# TEST REPORT

| | |
|---|---|
| Product Name: | UltraPro Controller |
| FCC ID: | 2BBA2-ULTRO41 |
| Trademark: | N/A |
| Model Number: | ultro41 |
| Prepared For: | guangzhoushihuizhimaoyiyouxiangongsi |
| Address: | Room 2107, Tonghe Road No. 330 Baiyun District, Guangzhou GUANGDONG 510515 |
| Manufacturer: | guangzhoushihuizhimaoyiyouxiangongsi |
| Address: | Room 2107, Tonghe Road No. 330 Baiyun District, Guangzhou GUANGDONG 510515 |
| Prepared By: | Shenzhen CTB Testing Technology Co., Ltd. |
| Address: | 1&2/F., Building A, No.26, Xinhe Road, Xinqiao, Xinqiao Street, Bao'an District, Shenzhen, Guangdong, China |
| Sample Received Date: | Apr. 25, 2023 |
| Sample tested Date: | Apr. 25, 2023 to May. 10, 20232 |
| Issue Date: | May. 10, 2023 |
| Report No.: | CTB230508031RFX |
| Test Standards | FCC Part15.247<br>ANSI C63.10:2013 |
| Test Results | PASS |
| Remark: | This is Bluetooth radio test report. |

| Compiled by: | Reviewed by: | Approved by: |
|---|---|---|
| Chen Zheng | Arron Liu | Bin Mei / Director |

Note: If there is any objection to the inspection results in this report, please submit a written report to the company within 15 days from the date of receiving the report. The test report is effective only with both signature and specialized stamp. This result(s) shown in this report refer only to the sample(s) tested. Without written approval of Shenzhen CTB Testing Technology Co., Ltd. this report can't be reproduced except in full. The tested sample(s) and the sample information are provided by the client. "*" indicates the testing items were fulfilled by subcontracted lab. "#" indicates the items are not in CNAS accreditation scope.

## TABLE OF CONTENT

Test Report Declaration Page
**1. VERSION** . . . . . 4
**2. TEST SUMMARY** . . . . . 5
**3. MEASUREMENT UNCERTAINTY** . . . . . 6
**4. PRODUCT INFORMATION AND TEST SETUP** . . . . . 7
4.1 Product Information . . . . . 7
4.2 Test Setup Configuration . . . . . 7
4.3 Support Equipment . . . . . 7
4.4 Channel List . . . . . 8
4.5 Test Mode . . . . . 8
4.6 Test Environment . . . . . 8
**5. TEST FACILITY AND TEST INSTRUMENT USED** . . . . . 9
5.1 Test Facility . . . . . 9
5.2 Test Instrument Used . . . . . 9
**6. AC POWER LINE CONDUCTED EMISSION** . . . . . 12
6.1 Block Diagram Of Test Setup . . . . . 12
6.2 Limit . . . . . 12
6.3 Test procedure . . . . . 12
6.4 Test Result . . . . . 14
**7. RADIATED SPURIOUS EMISSION** . . . . . 16
7.1 Block Diagram Of Test Setup . . . . . 16
7.2 Limit . . . . . 16
7.3 Test procedure . . . . . 17
7.4 Test Result . . . . . 18
**8. BAND EDGE AND RF COUNDUCTED SPURIOUS EMISSIONS** . . . . . 27
8.1 Block Diagram Of Test Setup . . . . . 27
8.2 Limit . . . . . 27
8.3 Test procedure . . . . . 27
8.4 Test Result . . . . . 28
**9. COUDUCTED PEAK OUTPUT POWER** . . . . . 35
9.1 Block Diagram Of Test Setup . . . . . 35
9.2 Limit . . . . . 35
9.3 Test procedure . . . . . 35
9.4 Test Result . . . . . 36
**10. 20DB OCCUPIED BANDWIDTH** . . . . . 40
10.1 Block Diagram Of Test Setup . . . . . 40
10.2 Limit . . . . . 40
10.3 Test procedure . . . . . 40
10.4 Test Result . . . . . 40
**11. CARRIERFREQUENCIES SEPARATION** . . . . . 44
11.1 Block Diagram Of Test Setup . . . . . 44
11.2 Limit . . . . . 44
11.3 Test procedure . . . . . 44
11.4 Test Result . . . . . 44
**12. HOPPING CHANNEL NUMBER** . . . . . 48
12.1 Block Diagram Of Test Setup . . . . . 48
12.2 Limit . . . . . 48
12.3 Test procedure . . . . . 48
12.4 Test Result . . . . . 48

**13. DWELL TIME** . . . . . 50
13.1 Block Diagram Of Test Setup . . . . . 50
13.2 Limit . . . . . 50
13.3 Test procedure . . . . . 50
13.4 Test Result . . . . . 51
**14. PSEUDORANDOM FREQUENCY** . . . . . 55
14.1 Limit . . . . . 55
14.2 Test procedure . . . . . 55
14.3 Test Result . . . . . 56
**15. ANTENNA REQUIREMENT** . . . . . 57
**16. EUT TEST SETUP PHOTOGRAPHS** . . . . . 58

*(Note: N/A means not applicable)*

## 1. VERSION

| Report No. | Issue Date | Description | Approved |
|---|---|---|---|
| CTB230508031RFX | May. 10, 2023 | Original | Valid |

## 2. TEST SUMMARY

The Product has been tested according to the following specifications:

| Test Item | Test Requirement | Test method | Result |
|---|---|---|---|
| **AC Power Line Conducted Emission** | 47 CFR Part 15 Subpart C Section 15.207 | ANSI C63.10-2013 | PASS |
| **Radiated Spurious emissions** | 47 CFR Part 15 Subpart C Section 15.205/15.209 | ANSI C63.10-2013 | PASS |
| **Band edge and RF Conducted Spurious Emissions** | 47 CFR Part 15 Subpart C Section 15.247(d)/15.205(a) | ANSI C63.10-2013 | PASS |
| **Conducted Peak Output Power** | 47 CFR Part 15 Subpart C Section 15.247 (b)(1) | ANSI C63.10-2013 | PASS |
| **20dB Occupied Bandwidth** | 47 CFR Part 15 Subpart C Section 15.247 (a)(1) | ANSI C63.10-2013 | PASS |
| **Carrier Frequencies Separation** | 47 CFR Part 15 Subpart C Section 15.247 (a)(1) | ANSI C63.10-2013 | PASS |
| **Hopping Channel Number** | 47 CFR Part 15 Subpart C Section 15.247 (b) | ANSI C63.10-2013 | PASS |
| **Dwell Time** | 47 CFR Part 15 Subpart C Section 15.247 (a)(1) | ANSI C63.10-2013 | PASS |
| **Pseudorandom Frequency Hopping Sequence** | 47 CFR Part 15 Subpart C Section 15.247(a)&TCB Exclusion List (7 July 2002) | ANSI C63.10-2013 | PASS |
| **Antenna Requirement** | 47 CFR Part 15 Subpart C Section 15.203/15.247 (b) | / | PASS |
| **RF Exposure Evaluation** | 47 CFR Part 15 Subpart C Section 15.247 (i)/1.1310/2.1093 | KDB447498D01v06 | PASS |

Remark:
Test according to ANSI C63.10-2013.

## 3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| Item | Uncertainty |
|---|---|
| Occupancy bandwidth | 54.3kHz |
| Conducted output power Above 1G | 0.9dB |
| Conducted output power below 1G | 0.9dB |
| Power Spectral Density , Conduction | 0.9dB |
| Conduction spurious emissions | 2.0dB |
| Out of band emission | 2.0dB |
| 3m camber Radiated spurious emission(9KHz-30MHz) | 4.8dB |
| 3m camber Radiated spurious emission(30MHz-1GHz) | 4.6dB |
| 3m chamber Radiated spurious emission(1GHz-18GHz) | 5.1dB |
| 3m chamber Radiated spurious emission(18GHz-40GHz) | 3.4dB |
| humidity uncertainty | 5.5% |
| Temperature uncertainty | 0.63℃ |
| frequency | 1×10-7 |
| Conducted Emission (150KHz-30MHz) | 3.2 dB |
| Radiated Emission(30MHz ~ 1000MHz) | 4.8 dB |
| Radiated Emission(1GHz ~6GHz) | 4.9 dB |

## 4. PRODUCT INFORMATION AND TEST SETUP

### 4.1 Product Information

| | |
|---|---|
| Model(s): | ultro41 |
| Model Description: | N/A |
| Bluetooth Version: | Bluetooth 5.0 |
| Hardware Version: | V06 |
| Software Version: | 1.0 |
| Operation Frequency: | Bluetooth: 2402-2480MHz |
| Max. RF output power: | Bluetooth: -1.311dBm |
| Type of Modulation: | Bluetooth: GFSK, π/4 DQPSK, 8DPSK |
| Antenna installation: | Bluetooth: PCB antenna |
| Antenna Gain: | Bluetooth: -0.58dBi |
| Ratings: | DC 3V |

### 4.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

### 4.3 Support Equipment

| Item | Equipment | Mfr/Brand | Model/Type No. | Series No. | Note |
|---|---|---|---|---|---|
| | | | | | |

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

## 4.4 Channel List

| CH | Frequency (MHz) | CH | Frequency (MHz) | CH | Frequency (MHz) | CH | Frequency (MHz) |
|---|---|---|---|---|---|---|---|
| 0 | 2402 | 1 | 2403 | 2 | 2404 | 3 | 2405 |
| 4 | 2406 | 5 | 2407 | 6 | 2408 | 7 | 2409 |
| 8 | 2410 | 9 | 2411 | 10 | 2412 | 11 | 2413 |
| 12 | 2414 | 13 | 2415 | 14 | 2416 | 15 | 2417 |
| 16 | 2418 | 17 | 2419 | 18 | 2420 | 19 | 2421 |
| 20 | 2422 | 21 | 2423 | 22 | 2424 | 23 | 2425 |
| 24 | 2426 | 25 | 2427 | 26 | 2428 | 27 | 2429 |
| 28 | 2430 | 29 | 2431 | 30 | 2432 | 31 | 2433 |
| 32 | 2434 | 33 | 2435 | 34 | 2436 | 35 | 2437 |
| 36 | 2438 | 37 | 2439 | 38 | 2440 | 39 | 2441 |
| 40 | 2442 | 41 | 2443 | 42 | 2444 | 43 | 2445 |
| 44 | 2446 | 45 | 2447 | 46 | 2448 | 47 | 2449 |
| 48 | 2450 | 49 | 2451 | 50 | 2452 | 51 | 2453 |
| 52 | 2454 | 53 | 2455 | 54 | 2456 | 55 | 2457 |
| 56 | 2458 | 57 | 2459 | 58 | 2460 | 59 | 2461 |
| 60 | 2462 | 61 | 2463 | 62 | 2464 | 63 | 2465 |
| 64 | 2466 | 65 | 2467 | 66 | 2468 | 67 | 2469 |
| 68 | 2470 | 69 | 2471 | 70 | 2472 | 71 | 2473 |
| 72 | 2474 | 73 | 2475 | 74 | 2476 | 75 | 2477 |
| 76 | 2478 | 77 | 2479 | 78 | 2480 | 79 | / |

## 4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

| Test mode | Low channel | Middle channel | High channel |
|---|---|---|---|
| Transmitting (GFSK, π/4 DQPSK, 8DPSK) | 2402MHz | 2441MHz | 2480MHz |
| Receiving (GFSK, π/4 DQPSK, 8DPSK) | 2402MHz | 2441MHz | 2480MHz |

## 4.6 Test Environment

| | |
|---|---|
| Humidity(%): | 54 |
| Atmospheric Pressure(kPa): | 101 |
| Normal Voltage(DC): | 3V |
| Normal Temperature(℃) | 23 |
| Low Temperature(℃) | 0 |
| High Temperature(℃) | 40 |

## 5. TEST FACILITY AND TEST INSTRUMENT USED

### 5.1 Test Facility

All measurement facilities used to collect the measurement data are located at 1&2F., Building A, No. 26, Xinhe Road, Xinqiao, Xinqiao Street, Bao'an District, Shenzhen, Guangdong, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

### 5.2 Test Instrument Used

| Item | Equipment | Manufacturer | Type No. | Serial No. | Calibrated until |
|---|---|---|---|---|---|
| 1 | Spectrum Analyzer | Agilent | N9020A | MY52090073 | 2023.07.19 |
| 2 | Power Sensor | Agilent | U2021XA | MY56120032 | 2023.07.19 |
| 3 | Power Sensor | Agilent | U2021XA | MY56120034 | 2023.07.19 |
| 4 | Communication test set | R&S | CMW500 | 108058 | 2023.07.19 |
| 5 | Spectrum Analyzer | KEYSIGHT | N9020A | MY51289897 | 2023.07.19 |
| 6 | Signal Generator | Agilent | N5181A | MY50140365 | 2023.07.19 |
| 7 | Vector signal generator | Agilent | N5182A | MY47420195 | 2023.07.19 |
| 8 | Communication test set | Agilent | E5515C | MY50102567 | 2023.07.19 |
| 9 | 2.4 GHz Filter | Shenxiang | MSF2400-2483.5MS-1154 | 20181015001 | 2023.07.19 |
| 10 | 5 GHz Filter | Shenxiang | MSF5150-5850 MS-1155 | 20181015001 | 2023.07.19 |
| 11 | Filter | Xingbo | XBLBQ-DZA120 | 190821-1-1 | 2023.07.19 |
| 12 | BT&WI-FI Automatic test software | Micowave | MTS8000 | Ver. 2.0.0.0 | / |
| 13 | Rohde & Schwarz SFU Broadcast Test System | R&S | SFU | 101017 | 2023.10.30 |
| 14 | Temperature humidity chamber | Hongjing | TH-80CH | DG-15174 | 2023.07.19 |
| 15 | 234G Automatic test software | Micowave | MTS8200 | Ver. 2.0.0.0 | / |
| 16 | 966 chamber | C.R.T. | 966 | / | 2024.08.11 |
| 17 | Receiver | R&S | ESPI | 100362 | 2023.07.19 |
| 18 | Amplifier | HP | 8447E | 2945A02747 | 2023.07.19 |
| 19 | Amplifier | Agilent | 8449B | 3008A01838 | 2023.07.19 |

| | | | | | |
|---|---|---|---|---|---|
| 20 | TRILOG Broadband Antenna | Schwarzbeck | VULB 9168 | 00869 | 2023.07.22 |
| 21 | Double Ridged Broadband Horn Antenna | Schwarzbeck | BBHA9120D | 01911 | 2023.07.22 |
| 22 | EMI test software | Fala | EZ-EMC | FA-03A2 RE | / |
| 23 | Loop Antenna | Schwarzbeck | FMZB 1519B | 1519B-224 | 2023.07.23 |
| 24 | loop antenna | ZHINAN | ZN30900A | GTS534 | / |
| 25 | 40G Horn antenna | A/H/System | SAS-574 | 588 | 2024.10.30 |
| 26 | Amplifier | AEROFLEX | Aeroflex | 097 | 2024.10.30 |

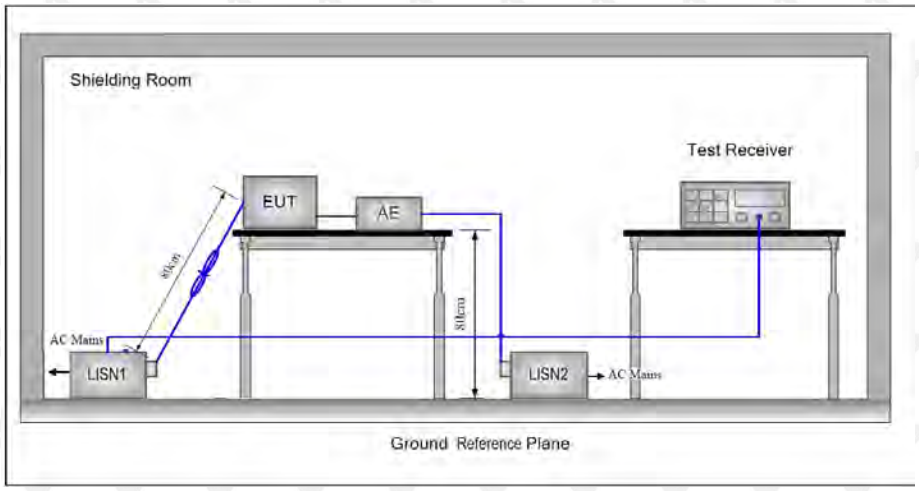
| Continuous disturbance | | | | | |
|---|---|---|---|---|---|
| No. | Equipment | Manufacturer | Model No. | Serial No. | Calibrated until |
| 1 | LISN | ROHDE&SCHWARZ | ESH3-Z5 | 100318 | 2023.07.19 |
| 2 | Pulse limiter | ROHDE&SCHWARZ | ESH3Z2 | 357881052 | 2023.07.19 |
| 3 | EMI TEST RECEIVER | ROHDE&SCHWARZ | ESCI | 100428/003 | 2023.07.19 |
| 4 | Coaxial cable | ZDECL | Z302S-NJ-SMAJ-12M | 18091905 | 2023.07.19 |
| 5 | ISN | Schwarzbeck | NTFM8158 | 183 | 2023.07.19 |
| 6 | Communication test set | Agilent | E5515C | MY50102567 | 2023.07.19 |
| 7 | Communication test set | R&S | CMW500 | 108058 | 2023.07.19 |
| 8 | EZ-EMC | Frad | EMC-con3A1.1 | / | / |

| Radiated emission | | | | | |
|---|---|---|---|---|---|
| No. | Equipment | Manufacturer | Model No. | Serial No. | Calibrated until |
| 1 | Double Ridged Broadband Horn Antenna | Schwarzbeck | BBHA 9120 D | 01911 | 2023.07.22 |
| 2 | TRILOG Broadband Antenna | Schwarzbeck | VULB 9168 | 00869 | 2023.07.22 |
| 3 | Amplifier | Agilent | 8449B | 3008A01838 | 2023.07.19 |
| 4 | Amplifier | HP | 8447E | 2945A02747 | 2023.07.19 |
| 5 | EMI TEST RECEIVER | ROHDE&SCHWARZ | ESCI | 100428/003 | 2023.07.19 |
| 6 | Coaxial cable | ETS | RFC-SNS-100-NMS-80 NI | / | 2023.07.19 |
| 7 | Coaxial cable | ETS | RFC-SNS-100-NMS-20 NI | / | 2023.07.19 |
| 8 | Coaxial cable | ETS | RFC-SNS-100-SMS-20 NI | / | 2023.07.19 |
| 9 | Coaxial cable | ETS | RFC-NNS-100 -NMS-300 NI | / | 2023.07.19 |
| 10 | Communication test set | Agilent | E5515C | MY50102567 | 2023.07.19 |
| 11 | Communication test set | R&S | CMW500 | 108058 | 2023.07.19 |

| | | | | | |
|---|---|---|---|---|---|
| 12 | EZ-EMC | Frad | EMC-con3A1.1 | / | / |

## 6. AC POWER LINE CONDUCTED EMISSION

### 6.1 Block Diagram Of Test Setup




### 6.2 Limit

**Table 4 – AC power-line conducted emissions limits**

| Frequency (MHz) | Conducted limit (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15 - 0.5 | 66 to 56[Note 1] | 56 to 46[Note 1] |
| 0.5 – 5 | 56 | 46 |
| 5 – 30 | 60 | 50 |

**Note 1:** The level decreases linearly with the logarithm of the frequency.

* Decreasing linearly with the logarithm of the frequency

### 6.3 Test procedure

1) The mains terminal disturbance voltage test was conducted in a shielded room.

2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.

3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,

4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0,4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane.

This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.

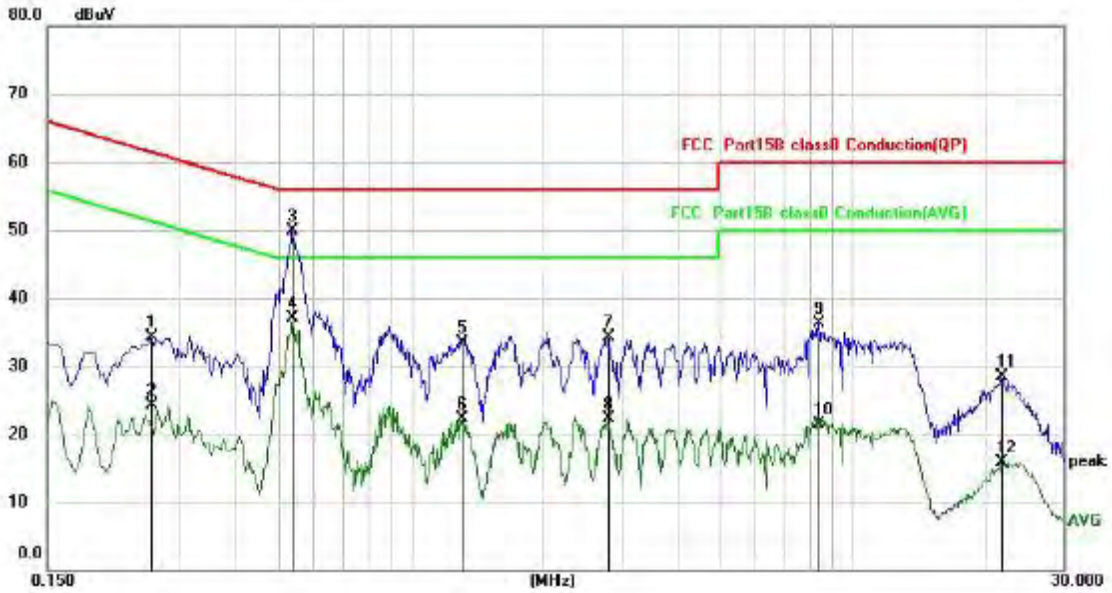
5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10:2013 on conducted measurement.

6) All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.

7) If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.

6.4 Test Result

**L: Worst case-GFSK(low channel)**

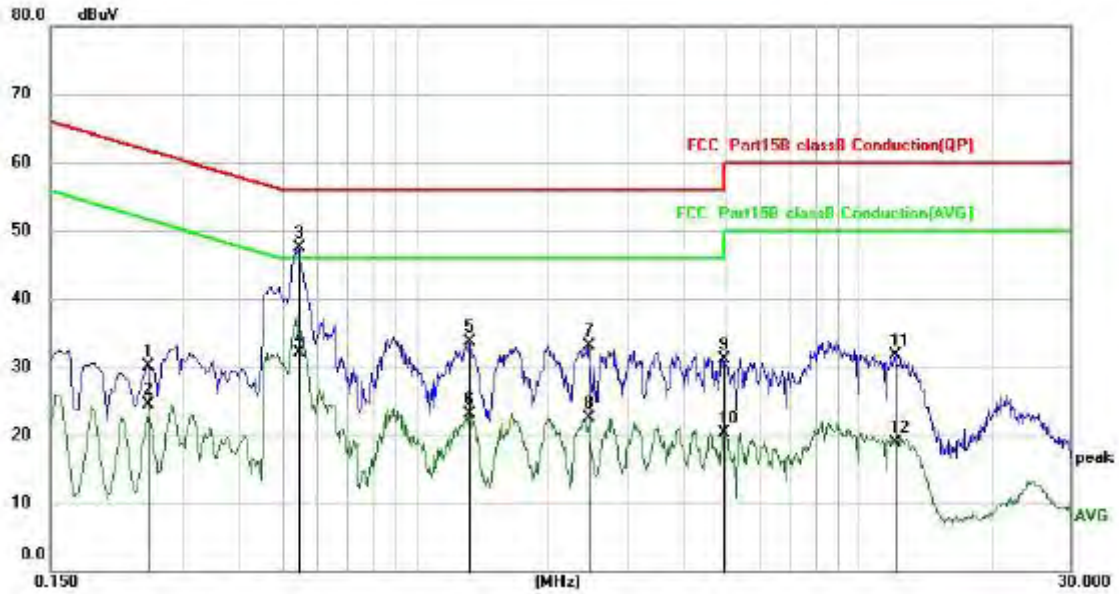



| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | |
|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector |
| 1 | | 0.2580 | 24.23 | 10.00 | 34.23 | 61.50 | -27.27 | QP |
| 2 | | 0.2580 | 14.22 | 10.00 | 24.22 | 51.50 | -27.28 | AVG |
| 3 | * | 0.5380 | 40.00 | 9.97 | 49.97 | 56.00 | -6.03 | QP |
| 4 | | 0.5380 | 27.08 | 9.97 | 37.05 | 46.00 | -8.95 | AVG |
| 5 | | 1.3020 | 23.55 | 9.99 | 33.54 | 56.00 | -22.46 | QP |
| 6 | | 1.3020 | 12.23 | 9.99 | 22.22 | 46.00 | -23.78 | AVG |
| 7 | | 2.7860 | 24.30 | 10.06 | 34.36 | 56.00 | -21.64 | QP |
| 8 | | 2.7860 | 12.21 | 10.06 | 22.27 | 46.00 | -23.73 | AVG |
| 9 | | 8.3540 | 25.95 | 10.29 | 36.24 | 60.00 | -23.76 | QP |
| 10 | | 8.3540 | 11.23 | 10.29 | 21.52 | 50.00 | -28.48 | AVG |
| 11 | | 21.6420 | 17.99 | 10.58 | 28.57 | 60.00 | -31.43 | QP |
| 12 | | 21.6420 | 5.37 | 10.58 | 15.95 | 50.00 | -34.05 | AVG |

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

**N:** Worst case-GFSK(low channel)




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | |
|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV | dBuV | dB | Detector |
| 1 | | 0.2500 | 20.18 | 10.00 | 30.18 | 61.76 | -31.58 | QP |
| 2 | | 0.2500 | 14.51 | 10.00 | 24.51 | 51.76 | -27.25 | AVG |
| 3 | * | 0.5460 | 37.54 | 9.97 | 47.51 | 56.00 | -8.49 | QP |
| 4 | | 0.5460 | 22.19 | 9.97 | 32.16 | 46.00 | -13.84 | AVG |
| 5 | | 1.3180 | 23.76 | 10.00 | 33.76 | 56.00 | -22.24 | QP |
| 6 | | 1.3180 | 13.01 | 10.00 | 23.01 | 46.00 | -22.99 | AVG |
| 7 | | 2.4500 | 23.06 | 10.05 | 33.11 | 56.00 | -22.89 | QP |
| 8 | | 2.4500 | 12.46 | 10.05 | 22.51 | 46.00 | -23.49 | AVG |
| 9 | | 4.9300 | 21.00 | 10.17 | 31.17 | 56.00 | -24.83 | QP |
| 10 | | 4.9300 | 10.16 | 10.17 | 20.33 | 46.00 | -25.67 | AVG |
| 11 | | 12.1059 | 21.29 | 10.40 | 31.69 | 60.00 | -28.31 | QP |
| 12 | | 12.1059 | 8.55 | 10.40 | 18.95 | 50.00 | -31.05 | AVG |

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

## 7. RADIATED SPURIOUS EMISSION

### 7.1 Block Diagram Of Test Setup

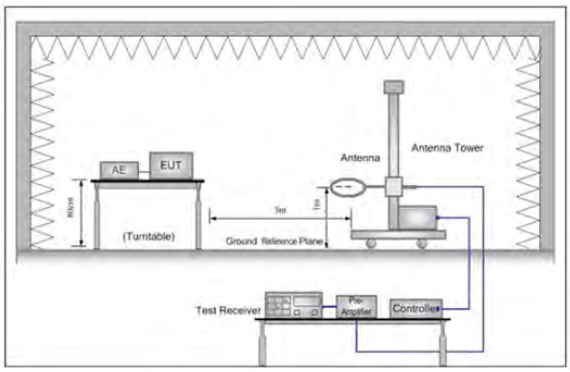



Figure 1. Below 30MHz

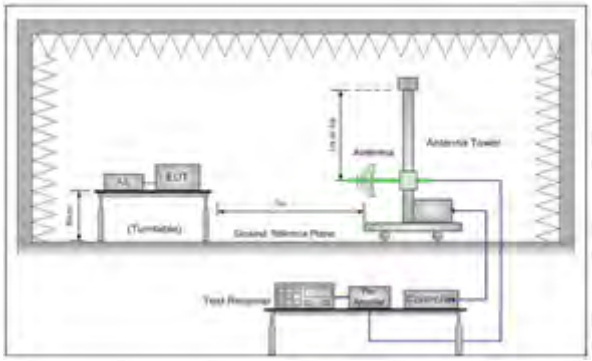


Figure 2. 30MHz to 1GHz

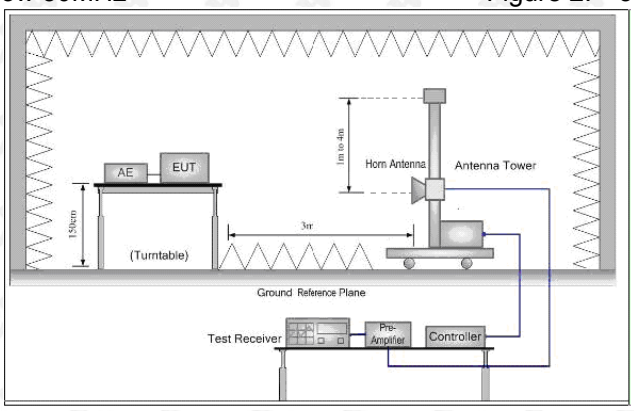



Figure 3. Above 1GHz

### 7.2 Limit

Spurious Emissions:

| Frequency | Field strength (microvolt/meter) | Limit (dBμV/m ) | Remark | Measurement distance (m) |
|---|---|---|---|---|
| 0.009MHz-0.490MHz | 2400/F(kHz) | - | - | 300 |
| 0.490MHz-1.705MHz | 24000/F(kHz) | - | - | 30 |
| 1.705MHz-30MHz | 30 | - | - | 30 |
| 30MHz-88MHz | 100 | 40.0 | Quasi-peak | 3 |
| 88MHz-216MHz | 150 | 43.5 | Quasi-peak | 3 |
| 216MHz-960MHz | 200 | 46.0 | Quasi-peak | 3 |
| 960MHz-1GHz | 500 | 54.0 | Quasi-peak | 3 |
| Above 1GHz | 500 | 54.0 | Average | 3 |

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

7.3 Test procedure

**Below 1GHz test procedure as below:**

a.The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b.The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c.The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d.For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.

e.The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f.If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

**Above 1GHz test procedure as below:**

g.Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter( Above 18GHz the distance is 1 meter and table is 1.5 meter).

h.Test the EUT in the lowest channel ,the middle channel ,the Highest channel

i.Repeat above procedures until all frequencies measured was complete.

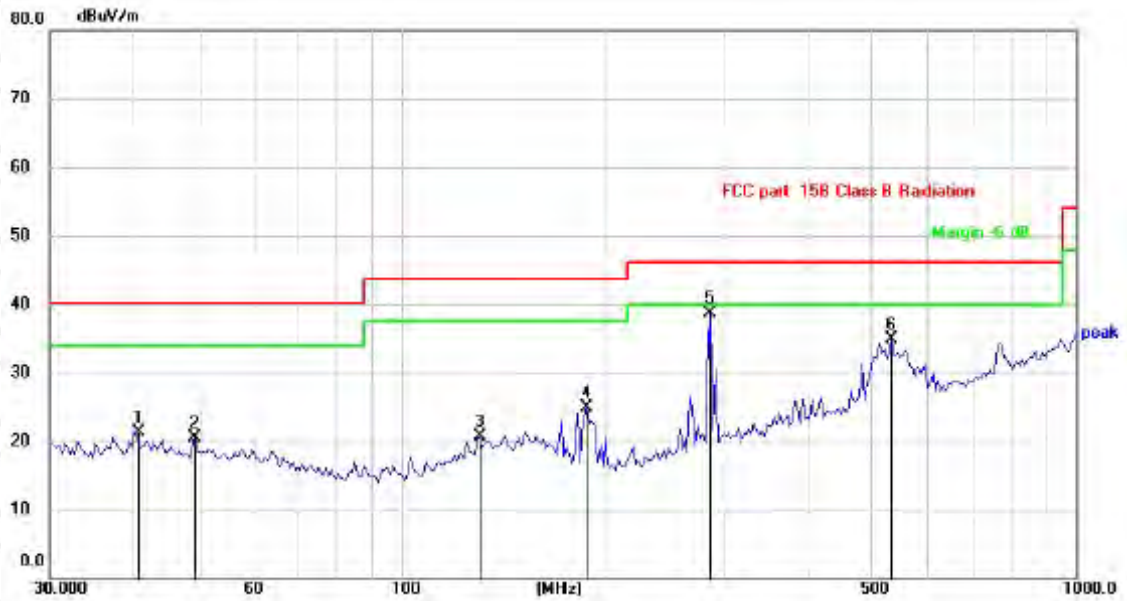
j. Full battery is usedduring test

Receiver set:

| Frequency | Detector | RBW | VBW | Remark |
|---|---|---|---|---|
| 0.009MHz-0.090MHz | Peak | 10kHz | 30KHz | Peak |
| 0.009MHz-0.090MHz | Average | 10kHz | 30KHz | Average |
| 0.090MHz-0.110MHz | Quasi-peak | 10kHz | 30KHz | Quasi-peak |
| 0.110MHz-0.490MHz | Peak | 10kHz | 30KHz | Peak |
| 0.110MHz-0.490MHz | Average | 10kHz | 30KHz | Average |
| 0.490MHz -30MHz | Quasi-peak | 10kHz | 30kHz | Quasi-peak |
| 30MHz-1GHz | Quasi-peak | 120 kHz | 300KHz | Quasi-peak |
| Above 1GHz | Peak | 1MHz | 3MHz | Peak |
| | Peak | 1MHz | 10Hz | Average |

7.4 Test Result

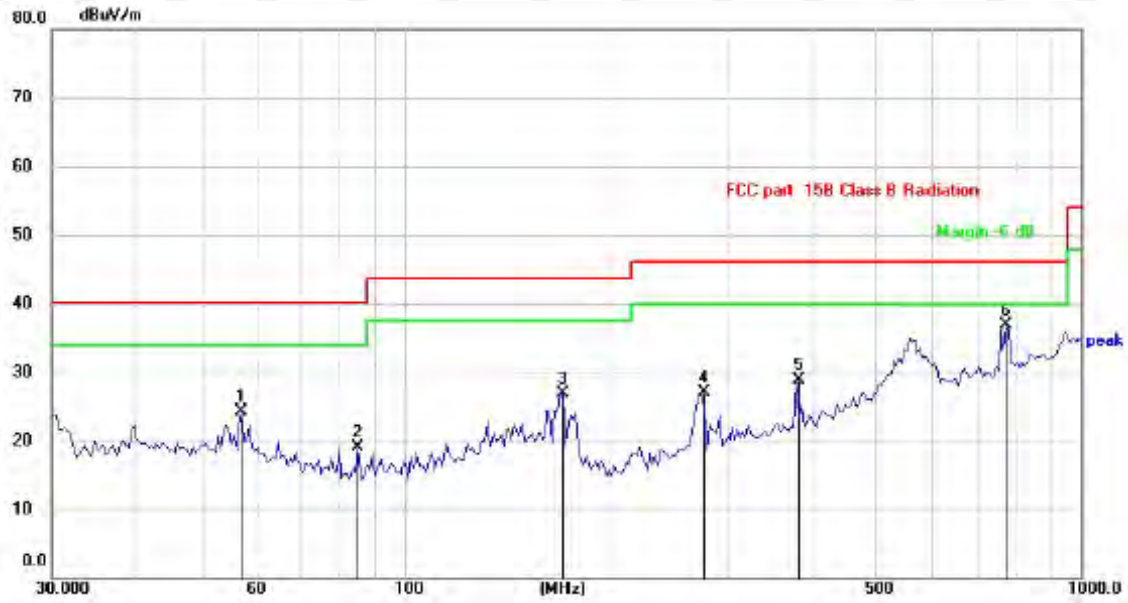
Below 1GHz Test Results:
Antenna polarity: H
Worst case-GFSK(low channel)




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | |
|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV/m | dB/m | dB | Detector |
| 1 | | 40.4172 | 27.79 | -6.48 | 21.31 | 40.00 | -18.69 | QP |
| 2 | | 49.4460 | 27.02 | -6.61 | 20.41 | 40.00 | -19.59 | QP |
| 3 | | 129.6950 | 26.99 | -6.35 | 20.64 | 43.50 | -22.86 | QP |
| 4 | | 189.0743 | 33.93 | -8.93 | 25.00 | 43.50 | -18.50 | QP |
| 5 | * | 287.9904 | 44.64 | -6.03 | 38.61 | 46.00 | -7.39 | QP |
| 6 | | 536.6473 | 33.98 | 0.92 | 34.90 | 46.00 | -11.10 | QP |

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement– Limit

Antenna polarity: V
Worst case-GFSK(low channel)




| No. | Mk. | Freq. | Reading Level | Correct Factor | Measure-ment | Limit | Over | |
|---|---|---|---|---|---|---|---|---|
| | | MHz | dBuV | dB | dBuV/m | dB/m | dB | Detector |
| 1 | | 57.3923 | 31.71 | -7.31 | 24.40 | 40.00 | -15.60 | QP |
| 2 | | 85.1486 | 29.48 | -10.35 | 19.13 | 40.00 | -20.87 | QP |
| 3 | | 171.6933 | 33.88 | -6.88 | 27.00 | 43.50 | -16.50 | QP |
| 4 | | 275.6399 | 33.68 | -6.61 | 27.07 | 46.00 | -18.93 | QP |
| 5 | | 381.2487 | 31.99 | -3.17 | 28.82 | 46.00 | -17.18 | QP |
| 6 | * | 775.5169 | 31.68 | 5.31 | 36.99 | 46.00 | -9.01 | QP |

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement– Limit

Above 1 GHz Test Results:

CH Low (2402MHz)
Horizontal:

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4804 | 57.64 | -3.65 | 53.99 | 74.00 | -20.01 | peak |
| 4804 | 49.21 | -3.65 | 45.56 | 54.00 | -8.44 | AVG |
| 7206 | 59.04 | -0.95 | 58.09 | 74.00 | -15.91 | peak |
| 7206 | 42.56 | -0.95 | 41.61 | 54.00 | -12.39 | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

Vertical:

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4804 | 59.02 | -3.65 | 55.37 | 74.00 | -18.63 | peak |
| 4804 | 48.93 | -3.65 | 45.28 | 54.00 | -8.72 | AVG |
| 7206 | 59.90 | -0.95 | 58.95 | 74.00 | -15.05 | peak |
| 7206 | 41.14 | -0.95 | 40.19 | 54.00 | -13.81 | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

CH Middle (2441MHz)
Horizontal:

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4882.00 | 58.22 | -3.54 | 54.68 | 74.00 | -19.32 | peak |
| 4882.00 | 48.22 | -3.54 | 44.68 | 54.00 | -9.32 | AVG |
| 7323.00 | 56.63 | -0.81 | 55.82 | 74.00 | -18.18 | peak |
| 7323.00 | 43.00 | -0.81 | 42.19 | 54.00 | -11.81 | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

Vertical:

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4882.00 | 56.83 | -3.54 | 53.29 | 74.00 | -20.71 | peak |
| 4882.00 | 50.97 | -3.54 | 47.43 | 54.00 | -6.57 | AVG |
| 7323.00 | 58.05 | -0.81 | 57.24 | 74.00 | -16.76 | peak |
| 7323.00 | 41.58 | -0.81 | 40.77 | 54.00 | -13.23 | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

CH High (2480MHz)
Horizontal:

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4960 | 56.66 | -3.43 | 53.23 | 74.00 | -20.77 | peak |
| 4960 | 48.79 | -3.44 | 45.35 | 54.00 | -8.65 | AVG |
| 7440 | 61.09 | -0.77 | 60.32 | 74.00 | -13.68 | peak |
| 7440 | 40.47 | -0.77 | 39.70 | 54.00 | -14.30 | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

Vertical:

| Frequency (MHz) | Reading Result (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 4960 | 57.16 | -3.43 | 53.73 | 74.00 | -20.27 | peak |
| 4960 | 49.30 | -3.44 | 45.86 | 54.00 | -8.14 | AVG |
| 7440 | 60.15 | -0.77 | 59.38 | 74.00 | -14.62 | peak |
| 7440 | 42.32 | -0.77 | 41.55 | 54.00 | -12.45 | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

The test range is 9K ~10 times the main wave, and other spurious below the limit of 20dB will not be reflected in the report

**Restricted bands around fundamental frequency (Radiated)**

hopping
Operation Mode: TX CH Low (2402MHz)
Horizontal (Worst case-GFSK)

| Frequency | Meter Reading | Factor | Emission Level | Limits | Margin | Detector Type |
|---|---|---|---|---|---|---|
| (MHz) | (dBμV) | (dB) | (dBμV/m) | (dBμV/m) | (dB) | |
| 2310.00 | 57.46 | -5.81 | 51.65 | 74.00 | -22.35 | peak |
| 2310.00 | / | -5.81 | / | 54.00 | / | AVG |
| 2390.00 | 55.00 | -5.84 | 49.16 | 74.00 | -24.84 | peak |
| 2390.00 | / | -5.84 | / | 54.00 | / | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

Vertical:

| Frequency | Meter Reading | Factor | Emission Level | Limits | Margin | Detector Type |
|---|---|---|---|---|---|---|
| (MHz) | (dBμV) | (dB) | (dBμV/m) | (dBμV/m) | (dB) | |
| 2310.00 | 57.08 | -5.81 | 51.27 | 74.00 | -22.73 | peak |
| 2310.00 | / | -5.81 | / | 54.00 | / | AVG |
| 2390.00 | 56.73 | -5.84 | 50.89 | 74.00 | -23.11 | peak |
| 2390.00 | / | -5.84 | / | 54.00 | / | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission Margin = Emission level - Limits | | | | | | |

When the peak value is smaller than the AVG limit, AVG is not reflected.

Operation Mode: TX CH High (2480MHz)
Horizontal (Worst case-GFSK)

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2483.50 | 54.12 | -5.81 | 48.31 | 74.00 | -25.69 | peak |
| 2483.50 | / | -5.81 | / | 54.00 | / | AVG |
| 2500.00 | 53.17 | -6.06 | 47.11 | 74.00 | -26.89 | peak |
| 2500.00 | / | -6.06 | / | 54.00 | / | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

Vertical:

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2483.50 | 56.29 | -5.81 | 50.48 | 74.00 | -23.52 | peak |
| 2483.50 | / | -5.81 | / | 54.00 | / | AVG |
| 2500.00 | 53.69 | -6.06 | 47.63 | 74.00 | -26.37 | peak |
| 2500.00 | / | -6.06 | / | 54.00 | / | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |
| Remark: All the other emissions not reported were too low to read and deemed to comply with FCC limit. | | | | | | |

When the peak value is smaller than the AVG limit, AVG is not reflected.

NO hopping

Operation Mode: TX CH Low (2402MHz)
Horizontal (Worst case-GFSK)

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2310.00 | 56.55 | -5.81 | 50.74 | 74.00 | -23.26 | peak |
| 2310.00 | / | -5.81 | / | 54.00 | / | AVG |
| 2390.00 | 53.94 | -5.84 | 48.10 | 74.00 | -25.90 | peak |
| 2390.00 | / | -5.84 | / | 54.00 | / | AVG |

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2310.00 | 55.28 | -5.81 | 49.47 | 74.00 | -24.53 | peak |
| 2310.00 | / | -5.81 | / | 54.00 | / | AVG |
| 2390.00 | 53.34 | -5.84 | 47.50 | 74.00 | -26.50 | peak |
| 2390.00 | / | -5.84 | / | 54.00 | / | AVG |

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

When the peak value is smaller than the AVG limit, AVG is not reflected.

Operation Mode: TX CH High (2480MHz)
Horizontal (Worst case-GFSK)

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2483.50 | 56.43 | -5.81 | 50.62 | 74.00 | -23.38 | peak |
| 2483.50 | / | -5.81 | / | 54.00 | / | AVG |
| 2500.00 | 55.43 | -6.06 | 49.37 | 74.00 | -24.63 | peak |
| 2500.00 | / | -6.06 | / | 54.00 | / | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |

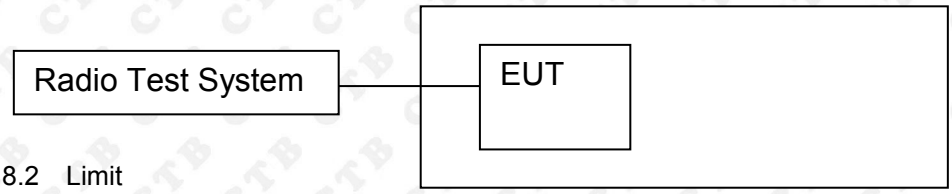
Vertical:

| Frequency (MHz) | Meter Reading (dBμV) | Factor (dB) | Emission Level (dBμV/m) | Limits (dBμV/m) | Margin (dB) | Detector Type |
|---|---|---|---|---|---|---|
| 2483.50 | 56.83 | -5.81 | 51.02 | 74.00 | -22.98 | peak |
| 2483.50 | / | -5.81 | / | 54.00 | / | AVG |
| 2500.00 | 55.28 | -6.06 | 49.22 | 74.00 | -24.78 | peak |
| 2500.00 | / | -6.06 | / | 54.00 | / | AVG |
| Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits | | | | | | |
| Remark: All the other emissions not reported were too low to read and deemed to comply with FCC limit. | | | | | | |

When the peak value is smaller than the AVG limit, AVG is not reflected.

## 8. BAND EDGE AND RF COUNDUCTED SPURIOUS EMISSIONS

### 8.1 Block Diagram Of Test Setup




### 8.2 Limit

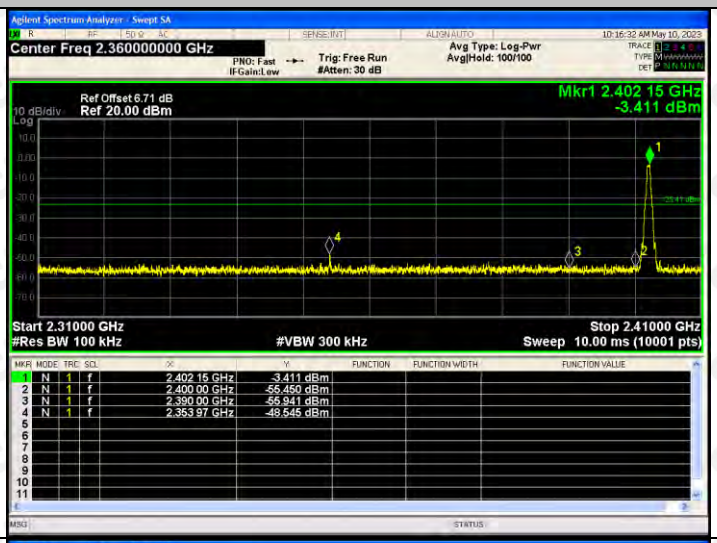
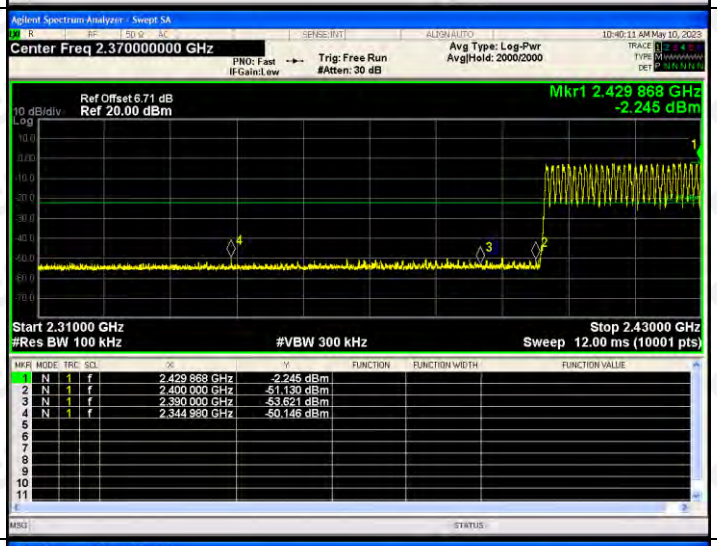
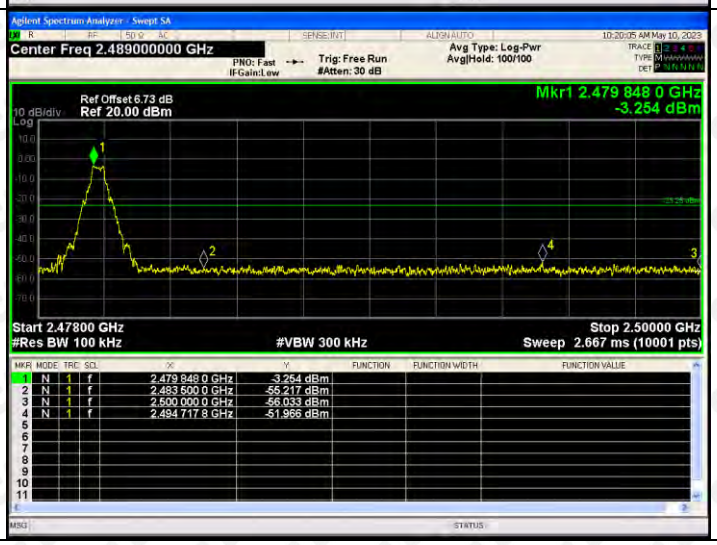
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the 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)).

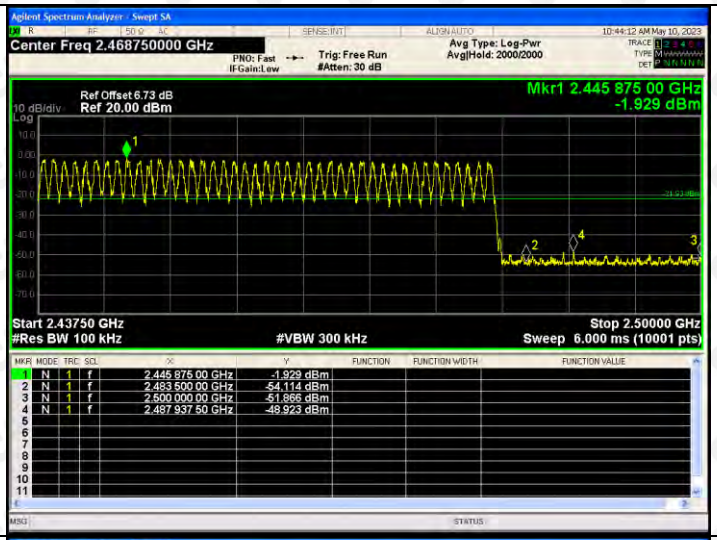
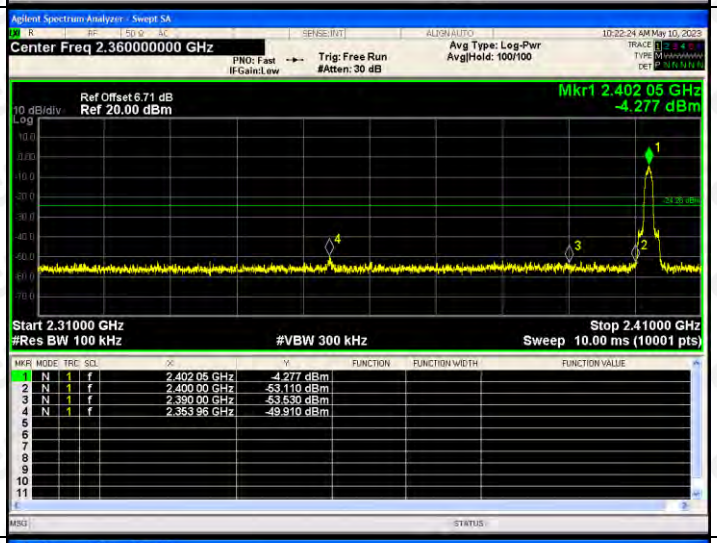
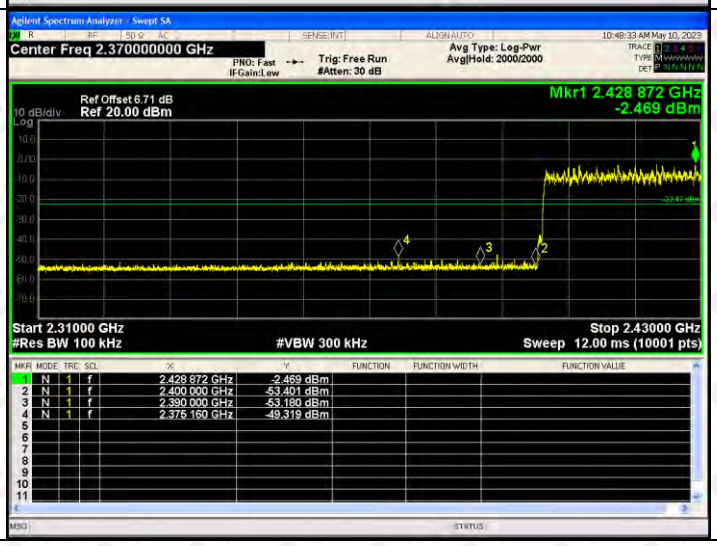
### 8.3 Test procedure

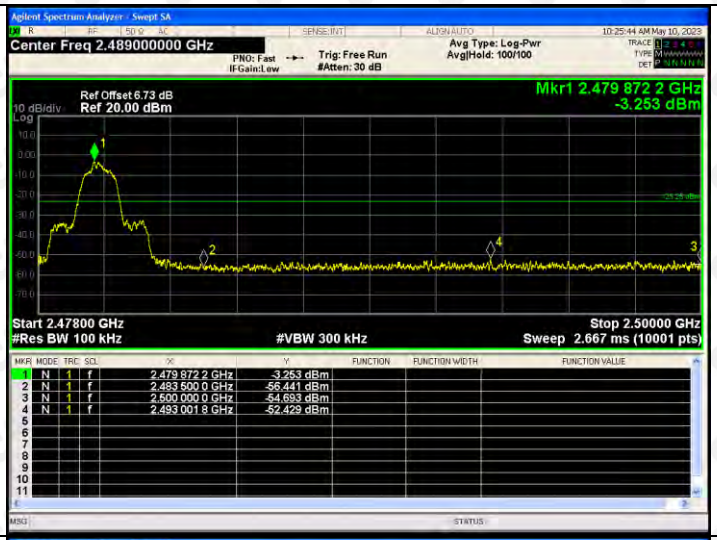
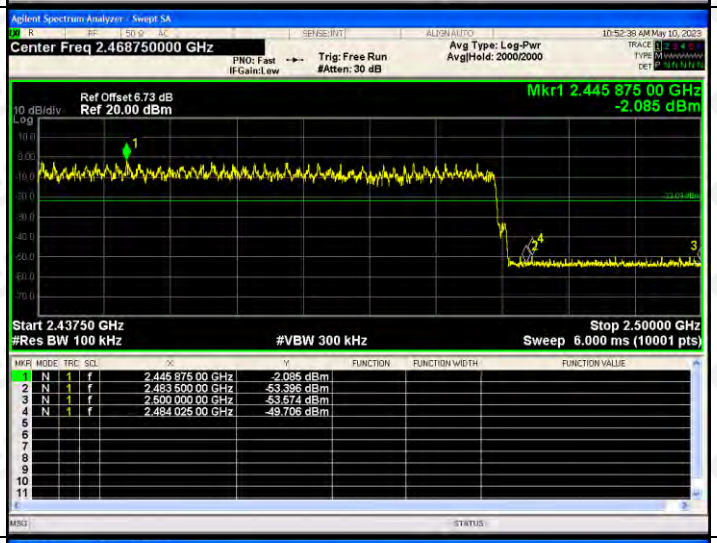
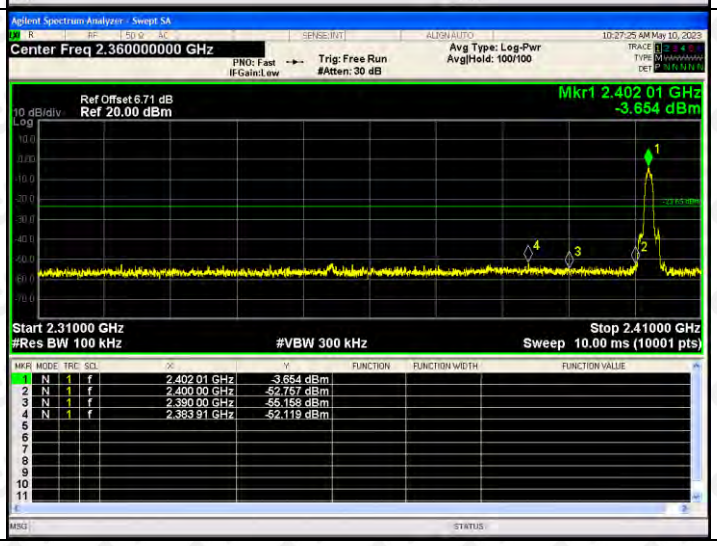
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:

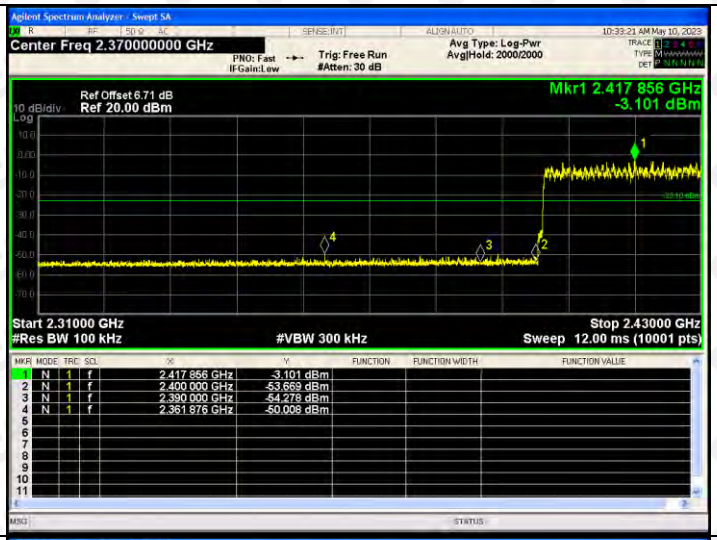
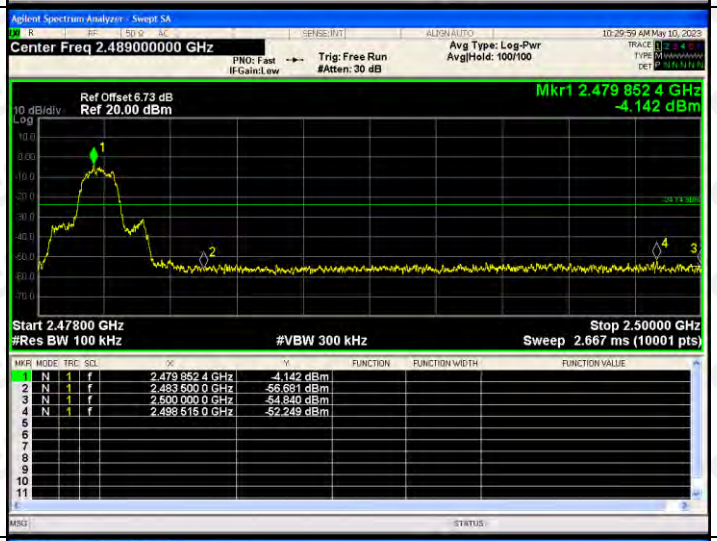
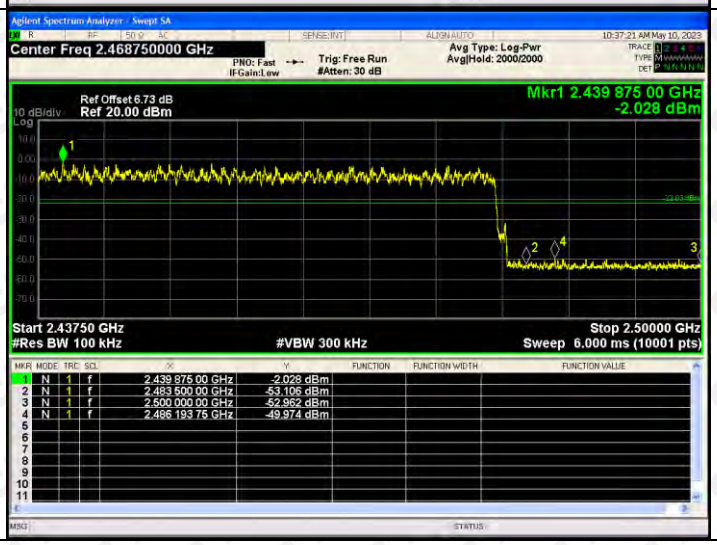
Blow 30MHz:
RBW = 100kHz, VBW = 300kHz, Sweep = auto
Detector function = peak, Trace = max hold
Above 30MHz:
RBW = 100KHz, VBW = 300KHz, Sweep = auto
Detector function = peak, Trace = max hold

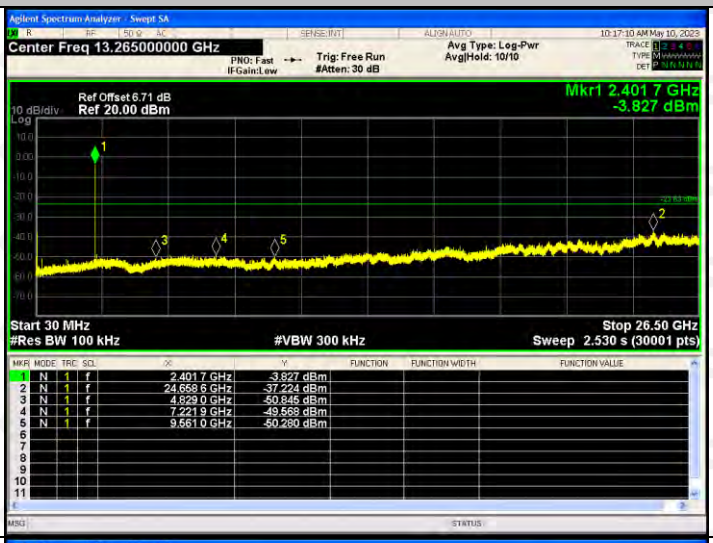
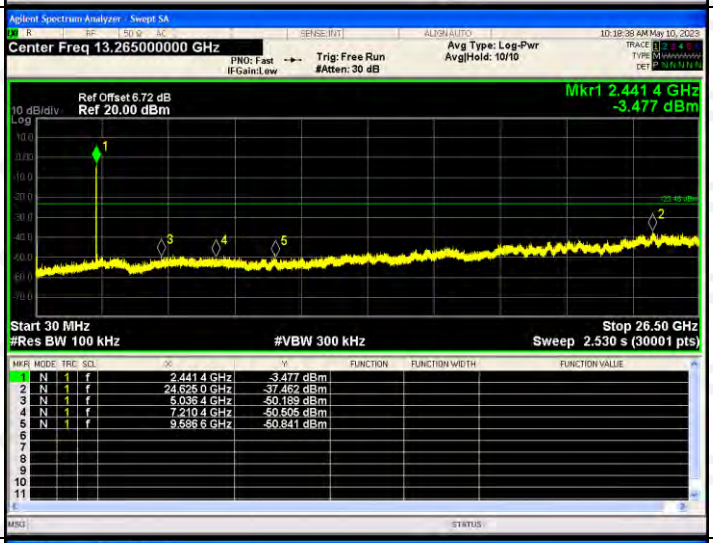
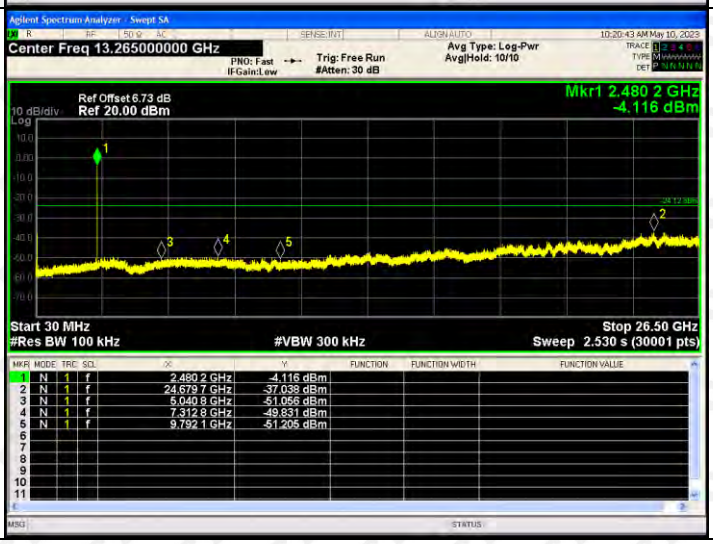
## 8.4 Test Result

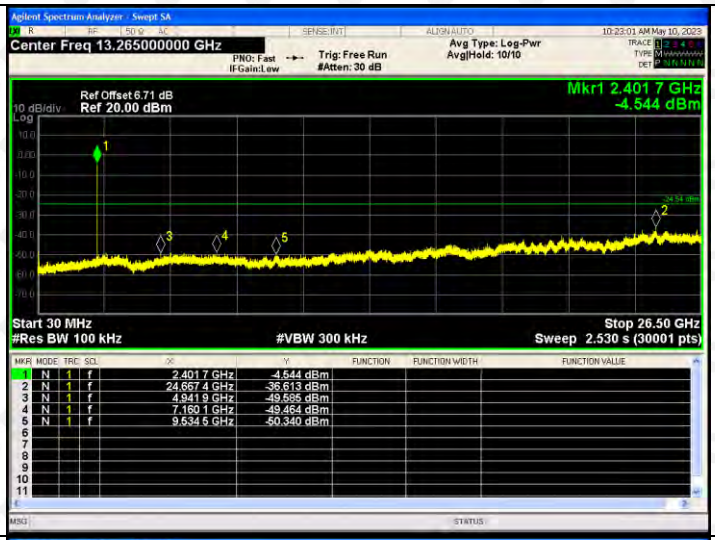
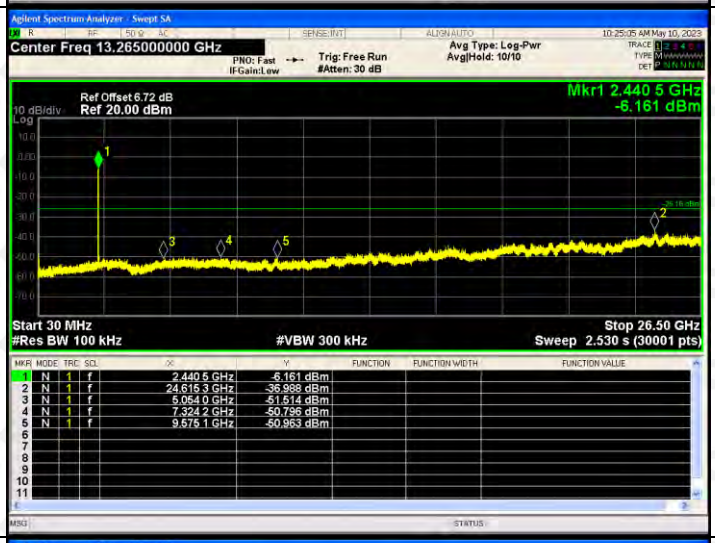
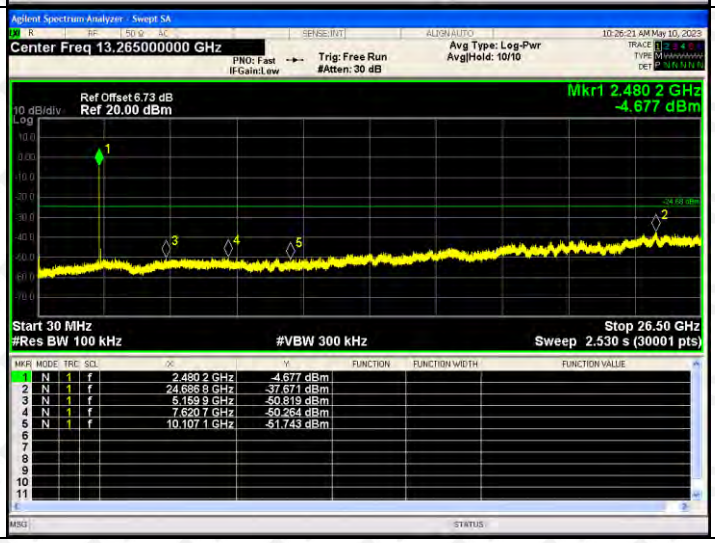
| BAND EDGE Graphs | | | |
|---|---|---|---|
| GFSK/LCH/ No Hop | |  | |
| GFSK/LCH/ Hop | |  | |
| GFSK/HCH/ No Hop | |  | |

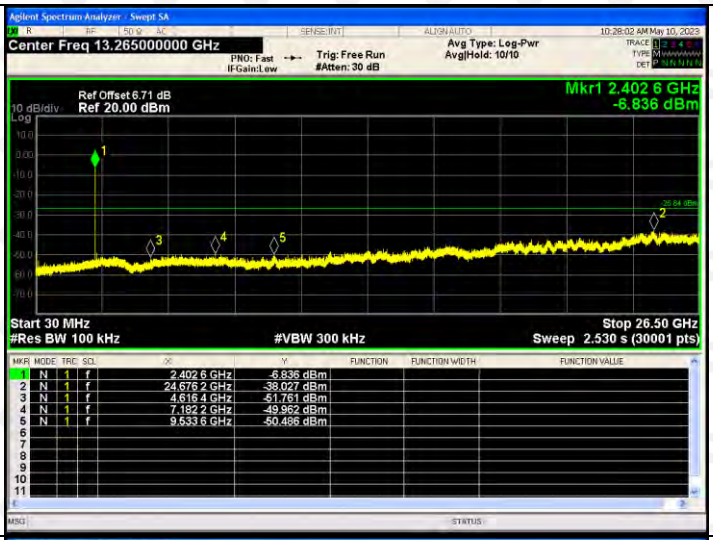
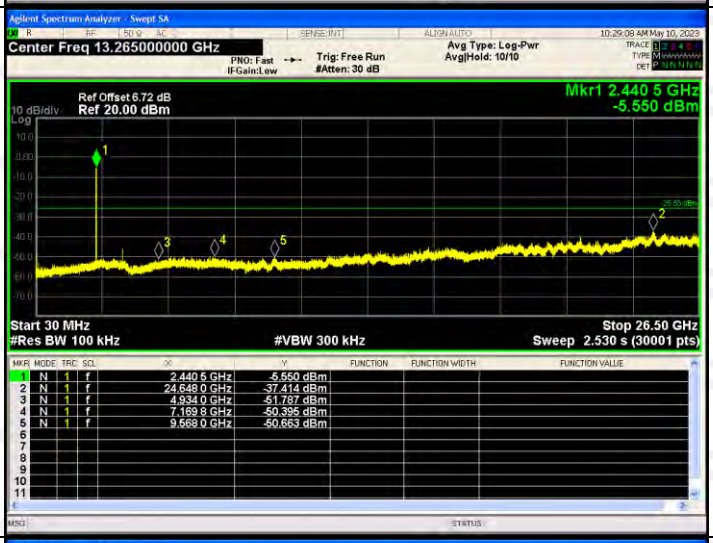
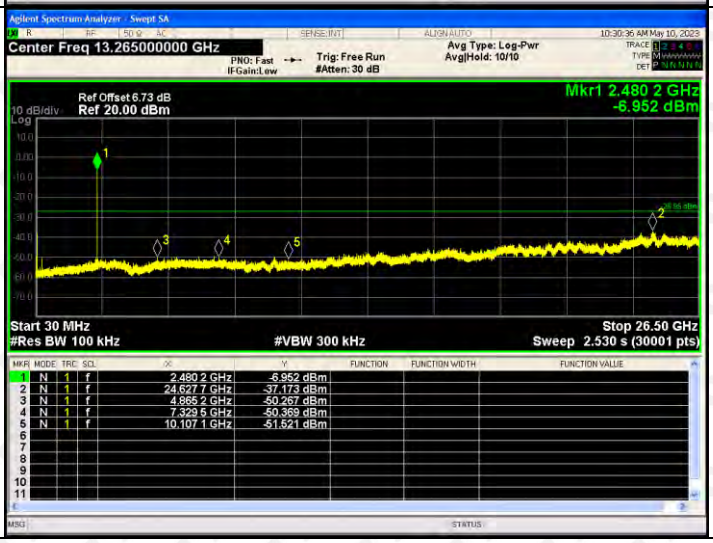
| | | | |
|---|---|---|---|
| GFSK/HCH/ Hop | |  | |
| π/4DQPSK/LCH/ No Hop | |  | |
| π/4DQPSK/LCH/ Hop | |  | |

| | | | |
|---|---|---|---|
| π/4DQPSK/HCH/ No Hop | |  | |
| π/4DQPSK/HCH/ Hop | |  | |
| 8DPSK/LCH/No Hop | |  | |

| | | | |
|---|---|---|---|
| 8DPSK /LCH/Hop | |  | |
| 8DPSK /HCH/No Hop | |  | |
| 8DPSK /HCH/Hop | |  | |

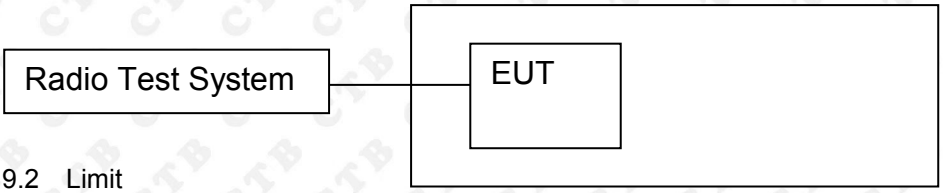
| RF Conducted Spurious Emissions Graphs | | | |
|---|---|---|---|
| GFSK/LCH | |  | |
| GFSK/MCH | |  | |
| GFSK/HCH | |  | |

| | | | |
|---|---|---|---|
| π/4DQPSK /LCH | |  | |
| π/4DQPSK/MCH | |  | |
| π/4DQPSK/HCH | |  | |

| | | | |
|---|---|---|---|
| 8DPSK /LCH | |  | |
| 8DPSK /MCH | |  | |
| 8DPSK /HCH | |  | |

## 9. COUDUCTED PEAK OUTPUT POWER

### 9.1 Block Diagram Of Test Setup




### 9.2 Limit

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.

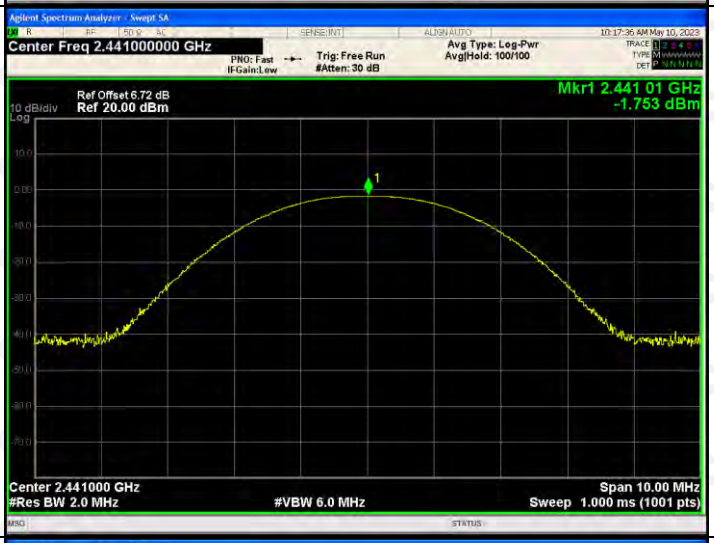
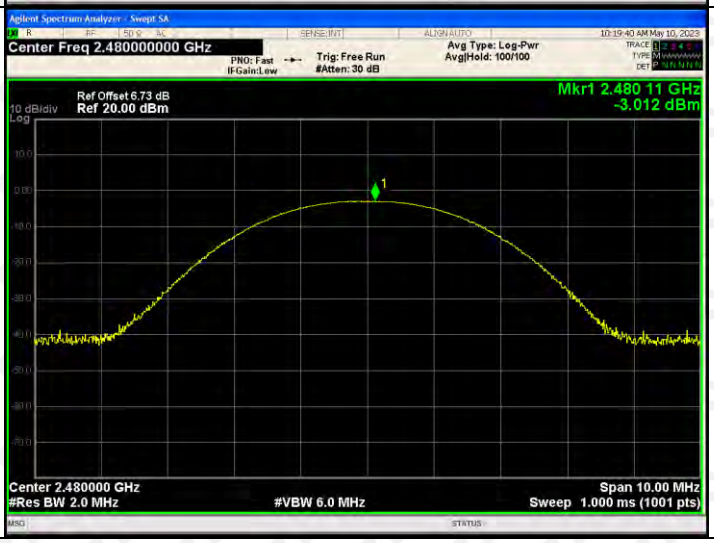
### 9.3 Test procedure

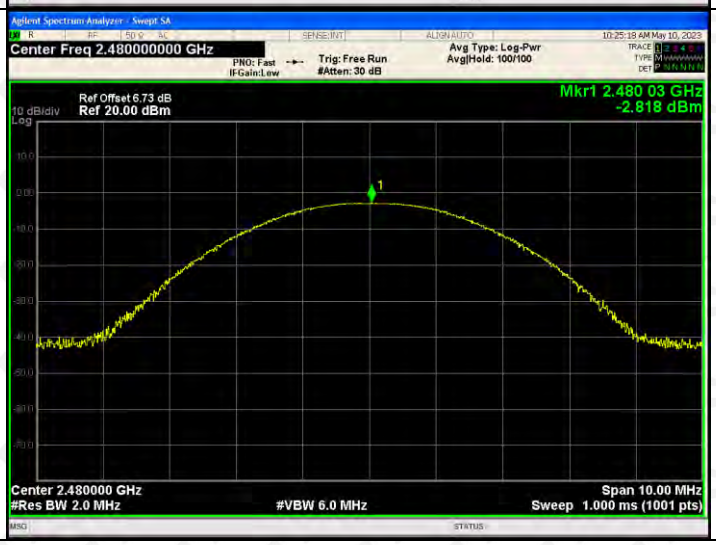
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 2MHz. VBW = 6MHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

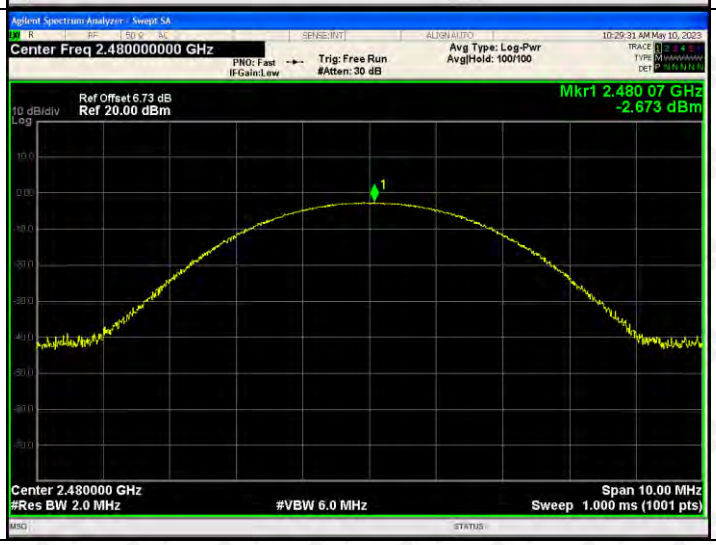
9.4 Test Result

| Mode | Channel. | Maximum Peak Output Power [dBm] | Limit [dBm] | Verdict |
|---|---|---|---|---|
| EDR mode (GFSK) | LCH | -2.889 | 20.97 | PASS |
| | MCH | -1.753 | 20.97 | PASS |
| | HCH | -3.012 | 20.97 | PASS |
| EDR mode (π/4DQPSK) | LCH | -2.383 | 20.97 | PASS |
| | MCH | -1.437 | 20.97 | PASS |
| | HCH | -2.818 | 20.97 | PASS |
| EDR mode (8DPSK) | LCH | -2.257 | 20.97 | PASS |
| | MCH | -1.311 | 20.97 | PASS |
| | HCH | -2.673 | 20.97 | PASS |

**Test Graph:**

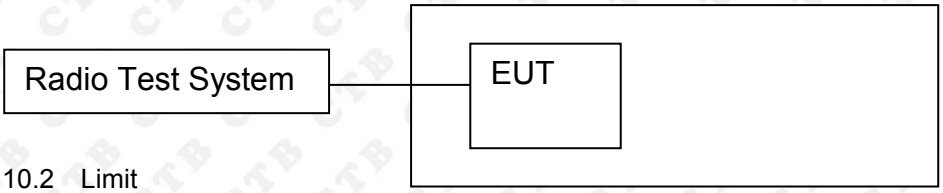
| Graphs | | | |
|---|---|---|---|
| GFSK/LCH | | | |
| GFSK/MCH | |  | |
| GFSK/HCH | |  | |

| | | | |
|---|---|---|---|
| π/4DQPSK/LCH | | | |
| π/4DQPSK/MCH | | | |
| π/4DQPSK/HCH | |  | |

| | | | |
|---|---|---|---|
| 8DPSK/LCH | | | |
| 8DPSK /MCH | | | |
| 8DPSK /HCH | |  | |

## 10. 20DB OCCUPIED BANDWIDTH

### 10.1 Block Diagram Of Test Setup




### 10.2 Limit

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

### 10.3 Test procedure

1. Rem1. Set RBW = 30 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

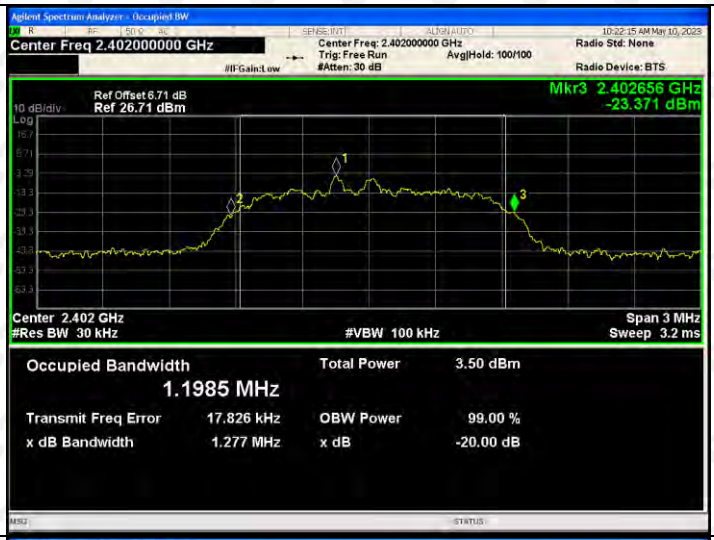
### 10.4 Test Result

| Test Mode | Frequency | 20dB Bandwidth (MHz) | Result |
|---|---|---|---|
| GFSK | Low channel | 0.913 | **PASS** |
| | Mid channel | 0.977 | **PASS** |
| | High channel | 0.919 | **PASS** |
| π/4DQPSK | Low channel | 1.277 | **PASS** |
| | Mid channel | 1.281 | **PASS** |
| | High channel | 1.276 | **PASS** |
| 8DPSK | Low channel | 1.306 | **PASS** |
| | Mid channel | 1.32 | **PASS** |
| | High channel | 1.288 | **PASS** |

Note: All modes of operation were Pre-scan and the worst-case emissions are reported.

Test Graph:

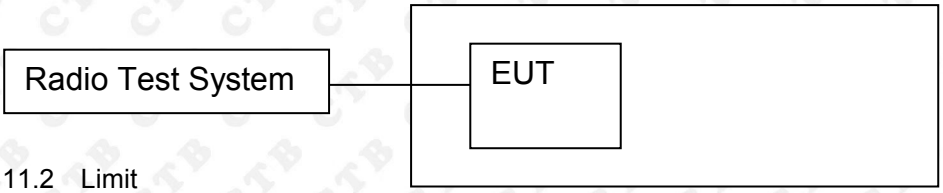
| | | | |
|---|---|---|---|
| GFSK<br>Low channel | | | |
| GFSK<br>Mid channel | | | |
| GFSK<br>High channel | | | |

| | | | |
|---|---|---|---|
| π/4-DQPSK<br>Low channel | |  | |
| π/4-DQPSK<br>Mid channel | | | |
| π/4-DQPSK<br>High channel | | | |

| | | | |
|---|---|---|---|
| 8DPSK<br>Low channel | | | |
| 8DPSK<br>Mid channel | | | |
| 8DPSK<br>High channel | | | |

## 11. CARRIERFREQUENCIES SEPARATION

### 11.1 Block Diagram Of Test Setup




### 11.2 Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125W.

### 11.3 Test procedure

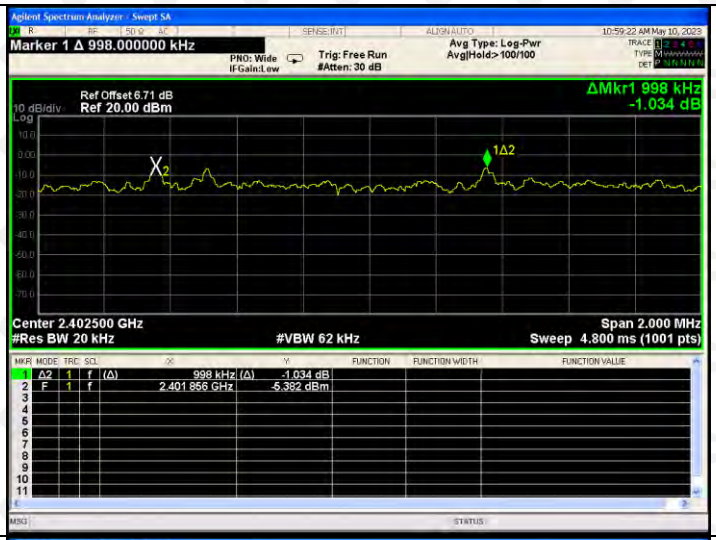
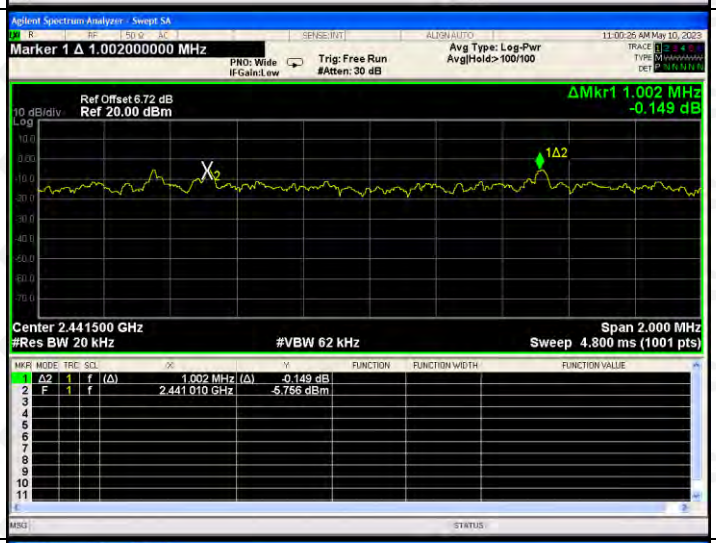
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz , Span = 2MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section Submit this plot.

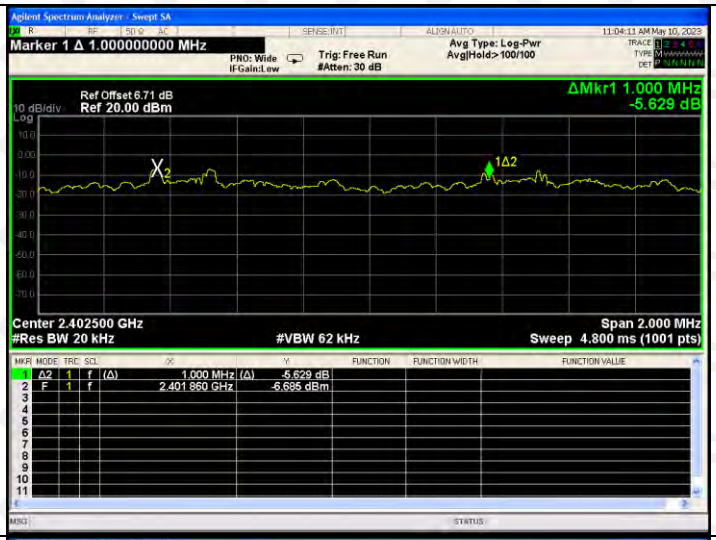
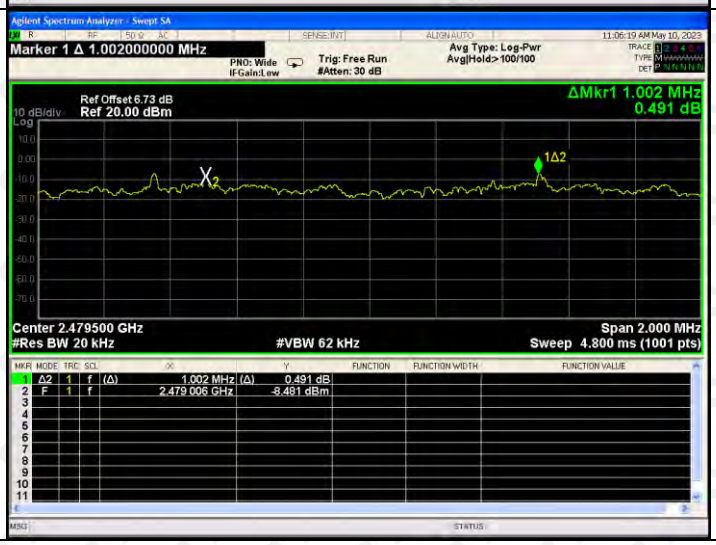
### 11.4 Test Result

| Mode | Channel. | Carrier Frequency Separation [MHz] | Limit(2/3 of the 20dB bandwidth MHz) | Verdict |
|---|---|---|---|---|
| GFSK | LCH | 0.998 | 0.609 | PASS |
| GFSK | MCH | 1.002 | 0.651 | PASS |
| GFSK | HCH | 0.994 | 0.613 | PASS |
| π/4DQPSK | LCH | 0.998 | 0.851 | PASS |
| π/4DQPSK | MCH | 1.002 | 0.854 | PASS |
| π/4DQPSK | HCH | 1.002 | 0.851 | PASS |
| 8DPSK | LCH | 1.000 | 0.871 | PASS |
| 8DPSK | MCH | 1.002 | 0.880 | PASS |
| 8DPSK | HCH | 1.002 | 0.859 | PASS |

**Test Graph**

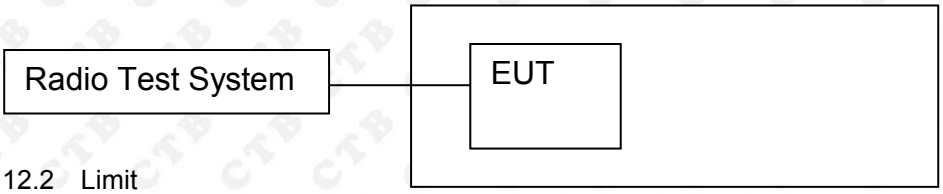
| Graphs | | | |
|---|---|---|---|
| GFSK/LCH | | | |
| GFSK/MCH | | | |
| GFSK/HCH | | | |

| | | | |
|---|---|---|---|
| π/4DQPSK/LCH | |  | |
| π/4DQPSK/MCH | |  | |
| π/4DQPSK/HCH | | | |

| | | | |
|---|---|---|---|
| 8DPSK/LCH | |  | |
| 8DPSK /MCH | | | |
| 8DPSK /HCH | |  | |

## 12. HOPPING CHANNEL NUMBER

### 12.1 Block Diagram Of Test Setup




### 12.2 Limit

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

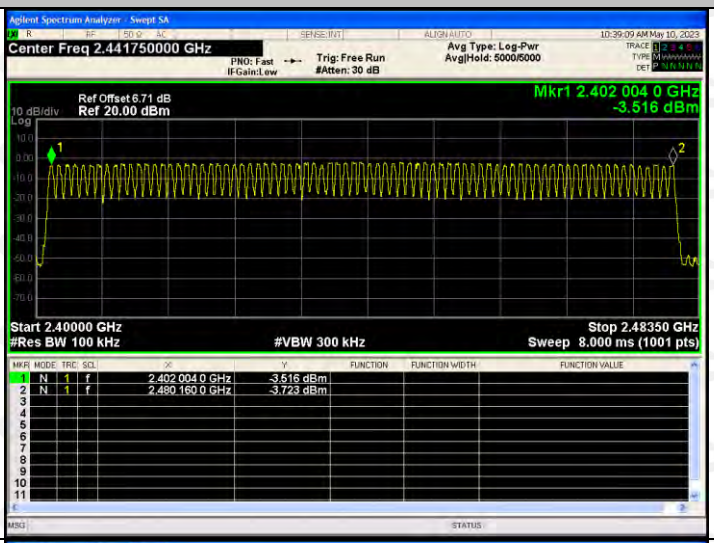
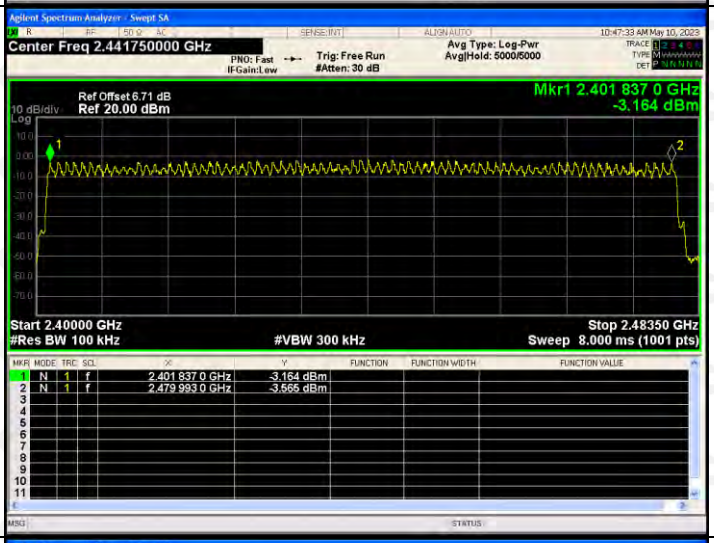
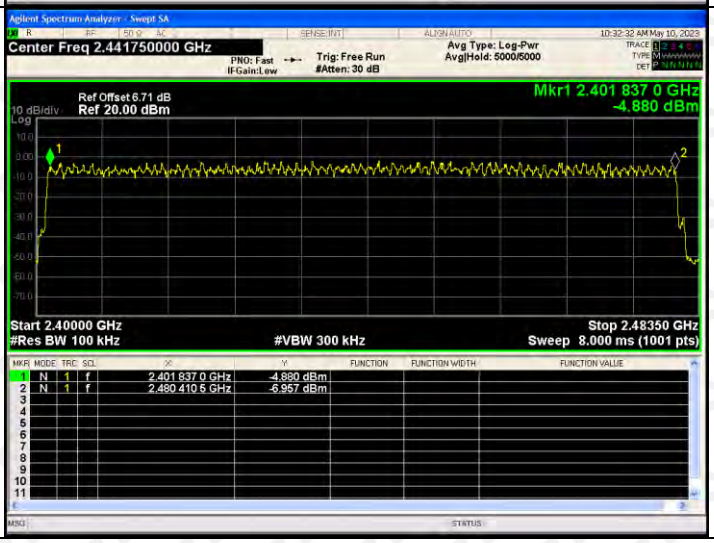
### 12.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100kHz. VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

### 12.4 Test Result

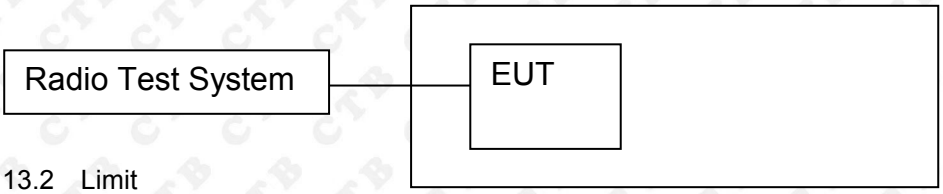
| Mode | Channel. | Number of Hopping Channel | Limit | Verdict |
|---|---|---|---|---|
| GFSK | Hop | 79 | ⩾15 | PASS |
| π/4DQPSK | Hop | 79 | ⩾15 | PASS |
| 8DPSK | Hop | 79 | ⩾15 | PASS |

**Test Graph**

| Graphs | | | |
|---|---|---|---|
| GFSK/Hop | |  | |
| π/4DQPSK/Hop | |  | |
| 8DPSK/Hop | |  | |

## 13. DWELL TIME

### 13.1 Block Diagram Of Test Setup




### 13.2 Limit

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.

### 13.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz.Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

13.4 Test Result

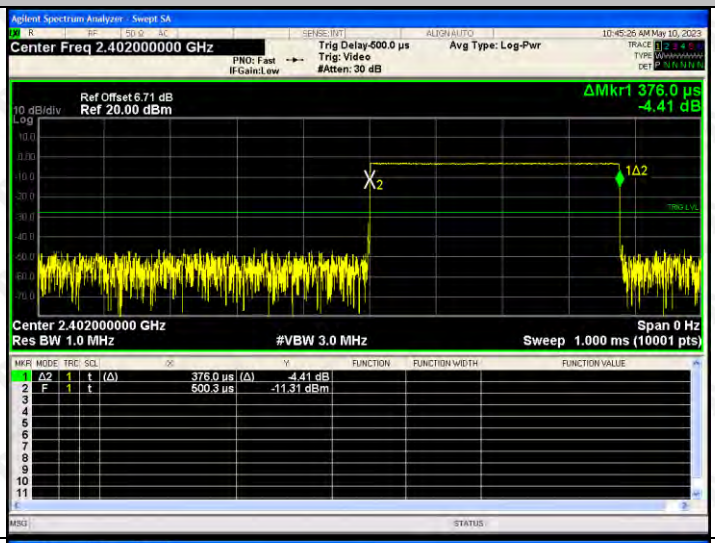
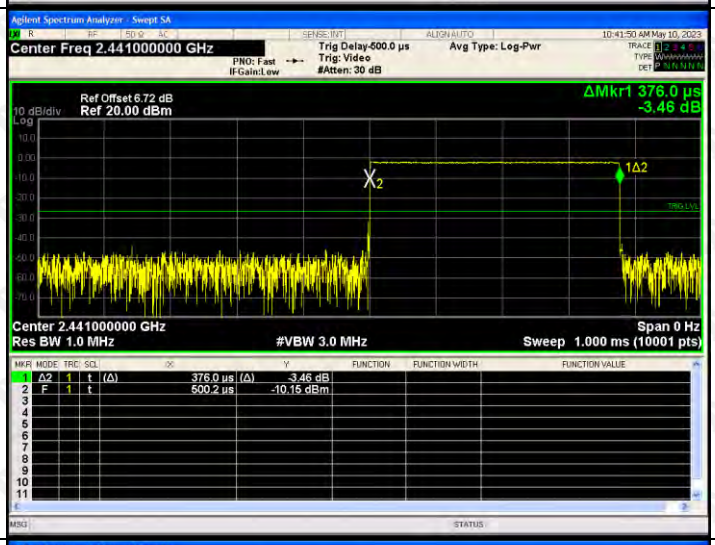
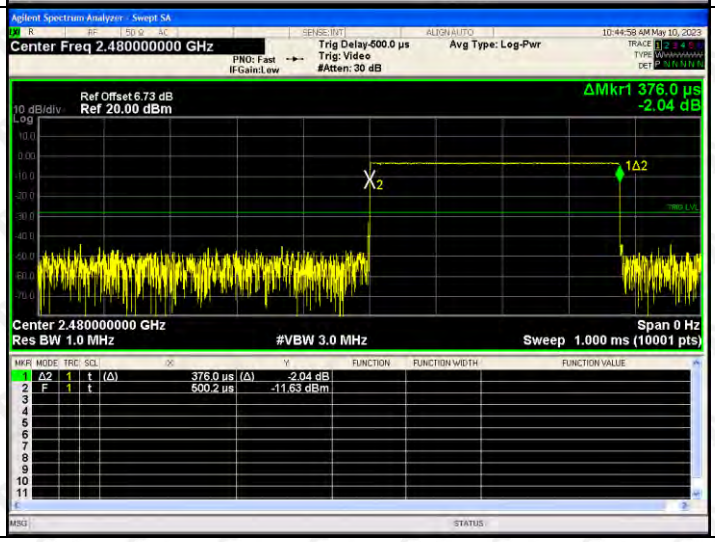
Worst case-GFSK:

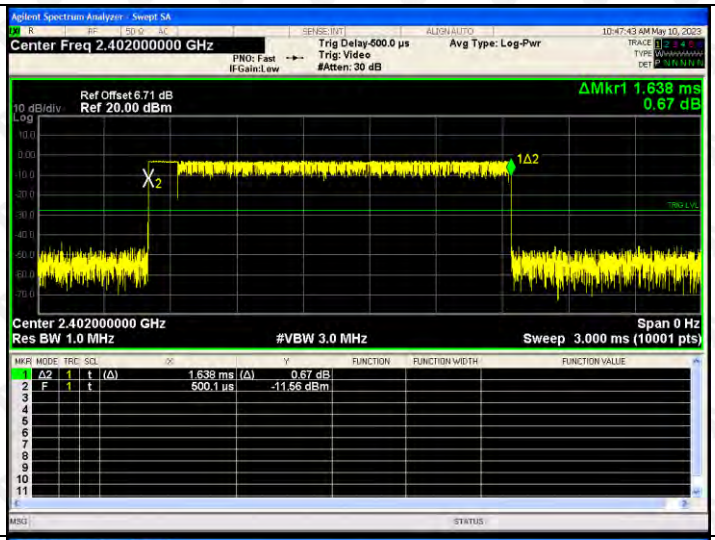
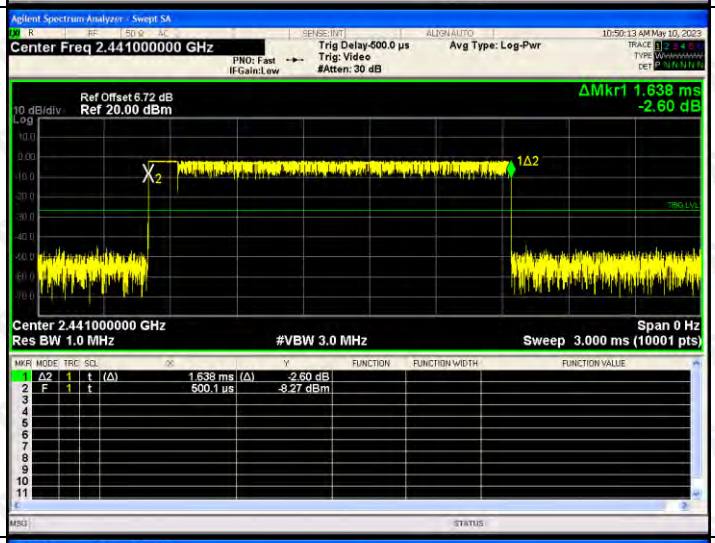
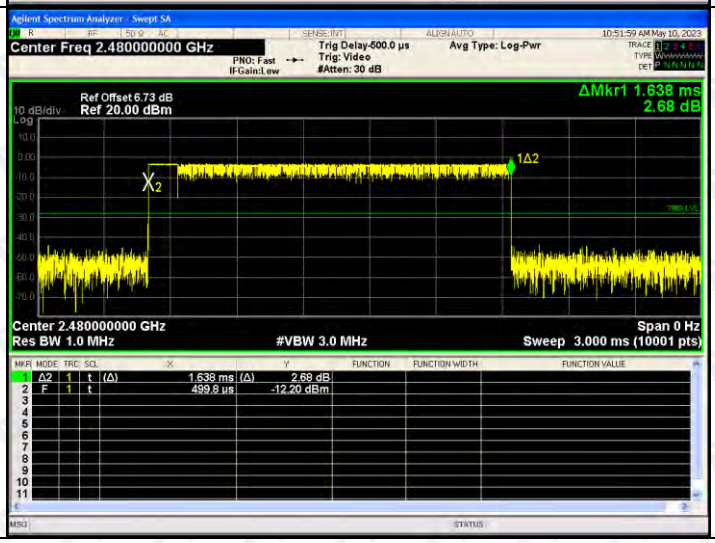
| Mode | Packet | Channel | Pulse Time (ms) | Total Dwell Time (ms) | Limit (ms) | Verdict |
|---|---|---|---|---|---|---|
| GFSK | DH1 | LCH | 0.376 | 120.32 | 400 | PASS |
| | DH1 | MCH | 0.376 | 120.32 | 400 | PASS |
| | DH1 | HCH | 0.376 | 120.32 | 400 | PASS |
| | DH3 | LCH | 1.638 | 262.08 | 400 | PASS |
| | DH3 | MCH | 1.638 | 262.08 | 400 | PASS |
| | DH3 | HCH | 1.638 | 262.08 | 400 | PASS |
| | DH5 | LCH | 2.888 | 308.053 | 400 | PASS |
| | DH5 | MCH | 2.888 | 308.053 | 400 | PASS |
| | DH5 | HCH | 2.888 | 308.053 | 400 | PASS |

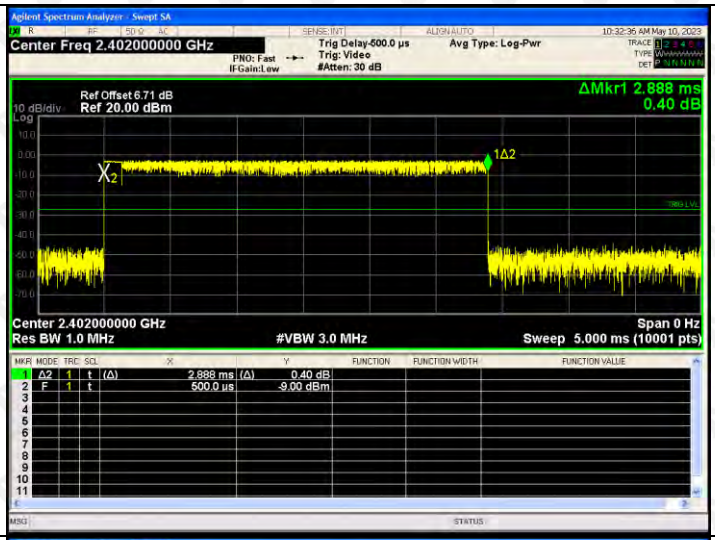
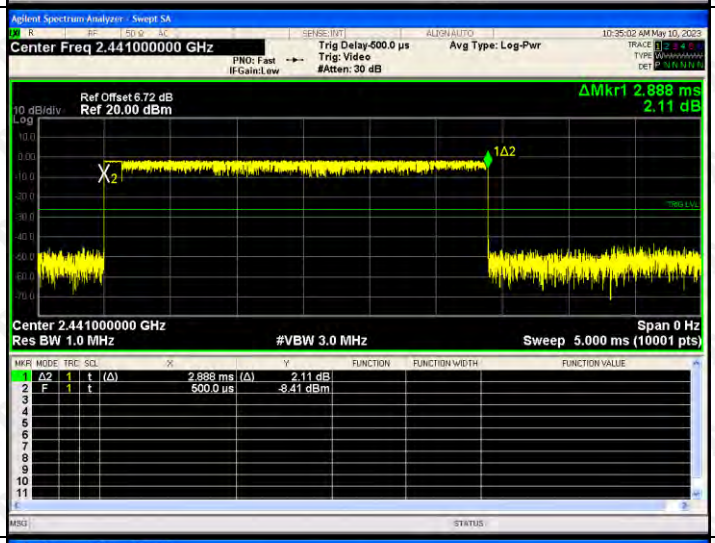
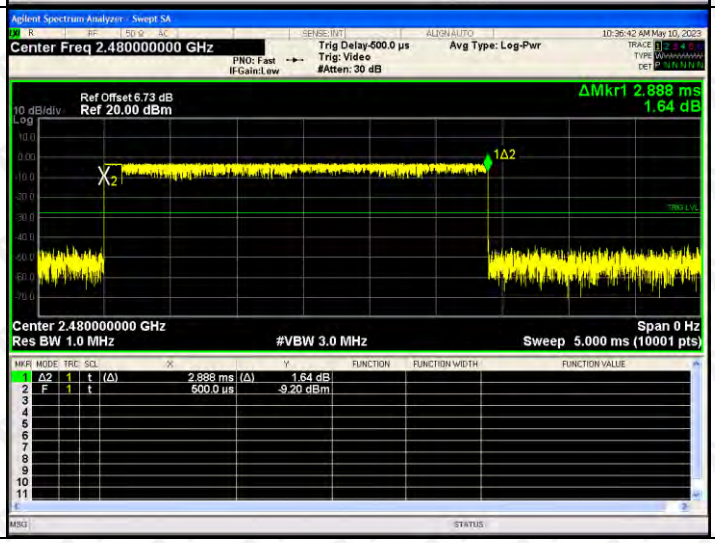
Remark: DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).
DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).
DH1 Packet permit maximum 1600 / 79 /2 hops per second in each channel (1 time slot RX, 1 time slot TX). So, the Dwell Time can be calculated as follows:

DH5:1600/79/6*0.4*79*(MkrDelta)/1000
DH3:1600/79/4*0.4*79*(MkrDelta)/1000
DH1:1600/79/2*0.4*79*(MkrDelta)/1000
Remark: Mkr Delta is once pulse time.

**Test Graph**

| Graphs | | | |
|---|---|---|---|
| GFSK_DH1/LCH | |  | |
| GFSK_DH1/MCH | |  | |
| GFSK_DH1/HCH | |  | |

| | | | |
|---|---|---|---|
| GFSK_DH3/LCH | |  | |
| GFSK_DH3/MCH | |  | |
| GFSK_DH3/HCH | |  | |

| | | | |
|---|---|---|---|
| GFSK_DH5/LCH | |  | |
| GFSK_DH5/MCH | |  | |
| GFSK_DH5/HCH | |  | |

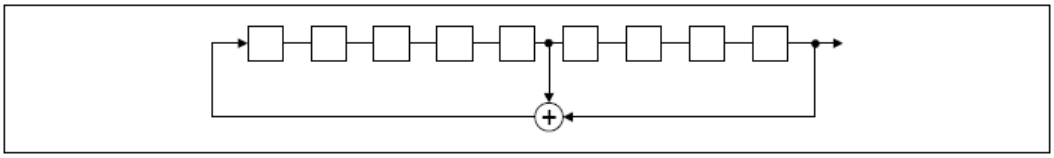
## 14. PSEUDORANDOM FREQUENCY

### 14.1 Limit

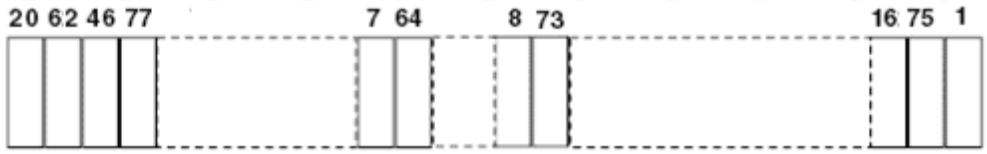
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom 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.

### 14.2 Test procedure

The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.
• Number of shift register stages: 9
• Length of pseudo-random sequence: 29 -1 = 511 bits
• Longest sequence of zeros: 8 (non-inverted signal)



An example of Pseudorandom Frequency Hopping Sequence as follow:




Each frequency used equally on the average by each transmitter.
The system receivers have input bandwidths that match the hopping channel bandwidths of their Corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

## 14.3 Test Result

The device does not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

## 15. 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, 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.
15.247(b) (4) requirement:
The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

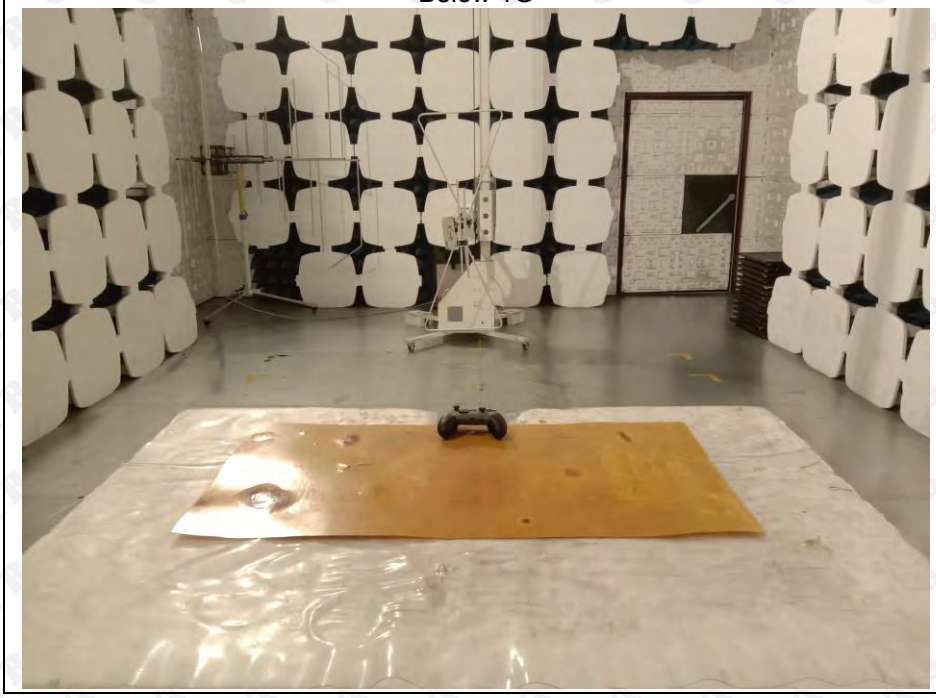
**EUT Antenna:**

The antenna is PCB antenna. The best case gain of the antenna is -0.58dBi.

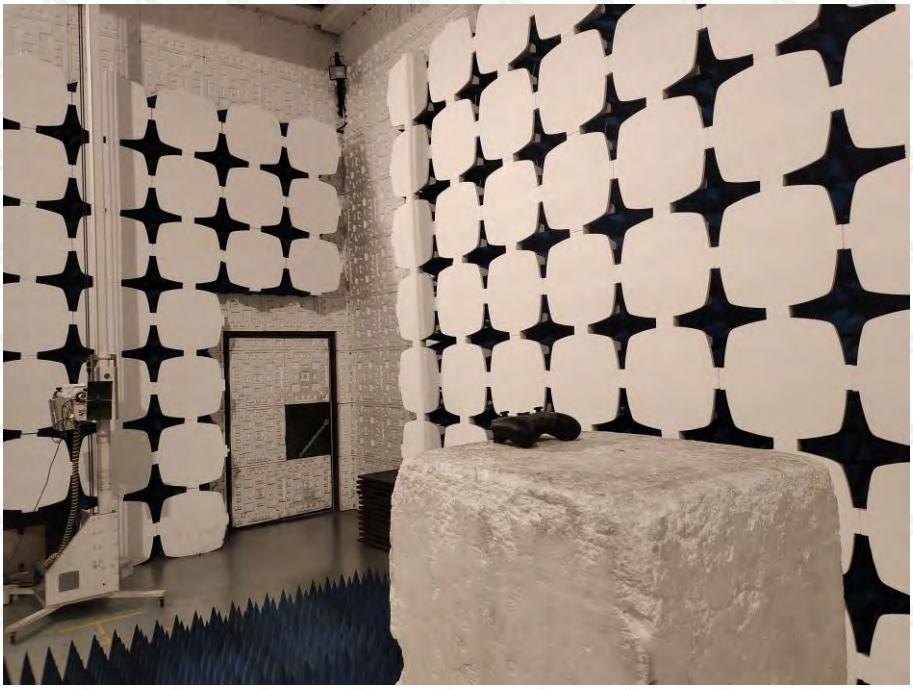
## 16. EUT TEST SETUP PHOTOGRAPHS

Radiated Emission

Below 1G



Above 1G



Conducted emissions

※※※※※ **END OF REPORT** ※※※※※