

# Test Report

**Report No.:** MTi230414004-01E1

**Date of issue:** 2023-05-08

**Applicant:** Shenzhen Boyi Electronics Co., Ltd.

**Product:** Wireless CarPlay Adapter

**Model(s):** BY960

**FCC ID:** 2A5XO-BY960

Shenzhen Microtest Co., Ltd.

<http://www.mtitest.com>

## Instructions

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2. The test results in this test report are only responsible for the samples submitted
3. This test report is invalid without the seal and signature of the laboratory.
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5. Any objection to this test report shall be submitted to the laboratory within 15 days from the date of receipt of the report.

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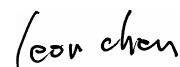
| Test Result Certification  |                                                                                                             |
|----------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>Applicant:</b>          | <b>Shenzhen Boyi Electronics Co., Ltd.</b>                                                                  |
| <b>Address:</b>            | 5F, #Building 5, Longbi Industrial Zone, NO.27 Dafa Road, Bantian Street, Longgang District Shenzhen, China |
| <b>Manufacturer:</b>       | <b>Shenzhen Boyi Electronics Co., Ltd.</b>                                                                  |
| <b>Address:</b>            | 5F, #Building 5, Longbi Industrial Zone, NO.27 Dafa Road, Bantian Street, Longgang District Shenzhen, China |
| <b>Product description</b> |                                                                                                             |
| <b>Product name:</b>       | Wireless CarPlay Adapter                                                                                    |
| <b>Trademark:</b>          | N/A                                                                                                         |
| <b>Model name:</b>         | BY960                                                                                                       |
| <b>Series Model:</b>       | N/A                                                                                                         |
| <b>Standards:</b>          | FCC 47 CFR Part 15 Subpart C                                                                                |
| <b>Test method:</b>        | ANSI C63.10-2013                                                                                            |
| <b>Date of Test</b>        |                                                                                                             |
| <b>Date of test:</b>       | 2023-04-27 ~ 2023-05-06                                                                                     |
| <b>Test result:</b>        | Pass                                                                                                        |

Test Engineer :



(Yanice Xie)

Reviewed By :



(Leon Chen)

Approved By :



(Tom Xue)

## 1 General Description

### 1.1 Description of the EUT

|                                 |                                                     |
|---------------------------------|-----------------------------------------------------|
| Product name:                   | Wireless CarPlay Adapter                            |
| Model name:                     | BY960                                               |
| Series Model:                   | N/A                                                 |
| Model difference:               | N/A                                                 |
| Electrical rating:              | Input: DC 5V                                        |
| Hardware version:               | V2.0                                                |
| Software version:               | V1.0                                                |
| Accessories:                    | N/A                                                 |
| Test sample(s) number:          | MTi230414004-01S1001                                |
| <b>RF specification:</b>        |                                                     |
| Bluetooth version:              | V5.0                                                |
| Operation frequency:            | 2402 MHz ~ 2480 MHz                                 |
| Modulation type:                | GFSK, $\pi/4$ -DQPSK, 8DPSK                         |
| Antenna(s) information:         | Antenna type: FPC antenna<br>Antenna gain: 3.09 dBi |
| Maximum conducted output power: | 4.64 dBm                                            |

### 1.2 Description of test modes

#### 1.2.1 Operation channel list

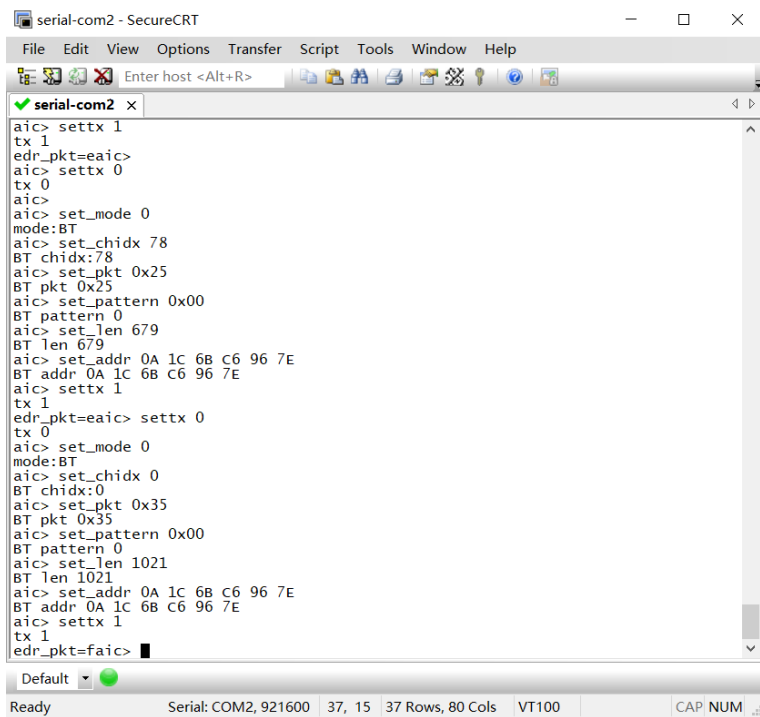
| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| 0       | 2402            | 20      | 2422            | 40      | 2442            | 60      | 2462            |
| 1       | 2403            | 21      | 2423            | 41      | 2443            | 61      | 2463            |
| 2       | 2404            | 22      | 2424            | 42      | 2444            | 62      | 2464            |
| 3       | 2405            | 23      | 2425            | 43      | 2445            | 63      | 2465            |
| 4       | 2406            | 24      | 2426            | 44      | 2446            | 64      | 2466            |
| 5       | 2407            | 25      | 2427            | 45      | 2447            | 65      | 2467            |
| 6       | 2408            | 26      | 2428            | 46      | 2448            | 66      | 2468            |
| 7       | 2409            | 27      | 2429            | 47      | 2449            | 67      | 2469            |
| 8       | 2410            | 28      | 2430            | 48      | 2450            | 68      | 2470            |
| 9       | 2411            | 29      | 2431            | 49      | 2451            | 69      | 2471            |
| 10      | 2412            | 30      | 2432            | 50      | 2452            | 70      | 2472            |
| 11      | 2413            | 31      | 2433            | 51      | 2453            | 71      | 2473            |
| 12      | 2414            | 32      | 2434            | 52      | 2454            | 72      | 2474            |

| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| 13      | 2415            | 33      | 2435            | 53      | 2455            | 73      | 2475            |
| 14      | 2416            | 34      | 2436            | 54      | 2456            | 74      | 2476            |
| 15      | 2417            | 35      | 2437            | 55      | 2457            | 75      | 2477            |
| 16      | 2418            | 36      | 2438            | 56      | 2458            | 76      | 2478            |
| 17      | 2419            | 37      | 2439            | 57      | 2459            | 77      | 2479            |
| 18      | 2420            | 38      | 2440            | 58      | 2460            | 78      | 2480            |
| 19      | 2421            | 39      | 2441            | 59      | 2461            | -       | -               |

**Note:** The test software provided by manufacturer is used to control EUT for working in engineering mode, that enables selectable channel, and capable of continuous transmitting mode.

| Mode           | Test Software | SecureCRT 8.1 |         |         |
|----------------|---------------|---------------|---------|---------|
|                | Channel       | 2402MHz       | 2441MHz | 2480MHz |
| GFSK           | Power setting | Default       | Default | Default |
| $\pi/4$ -DQPSK |               | Default       | Default | Default |
| 8DPSK          |               | Default       | Default | Default |

### The test software:



```

serial-com2 - SecureCRT
File Edit View Options Transfer Script Tools Window Help
Enter host <Alt+R>
serial-com2 x
aic> settx 1
tx 1
edr_pkt=eaic>
aic> settx 0
tx 0
aic>
aic> set_mode 0
mode:BT
aic> set_chidx 78
BT chidx:78
aic> set_pkt 0x25
BT pkt 0x25
aic> set_pattern 0x00
BT pattern 0
aic> set_len 679
BT len 679
aic> set_addr 0A 1C 6B C6 96 7E
BT addr 0A 1C 6B C6 96 7E
aic> settx 1
tx 1
edr_pkt=eaic> settx 0
tx 0
aic> set_mode 0
mode:BT
aic> set_chidx 0
BT chidx:0
aic> set_pkt 0x35
BT pkt 0x35
aic> set_pattern 0x00
BT pattern 0
aic> set_len 1021
BT len 1021
aic> set_addr 0A 1C 6B C6 96 7E
BT addr 0A 1C 6B C6 96 7E
aic> settx 1
tx 1
edr_pkt=faic>
Default
Ready Serial: COM2, 921600 37, 15 37 Rows, 80 Cols VT100 CAP NUM
  
```

### 1.3 Test conditions

Environment of test site:

|              |                   |
|--------------|-------------------|
| Temperature: | 15°C~35°C         |
| Humidity:    | 20 % RH ~ 75 % RH |

### 1.4 Description of support units

| Support equipment list |            |            |              |
|------------------------|------------|------------|--------------|
| Description            | Model      | Serial No. | Manufacturer |
| NOTEBOOK               | /          | /          | XIAOMI       |
| Support cable list     |            |            |              |
| Description            | Length (m) | From       | To           |
| /                      | /          | /          | /            |

## 2 Measurement uncertainty

| Parameter                                       | Measurement uncertainty |
|-------------------------------------------------|-------------------------|
| AC power line conducted emission (9 kHz~30 MHz) | $\pm 2.5$ dB            |
| Occupied Bandwidth                              | $\pm 3$ %               |
| Conducted RF output power                       | $\pm 0.16$ dB           |
| Conducted spurious emissions                    | $\pm 0.21$ dB           |
| Radiated emission (9 kHz ~ 30 MHz)              | $\pm 4.0$ dB            |
| Radiated emission (30 MHz~1 GHz)                | $\pm 4.2$ dB            |
| Radiated emission (above 1 GHz)                 | $\pm 4.3$ dB            |

**Note:** the measurement uncertainty is calculated and correspond to a factor  $k = 2$  (which provide confidence levels of 95.45 %)

### 3 Summary of Test Result

| No. | FCC reference                  | Description of test               | Result |
|-----|--------------------------------|-----------------------------------|--------|
| 1   | § 15.203                       | Antenna requirement               | Pass   |
| 2   | § 15.207                       | AC power line conducted emissions | N/A    |
| 3   | § 15.247(d),<br>15.209, 15.205 | Radiated spurious emissions       | Pass   |
| 4   | § 15.247(a)(1)                 | 20dB emission bandwidth           | Pass   |
| 5   | § 15.247(b)(1)                 | Maximum conducted output power    | Pass   |
| 6   | § 15.247(a)(1)                 | Carrier Frequencies Separation    | Pass   |
| 7   | § 15.247(a)(1)                 | Time of occupancy                 | Pass   |
| 8   | § 15.247(a)(1)                 | Number of hopping channels        | Pass   |
| 9   | § 15.247(d)                    | Band edge (Conducted)             | Pass   |
| 10  | § 15.247(d)                    | Conducted spurious emissions      | Pass   |

**Notes:**

N/A means not applicable.

The the EUT is not intended to be connected to AC mains power. Therefore, this test is not applicable.

## 4 Test Laboratory

|                        |                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Test laboratory:       | Shenzhen Microtest Co., Ltd.                                                                                                         |
| Test site location:    | 101, No.7, Zone 2, Xinxing Industrial Park, Fuhai Avenue, Xinhe Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China |
| Telephone:             | (86-755)88850135                                                                                                                     |
| Fax:                   | (86-755)88850136                                                                                                                     |
| CNAS Registration No.: | CNAS L5868                                                                                                                           |
| FCC Registration No.:  | 448573                                                                                                                               |

## 5 Equipment List

| No.       | Equipment                | Manufacturer    | Model                  | Serial No.   | Cal. date  | Cal. Due   |
|-----------|--------------------------|-----------------|------------------------|--------------|------------|------------|
| MTi-E002  | EMI Test Receiver        | R&S             | ESCI3                  | 101368       | 2023/04/26 | 2024/04/25 |
| MTi-E023  | Artificial power network | Schwarzbeck     | NSLK8127               | NSLK8127#841 | 2022/05/05 | 2023/05/04 |
| MTi-E023  | Artificial power network | Schwarzbeck     | NSLK8127               | NSLK8127#841 | 2023/05/04 | 2024/05/03 |
| MTi-E025  | Artificial power network | Schwarzbeck     | NSLK8127               | 8127183      | 2023/04/26 | 2024/04/25 |
| MTi-E043  | EMI test receiver        | R&S             | ESCI7                  | 101166       | 2023/04/26 | 2024/04/25 |
| MTi-E046  | Active Loop Antenna      | Schwarzbeck     | FMZB 1519 B            | 00044        | 2021/05/30 | 2024/05/29 |
| MTi-E044  | Broadband antenna        | Schwarzbeck     | VULB9163               | 9163-1338    | 2021/05/30 | 2024/05/29 |
| MTi-E045  | Horn antenna             | Schwarzbeck     | BBHA9120D              | 9120D-2278   | 2021/05/30 | 2024/05/29 |
| MTi-E047  | Pre-amplifier            | Hewlett-Packard | 8447F                  | 3113A06184   | 2023/04/26 | 2024/04/25 |
| MTi-E048  | Pre-amplifier            | Agilent         | 8449B                  | 3008A01120   | 2022/05/05 | 2023/05/04 |
| MTi-E048  | Pre-amplifier            | Agilent         | 8449B                  | 3008A01120   | 2023/05/04 | 2024/05/03 |
| MTi-E120  | Broadband antenna        | Schwarzbeck     | VULB9163               | 9163-1419    | 2021/05/30 | 2024/05/29 |
| MTi-E121  | Pre-amplifier            | Hewlett-Packard | 8447D                  | 2944A09365   | 2022/05/05 | 2023/05/04 |
| MTi-E123  | Pre-amplifier            | Agilent         | 8449B                  | 3008A04723   | 2022/05/05 | 2023/05/04 |
| MTi-E121  | Pre-amplifier            | Hewlett-Packard | 8447D                  | 2944A09365   | 2023/05/04 | 2024/05/03 |
| MTi-E123  | Pre-amplifier            | Agilent         | 8449B                  | 3008A04723   | 2023/05/04 | 2024/05/03 |
| MTi-E135  | Horn antenna             | Schwarzbeck     | BBHA 9170              | 00987        | 2021/05/30 | 2024/05/29 |
| MTi-E136  | Pre-amplifier            | Space-Dtronics  | EWLAN1840G-G45         | 210405001    | /          | /          |
| MTi-E062  | PXA Signal Analyzer      | Agilent         | N9030A                 | MY51350296   | 2023/04/25 | 2024/04/24 |
| MTi-E067  | RF Control Unit          | Tonscend        | JS0806-1               | 19D8060152   | 2023/04/26 | 2024/04/25 |
| MTi-E068  | RF Control Unit          | Tonscend        | JS0806-2               | 19D8060153   | 2023/04/26 | 2024/04/25 |
| MTi-E069  | Band Reject Filter Group | Tonscend        | JS0806-F               | 19D8060160   | 2022/05/05 | 2023/05/04 |
| MTi-E069  | Band Reject Filter Group | Tonscend        | JS0806-F               | 19D8060160   | 2023/05/04 | 2024/05/03 |
| MTi-E010S | EMI Measurement Software | Farad           | EZ-EMC Ver. EMEC-3A1   | /            | /          | /          |
| MTi-E014S | RF Test System           | Tonscend        | TS@JS1120 V2.6.88.0330 | /            | /          | /          |

**Note:** the calibration interval of the test equipment is 12 or 24 months and the calibrations are traceable to international system unit(SI)

## 6 Test Result

### 6.1 Antenna requirement

§ 15.203 requirement: 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

#### Description of the antenna of EUT

The antenna of the EUT is permanently attached.

#### Conclusion:

The EUT complies with the requirement of § 15.203.

## 6.2 AC power line conducted emissions

### 6.2.1 Limits

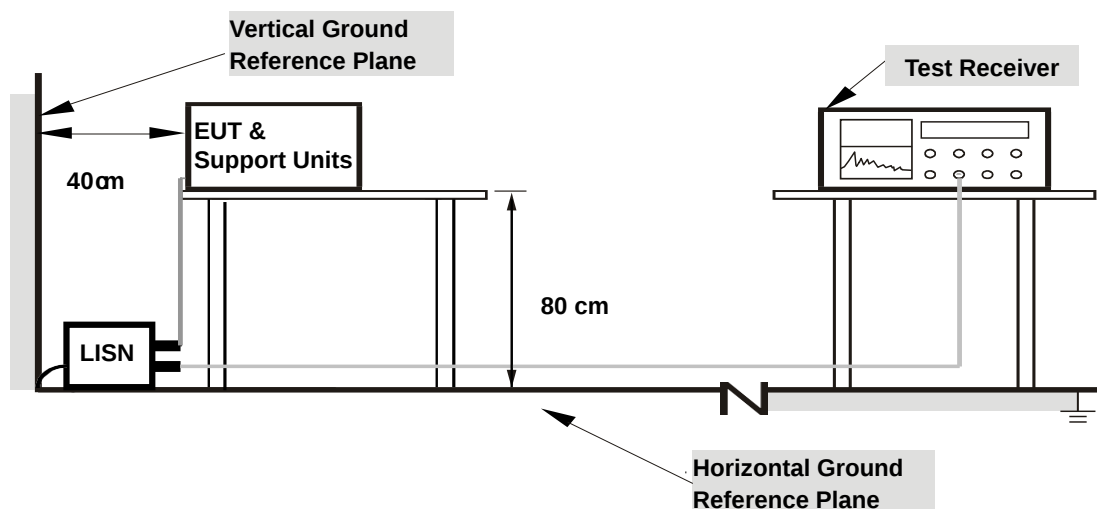
| Frequency (MHz) | Detector type / Bandwidth | Limit-Quasi-peak dB $\mu$ V | Limit-Average dB $\mu$ V |
|-----------------|---------------------------|-----------------------------|--------------------------|
| 0.15 -0.5       | Average / 9 kHz           | 66 to 56                    | 56 to 46                 |
| 0.5 -5          |                           | 56                          | 46                       |
| 5 -30           |                           | 60                          | 50                       |

**Note 1:** the limit decreases with the logarithm of the frequency in the range of 0.15 MHz to 0.5 MHz.

### 6.2.2 Test Procedures

- Test method: ANSI C63.10-2013 Section 6.2.
- The EUT is connected to the main power through a line impedance stabilization network (LISN). All support equipment is powered from additional LISN(s).
- Emissions were measured on each current carrying line of the EUT using an EMI test receiver connected to the LISN powering the EUT.
- The test receiver scanned from 150 kHz to 30 MHz for emissions in each of the test modes described in Item 1.2.
- The test data of the worst-case condition(s) was recorded.

### 6.2.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the test setup.

### 6.2.4 Test Result

#### Notes:

N/A means not applicable.

The EUT is not intended to be connected to AC mains power. Therefore, this test is not applicable.

## 6.3 Radiated spurious emission

### 6.3.1 Limits

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

§ 15.209 Radiated emission limits; general requirements.

| Frequency<br>(MHz) | Field strength<br>(microvolts/meter) | Measurement distance<br>(meters) |
|--------------------|--------------------------------------|----------------------------------|
| 0.009-0.490        | 2400/F(kHz)                          | 300                              |
| 0.490-1.705        | 24000/F(kHz)                         | 30                               |
| 1.705-30.0         | 30                                   | 30                               |
| 30-88              | 100                                  | 3                                |
| 88-216             | 150                                  | 3                                |
| 216-960            | 200                                  | 3                                |
| Above 960          | 500                                  | 3                                |

**Note 1:** the tighter limit applies at the band edges.

**Note 2:** the emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector

§ 15.35 (b) requirements:

When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§ 15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

According to ANSI C63.10-2013, the tests shall be performed in the frequency range shown in the following table:

**Frequency range of measurements for unlicensed wireless device**

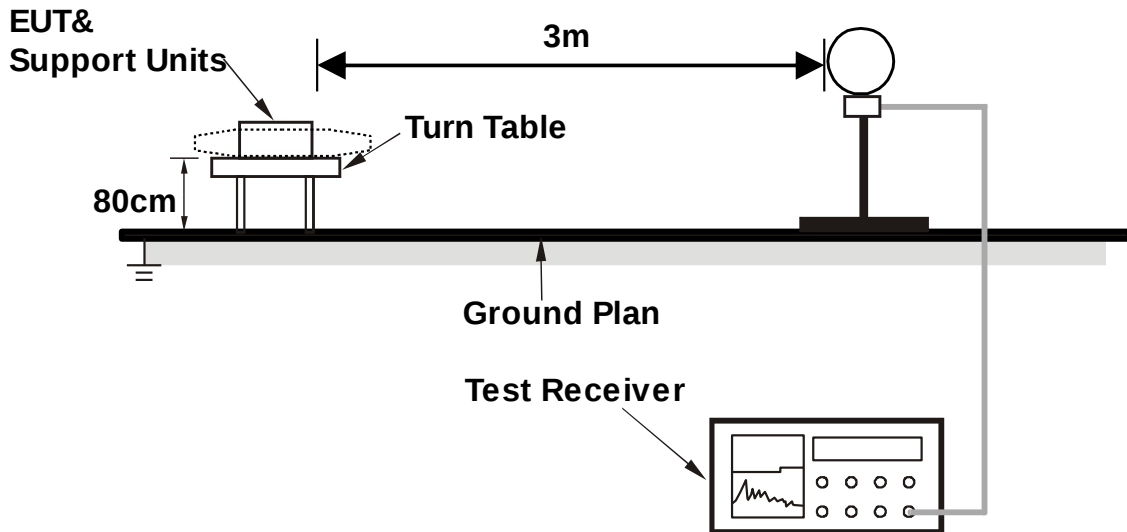
| Lowest frequency generated in the device | Upper frequency range of measurement                                                                        |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| 9 kHz to below 10 GHz                    | 10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower                             |
| At or above 10 GHz to below 30 GHz       | 5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower                             |
| At or above 30 GHz                       | 5th harmonic of highest fundamental frequency or to 200 GHz, whichever is lower, unless otherwise specified |

**Frequency range of measurements for unlicensed wireless device with digital device**

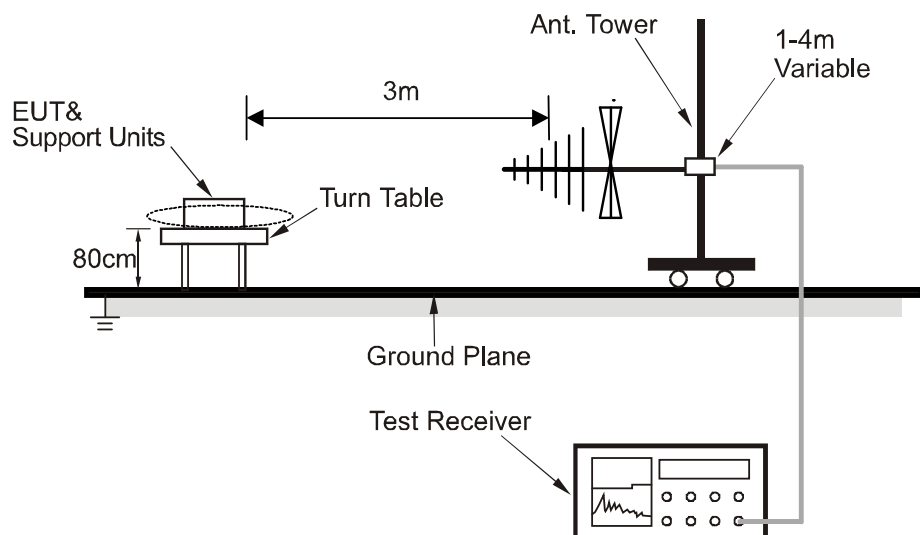
| Highest frequency generated or used in the device or on which the device operates or tunes | Upper frequency range of measurement                                |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| Below 1.705 MHz                                                                            | 30 MHz                                                              |
| 1.705 MHz to 108 MHz                                                                       | 1000 MHz                                                            |
| 108 MHz to 500 MHz                                                                         | 2000 MHz                                                            |
| 500 MHz to 1000 MHz                                                                        | 5000 MHz                                                            |
| Above 1000 MHz                                                                             | 5th harmonic of the highest frequency or 40 GHz, whichever is lower |

### 6.3.2 Test setup

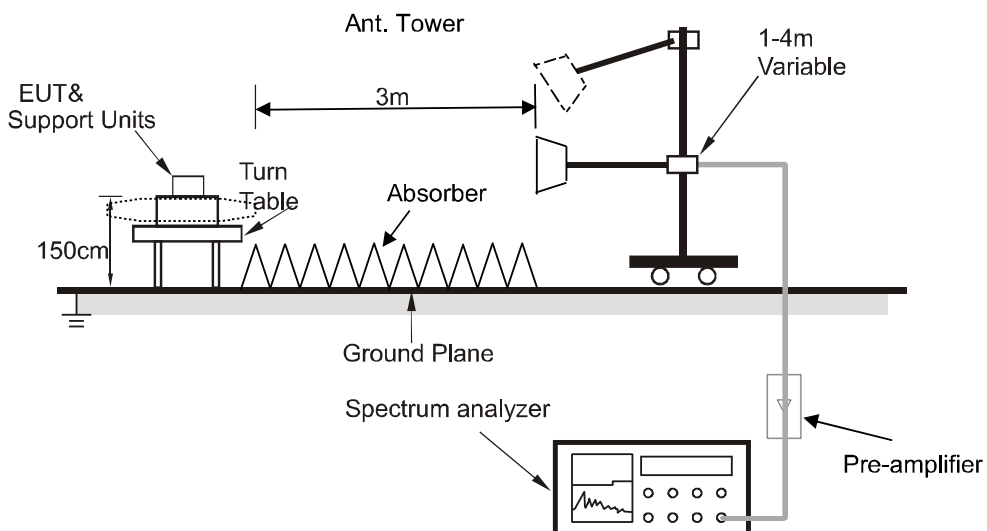
Below 30MHz



30MHz~1GHz



Above 1GHz



For the actual test configuration, please refer to the related item – Photographs of the test setup.

### 6.3.3 Test procedure

- a) Test method: ANSI C63.10-2013 Section 6.3, 6.4, 6.5, 6.6, 6.10.
- b) The EUT is placed on an on-conducting table 0.8 meters above the ground plane for measurement below 1GHz, 1.5 meters above the ground plane for measurement above 1GHz.
- c) Emission below 18 GHz were measured at a 3 meters test distance, above 18 GHz were measured at 1-meter test distance with the application of a distance correction factor
- d) The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

KDB 558074 D01 15.247 Meas Guidance v05r02

The use of a duty cycle correction factor (DCCF) is permitted for calculating average radiated field strength emission levels for an FHSS device in 15.247. This DCCF can be applied when the unwanted emission limit is subject to an average field strength limit (e.g., within a Government Restricted band) and the conditions specified in Section 15.35(c) can be satisfied. The average radiated field strength is calculated by subtracting the DCCF from the maximum radiated field strength level as determined through measurement. The maximum radiated field strength level represents the worst-case (maximum amplitude) RMS measurement of the emission(s) during continuous transmission (i.e., not including any time intervals during which the transmitter is off or is transmitting at a reduced power level). It is also acceptable to apply the DCCF to a measurement performed with a peak detector instead of the specified RMS power averaging detector. Note that Section 15.35(c) specifies that the DCCF shall represent the worst-case (greatest duty cycle) over any 100 msec transmission period.

### Test instrument setup

| Frequency        | Test receiver / Spectrum analyzer setting                                                |
|------------------|------------------------------------------------------------------------------------------|
| 9 kHz ~ 150 kHz  | Quasi Peak / RBW: 200 Hz                                                                 |
| 150 kHz ~ 30 MHz | Quasi Peak / RBW: 9 kHz                                                                  |
| 30 MHz ~ 1 GHz   | Quasi Peak / RBW: 120 kHz                                                                |
| Above 1 GHz      | Peak / RBW: 1 MHz, VBW: 3MHz, Peak detector<br>AVG / RBW: 1 MHz, VBW: 1/T, Peak detector |

### 6.3.4 Test results

#### Notes:

The amplitude of spurious emissions which are attenuated more than 20 dB below the limits are not reported.

All modes of operation of the EUT were investigated, and only the worst-case results are reported.

There were no emissions found below 30MHz within 20dB of the limit.

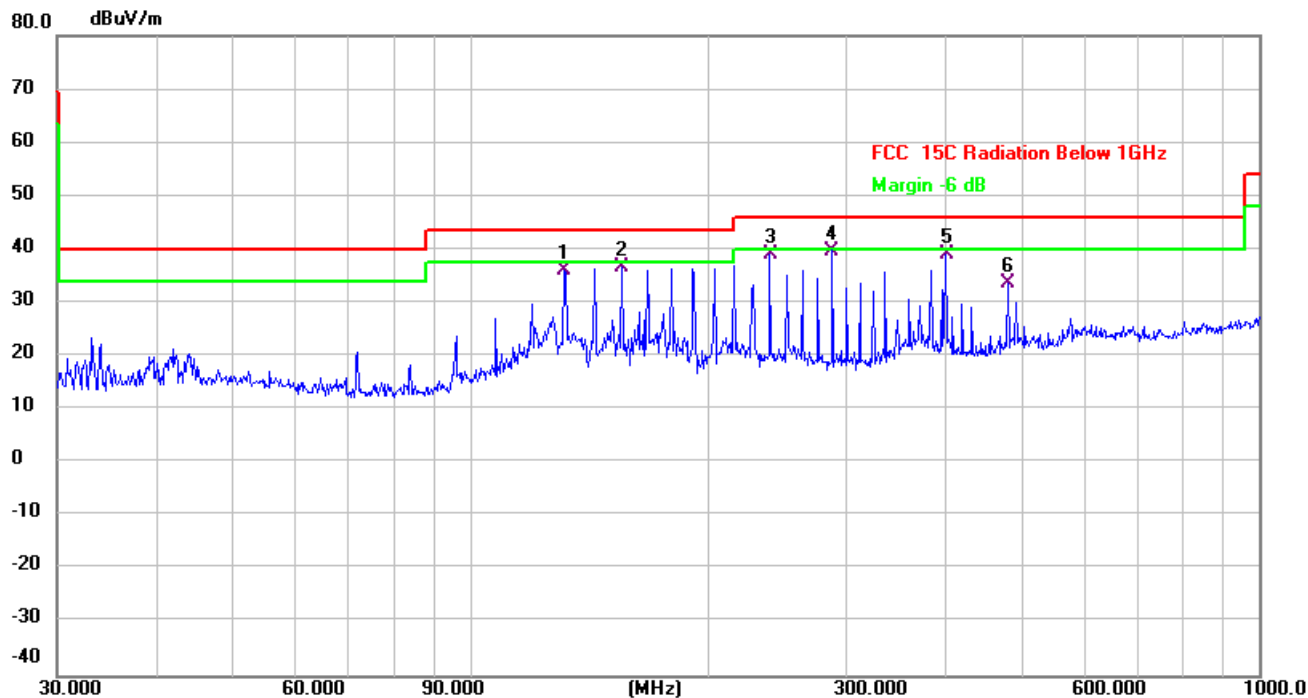
#### Calculation formula:

Measurement (dB $\mu$ V/m) = Reading Level (dB $\mu$ V) + Correct Factor (dB/m)

Over (dB) = Measurement (dB $\mu$ V/m) – Limit (dB $\mu$ V/m)

**Radiated emissions between 30MHz – 1GHz**

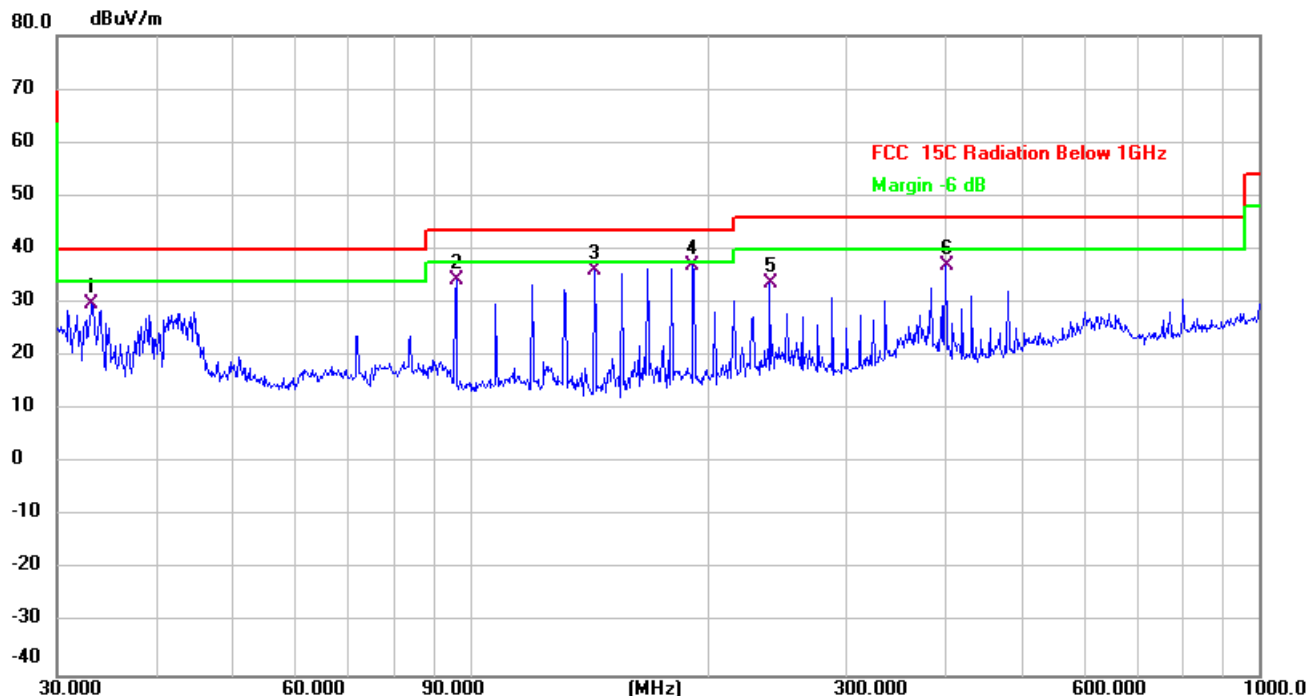
|               |              |               |              |
|---------------|--------------|---------------|--------------|
| Test mode:    | TX 2DH5-2480 | Polarization: | Horizontal   |
| Power supply: | DC 5V        | Test site:    | RE chamber 2 |



| No. | Mk. | Freq.    | Reading | Correct | Measure- | Limit  | Over     |
|-----|-----|----------|---------|---------|----------|--------|----------|
|     |     | MHz      | Level   | Factor  | ment     |        |          |
|     |     |          | dBuV    | dB      | dBuV/m   | dBuV/m | dB       |
|     |     |          |         |         |          |        | Detector |
| 1   |     | 131.7577 | 48.88   | -12.83  | 36.05    | 43.50  | -7.45    |
| 2   |     | 155.9101 | 48.82   | -12.09  | 36.73    | 43.50  | -6.77    |
| 3   |     | 239.9874 | 47.56   | -8.53   | 39.03    | 46.00  | -6.97    |
| 4   | *   | 287.9904 | 47.87   | -8.07   | 39.80    | 46.00  | -6.20    |
| 5   |     | 400.4319 | 46.08   | -6.95   | 39.13    | 46.00  | -6.87    |
| 6   |     | 480.5276 | 39.67   | -5.91   | 33.76    | 46.00  | -12.24   |

**Radiated emissions between 30MHz – 1GHz**

|               |              |               |              |
|---------------|--------------|---------------|--------------|
| Test mode:    | TX 2DH5-2480 | Polarization: | Vertical     |
| Power supply: | DC 5V        | Test site:    | RE chamber 2 |



| No. | Mk. | Freq.    | Reading Level | Correct Factor | Measurement | Limit  | Over   |          |
|-----|-----|----------|---------------|----------------|-------------|--------|--------|----------|
|     |     | MHz      | dBuV          | dB             | dBuV/m      | dBuV/m | dB     | Detector |
| 1   |     | 33.2112  | 40.10         | -10.35         | 29.75       | 40.00  | -10.25 | QP       |
| 2   |     | 96.0986  | 44.83         | -10.55         | 34.28       | 43.50  | -9.22  | QP       |
| 3   |     | 143.8295 | 48.63         | -12.71         | 35.92       | 43.50  | -7.58  | QP       |
| 4   | *   | 191.7450 | 47.52         | -10.52         | 37.00       | 43.50  | -6.50  | QP       |
| 5   |     | 239.9874 | 42.07         | -8.53          | 33.54       | 46.00  | -12.46 | QP       |
| 6   |     | 400.4319 | 43.80         | -6.95          | 36.85       | 46.00  | -9.15  | QP       |

**Radiated emissions 1 GHz ~ 25 GHz**

| Frequency                           | Reading Level | Correct Factor | Measurement | Limits   | Over   | Detector | Polarization |
|-------------------------------------|---------------|----------------|-------------|----------|--------|----------|--------------|
| (MHz)                               | (dBμV)        | (dB/m)         | (dBμV/m)    | (dBμV/m) | (dB)   | Peak/AVG | H/V          |
| <b>π/4-DQPSK - 2402 MHz TX mode</b> |               |                |             |          |        |          |              |
| 4804                                | 39.07         | 0.74           | 39.81       | 74.00    | -34.19 | Peak     | V            |
| 4804                                | 32.75         | 0.74           | 33.49       | 54.00    | -20.51 | AVG      | V            |
| 7206                                | 40.84         | 6.02           | 46.86       | 74.00    | -27.14 | Peak     | V            |
| 7206                                | 34.33         | 6.02           | 40.35       | 54.00    | -13.65 | AVG      | V            |
| 9608                                | 41.48         | 5.88           | 47.36       | 74.00    | -26.64 | Peak     | V            |
| 9608                                | 35.34         | 5.88           | 41.22       | 54.00    | -12.78 | AVG      | V            |
| 4804                                | 39.53         | 0.74           | 40.27       | 74.00    | -33.73 | Peak     | H            |
| 4804                                | 33.44         | 0.74           | 34.18       | 54.00    | -19.82 | AVG      | H            |
| 7206                                | 41.47         | 6.02           | 47.49       | 74.00    | -26.51 | Peak     | H            |
| 7206                                | 35.21         | 6.02           | 41.23       | 54.00    | -12.77 | AVG      | H            |
| 9608                                | 41.29         | 5.88           | 47.17       | 74.00    | -26.83 | Peak     | H            |
| 9608                                | 35.24         | 5.88           | 41.12       | 54.00    | -12.88 | AVG      | H            |
| <b>π/4-DQPSK - 2441 MHz TX mode</b> |               |                |             |          |        |          |              |
| 4882                                | 39.96         | 1.05           | 41.01       | 74.00    | -32.99 | Peak     | V            |
| 4882                                | 33.64         | 1.05           | 34.69       | 54.00    | -19.31 | AVG      | V            |
| 7323                                | 40.67         | 5.94           | 46.61       | 74.00    | -27.39 | Peak     | V            |
| 7323                                | 34.34         | 5.94           | 40.28       | 54.00    | -13.72 | AVG      | V            |
| 9764                                | 41.03         | 6.55           | 47.58       | 74.00    | -26.42 | Peak     | V            |
| 9764                                | 34.68         | 6.55           | 41.23       | 54.00    | -12.77 | AVG      | V            |
| 4882                                | 40.36         | 1.05           | 41.41       | 74.00    | -32.59 | Peak     | H            |
| 4882                                | 34.17         | 1.05           | 35.22       | 54.00    | -18.78 | AVG      | H            |
| 7323                                | 41.21         | 5.94           | 47.15       | 74.00    | -26.85 | Peak     | H            |
| 7323                                | 35.16         | 5.94           | 41.10       | 54.00    | -12.90 | AVG      | H            |
| 9764                                | 40.91         | 6.55           | 47.46       | 74.00    | -26.54 | Peak     | H            |
| 9764                                | 34.69         | 6.55           | 41.24       | 54.00    | -12.76 | AVG      | H            |

| Frequency                           | Reading Level | Correct Factor | Measurement | Limits   | Over   | Detector | Polarization |
|-------------------------------------|---------------|----------------|-------------|----------|--------|----------|--------------|
| (MHz)                               | (dBμV)        | (dB/m)         | (dBμV/m)    | (dBμV/m) | (dB)   | Peak/AVG | H/V          |
| <b>π/4-DQPSK - 2480 MHz TX mode</b> |               |                |             |          |        |          |              |
| 4960                                | 41.75         | 1.50           | 43.25       | 74.00    | -30.75 | Peak     | V            |
| 4960                                | 35.64         | 1.50           | 37.14       | 54.00    | -16.86 | AVG      | V            |
| 7440                                | 39.70         | 5.61           | 45.31       | 74.00    | -28.69 | Peak     | V            |
| 7440                                | 33.65         | 5.61           | 39.26       | 54.00    | -14.74 | AVG      | V            |
| 9920                                | 41.31         | 6.10           | 47.41       | 74.00    | -26.59 | Peak     | V            |
| 9920                                | 35.13         | 6.10           | 41.23       | 54.00    | -12.77 | AVG      | V            |
| 4960                                | 42.23         | 1.50           | 43.73       | 74.00    | -30.27 | Peak     | H            |
| 4960                                | 35.88         | 1.50           | 37.38       | 54.00    | -16.62 | AVG      | H            |
| 7440                                | 40.35         | 5.61           | 45.96       | 74.00    | -28.04 | Peak     | H            |
| 7440                                | 33.93         | 5.61           | 39.54       | 54.00    | -14.46 | AVG      | H            |
| 9920                                | 42.03         | 6.10           | 48.13       | 74.00    | -25.87 | Peak     | H            |
| 9920                                | 36.00         | 6.10           | 42.10       | 54.00    | -11.90 | AVG      | H            |

**Radiated emissions at band edge**

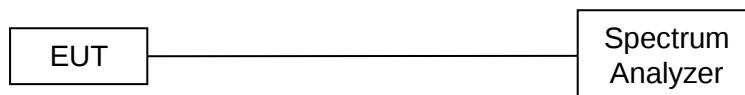
| Frequency                         | Reading Level | Correct Factor | Measurement | Limits   | Over   | Detector | Polarization |
|-----------------------------------|---------------|----------------|-------------|----------|--------|----------|--------------|
| (MHz)                             | (dBμV)        | (dB/m)         | (dBμV/m)    | (dBμV/m) | (dB)   | Peak/AVG | H/V          |
| <b>π/4-DQPSK – Low band-edge</b>  |               |                |             |          |        |          |              |
| (MHz)                             | (dBμV)        | (dB/m)         | (dBμV/m)    | (dBμV/m) | (dB)   | Peak/AVG | H/V          |
| 2310                              | 46.43         | -8.08          | 38.35       | 74.00    | -35.65 | Peak     | V            |
| 2310                              | 37.25         | -8.08          | 29.17       | 54.00    | -24.83 | AVG      | V            |
| 2390                              | 46.50         | -7.71          | 38.79       | 74.00    | -35.21 | Peak     | V            |
| 2390                              | 37.44         | -7.71          | 29.73       | 54.00    | -24.27 | AVG      | V            |
| 2310                              | 46.85         | -8.08          | 38.77       | 74.00    | -35.23 | Peak     | H            |
| 2310                              | 37.40         | -8.08          | 29.32       | 54.00    | -24.68 | AVG      | H            |
| 2390                              | 47.68         | -7.71          | 39.97       | 74.00    | -34.03 | Peak     | H            |
| 2390                              | 37.90         | -7.71          | 30.19       | 54.00    | -23.81 | AVG      | H            |
| <b>π/4-DQPSK – High band-edge</b> |               |                |             |          |        |          |              |
| 2483.5                            | 48.21         | -7.24          | 40.97       | 74.00    | -33.03 | Peak     | V            |
| 2483.5                            | 38.40         | -7.24          | 31.16       | 54.00    | -22.84 | AVG      | V            |
| 2500                              | 49.02         | -7.17          | 41.85       | 74.00    | -32.15 | Peak     | V            |
| 2500                              | 38.27         | -7.17          | 31.10       | 54.00    | -22.90 | AVG      | V            |
| 2483.5                            | 55.67         | -7.24          | 48.43       | 74.00    | -25.57 | Peak     | H            |
| 2483.5                            | 44.98         | -7.24          | 37.74       | 54.00    | -16.26 | AVG      | H            |
| 2500                              | 47.95         | -7.17          | 40.78       | 74.00    | -33.22 | Peak     | H            |
| 2500                              | 38.10         | -7.17          | 30.93       | 54.00    | -23.07 | AVG      | H            |

## 6.4 20dB emission bandwidth

### 6.4.1 Limits

None, for reporting purposes only.

### 6.4.2 Test setup



### 6.4.3 Test procedures

Test method: ANSI C63.10-2013 Section 6.9.2

### 6.4.4 Test results

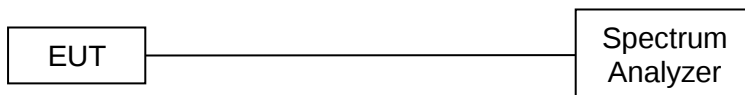
**Note:** See the Appendix A

## 6.5 Maximum conducted output power

### 6.5.1 Limits

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

### 6.5.2 Test setup



### 6.5.3 Test procedure

Test method: ANSI C63.10-2013 Section 7.8.5

### 6.5.4 Test results

**Note: see the Appendix B**

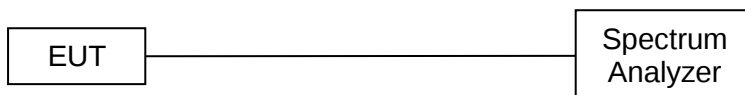
## 6.6 Carrier frequency separation

### 6.6.1 Limits

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater

### 6.6.2 Test setup



### 6.6.3 Test procedure

Test method: ANSI C63.10-2013 Section 7.8.2

### 6.6.4 Test results

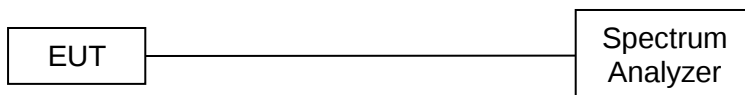
**Note:** see the Appendix C

## 6.7 Time of occupancy

### 6.7.1 Limits

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.

### 6.7.2 Test setup



### 6.7.3 Test procedure

Test method: ANSI C63.10-2013 Section 7.8.4

### 6.7.4 Test results

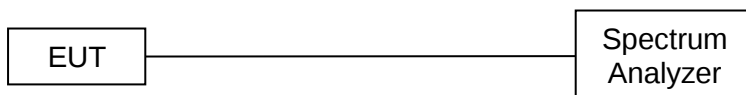
**Note:** see the Appendix D

## 6.8 Number of hopping channels

### 6.8.1 Limit

Frequency hopping systems in the 2400-2483.5MHz band shall use at least 15 channels.

### 6.8.2 Test setup



### 6.8.3 Test procedure

Test method: ANSI C63.10-2013 Section 7.8.3

### 6.8.4 Test results

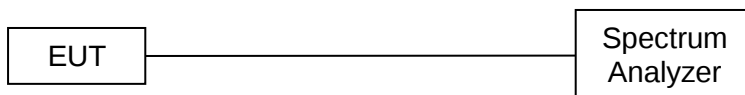
**Note: see the Appendix E**

## 6.9 Band edge (Conducted)

### 6.9.1 Limits

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)).

### 6.9.2 Test setup



### 6.9.3 Test procedure

Test method: ANSI C63.10-2013 Section 6.10.4

### 6.9.4 Test results

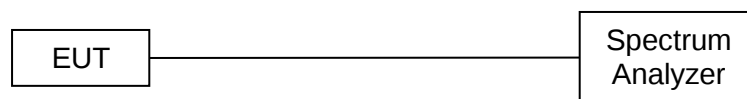
**Note:** see the Appendix F

## 6.10 Conducted spurious emissions

### 6.10.1 Limits

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)).

### 6.10.2 Test setup



### 6.10.3 Test procedure

Test method: ANSI C63.10-2013 Section 7.8.8

### 6.10.4 Test results

**Note: See the Appendix G**

**APPENDIX A: 20DB EMISSION BANDWIDTH**

## Test Result

| Test Mode | Antenna | Frequency<br>[MHz] | 20db EBW<br>[MHz] |
|-----------|---------|--------------------|-------------------|
| DH5       | Ant1    | 2402               | 0.954             |
|           |         | 2441               | 0.948             |
|           |         | 2480               | 0.954             |
| 2DH5      | Ant1    | 2402               | 1.299             |
|           |         | 2441               | 1.296             |
|           |         | 2480               | 1.284             |
| 3DH5      | Ant1    | 2402               | 1.350             |
|           |         | 2441               | 1.290             |
|           |         | 2480               | 1.281             |

## Test Graphs

DH5\_Ant1\_2402



DH5\_Ant1\_2441



DH5\_Ant1\_2480



## 2DH5\_Ant1\_2402



## 2DH5\_Ant1\_2441



## 2DH5\_Ant1\_2480



## 3DH5\_Ant1\_2402



## 3DH5\_Ant1\_2441



## 3DH5\_Ant1\_2480

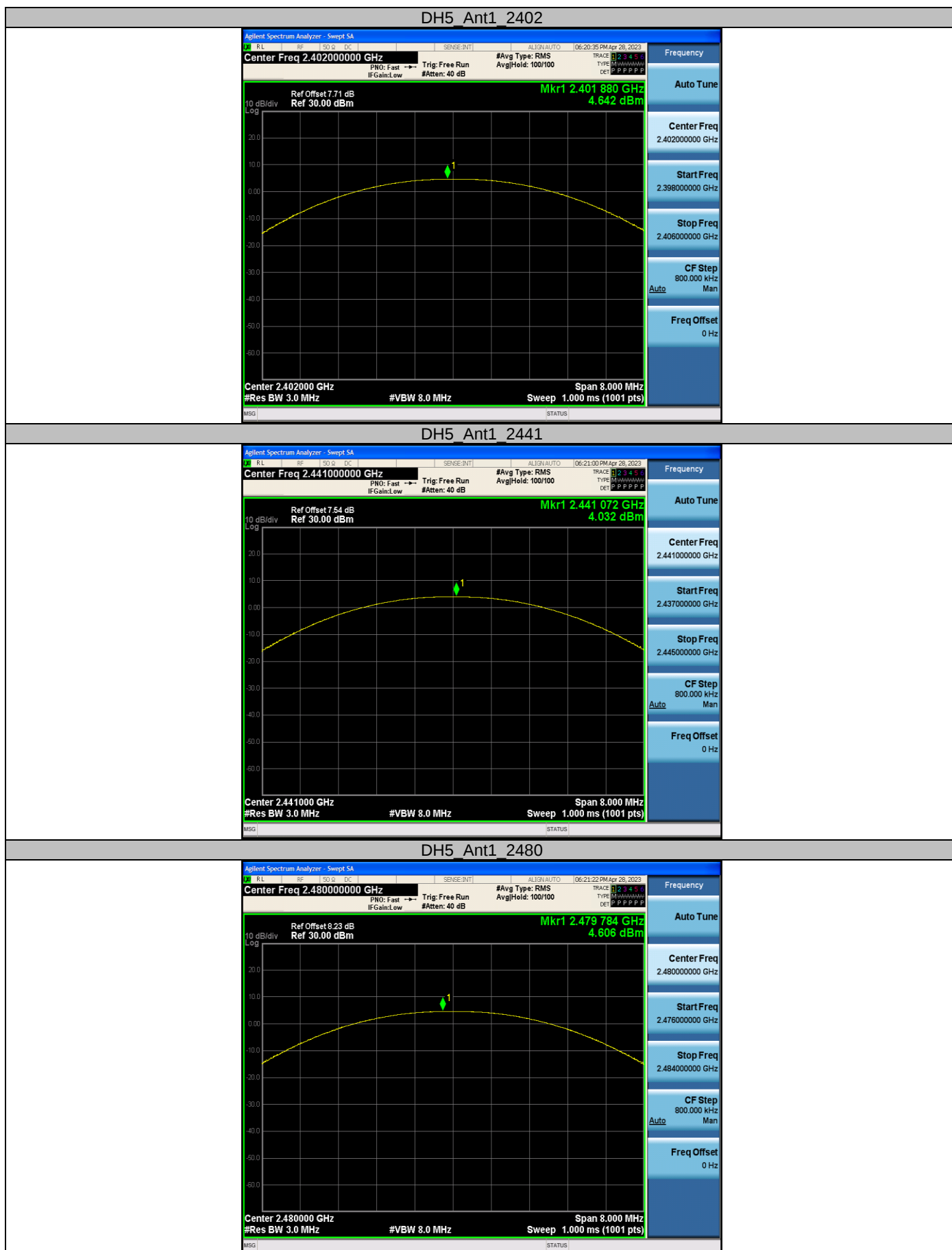


**APPENDIX B: MAXIMUM CONDUCTED OUTPUT POWER**

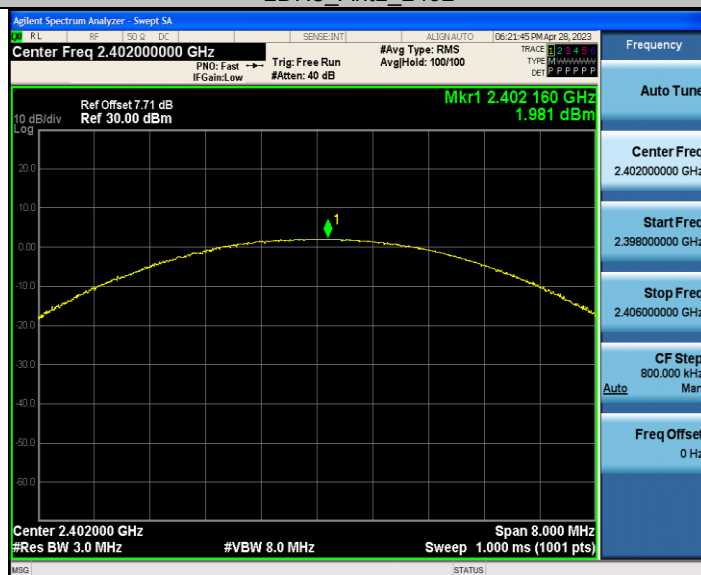
## Test Result Peak

| Test Mode | Antenna | Frequency [MHz] | Conducted Peak Power [dBm] | Limit [dBm] | Verdict |
|-----------|---------|-----------------|----------------------------|-------------|---------|
| DH5       | Ant1    | 2402            | 4.64                       | ≤30         | PASS    |
|           |         | 2441            | 4.03                       | ≤30         | PASS    |
|           |         | 2480            | 4.61                       | ≤30         | PASS    |
| 2DH5      | Ant1    | 2402            | 1.98                       | ≤20.97      | PASS    |
|           |         | 2441            | 1.39                       | ≤20.97      | PASS    |
|           |         | 2480            | 1.97                       | ≤20.97      | PASS    |
| 3DH5      | Ant1    | 2402            | 2.19                       | ≤20.97      | PASS    |
|           |         | 2441            | 1.51                       | ≤20.97      | PASS    |
|           |         | 2480            | 2.19                       | ≤20.97      | PASS    |

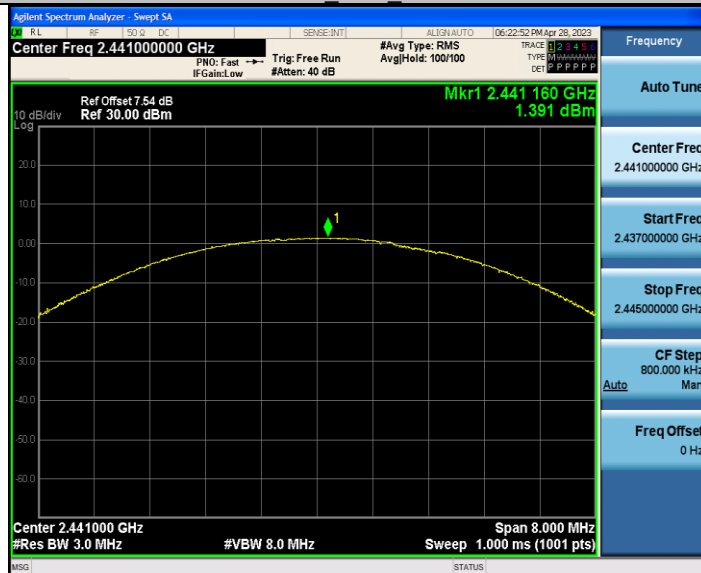
## Test Graphs



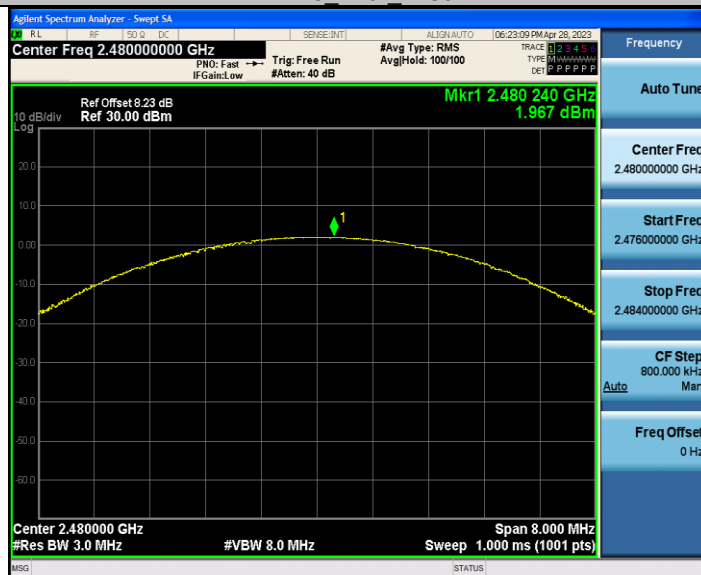
## 2DH5\_Ant1\_2402



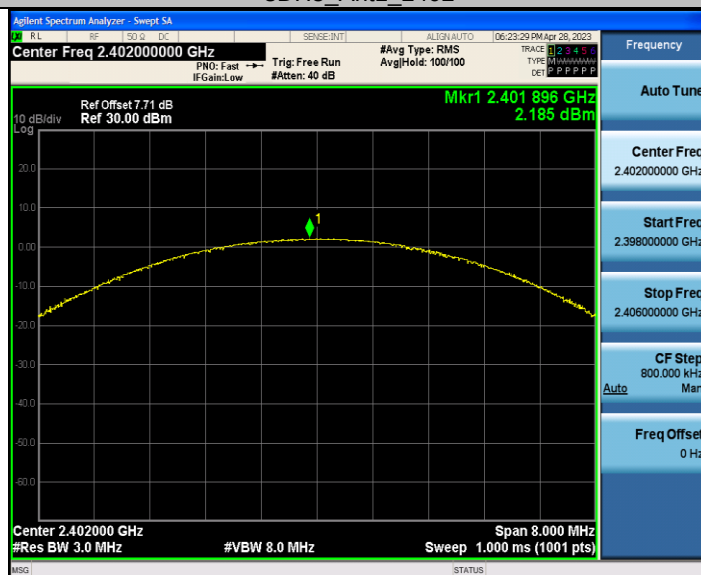
## 2DH5\_Ant1\_2441



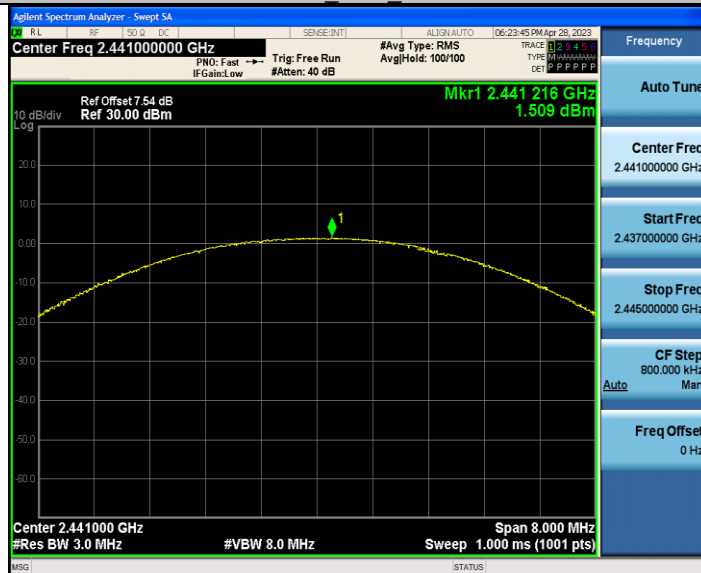
## 2DH5\_Ant1\_2480



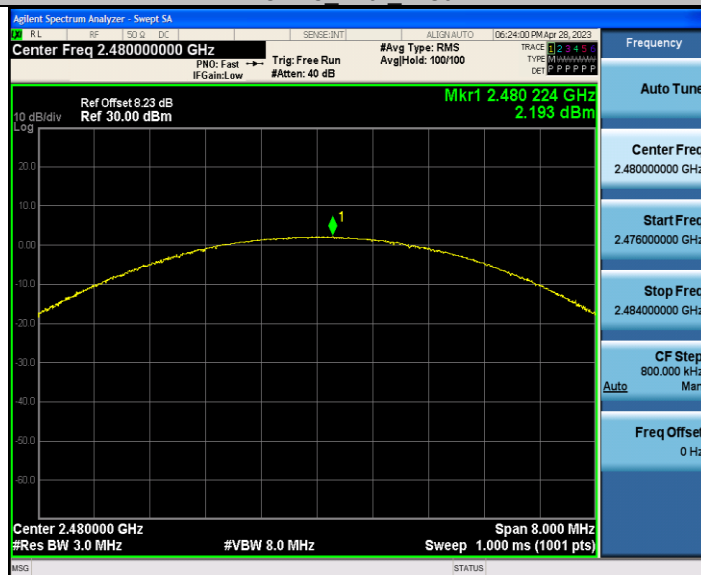
## 3DH5\_Ant1\_2402



## 3DH5\_Ant1\_2441



## 3DH5\_Ant1\_2480



## APPENDIX C: CARRIER FREQUENCY SEPARATION

### Test Result

| Test Mode | Antenna | Frequency<br>[MHz] | Result<br>[MHz] | Limit<br>[MHz] | Verdict |
|-----------|---------|--------------------|-----------------|----------------|---------|
| DH5       | Ant1    | Hop                | 0.996           | $\geq 0.954$   | PASS    |
| 2DH5      | Ant1    | Hop                | 1               | $\geq 0.866$   | PASS    |
| 3DH5      | Ant1    | Hop                | 0.998           | $\geq 0.900$   | PASS    |

## Test Graphs



## APPENDIX D: TIME OF OCCUPANCY

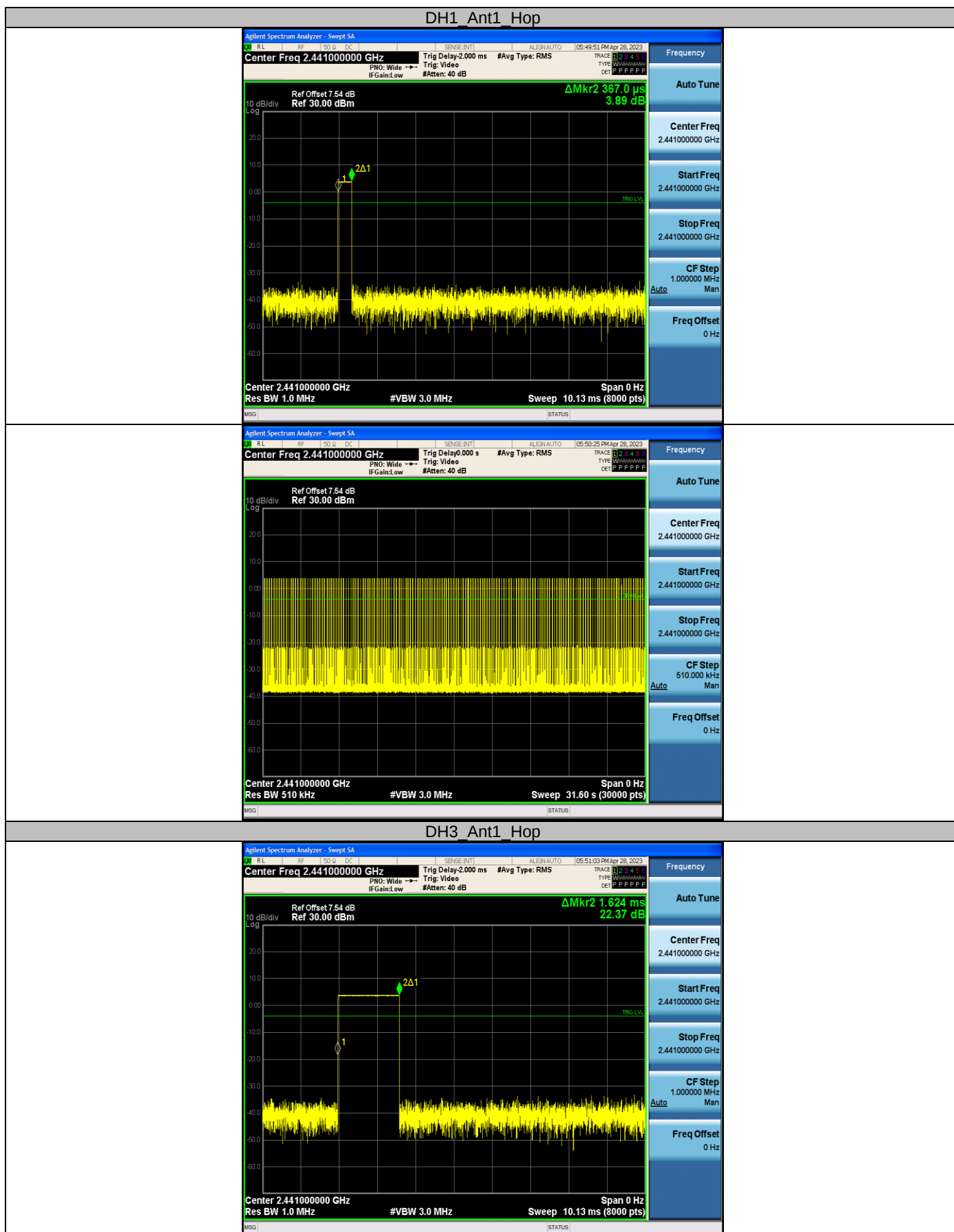
### Test Result

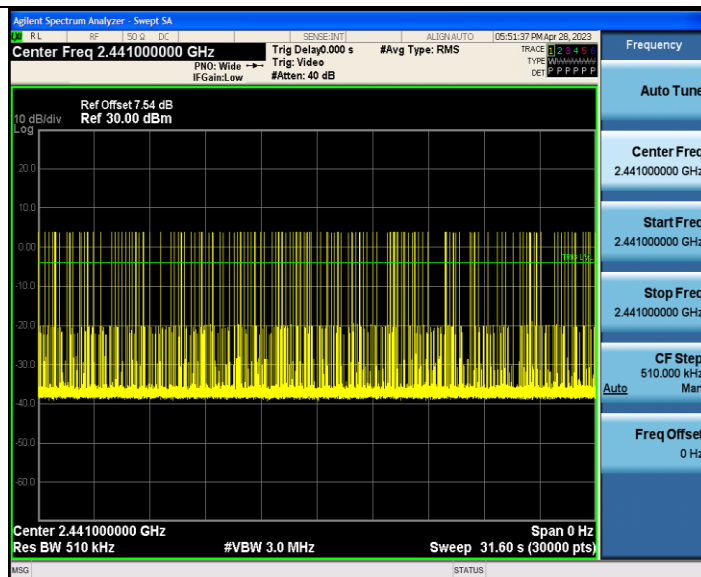
| Test Mode | Antenna | Frequency [MHz] | BurstWidth [ms] | Hops in 31.6s [Num] | Result [s] | Limit [s] | Verdict |
|-----------|---------|-----------------|-----------------|---------------------|------------|-----------|---------|
| DH1       | Ant1    | Hop             | 0.367           | 320                 | 0.117      | ≤0.4      | PASS    |
| DH3       | Ant1    | Hop             | 1.624           | 156                 | 0.253      | ≤0.4      | PASS    |
| DH5       | Ant1    | Hop             | 2.870           | 117                 | 0.336      | ≤0.4      | PASS    |
| 2DH1      | Ant1    | Hop             | 0.376           | 320                 | 0.12       | ≤0.4      | PASS    |
| 2DH3      | Ant1    | Hop             | 1.629           | 146                 | 0.238      | ≤0.4      | PASS    |
| 2DH5      | Ant1    | Hop             | 2.877           | 105                 | 0.302      | ≤0.4      | PASS    |
| 3DH1      | Ant1    | Hop             | 0.377           | 320                 | 0.121      | ≤0.4      | PASS    |
| 3DH3      | Ant1    | Hop             | 1.628           | 161                 | 0.262      | ≤0.4      | PASS    |
| 3DH5      | Ant1    | Hop             | 2.879           | 96                  | 0.276      | ≤0.4      | PASS    |

### Notes:

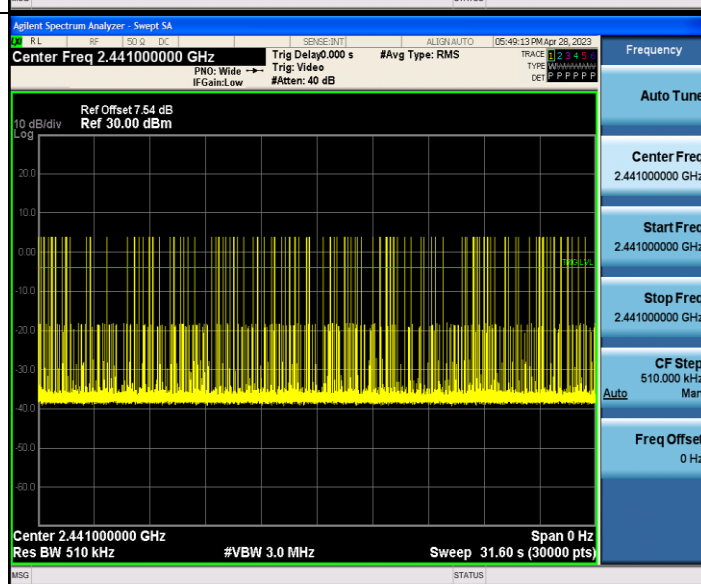
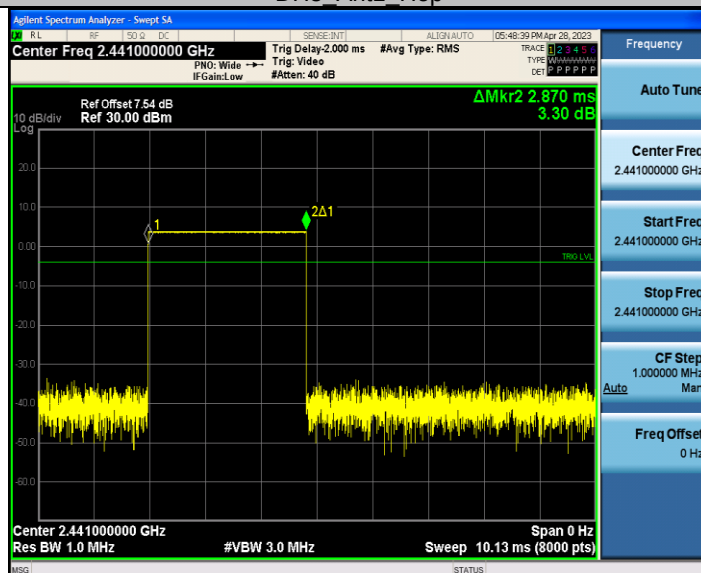
1. Period time =  $0.4s * 79 = 31.6s$
2. Result (Time of occupancy) = BurstWidth[ms] \* Hops in 31.6s [Num]

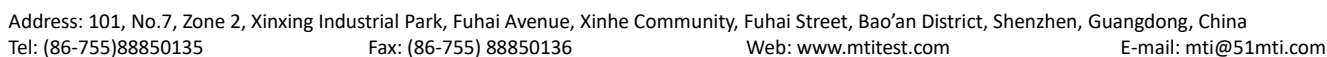
## Test Graphs

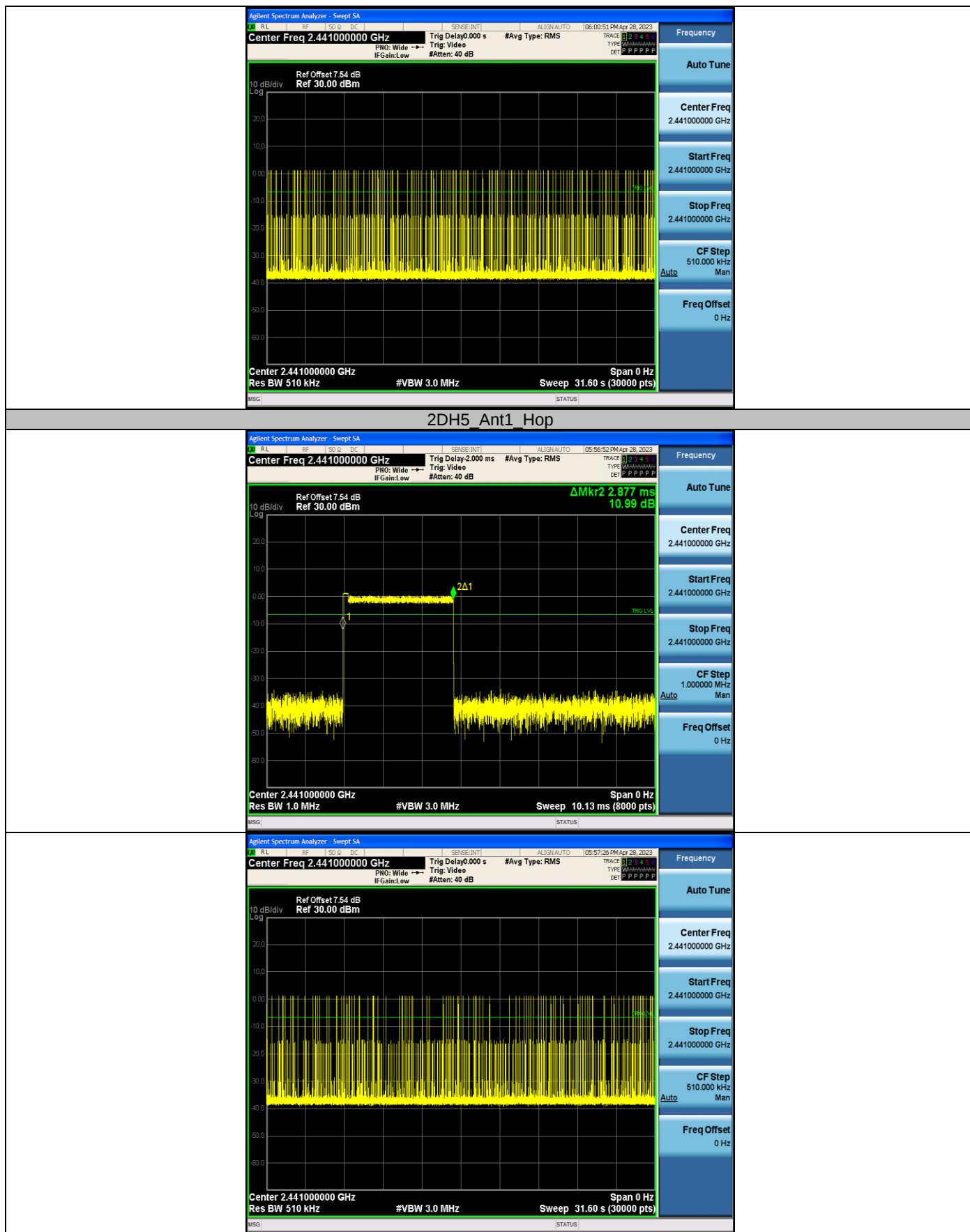


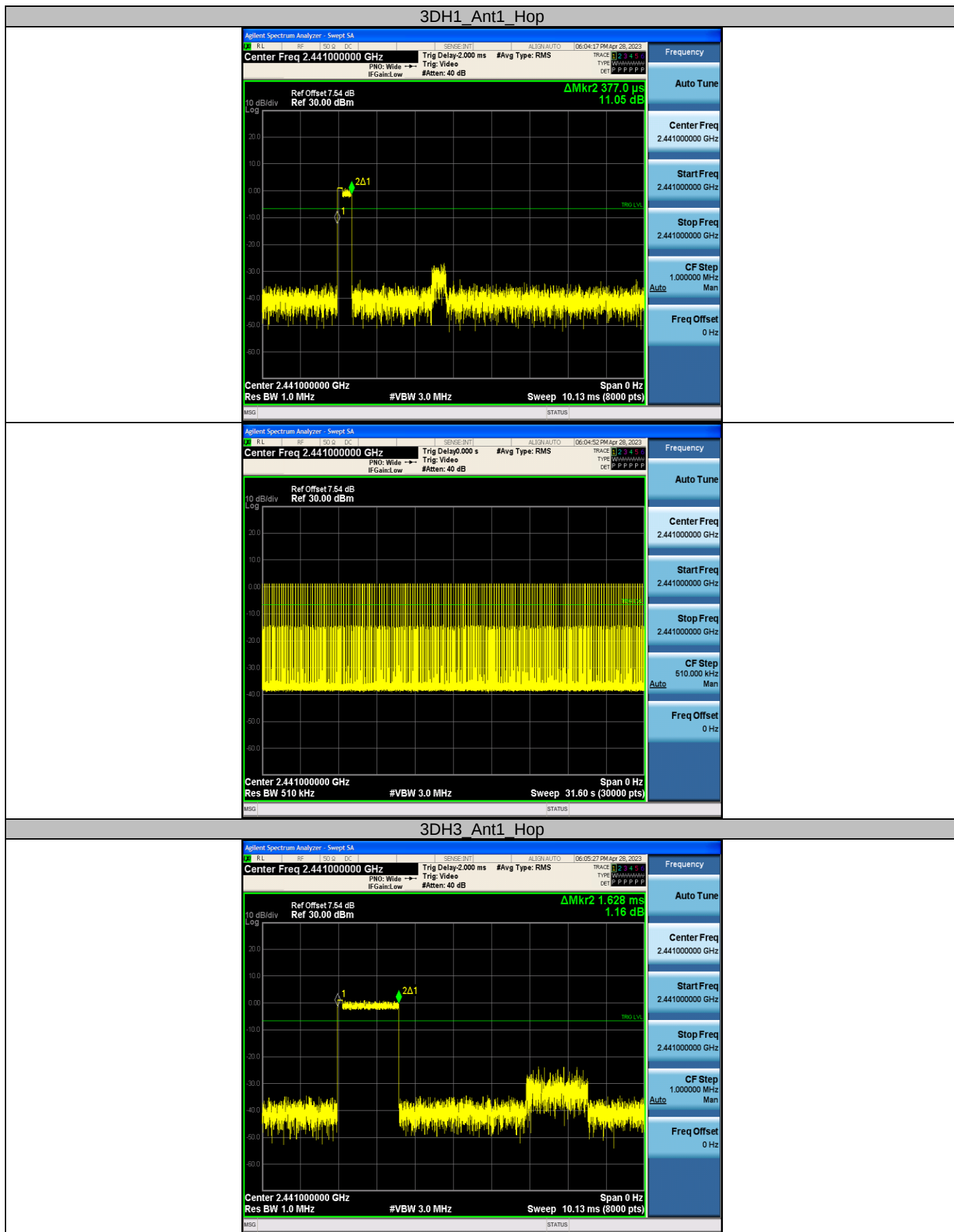


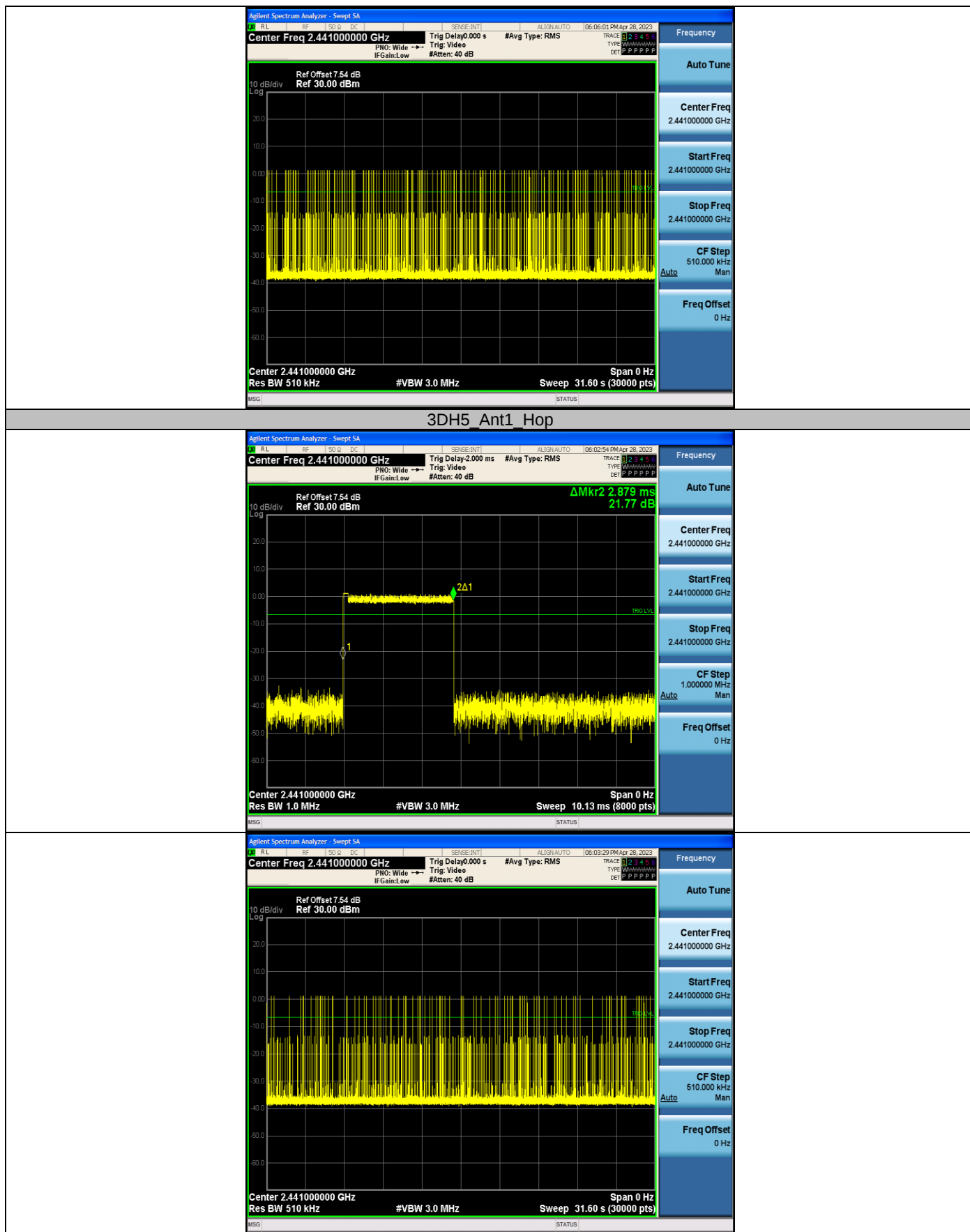
DH5\_Ant1\_Hop











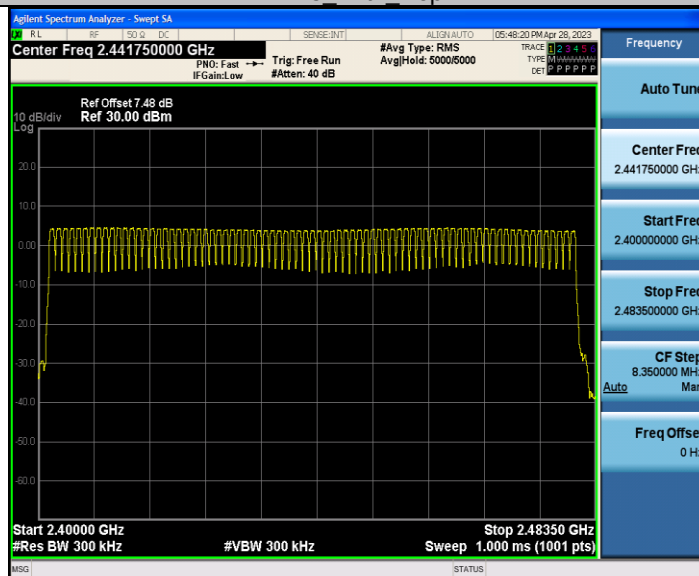
## APPENDIX E: NUMBER OF HOPPING CHANNELS

### Test Result

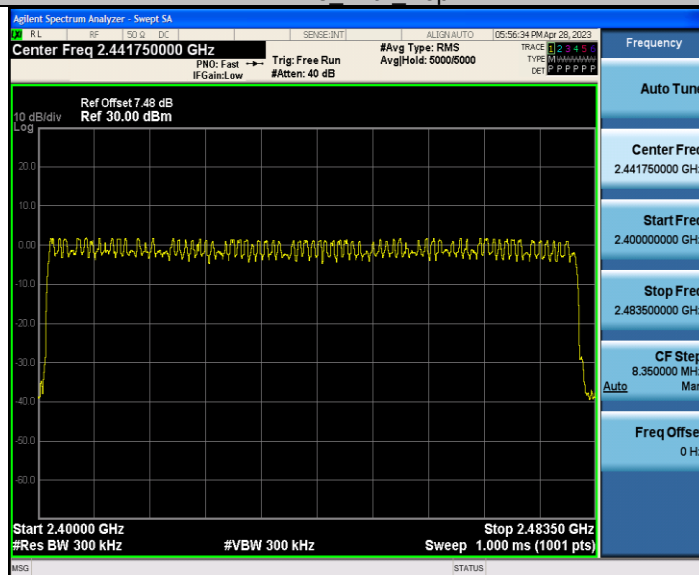
| Test Mode | Antenna | Frequency<br>[MHz] | Result<br>[Num] | Limit<br>[Num] | Verdict |
|-----------|---------|--------------------|-----------------|----------------|---------|
| DH5       | Ant1    | Hop                | 79              | ≥15            | PASS    |
| 2DH5      | Ant1    | Hop                | 79              | ≥15            | PASS    |
| 3DH5      | Ant1    | Hop                | 79              | ≥15            | PASS    |

## Test Graphs

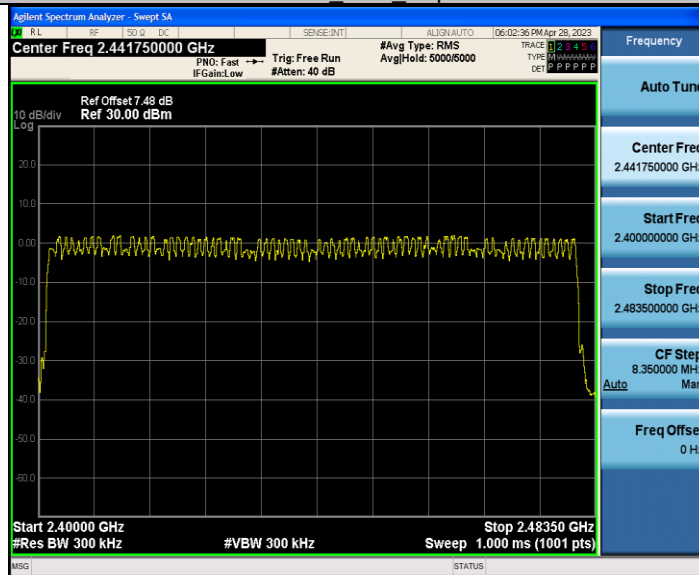
DH5\_Ant1\_Hop



2DH5\_Ant1\_Hop

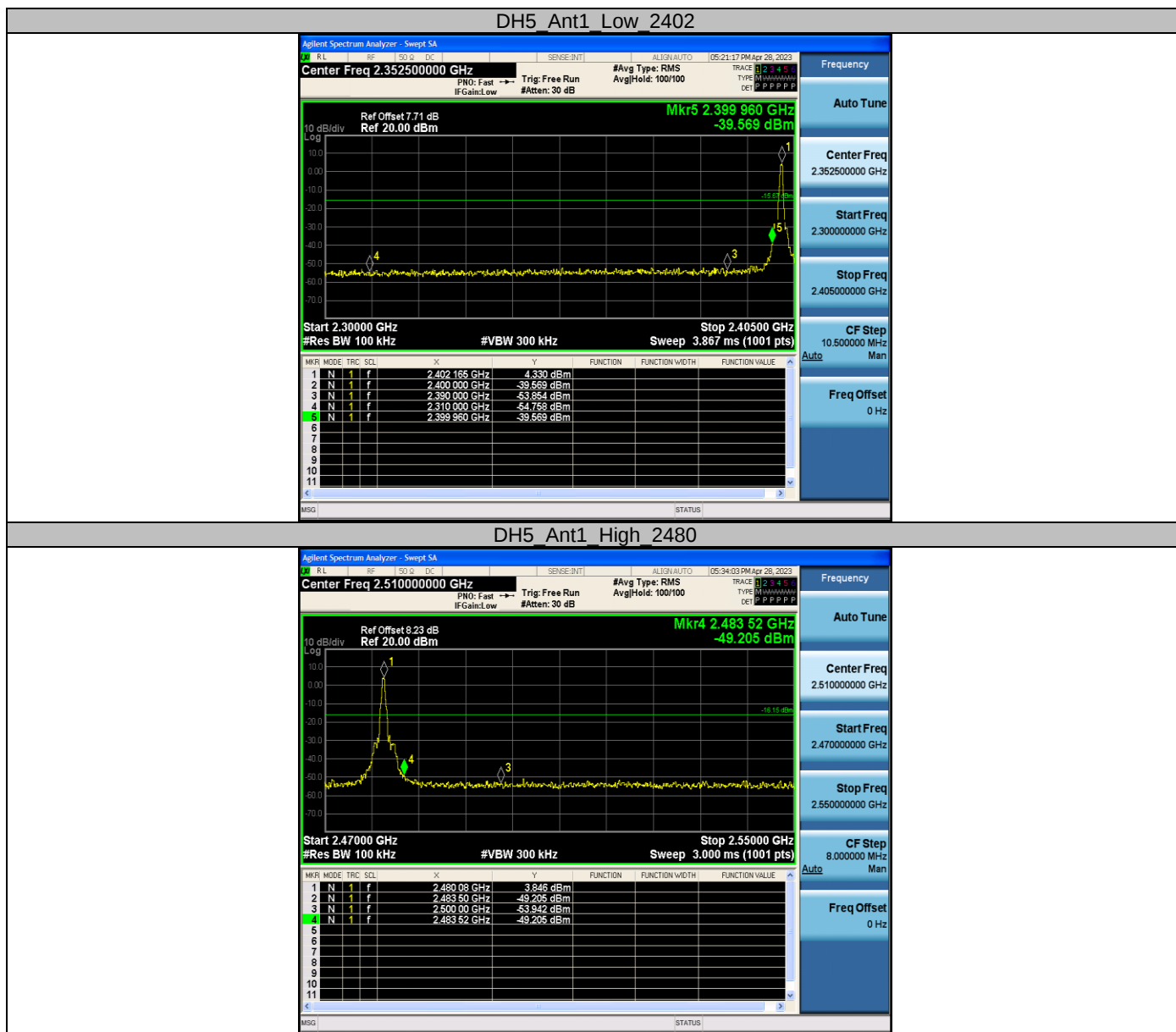


3DH5\_Ant1\_Hop

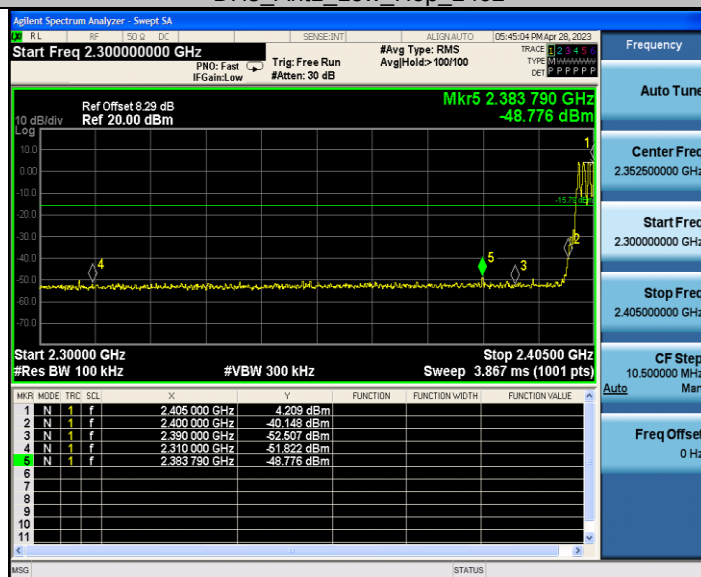


## APPENDIX F: BAND EDGE MEASUREMENTS

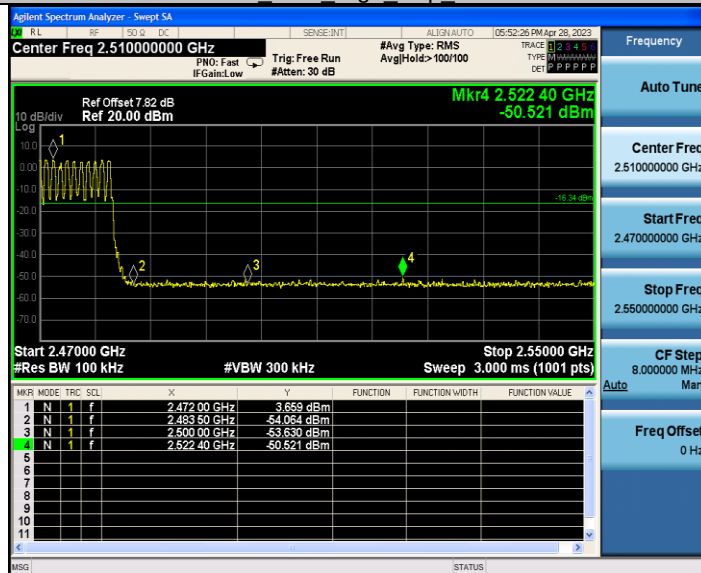
### Test Graphs



## DH5\_Ant1\_Low\_Hop\_2402



## DH5\_Ant1\_High\_Hop\_2480



## 2DH5\_Ant1\_Low\_2402

