# TEST REPORT

| | |
|---|---|
| Applicant Name : | Shenzhen Jiayz photo industrial ., Ltd |
| Address : | A16 Building,Intelligent Terminal Industrial Park of Silicon Valley Power, Guanlan, Longhua District, Shenzhen, China |
| Report Number : | RA230331-14552E-RF-00 |
| FCC ID: | 2ARN3-111911RX |

**Test Standard (s)**

FCC PART 15.247

**Sample Description**

| | |
|---|---|
| Product Type: | Microphone |
| Model No.: | BOYALINK-RX |
| Multiple Model(s) No.: | N/A |
| Trade Mark: | N/A |
| Date Received: | 2023/03/31 |
| Report Date: | 2023/04/14 |

| | |
|---|---|
| Test Result: | Pass* |

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

**Prepared and Checked By:**

Roger Ling
EMC Engineer

**Approved By:**

Candy Li
EMC Engineer

# TABLE OF CONTENTS

# DOCUMENT REVISION HISTORY

| Revision Number | Report Number | Description of Revision | Date of Revision |
|---|---|---|---|
| 0 | RA230331-14552E-RF-00 | Original Report | 2023-04-14 |

# GENERAL INFORMATION

## Product Description for Equipment under Test (EUT)

| | |
|---|---|
| Frequency Range | 2402~2480MHz |
| Maximum conducted Peak output power | -0.2dBm |
| Modulation Technique | GFSK |
| Antenna Specification* | 4.11dBi (provided by the applicant) |
| Voltage Range | DC3.7V from battery or DC5V from USB Charging Port |
| Sample serial number | 23YV_1for RF Conducted Test<br>23YV_2 for Conducted and Radiated Emissions<br>(Assigned by ATC) |
| Sample/EUT Status | Good condition |

## Objective

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

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

## Test Methodology

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

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. 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 Frequency | | $0.082*10^{-7}$ |
| RF output power, conducted | | 0.73dB |
| Unwanted Emission, conducted | | 1.6dB |
| AC Power Lines Conducted Emissions | | 2.72dB |
| Audio Frequency Response | | 0.1dB |
| Low Pass Filter Response | | 1.2dB |
| Modulation Limiting | | 1% |
| Emissions, Radiated | 9kHz - 30MHz | 2.66dB |
| | 30MHz - 1GHz | 4.28dB |
| | 1GHz - 18GHz | 4.98dB |
| | 18GHz - 26.5GHz | 5.06dB |
| | 26.5GHz - 40GHz | 4.72dB |
| Temperature | | 1℃ |
| Humidity | | 6% |
| Supply voltages | | 0.4% |

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

## Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the Floor 1, KuMaKe Building, Dongzhou Community, Guangming Street, Guangming District, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016. The Registration Number is 30241.

# SYSTEM TEST CONFIGURATION

## Description of Test Configuration

The system was configured for testing in an engineering mode.

Channel list:

| Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) | Channel No. | Frequency (MHz) |
|---|---|---|---|---|---|---|---|
| 1 | 2402 | 21 | 2422 | 41 | 2442 | 61 | 2462 |
| 2 | 2403 | 22 | 2423 | 42 | 2443 | 62 | 2463 |
| 3 | 2404 | 23 | 2424 | 43 | 2444 | 63 | 2464 |
| 4 | 2405 | 24 | 2425 | 44 | 2445 | 64 | 2465 |
| 5 | 2406 | 25 | 2426 | 45 | 2446 | 65 | 2466 |
| 6 | 2407 | 26 | 2427 | 46 | 2447 | 66 | 2467 |
| 7 | 2408 | 27 | 2428 | 47 | 2448 | 67 | 2468 |
| 8 | 2409 | 28 | 2429 | 48 | 2449 | 68 | 2469 |
| 9 | 2410 | 29 | 2430 | 49 | 2450 | 69 | 2470 |
| 10 | 2411 | 30 | 2431 | 50 | 2451 | 70 | 2471 |
| 11 | 2412 | 31 | 2432 | 51 | 2452 | 71 | 2472 |
| 12 | 2413 | 32 | 2433 | 52 | 2453 | 72 | 2473 |
| 13 | 2414 | 33 | 2434 | 53 | 2454 | 73 | 2474 |
| 14 | 2415 | 34 | 2435 | 54 | 2455 | 74 | 2475 |
| 15 | 2416 | 35 | 2436 | 55 | 2456 | 75 | 2476 |
| 16 | 2417 | 36 | 2437 | 56 | 2457 | 76 | 2477 |
| 17 | 2418 | 37 | 2438 | 57 | 2458 | 77 | 2478 |
| 18 | 2419 | 38 | 2439 | 58 | 2459 | 78 | 2479 |
| 19 | 2420 | 39 | 2440 | 59 | 2460 | 79 | 2480 |
| 20 | 2421 | 40 | 2441 | 60 | 2461 | / | / |

Channel 1, 40, 79 was tested.

The device supply with three type of adapters: 3.5mm TRS, USB-C and iOS Lightning, the worst case USB-C was select to test and recorded in report.

## EUT Exercise Software

"FCC_assist1.0.4.exe *" software was used and the power level is 10*. The software and power level was provided by the manufacturer.

## Special Accessories

No special accessory.

## Equipment Modifications

No modification was made to the EUT tested.

## Support Equipment List and Details

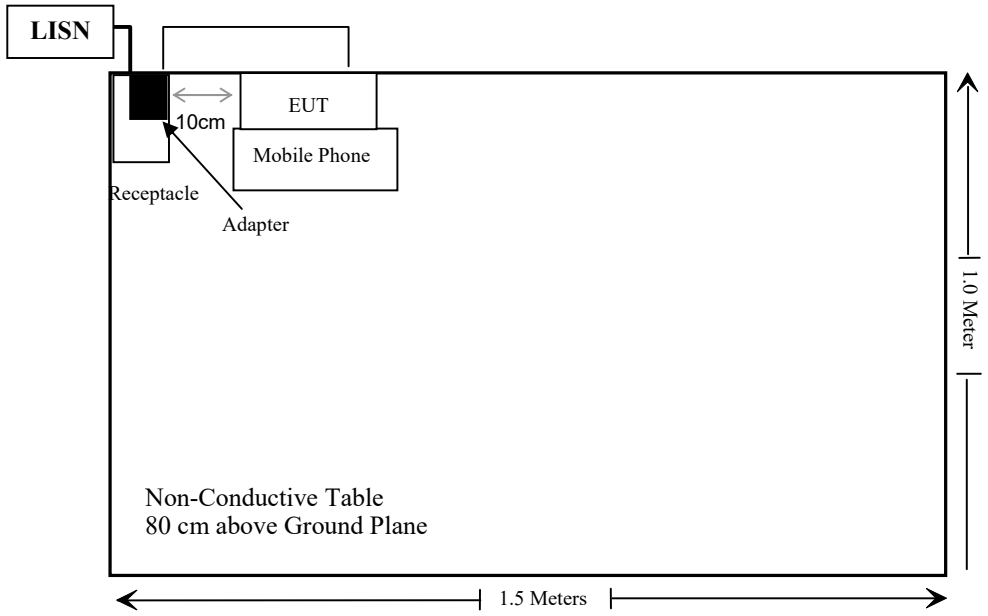
| Manufacturer | Description | Model | Serial Number |
|---|---|---|---|
| Huawei | Adapter | HW-050450C00 | Unknown |
| Bull | Receptacle | 902# | Unknown |
| Huawei | Mobile Phone | Unknown | Unknown |

## External I/O Cable

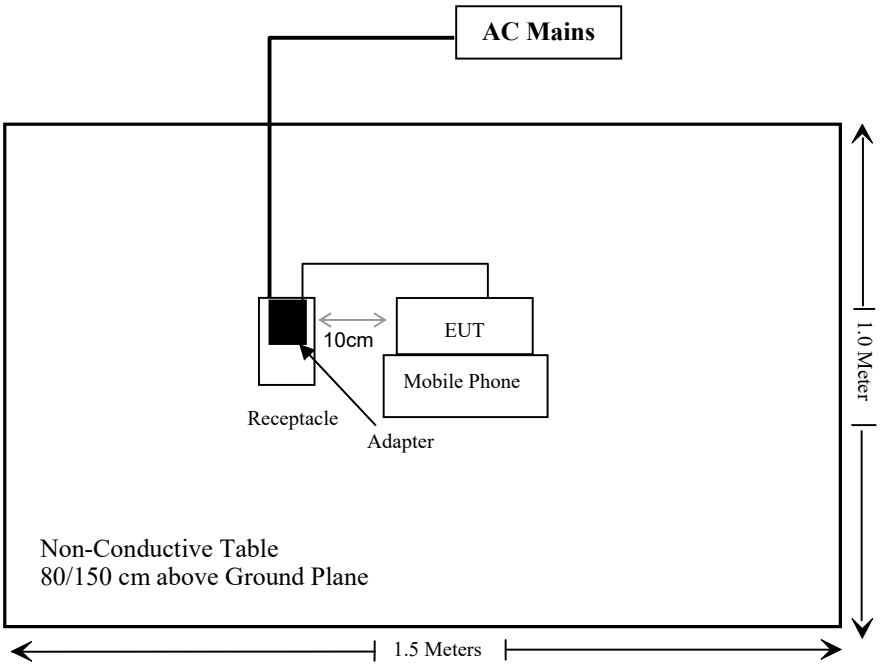
| Cable Description | Length (m) | From/Port | To |
|---|---|---|---|
| Un-shielding Detachable USB Cable | 0.3 | EUT | Adapter |
| Un-shielded Un-detachable Cable | 1.2 | Receptacle | LISN/AC Mains |

## Block Diagram of Test Setup

For conducted emission**:**



For Radiated Emissions:



# SUMMARY OF TEST RESULTS

| FCC Rules | Description of Test | Result |
|---|---|---|
| FCC§15.247 (i), §1.1307 (b) (1) &§2.1093 | RF EXPOSURE | Compliant |
| §15.203 | Antenna Requirement | Compliant |
| §15.207(a) | AC Line Conducted Emissions | Compliant |
| §15.205, §15.209 & §15.247(d) | Radiated Emissions | Compliant |
| §15.247(a)(1) | 20 dB Emission Bandwidth & 99% Occupied Bandwidth | Compliant |
| §15.247(a)(1) | Channel Separation Test | Compliant |
| §15.247(a)(1)(iii) | Time of Occupancy (Dwell Time) | Compliant |
| §15.247(a)(1)(iii) | Quantity of hopping channel Test | Compliant |
| §15.247(b)(1) | Peak Output Power Measurement | Compliant |
| §15.247(d) | Band edges | Compliant |

# TEST EQUIPMENT LIST

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| **Conducted Emissions Test** | | | | | |
| Rohde& Schwarz | EMI Test Receiver | ESCI | 100784 | 2022/11/25 | 2023/11/24 |
| Rohde & Schwarz | L.I.S.N. | ENV216 | 101314 | 2022/11/25 | 2023/11/24 |
| Anritsu Corp | 50 Coaxial Switch | MP59B | 6100237248 | 2022/12/07 | 2023/12/06 |
| Unknown | RF Coaxial Cable | No.17 | N0350 | 2022/11/25 | 2023/11/24 |
| Conducted Emission Test Software: e3 19821b (V9) | | | | | |
| **Radiated Emissions Test** | | | | | |
| Rohde& Schwarz | Test Receiver | ESR | 102725 | 2022/11/25 | 2023/11/24 |
| Rohde&Schwarz | Spectrum Analyzer | FSV40 | 101949 | 2022/11/25 | 2023/11/24 |
| SONOMA INSTRUMENT | Amplifier | 310 N | 186131 | 2022/11/08 | 2023/11/07 |
| A.H. Systems, inc. | Preamplifier | PAM-0118P | 135 | 2022/11/08 | 2023/11/07 |
| Quinstar | Amplifier | QLW-18405536-J0 | 15964001002 | 2022/11/08 | 2023/11/07 |
| Schwarzbeck | Bilog Antenna | VULB9163 | 9163-323 | 2021/07/06 | 2024/07/05 |
| Schwarzbeck | Horn Antenna | BBHA9120D | 9120D-1067 | 2022/11/30 | 2025/11/29 |
| Schwarzbeck | HORN ANTENNA | BBHA9170 | 9170-359 | 2022/12/26 | 2025/12/25 |
| Radiated Emission Test Software: e3 19821b (V9) | | | | | |
| Unknown | RF Coaxial Cable | No.10 | N050 | 2022/11/25 | 2023/11/24 |
| Unknown | RF Coaxial Cable | No.11 | N1000 | 2022/11/25 | 2023/11/24 |
| Unknown | RF Coaxial Cable | No.12 | N040 | 2022/11/25 | 2023/11/24 |
| Unknown | RF Coaxial Cable | No.13 | N300 | 2022/11/25 | 2023/11/24 |
| Unknown | RF Coaxial Cable | No.14 | N800 | 2022/11/25 | 2023/11/24 |
| Unknown | RF Coaxial Cable | No.15 | N600 | 2022/11/25 | 2023/11/24 |
| Unknown | RF Coaxial Cable | No.16 | N650 | 2022/11/25 | 2023/11/24 |
| **RF Conducted Test** | | | | | |
| Rohde&Schwarz | Spectrum Analyzer | FSV-40 | 101948 | 2022/11/25 | 2023/11/24 |
| WEINSCHEL | 10dB Attenuator | 5324 | AU 3842 | 2022/11/25 | 2023/11/24 |

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

# FCC§15.247 (i)& §1.1307 (b) & §2.1093 – RF EXPOSURE

**Applicable Standard**

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

According to KDB 447498 D04 Interim General RF Exposure Guidance v01, clause 2.1.2 – 1-mW test Exemption:

Per § 1.1307(b)(3)(i)(A), a single RF source is exempt RF device (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance.
This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions. This is a standalone exemption, and it cannot be applied in conjunction with any other test exemption.

## Test Result

For worst case:

| Mode | Frequency | Maximum Tune-up Conducted Power | | 1-mW test Exemption |
|---|---|---|---|---|
| | (MHz) | (dBm) | (mW) | |
| GFSK | 2402-2480 | 0 | 1 | Yes |

Note: The tune-up power was declared by the applicant.

**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 and the antenna gain is 4.11 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

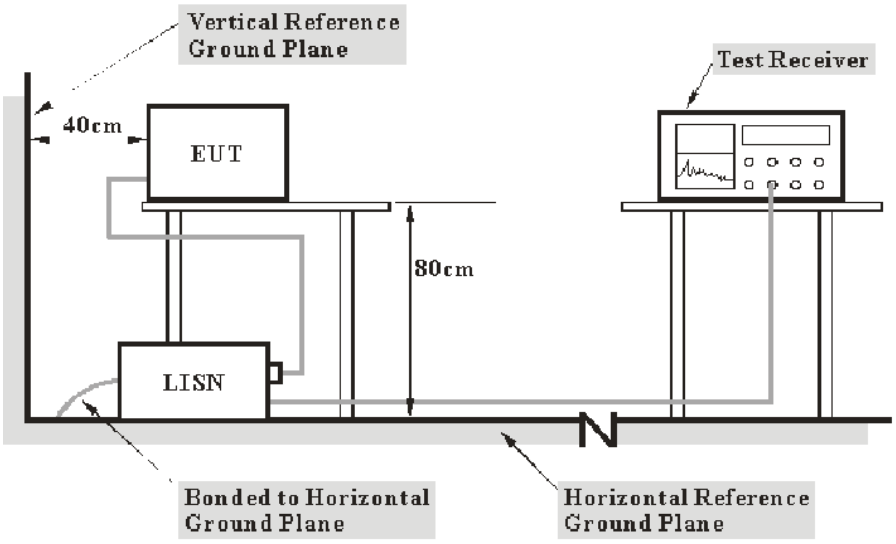
**Result:** Compliance.

# FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

## Applicable Standard

FCC §15.207(a)

## EUT Setup




Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

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

The spacing between the peripherals was 10 cm.

## EMI Test Receiver Setup

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

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

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

## Test Procedure

During the conducted emission test, the 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.

## Transd Factor & Margin Calculation

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

Transd Factor = LISN VDF + Cable Loss

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

Over Limit = level – Limit
Level= reading level+ Transd Factor

## Test Data

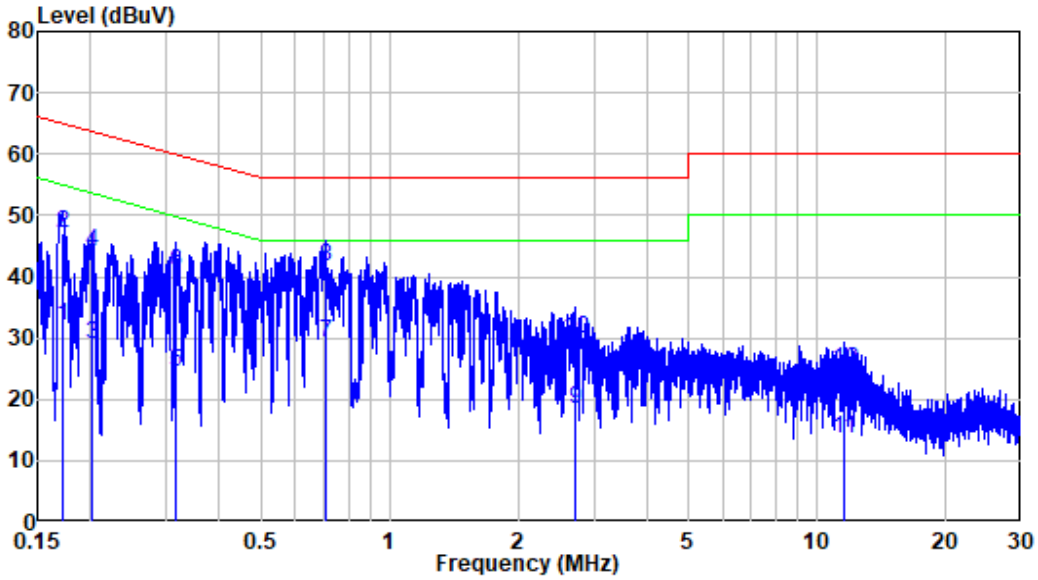
### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 23 ℃ |
| **Relative Humidity:** | 60% |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Jerry on 2023-04-13.*

*EUT operation mode: Transmitting (the worst case is middle channel)*

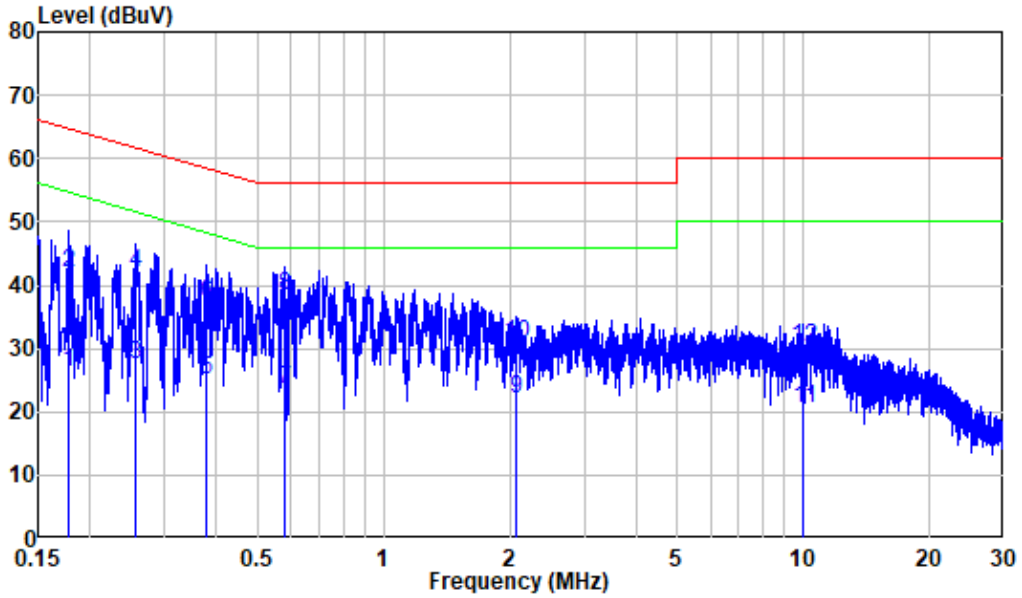
**AC 120V/60 Hz, Line**




Site : Shielding Room
Condition: Line
Job No. : RA230331-14552E-RF
Mode : Charging+Transmitting
Power : AC 120V 60Hz

| | Freq | Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dB | dBuV | dBuV | dBuV | dB | |
| 1 | 0.171 | 10.25 | 21.89 | 32.14 | 54.89 | -22.75 | Average |
| 2 | 0.171 | 10.25 | 36.73 | 46.98 | 64.89 | -17.91 | QP |
| 3 | 0.201 | 10.30 | 18.55 | 28.85 | 53.57 | -24.72 | Average |
| 4 | 0.201 | 10.30 | 33.74 | 44.04 | 63.57 | -19.53 | QP |
| 5 | 0.317 | 10.30 | 14.11 | 24.41 | 49.80 | -25.39 | Average |
| 6 | 0.317 | 10.30 | 30.39 | 40.69 | 59.80 | -19.11 | QP |
| 7 | 0.708 | 10.41 | 18.96 | 29.37 | 46.00 | -16.63 | Average |
| 8 | 0.708 | 10.41 | 31.29 | 41.70 | 56.00 | -14.30 | QP |
| 9 | 2.703 | 10.43 | 7.98 | 18.41 | 46.00 | -27.59 | Average |
| 10 | 2.703 | 10.43 | 19.44 | 29.87 | 56.00 | -26.13 | QP |
| 11 | 11.529 | 10.35 | 3.34 | 13.69 | 50.00 | -36.31 | Average |
| 12 | 11.529 | 10.35 | 14.28 | 24.63 | 60.00 | -35.37 | QP |

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




Site : Shielding Room
Condition: Neutral
Job No. : RA230331-14552E-RF
Mode : Charging+Transmitting
Power : AC 120V 60Hz

| | Freq | Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dB | dBuV | dBuV | dBuV | dB | |
| 1 | 0.177 | 9.80 | 16.42 | 26.22 | 54.61 | -28.39 | Average |
| 2 | 0.177 | 9.80 | 32.11 | 41.91 | 64.61 | -22.70 | QP |
| 3 | 0.257 | 9.80 | 17.53 | 27.33 | 51.53 | -24.20 | Average |
| 4 | 0.257 | 9.80 | 32.18 | 41.98 | 61.53 | -19.55 | QP |
| 5 | 0.379 | 9.80 | 15.22 | 25.02 | 48.30 | -23.28 | Average |
| 6 | 0.379 | 9.80 | 27.29 | 37.09 | 58.30 | -21.21 | QP |
| 7 | 0.583 | 9.81 | 13.75 | 23.56 | 46.00 | -22.44 | Average |
| 8 | 0.583 | 9.81 | 28.54 | 38.35 | 56.00 | -17.65 | QP |
| 9 | 2.067 | 9.82 | 12.16 | 21.98 | 46.00 | -24.02 | Average |
| 10 | 2.067 | 9.82 | 20.86 | 30.68 | 56.00 | -25.32 | QP |
| 11 | 10.005 | 9.90 | 10.61 | 20.51 | 50.00 | -29.49 | Average |
| 12 | 10.005 | 9.90 | 20.32 | 30.22 | 60.00 | -29.78 | QP |

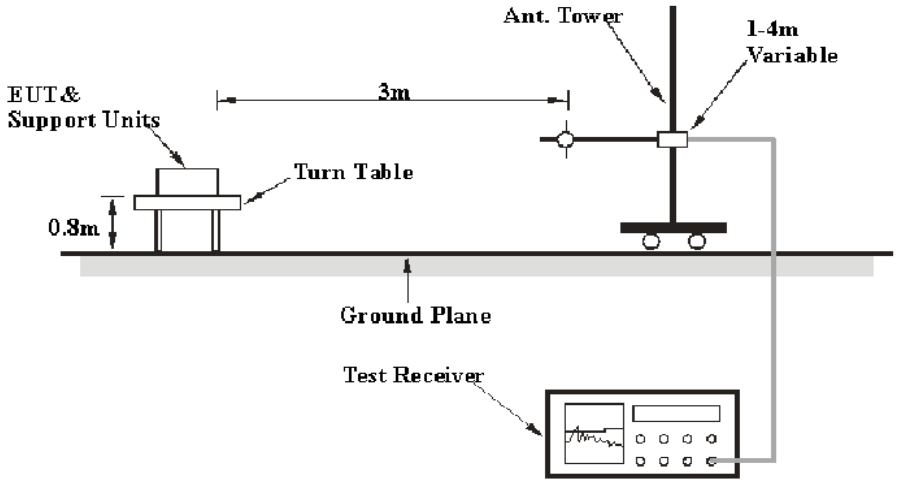
# FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

## Applicable Standard

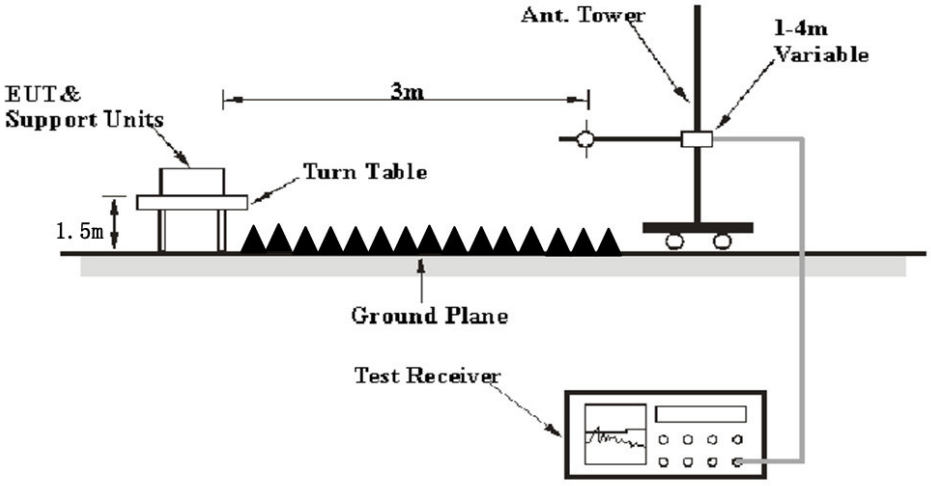
FCC §15.205; §15.209; §15.247(d)

## EUT Setup

**Below 1 GHz:**




**Above 1GHz:**




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

## EMI Test Receiver & Spectrum Analyzer Setup

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

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

For average 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.
Average Emission Level=Peak Emission Level+20*log(Duty cycle)

## Test Procedure

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

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

## Corrected Factor & Margin Calculation

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

Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain

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

Margin/Over Limit = Corrected Amplitude/Level-Limit
Corrected Amplitude/Level = Reading + Corrected Factor

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 23~27.3 ℃ |
| **Relative Humidity:** | 57~64 % |
| **ATM Pressure:** | 101.0 kPa |

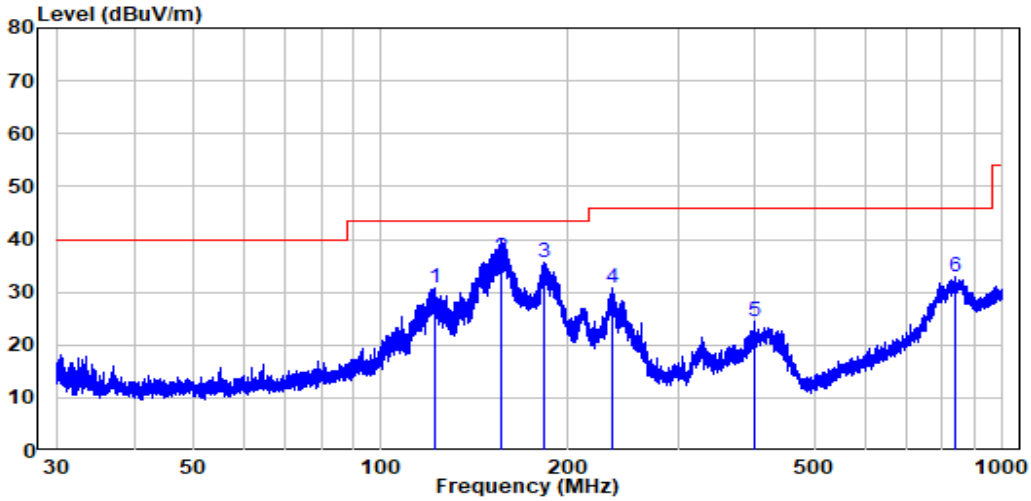
*The testing was performed by Jason Liu on 2023-04-13 for below 1GHz and Zeki Ma on 2022-04-12 for above 1GHz.*

*EUT operation mode: Transmitting (Pre-scan in the X,Y and Z axes of orientation, the worst case X-axes orientation was recorded)*

**30MHz-1GHz:** *(worst case is middle channel)*

*Note: When the test result of Peak was less than the limit of QP, just the peak value was recorded.*

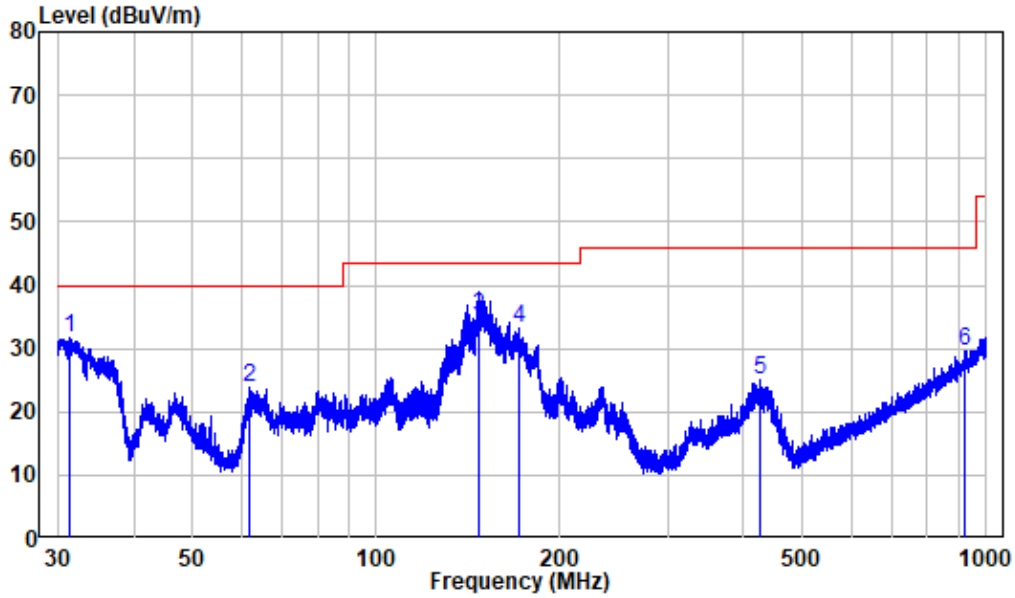
**Horizontal:**




Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230331-14552E-RF
Test Mode: Charging+Transmitting

| | Freq | Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 121.922 | -10.93 | 41.70 | 30.77 | 43.50 | -12.73 | Peak |
| 2 | 156.252 | -10.32 | 46.90 | 36.58 | 43.50 | -6.92 | QP |
| 3 | 183.201 | -10.31 | 45.82 | 35.51 | 43.50 | -7.99 | Peak |
| 4 | 235.094 | -11.76 | 42.68 | 30.92 | 46.00 | -15.08 | Peak |
| 5 | 399.906 | -12.22 | 36.69 | 24.47 | 46.00 | -21.53 | Peak |
| 6 | 838.079 | -3.30 | 36.23 | 32.93 | 46.00 | -13.07 | Peak |

**Vertical**




Site : chamber
Condition: 3m VERTICAL
Job No. : RA230331-14552E-RF
Test Mode: Charging+Transmitting

| | Freq | Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 31.427 | -14.38 | 46.12 | 31.74 | 40.00 | -8.26 | Peak |
| 2 | 61.914 | -13.84 | 37.65 | 23.81 | 40.00 | -16.19 | Peak |
| 3 | 147.727 | -10.38 | 45.29 | 34.91 | 43.50 | -8.59 | QP |
| 4 | 170.868 | -10.28 | 43.59 | 33.31 | 43.50 | -10.19 | Peak |
| 5 | 425.028 | -14.16 | 39.29 | 25.13 | 46.00 | -20.87 | Peak |
| 6 | 921.304 | 0.09 | 29.56 | 29.65 | 46.00 | -16.35 | Peak |

**Above 1GHz:**

| Frequency (MHz) | Receiver | | Turntable Angle Degree | Rx Antenna | | Factor (dB/m) | Corrected Ampitude (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| | Reading (dBμV) | PK/Ave | | Height (m) | Polar (H/V) | | | | |
| Low Channel(2402MHz) | | | | | | | | | |
| 2389.36 | 69.13 | PK | 215 | 1 | H | -10.70 | 58.43 | 74 | -15.57 |
| 2343.34 | 65.69 | PK | 51 | 1.3 | V | -10.72 | 54.97 | 74 | -19.03 |
| 2390 | 68.14 | PK | 186 | 2.1 | H | -10.70 | 57.44 | 74 | -16.56 |
| 2390 | 64.24 | PK | 226 | 2.3 | V | -10.70 | 53.54 | 74 | -20.46 |
| 4804 | 60.43 | PK | 86 | 1.6 | H | -6.11 | 54.32 | 74 | -19.68 |
| 4804 | 59.82 | PK | 281 | 1.6 | V | -6.11 | 53.71 | 74 | -20.29 |
| Middle Channel(2441MHz) | | | | | | | | | |
| 4882 | 59.98 | PK | 282 | 1.5 | H | -5.90 | 54.08 | 74 | -19.92 |
| 4882 | 59.54 | PK | 29 | 1.5 | V | -5.90 | 53.64 | 74 | -20.36 |
| High Channel(2480 MHz) | | | | | | | | | |
| 2483.5 | 71.20 | PK | 167 | 1.1 | H | -10.55 | 60.65 | 74 | -13.35 |
| 2483.5 | 66.85 | PK | 221 | 1.1 | V | -10.55 | 56.30 | 74 | -17.70 |
| 2484.92 | 74.01 | PK | 195 | 1.2 | H | -10.54 | 63.47 | 74 | -10.53 |
| 2492.28 | 67.38 | PK | 348 | 2.3 | V | -10.48 | 56.90 | 74 | -17.10 |
| 4960 | 60.32 | PK | 267 | 1.3 | H | -5.47 | 54.85 | 74 | -19.15 |
| 4960 | 59.04 | PK | 136 | 1.3 | V | -5.47 | 53.57 | 74 | -20.43 |

| Field Strength of Average | | | | | | | |
|---|---|---|---|---|---|---|---|
| Frequency (MHz) | Peak Measurement @3m (dBμV/m) | Polar (H/V) | Duty Cycle Correction Factor (dB) | Corrected Ampitude (dBμV/m) | FCC Part 15.249 | | |
| | | | | | Limit (dBμV/m) | Margin (dB) | Comment |
| Low Channel(2402MHz) | | | | | | | |
| 2389.36 | 58.43 | H | -24.66 | 33.77 | 54 | -20.23 | Bandedge |
| 2343.34 | 54.97 | V | -24.66 | 30.31 | 54 | -23.69 | Bandedge |
| 2390 | 57.44 | H | -24.66 | 32.78 | 54 | -21.22 | Bandedge |
| 2390 | 53.54 | V | -24.66 | 28.88 | 54 | -25.12 | Bandedge |
| 4804 | 54.32 | H | -24.66 | 29.66 | 54 | -24.34 | Harmonic |
| 4804 | 53.71 | V | -24.66 | 29.05 | 54 | -24.95 | Harmonic |
| Middle Channel(2441MHz) | | | | | | | |
| 4882 | 54.08 | H | -24.66 | 29.42 | 54 | -24.58 | Harmonic |
| 4882 | 53.64 | V | -24.66 | 28.98 | 54 | -25.02 | Harmonic |
| High Channel(2480MHz) | | | | | | | |
| 2483.5 | 60.65 | H | -24.66 | 35.99 | 54 | -18.01 | Bandedge |
| 2483.5 | 56.30 | V | -24.66 | 31.64 | 54 | -22.36 | Bandedge |
| 2484.92 | 63.47 | H | -24.66 | 38.81 | 54 | -15.19 | Bandedge |
| 2492.28 | 56.90 | V | -24.66 | 32.24 | 54 | -21.76 | Bandedge |
| 4960 | 54.85 | H | -24.66 | 30.19 | 54 | -23.81 | Harmonic |
| 4960 | 53.57 | V | -24.66 | 28.91 | 54 | -25.09 | Harmonic |

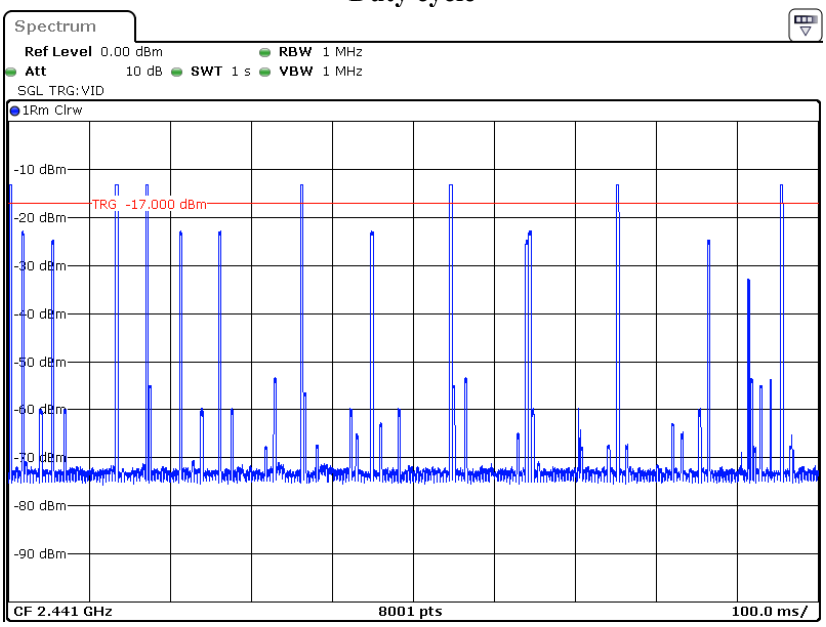
Note:

Corrected. Amplitude = Corrected Factor + Reading
Margin = Corrected. Amplitude - Limit
Average level= Peak level+ Duty Cycle Corrected Factor
Other emissions which was 20dB below limit or in noise floor level was not recorded.

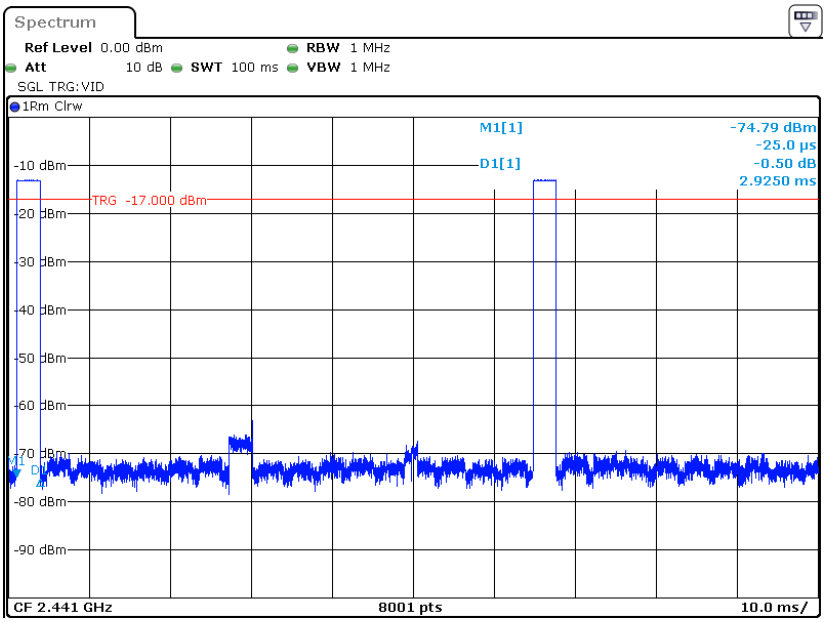
Wost case duty cycle:

Refer below plots, the maximum hops in 100ms is 2 (Second high signals were other channel), so:
Duty cycle = Ton/100ms = 2.925*2/100=0.0585
Duty Cycle Corrected Factor = 20lg (Duty cycle) = 20lg0.0585 = -24.66

## Duty cycle




Date: 12.APR.2023 14:34:18

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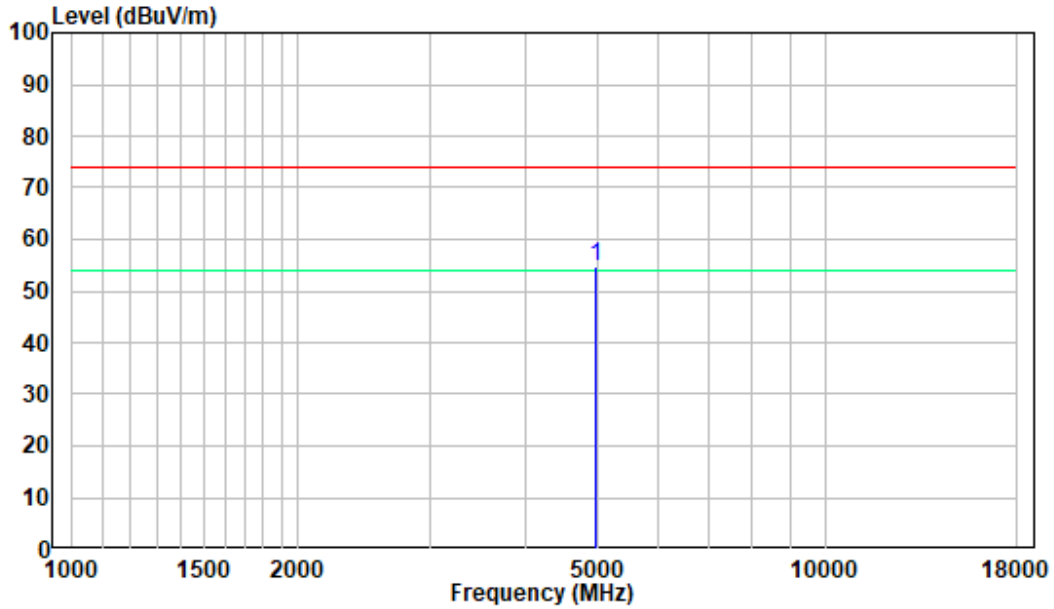
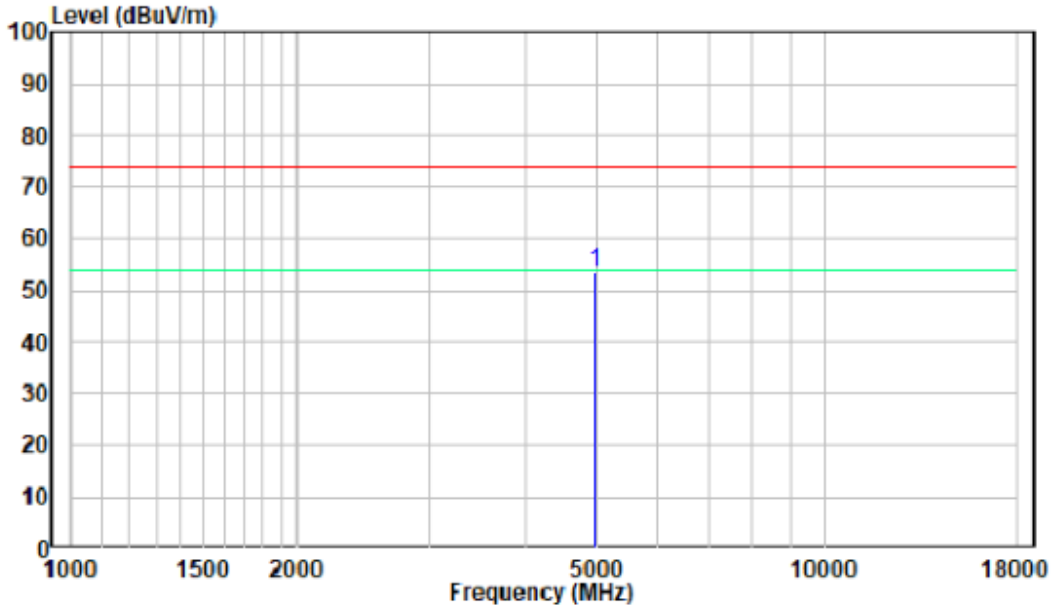
## 1-18GHz

**Pre-scan for High Channel**

**Horizontal:**



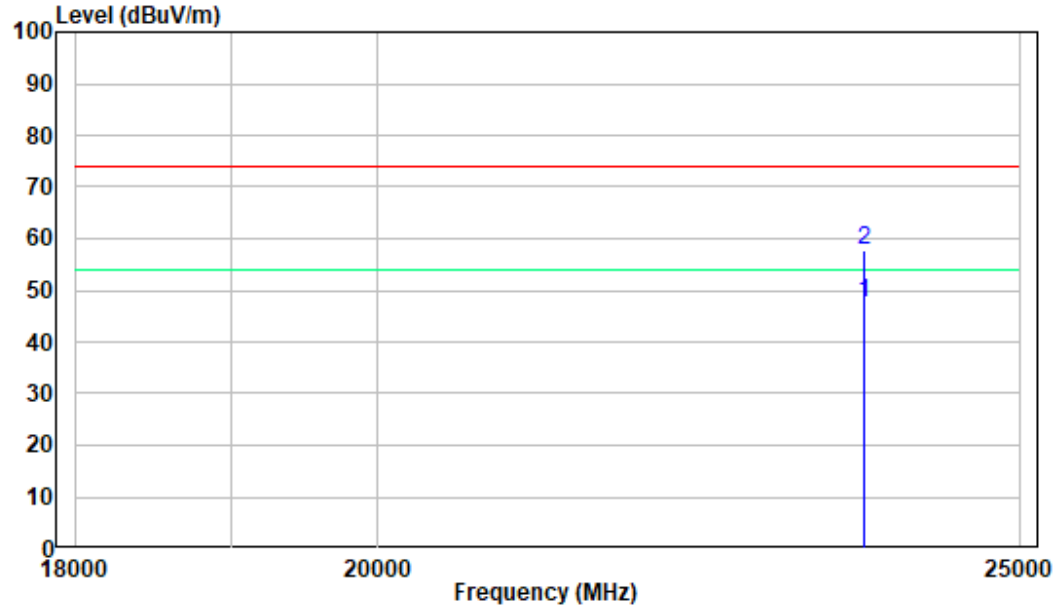

**Vertical:**



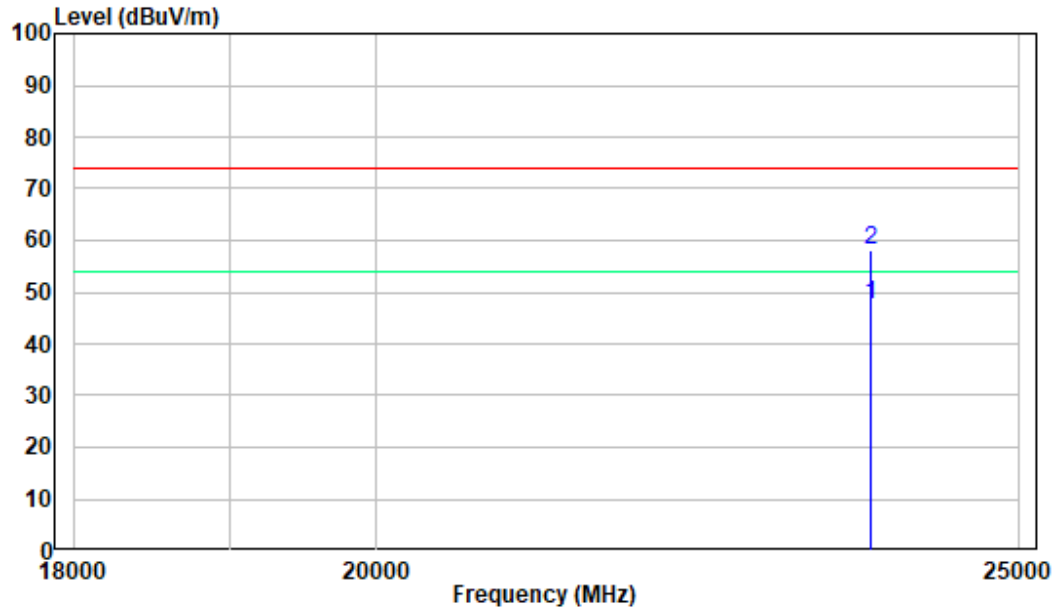
**18-25GHz**

**Pre-scan for High Channel**

**Horizontal:**




**Vertical:**



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

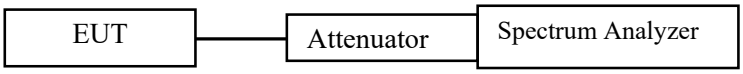
## Applicable Standard

Frequency hopping systems shall have hoping 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:** | 27.3℃ |
| **Relative Humidity:** | 41 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2023-04-12.*

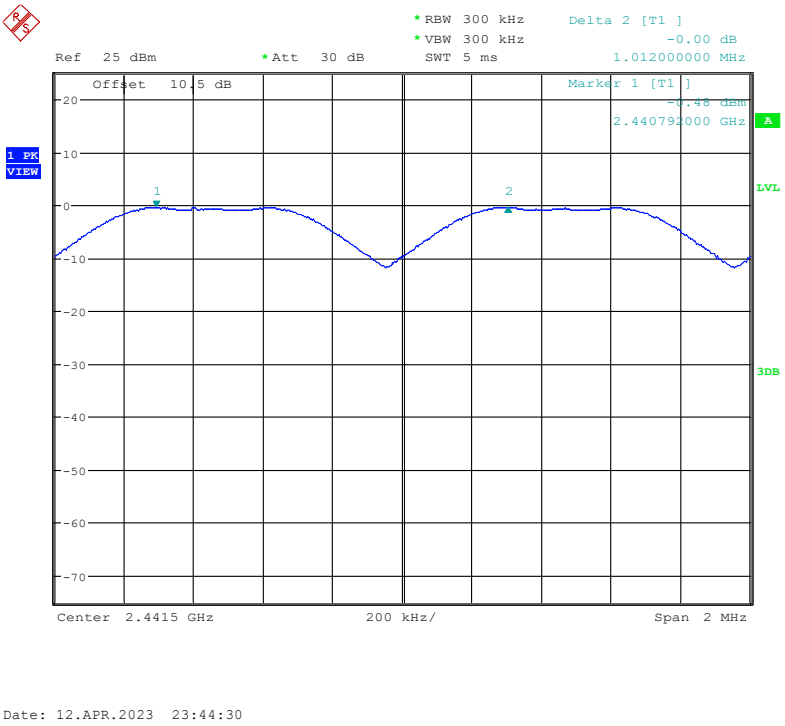
*EUT operation mode: Transmitting*

Test Result: Compliant.

| Test Mode | Channel Separation (MHz) | 20 dBc BW (MHz) | Two-thirds of the 20 dB bandwidth (MHz) | Channel Separation Limit | Result |
|---|---|---|---|---|---|
| **GFSK** | | | | | |
| Middle | 1.012 | 0.957 | 0.638 | > two-thirds of the 20 dB bandwidth | Middle |

Please refer to the below plots:

**GFSK_Hop**



# FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED 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

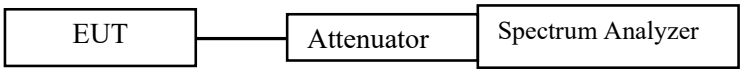
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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 resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 27.3℃ |
| **Relative Humidity:** | 41 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2023-04-12.*

*EUT operation mode: Transmitting*

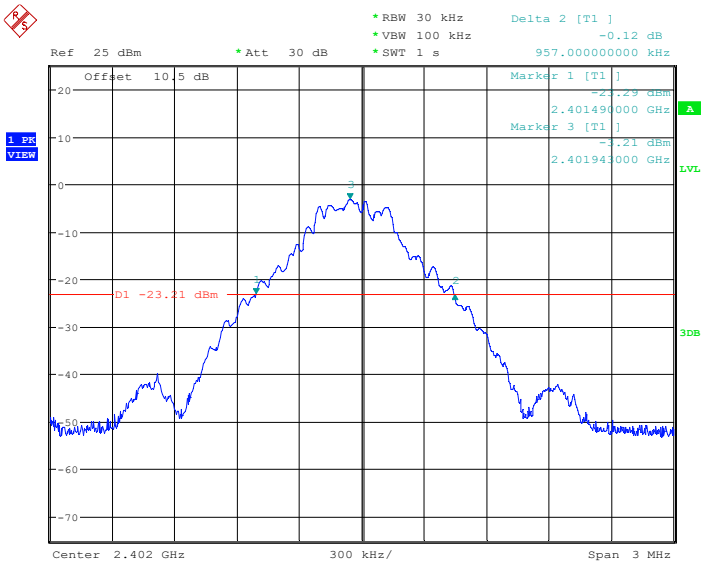
Test Result: Compliant.

| Mode | Channel | Frequency (MHz) | 99% Emission Bandwidth (MHz) | 20 dB Emission Bandwidth (MHz) |
|---|---|---|---|---|
| GFSK | Low | 2402 | 0.870 | 0.957 |
| | Middle | 2441 | 0.867 | 0.957 |
| | High | 2480 | 0.873 | 0.957 |

Please refer to the below plots:

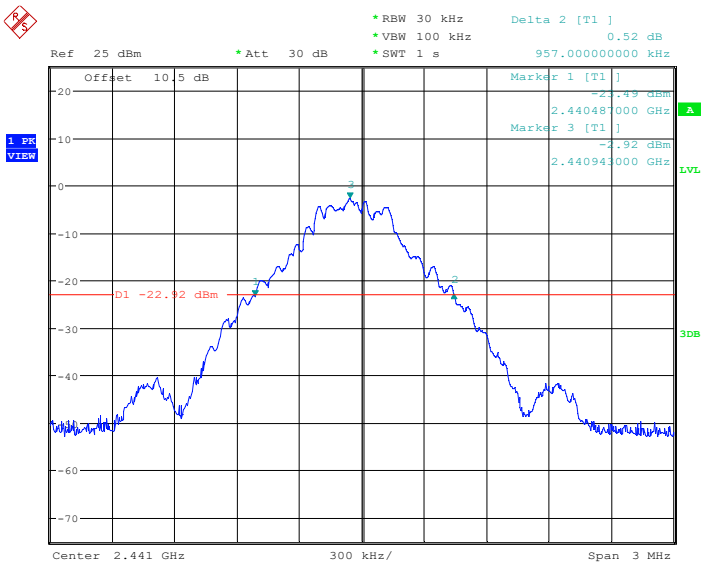
## 20 dB Emission Bandwidth:

**2402MHz**



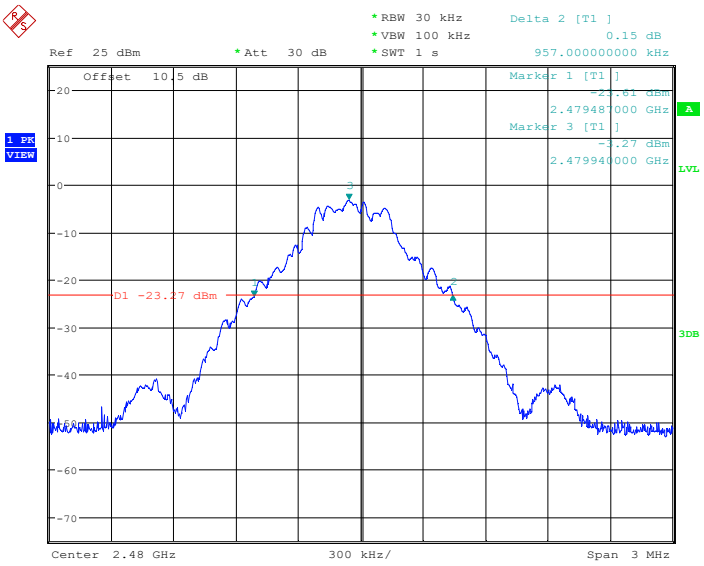

Date: 12.APR.2023 23:13:50

**2441MHz**




Date: 12.APR.2023 23:24:17

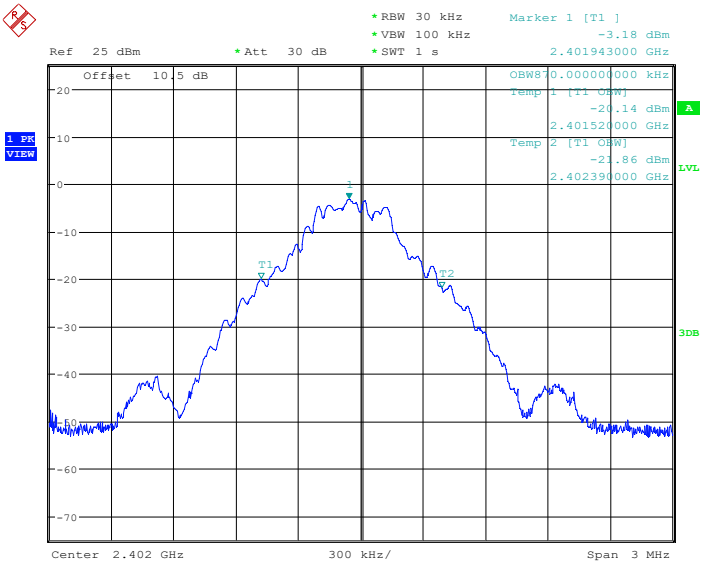
**2480MHz**




Date: 12.APR.2023 23:31:45

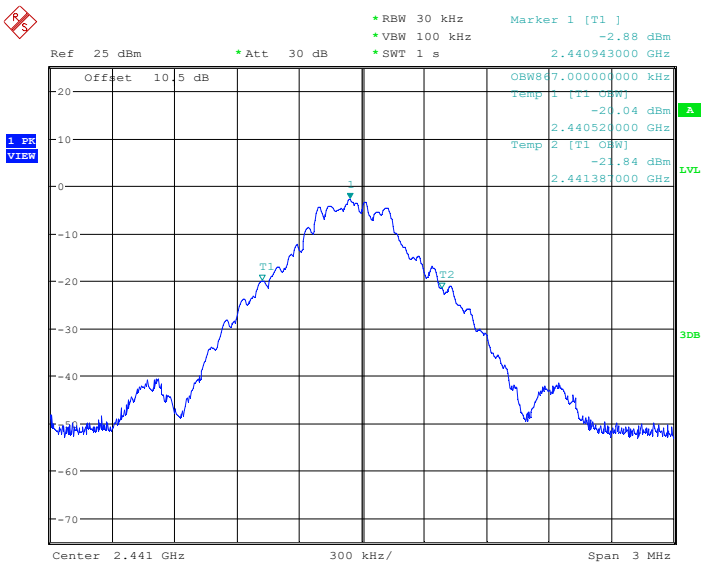
## 99% Emission Bandwidth:

**2402MHz**



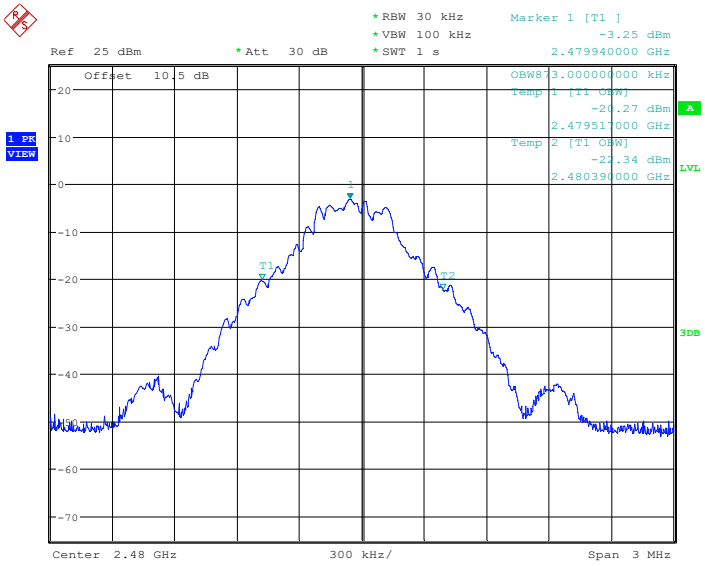

Date: 12.APR.2023 23:13:14

**2441MHz**




Date: 12.APR.2023 23:23:40

**2480MHz**




Date: 12.APR.2023 23:31:10

# 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.

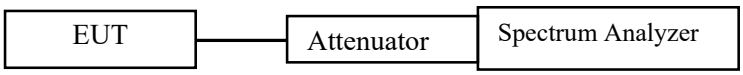
## Test Procedure

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:** | 27.3℃ |
| **Relative Humidity:** | 41 % |
| **ATM Pressure:** | 101.0 kPa |

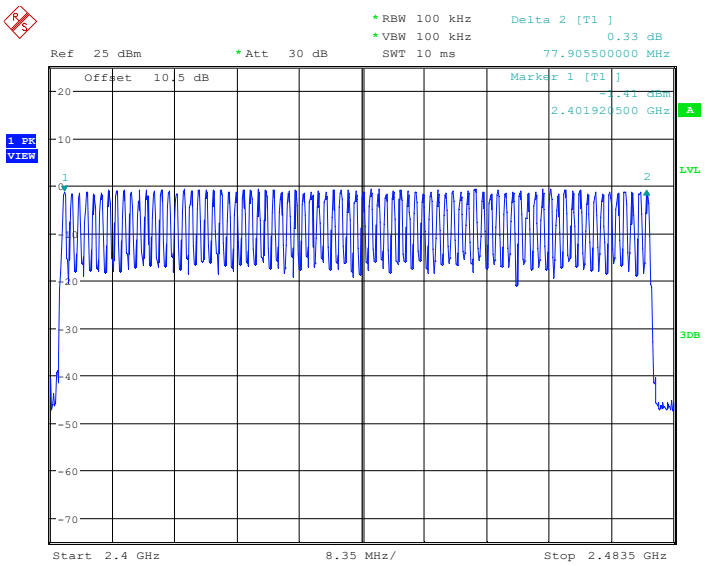
*The testing was performed by Roger Ling on 2023-04-12.*

*EUT operation mode: Transmitting*

Test Result: Compliant.

| Mode | Frequency Range (MHz) | Number of Hopping Channel (CH) | Limit (CH) |
|---|---|---|---|
| **GFSK** | 2402~2480 | 79 | ≥15 |

**GFSK_Hop**


RBW 100 kHz
VBW 100 kHz
SWT 10 ms
Delta 2 [T1 ]
0.33 dB
77.905500000 MHz
Ref 25 dBm
Att 30 dB
Offset 10.5 dB
Marker 1 [T1 ]
-1.41 dBm
2.401920500 GHz
1 PK VIEW
A
LVL
3DB
Start 2.4 GHz
8.35 MHz/
Stop 2.4835 GHz
Date: 12.APR.2023 23:43:07

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

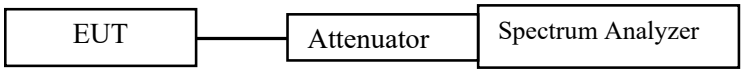
## Applicable Standard

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 ≥ 3×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:** | 27.3℃ |
| **Relative Humidity:** | 41 % |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2023-04-12.*

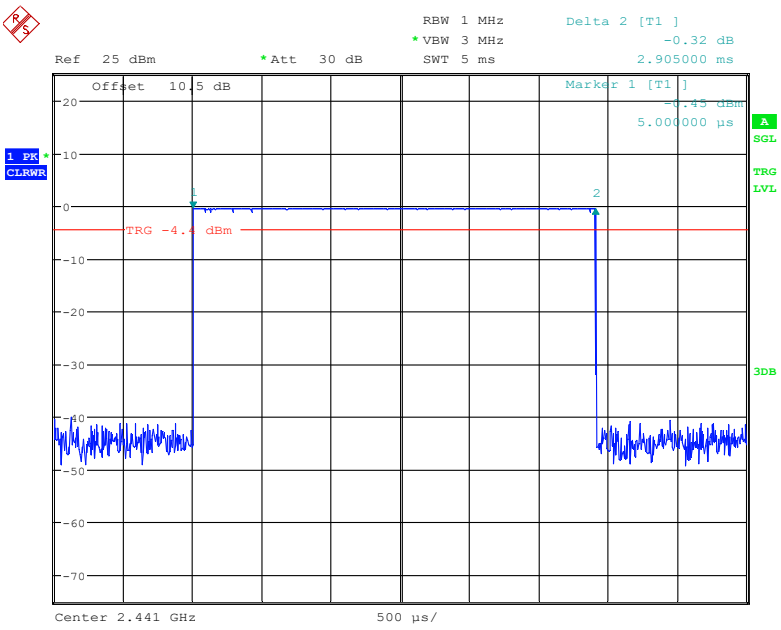
*EUT operation mode: Transmitting*

Test Result: Compliant.

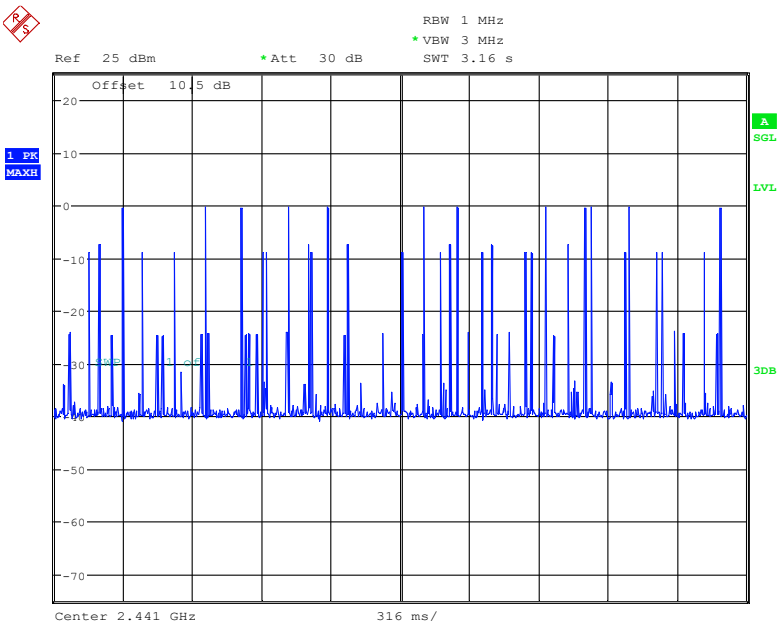
| Test Mode | Channel | Pulse Time [ms] | Total Hops [Num] | Result[s] | Limit[s] | Verdict |
|---|---|---|---|---|---|---|
| GFSK | Hop | 2.905 | 120 | 0.349 | <=0.4 | PASS |

Note 1: A period time=0.4*79=31.6(S), Result= Pulse Time *Total hops
Note 2: Total hops=Hopping Number in 3.16s*10
Note 3: Hopping Number in 3.16s=Total of highest signals in 3.16s (Second high signals were other channel)

## Hop




Date: 12.APR.2023 23:45:05




Date: 12.APR.2023 23:44:45

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

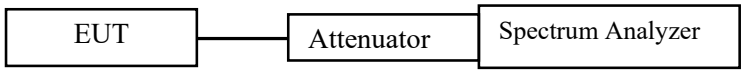
## Applicable Standard

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:** | 27.3℃ |
| **Relative Humidity:** | 41 % |
| **ATM Pressure:** | 101.0 kPa |

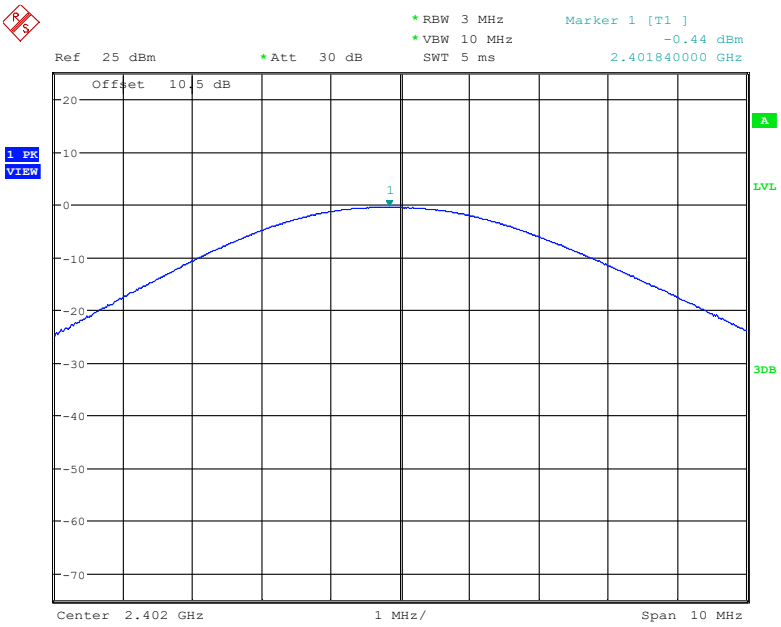
*The testing was performed by Roger Ling on 2023-04-12.*

*EUT operation mode: Transmitting*

Test Result: Compliant.

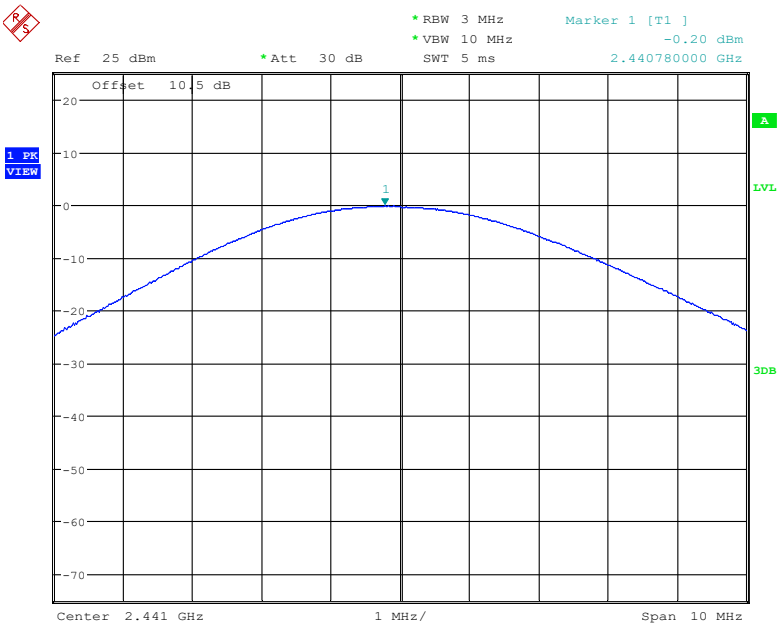
| Mode | Channel | Frequency (MHz) | Peak Output Power (dBm) | Limit (dBm) |
|---|---|---|---|---|
| GFSK | Low | 2402 | -0.44 | 21 |
| | Middle | 2441 | -0.20 | 21 |
| | High | 2480 | -0.44 | 21 |

**GFSK_2402**



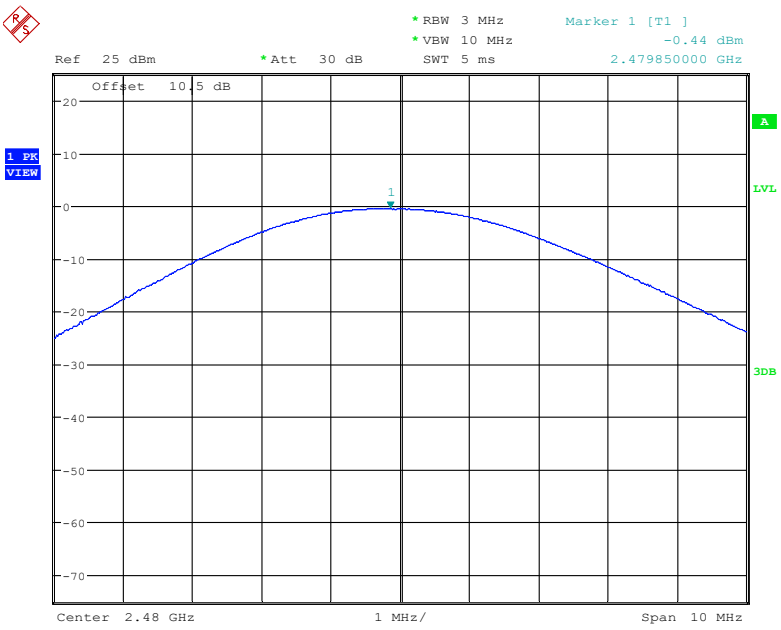

Date: 12.APR.2023 23:12:38

**GFSK_2441**




Date: 12.APR.2023 23:23:05

**GFSK_2480**


RBW 3 MHz
VBW 10 MHz
SWT 5 ms
Marker 1 [T1 ]
-0.44 dBm
2.479850000 GHz
Ref 25 dBm
Att 30 dB
Offset 10.5 dB
1 PK
VIEW
A
LVL
3DB
Center 2.48 GHz
1 MHz/
Span 10 MHz
Date: 12.APR.2023 23:30:36

# FCC §15.247(d) - BAND EDGES TESTING

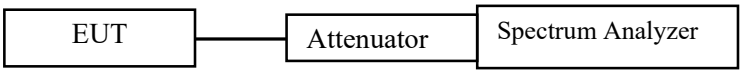
## Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

## Test Procedure

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:** | 27.3℃ |
| **Relative Humidity:** | 41 % |
| **ATM Pressure:** | 101.0 kPa |

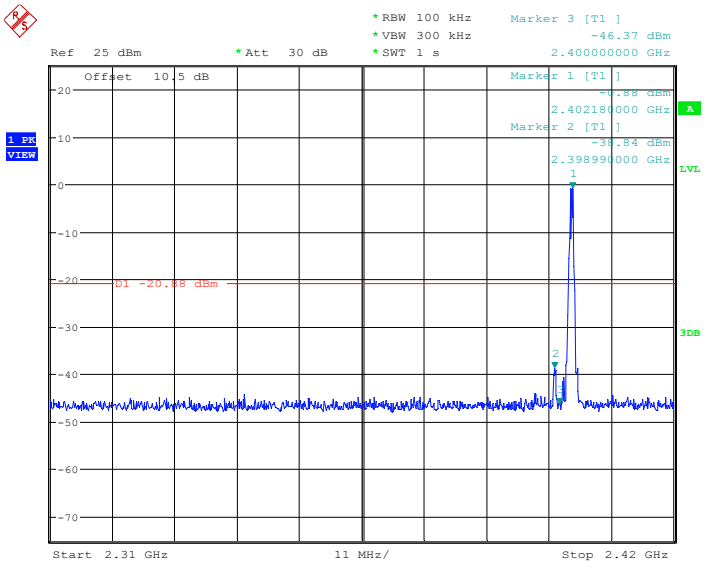
*The testing was performed by Roger Ling on 2023-04-12.*

*EUT operation mode: Transmitting*

Test Result: Compliant.

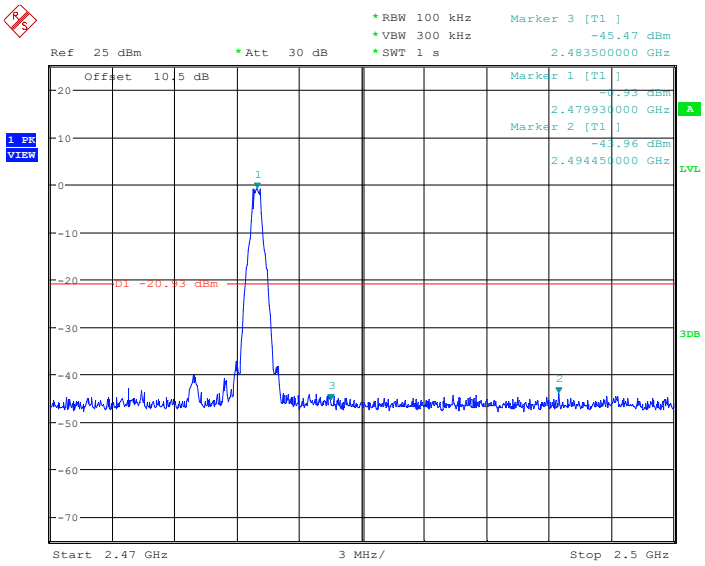
## Conducted Band Edge Result:

**Low_2402MHz**



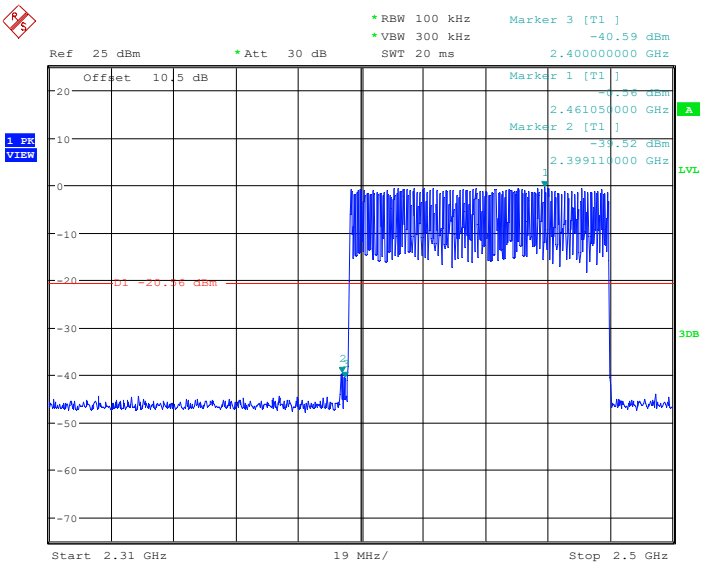

Date: 12.APR.2023 23:14:12

**High_2480MHz**




Date: 12.APR.2023 23:32:10

**Low_Hop**

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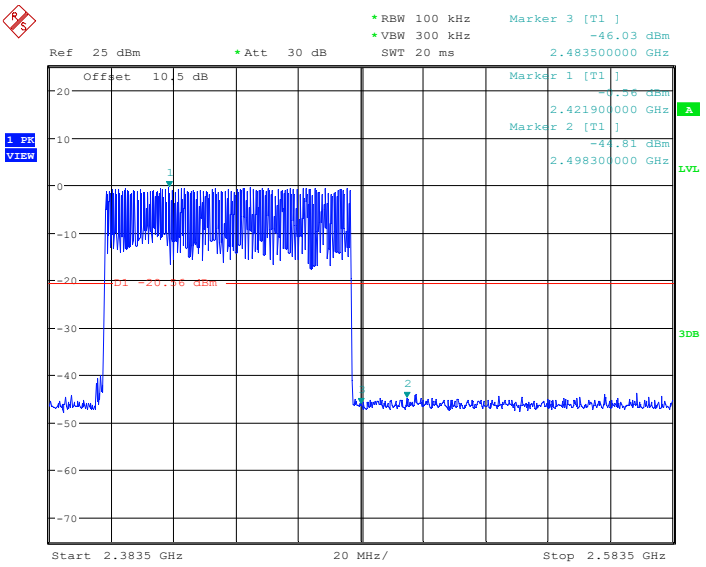
**High_Hop**

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