# TEST REPORT

| | |
|---|---|
| Applicant Name : | ShenZhen QINGQING Trading CO.,LTD |
| Address : | ZhongYuGuan, ChanYeYuan, A4-701 Fang LongHuaQu, LongHuaJieDao, BuLongLu, YouSongSheQu Shenzhen, Guangdong, China |
| Report Number : | RA221028-50156E-RF-00 |
| FCC ID: | 2A2AZ-XKZBT01 |

**Test Standard (s)**

FCC PART 15.247

**Sample Description**

| | |
|---|---|
| Product Type: | Bluetooth beanie hat |
| Model No.: | FLBT-01 |
| Multiple Model(s) No.: | XKZBT-01,XKZBT-02,XKZBT-03,XKZBT-04, ZRBT-01,ZRBT-02,ZRBT-03, FULLLIGHTTECHLMZXX02BLFLUS, FLBT-02,FLBT-03, YYBT-01,YYBT-02,YYBT-03, GWBB-001, GWBB-002, ,GWBB-004 |
| Trade Mark: | N/A |
| Date Received: | 2022/10/28 |
| Report Date: | 2022/11/10 |

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

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

**Prepared and Checked By:**

Audy Yu

EMC Engineer

**Approved By:**

Candy Li

EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★ ".
Shenzhen Accurate Technology Co., Ltd. is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk '*'. Customer model name, addresses, names, trademarks etc. are not considered data.
This report cannot be reproduced except in full, without prior written approval of the Company. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

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# GENERAL INFORMATION

## Product Description for Equipment under Test (EUT)

| | |
|---|---|
| Product | Bluetooth beanie hat |
| Tested Model | FLBT-01 |
| Multiple Models | XKZBT-01,XKZBT-02,XKZBT-03,XKZBT-04,<br>ZRBT-01,ZRBT-02,ZRBT-03, FULLLIGHTTECHLMZXX02BLFLUS,<br>FLBT-02,FLBT-03, YYBT-01,YYBT-02,YYBT-03, GWBB-001,<br>GWBB-002, GWBB-004<br>(model difference see product declaration letter of similarity) |
| Frequency Range | Bluetooth: 2402~2480MHz |
| Maximum conducted Peak output power | Bluetooth: 0.53dBm |
| Modulation Technique | Bluetooth: GFSK, π/4-DQPSK, 8DPSK |
| Antenna Specification* | 4.34 dBi (provided by the applicant) |
| Voltage Range | DC3.7V from battery or DC5V from USB Charging Port |
| Sample serial number | 1O5L-3 for Radiated Emissions Test<br>1O5M-4 for RF Conducted Test<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, 15.209 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 |
|---|---|---|
| AC Line Conducted emission | | 2.72dB |
| Emissions, Radiated | 30MHz - 1GHz | 4.28dB |
| | 1GHz - 18GHz | 4.98dB |
| | 18GHz - 26.5GHz | 5.06dB |

*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 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. 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.

Listed by Innovation, Science and Economic Development Canada (ISEDC), the Registration Number is 5077A.

# SYSTEM TEST CONFIGURATION

## Description of Test Configuration

The system was configured for testing in an engineering mode.

## EUT Exercise Software

"bt_tool_v1.1.2*" exercise software was used and the power level is 6*, which provided by applicant.

## Special Accessories

No special accessory.

## Equipment Modifications

No modification was made to the EUT tested.

## Support Equipment List and Details

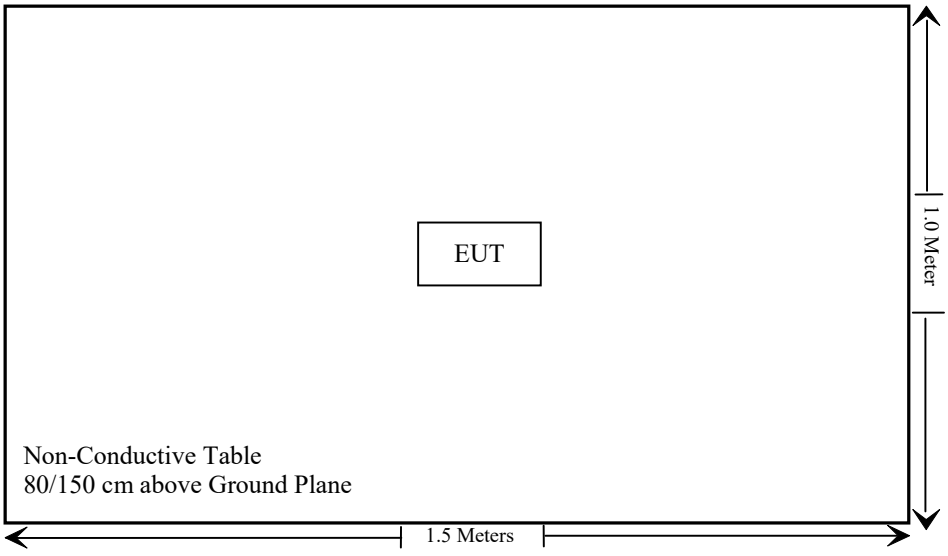
| Manufacturer | Description | Model | Serial Number |
|---|---|---|---|
| / | / | / | / |

## External I/O Cable

| Cable Description | Length (m) | From Port | To |
|---|---|---|---|
| / | / | / | / |

## Block Diagram of Test Setup

For Radiated Emissions:



# SUMMARY OF TEST RESULTS

| FCC Rules | Description of Test | Result |
|---|---|---|
| FCC§15.247 (i), §1.1307 (b) (3) &§2.1093 | RF Exposure | Compliant |
| §15.203 | Antenna Requirement | Compliant |
| §15.207(a) | AC Line Conducted Emissions | Not Applicable |
| §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 |

Not Applicable: The Bluetooth function cannot use when charging.

# TEST EQUIPMENT LIST

| Manufacturer | Description | Model | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| **Radiated Emissions Test** | | | | | |
| Rohde& Schwarz | Test Receiver | ESR | 102725 | 2021/12/13 | 2022/12/12 |
| Rohde&Schwarz | Spectrum Analyzer | FSV40 | 101949 | 2021/12/13 | 2022/12/12 |
| SONOMA INSTRUMENT | Amplifier | 310 N | 186131 | 2021/11/09 | 2022/11/08 |
| A.H. Systems, inc. | Preamplifier | PAM-0118P | 135 | 2021/11/09 | 2022/11/08 |
| Quinstar | Amplifier | QLW-18405536-J0 | 15964001002 | 2021/11/11 | 2022/11/10 |
| Schwarzbeck | Bilog Antenna | VULB9163 | 9163-323 | 2021/07/06 | 2024/07/05 |
| Schwarzbeck | Horn Antenna | BBHA9120D | 9120D-1067 | 2020/01/05 | 2023/01/04 |
| Schwarzbeck | HORN ANTENNA | BBHA9170 | 9170-359 | 2020/01/05 | 2023/01/04 |
| Radiated Emission Test Software: e3 19821b (V9) | | | | | |
| Unknown | RF Coaxial Cable | No.10 | N050 | 2021/12/14 | 2022/12/13 |
| Unknown | RF Coaxial Cable | No.11 | N1000 | 2021/12/14 | 2022/12/13 |
| Unknown | RF Coaxial Cable | No.12 | N040 | 2021/12/14 | 2022/12/13 |
| Unknown | RF Coaxial Cable | No.13 | N300 | 2021/12/14 | 2022/12/13 |
| Unknown | RF Coaxial Cable | No.14 | N800 | 2021/12/14 | 2022/12/13 |
| Unknown | RF Coaxial Cable | No.15 | N600 | 2021/12/14 | 2022/12/13 |
| Unknown | RF Coaxial Cable | No.16 | N650 | 2021/12/14 | 2022/12/13 |
| Wainwright | High Pass Filter | WHKX3.6/18G-10SS | 5 | 2021/12/14 | 2022/12/13 |
| **RF conducted test** | | | | | |
| Rohde&Schwarz | Spectrum Analyzer | FSV-40 | 101495 | 2021/12/13 | 2022/12/12 |
| Tonscend | RF Control Unit | JS0806-2 | 19G8060182 | 2022/07/06 | 2023/07/05 |
| WEINSCHEL | 10dB Attenuator | 5324 | AU 3842 | 2021/12/14 | 2022/12/13 |
| Unknown | RF Coaxial Cable | No.31 | RF-01 | Each time | |

*** 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) (3) &§2.1093 – RF EXPOSURE

## Applicable Standard

According to FCC §2.1093 and §1.1307(b) (3), 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

SAR-Based Exemption:

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum timeaveraged power or maximum time-averaged ERP, whichever is greater.

Per § 1.1307(b)(3)(i)(B), for single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2) of this section): A single RF source is exempt if:

the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold $P_{th}$ (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). $P_{th}$ is given by:

$$P_{th}\ (\text{mW}) = \begin{cases} ERP_{20\ cm}(d/20\ \text{cm})^x & d \le 20\ \text{cm} \\ ERP_{20\ cm} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20\ cm}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

$d$ = the separation distance (cm);

**For worst case:**

Exemption limit:

For $f$=2.48GHz, $d$=0.5cm, the $P_{th}$=2.72mW

The higher of the available maximum time-averaged power or effective radiated power (ERP):

The antenna gain is 4.34dBi(2.19dBd), 0dBd=2.15dBi

The maximum tune-up conducted power is 1.0dBm

The maximum tune-up ERP = 2.19+1.0dBm = 3.19dBm (2.08mW), which less than 2.72mW@2480MHz exemption limit.

**So the stand-alone SAR evaluation can be exempted.**

# 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, which was permanently attached, and the maximum antenna gain is 4.34dBi, fulfill the requirement of this section. Please refer to the EUT photos.

**Result:** Compliant.

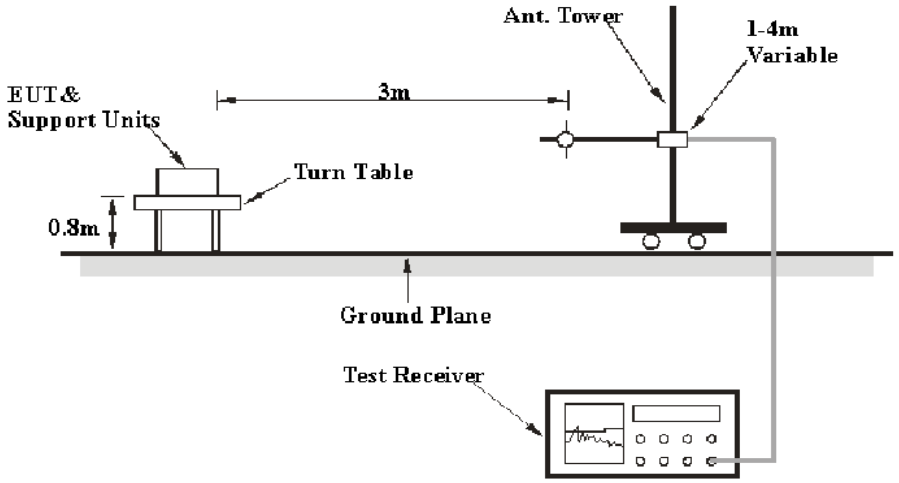
# FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

## Applicable Standard

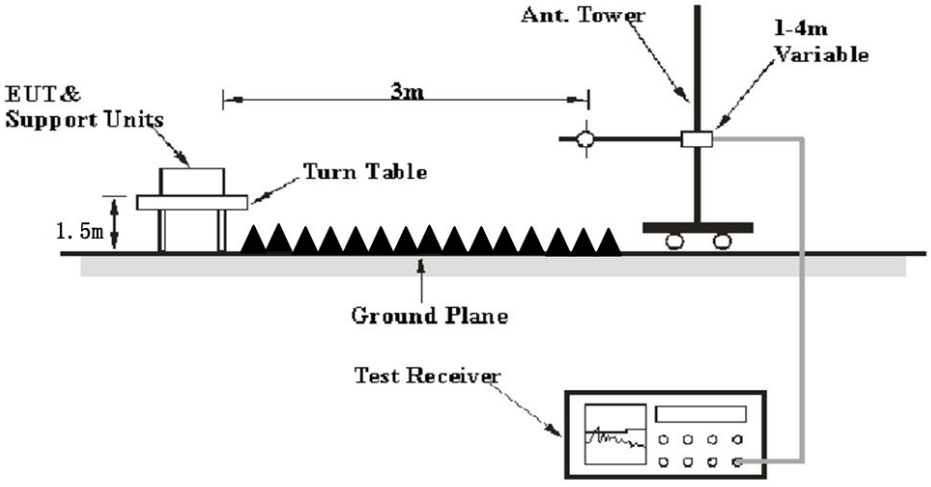
FCC §15.205; §15.209; §15.247(d)

## 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.

## Factor & 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:

Factor = Antenna Factor + Cable Loss - 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:

Over Limit/Margin = Level / Corrected Amplitude – Limit
Level / Corrected Amplitude = Read Level + Factor

## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 23~28.8℃ |
| **Relative Humidity:** | 52~61 % |
| **ATM Pressure:** | 101~101.2 kPa |

*The testing was performed by Jimi on 2022-11-08 for below 1GHz, Jeff Jiang on 2022-11-02 for above 1GHz*

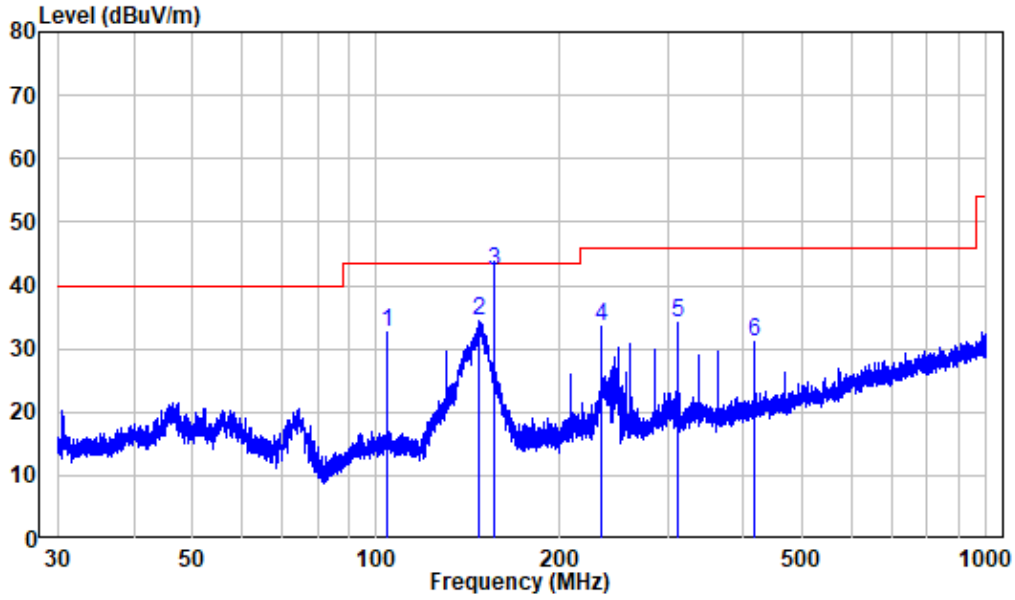
*EUT operation mode: Transmitting*

*Note: Pre-scan in the X, Y and Z axes of orientation, the worst case X-axis of orientation was recorded*

**30MHz-1GHz:** *(worst case is 8DPSK Mode, high channel)*

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

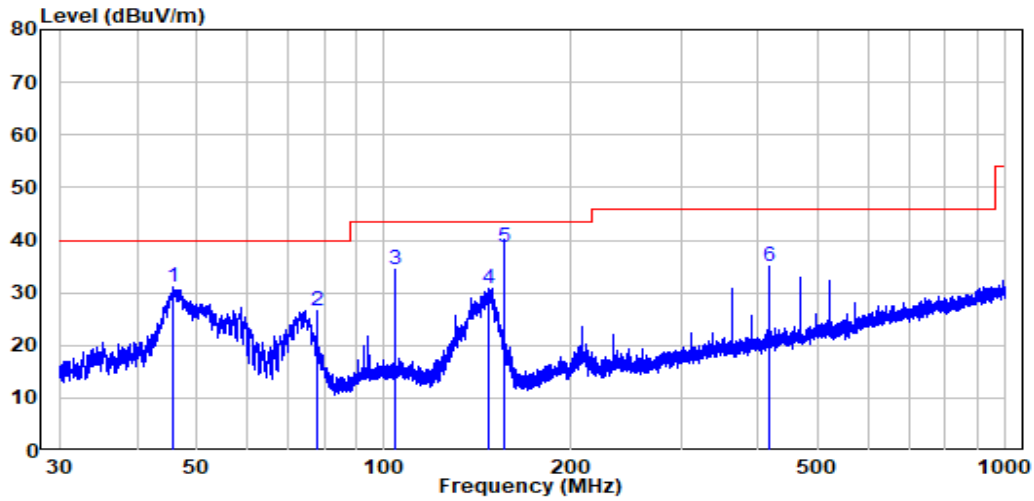
**Horizontal:**




Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA221028-50156E-RF
Test Mode: BT Transmitting

| | Freq | Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 103.988 | -11.74 | 44.30 | 32.56 | 43.50 | -10.94 | Peak |
| 2 | 147.468 | -15.43 | 49.87 | 34.44 | 43.50 | -9.06 | Peak |
| 3 | 156.047 | -14.81 | 57.10 | 42.29 | 43.50 | -1.21 | QP |
| 4 | 233.963 | -10.99 | 44.51 | 33.52 | 46.00 | -12.48 | Peak |
| 5 | 312.043 | -8.82 | 42.79 | 33.97 | 46.00 | -12.03 | Peak |
| 6 | 415.997 | -6.21 | 37.39 | 31.18 | 46.00 | -14.82 | Peak |

**Vertical**




Site : chamber
Condition: 3m VERTICAL
Job No. : RA221028-50156E-RF
Test Mode: BT Transmitting

| | Freq | Factor | Read Level | Level | Limit Line | Over Limit | Remark |
|---|---|---|---|---|---|---|---|
| | MHz | dB/m | dBuV | dBuV/m | dBuV/m | dB | |
| 1 | 45.775 | -9.98 | 41.12 | 31.14 | 40.00 | -8.86 | Peak |
| 2 | 77.968 | -16.61 | 43.27 | 26.66 | 40.00 | -13.34 | Peak |
| 3 | 103.988 | -11.74 | 46.17 | 34.43 | 43.50 | -9.07 | Peak |
| 4 | 147.468 | -15.43 | 46.19 | 30.76 | 43.50 | -12.74 | Peak |
| 5 | 155.979 | -14.82 | 53.40 | 38.58 | 43.50 | -4.92 | QP |
| 6 | 415.997 | -6.21 | 41.37 | 35.16 | 46.00 | -10.84 | Peak |

**Above 1GHz:** *(worst case is 8DPSK Mode, 3DH5)*

| Frequency (MHz) | Receiver | | Turntable Angle Degree | Rx Antenna | | Factor (dB/m) | Absolute Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| | Reading (dBμV) | PK/Ave | | Height (m) | Polar (H/V) | | | | |
| Low Channel(2402MHz) | | | | | | | | | |
| 2310 | 60.51 | PK | 219 | 1.2 | H | -7.24 | 53.27 | 74 | -20.73 |
| 2310 | 60.63 | PK | 295 | 2.1 | V | -7.24 | 53.39 | 74 | -20.61 |
| 2390 | 63.50 | PK | 273 | 1.4 | H | -7.22 | 56.28 | 74 | -17.72 |
| 2390 | 63.01 | PK | 189 | 1.6 | V | -7.22 | 55.79 | 74 | -18.21 |
| 4804 | 58.87 | PK | 9 | 1.7 | H | -3.51 | 55.36 | 74 | -18.64 |
| 4804 | 58.48 | PK | 50 | 1.7 | V | -3.51 | 54.97 | 74 | -19.03 |
| Middle Channel(2441MHz) | | | | | | | | | |
| 4882 | 58.79 | PK | 35 | 1.2 | H | -3.37 | 55.42 | 74 | -18.58 |
| 4882 | 56.89 | PK | 241 | 1.2 | V | -3.37 | 53.52 | 74 | -20.48 |
| High Channel(2480 MHz) | | | | | | | | | |
| 2483.5 | 63.48 | PK | 194 | 1 | H | -7.20 | 56.28 | 74 | -17.72 |
| 2483.5 | 63.11 | PK | 286 | 2.2 | V | -7.20 | 55.91 | 74 | -18.09 |
| 2500 | 62.15 | PK | 273 | 1.8 | H | -7.18 | 54.97 | 74 | -19.03 |
| 2500 | 62.44 | PK | 278 | 1 | V | -7.18 | 55.26 | 74 | -18.74 |
| 4960 | 58.20 | PK | 199 | 2.3 | H | -3.01 | 55.19 | 74 | -18.81 |
| 4960 | 56.63 | PK | 249 | 2.3 | V | -3.01 | 53.62 | 74 | -20.38 |

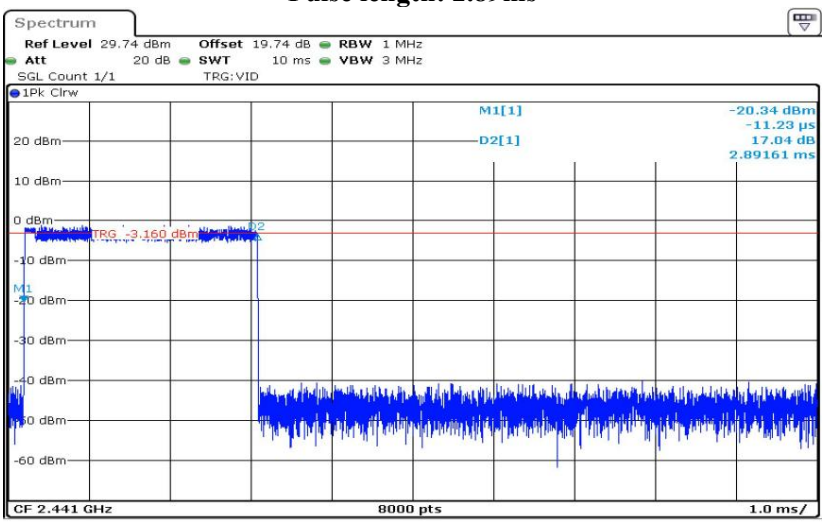
| Field Strength of Average | | | | | | |
|---|---|---|---|---|---|---|
| Frequency (MHz) | Peak Measurement @3m (dBμV/m) | Polar (H/V) | Duty Cycle Correction Factor (dB) | Corrected Ampitude (dBμV/m) | FCC Part 15.247 | |
| | | | | | Limit (dBμV/m) | Margin (dB) |
| Low Channel(2402MHz) | | | | | | |
| 2310 | 53.27 | H | -24.76 | 28.51 | 54 | -25.49 |
| 2310 | 53.39 | V | -24.76 | 28.63 | 54 | -25.37 |
| 2390 | 56.28 | H | -24.76 | 31.52 | 54 | -22.48 |
| 2390 | 55.79 | V | -24.76 | 31.03 | 54 | -22.97 |
| 4804 | 55.36 | H | -24.76 | 30.60 | 54 | -23.40 |
| 4804 | 54.97 | V | -24.76 | 30.21 | 54 | -23.79 |
| Middle Channel(2441MHz) | | | | | | |
| 4882 | 55.42 | H | -24.76 | 30.66 | 54 | -23.34 |
| 4882 | 53.52 | V | -24.76 | 28.76 | 54 | -25.24 |
| High Channel(2480MHz) | | | | | | |
| 2483.5 | 56.28 | H | -24.76 | 31.52 | 54 | -22.48 |
| 2483.5 | 55.91 | V | -24.76 | 31.15 | 54 | -22.85 |
| 2500 | 54.97 | H | -24.76 | 30.21 | 54 | -23.79 |
| 2500 | 55.26 | V | -24.76 | 30.50 | 54 | -23.50 |
| 4924 | 55.19 | H | -24.76 | 30.43 | 54 | -23.57 |
| 4924 | 53.62 | V | -24.76 | 28.86 | 54 | -25.14 |

Note:

Absolute Level = Corrected Factor + Reading
Margin = Corrected. Amplitude - Limit
Average level= Peak level+ Duty Cycle Corrected Factor

The worst case duty cycle as below:
Duty cycle = Ton/100ms = 2.89*2/100=0.0578
Duty Cycle Corrected Factor = 20lg (Duty cycle) = 20lg0.0578 = -24.76

**Pulse length: 2.89ms**

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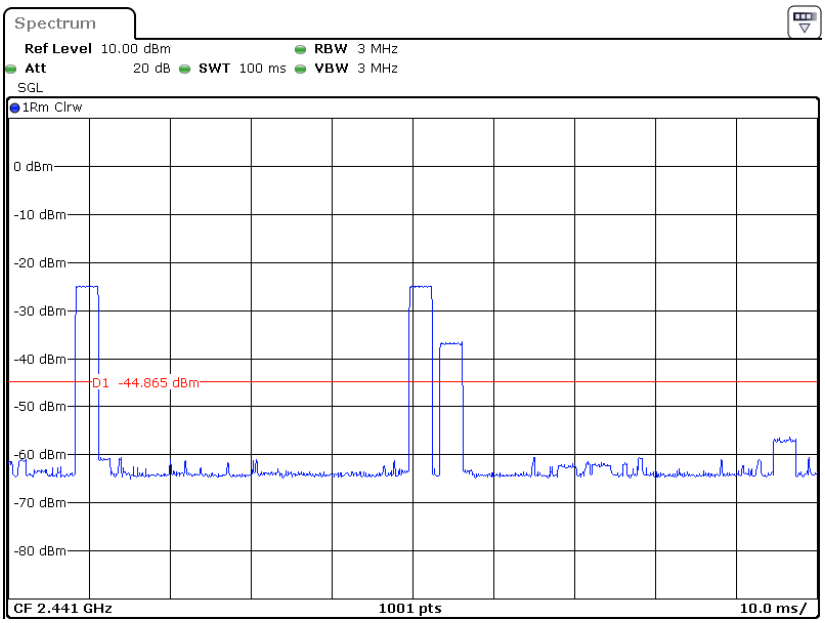
**Maximum Pulse number in 100ms: 2**

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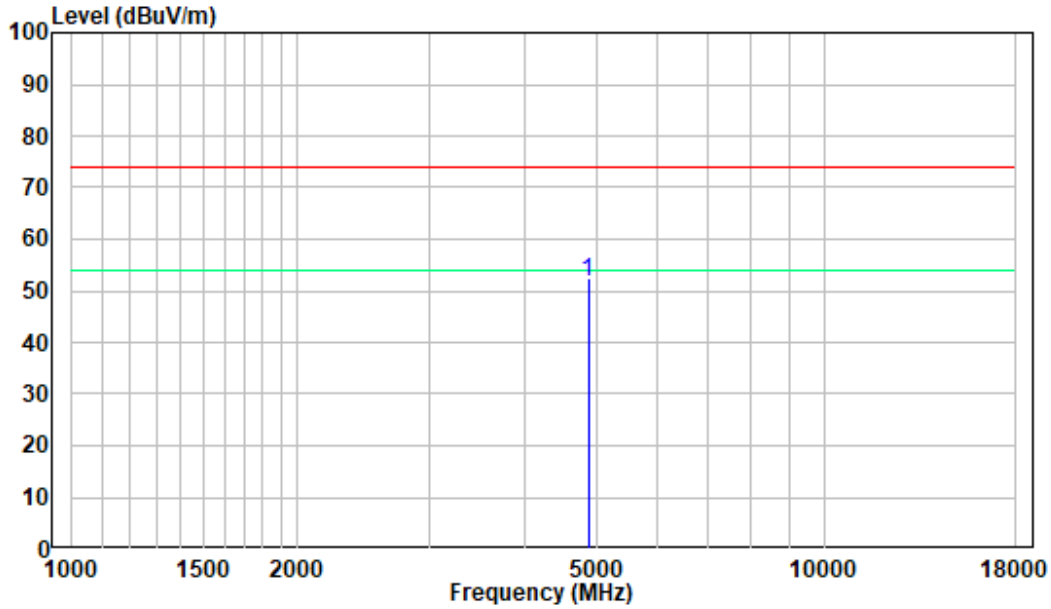
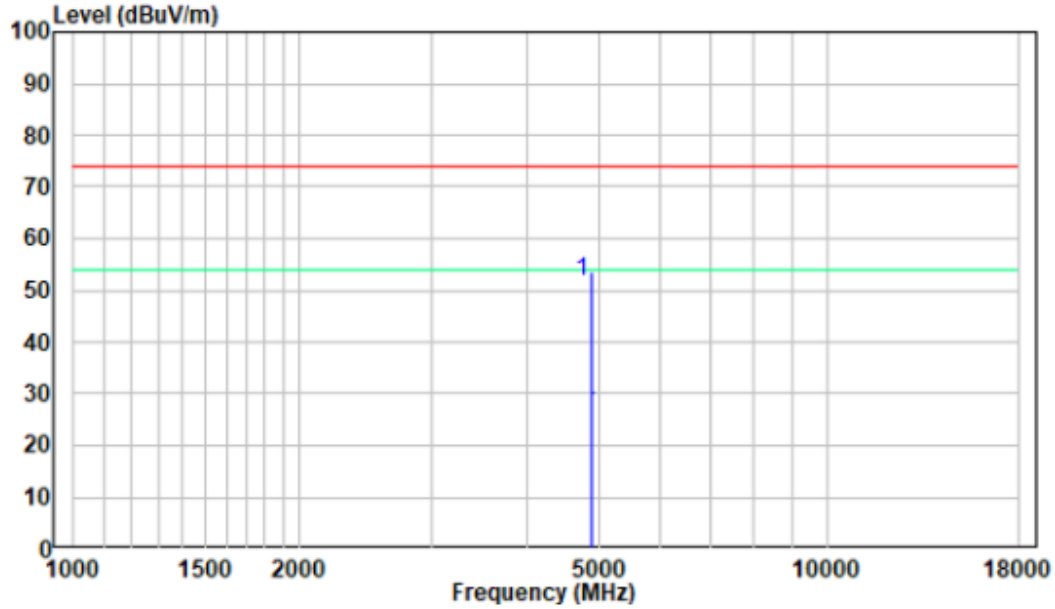
**1-18GHz**

**Pre-scan for Middle Channel**

**Horizontal:**



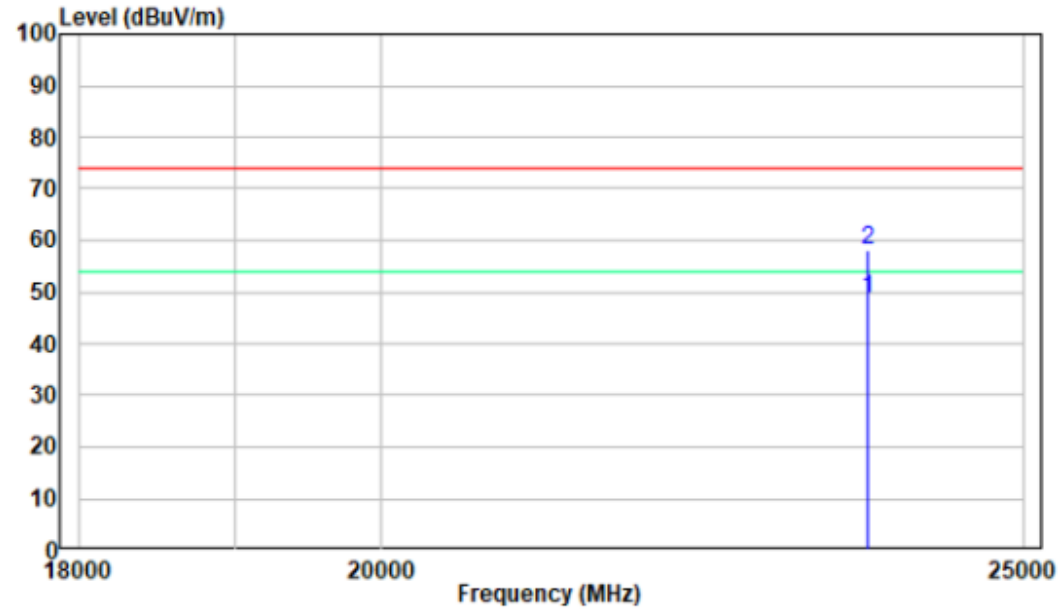

**Vertical:**



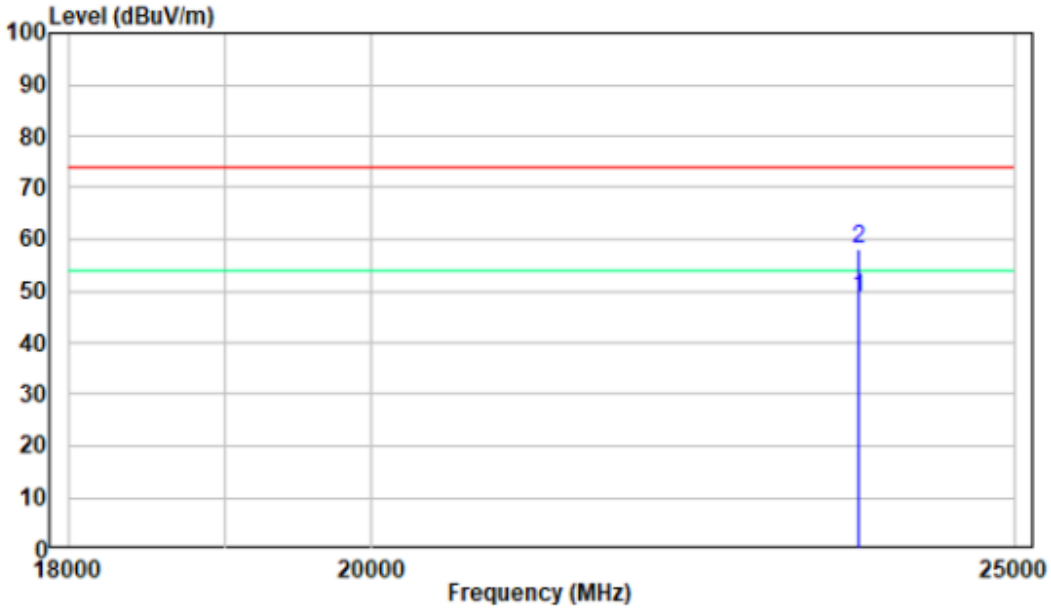
**18-25GHz**

**Pre-scan for Middle Channel**

**Horizontal:**




**Vertical:**



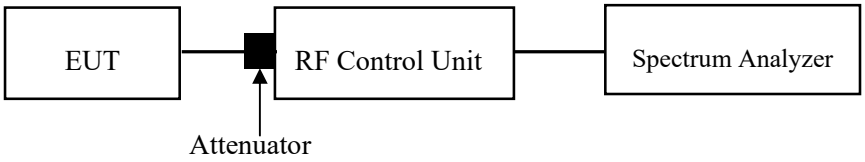
# FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

## 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

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




## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 45% |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2022-11-02.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

# 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

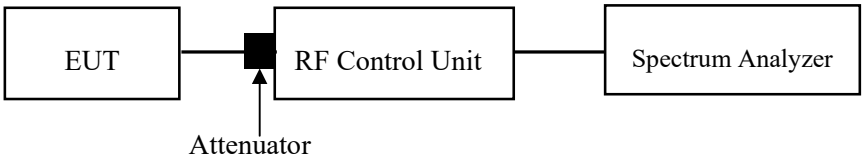
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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:** | 25 ℃ |
| **Relative Humidity:** | 45% |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2022-11-02.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

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

## Applicable Standard

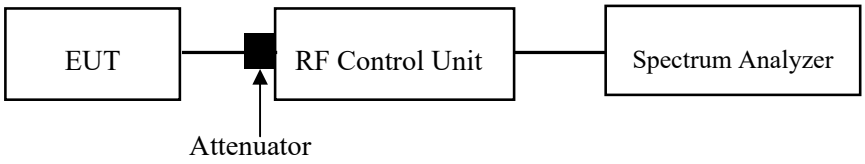
Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

## Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.

2. Set the EUT in hopping mode from first channel to last.

3. By using the max-hold function record the quantity of the channel.




## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 45% |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2022-11-02.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

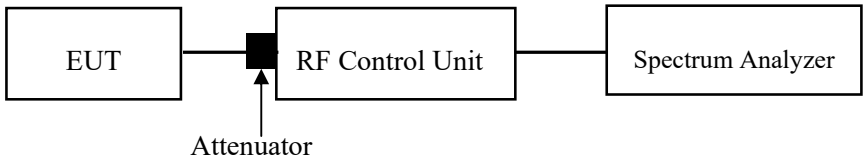
# FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

## Applicable Standard

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

## Test Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW ≥ 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:** | 25 ℃ |
| **Relative Humidity:** | 45% |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2022-11-02.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

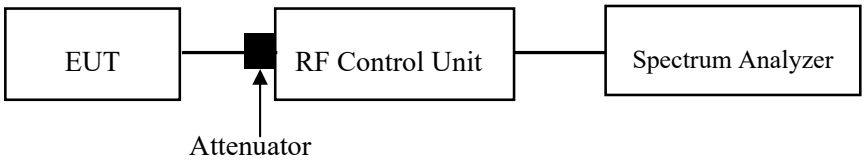
# FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

## Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

## Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.




## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 45% |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2022-11-02.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

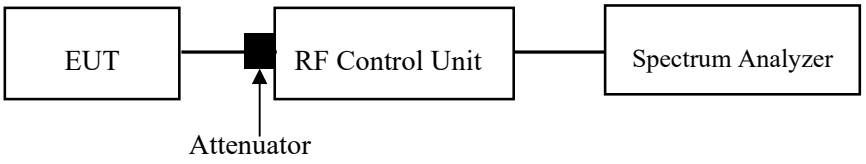
# FCC §15.247(d) - BAND EDGES TESTING

## Applicable Standard

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

## Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.




## Test Data

### Environmental Conditions

| | |
|---|---|
| **Temperature:** | 25 ℃ |
| **Relative Humidity:** | 45% |
| **ATM Pressure:** | 101.0 kPa |

*The testing was performed by Roger Ling on 2022-11-02.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

# APPENDIX

## Appendix A: 20dB Emission Bandwidth

### Test Result

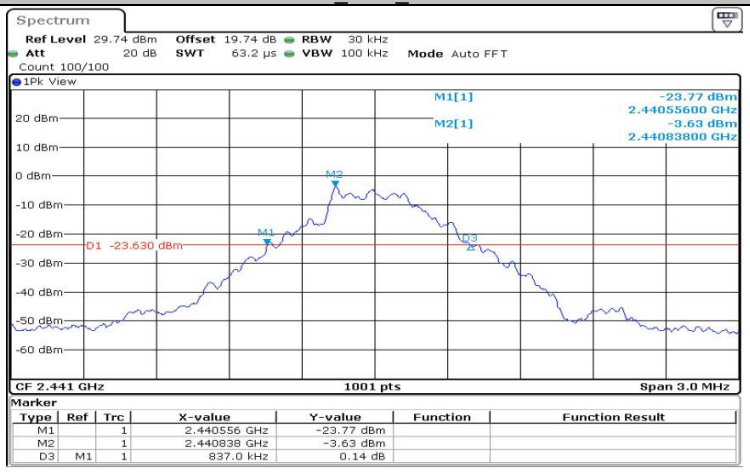
| Test Mode | Antenna | Frequency[MHz] | 20db EBW[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|
| DH1 | Ant1 | 2402 | 0.84 | --- | --- |
| | | 2441 | 0.84 | --- | --- |
| | | 2480 | 0.84 | --- | --- |
| 2DH1 | Ant1 | 2402 | 1.22 | --- | --- |
| | | 2441 | 1.22 | --- | --- |
| | | 2480 | 1.22 | --- | --- |
| 3DH1 | Ant1 | 2402 | 1.22 | --- | --- |
| | | 2441 | 1.22 | --- | --- |
| | | 2480 | 1.22 | --- | --- |

## Test Graphs

DH1_Ant1_2402

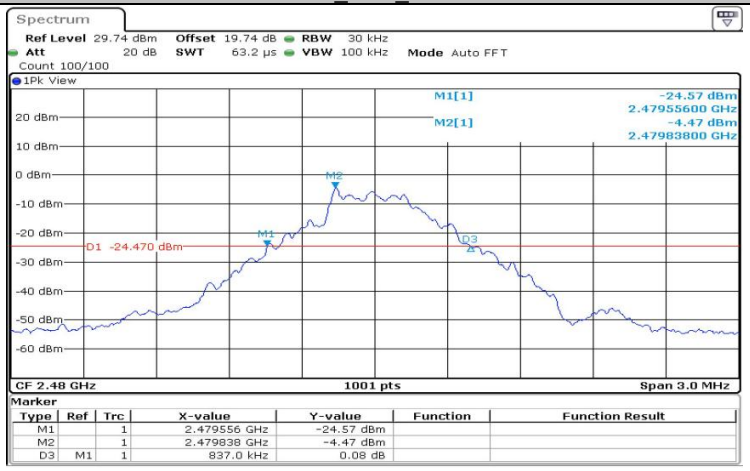

Date: 2.NOV.2022 03:30:07

DH1_Ant1_2441



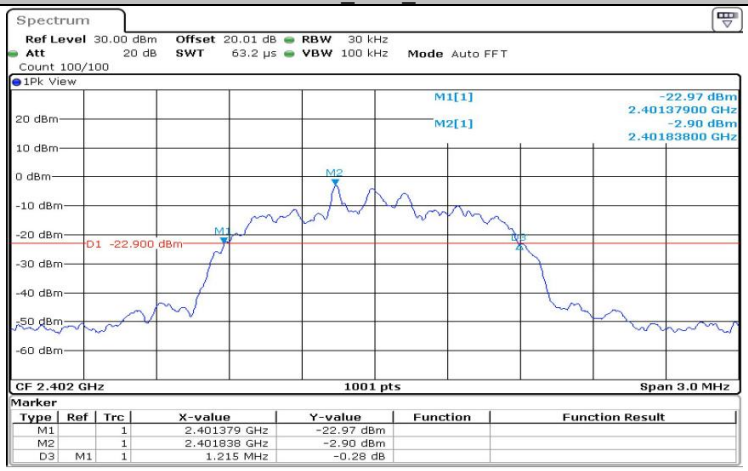

Date: 2.NOV.2022 03:31:12

DH1_Ant1_2480

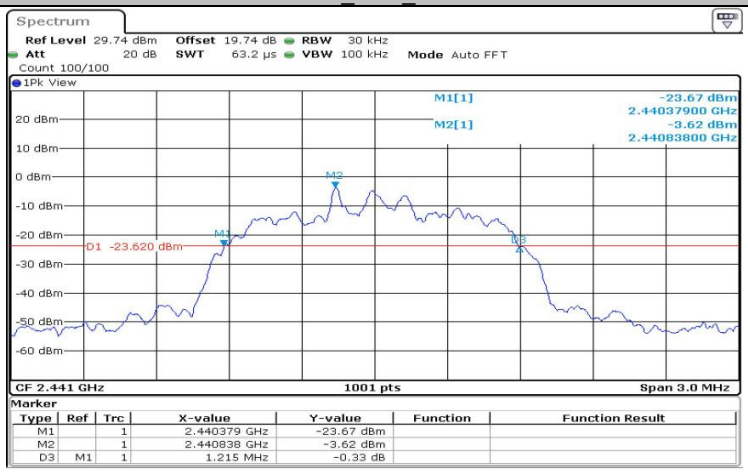



Date: 2.NOV.2022 03:32:12

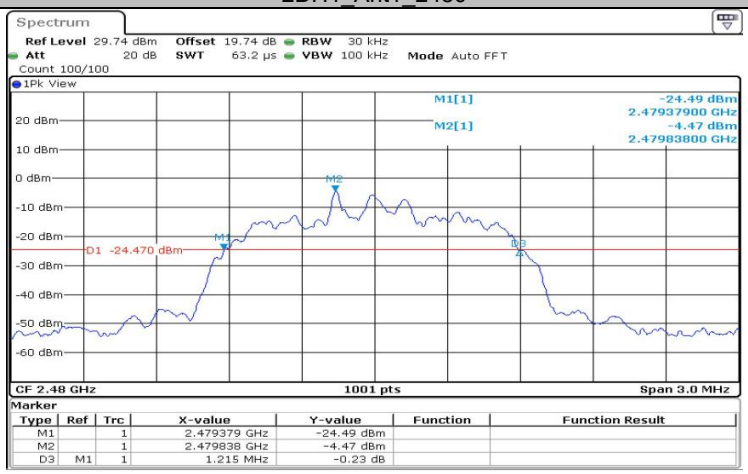
2DH1_Ant1_2402



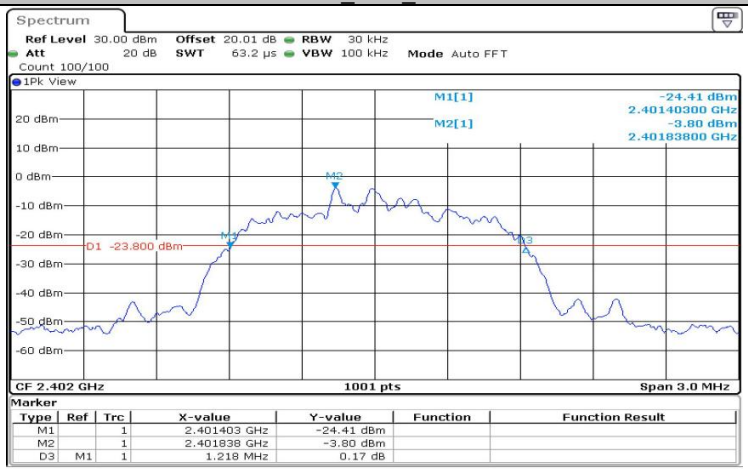

2DH1_Ant1_2441



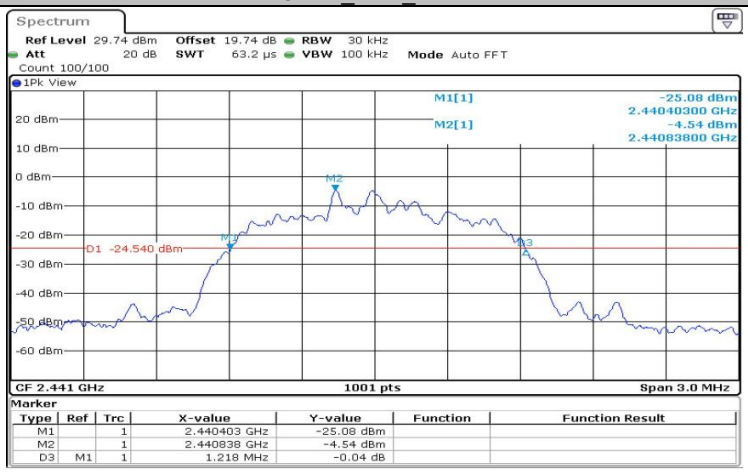

2DH1_Ant1_2480



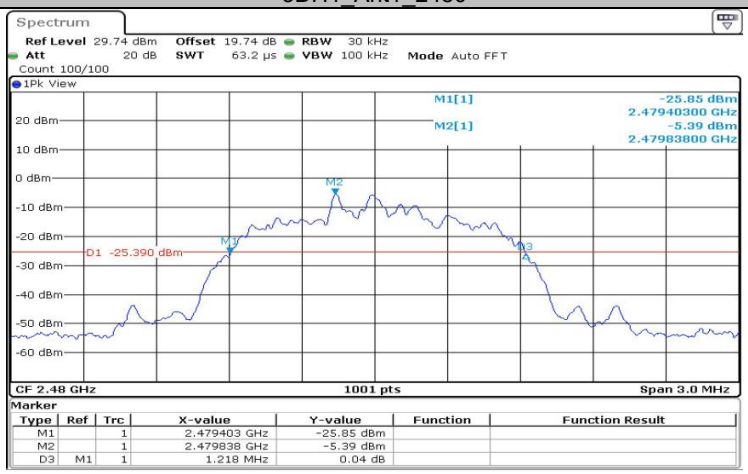
3DH1_Ant1_2402




3DH1_Ant1_2441




3DH1_Ant1_2480



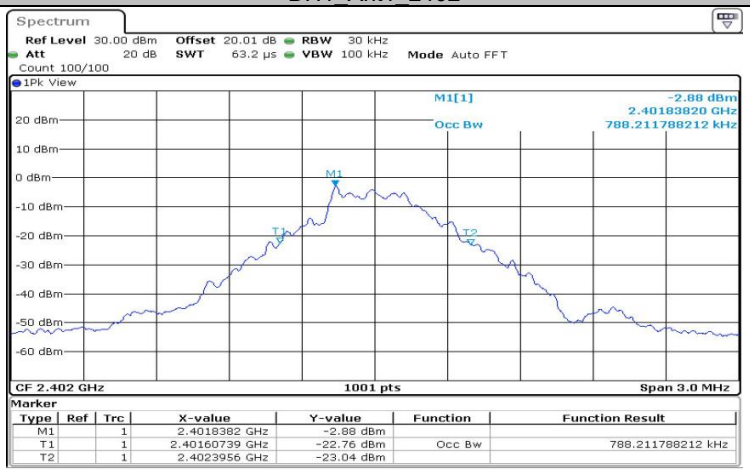
# Appendix B: Occupied Channel Bandwidth

## Test Result

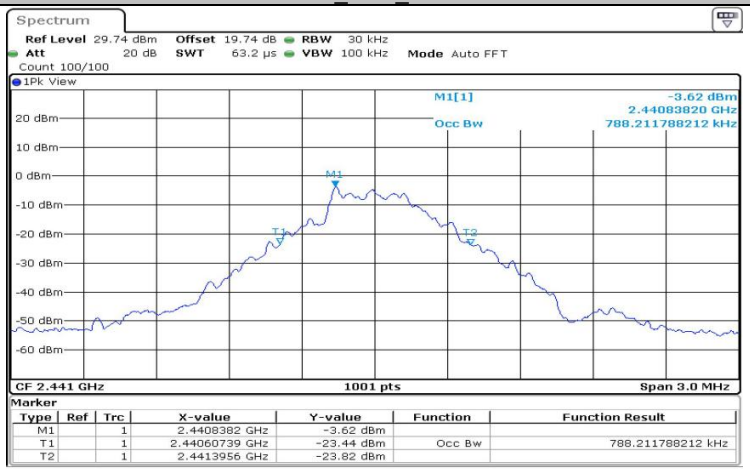
| Test Mode | Antenna | Frequency[MHz] | OCB [MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|
| DH1 | Ant1 | 2402 | 0.788 | --- | --- |
| | | 2441 | 0.788 | --- | --- |
| | | 2480 | 0.788 | --- | --- |
| 2DH1 | Ant1 | 2402 | 1.145 | --- | --- |
| | | 2441 | 1.145 | --- | --- |
| | | 2480 | 1.145 | --- | --- |
| 3DH1 | Ant1 | 2402 | 1.133 | --- | --- |
| | | 2441 | 1.133 | --- | --- |
| | | 2480 | 1.133 | --- | --- |

## Test Graphs

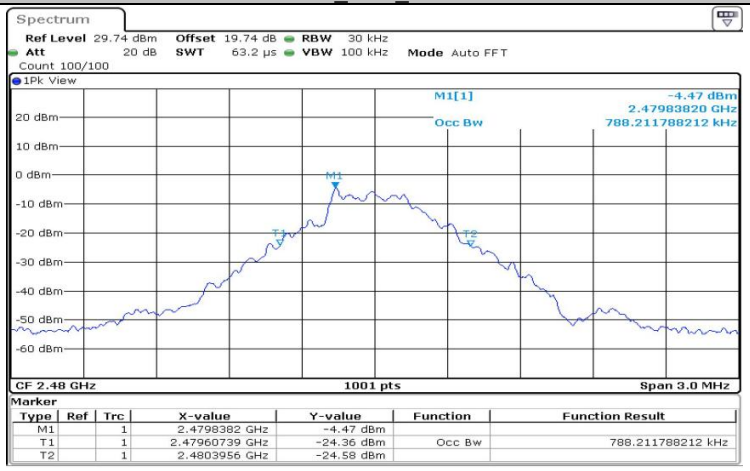
DH1_Ant1_2402



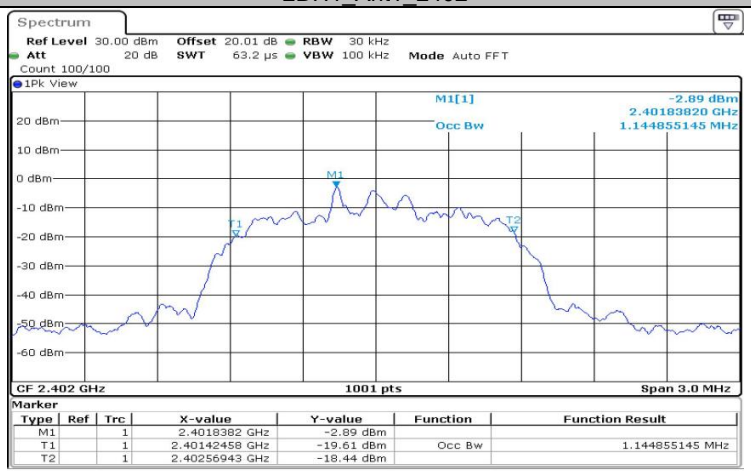

DH1_Ant1_2441



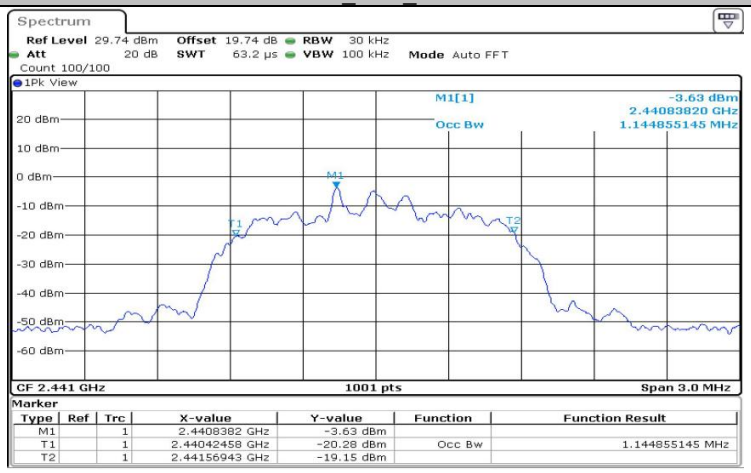

DH1_Ant1_2480



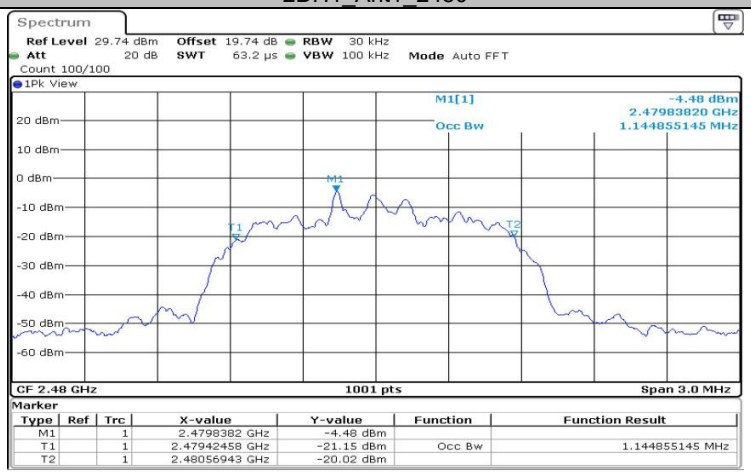
2DH1_Ant1_2402



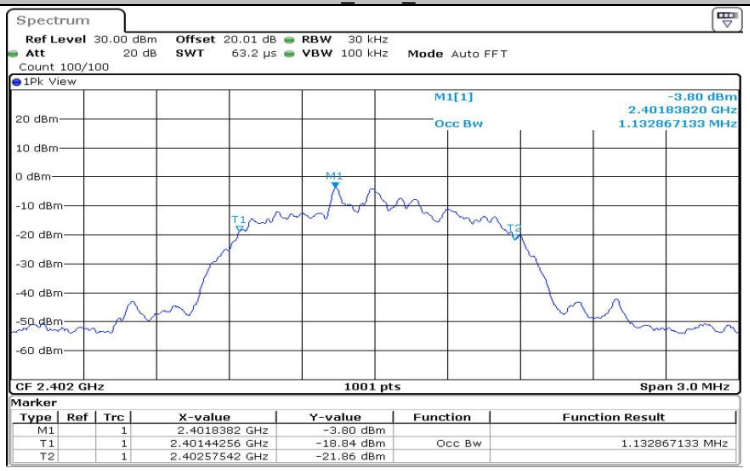

2DH1_Ant1_2441



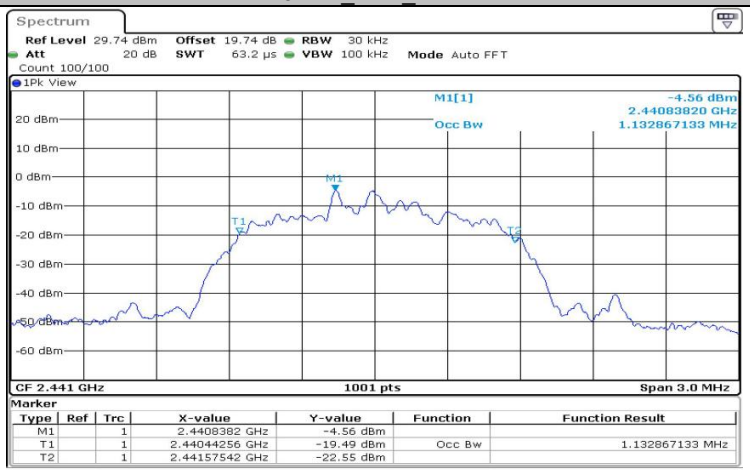

2DH1_Ant1_2480



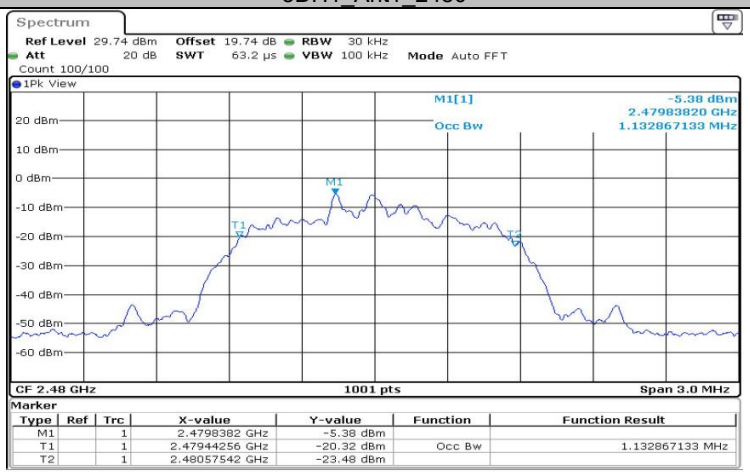
3DH1_Ant1_2402




3DH1_Ant1_2441




3DH1_Ant1_2480



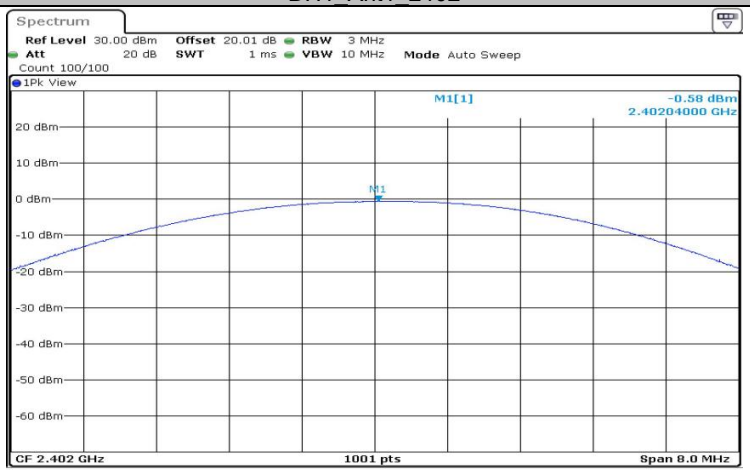
# Appendix C: Maximum conducted output power

## Test Result

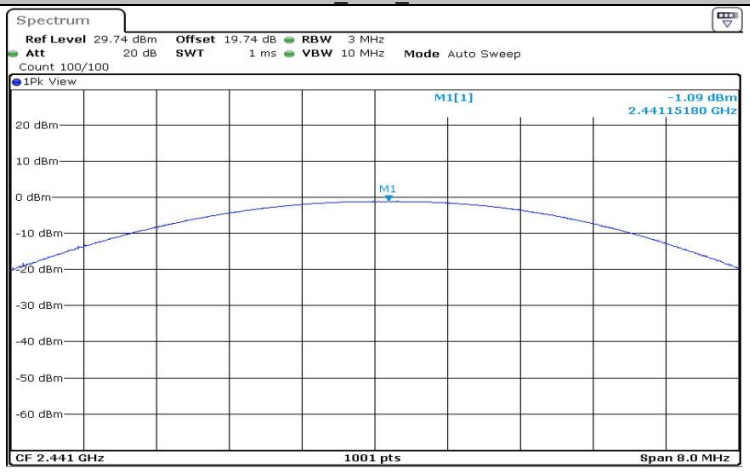
| Test Mode | Antenna | Frequency[MHz] | Conducted Peak Power [dBm] | Conducted Limit [dBm] | Verdict |
|---|---|---|---|---|---|
| DH1 | Ant1 | 2402 | -0.58 | ≤20.97 | PASS |
| | | 2441 | -1.09 | ≤20.97 | PASS |
| | | 2480 | -1.80 | ≤20.97 | PASS |
| 2DH1 | Ant1 | 2402 | -0.10 | ≤20.97 | PASS |
| | | 2441 | -0.69 | ≤20.97 | PASS |
| | | 2480 | -1.39 | ≤20.97 | PASS |
| 3DH1 | Ant1 | 2402 | 0.53 | ≤20.97 | PASS |
| | | 2441 | 0 | ≤20.97 | PASS |
| | | 2480 | -0.70 | ≤20.97 | PASS |

## Test Graphs

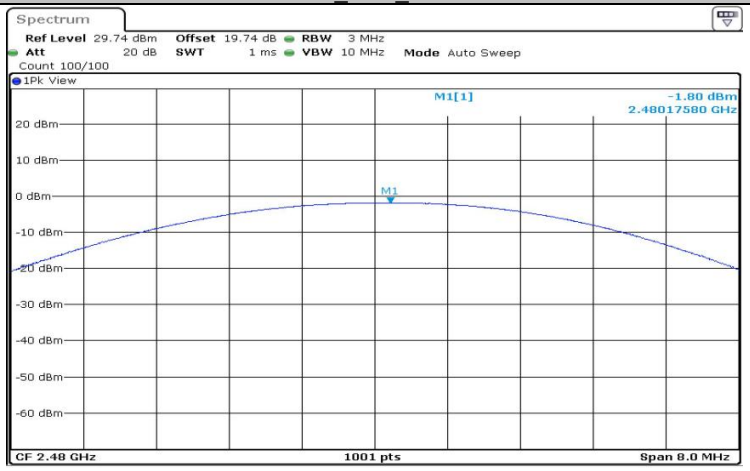
DH1_Ant1_2402



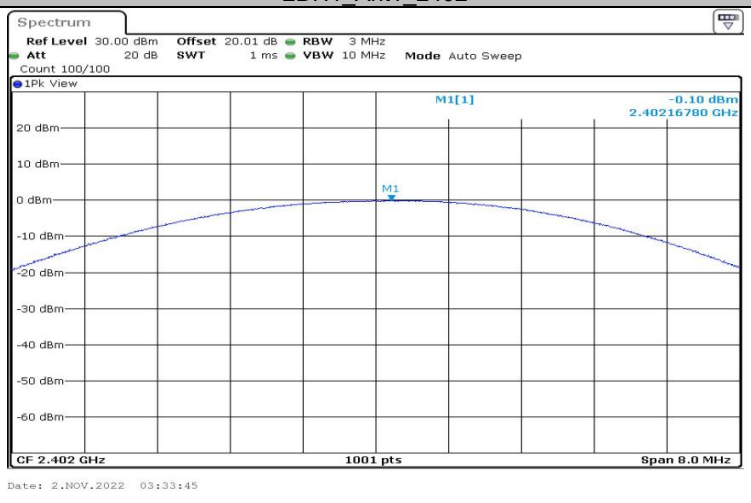

DH1_Ant1_2441



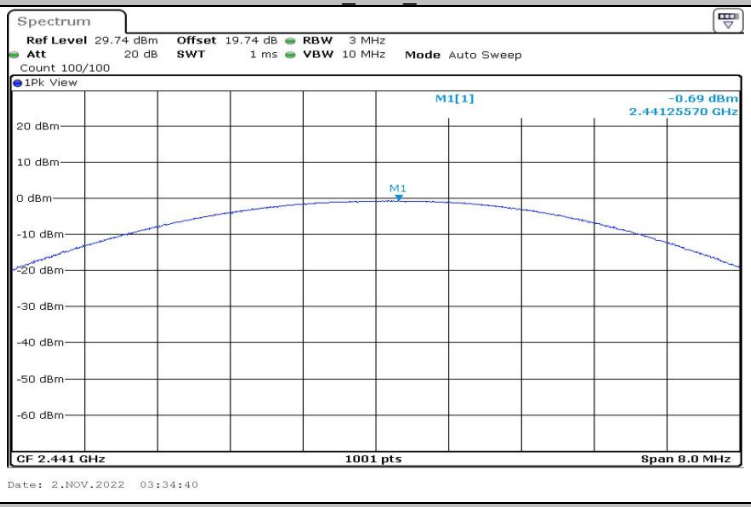

DH1_Ant1_2480



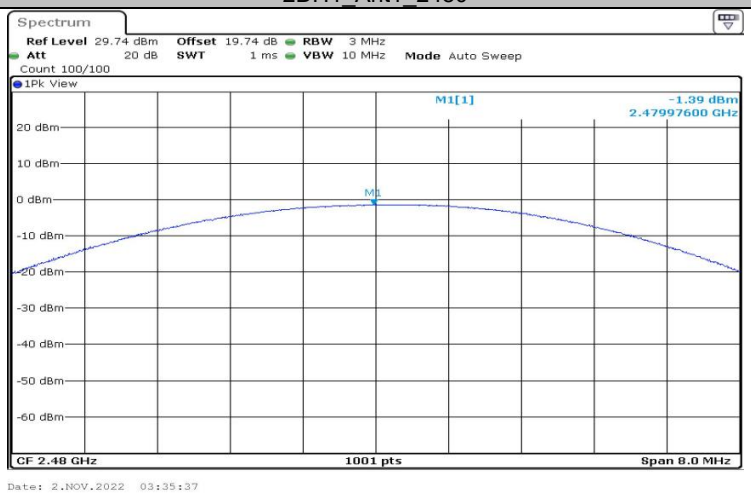
2DH1_Ant1_2402



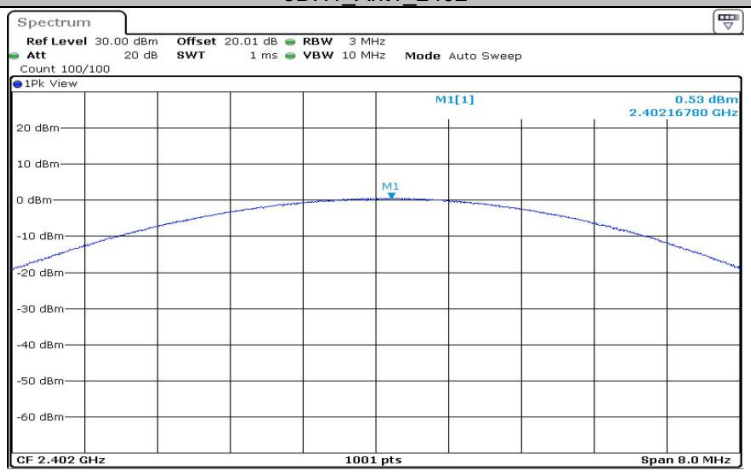

2DH1_Ant1_2441



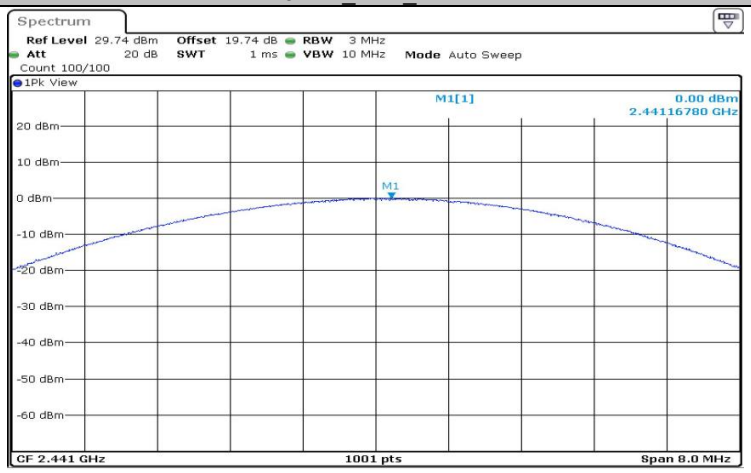

2DH1_Ant1_2480



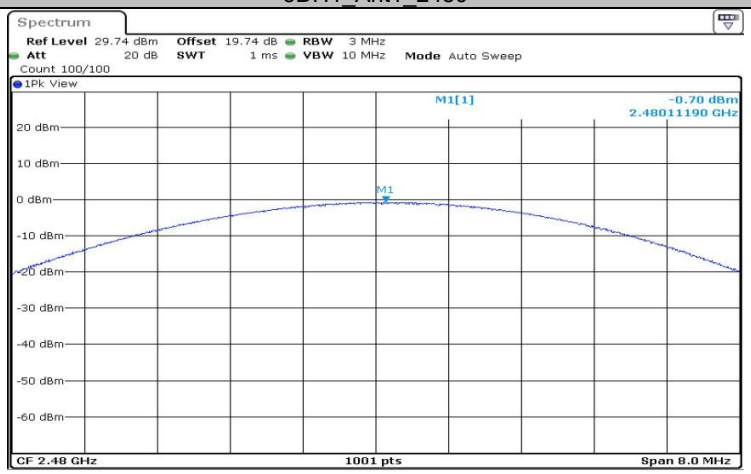
3DH1_Ant1_2402




3DH1_Ant1_2441




3DH1_Ant1_2480



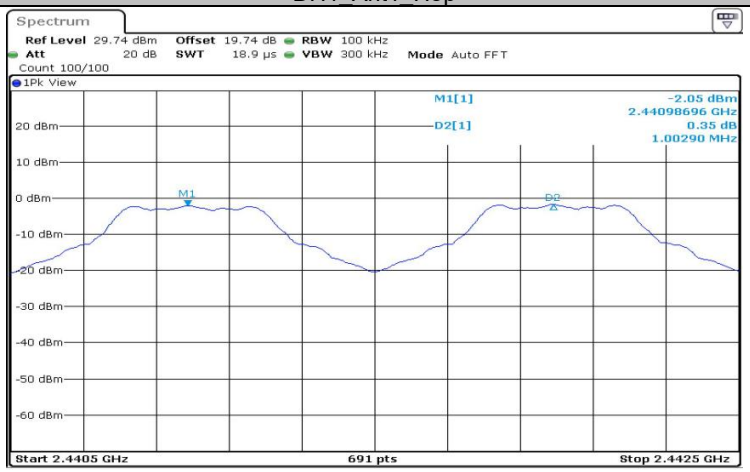
## Appendix D: Carrier frequency separation

### Test Result

| Test Mode | Antenna | Frequency[MHz] | Result[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|
| DH1 | Ant1 | Hop | 1.003 | ≥0.560 | PASS |
| 2DH1 | Ant1 | Hop | 1.003 | ≥0.813 | PASS |
| 3DH1 | Ant1 | Hop | 1.000 | ≥0.813 | PASS |

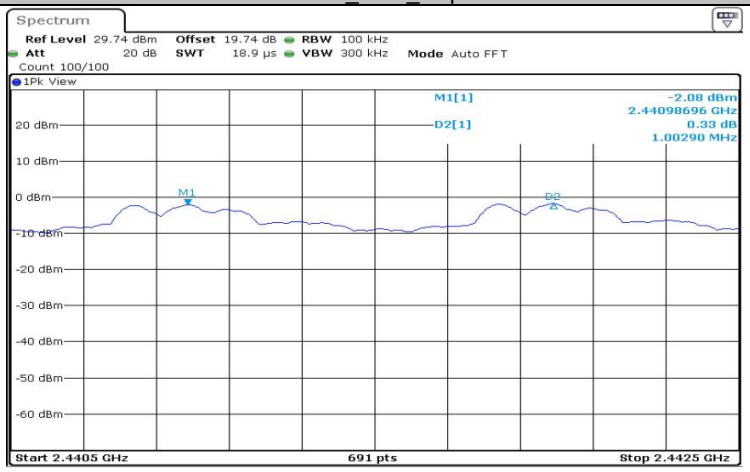
## Test Graphs

DH1_Ant1_Hop



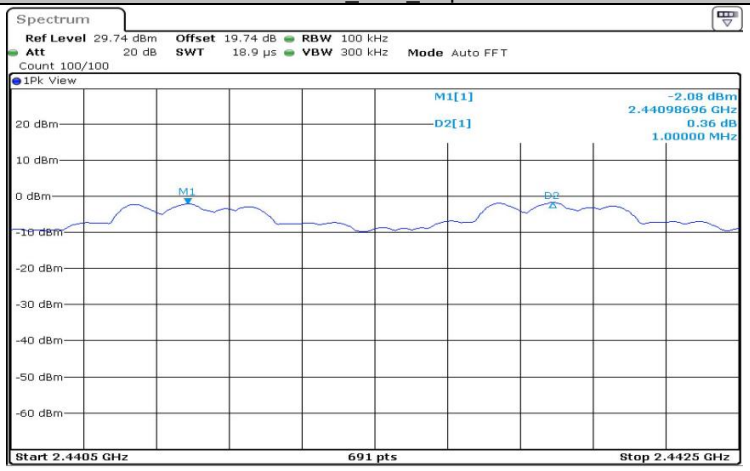

Date: 2.NOV.2022 03:42:35

2DH1_Ant1_Hop




Date: 2.NOV.2022 03:47:30

3DH1_Ant1_Hop




Date: 2.NOV.2022 03:54:56

## Appendix E: Time of occupancy

### Test Result

| Test Mode | Antenna | Frequency[MHz] | BurstWidth [ms] | Total Hops [Num] | Result[s] | Limit[s] | Verdict |
|---|---|---|---|---|---|---|---|
| DH1 | Ant1 | Hop | 0.39 | 320 | 0.125 | ≤0.4 | PASS |
| DH3 | Ant1 | Hop | 1.64 | 150 | 0.246 | ≤0.4 | PASS |
| DH5 | Ant1 | Hop | 2.88 | 130 | 0.374 | ≤0.4 | PASS |
| 2DH1 | Ant1 | Hop | 0.40 | 320 | 0.128 | ≤0.4 | PASS |
| 2DH3 | Ant1 | Hop | 1.65 | 170 | 0.281 | ≤0.4 | PASS |
| 2DH5 | Ant1 | Hop | 2.89 | 110 | 0.318 | ≤0.4 | PASS |
| 3DH1 | Ant1 | Hop | 0.41 | 320 | 0.131 | ≤0.4 | PASS |
| 3DH3 | Ant1 | Hop | 1.65 | 150 | 0.248 | ≤0.4 | PASS |
| 3DH5 | Ant1 | Hop | 2.89 | 110 | 0.318 | ≤0.4 | PASS |

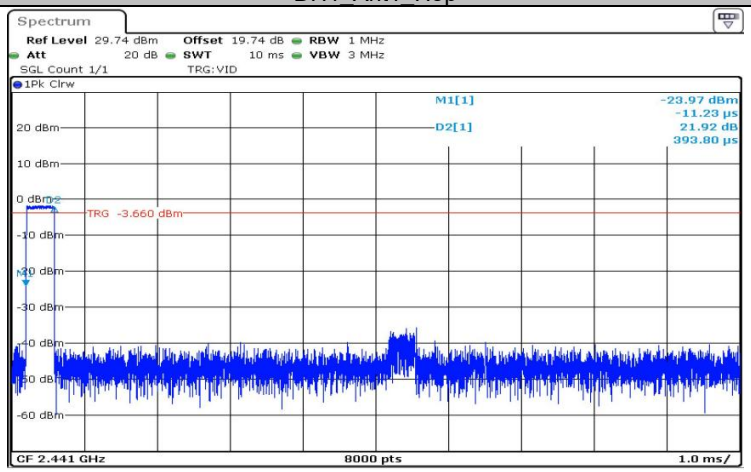
Note 1：A period time=0.4*79=31.6(S), Result=BurstWidth*Totalhops

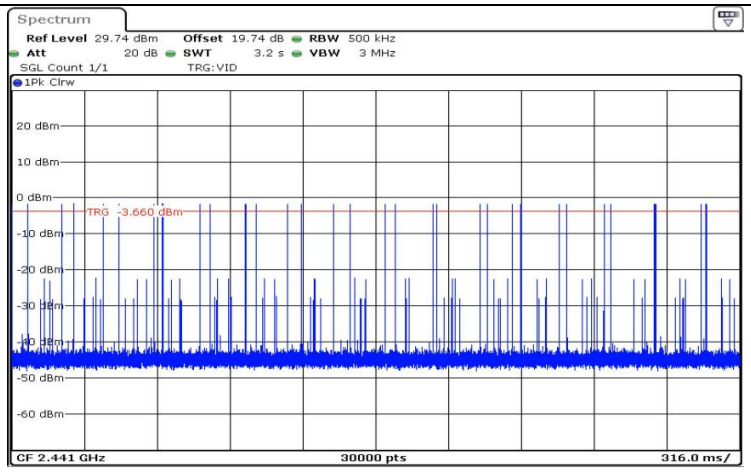
Note 2: Totalhops=Hopping Number in 3.16s*10

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

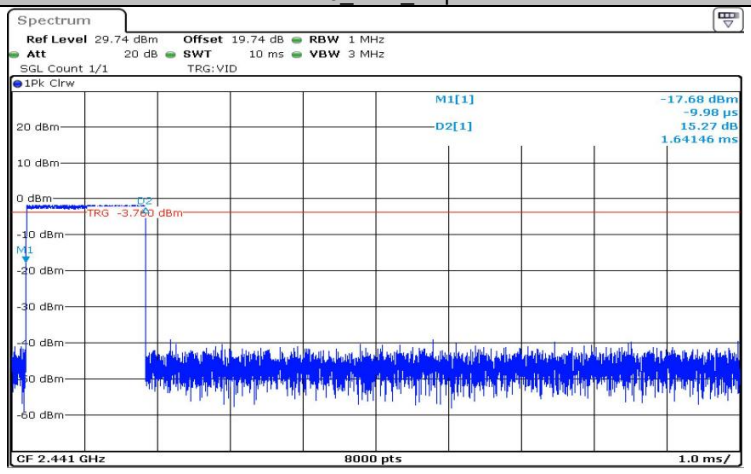
## Test Graphs

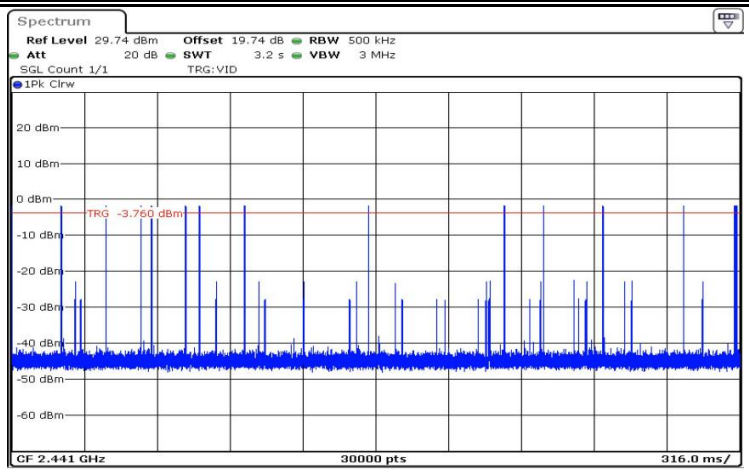
DH1_Ant1_Hop



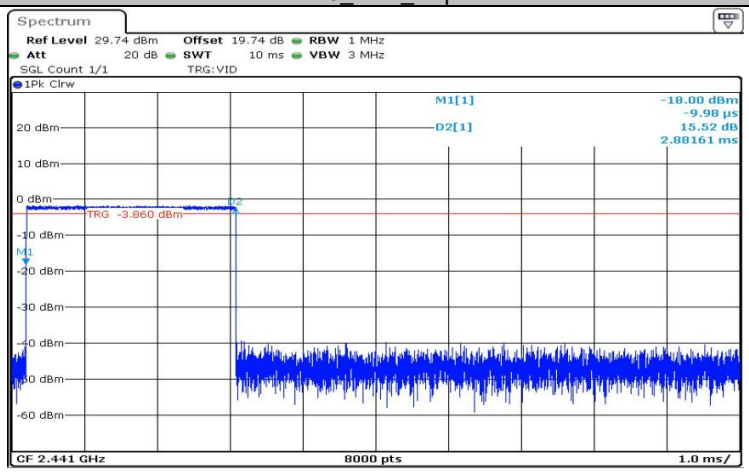



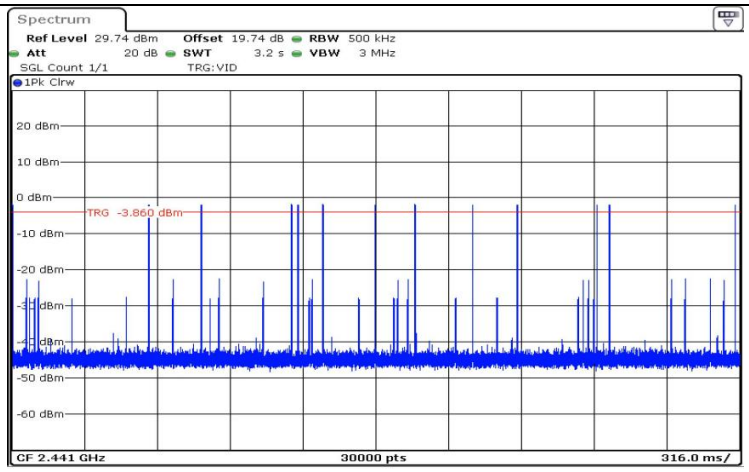

DH3_Ant1_Hop

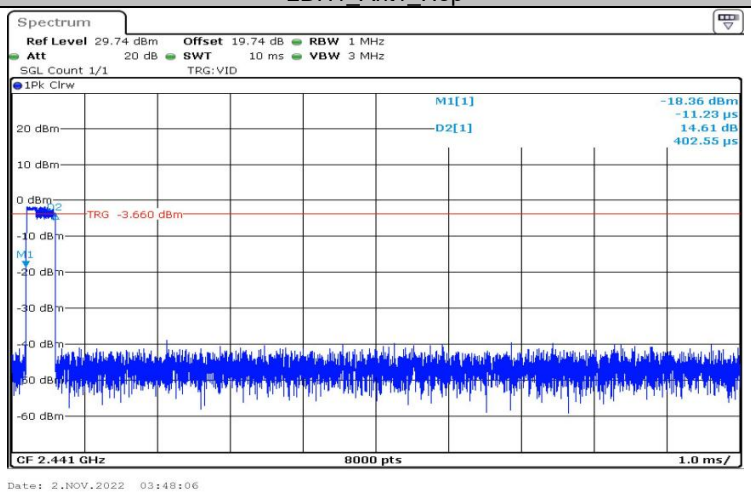
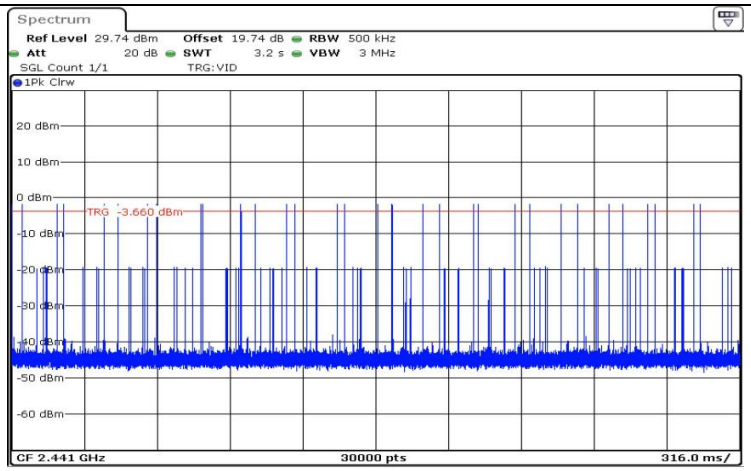
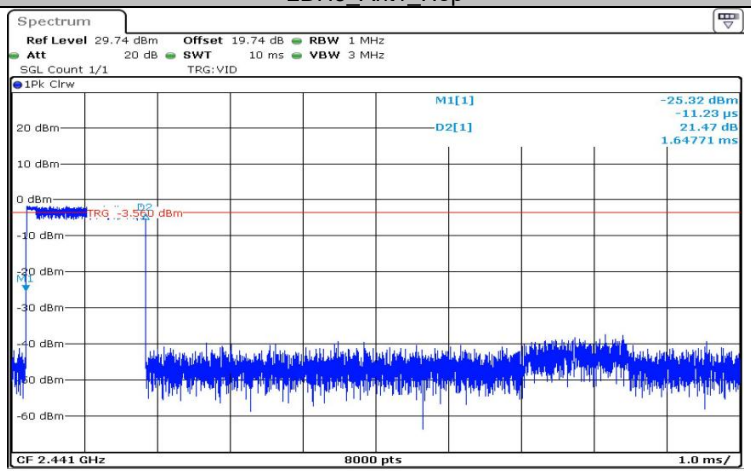


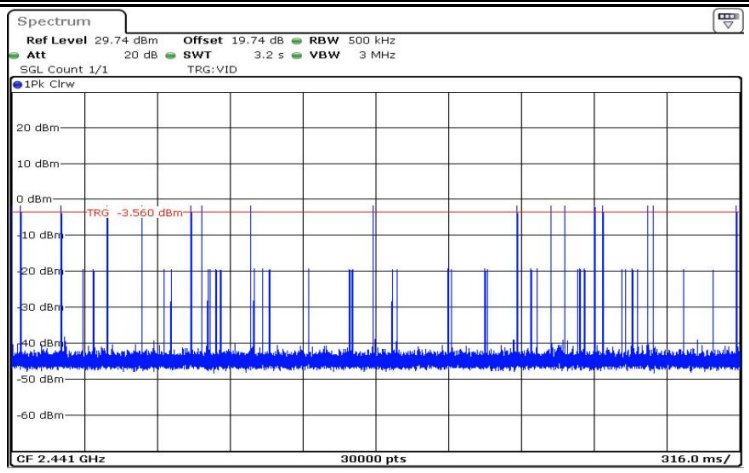

Spectrum
Ref Level 29.74 dBm Offset 19.74 dB RBW 500 kHz
Att 20 dB SWT 3.2 s VBW 3 MHz
SGL Count 1/1 TRG:VID
1Pk Clrw
20 dBm
10 dBm
0 dBm
TRG -3.760 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
30000 pts
316.0 ms/
Date: 2.NOV.2022 03:43:10

DH5_Ant1_Hop

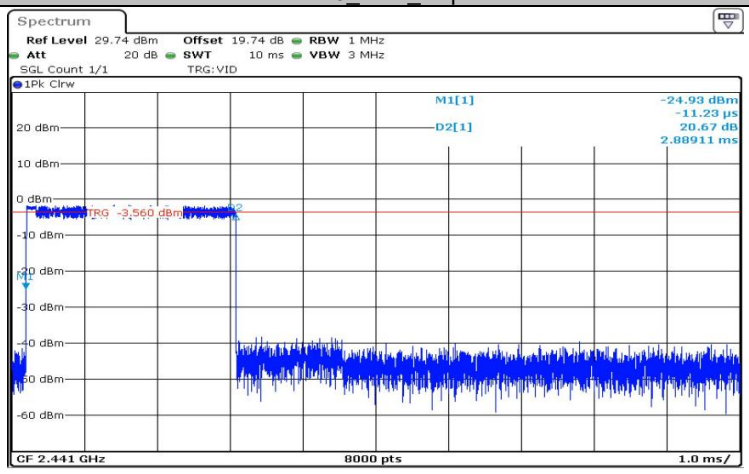

Spectrum
Ref Level 29.74 dBm Offset 19.74 dB RBW 1 MHz
Att 20 dB SWT 10 ms VBW 3 MHz
SGL Count 1/1 TRG:VID
1Pk Clrw
M1[1] -18.00 dBm
-9.98 µs
D2[1] 15.52 dB
2.88161 ms
20 dBm
10 dBm
0 dBm
D2
TRG -3.860 dBm
-10 dBm
M1
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
8000 pts
1.0 ms/
Date: 2.NOV.2022 03:45:44

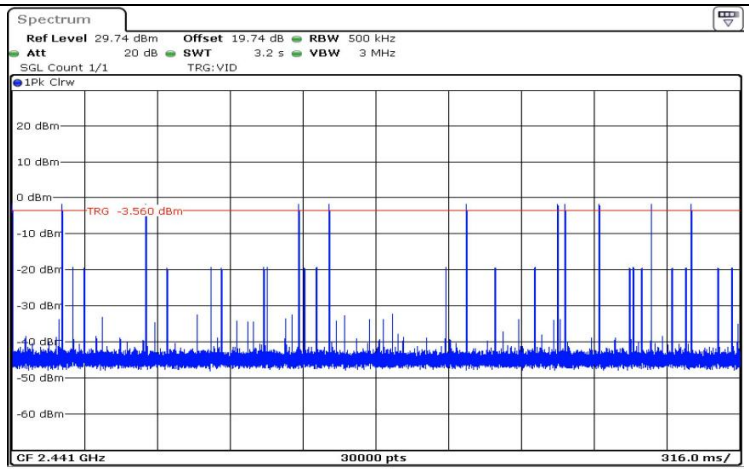

Spectrum
Ref Level 29.74 dBm Offset 19.74 dB RBW 500 kHz
Att 20 dB SWT 3.2 s VBW 3 MHz
SGL Count 1/1 TRG:VID
1Pk Clrw
20 dBm
10 dBm
0 dBm
TRG -3.860 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
CF 2.441 GHz
30000 pts
316.0 ms/
Date: 2.NOV.2022 03:45:49

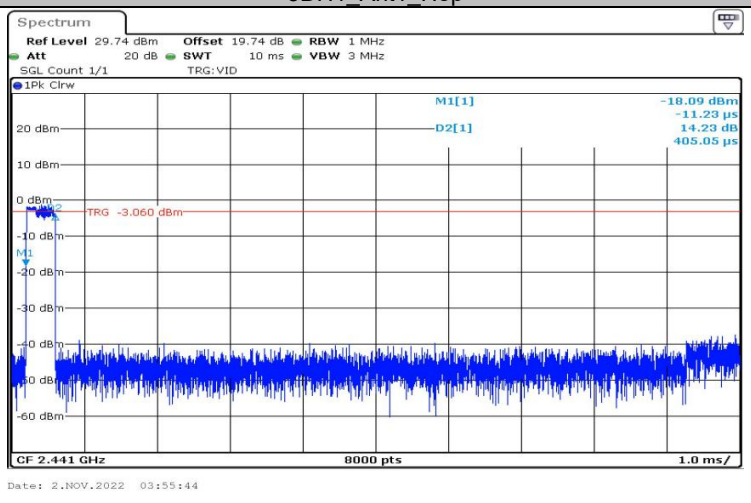
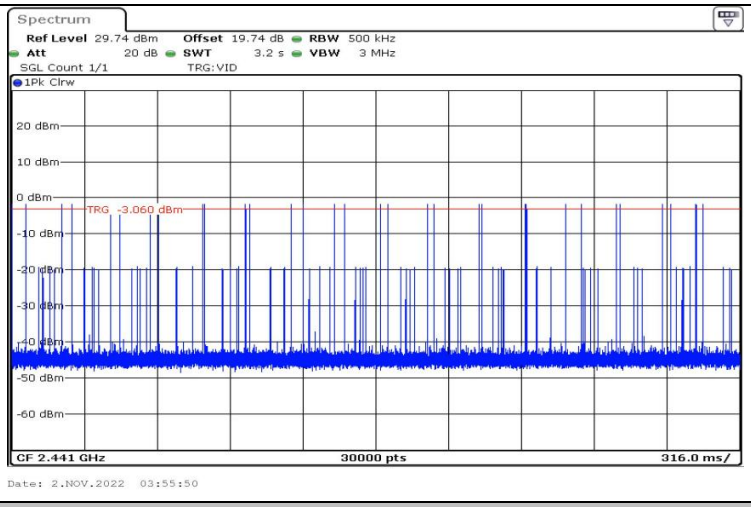
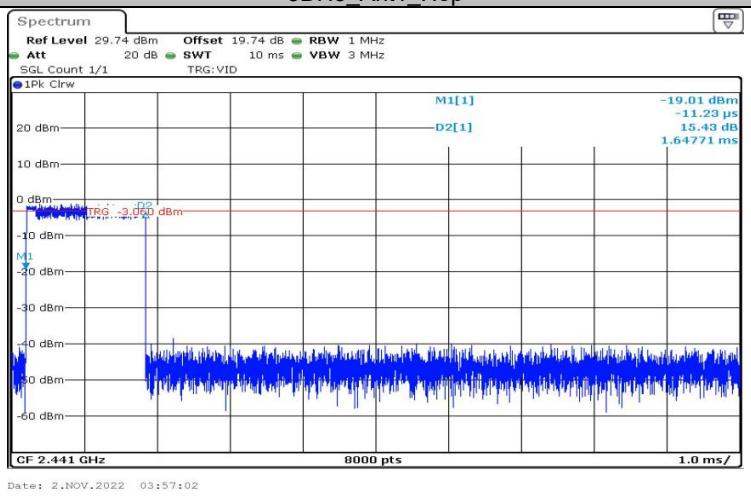
| 2DH1_Ant1_Hop |
| --- |
|  |
|  |
| 2DH3_Ant1_Hop |
|  |

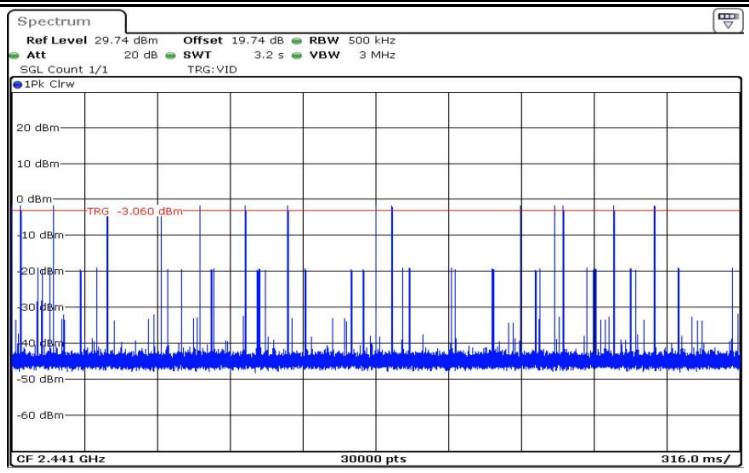



2DH5_Ant1_Hop

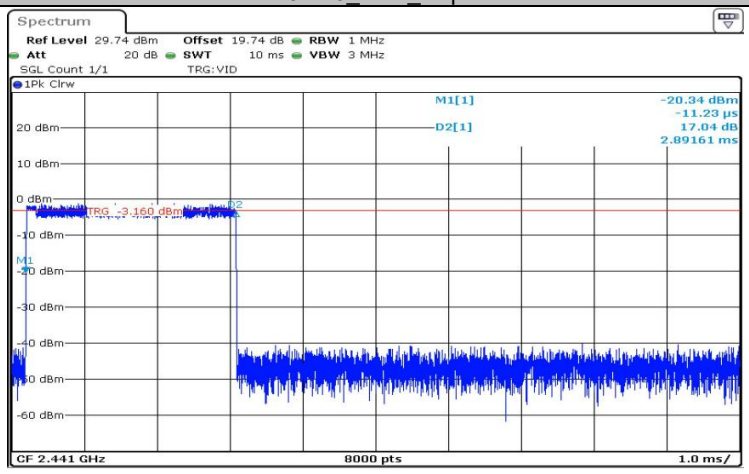


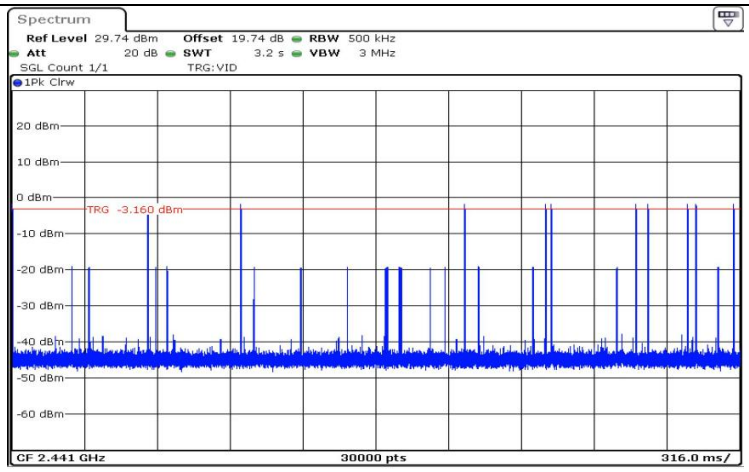



| 3DH1_Ant1_Hop |
| --- |
|  |
|  |
| 3DH3_Ant1_Hop |
|  |




3DH5_Ant1_Hop



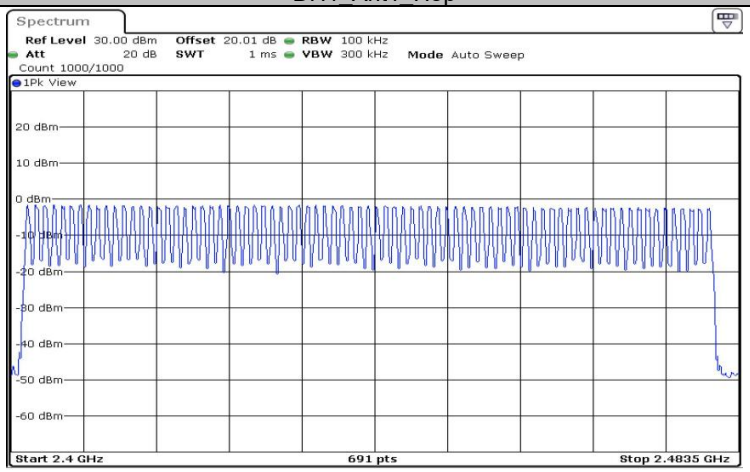
## Appendix F: Number of hopping channels

### Test Result

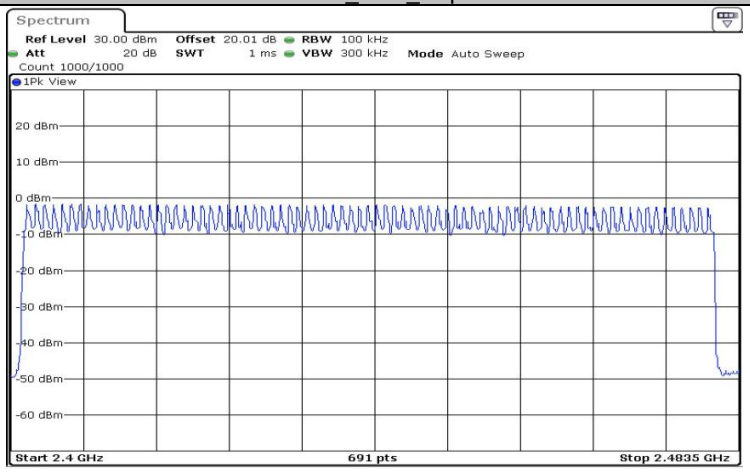
| Test Mode | Antenna | Frequency[MHz] | Result[Num] | Limit[Num] | Verdict |
|---|---|---|---|---|---|
| DH1 | Ant1 | Hop | 79 | ≥15 | PASS |
| 2DH1 | Ant1 | Hop | 79 | ≥15 | PASS |
| 3DH1 | Ant1 | Hop | 79 | ≥15 | PASS |

## Test Graphs

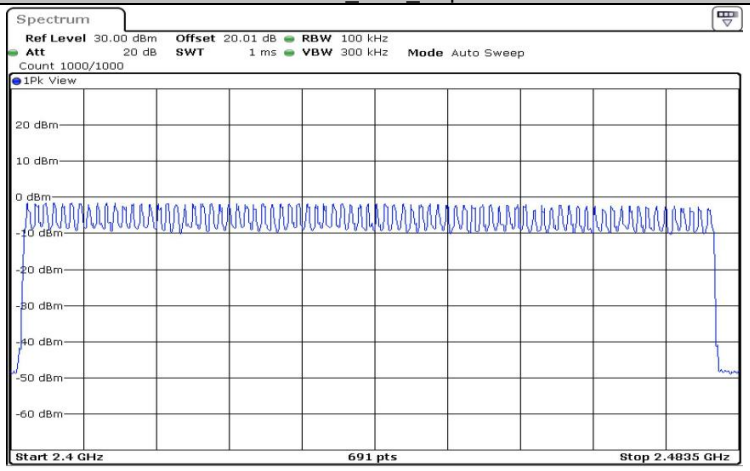
DH1_Ant1_Hop




2DH1_Ant1_Hop



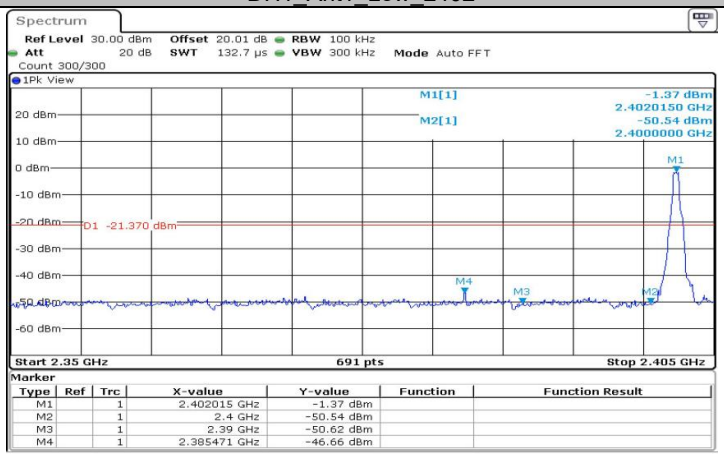

3DH1_Ant1_Hop



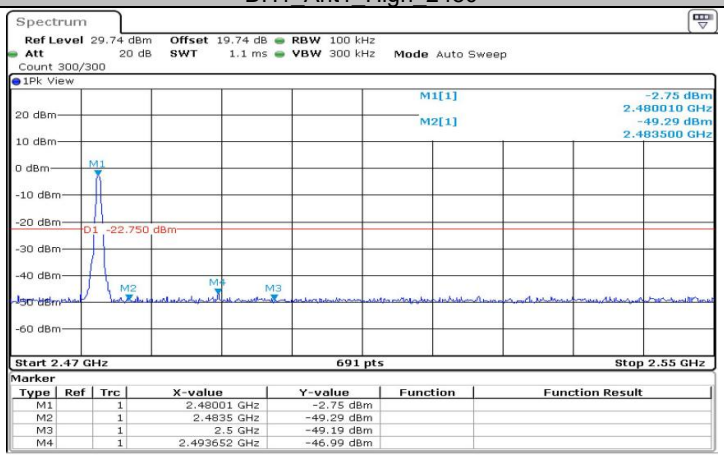
# Appendix G: Band edge measurements

## Test Graphs

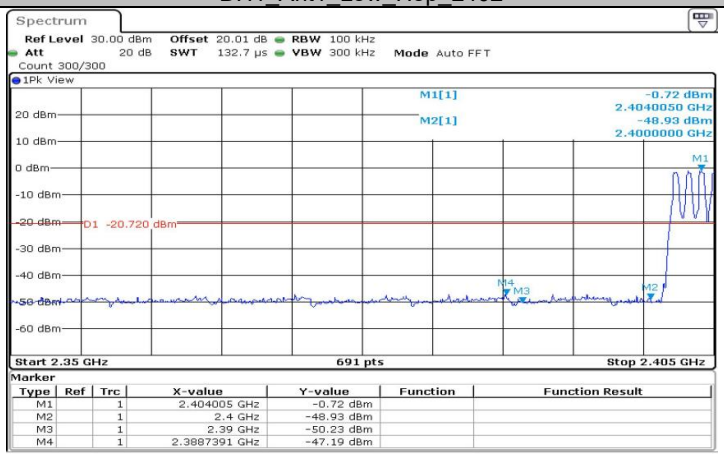
DH1_Ant1_Low_2402



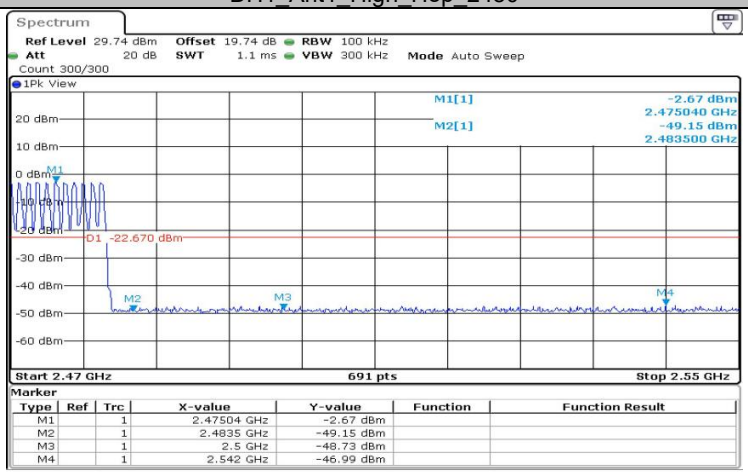

DH1_Ant1_High_2480




DH1_Ant1_Low_Hop_2402



DH1_Ant1_High_Hop_2480

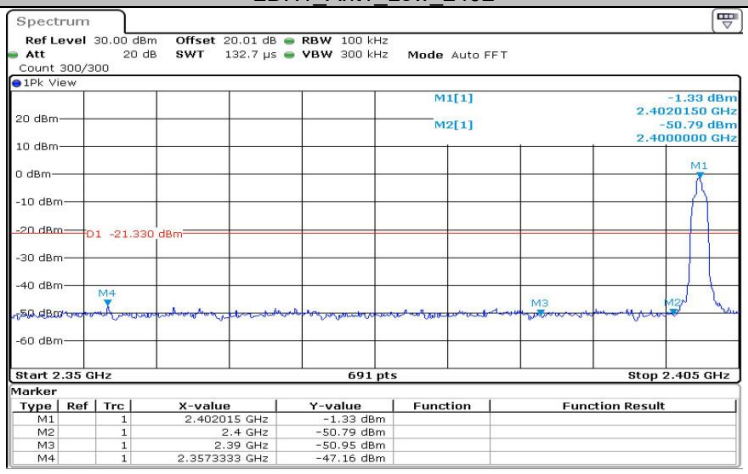



Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.47504 GHz | -2.67 dBm | | |
| M2 | | 1 | 2.4835 GHz | -49.15 dBm | | |
| M3 | | 1 | 2.5 GHz | -48.73 dBm | | |
| M4 | | 1 | 2.542 GHz | -46.99 dBm | | |

Date: 2.NOV.2022 03:41:29

2DH1_Ant1_Low_2402

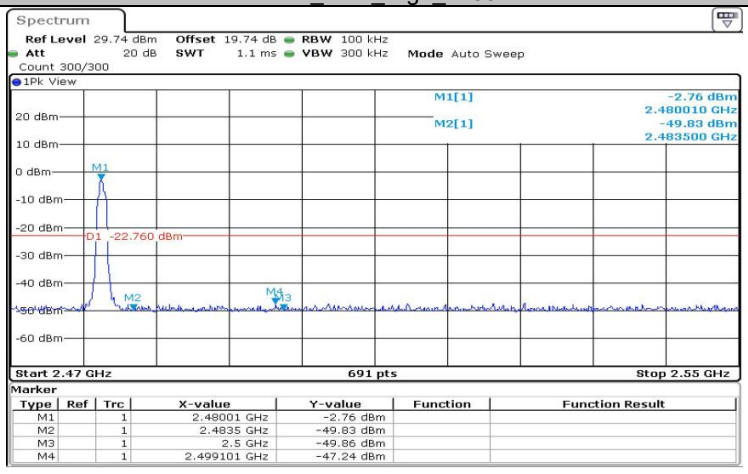



Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.402015 GHz | -1.33 dBm | | |
| M2 | | 1 | 2.4 GHz | -50.79 dBm | | |
| M3 | | 1 | 2.39 GHz | -50.95 dBm | | |
| M4 | | 1 | 2.3573333 GHz | -47.16 dBm | | |

Date: 2.NOV.2022 03:33:37

2DH1_Ant1_High_2480

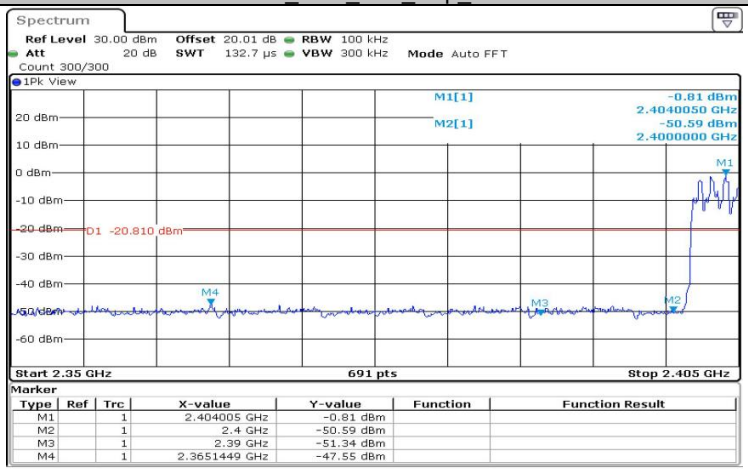



Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.48001 GHz | -2.76 dBm | | |
| M2 | | 1 | 2.4835 GHz | -49.83 dBm | | |
| M3 | | 1 | 2.5 GHz | -49.86 dBm | | |
| M4 | | 1 | 2.499101 GHz | -47.24 dBm | | |

Date: 2.NOV.2022 03:35:29

2DH1_Ant1_Low_Hop_2402

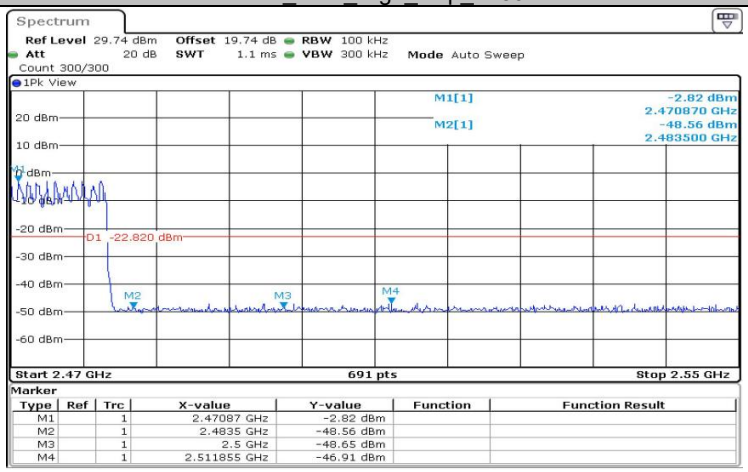



Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.404005 GHz | -0.81 dBm | | |
| M2 | | 1 | 2.4 GHz | -50.59 dBm | | |
| M3 | | 1 | 2.39 GHz | -51.34 dBm | | |
| M4 | | 1 | 2.3651449 GHz | -47.55 dBm | | |

Date: 2.NOV.2022 03:46:24

2DH1_Ant1_High_Hop_2480

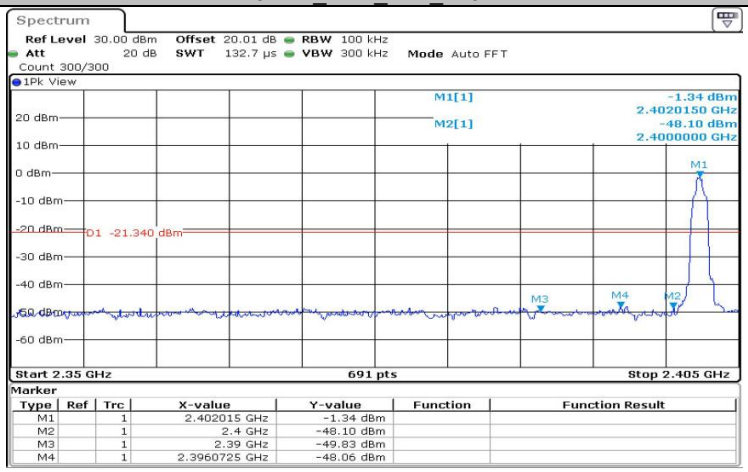



Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.47087 GHz | -2.82 dBm | | |
| M2 | | 1 | 2.4835 GHz | -48.56 dBm | | |
| M3 | | 1 | 2.5 GHz | -48.65 dBm | | |
| M4 | | 1 | 2.511855 GHz | -46.91 dBm | | |

Date: 2.NOV.2022 03:48:29

3DH1_Ant1_Low_2402

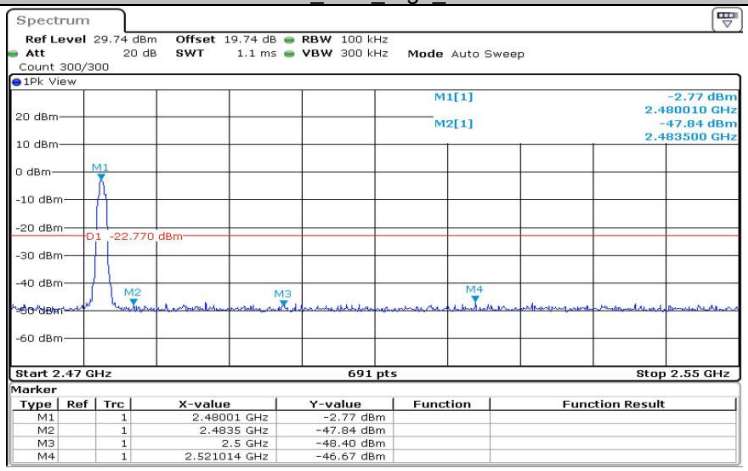



Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.402015 GHz | -1.34 dBm | | |
| M2 | | 1 | 2.4 GHz | -48.10 dBm | | |
| M3 | | 1 | 2.39 GHz | -49.83 dBm | | |
| M4 | | 1 | 2.3960725 GHz | -48.06 dBm | | |

Date: 2.NOV.2022 03:36:29

3DH1_Ant1_High_2480

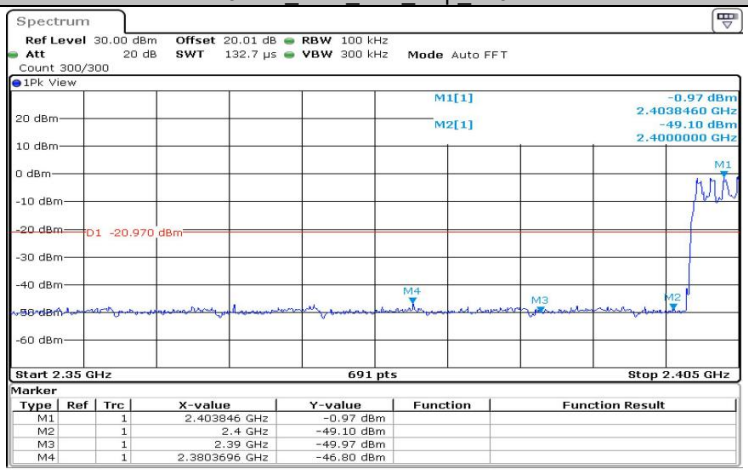



Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.48001 GHz | -2.77 dBm | | |
| M2 | | 1 | 2.4835 GHz | -47.84 dBm | | |
| M3 | | 1 | 2.5 GHz | -48.40 dBm | | |
| M4 | | 1 | 2.521014 GHz | -46.67 dBm | | |

Date: 2.NOV.2022 03:38:34

3DH1_Ant1_Low_Hop_2402

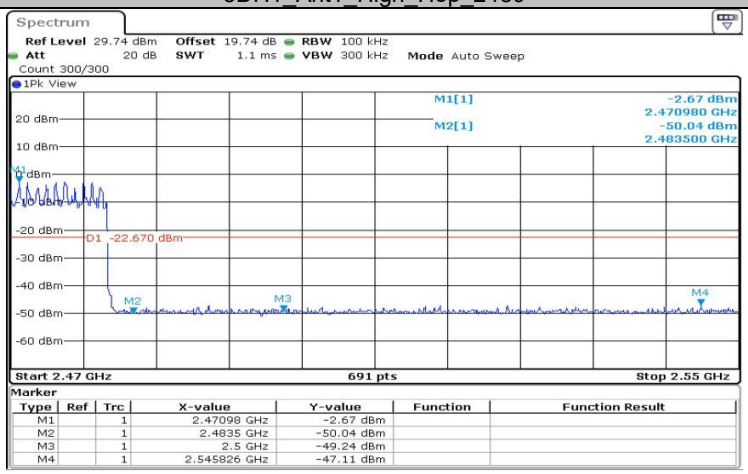



Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.403846 GHz | -0.97 dBm | | |
| M2 | | 1 | 2.4 GHz | -49.10 dBm | | |
| M3 | | 1 | 2.39 GHz | -49.97 dBm | | |
| M4 | | 1 | 2.3803696 GHz | -46.80 dBm | | |

Date: 2.NOV.2022 03:53:50

3DH1_Ant1_High_Hop_2480




Marker

| Type | Ref | Trc | X-value | Y-value | Function | Function Result |
|---|---|---|---|---|---|---|
| M1 | | 1 | 2.47098 GHz | -2.67 dBm | | |
| M2 | | 1 | 2.4835 GHz | -50.04 dBm | | |
| M3 | | 1 | 2.5 GHz | -49.24 dBm | | |
| M4 | | 1 | 2.545826 GHz | -47.11 dBm | | |

Date: 2.NOV.2022 03:56:04

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