# TEST REPORT

| | |
|---|---|
| Report No. | CISRR240910076 |
| Project No. | CISR240910076 |
| FCC ID | 2BK6K-J20 |
| Applicant | Dongguan Qingzhu Electronic Technology Co., Ltd |
| Address | Room 302,Building 1,No.16 Industrial Road, Tangxia Town,Dongguan City,Guangdong Province,Dongguan,China |
| Manufacturer | Dongguan Qingzhu Electronic Technology Co., Ltd |
| Address | Room 302,Building 1,No.16 Industrial Road, Tangxia Town,Dongguan City,Guangdong Province,Dongguan,China |
| Product Name | Wireless Earphone |
| Trade Mark | -- |
| Model/Type reference | J20 |
| Listed Model(s) | J50 |
| Standard | Part 15 Subpart C Section 15.247 |
| Test date | September 10, 2024 ~ September 18, 2024 |
| Issue date | September 28, 2024 |
| **Test result** | **Complied** |

Rory Huang

**Prepared by: Rory Huang**

Genry Long

**Approved by: Genry Long**

*The test results relate only to the tested samples.*

*The test report should not be reproduced except in full without the written approval of Shenzhen Bangce Testing Technology Co., Ltd.*

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# 1. REPORT VERSION

| Version No. | Issue date | Description |
|---|---|---|
| 00 | September 28, 2024 | Original |
| | | |
| | | |

## 2. SUMMARY OF TEST RESULT

| Report clause | Test Item | Standard Requirement | Result |
|---|---|---|---|
| 5.1 | Antenna Requirement | 15.203/15.247 (c) | PASS |
| 5.2 | AC Conducted Emission | 15.207 | PASS |
| 5.3 | Peak Output Power | 15.247 (b)(1) | PASS |
| 5.4 | 20 dB Bandwidth | 15.247 (a)(1) | PASS |
| 5.5 | 99% Occupied Bandwidth | - | PASS*1 |
| 5.6 | Carrier Frequency Separation | 15.247 (a)(1) | PASS |
| 5.7 | Hopping Channel Number | 15.247 (a)(1) | PASS |
| 5.8 | Dwell Time | 15.247 (a)(1) | PASS |
| 5.9 | Duty Cycle Correction Factor | - | PASS*1 |
| 5.10 | Pseudorandom Frequency Hopping Sequence | 15.247(a)(1) | PASS |
| 5.11 | Conducted Band Edge and Spurious Emission | 15.247(d)/15.205 | PASS |
| 5.12 | Radiated Band Edge Emission | 15.205/15.209 | PASS |
| 5.13 | Radiated Spurious Emission | 15.247(d)/15.205/15.209 | PASS |

Note:

– The measurement uncertainty is not included in the test result.

– *1: No requirement on standard, only report these test data.

# 3. SUMMARY

## 3.1. Product Description

| Main unit information: | |
|---|---|
| Product Name: | Wireless Earphone |
| Trade Mark: | -- |
| Model No.: | J20 |
| Listed Model(s): | J50 |
| Power supply: | Input: DC 5V<br>DC 3.7V from Battery |
| Hardware version: | V2.2 |
| Software version: | V1.0 |

## 3.2. Radio Specification Description

| | |
|---|---|
| Technology: | Bluetooth |
| Transmission technology: | FHSS |
| Modulation: | BR/1Mbps: GFSK, EDR/2Mbps: π/4DQPSK, EDR/3Mbps: 8DPSK |
| Operation frequency: | 2402MHz~2480MHz |
| Channel number: | 79 |
| Channel separation: | 1MHz |
| Antenna type: | PCB Antenna |
| Antenna gain: | 1.9dBi |

Channel List:

BT : BR/1Mbps: GFSK, EDR/2Mbps: π/4DQPSK, EDR/3Mbps: 8DPSK

| | | | |
|---|---|---|---|
| CH00 | **2402 MHz** | CH20 | 2421 MHz |
| CH01 | 2403 MHz | CH21 | 2422 MHz |
| CH02 | 2404 MHz | CH22 | 2423 MHz |
| -- | -- | -- | -- |
| -- | -- | CH39 | **2441 MHz** |
| -- | -- | -- | -- |
| CH18 | 2419 MHz | CH77 | 2479 MHz |
| CH19 | 2420 MHz | CH78 | **2480 MHz** |

## 3.3. Modification of EUT

No modifications are made to the EUT during all test items.

## 3.4. Testing Site

| | |
|---|---|
| Laboratory Name | Shenzhen Bangce Testing Technology Co., Ltd. |
| Laboratory Location | 101, building 10, Yunli Intelligent Park, Shutianpu community, Matian Street, Guangming District, Shenzhen, Guangdong, China |
| FCC registration number | 736346 |

## 3.5. Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

**FS (dBuV/m) = RA (dBuV) + AF (dB/m) + CL (dB) – AG (dB)**

| | |
|---|---|
| Where FS = Field Strength | CL = Cable Attenuation Factor (Cable Loss) |
| RA = Reading Amplitude | AG = Amplifier Gain |
| AF = Antenna Factor | |

## 3.6. DISTURBANCE Calculation

The AC mains conducted disturbance is calculated by adding the 10dB Pulse Limiter and Cable Factor and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

**CD (dBuV) = RA (dBuV) + PL (dB) + CL (dB)**

| | |
|---|---|
| Where CD = Conducted Disturbance | CL = Cable Attenuation Factor (Cable Loss) |
| RA = Reading Amplitude | PL = 10 dB Pulse Limiter Factor |

# 4. TEST CONFIGURATION

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

## 4.1. Test frequency list

| Channel | Frequency (MHz) |
|---|---|
| CH-L | 2402 |
| CH-M | 2441 |
| CH-H | 2480 |

## 4.2. Test mode

| For RF test items: | | |
|---|---|---|
| The engineering test program was provided(bt_tool_v1.1.2) and enabled to make EUT continuous transmitting.Power setting Default. | | |
| Test Item | Test Mode | Modulation |
| Conducted test item | TX CH-L | GFSK |
| | TX CH-M | GFSK |
| | TX CH-H | GFSK |
| | TX CH-L | π/4DQPSK |
| | TX CH-M | π/4DQPSK |
| | TX CH-H | π/4DQPSK |
| | TX CH-L | 8DPSK |
| | TX CH-M | 8DPSK |
| | TX CH-H | 8DPSK |
| | Hopping | GFSK |
| | Hopping | π/4DQPSK |
| | Hopping | 8DPSK |
| | Normal link | -- |
| | Charging | -- |
| Radiated test item | TX CH-L | GFSK |
| | TX CH-M | GFSK |
| | TX CH-H | GFSK |
| | TX CH-L | π/4DQPSK |
| | TX CH-M | π/4DQPSK |
| | TX CH-H | π/4DQPSK |
| | TX CH-L | 8DPSK |
| | TX CH-M | 8DPSK |
| | TX CH-H | 8DPSK |
| | Hopping | GFSK |
| | Hopping | π/4DQPSK |
| | Hopping | 8DPSK |

| | | |
|---|---|---|
| | Normal link | -- |
| | Charging | -- |
| Remark:<br>– The EUT in each of three orthogonal axis emissions had been tested, but only the worst case (X axis) data recorded in the report.All patterns have predictions, and the report only shows the worst pattern data. | | |

## 4.3. Support unit used in test configuration and system

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application.

The following peripheral devices and interface cables were connected during the measurement:

| Item | Equipment name | Trade Name | Model No. |
|---|---|---|---|
| 1 | Adapter | Jishunyuan | JSY-0501000 |
| 2 | Phone | Huawei | MLD-AL00 |

## 4.4. Test sample information

| Type | Sample no. |
|---|---|
| Engineer sample | CISR240910076-S01 |
| Normal sample | CISR240910076-S02 |

## 4.5. Testing environmental condition

| Type | Requirement | Actual |
|---|---|---|
| Temperature: | 15~35°C | 25°C |
| Relative Humidity: | 25~75% | 50% |
| Air Pressure: | 860~1060mbar | 1000mbar |

## 4.6. Statement of the measurement uncertainty

| No. | Test Items | Measurement Uncertainty |
|---|---|---|
| 1 | AC Conducted Emission | 1.63dB |
| 2 | Peak Output Power | 1.34dB |
| 3 | Power Spectral Density | 1.34dB |
| 4 | 6dB Bandwidth | 0.002% |
| 5 | 99% Occupied Bandwidth | 0.002% |
| 6 | Duty cycle | - |
| 7 | Conducted Band Edge and Spurious Emission | 1.93dB |
| 8 | Radiated Band Edge Emission | 3.76dB for 30MHz-1GHz<br>3.80dB for above 1GHz |
| 9 | Radiated Spurious Emission | 3.76dB for 30MHz-1GHz |

| | | |
|---|---|---|
| | | 3.80dB for above 1GHz |

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=1.96.

## 4.7. Equipment Used during the Test

| Equipment | Manufacture | Model No. | Serial No. | Last cal. | Cal Interval |
|---|---|---|---|---|---|
| 9*6*6 anechoic chamber | SKET | 9.3*6.3*6 | N/A | 2021.10.15 | 3Year |
| Spectrum analyzer | Agilent | N9020A | MY50530263 | 2024.01.08 | 1Year |
| Receiver | ROHDE&SCHWARZ | ESCI | 100853 | 2024.01.08 | 1Year |
| Spectrum analyzer | R&S | FSV-40N | / | 2024.01.08 | 1Year |
| Bilog Antenna | Schwarzbeck | VULB 9163 | 1463 | 2023.01.09 | 2Year |
| Horn Antenna | SCHWARZBECK | BBHA 9120 D | 2487 | 2023.01.09 | 2Year |
| Active Loop Antenna | SCHWARZBECK | FMZB 1519B | / | 2023.01.09 | 2Year |
| RF Cable | Tonscend | Cable 1 | / | 2024.01.08 | 1Year |
| RF Cable | Tonscend | Cable 2 | / | 2024.01.08 | 1Year |
| RF Cable | SKET | Cable 3 | / | 2024.01.08 | 1Year |
| Pre-amplifier | Tonscend | TAP9K3G32 | AP21G806153 | 2024.01.08 | 1Year |
| Pre-amplifier | Tonscend | TAP01018050 | AP22E806229 | 2024.01.08 | 1Year |
| L.I.S.N.#1 | Schwarzbeck | NSLK8127 | / | 2024.01.08 | 1Year |
| L.I.S.N.#2 | ROHDE&SCHWARZ | ENV216 | / | 2024.01.08 | 1 Year |
| Horn Antenna | SCHWARZBECK | BBHA9170 | 1130 | 2023.01.09 | 2 Year |
| Preamplifier | Tonscend | TAP18040048 | AP21C806126 | 2024.01.08 | 1 Year |
| Antenna tower | SKET | Bk-4AT-BS | AT2021040101-V1 | N/A | N/A |
| variable-frequency power source | Pinhong | PH1110 | / | 2024.01.08 | 1 Year |
| 6dB Attenuator | SKET | DC-6G | / | N/A | N/A |
| Artificial power network | Schwarzbeck | NSLK8127 | 8127-01096 | 2024.01.08 | 1 Year |
| EMI Test Receiver | Rohde&schwarz | ESCI7 | 100853 | 2024.01.08 | 1 Year |
| 8-wire Impedance Stabilization Network | Schwarzbeck | NTFM 8158 | 8158-00337 | 2024.01.08 | 1 Year |
| Antenna tower | SKET | Bk-4AT-BS | AT2021040101-V1 | N/A | N/A |

# 5. TEST CONDITIONS AND RESULTS

## 5.1. Antenna Requirement

| | |
|---|---|
| Standard Applicable | **FCC CFR Title 47 Part 15 Subpart C Section 15.203:**<br>An intentional radiator shall be designed to ensure that no antenna other than that furnished by the response-ble 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.<br><br>**FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1) (I):**<br>(i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi. |
| Description | The EUT antenna is PCB antenna (1.9dBi), the directional gain of the antenna less than 6dBi. It comply with the standard requirement. In case of replacement of broken antenna the same antenna type must be used.Antenna structure please refer to the EUT internal photographs antenna photo. |

Remark: The antenna gain is provided by the customer , if the data provided by the customer is not accurate, Shenzhen Bangce Testing Technology Co., Ltd. does not assume any responsibility.

## 5.2. AC Conducted Emission

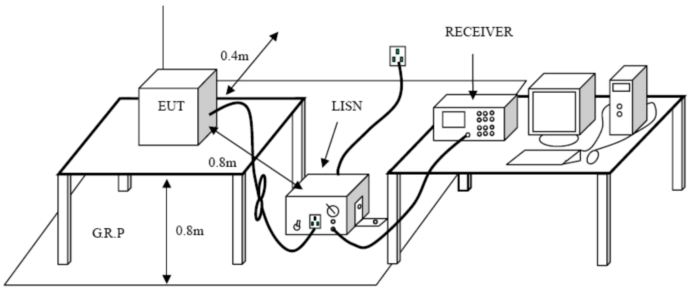
Limit:

**FCC CFR Title 47 Part 15 Subpart C Section 15.207**

| Frequency range (MHz) | Limit (dBuV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

* Decreases with the logarithm of the frequency.

Test configuration:




Test procedure:

1. The EUT was setup according to ANSI C63.10 requirements.
2. The EUT was placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above the conducting ground plane. The vertical conducting plane was located 40 cm to the rear of the EUT. All other surfaces of EUT were at least 80 cm from any other grounded conducting surface.
3. The EUT and simulators are connected to the main power through a line impedances stabilization network (LISN). The LISN provides a 50 ohm /50uH coupling impedance for the measuring equipment.
4. The peripheral devices are also connected to the main power through a LISN. (Refer to the block diagram of the test setup and photographs)
5. Each current-carrying conductor of the EUT power cord, except the ground (safety) conductor, was individually connected through a LISN to the input power source.
6. The excess length of the power cord between the EUT and the LISN receptacle were folded back and forth at the center of the lead to form a bundle not exceeding 40 cm in length.
7. Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9 kHz.
8. During the above scans, the emissions were maximized by cable manipulation.

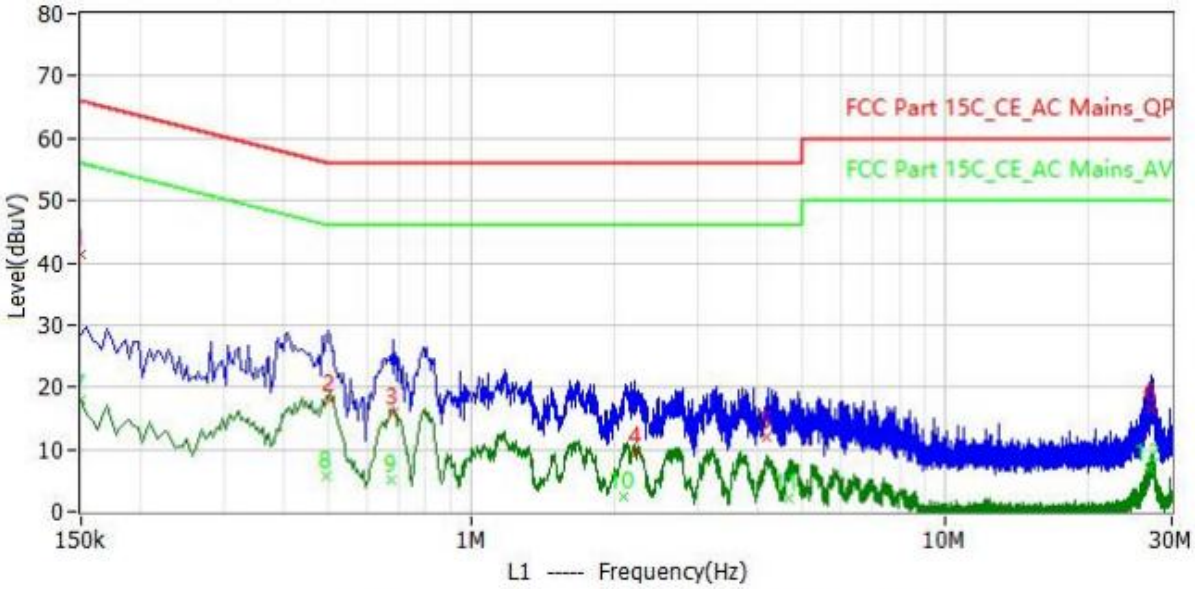
Test mode: Refer to the clause 4.2

Result: **Passed**

Note:
1. Factor = LISN Factor + Cable Factor
2. Level= Reading + Factor
3. Margin= Level – Limit

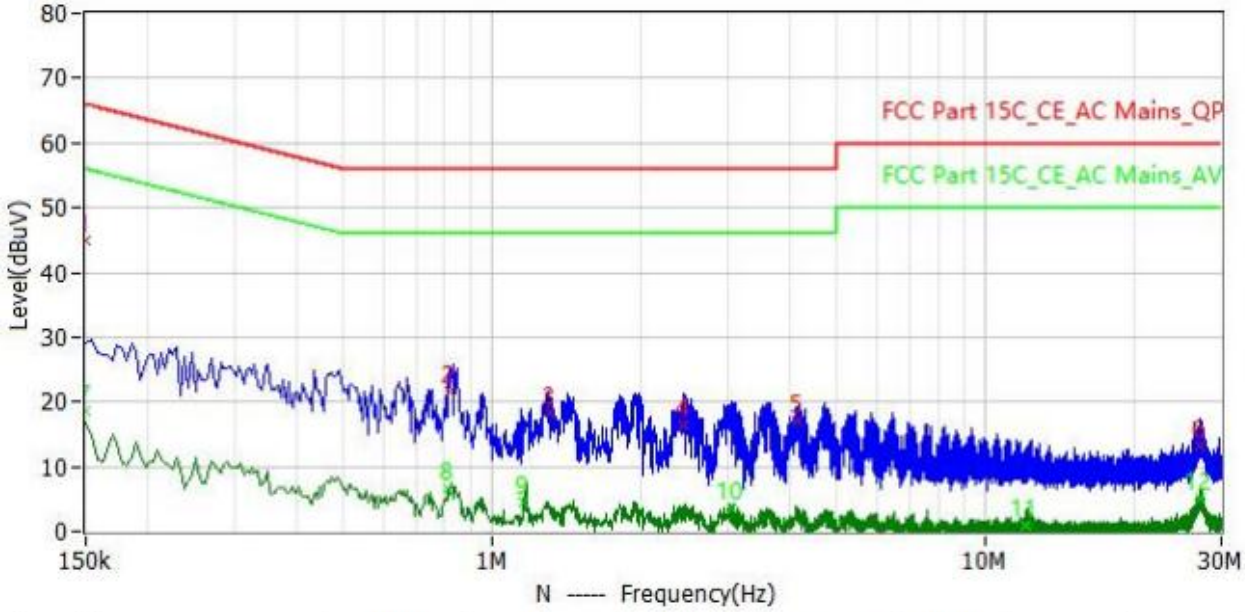
**Test Mode: Charging**

| Test Line: | L |
|---|---|



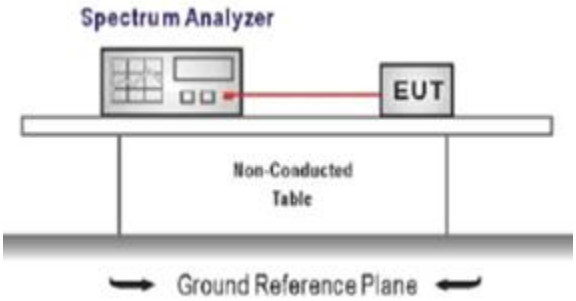

| No. | Frequency | Limit dBuV | Level dBuV | Margin dB | Reading dBuV | Factor dB | Detector | Polar |
|---|---|---|---|---|---|---|---|---|
| 1 | 150.000kHz | 66.0 | 41.2 | -24.8 | 41.2 | 0.0 | QP | L1 |
| 2 | 502.000kHz | 56.0 | 18.0 | -38.0 | 17.9 | 0.1 | QP | L1 |
| 3 | 682.000kHz | 56.0 | 15.9 | -40.1 | 15.8 | 0.1 | QP | L1 |
| 4 | 2.222MHz | 56.0 | 9.7 | -46.3 | 9.6 | 0.1 | QP | L1 |
| 5 | 4.186MHz | 56.0 | 12.0 | -44.0 | 11.8 | 0.2 | QP | L1 |
| 6 | 27.238MHz | 60.0 | 16.6 | -43.4 | 16.0 | 0.6 | QP | L1 |
| 7 | 150.000kHz | 56.0 | 17.9 | -38.1 | 17.9 | 0.0 | CAV | L1 |
| 8 | 494.000kHz | 46.1 | 5.6 | -40.5 | 5.5 | 0.1 | CAV | L1 |
| 9 | 678.000kHz | 46.0 | 5.0 | -41.0 | 4.9 | 0.1 | CAV | L1 |
| 10 | 2.098MHz | 46.0 | 2.3 | -43.7 | 2.2 | 0.1 | CAV | L1 |
| 11 | 4.682MHz | 46.0 | 2.1 | -43.9 | 1.9 | 0.2 | CAV | L1 |
| 12 | 26.958MHz | 50.0 | 6.9 | -43.1 | 6.3 | 0.6 | CAV | L1 |

| Test Line: | N |
|---|---|

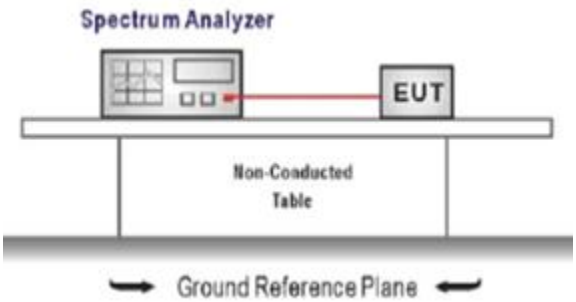



| No. | Frequency | Limit dBuV | Level dBuV | Margin dB | Reading dBuV | Factor dB | Detector | Polar |
|---|---|---|---|---|---|---|---|---|
| 1 | 150.000kHz | 66.0 | 45.0 | -21.0 | 45.0 | 0.0 | QP | N |
| 2 | 822.000kHz | 56.0 | 21.6 | -34.4 | 21.5 | 0.1 | QP | N |
| 3 | 1.310MHz | 56.0 | 18.3 | -37.7 | 18.2 | 0.1 | QP | N |
| 4 | 2.438MHz | 56.0 | 16.4 | -39.6 | 16.3 | 0.1 | QP | N |
| 5 | 4.154MHz | 56.0 | 17.0 | -39.0 | 16.8 | 0.2 | QP | N |
| 6 | 27.162MHz | 60.0 | 13.2 | -46.8 | 12.5 | 0.7 | QP | N |
| 7 | 150.000kHz | 56.0 | 18.6 | -37.4 | 18.6 | 0.0 | CAV | N |
| 8 | 814.000kHz | 46.0 | 6.5 | -39.5 | 6.4 | 0.1 | CAV | N |
| 9 | 1.158MHz | 46.0 | 4.5 | -41.5 | 4.4 | 0.1 | CAV | N |
| 10 | 3.050MHz | 46.0 | 3.5 | -42.5 | 3.4 | 0.1 | CAV | N |
| 11 | 12.026MHz | 50.0 | 0.9 | -49.1 | 0.6 | 0.3 | CAV | N |
| 12 | 27.054MHz | 50.0 | 5.2 | -44.8 | 4.5 | 0.7 | CAV | N |

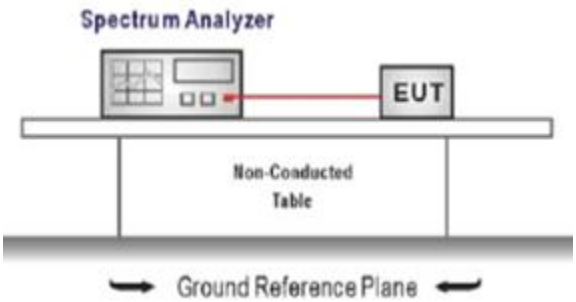
## 5.3. Peak Output Power

| | |
|---|---|
| Limit: | **FCC CFR Title 47 Part 15 Subpart C Section 15.247 (b)(1):**<br>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.<br>For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts. |
| Test configuration: |  |
| Test procedure: | 1. The transmitter output was connected to the spectrum analyzer through an attenuator, the pathloss was compensated to the results for each measurement.<br>2. Set to the maximum power setting and enable the EUT transmit continuously<br>3. Use the following spectrum analyzer settings:<br>Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel<br>RBW≥ the 20 dB bandwidth of the emission being measured, VBW≥RBW<br>Sweep = auto, Detector function = peak, Trace = max hold<br>4. Measure and record the results in the test report. |
| Test mode: | Refer to the clause 4.2 |
| Test data: | Refer to the Appendix A |
| Result: | **Passed** |

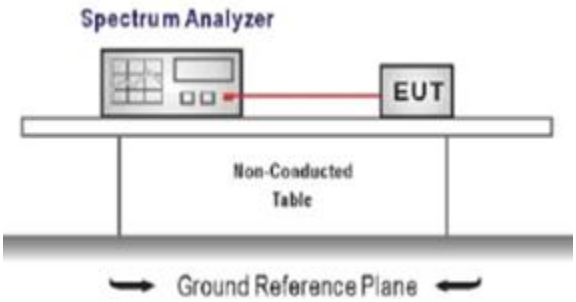
## 5.4. 20 dB Bandwidth

| | |
|---|---|
| Limit: | -- |
| Test configuration: |  |
| Test procedure: | 1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.<br>2. Set to the maximum power setting and enable the EUT transmit continuously<br>3. Use the following spectrum analyzer settings:<br>Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel<br>RBW ≥ 1% of the 20 dB bandwidth, VBW ≥ RBW<br>Sweep = auto, Detector function = peak, Trace = max hold<br>4. Measure and record the results in the test report. |
| Test mode: | Refer to the clause 4.2 |
| Test data: | Refer to the Appendix A |
| Result: | **Passed** |

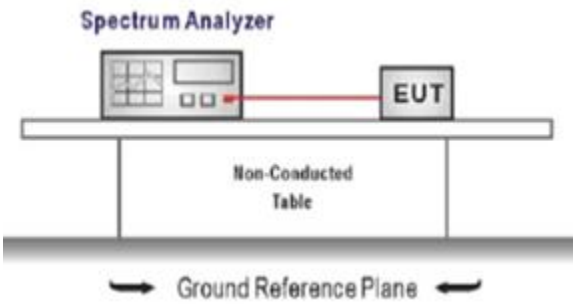
## 5.5. 99% Occupied Bandwidth

| | |
|---|---|
| Limit: | -- |
| Test configuration: |  |
| Test procedure: | 1. Connect the antenna port(s) to the spectrum analyzer input.<br>2. Configure the spectrum analyzer as shown below (enter all losses between the transmitter output andthe spectrum analyzer).<br>Center Frequency =channel center frequency<br>Span≥1.5 x OBW<br>RBW = 1%~5%OBW, VBW ≥ 3 × RBW<br>Sweep time= auto couple<br>Detector = Peak, Trace mode = max hold<br>3. Place the radio in continuous transmit mode, allow the trace to stabilize, view the transmitter waveform on the spectrum analyzer. |
| Test mode: | Refer to the clause 4.2 |
| Test data: | Refer to the Appendix A |
| Result: | **Passed** |

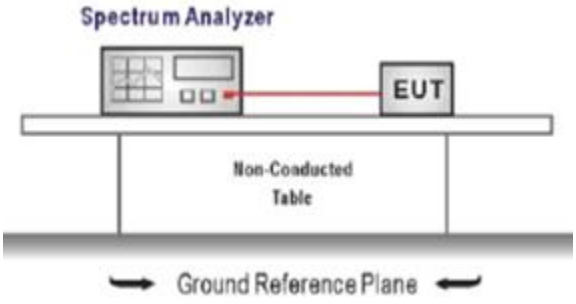
## 5.6. Carrier Frequencies Separation

| | |
|---|---|
| Limit: | **FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):**<br>Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively,<br><br>Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. |
| Test configuration: |  |
| Test procedure: | 1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.<br>2. Set to the maximum power setting and enable the EUT transmit continuously<br>3. Use the following spectrum analyzer settings:<br>Span = wide enough to capture the peaks of two adjacent channels<br>RBW ≥ 1% of the span, VBW ≥ RBW<br>Sweep = auto, Detector function = peak, Trace = max hold<br>4. Measure and record the results in the test report. |
| Test mode: | Refer to the clause 4.2 |
| Test data: | Refer to the Appendix A |
| Result: | **Passed** |

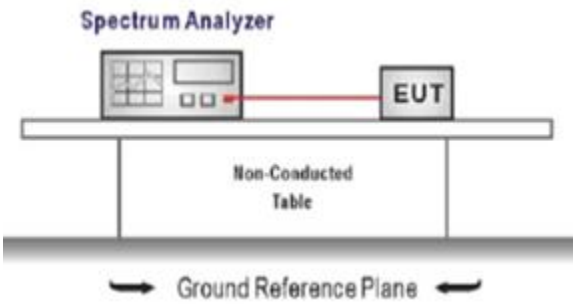
## 5.7. Hopping Channel Number

| | |
|---|---|
| Limit: | **FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):**<br>Frequency hopping systems in the 2400–2483.5 MHz band shall use at least **15** channels. |
| Test configuration: |  |
| Test procedure: | 1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.<br>2. Set to the maximum power setting and enable the EUT transmit continuously<br>3. Use the following spectrum analyzer settings:<br>Span = the frequency band of operation<br>RBW ≥ 1% of the span, VBW ≥ RBW<br>Sweep = auto, Detector function = peak, Trace = max hold<br>4. Measure and record the results in the test report. |
| Test mode: | Refer to the clause 4.2 |
| Test data: | Refer to the Appendix A |
| Result: | **Passed** |

## 5.8. Dwell Time

| | |
|---|---|
| Limit: | **FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):**<br>The average time of occupancy on any channel shall not be greater than 0.4 seconds within a pe-riod of 0.4 seconds multiplied by the number of hopping channels employed. |
| Test configuration: |  |
| Test procedure: | 1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.<br>2. Set to the maximum power setting and enable the EUT transmit continuously<br>3. Use the following spectrum analyzer settings:<br>Span = zero span, centered on a hopping channel, RBW= 1 MHz, VBW ≥ RBW<br>Sweep = as necessary to capture the entire dwell time per hopping channel,<br>Detector function = peak, Trace = max hold<br>4. Measure and record the results in the test report. |
| Test mode: | Refer to the clause 4.2 |
| Test data: | Refer to the Appendix A |
| Result: | **Passed** |

## 5.9. Duty Cycle Correction Factor (DCCF)

| | |
|---|---|
| Limit: | -- |
| Test configuration: |  |
| Test procedure: | 1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.<br>2. Set to the maximum power setting and enable the EUT transmit continuously<br>3. Use the following spectrum analyzer settings:<br>Span = zero span, centered on a hopping channel, RBW= 10 MHz,<br>VBW ≥ RBW, Sweep = as necessary to capture the entire dwell time per hopping channel,<br>Detector function = RMS, Trigger mode<br>4. Measure and record the duty cycle data |
| Test mode: | Refer to the clause 4.2 |
| Test data: | Refer to the Appendix A |
| Result: | **Passed** |

## 5.10. Pseudorandom Frequency Hopping Sequence

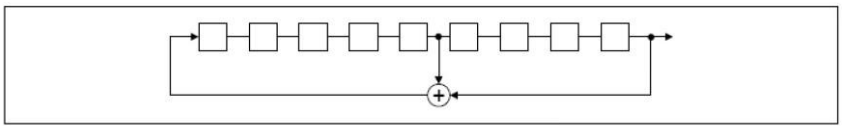
Limit:

**FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1):**
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hop-ping channel, whichever is greater. Al-ternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo ran-domly 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 hop-ping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Result:

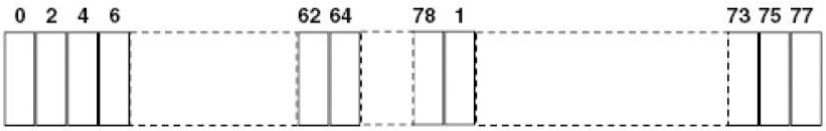
the pseudorandom frequency hopping sequence may be generated in a nice-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive ones, for example: 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)



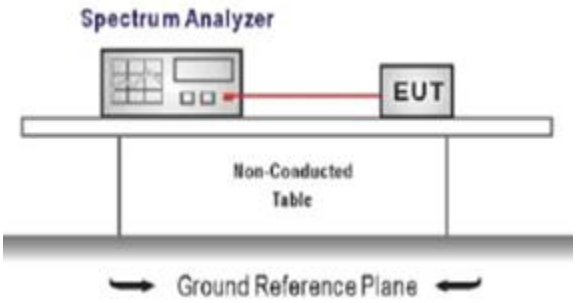
*Linear Feedback Shift Register for Generation of the PRBS sequence*

An explame of pseudorandom frequency hopping sequence as follows:

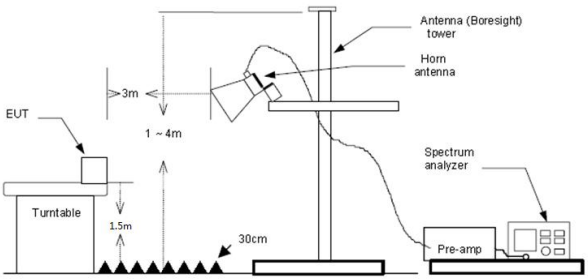



Each frequency used equally one the average by each transmitter.
The system receiver has input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shift frequencies in synchronization with the transmitted signals.

## 5.11. Conducted Band edge and Spurious Emission

| | |
|---|---|
| Limit: | **FCC CFR Title 47 Part 15 Subpart C Section15.247 (d):**<br>In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. |
| Test configuration: |  |
| Test procedure: | 1. Connect the antenna port(s) to the spectrum analyzer input.<br>2. Emission level measurement<br>Set the center frequency and span to encompass frequency range to be measured<br>RBW = 100 kHz, VBW ≥ 3 x RBW<br>Detector = peak, Sweep time = auto couple, Trace mode = max hold<br>Allow trace to fully stabilize<br>Use the peak marker function to determine the maximum amplitude level.<br>3. Place the radio in continuous transmit mode, allow the trace to stabilize, view the transmitter waveform on the spectrum analyzer.<br>4. Ensure that the amplitude of all unwanted emission outside of the authorized frequency band excluding restricted frequency bands) are attenuated by at least the minimum requirements specified (at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz). Report the three highest emission relative to the limit. |
| Test mode: | Refer to the clause 4.2 |
| Test data: | Refer to the Appendix A |
| Result: | **Passed** |

## 5.12. Radiated Band edge Emission

| | |
|---|---|
| Limit: | **FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d):**<br>In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, Radiated Emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the Radiated Emissions limits specified in §15.209(a) (see §15.205(c)). |
| Test configuration: |  |
| Test procedure: | 1. The EUT was setup and tested according to ANSI C63.10 .<br>2. The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level.<br>3. The EUT waspositioned such that the distance from antenna to the EUT was 3 meters.<br>4. The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. Thisis repeated for both horizontal and vertical polarization of the antenna. In order to find themaximum emission, all of the interface cables were manipulated according to ANSI C63.10 on radiated measurement.<br>5. Use the following spectrum analyzer settings:<br>a) Span shall wide enough to fully capture the emission being measured<br>b) Set RBW=100kHz for <1GHz, VBW=3*RBW, Sweep time=auto, Detector=peak, Trace=max hold<br>c) Set RBW=1MHz, VBW=3MHz for >1GHz, Sweep time=auto, Detector=peak, Trace=max hold for Peak measurement<br>d) Set RBW=1MHz, VBW=3MHz for >1GHz, Sweep time=auto, Detector=Average, Trace=RMS for Average measurement |
| Test mode: | Refer to the clause 4.2 |
| Result: | **Passed** |

Note:

1) Level= Reading + Factor; Factor =Antenna Factor+ Cable Loss- Preamp Factor
2) Margin = Limit - Level
3) Average measurement was not performed if peak level is lower than average limit
4) Have pre-scan all test channel, found GFSK DH5 mode which it was worst case, so only show the worst case’s data on this report.
5) The other emission levels were very low against the limit.

Right:

| Test channel:CH00(GFSK) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 2390.00 | 70.23 | 28.62 | 4.08 | 38.62 | -5.92 | 64.31 | 74 | 9.69 | Peak | Horizontal |
| 2390.00 | 51.38 | 28.62 | 4.08 | 38.62 | -5.92 | 45.46 | 54 | 8.54 | Average | Horizontal |
| 2390.00 | 69.42 | 28.62 | 4.08 | 38.62 | -5.92 | 63.50 | 74 | 10.50 | Peak | Vertical |
| 2390.00 | 49.82 | 28.62 | 4.08 | 38.62 | -5.92 | 43.90 | 54 | 10.10 | Average | Vertical |

| Test channel:CH78(GFSK) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 2483.50 | 69.34 | 29.45 | 3.91 | 40.17 | -6.81 | 62.53 | 74 | 11.47 | Peak | Horizontal |
| 2483.50 | 50.23 | 29.45 | 3.91 | 40.17 | -6.81 | 43.42 | 54 | 10.58 | Average | Horizontal |
| 2483.50 | 68.02 | 29.45 | 3.91 | 40.17 | -6.81 | 61.21 | 74 | 12.79 | Peak | Vertical |
| 2483.50 | 51.14 | 29.45 | 3.91 | 40.17 | -6.81 | 44.33 | 54 | 9.67 | Average | Vertical |

Left:

| Test channel:CH00(GFSK) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 2390.00 | 70.64 | 28.62 | 4.08 | 38.62 | -5.92 | 64.72 | 74 | 9.28 | Peak | Horizontal |
| 2390.00 | 51.42 | 28.62 | 4.08 | 38.62 | -5.92 | 45.50 | 54 | 8.50 | Average | Horizontal |
| 2390.00 | 69.16 | 28.62 | 4.08 | 38.62 | -5.92 | 63.24 | 74 | 10.76 | Peak | Vertical |
| 2390.00 | 50.57 | 28.62 | 4.08 | 38.62 | -5.92 | 44.65 | 54 | 9.35 | Average | Vertical |

| Test channel:CH78(GFSK) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 2483.50 | 69.80 | 29.45 | 3.91 | 40.17 | -6.81 | 62.99 | 74 | 11.01 | Peak | Horizontal |
| 2483.50 | 50.33 | 29.45 | 3.91 | 40.17 | -6.81 | 43.52 | 54 | 10.48 | Average | Horizontal |
| 2483.50 | 68.54 | 29.45 | 3.91 | 40.17 | -6.81 | 61.73 | 74 | 12.27 | Peak | Vertical |
| 2483.50 | 50.62 | 29.45 | 3.91 | 40.17 | -6.81 | 43.81 | 54 | 10.19 | Average | Vertical |

## 5.13. Radiated Spurious Emission

Limit:

**FCC CFR Title 47 Part 15 Subpart C Section 15.209**

| Frequency | Limit (dBuV/m) | Value |
|---|---|---|
| 0.009 MHz ~0.49 MHz | 2400/F(kHz) @300m | Quasi-peak |
| 0.49 MHz ~ 1.705 MHz | 24000/F(kHz) @30m | Quasi-peak |
| 1.705 MHz ~30 MHz | 30 @30m | Quasi-peak |

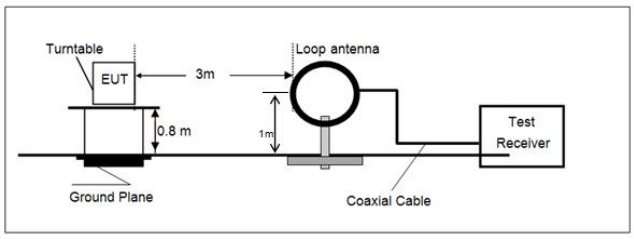
Limit dBuV/m @3m = Limit dBuV/m @300m + 40*log(300/3

Limit dBuV/m @3m = Limit dBuV/m @30m +40*log(30/3)

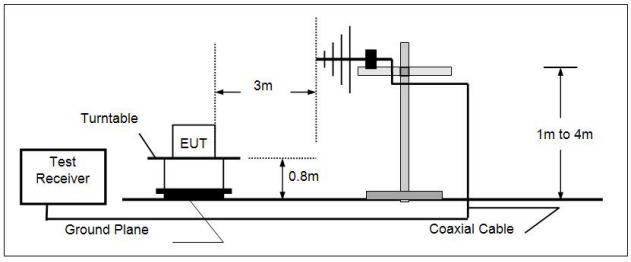
| Frequency | Limit (dBuV/m @3m) | Value |
|---|---|---|
| 30MHz~88MHz | 40.00 | Quasi-peak |
| 88MHz~216MHz | 43.50 | Quasi-peak |
| 216MHz~960MHz | 46.00 | Quasi-peak |
| 960MHz~1GHz | 54.00 | Quasi-peak |
| Above 1GHz | 54.00 | Average |
| | 74.00 | Peak |

Test configuration:

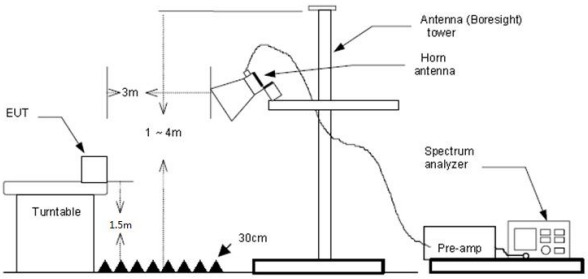
9kHz~30MHz




30 MHz ~ 1 GHz




Above 1 GHz



| | |
|---|---|
| Test procedure: | 1. The EUT was setup and tested according to ANSI C63.10.<br>2. The EUT is placed on a turn table which is 0.8 meter above ground for below 1 GHz, and 1.5 m for above 1 GHz. The turn table is rotated 360 degrees to determine the position of the maximum emission level.<br>3. The EUT was set 3 meters from the receiving antenna, which was mounted on the top of a variable height antenna tower.<br>4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.<br>5. Set to the maximum power setting and enable the EUT transmit continuously.<br>6. Use the following spectrum analyzer settings<br>a) Span shall wide enough to fully capture the emission being measured;<br>b) Below 1 GHz:<br>RBW=120 kHz, VBW=300 kHz, Sweep=auto, Detector function=peak, Trace=max hold;<br>If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.<br>c) Set RBW=1MHz, VBW=3MHz for >1GHz, Sweep time=auto, Detector=peak, Trace=max hold for Peak measurement<br>d) Set RBW=1MHz, VBW=3MHz for >1GHz, Sweep time=auto, Detector=Average, Trace=RMS for Average measurement |
| Test mode: | Refer to the clause 4.2 |
| Result: | **Passed** |

Note:

1) Level= Reading + Factor/Transd; Factor/Transd =Antenna Factor+ Cable Loss- Preamp Factor
2) Margin = Limit – Level
3) Average measurement was not performed if peak level is lower than average limit(54 dBuV/m) for above 1GHz.
4) The other emission levels were very low against the limit.
5) This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.

**For 9 kHz ~ 30 MHz**

The EUT was pre-scanned this frequency band, found the radiated level 20dB lower than the limit, so don't show data on this report.

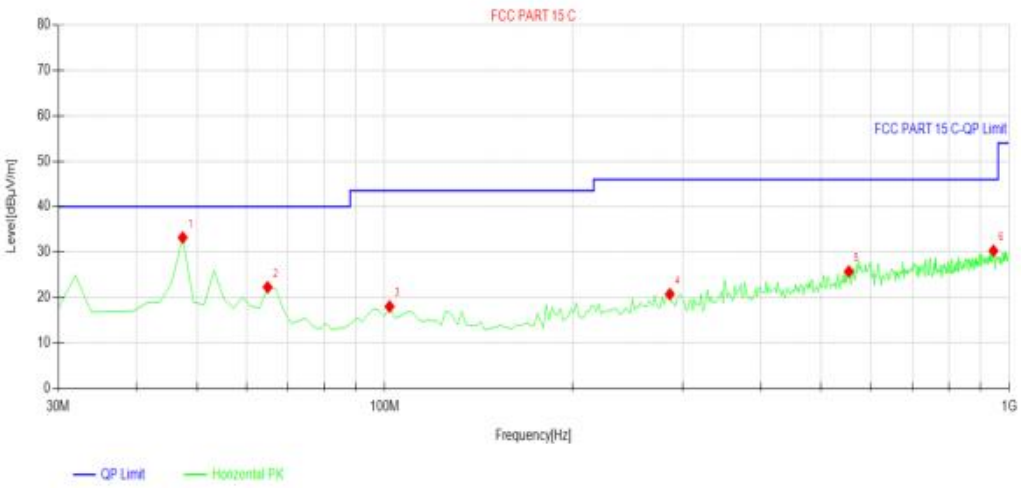
**For 30 MHz ~ 1000 MHz**

Have pre-scan all test channel, found GFSK DH5 mode CH00 which it was worst case, so only show the worst case’s data on this report.

Right:

| Polarization: | Horizontal |
|---|---|

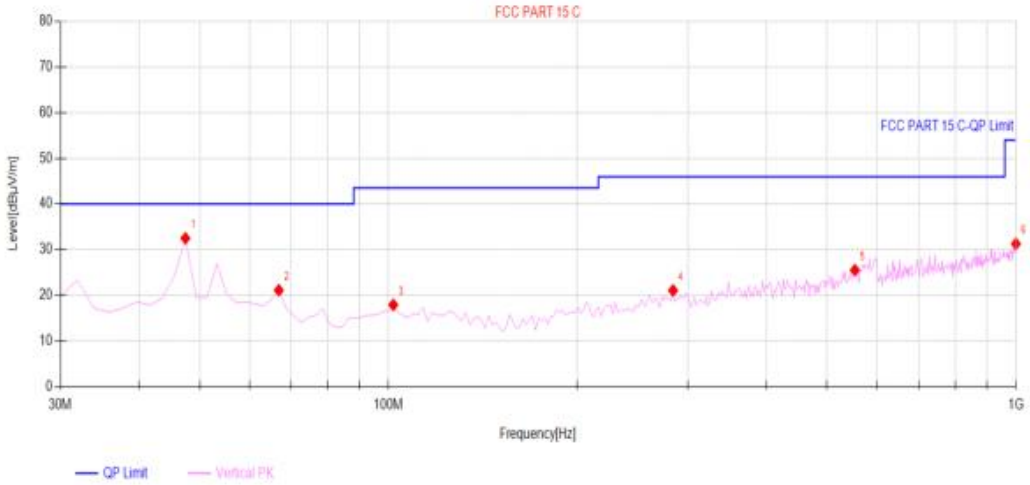
**Test Graph**




| Suspected Data List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Reading [dBµV/m] | Level [dBµV/m] | Factor [dB] | Limit [dBµV/m] | Margin [dB] | Polarity | Verdict |
| 1 | 47.46 | 17.69 | 33.21 | 15.52 | 40.00 | 6.79 | Horizontal | PASS |
| 2 | 64.92 | 9.42 | 22.28 | 12.86 | 40.00 | 17.72 | Horizontal | PASS |
| 3 | 101.78 | 4.35 | 18.02 | 13.67 | 43.50 | 25.48 | Horizontal | PASS |
| 4 | 286.08 | 5.43 | 20.75 | 15.32 | 46.00 | 25.25 | Horizontal | PASS |
| 5 | 553.8 | 4.99 | 25.73 | 20.74 | 46.00 | 20.27 | Horizontal | PASS |
| 6 | 943.74 | 4.45 | 30.29 | 25.84 | 46.00 | 15.71 | Horizontal | PASS |

| Polarization: | Vertical |
|---|---|

**Test Graph**

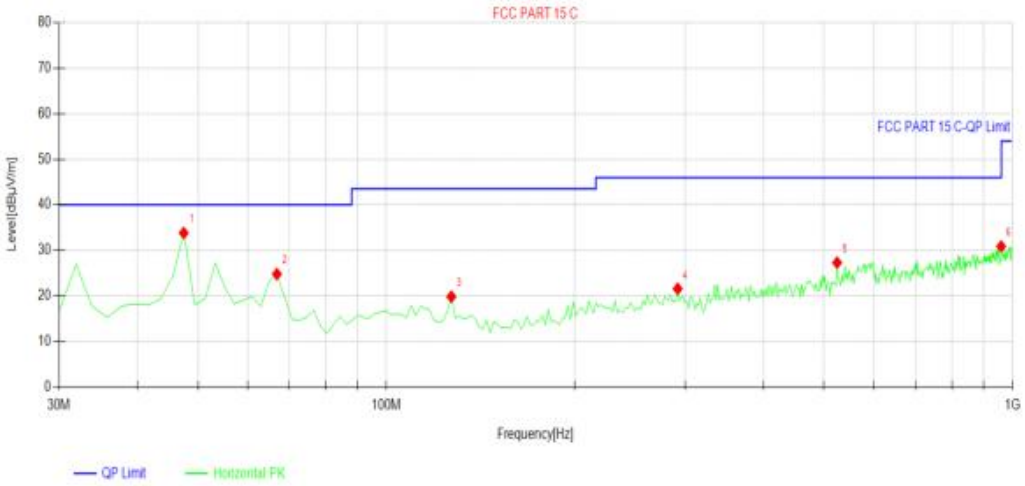



| Suspected Data List | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NO. | Freq. [MHz] | Reading [dBµV/m] | Level [dBµV/m] | Factor [dB] | Limit [dBµV/m] | Margin [dB] | Polarity | Verdict |
| 1 | 47.46 | 16.98 | 32.50 | 15.52 | 40.00 | 7.50 | Vertical | PASS |
| 2 | 66.86 | 8.74 | 21.13 | 12.39 | 40.00 | 18.87 | Vertical | PASS |
| 3 | 101.78 | 4.24 | 17.91 | 13.67 | 43.50 | 25.59 | Vertical | PASS |
| 4 | 284.14 | 5.82 | 21.09 | 15.27 | 46.00 | 24.91 | Vertical | PASS |
| 5 | 553.8 | 4.79 | 25.53 | 20.74 | 46.00 | 20.47 | Vertical | PASS |
| 6 | 1000 | 5.03 | 31.29 | 26.26 | 54.00 | 22.71 | Vertical | PASS |

Left:

| Polarization: | Horizontal |
|---|---|

**Test Graph**

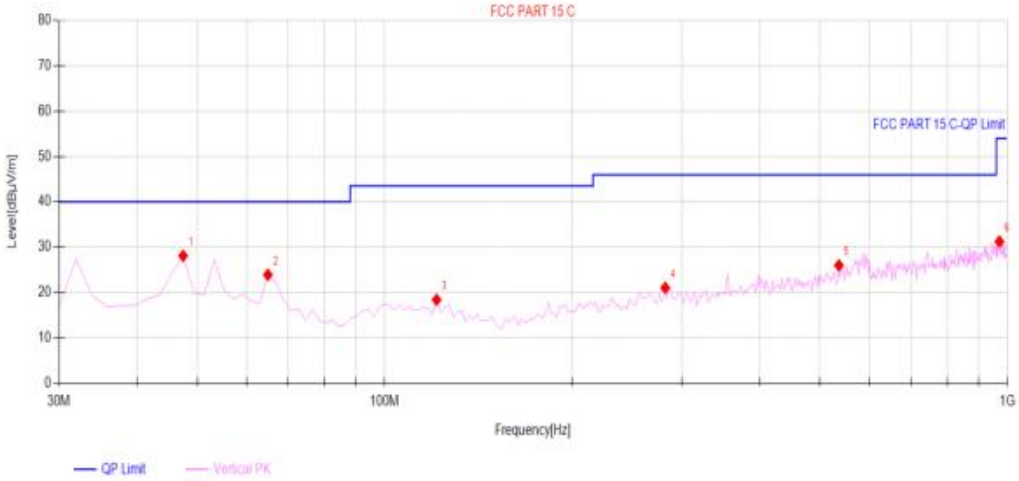



**Suspected Data List**

| NO. | Freq. [MHz] | Reading [dBµV/m] | Level [dBµV/m] | Factor [dB] | Limit [dBµV/m] | Margin [dB] | Polarity | Verdict |
|---|---|---|---|---|---|---|---|---|
| 1 | 47.46 | 18.31 | 33.83 | 15.52 | 40.00 | 6.17 | Horizontal | PASS |
| 2 | 66.86 | 12.42 | 24.81 | 12.39 | 40.00 | 15.19 | Horizontal | PASS |
| 3 | 127 | 8.86 | 19.85 | 10.99 | 43.50 | 23.65 | Horizontal | PASS |
| 4 | 291.9 | 6.16 | 21.59 | 15.43 | 46.00 | 24.41 | Horizontal | PASS |
| 5 | 524.7 | 7.16 | 27.32 | 20.16 | 46.00 | 18.68 | Horizontal | PASS |
| 6 | 959.26 | 4.94 | 30.88 | 25.94 | 46.00 | 15.12 | Horizontal | PASS |

| Polarization: | Vertical |
|---|---|

**Test Graph**




**Suspected Data List**

| NO. | Freq. [MHz] | Reading [dBµV/m] | Level [dBµV/m] | Factor [dB] | Limit [dBµV/m] | Margin [dB] | Polarity | Verdict |
|---|---|---|---|---|---|---|---|---|
| 1 | 47.46 | 12.60 | 28.12 | 15.52 | 40.00 | 11.88 | Vertical | PASS |
| 2 | 64.92 | 11.08 | 23.94 | 12.86 | 40.00 | 16.06 | Vertical | PASS |
| 3 | 121.18 | 6.47 | 18.41 | 11.94 | 43.50 | 25.09 | Vertical | PASS |
| 4 | 282.2 | 5.84 | 21.06 | 15.22 | 46.00 | 24.94 | Vertical | PASS |
| 5 | 536.34 | 5.63 | 26.01 | 20.38 | 46.00 | 19.99 | Vertical | PASS |
| 6 | 970.9 | 5.19 | 31.25 | 26.06 | 54.00 | 22.75 | Vertical | PASS |

**For 1 GHz ~ 25 GHz**

Have pre-scan all test channel, found GFSK DH5 mode which it was worst case, so only show the worst case's data on this report.

Right:

| Test channel:CH00 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 4804.00 | 68.73 | 31.33 | 4.23 | 38.62 | -3.06 | 65.67 | 74 | 8.33 | Peak | Horizontal |
| 4804.00 | 49.18 | 31.33 | 4.23 | 38.62 | -3.06 | 46.12 | 54 | 7.88 | Average | Horizontal |
| 4804.00 | 65.22 | 31.33 | 4.23 | 38.62 | -3.06 | 62.16 | 74 | 11.84 | Peak | Vertical |
| 4804.00 | 50.72 | 31.33 | 4.23 | 38.62 | -3.06 | 47.66 | 54 | 6.34 | Average | Vertical |

| Test channel:CH39 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 4880.00 | 70.31 | 30.26 | 4.09 | 38.29 | -3.94 | 66.37 | 74 | 7.63 | Peak | Horizontal |
| 4880.00 | 50.67 | 30.26 | 4.09 | 38.29 | -3.94 | 46.73 | 54 | 7.27 | Average | Horizontal |
| 4880.00 | 67.26 | 30.26 | 4.09 | 38.29 | -3.94 | 63.32 | 74 | 10.68 | Peak | Vertical |
| 4880.00 | 50.36 | 30.26 | 4.09 | 38.29 | -3.94 | 46.42 | 54 | 7.58 | Average | Vertical |

| Test channel:CH78 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 4960.00 | 64.59 | 31.97 | 4.11 | 38.47 | -2.39 | 62.20 | 74 | 11.80 | Peak | Horizontal |
| 4960.00 | 50.31 | 31.97 | 4.11 | 38.47 | -2.39 | 47.92 | 54 | 6.08 | Average | Horizontal |
| 4960.00 | 67.76 | 31.97 | 4.11 | 38.47 | -2.39 | 65.37 | 74 | 8.63 | Peak | Vertical |
| 4960.00 | 50.97 | 31.97 | 4.11 | 38.47 | -2.39 | 48.58 | 54 | 5.42 | Average | Vertical |

Left:

| Test channel:CH00 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 4804.00 | 69.14 | 31.33 | 4.23 | 38.62 | -3.06 | 66.08 | 74 | 7.92 | Peak | Horizontal |
| 4804.00 | 49.58 | 31.33 | 4.23 | 38.62 | -3.06 | 46.52 | 54 | 7.48 | Average | Horizontal |
| 4804.00 | 64.75 | 31.33 | 4.23 | 38.62 | -3.06 | 61.69 | 74 | 12.31 | Peak | Vertical |
| 4804.00 | 51.07 | 31.33 | 4.23 | 38.62 | -3.06 | 48.01 | 54 | 5.99 | Average | Vertical |

| Test channel:CH39 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 4880.00 | 70.07 | 30.26 | 4.09 | 38.29 | -3.94 | 66.13 | 74 | 7.87 | Peak | Horizontal |
| 4880.00 | 50.16 | 30.26 | 4.09 | 38.29 | -3.94 | 46.22 | 54 | 7.78 | Average | Horizontal |
| 4880.00 | 67.59 | 30.26 | 4.09 | 38.29 | -3.94 | 63.65 | 74 | 10.35 | Peak | Vertical |
| 4880.00 | 50.36 | 30.26 | 4.09 | 38.29 | -3.94 | 46.42 | 54 | 7.55 | Average | Vertical |

| Test channel:CH78 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Freq. (MHz) | Reading (dBuv) | Ant. Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) | Level (dBuv) | Limit (dBuV/m) | Margin (dB) | Remark | Polarity |
| 4960.00 | 64.15 | 31.97 | 4.11 | 38.47 | -2.39 | 61.76 | 74 | 12.24 | Peak | Horizontal |
| 4960.00 | 50.22 | 31.97 | 4.11 | 38.47 | -2.39 | 47.83 | 54 | 6.17 | Average | Horizontal |
| 4960.00 | 67.39 | 31.97 | 4.11 | 38.47 | -2.39 | 65.00 | 74 | 9.00 | Peak | Vertical |
| 4960.00 | 50.71 | 31.97 | 4.11 | 38.47 | -2.39 | 48.32 | 54 | 5.68 | Average | Vertical |

# 6. TEST SETUP PHOTOS

Please refer to separated files for Test Setup Photos of the EUT.

# 7. EXTERNAL AND INTERNAL PHOTOS

## 7.1 External photos

Please refer to separated files for External Photos of the EUT.

## 7.2 Internal photos

Please refer to separated files for Internal Photos of the EUT.

------End of the report------