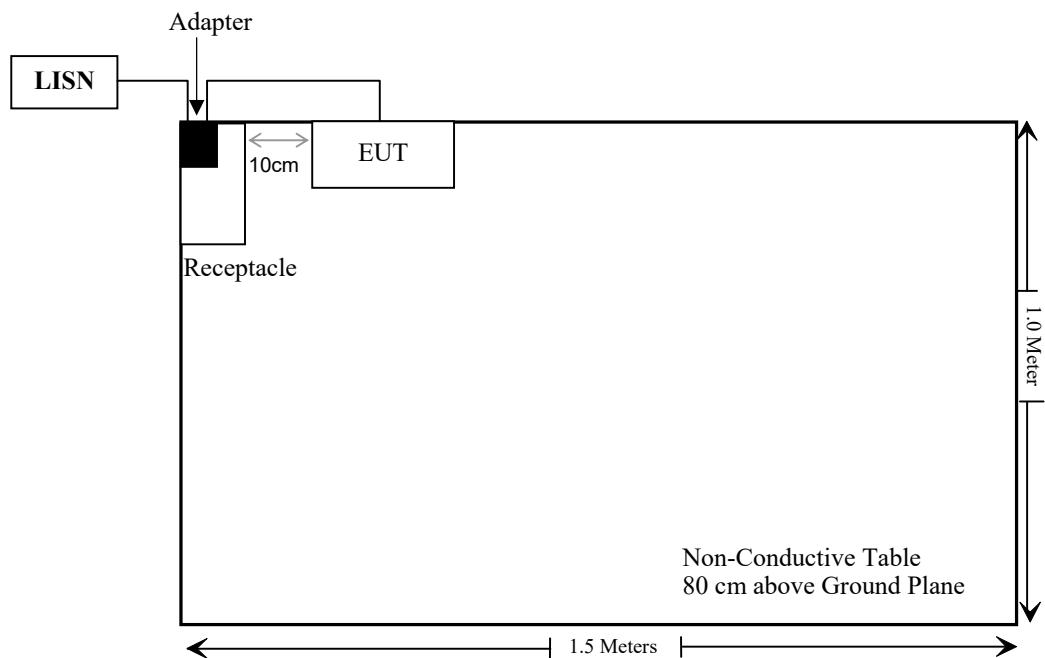
| Manufacturer | Description | Model | Serial Number |
|--------------|-------------|--------------|---------------|
| HUAWEI | Adapter | HW-100400C01 | Unknown |

External I/O Cable

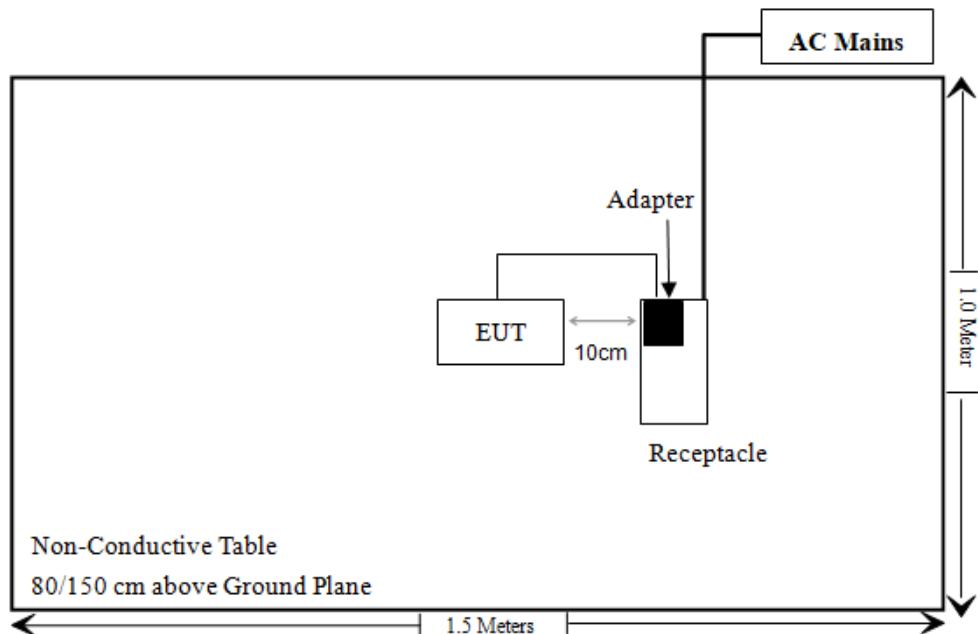
| Cable Description | Length (m) | From Port | To |
|-----------------------------------|------------|-----------|---------|
| Un-shielding Detachable USB Cable | 1.0 | EUT | Adapter |

Block Diagram of Test Setup

For Conducted Emissions:



For Radiated Emissions:



SUMMARY OF TEST RESULTS

| Rules | Description of Test | Result |
|----------------------------------|---|-----------|
| FCC§1.1307 ,§2.1091 | MPE-Based Exemption | Compliant |
| FCC §15.203 | Antenna Requirement | Compliant |
| FCC §15.207(a) | AC Line Conducted Emissions | Compliant |
| FCC §15.205, §15.209, §15.247(d) | Radiated Emissions | Compliant |
| FCC §15.247(a)(1) | 20 dB Emission Bandwidth & 99% Occupied Bandwidth | Compliant |
| FCC §15.247(a)(1) | Channel Separation Test | Compliant |
| FCC §15.247(a)(1)(iii) | Time of Occupancy (Dwell Time) | Compliant |
| FCC §15.247(a)(1)(iii) | Quantity of hopping channel Test | Compliant |
| FCC §15.247(b)(1) | Peak Output Power Measurement | Compliant |
| FCC §15.247(d) | Band edges | Compliant |

TEST EQUIPMENT LIST

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|--------------------------------|-------------------------|-------------------------|------------------------|------------------|----------------------|
| Conducted Emission Test | | | | | |
| Rohde & Schwarz | EMI Test Receiver | ESCI | 101120 | 2024/01/16 | 2025/01/15 |
| Rohde & Schwarz | LISN | ENV216 | 101613 | 2024/01/16 | 2025/01/15 |
| Rohde & Schwarz | Transient Limiter | ESH3Z2 | DE25985 | 2023/08/03 | 2024/08/02 |
| Unknown | CE Cable | CE Cable | UF A210B-1-0720-504504 | 2023/08/03 | 2024/08/02 |
| Audix | EMI Test software | E3 | 191218 | NCR | NCR |
| Radiated Emission Test | | | | | |
| R&S | EMI Test Receiver | ESR3 | 102455 | 2024/01/16 | 2025/01/15 |
| Sonoma instrument | Pre-amplifier | 310 N | 186238 | 2023/06/08 | 2024/06/07 |
| Sunol Sciences | Broadband Antenna | JB1 | A040904-1 | 2023/07/20 | 2024/07/19 |
| BACL | Active Loop Antenna | 1313-1A | 4031911 | 2024/03/21 | 2025/03/20 |
| Unknown | Cable | Chamber Cable 1 | F-03-EM236 | 2023/08/03 | 2024/08/02 |
| Unknown | Cable | Chamber Cable 4 | EC-007 | 2023/08/03 | 2024/08/02 |
| Audix | EMI Test software | E3 | 19821b(V9) | NCR | NCR |
| Rohde & Schwarz | Spectrum Analyzer | FSV40 | 101605 | 2024/03/27 | 2025/03/26 |
| COM-POWER | Pre-amplifier | PA-122 | 181919 | 2023/06/29 | 2024/06/28 |
| Schwarzbeck | Horn Antenna | BBHA9120D(1201) | 1143 | 2023/07/26 | 2024/07/25 |
| Unknown | RF Cable | KMSE | 0735 | 2023/10/08 | 2024/10/07 |
| Unknown | RF Cable | UFA147 | 219661 | 2023/10/08 | 2024/10/07 |
| SNSD | 2.4G Band Reject filter | BSF2402-2480MN-0898-001 | 2.4G filter | 2023/08/03 | 2024/08/02 |
| A.H.System | Pre-amplifier | PAM-1840VH | 190 | 2023/08/03 | 2024/08/02 |
| Electro-Mechanics Co | Horn Antenna | 3116 | 9510-2270 | 2023/09/18 | 2026/09/17 |
| Audix | EMI Test software | E3 | 191218(V9) | NCR | NCR |
| RF Conducted Test | | | | | |
| R&S | SPECTRUM ANALYZER | FSU26 | 200120 | 2024/01/08 | 2025/01/07 |
| Unknown | 10dB Attenuator | Unknown | F-03-EM190 | 2023/07/04 | 2024/07/03 |

*** 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 1.1307 (B) & §2.1091- MPE-BASED EXEMPTION

Applicable Standard

According to subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

According to KDB 447498 D04 Interim General RF Exposure Guidance

MPE-Based Exemption:

General frequency and separation-distance dependent MPE-based effective radiated power (ERP) thresholds are in Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

| RF Source frequency (MHz) | Threshold ERP (watts) |
|---------------------------|-----------------------|
| 0.3-1.34 | $1,920 R^2$. |
| 1.34-30 | $3,450 R^2/f^2$. |
| 30-300 | $3.83 R^2$. |
| 300-1,500 | $0.0128 R^2 f$. |
| 1,500-100,000 | $19.2R^2$. |

R is the minimum separation distance in meters

f = frequency in MHz

Result

| Mode | Frequency (MHz) | Tune up conducted power [#] | Antenna Gain [#] | | ERP | | Evaluation Distance (m) | ERP Limit (mW) |
|------|-----------------|--------------------------------------|---------------------------|-------|-------|------|-------------------------|----------------|
| | | (dBm) | (dBi) | (dBd) | (dBm) | (mW) | | |
| BT | 2402-2480 | 1.0 | -0.58 | -2.73 | -1.73 | 0.67 | 0.2 | 768 |

Note: 1. The tune up conducted power and antenna gain was declared by the applicant.
 2. $0\text{dBd}=2.15\text{dBi}$

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliant.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

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

Antenna Connector Construction

The EUT has one internal antenna arrangement, which was permanently attached, the antenna gain[#] is -0.58dBi, fulfill the requirement of this section. Please refer to the EUT photos.

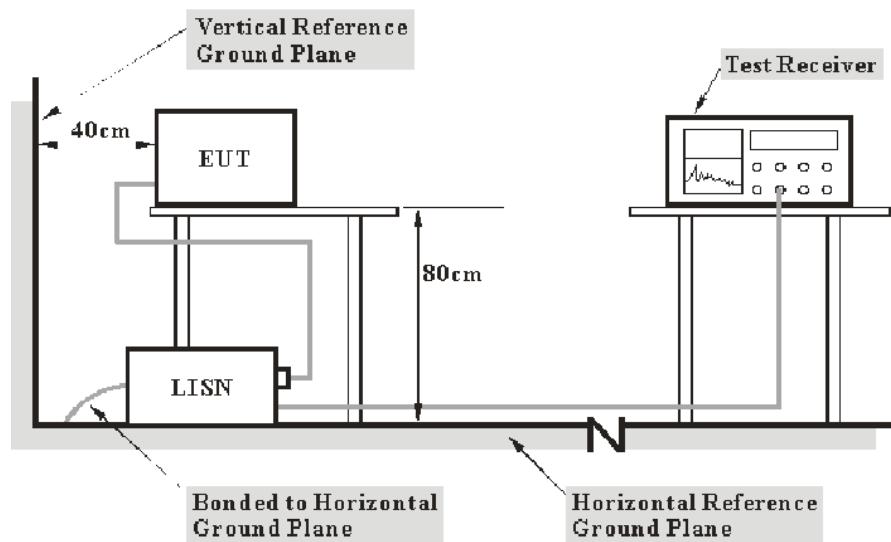
Result: Compliant

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.

Factor & Over Limit Calculation

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

$$\text{Factor} = \text{LISN VDF} + \text{Cable Loss}$$

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

$$\begin{aligned}\text{Over Limit} &= \text{Level} - \text{Limit} \\ \text{Level} &= \text{Read Level} + \text{Factor}\end{aligned}$$

Note: The term "cable loss" refers to the combination of a cable and a 10dB transient limiter (attenuator).

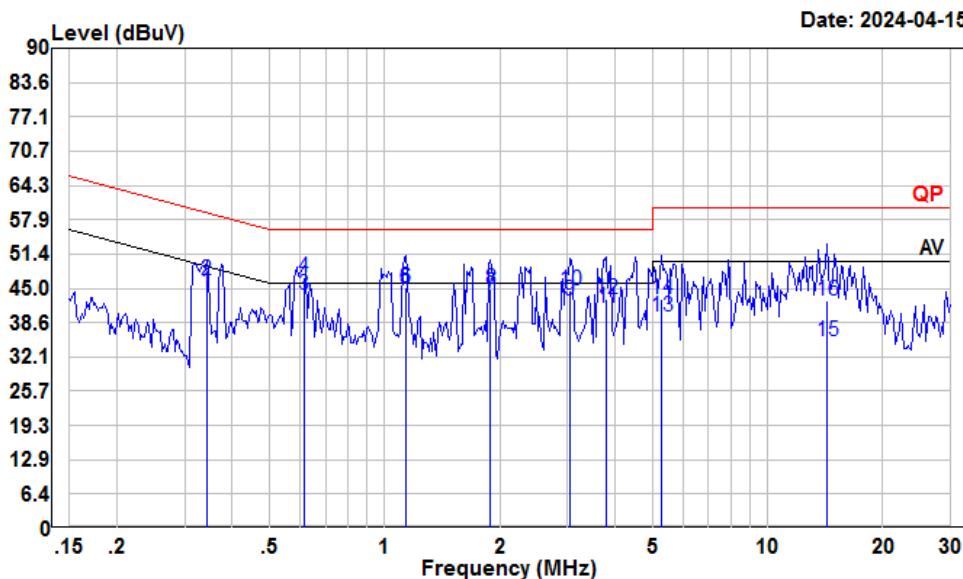
Test Data

Environmental Conditions

| | |
|---------------------------|-----------|
| Temperature: | 26 °C |
| Relative Humidity: | 60 % |
| ATM Pressure: | 101.0 kPa |

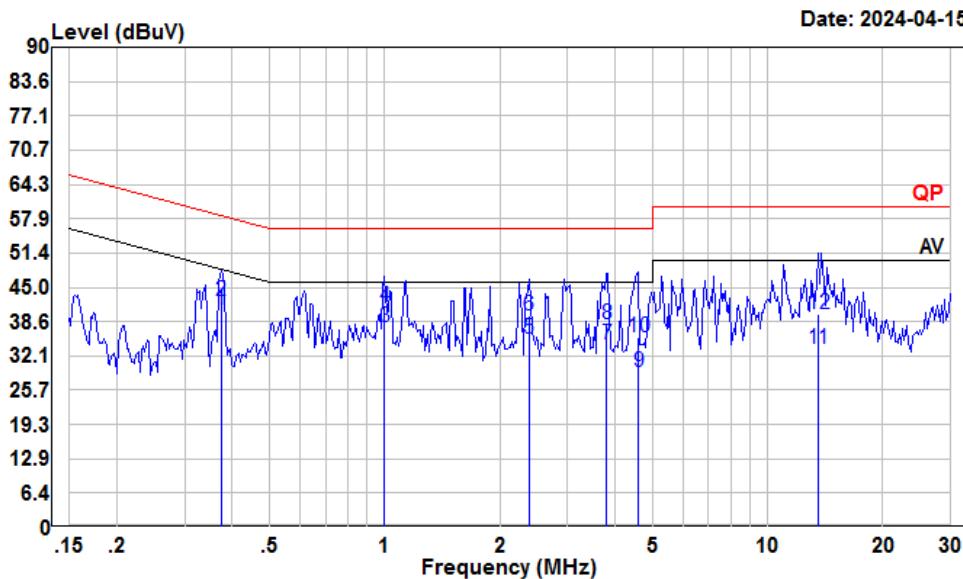
The testing was performed by Macy Shi on 2024-04-15.

EUT operation mode: Transmitting (Maximum output power mode, 8DPSK Low Channel)

AC 120V/60 Hz, Line

Condition: Line
 Project : 2401S68918E-RF
 Tester : Macy shi
 Note : BT

| Freq | Read | LISN | Cable | Limit | Over | Remark |
|------|-------|-------|-------|--------|-------|----------------------|
| | MHz | Level | Level | Factor | Loss | |
| 1 | 0.34 | 23.66 | 44.43 | 10.62 | 10.15 | 49.13 -4.70 Average |
| 2 | 0.34 | 25.73 | 46.50 | 10.62 | 10.15 | 59.13 -12.63 QP |
| 3 | 0.61 | 23.00 | 43.72 | 10.50 | 10.22 | 46.00 -2.28 Average |
| 4 | 0.61 | 26.30 | 47.02 | 10.50 | 10.22 | 56.00 -8.98 QP |
| 5 | 1.14 | 24.32 | 44.86 | 10.44 | 10.10 | 46.00 -1.14 Average |
| 6 | 1.14 | 24.71 | 45.25 | 10.44 | 10.10 | 56.00 -10.75 QP |
| 7 | 1.89 | 23.30 | 44.04 | 10.58 | 10.16 | 46.00 -1.96 Average |
| 8 | 1.89 | 24.00 | 44.74 | 10.58 | 10.16 | 56.00 -11.26 QP |
| 9 | 3.04 | 22.10 | 42.79 | 10.42 | 10.27 | 46.00 -3.21 Average |
| 10 | 3.04 | 23.80 | 44.49 | 10.42 | 10.27 | 56.00 -11.51 QP |
| 11 | 3.80 | 20.73 | 41.31 | 10.32 | 10.26 | 46.00 -4.69 Average |
| 12 | 3.80 | 22.52 | 43.10 | 10.32 | 10.26 | 56.00 -12.90 QP |
| 13 | 5.28 | 19.20 | 39.82 | 10.40 | 10.22 | 50.00 -10.18 Average |
| 14 | 5.28 | 22.40 | 43.02 | 10.40 | 10.22 | 60.00 -16.98 QP |
| 15 | 14.29 | 14.38 | 35.10 | 10.60 | 10.12 | 50.00 -14.90 Average |
| 16 | 14.29 | 21.87 | 42.59 | 10.60 | 10.12 | 60.00 -17.41 QP |

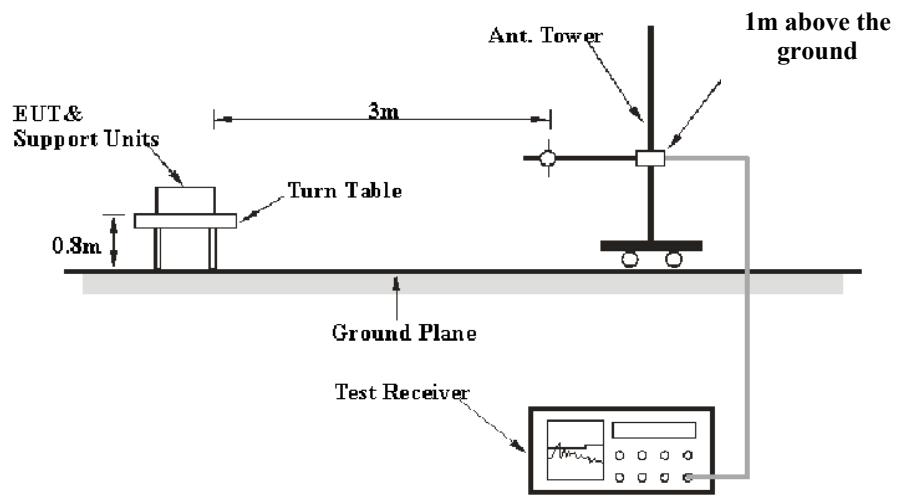
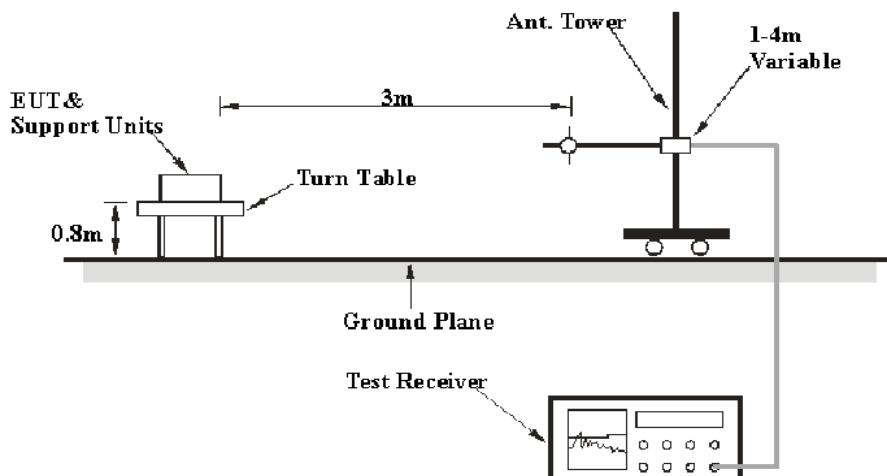
AC 120V/60 Hz, Neutral

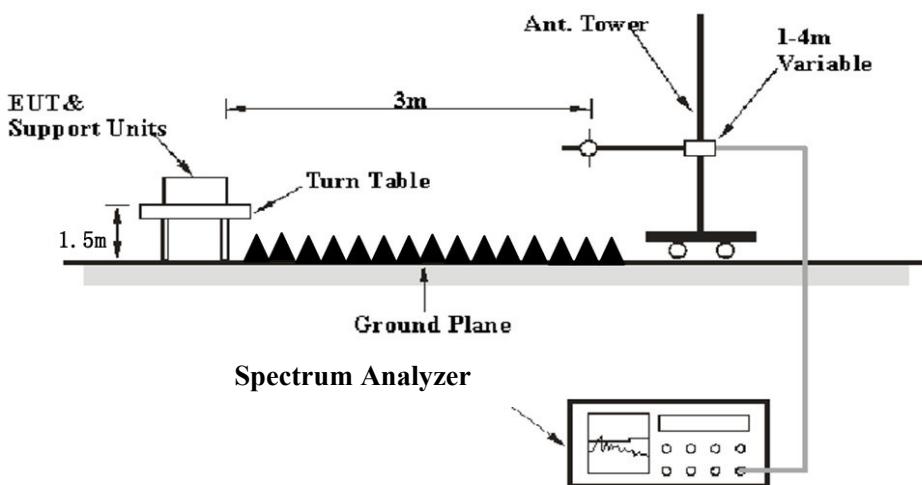
Condition: Neutral
Project : 2401S68918E-RF
Tester : Macy shi
Note : BT

| Freq | Read | LISN | Cable | Limit | Over | Remark |
|------|-------|-------|--------------|-------|-------|----------------------|
| | MHz | Level | Level Factor | Loss | Line | |
| 1 | 0.37 | 19.89 | 40.68 | 10.60 | 10.19 | 48.43 -7.75 Average |
| 2 | 0.37 | 21.61 | 42.40 | 10.60 | 10.19 | 58.43 -16.03 QP |
| 3 | 1.00 | 16.37 | 37.48 | 10.90 | 10.21 | 46.00 -8.52 Average |
| 4 | 1.00 | 20.33 | 41.44 | 10.90 | 10.21 | 56.00 -14.56 QP |
| 5 | 2.38 | 14.80 | 35.41 | 10.40 | 10.21 | 46.00 -10.59 Average |
| 6 | 2.38 | 19.10 | 39.71 | 10.40 | 10.21 | 56.00 -16.29 QP |
| 7 | 3.80 | 13.50 | 34.16 | 10.40 | 10.26 | 46.00 -11.84 Average |
| 8 | 3.80 | 17.50 | 38.16 | 10.40 | 10.26 | 56.00 -17.84 QP |
| 9 | 4.60 | 8.32 | 29.03 | 10.47 | 10.24 | 46.00 -16.97 Average |
| 10 | 4.60 | 15.00 | 35.71 | 10.47 | 10.24 | 56.00 -20.29 QP |
| 11 | 13.55 | 12.40 | 33.35 | 10.80 | 10.15 | 50.00 -16.65 Average |
| 12 | 13.55 | 19.00 | 39.95 | 10.80 | 10.15 | 60.00 -20.05 QP |

FCC §15.205, §15.209 & §15.247(d) - RADIATED EMISSIONS**Applicable Standard**

FCC §15.205; §15.209; §15.247(d)

EUT Setup**9 kHz-30MHz:****30MHz-1GHz:**

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

The EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

| Frequency Range | RBW | Video B/W | IF B/W | Measurement |
|-------------------|---|-----------|---------|-------------|
| 9 kHz – 150 kHz | / | / | 200 Hz | QP |
| | 300 Hz | 1 kHz | / | PK |
| 150 kHz – 30 MHz | / | / | 9 kHz | QP |
| | 10 kHz | 30 kHz | / | PK |
| 30 MHz – 1000 MHz | / | / | 120 kHz | QP |
| | 100 kHz | 300 kHz | / | PK |
| Above 1 GHz | Harmonics & Band Edge | | | |
| | 1MHz | 3 MHz | / | PK |
| | Average Emission Level=Peak Emission Level+20*log(Duty cycle) | | | |
| | Other Emissions | | | |
| | 1MHz | 3 MHz | / | PK |
| | 1MHz | 10 Hz | / | Average |

For Duty cycle measurement:

Use the duty cycle factor correction factor method per 15.35(c).

Duty cycle=On time/100milliseconds, On time=N1*L1+N2*L2+...Nn-1*Ln-1+Nn*Ln,
Where N1 is number of type 1 pulses, L1 is length of type 1 pulse, etc.

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 except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz, average detection modes for frequency bands 9–90 kHz and 110–490 kHz, peak and average detection modes for frequencies above 1 GHz.

For 9 kHz-30MHz, the report shall list the six emissions with the smallest margin relative to the limit, for each of the three antenna orientations (parallel, perpendicular, and ground-parallel) unless the margin is greater than 20 dB.

All emissions under the average limit and under the noise floor have not recorded in the report.

Factor & Over Limit/Margin Calculation

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

$$\text{Factor} = \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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

$$\begin{aligned}\text{Over Limit/Margin} &= \text{Level/Corrected Amplitude} - \text{Limit} \\ \text{Level / Corrected Amplitude} &= \text{Read Level} + \text{Factor}\end{aligned}$$

Test Data

Environmental Conditions

| | |
|---------------------------|------------|
| Temperature: | 25~25.3 °C |
| Relative Humidity: | 50~54 % |
| ATM Pressure: | 101.0 kPa |

The testing was performed by Warren Huang on 2024-04-17 for below 1GHz and Tyler Wu on 2024-05-14 and 2024-05-15 for above 1GHz.

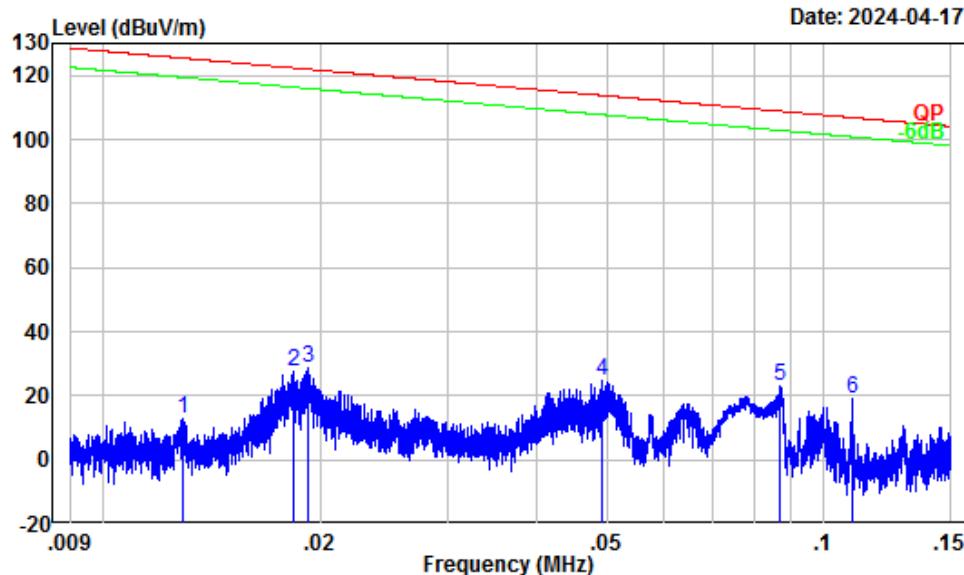
Test mode: Transmitting

Note: After pre-scan in the X, Y and Z axes of orientation, the worst case y-axis of orientation were recorded.

9 kHz-30MHz: (Maximum output power mode, 8DPSK Low Channel)

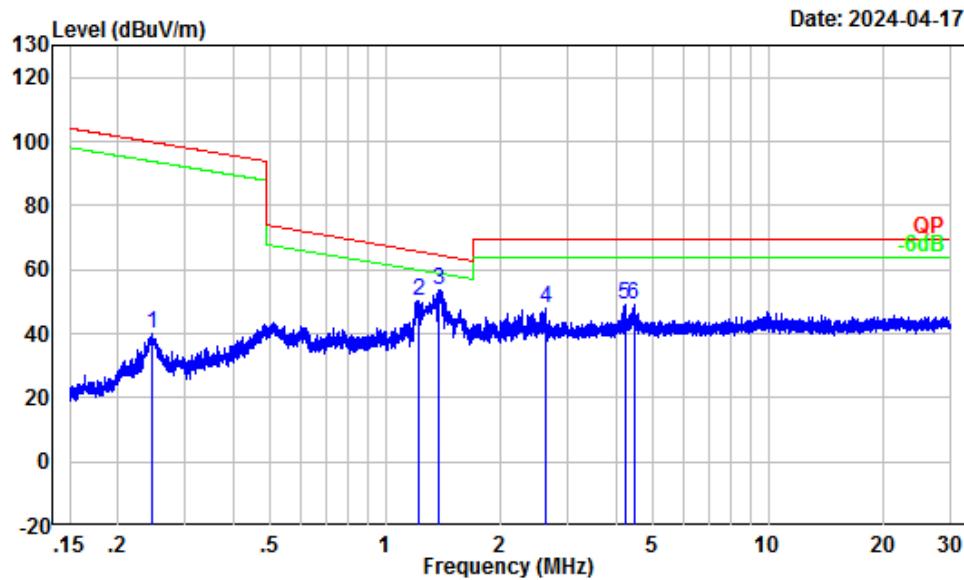
Note: When the test result of peak was less than the limit of QP/Average more than 6dB, just peak value were recorded.

Parallel (worst case)



Site : Chamber A
Condition : 3m
Project Number: 2401S68918-RF
Note : BT
Tester : Warren Huang

| | Freq | Factor | Read Level | Limit Level | Over Line | Over Limit | Remark |
|---|------|--------|------------|-------------|------------------|--------------------|--------|
| | | | MHz | dB/m | dB _{uV} | dB _{uV/m} | dB |
| 1 | 0.01 | -5.49 | 18.22 | 12.73 | 125.40 | -112.67 | Peak |
| 2 | 0.02 | -6.40 | 33.91 | 27.51 | 122.34 | -94.83 | Peak |
| 3 | 0.02 | -6.42 | 34.85 | 28.43 | 121.90 | -93.47 | Peak |
| 4 | 0.05 | -1.64 | 26.11 | 24.47 | 113.76 | -89.29 | Peak |
| 5 | 0.09 | 2.12 | 20.66 | 22.78 | 108.81 | -86.03 | Peak |
| 6 | 0.11 | 3.58 | 15.67 | 19.25 | 106.82 | -87.57 | Peak |

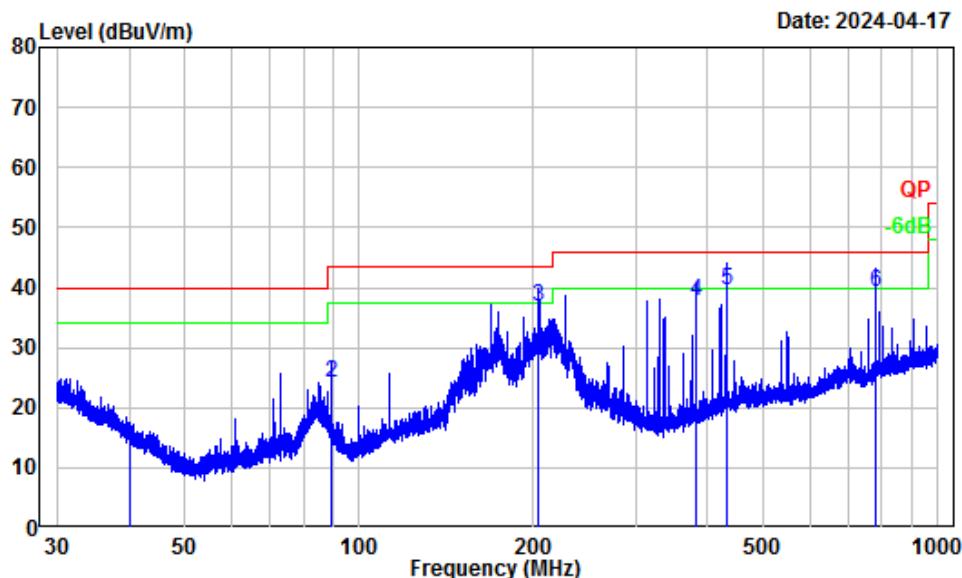


Site : Chamber A
Condition : 3m
Project Number: 2401S68918-RF
Note : BT
Tester : Warren Huang

| Freq | Factor | Read | Limit | Over | Remark |
|------|--------|-------|-------|-------|-------------------|
| | | Level | Level | Line | |
| 1 | 0.25 | 9.95 | 29.96 | 39.91 | 99.77 -59.86 Peak |
| 2 | 1.23 | 21.84 | 28.20 | 50.04 | 65.66 -15.62 Peak |
| 3 | 1.38 | 22.31 | 31.53 | 53.84 | 64.59 -10.75 Peak |
| 4 | 2.62 | 24.65 | 23.14 | 47.79 | 69.54 -21.75 Peak |
| 5 | 4.22 | 25.79 | 23.16 | 48.95 | 69.54 -20.59 Peak |
| 6 | 4.46 | 25.87 | 23.18 | 49.05 | 69.54 -20.49 Peak |

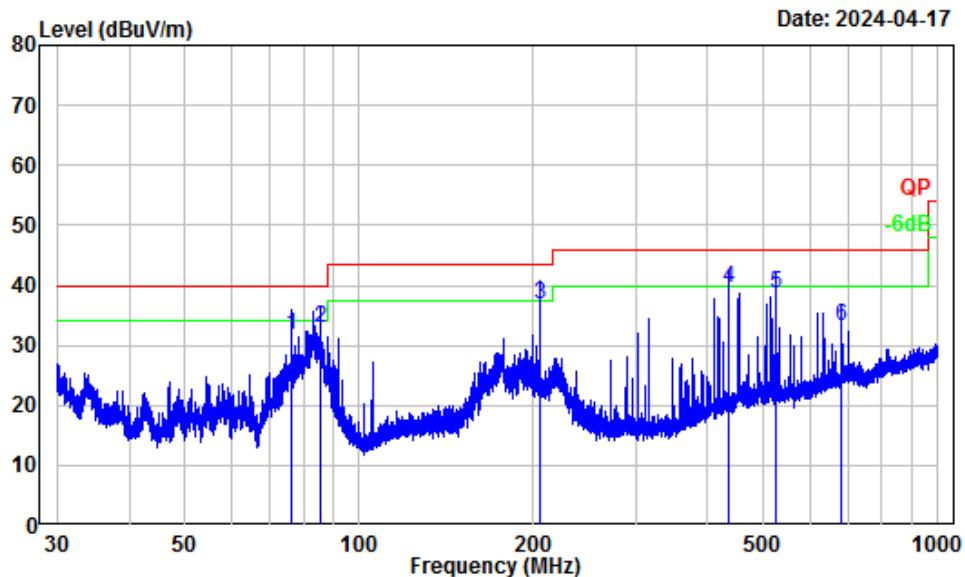
30MHz-1GHz: (Maximum output power mode, 8DPSK Low Channel)

Horizontal



Site : Chamber A
Condition : 3m Horizontal
Project Number: 2401S68918-RF
Note : BT
Tester : Warren Huang

| | Freq | Factor | Read Level | Limit Level | Over Line | Over Limit | Remark |
|---|--------|--------|------------------|--------------------|--------------------|------------|--------|
| | MHz | dB/m | dB _{uV} | dB _{uV/m} | dB _{uV/m} | dB | |
| 1 | 40.01 | -10.40 | 23.78 | 13.38 | 40.00 | -26.62 | QP |
| 2 | 89.43 | -16.57 | 40.68 | 24.11 | 43.50 | -19.39 | QP |
| 3 | 204.42 | -11.10 | 47.93 | 36.83 | 43.50 | -6.67 | QP |
| 4 | 382.92 | -8.21 | 45.97 | 37.76 | 46.00 | -8.24 | QP |
| 5 | 430.84 | -6.28 | 45.69 | 39.41 | 46.00 | -6.59 | QP |
| 6 | 778.58 | -1.03 | 40.20 | 39.17 | 46.00 | -6.83 | QP |

Vertical

Site : Chamber A
Condition : 3m Vertical
Project Number: 2401S68918-RF
Note : BT
Tester : Warren Huang

| | Freq | Factor | Read Level | Limit Level | Line | Over Limit | Remark |
|---|--------|--------|------------|-------------|--------|------------|--------|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 76.31 | -17.25 | 48.80 | 31.55 | 40.00 | -8.45 | QP |
| 2 | 85.67 | -17.30 | 50.09 | 32.79 | 40.00 | -7.21 | QP |
| 3 | 205.49 | -12.23 | 49.20 | 36.97 | 43.50 | -6.53 | QP |
| 4 | 434.26 | -6.58 | 46.18 | 39.60 | 46.00 | -6.40 | QP |
| 5 | 526.40 | -5.05 | 43.60 | 38.55 | 46.00 | -7.45 | QP |
| 6 | 680.85 | -2.27 | 35.50 | 33.23 | 46.00 | -12.77 | QP |

Above 1GHz:

| Frequency (MHz) | Receiver | | Polar (H/V) | Factor (dB/m) | Corrected Amplitude (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) | | | | | |
|------------------------|-------------------------|--------|----------------|------------------|--|-------------------------|----------------|--|--|--|--|--|
| | Reading (dB μ V) | PK/Ave | | | | | | | | | | |
| 8DPSK | | | | | | | | | | | | |
| Low Channel 2402MHz | | | | | | | | | | | | |
| 2371.38 | 55.25 | PK | H | -2.93 | 52.32 | 74 | -21.68 | | | | | |
| 2364.93 | 55.74 | PK | V | -2.93 | 52.81 | 74 | -21.19 | | | | | |
| 4804.00 | 65.76 | PK | H | 2.42 | 68.18 | 74 | -5.82 | | | | | |
| 4804.00 | 64.52 | PK | V | 2.42 | 66.94 | 74 | -7.06 | | | | | |
| Middle Channel 2441MHz | | | | | | | | | | | | |
| 4882.00 | 68.35 | PK | H | 2.58 | 70.93 | 74 | -3.07 | | | | | |
| 4882.00 | 67.31 | PK | V | 2.58 | 69.89 | 74 | -4.11 | | | | | |
| High Channel 2480MHz | | | | | | | | | | | | |
| 2483.54 | 62.03 | PK | H | -3.17 | 58.86 | 74 | -15.14 | | | | | |
| 2490.57 | 53.71 | PK | V | -3.18 | 50.53 | 74 | -23.47 | | | | | |
| 4960.00 | 65.71 | PK | H | 2.68 | 68.39 | 74 | -5.61 | | | | | |
| 4960.00 | 64.28 | PK | V | 2.68 | 66.96 | 74 | -7.04 | | | | | |

Note:

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

Corrected Amplitude = Factor + Reading

Margin = Corrected. Amplitude - Limit

The other spurious emission which is in the noise floor level was not recorded.

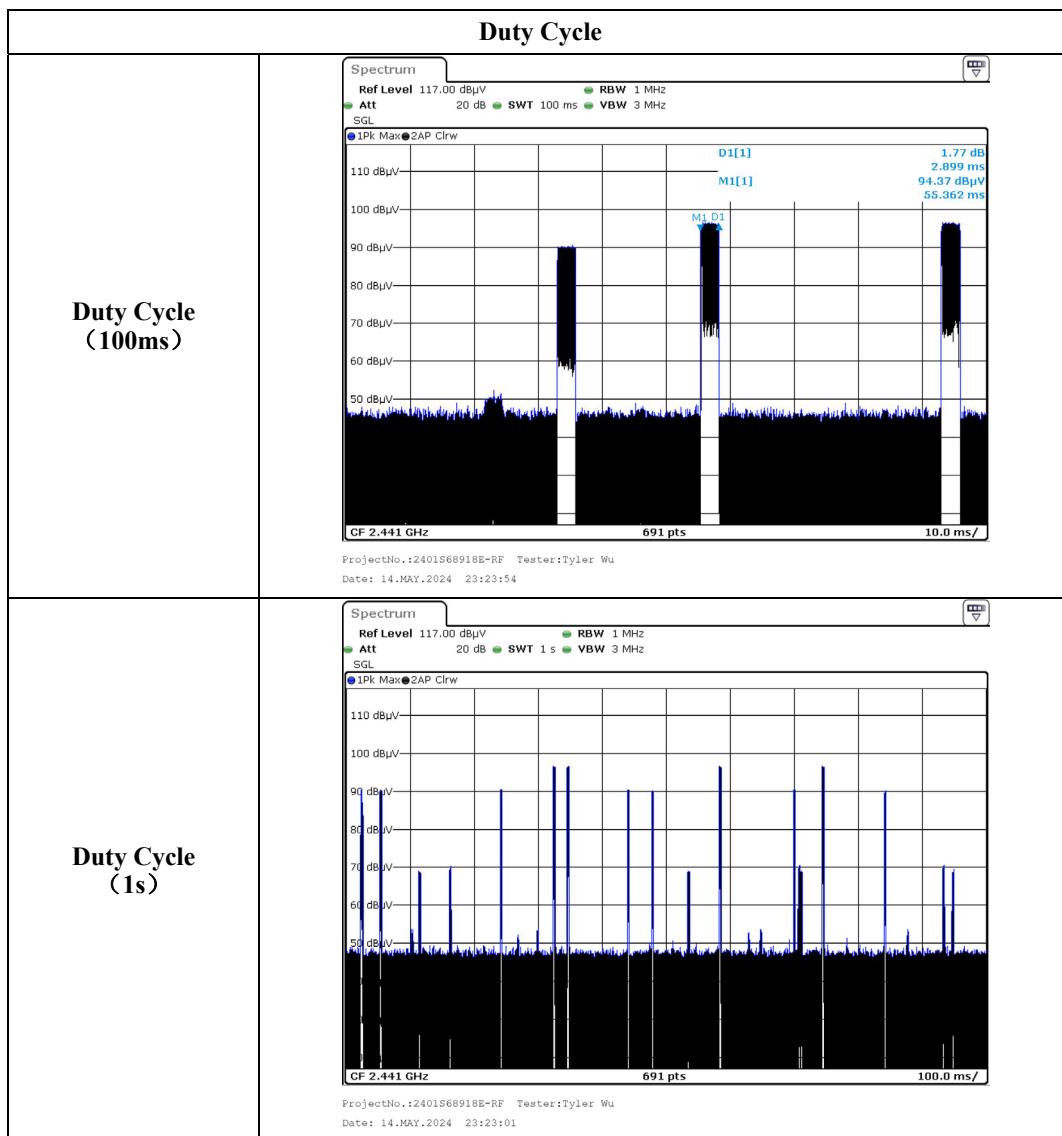
| Field Strength of Average | | | | | | | |
|-------------------------------|--|----------------|--|------------------------------------|-------------------------|----------------|----------|
| Frequency (MHz) | Peak Measurement @3m (dB μ V/m) | Polar (H/V) | Duty Cycle Correction Factor (dB) | Average level (dB μ V/m) | FCC Part 15.247 | | |
| | | | | | Limit (dB μ V/m) | Margin (dB) | Comment |
| Low Channel 2402MHz | | | | | | | |
| 2371.38 | 52.32 | H | -24.73 | 27.59 | 54 | -26.41 | Bandedge |
| 2364.93 | 52.81 | V | -24.73 | 28.08 | 54 | -25.92 | Bandedge |
| 4804.00 | 68.18 | H | -24.73 | 43.45 | 54 | -10.55 | Harmonic |
| 4804.00 | 66.94 | V | -24.73 | 42.21 | 54 | -11.79 | Harmonic |
| Middle Channel 2441MHz | | | | | | | |
| 4882.00 | 70.93 | H | -24.73 | 46.2 | 54 | -7.80 | Harmonic |
| 4882.00 | 69.89 | V | -24.73 | 45.16 | 54 | -8.84 | Harmonic |
| High Channel 2480MHz | | | | | | | |
| 2483.54 | 58.86 | H | -24.73 | 34.13 | 54 | -19.87 | Bandedge |
| 2490.57 | 50.53 | V | -24.73 | 25.8 | 54 | -28.2 | Bandedge |
| 4960.00 | 68.39 | H | -24.73 | 43.66 | 54 | -10.34 | Harmonic |
| 4960.00 | 66.96 | V | -24.73 | 42.23 | 54 | -11.77 | Harmonic |

Note: Average level= Peak level+ Duty Cycle Corrected Factor

Worst case duty cycle:

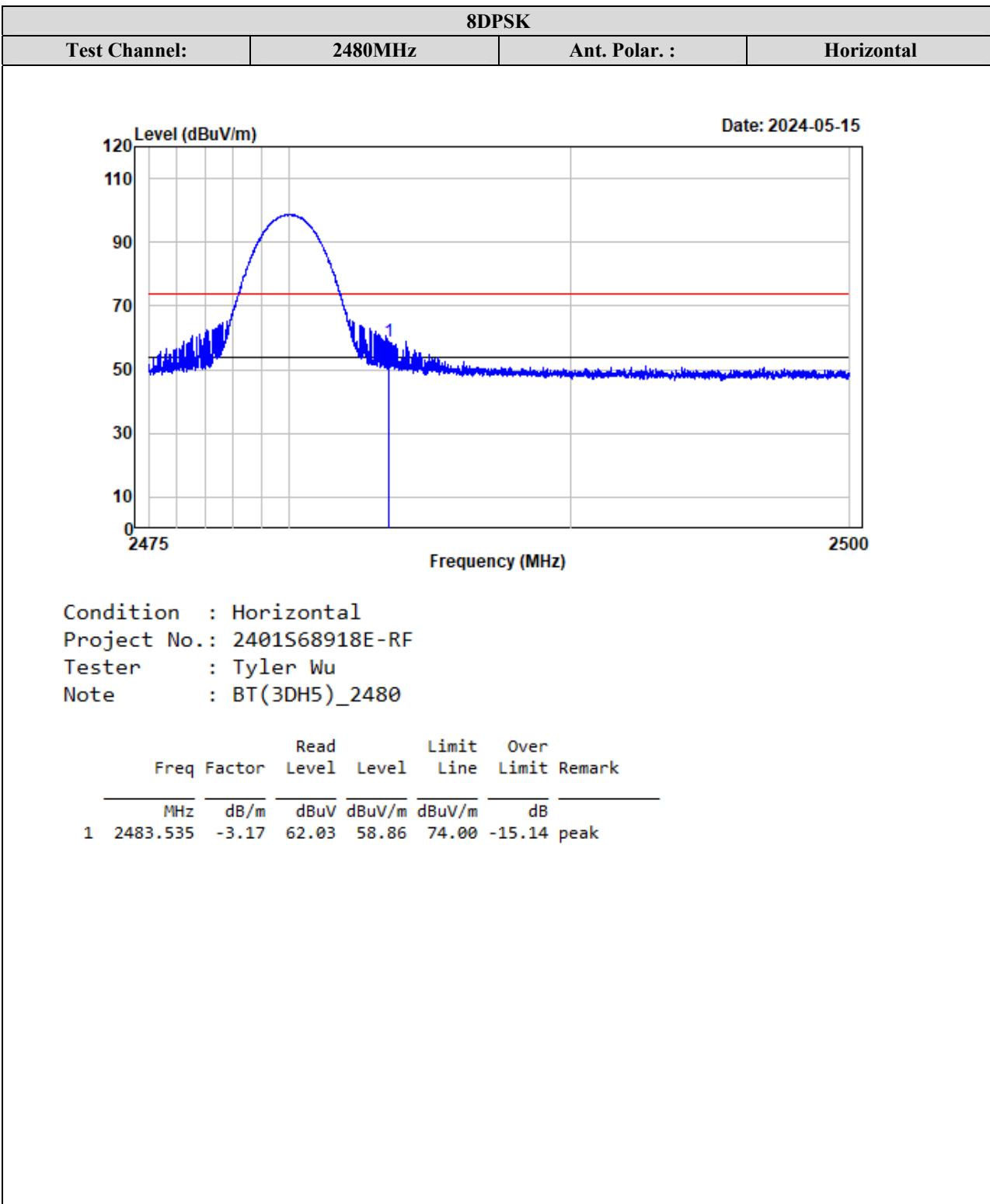
$$\text{Duty Cycle} = \text{Ton}/100\text{ms} = 2.899*2/100 = 0.05798$$

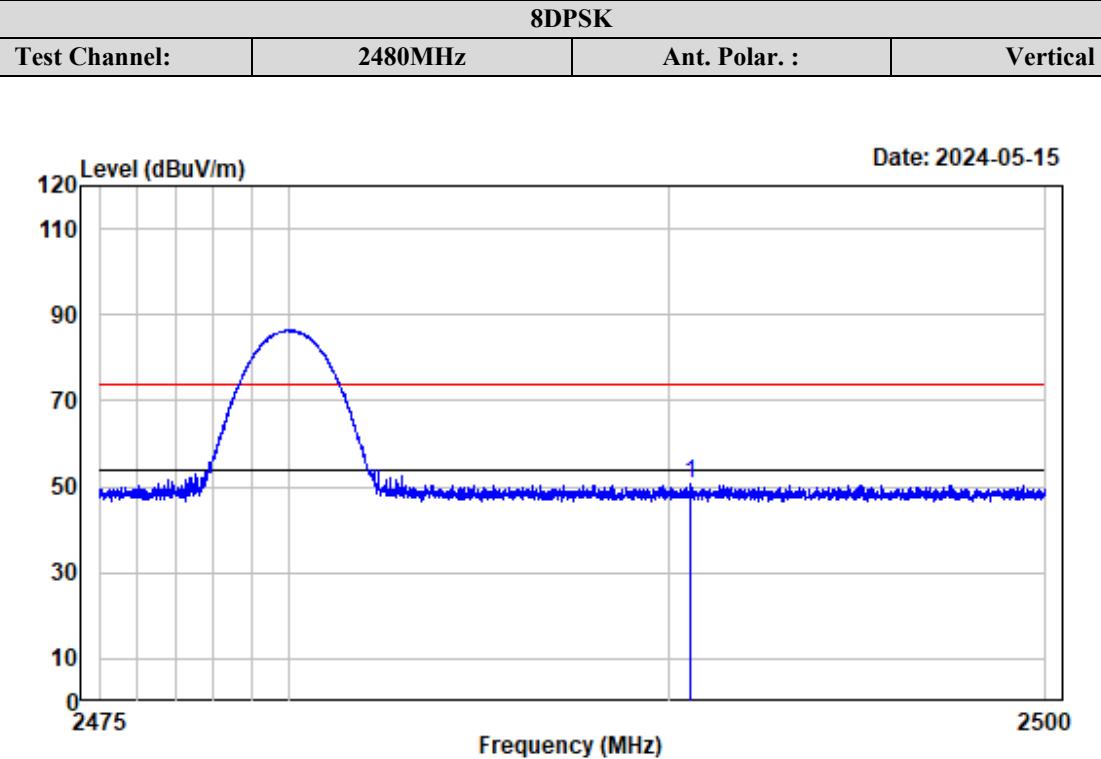
$$\text{Duty Cycle Corrected Factor} = 20\lg(\text{Duty Cycle}) = 20\lg 0.05798 = -24.73$$



Test plots for example as below:

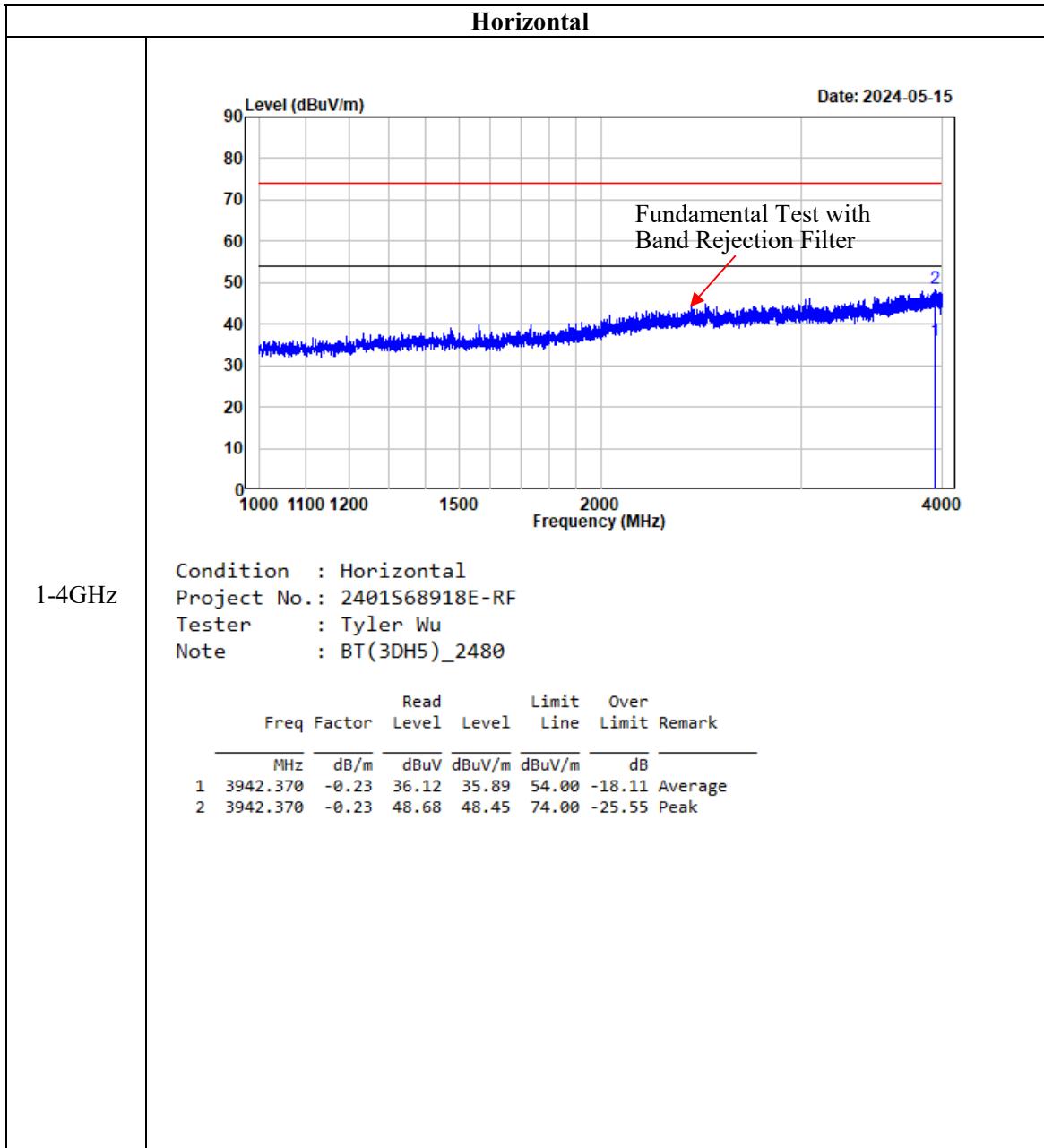
Band Edge Measurements (Radiated):

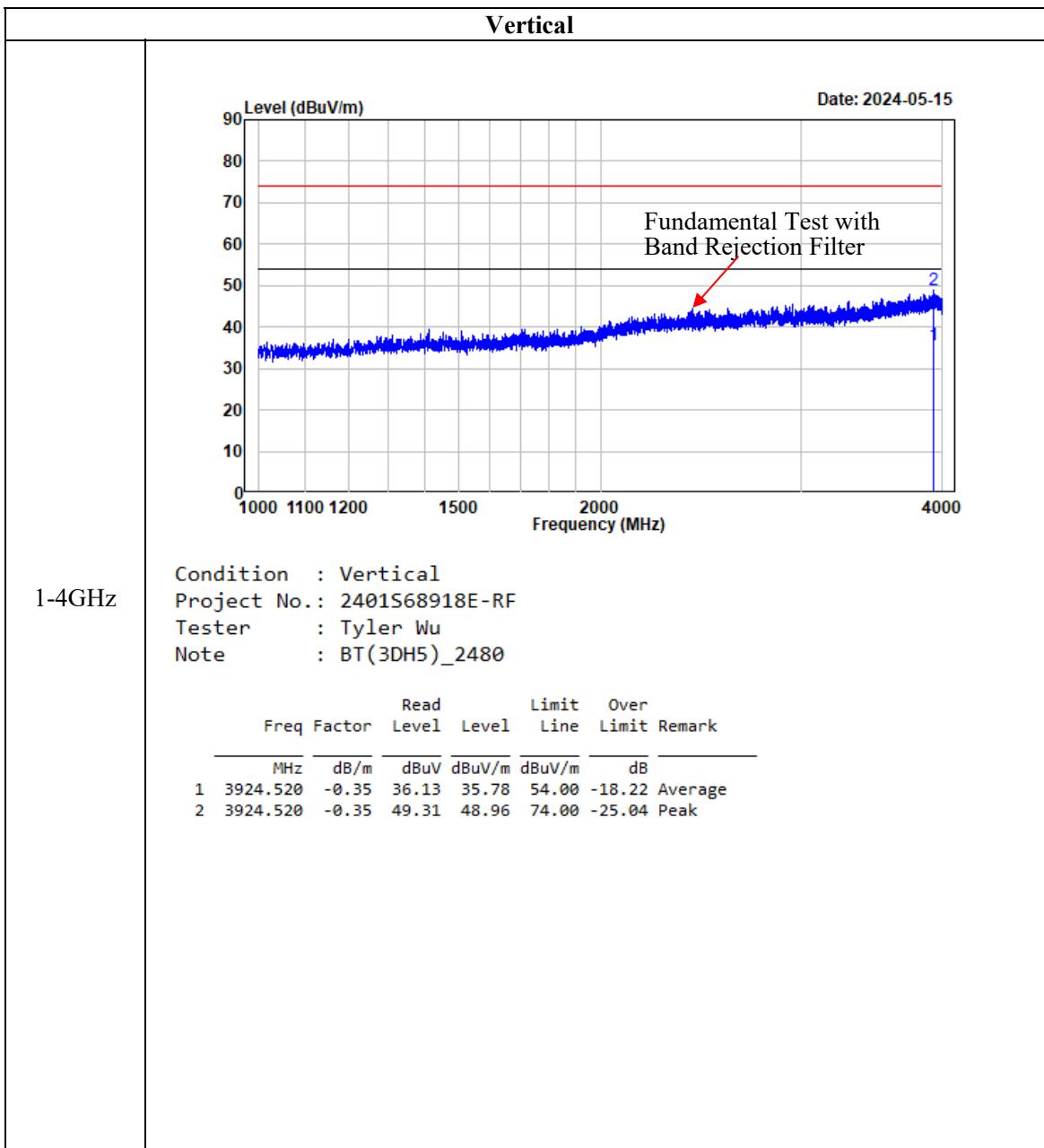


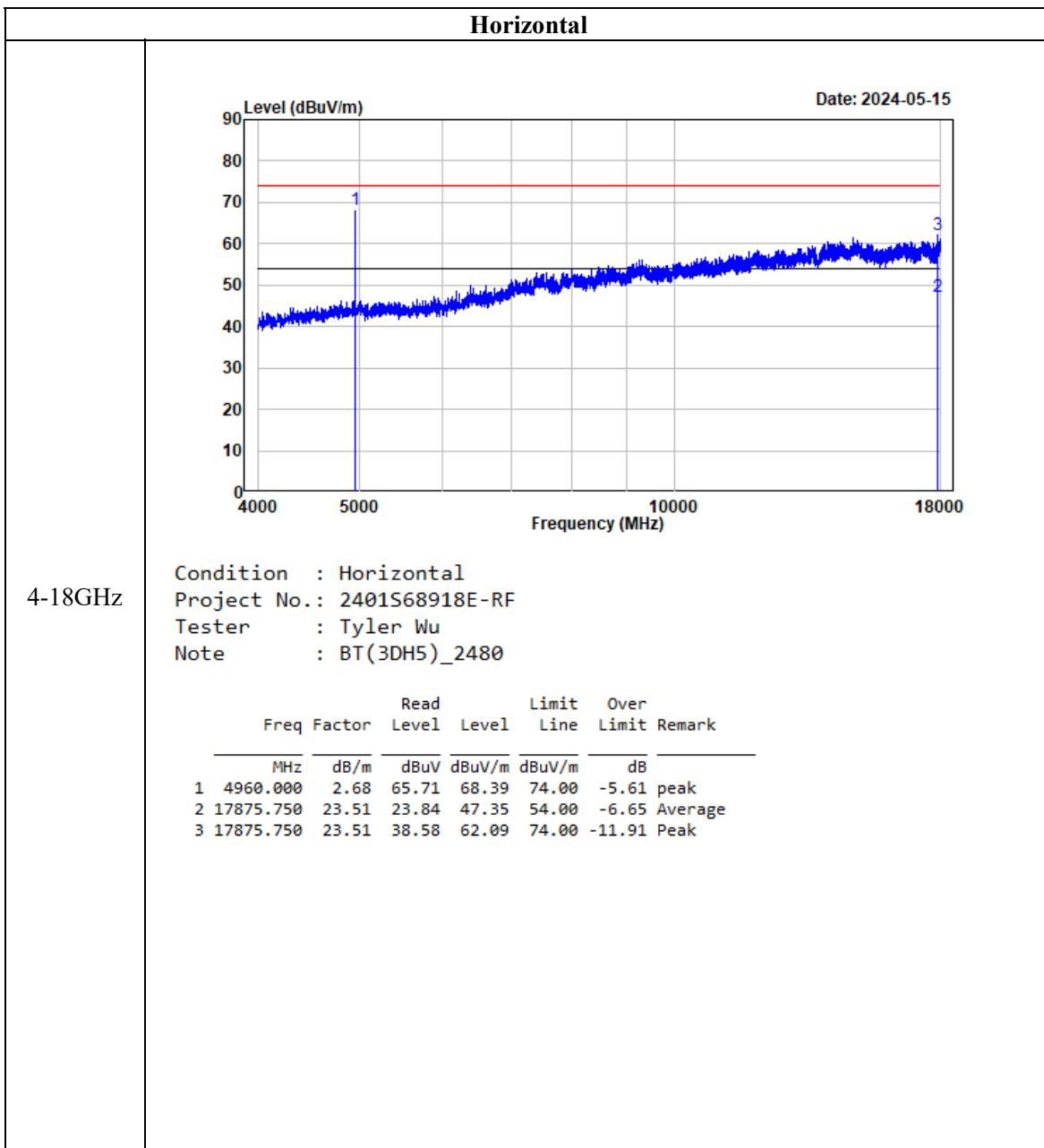


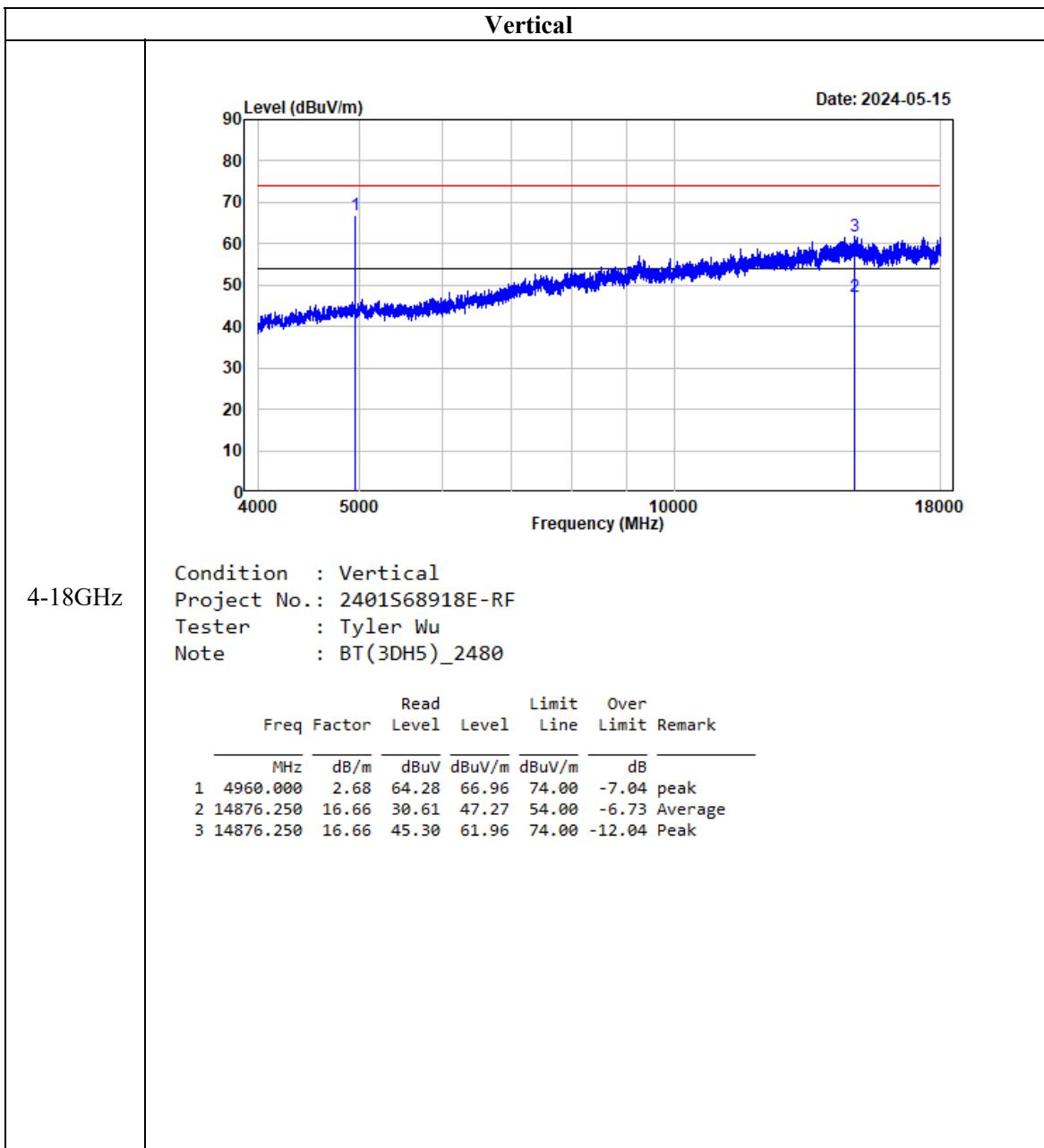
Condition : Vertical
Project No.: 2401S68918E-RF
Tester : Tyler Wu
Note : BT(3DH5)_2480

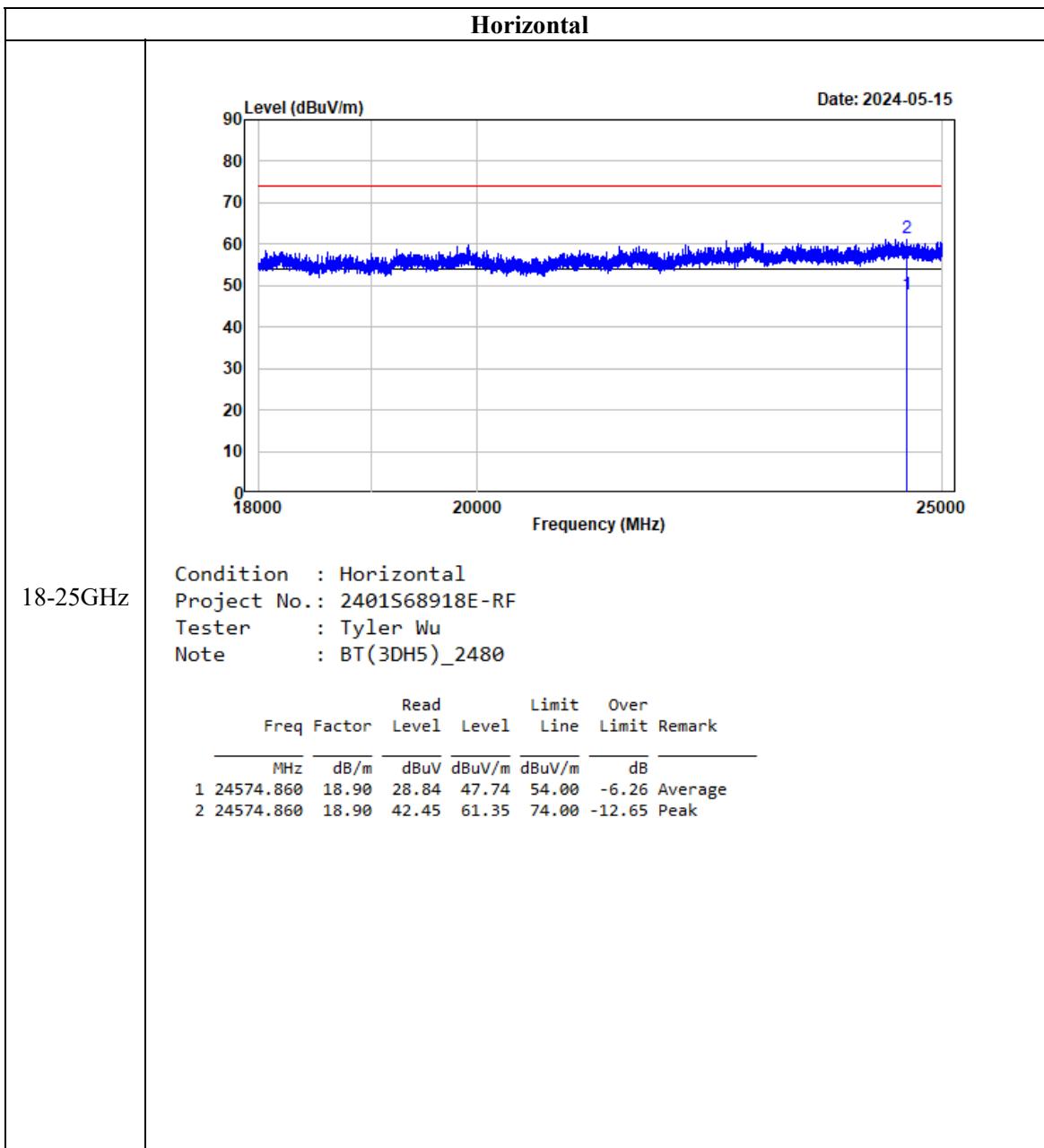
| Freq | Factor | Read | | Limit | | Over Line | Over Limit | Remark |
|------|----------|-------|-------|-------|--------|--------------|---------------|--------|
| | | Level | Level | Line | dBuV/m | | | |
| 1 | 2490.568 | -3.18 | 53.71 | 50.53 | 74.00 | -23.47 | peak | |

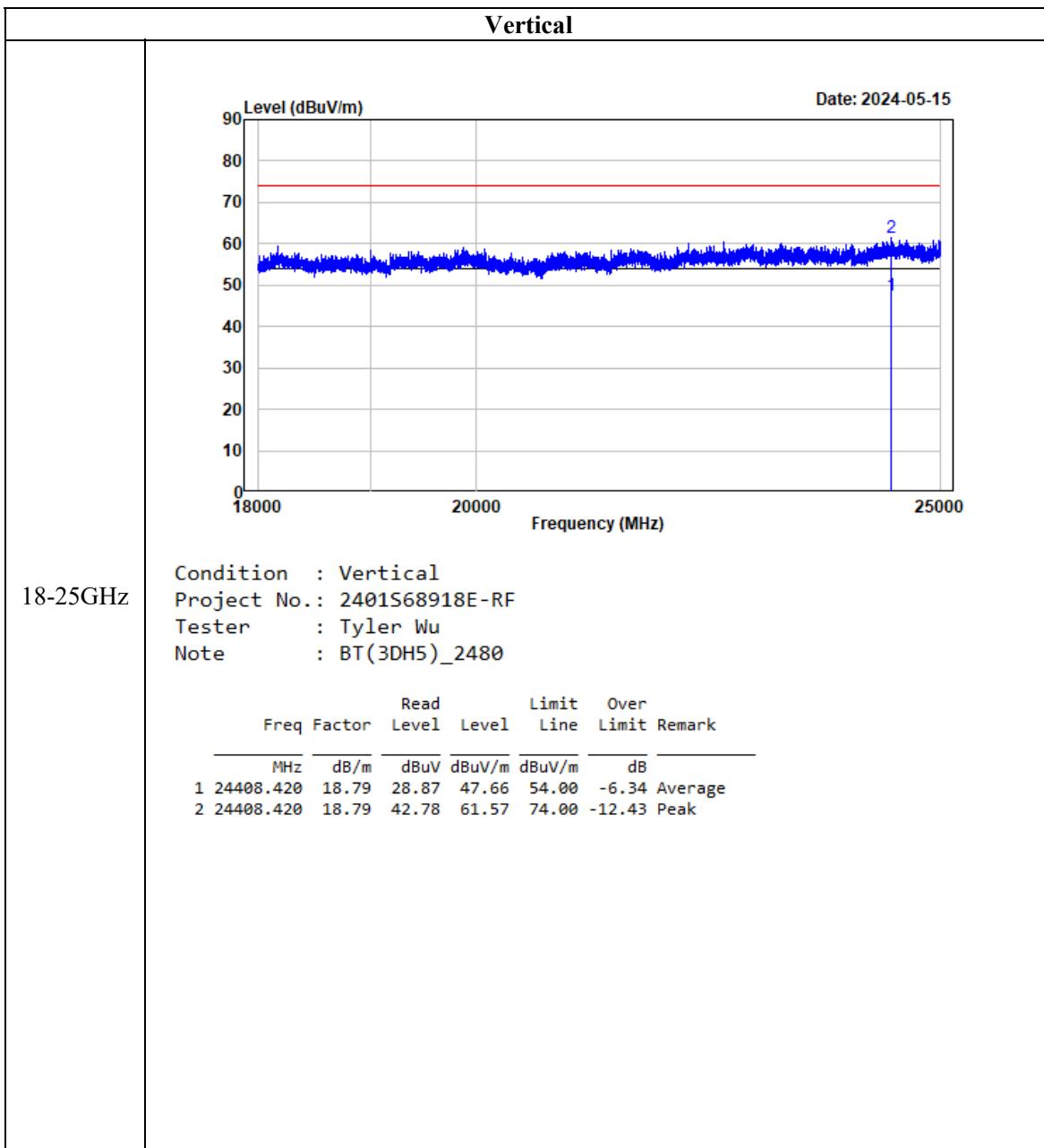
Harmonic Measurements:











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

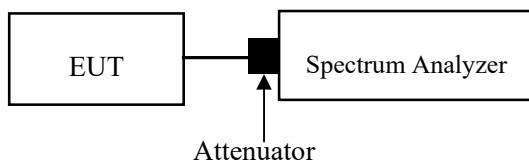
Applicable Standard

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

Test Method: ANSI C63.10-2013 Clause 7.8.2

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: | 26°C |
| Relative Humidity: | 50 % |
| ATM Pressure: | 101.0 kPa |

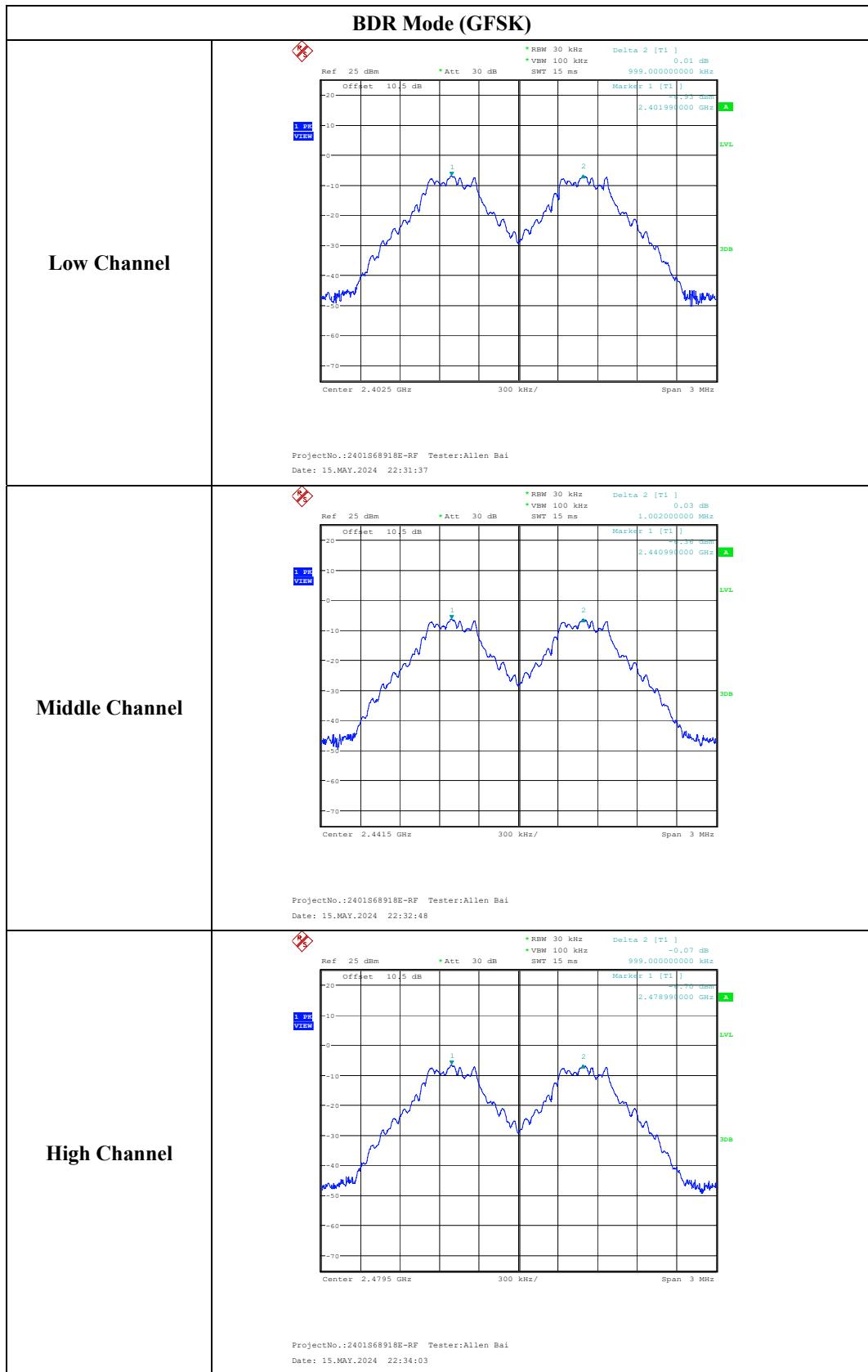
The testing was performed by Allen Bai on 2024-05-15.

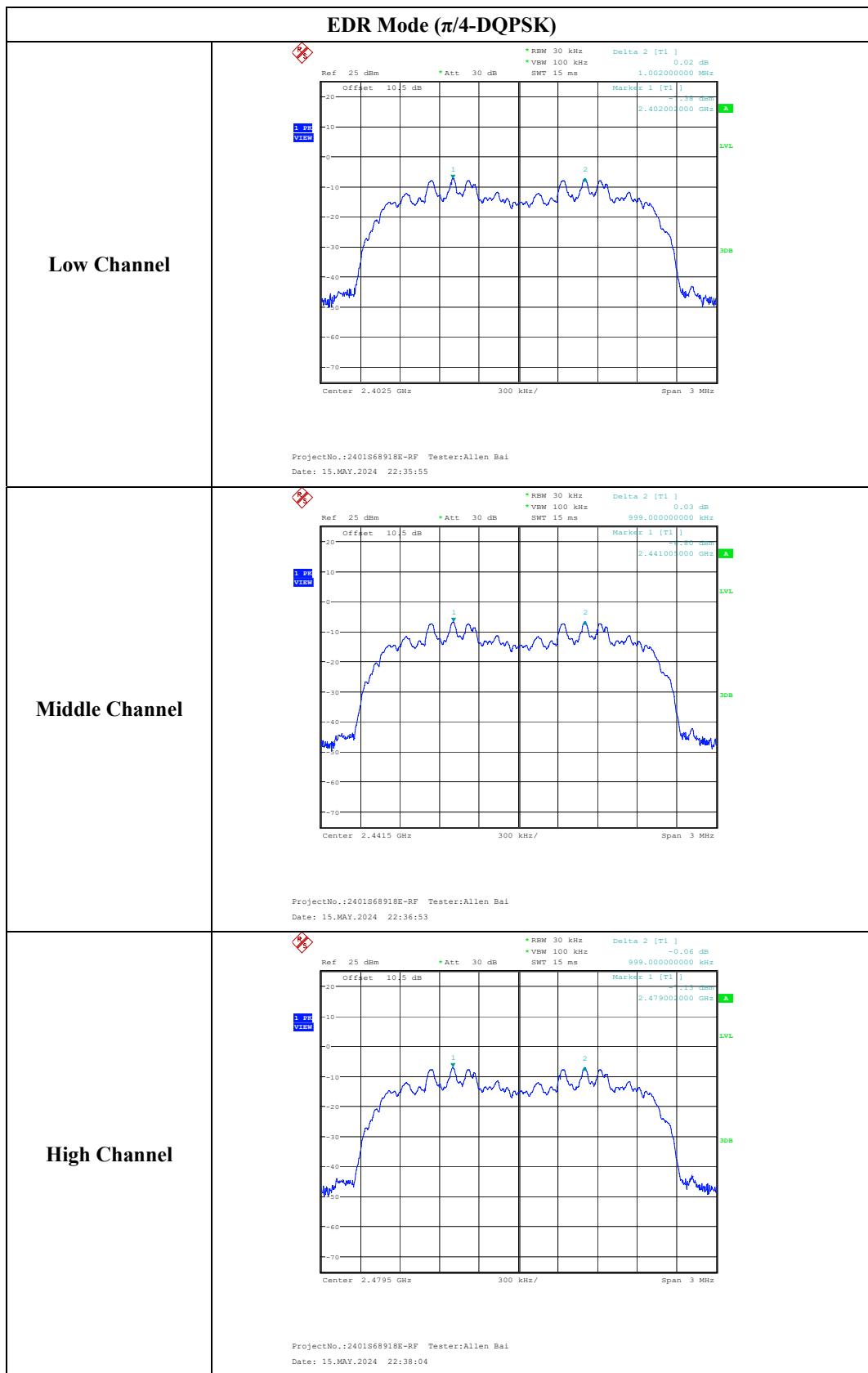
EUT operation mode: Transmitting

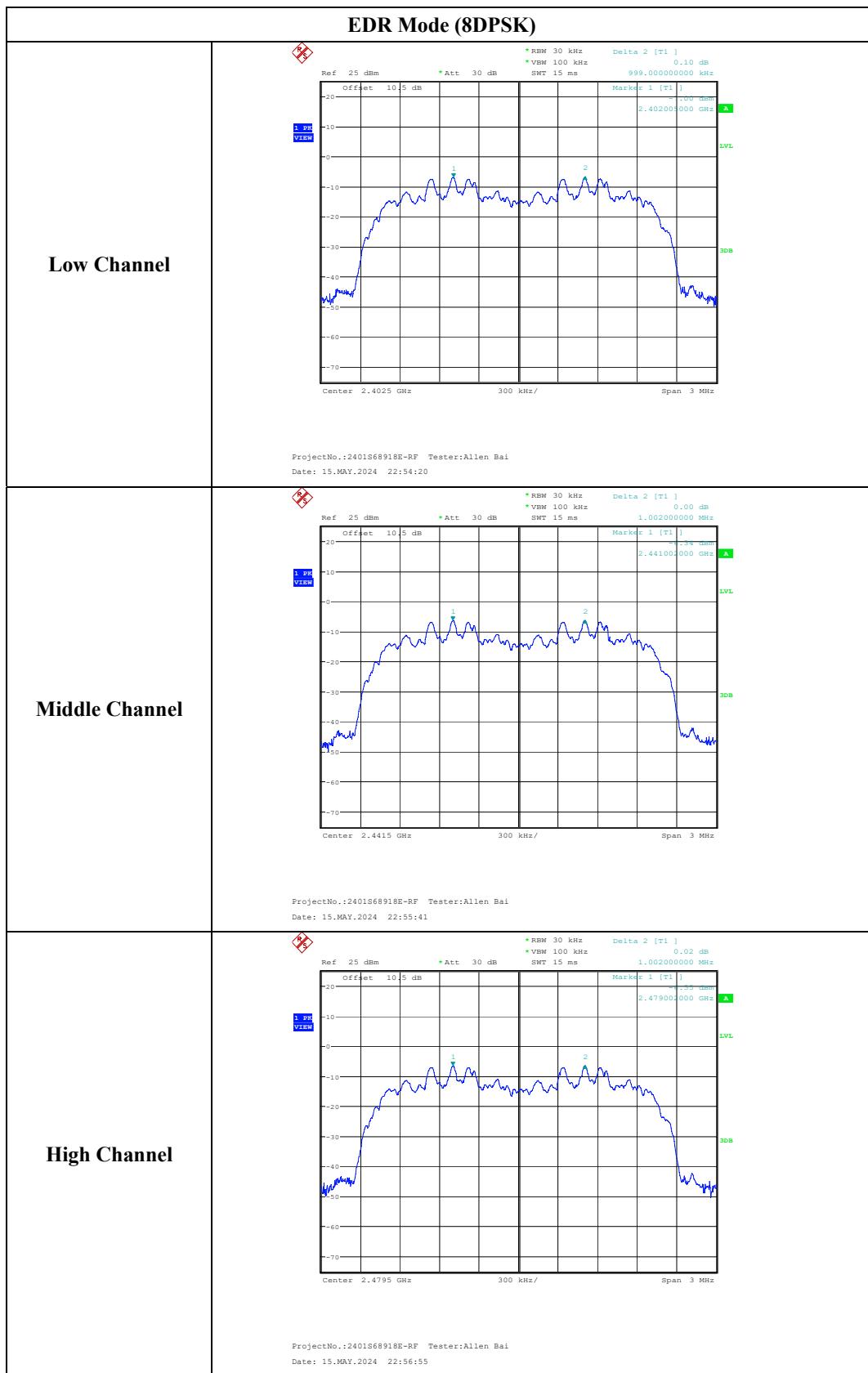
Test Result: Compliant.

| Test Modes | Test Frequency (MHz) | Channel Separation (MHz) | Limits (MHz) |
|----------------------------|----------------------|--------------------------|--------------|
| BDR Mode (GFSK) | 2402 | 0.999 | 0.644 |
| | 2441 | 1.002 | 0.640 |
| | 2480 | 0.999 | 0.636 |
| EDR Mode ($\pi/4$ -DQPSK) | 2402 | 1.002 | 0.862 |
| | 2441 | 0.999 | 0.860 |
| | 2480 | 0.999 | 0.860 |
| EDR Mode (8DPSK) | 2402 | 0.999 | 0.868 |
| | 2441 | 1.002 | 0.870 |
| | 2480 | 1.002 | 0.868 |

Note: Limit = two-thirds of the 20 dB bandwidth







FCC §15.247(a) (1) - 20 dB EMISSION BANDWIDTH

Applicable Standard

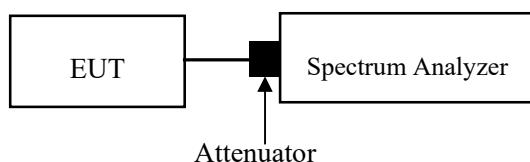
Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.7 & Clause 6.9.2

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.
- The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW/ 20dB bandwidth and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.



Test Data

Environmental Conditions

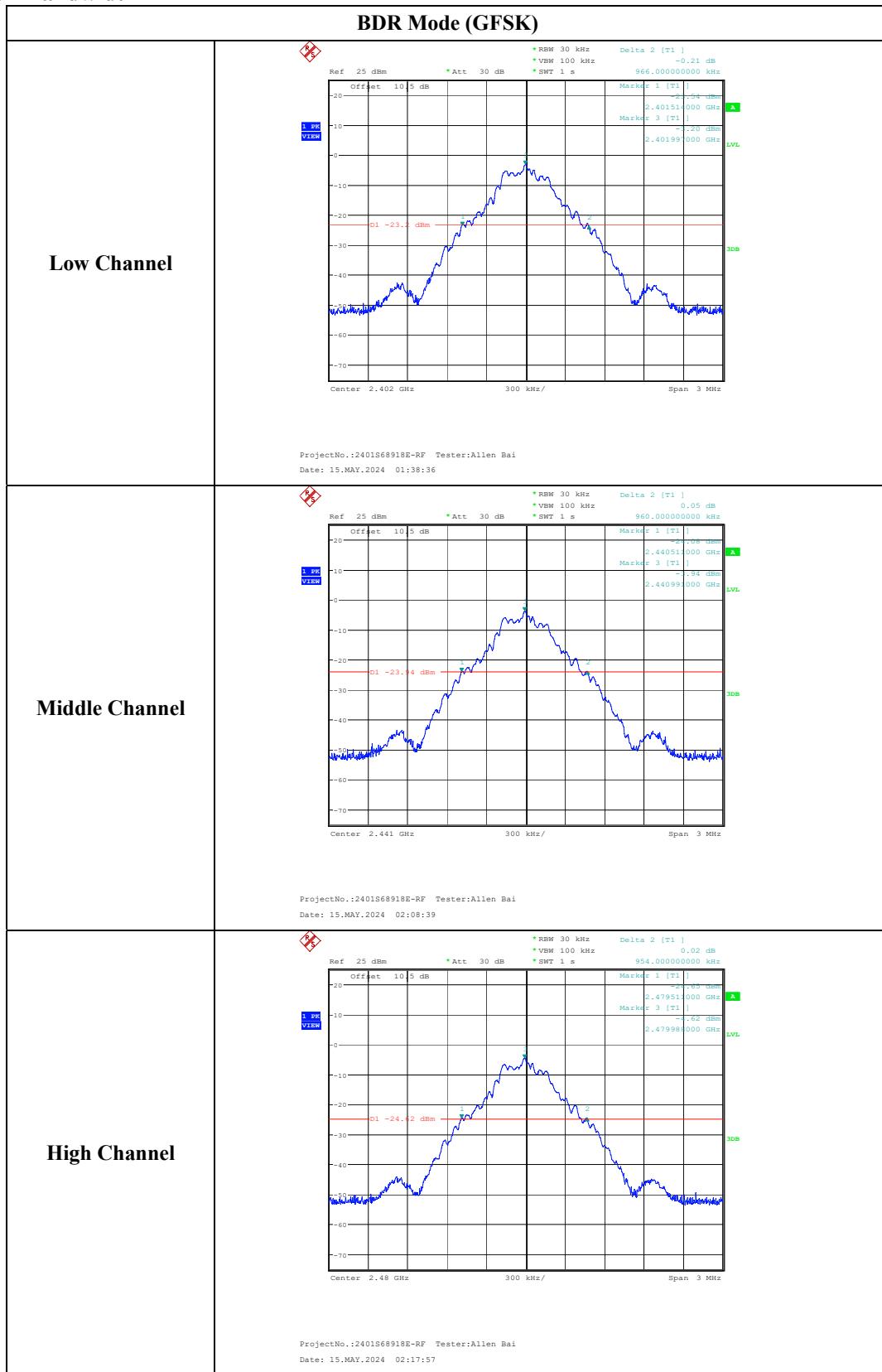
| | |
|--------------------|-----------|
| Temperature: | 26 °C |
| Relative Humidity: | 50 % |
| ATM Pressure: | 101.0 kPa |

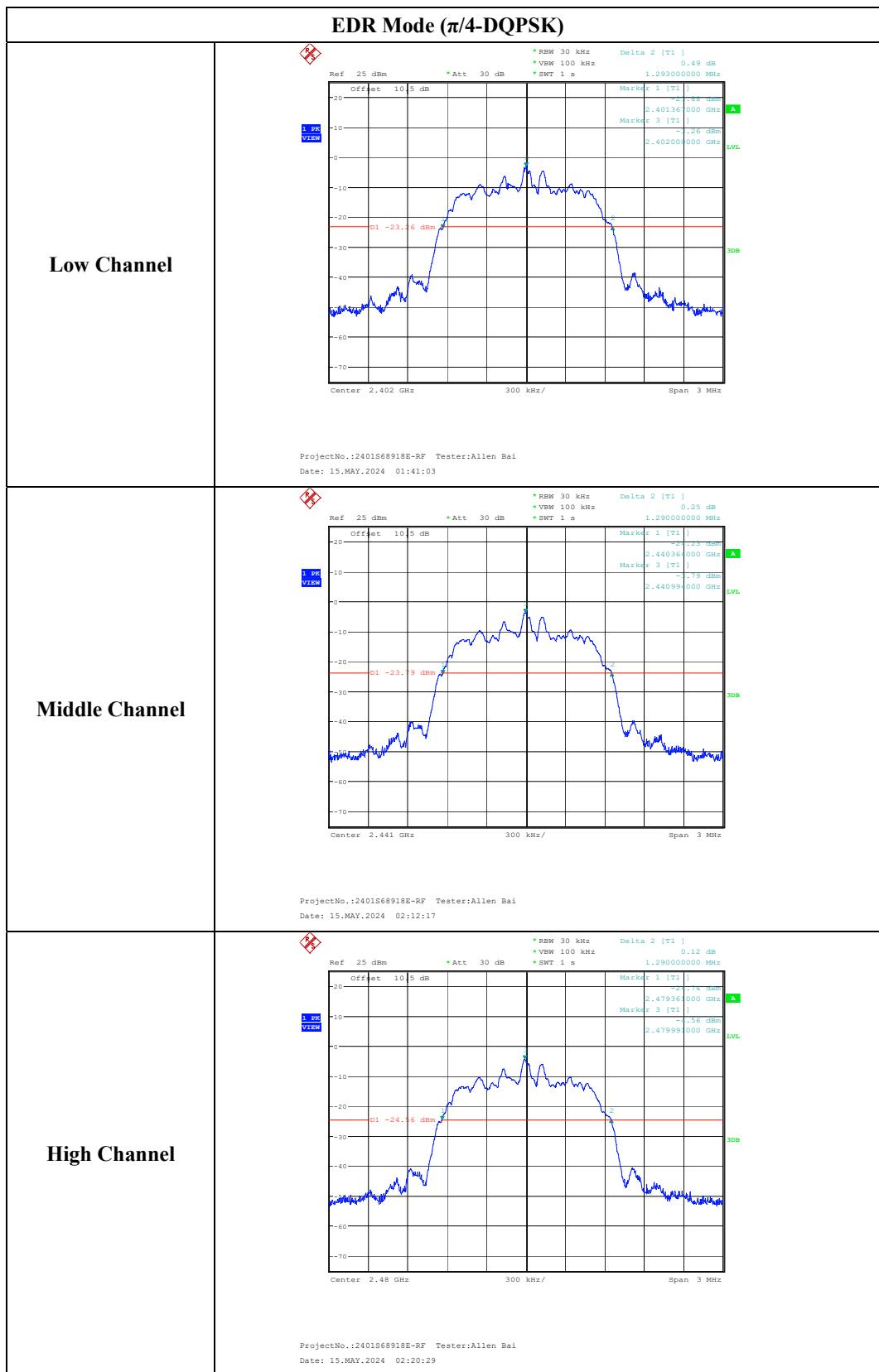
The testing was performed by Allen Bai on 2024-05-15.

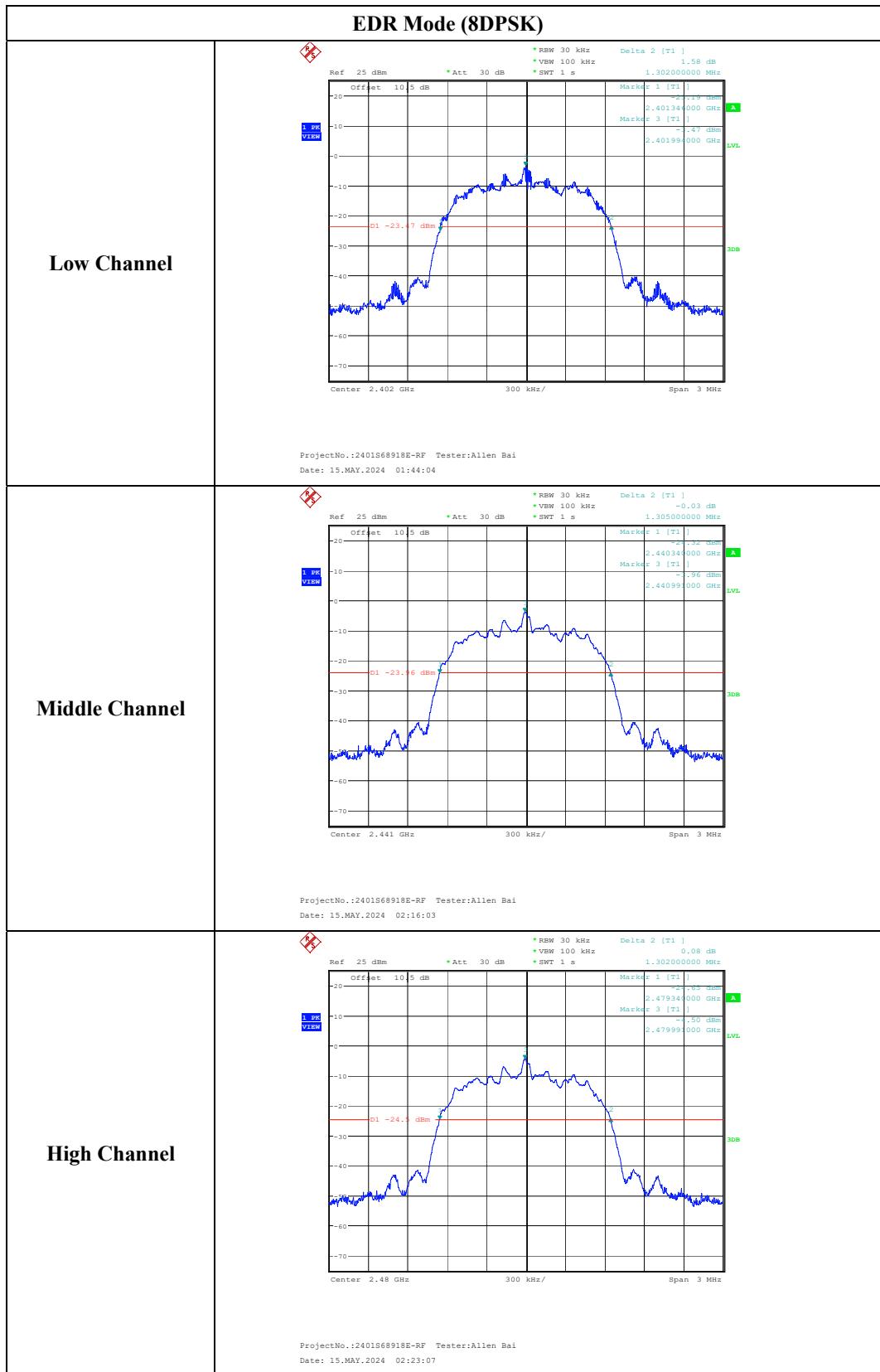
EUT operation mode: Transmitting

Test Result: Compliant.

| Test Modes | Test Channel | Test Frequency (MHz) | 20 dB Bandwidth (MHz) |
|----------------------------|--------------|----------------------|-----------------------|
| BDR Mode (GFSK) | Lowest | 2402 | 0.966 |
| | Middle | 2441 | 0.960 |
| | Highest | 2480 | 0.954 |
| EDR Mode ($\pi/4$ -DQPSK) | Lowest | 2402 | 1.293 |
| | Middle | 2441 | 1.290 |
| | Highest | 2480 | 1.290 |
| EDR Mode (8DPSK) | Lowest | 2402 | 1.302 |
| | Middle | 2441 | 1.305 |
| | Highest | 2480 | 1.302 |

20 dB Bandwidth





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

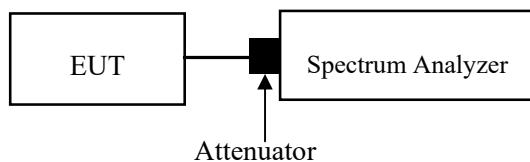
Applicable Standard

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

Test Method: ANSI C63.10-2013 Clause 7.8.3

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

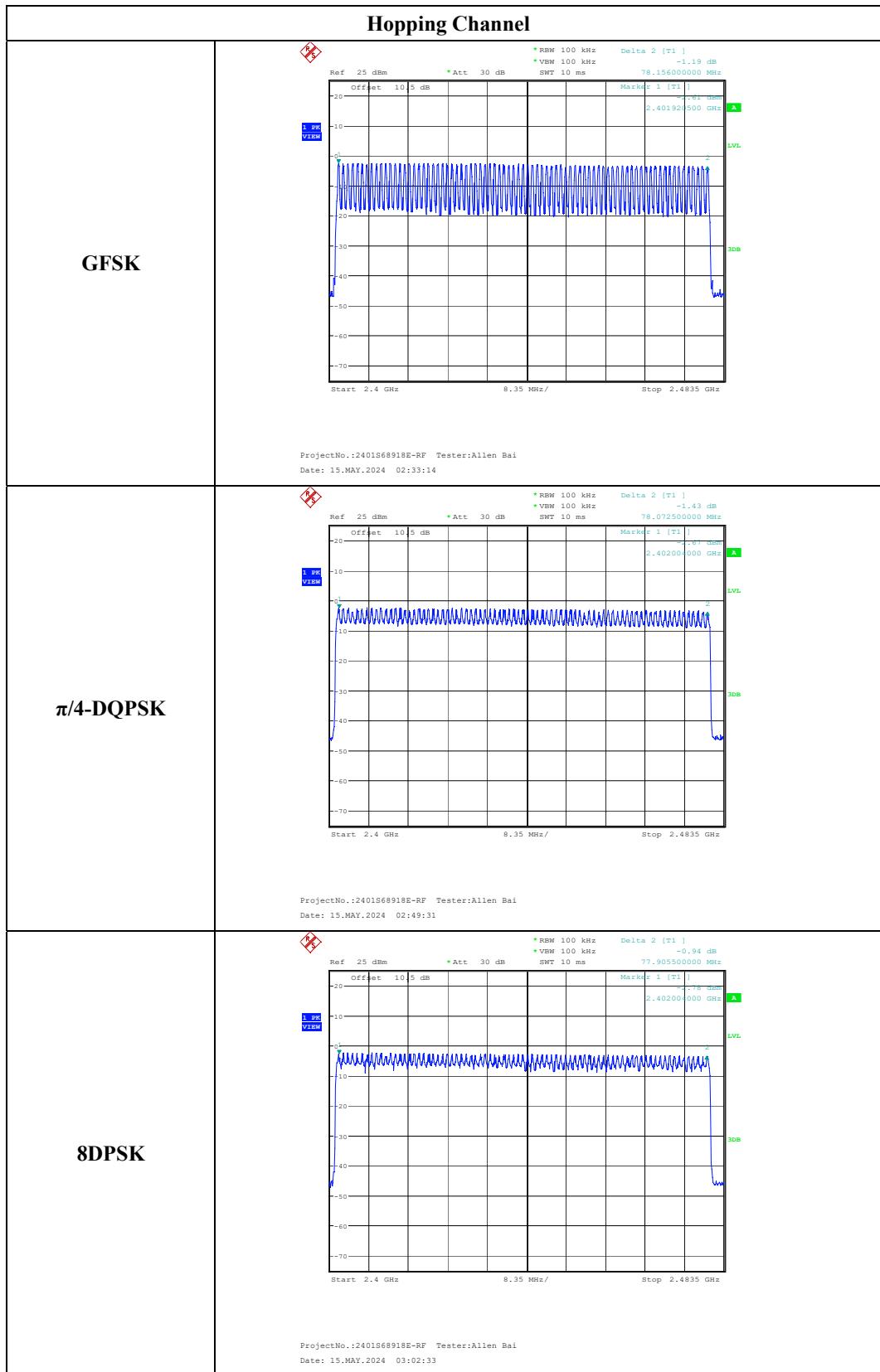
| | |
|---------------------------|-----------|
| Temperature: | 26 °C |
| Relative Humidity: | 50 % |
| ATM Pressure: | 101.0 kPa |

The testing was performed by Allen Bai on 2024-05-15.

EUT operation mode: Transmitting

Test Result: Compliant.

| Test Modes | Frequency Range (MHz) | Number of Hopping Channel | Limits |
|------------|-----------------------|---------------------------|--------|
| GFSK | 2400-2483.5 | 79 | ≥15 |
| π/4-DQPSK | 2400-2483.5 | 79 | ≥15 |
| 8DPSK | 2400-2483.5 | 79 | ≥15 |



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

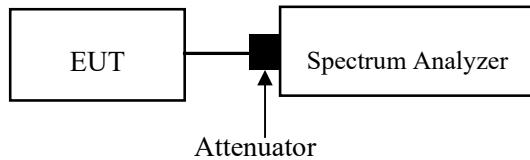
Applicable Standard

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

Test Method: ANSI C63.10-2013 Clause 7.8.4

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

| | |
|--------------------|-----------|
| Temperature: | 26~27 °C |
| Relative Humidity: | 50~52 % |
| ATM Pressure: | 101.0 kPa |

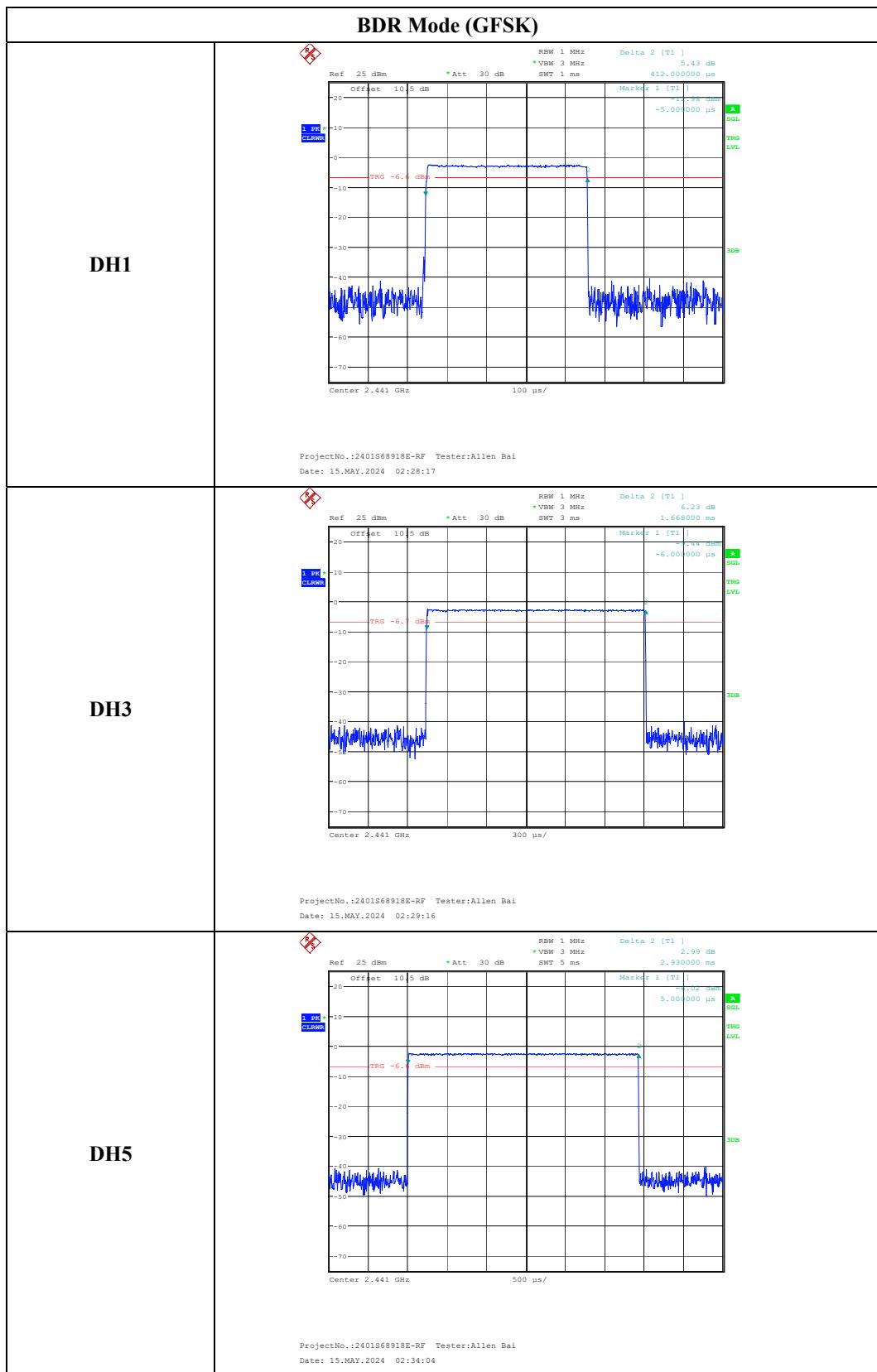
The testing was performed by Allen Bai on 2024-05-15 and 2024-05-17

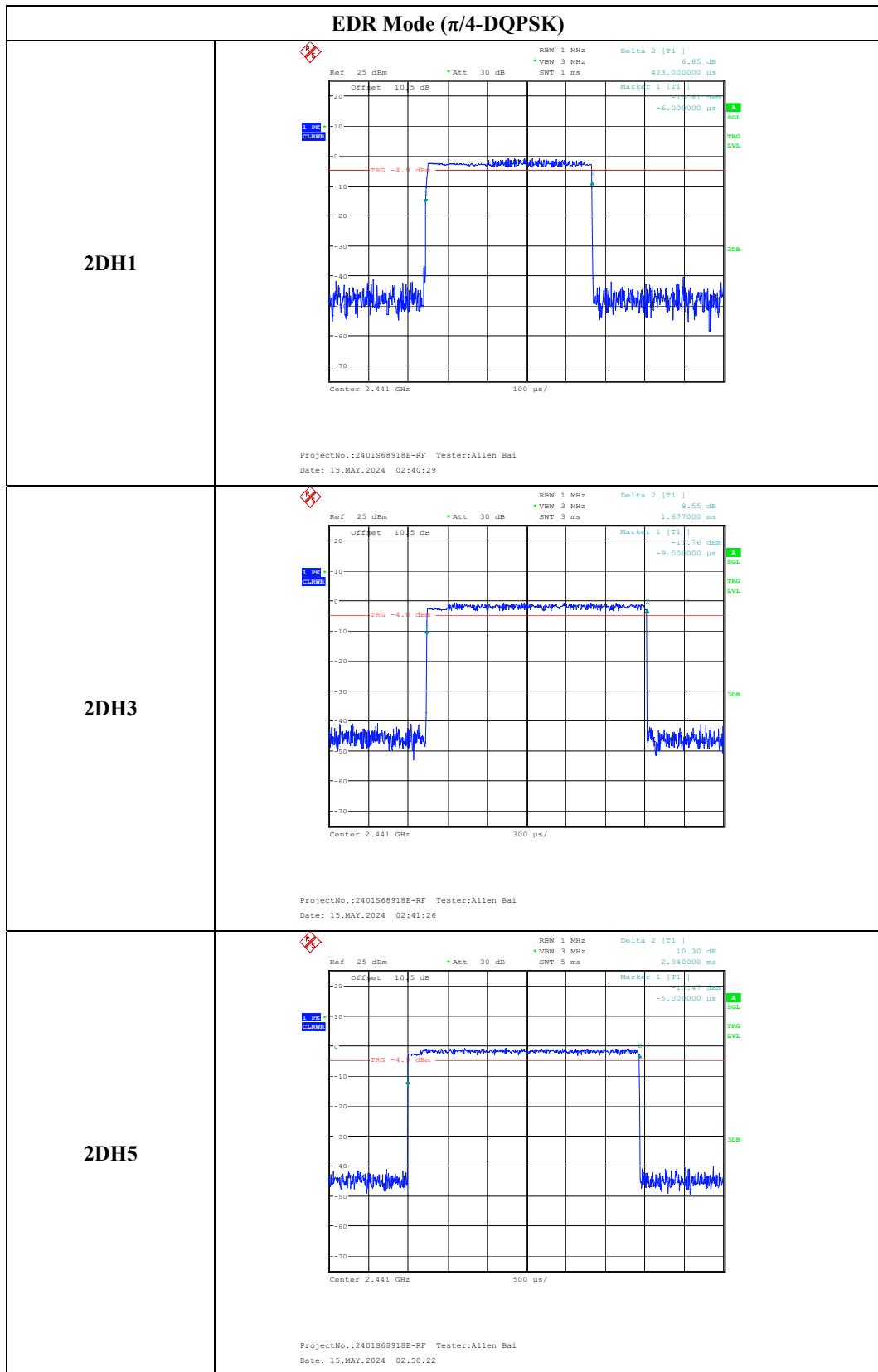
EUT operation mode: Transmitting

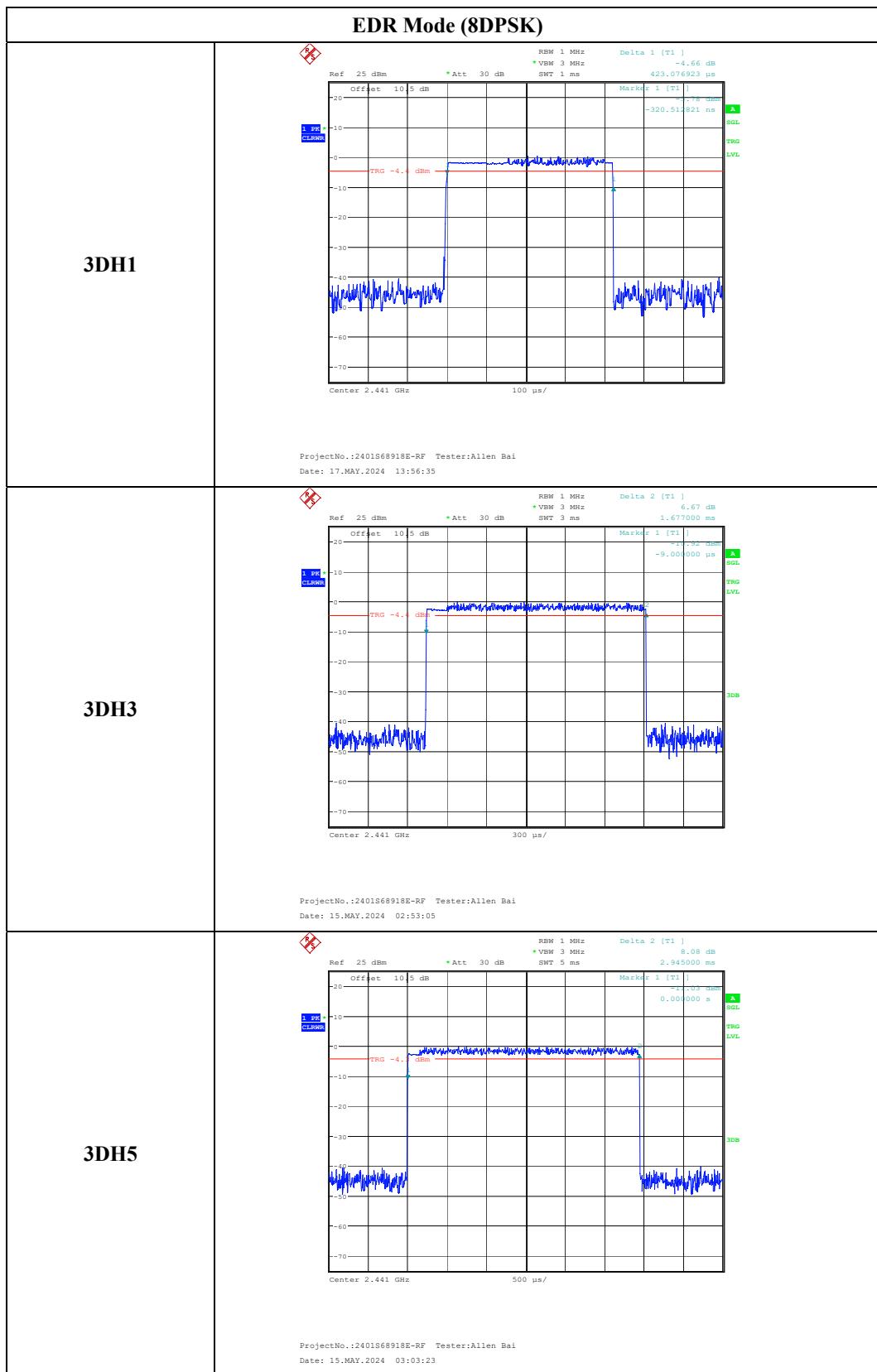
Test Result: Compliant.

| Test Modes | Packet Type | Test Frequency (MHz) | Pulse width (ms) | Result (s) | Limit (s) |
|----------------------------|-------------|----------------------|------------------|------------|-----------|
| BDR Mode (GFSK) | DH1 | 2441 | 0.412 | 0.132 | 0.400 |
| | DH3 | 2441 | 1.668 | 0.267 | 0.400 |
| | DH5 | 2441 | 2.930 | 0.313 | 0.400 |
| EDR Mode ($\pi/4$ -DQPSK) | 2DH1 | 2441 | 0.423 | 0.135 | 0.400 |
| | 2DH3 | 2441 | 1.677 | 0.268 | 0.400 |
| | 2DH5 | 2441 | 2.940 | 0.314 | 0.400 |
| EDR Mode (8DPSK) | 3DH1 | 2441 | 0.423 | 0.135 | 0.400 |
| | 3DH3 | 2441 | 1.677 | 0.268 | 0.400 |
| | 3DH5 | 2441 | 2.945 | 0.314 | 0.400 |

Note:
DH1/2DH1/3DH1:Dwell time=Pulse time (ms) \times (1600/2/79) \times 31.6 s
DH3/2DH3/3DH3:Dwell time=Pulse time (ms) \times (1600/4/79) \times 31.6 s
DH5/2DH5/3DH5:Dwell time=Pulse time (ms) \times (1600/6/79) \times 31.6 s







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

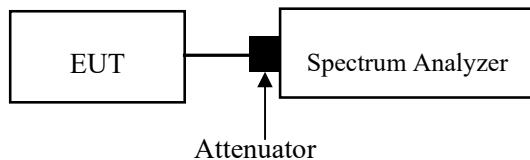
Applicable Standard

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

Test Method: ANSI C63.10-2013 Clause 7.8.5

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

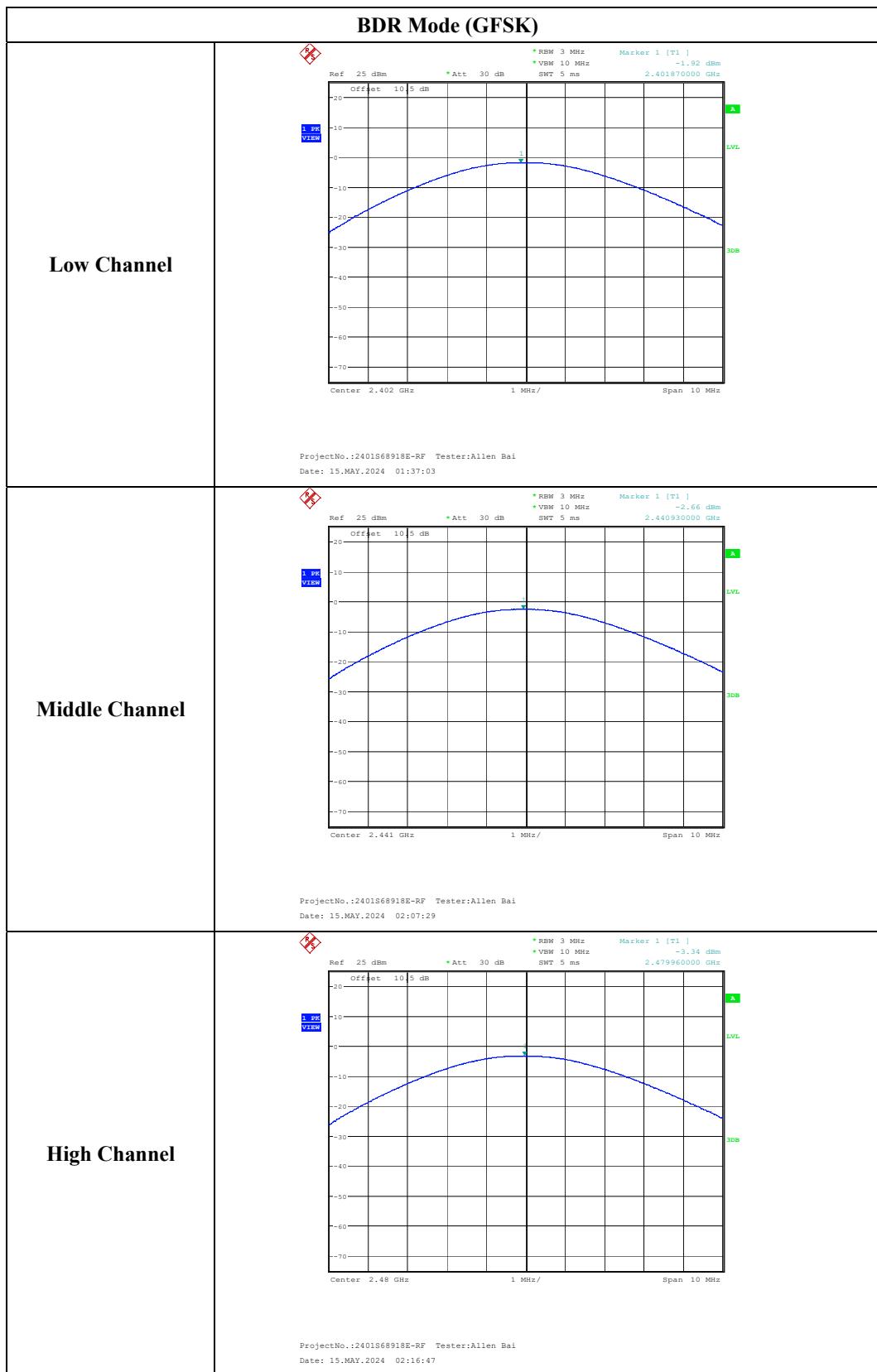
| | |
|--------------------|-----------|
| Temperature: | 26 °C |
| Relative Humidity: | 50 % |
| ATM Pressure: | 101.0 kPa |

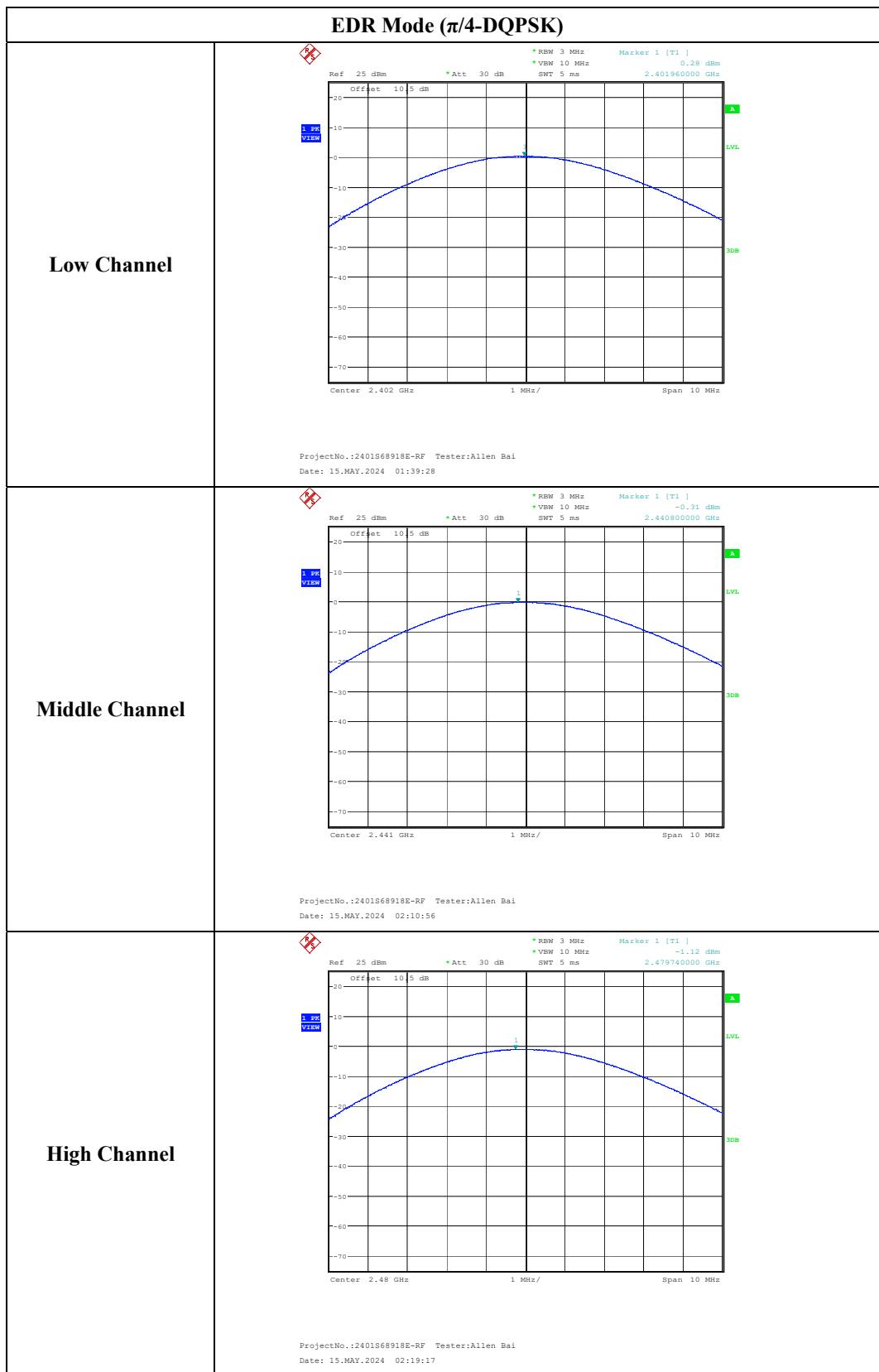
The testing was performed by Allen Bai on 2024-05-15.

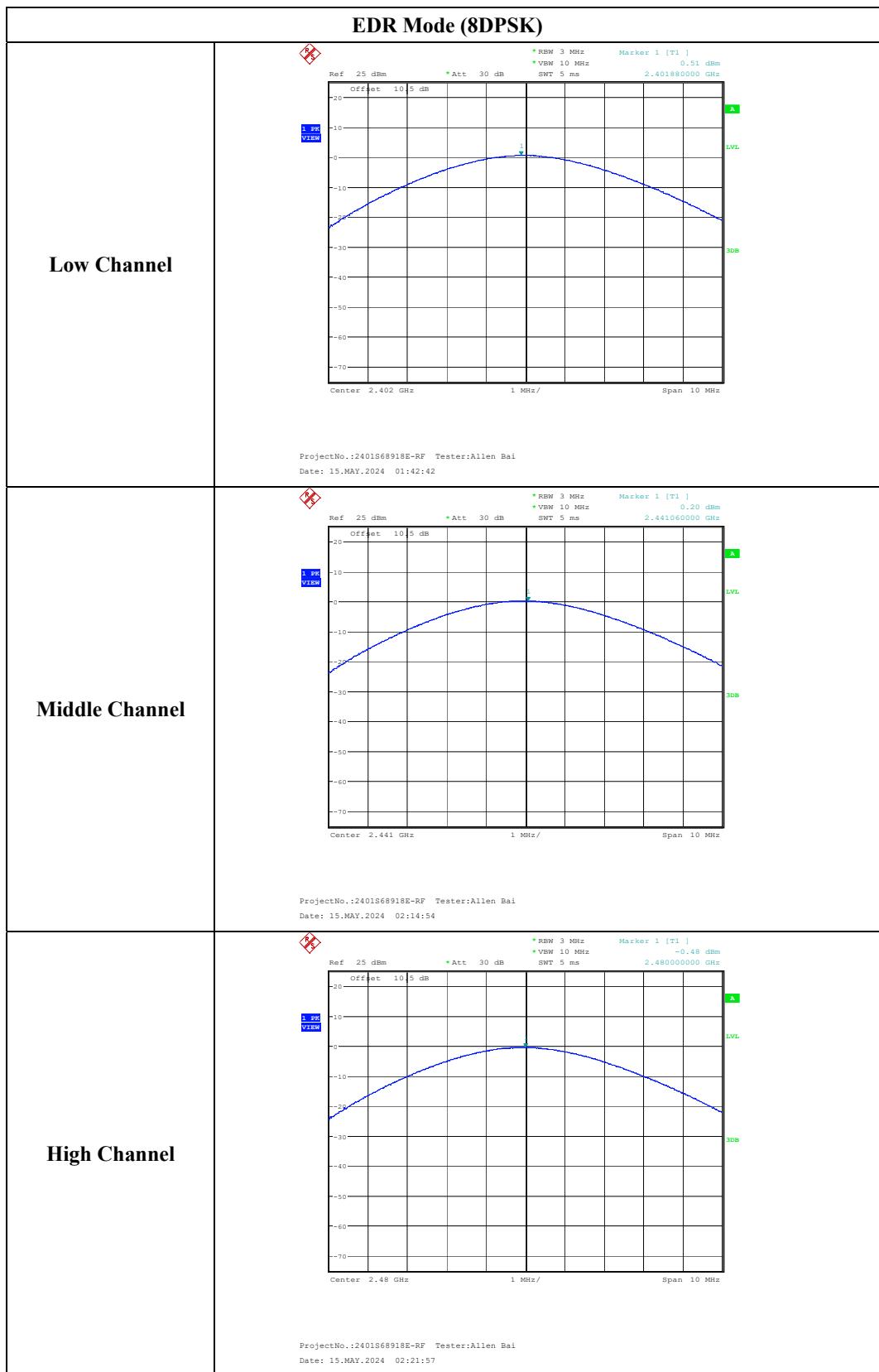
EUT operation mode: Transmitting

Test Result: Compliant.

| Test Modes | Test Frequency (MHz) | Peak Conducted Output Power (dBm) | Limits (dBm) |
|----------------------------|----------------------|-----------------------------------|--------------|
| BDR Mode (GFSK) | 2402 | -1.92 | 21 |
| | 2441 | -2.66 | 21 |
| | 2480 | -3.34 | 21 |
| EDR Mode ($\pi/4$ -DQPSK) | 2402 | 0.28 | 21 |
| | 2441 | -0.31 | 21 |
| | 2480 | -1.12 | 21 |
| EDR Mode (8DPSK) | 2402 | 0.51 | 21 |
| | 2441 | 0.20 | 21 |
| | 2480 | -0.48 | 21 |







FCC §15.247(d) § 5.5 - BAND EDGES TESTING

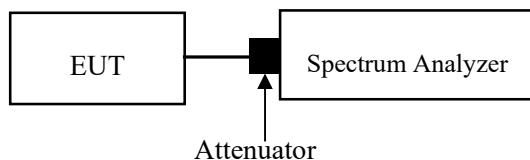
Applicable Standard

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

Test Method: ANSI C63.10-2013 Clause 7.8.6 & Clause 6.10

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

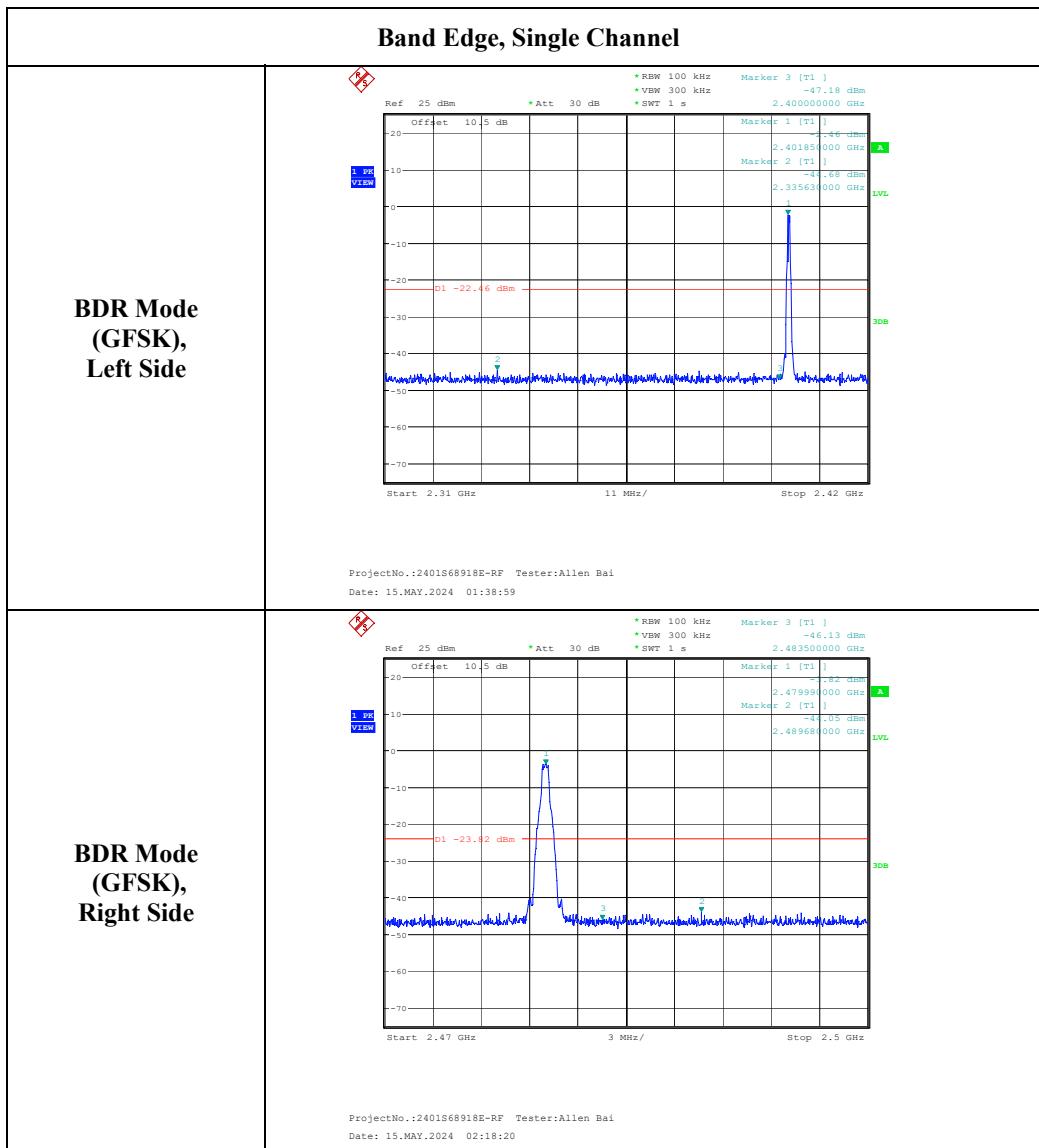
Environmental Conditions

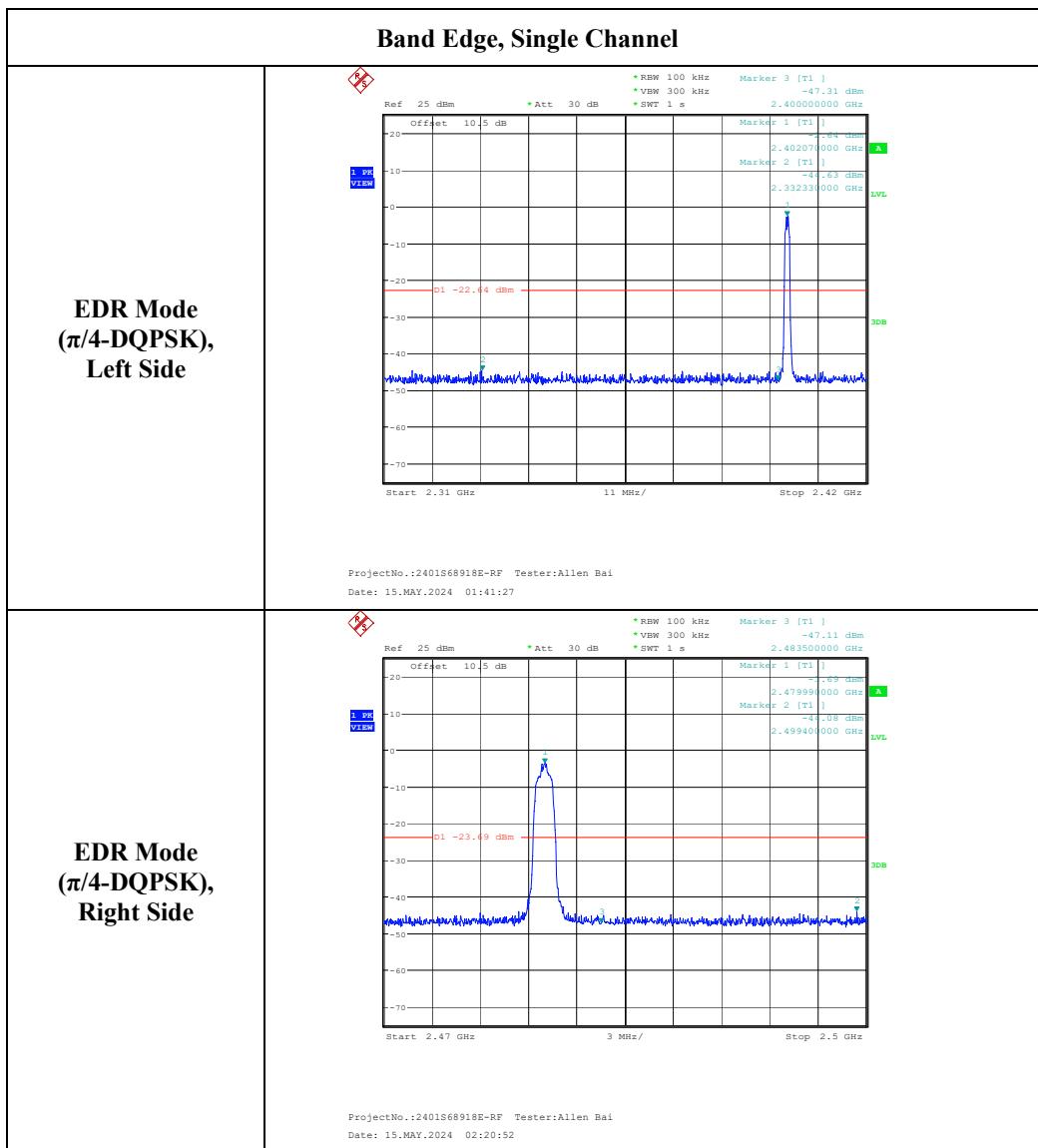
| | |
|--------------------|-----------|
| Temperature: | 26 °C |
| Relative Humidity: | 50 % |
| ATM Pressure: | 101.0 kPa |

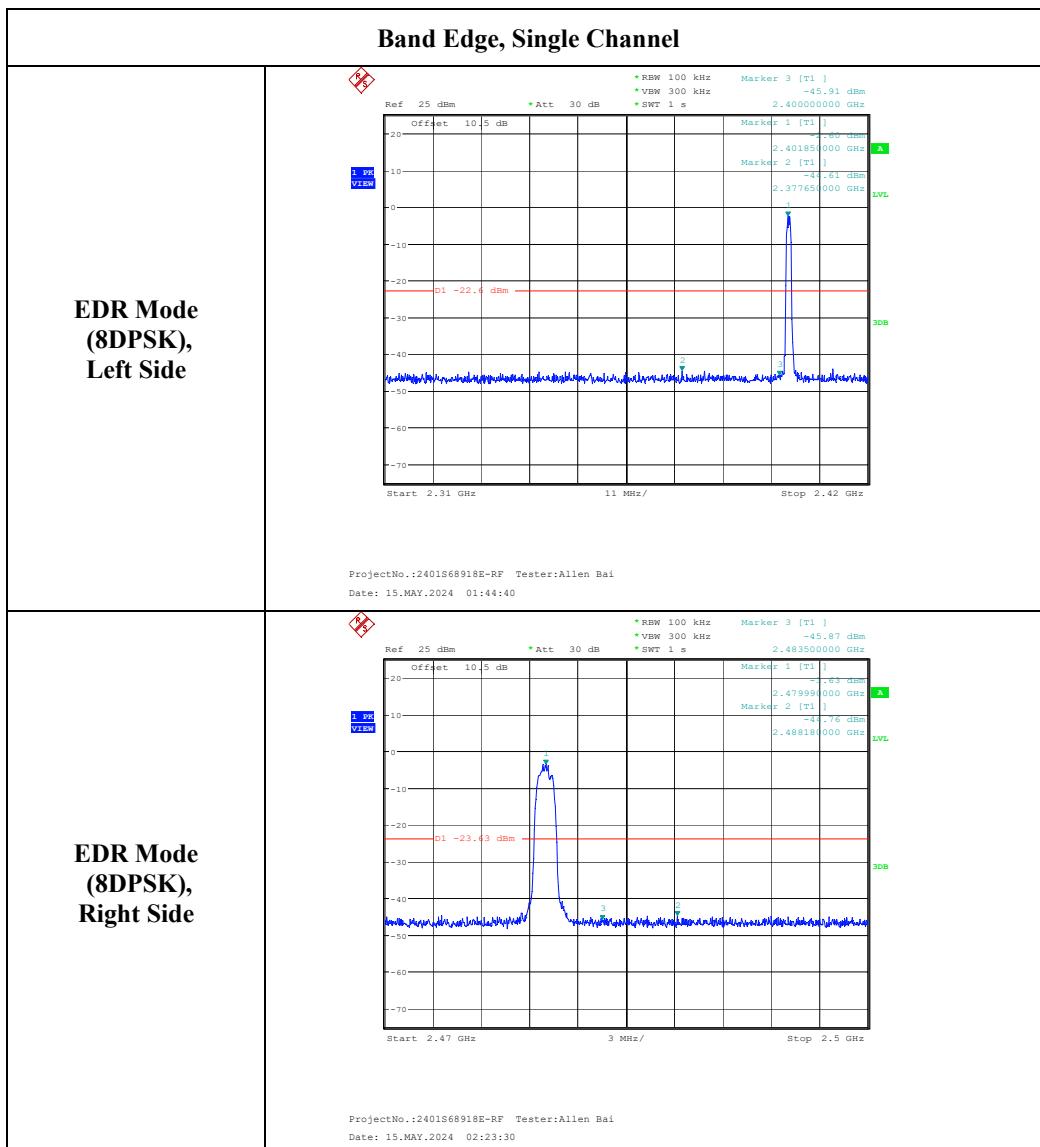
The testing was performed by Allen Bai on 2024-05-15.

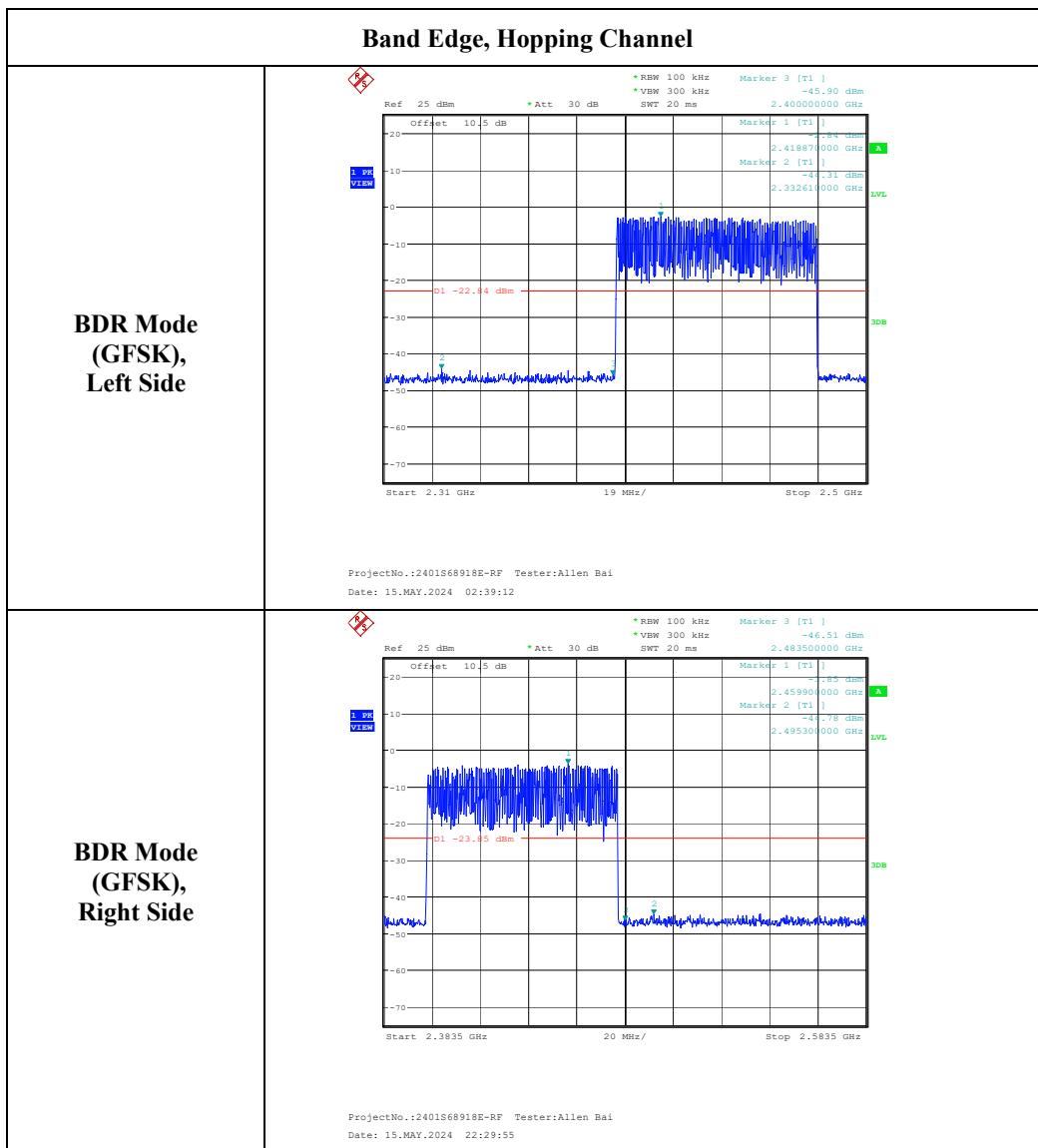
EUT operation mode: Transmitting

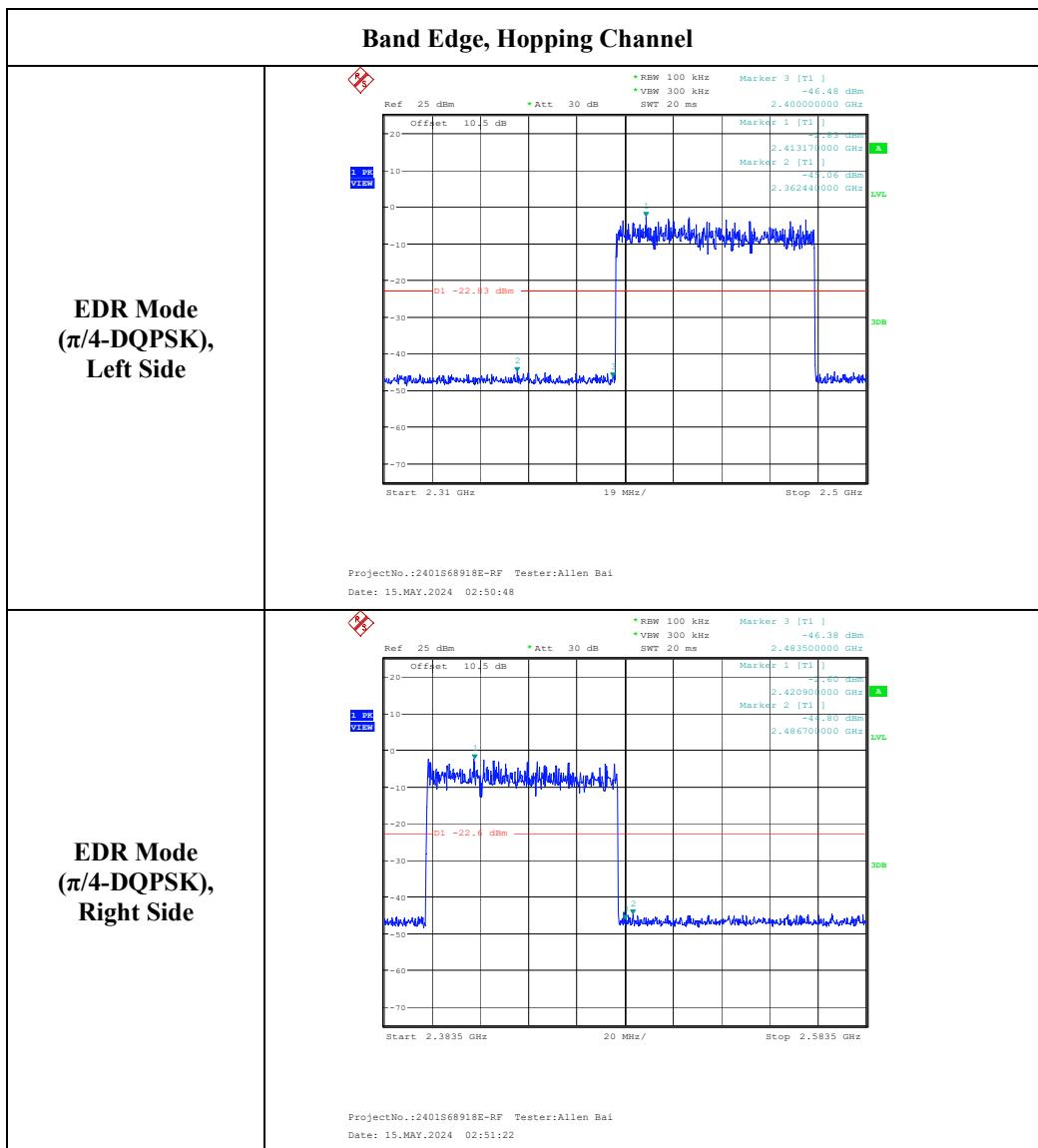
Test Result: Compliant.

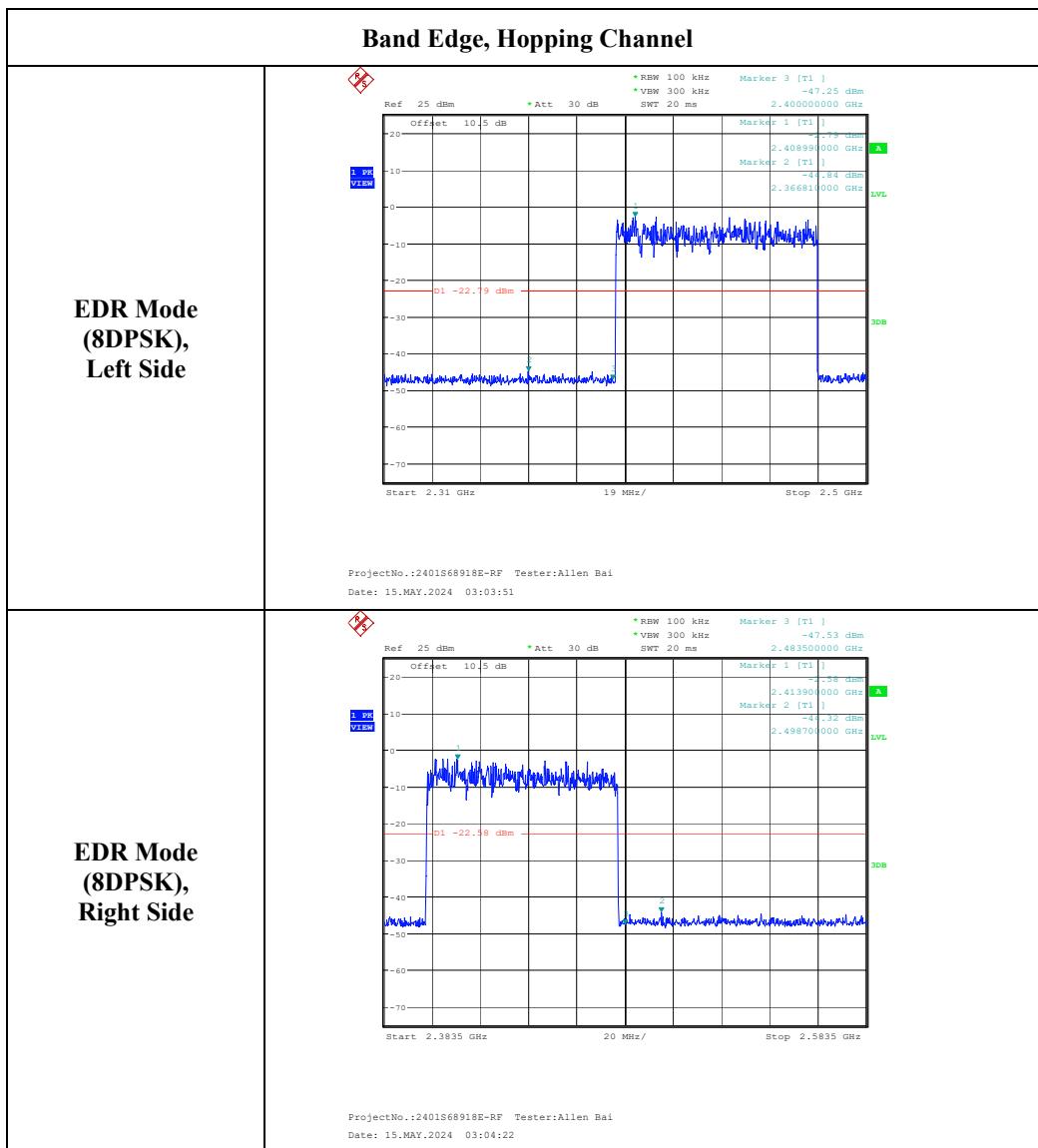












EUT PHOTOGRAPHS

Please refer to the attachment 2401S68918-RF External photo and 2401S68918-RF Internal photo.

TEST SETUP PHOTOGRAPHS

Please refer to the attachment 2401S68918-RF Test Setup photo.

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