

**FCC TEST REPORT**  
**FCC ID:2BFDF-ML903**

**Report Number.....: ZHT-240311029E-1**

Date of Test.....: Mar. 11, 2024 to Apr. 08, 2024

Date of issue.....: Apr. 08, 2024

Test Result .....: PASS

**Testing Laboratory.....: Guangdong Zhonghan Testing Technology Co., Ltd.**

Address .....: Room 104, Building 1, Yibaolai Industrial Park, Qiaotou Community,  
Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

**Applicant's name .....: Qingdao Thunderobot Technology Co.,Ltd.**

Address .....: No. 1, Haier Road, Laoshan District, Qingdao

**Manufacturer's name .....: Qingdao Thunderobot Technology Co.,Ltd.**

Address .....: No. 1, Haier Road, Laoshan District, Qingdao

**Test specification:**

Standard.....: FCC Part 15 Subpart C Section 15.249

Test procedure.....: ANSI C63.10:2013

Non-standard test method .....: N/A

This device described above has been tested by ZHT, and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

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**Product name.....: Thunderobot three-mode gaming mouse**

Trademark .....: THUNDEROBOT

Model/Type reference.....: ML903, ML901 Black, ML901 White, ML903 SE Black,  
ML903 SE White, ML903 Black, ML903 White, ML903 4K Black,  
ML903 4K White

Model difference.....: ML903 is tested model, other models are derivative models .  
The models are identical in circuit, only different on the model  
names, size and shape. So the test data of ML903 can represent  
the remaining models.

Ratings.....: DC 3.7V by battery or DC 5V by USB



**Testing procedure and testing location:**

**Testing Laboratory**.....: **Guangdong Zhonghan Testing Technology Co., Ltd.**

**Address**.....: Room 104, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

**Tested by (name + signature)**.....: Kevin Yang

**Reviewer (name + signature)**.....: Baret Wu

**Approved (name + signature)**.....: Levi Lee



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1. VERSION

| Report No.       | Version | Description             | Approved      |
|------------------|---------|-------------------------|---------------|
| ZHT-240311029E-1 | Rev.01  | Initial issue of report | Apr. 08, 2024 |
|                  |         |                         |               |
|                  |         |                         |               |

## 2. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:

| FCC Part15 (15.249) , Subpart C |                                  |          |        |
|---------------------------------|----------------------------------|----------|--------|
| Standard Section                | Test Item                        | Judgment | Remark |
| FCC part 15.207                 | AC Power Line Conducted Emission | PASS     |        |
| FCC part 15.215                 | Channel Bandwidth& 99% OCB       | PASS     |        |
| FCC part 15.249                 | Band Edge                        | PASS     |        |
| FCC part 15.205/15.209          | Spurious Emission                | PASS     |        |
| FCC part 15.249 (a)             | Field Strength of Fundamental    | PASS     |        |

NOTE:

(1)" N/A" denotes test is not applicable in this Test Report

## 2.1 TEST FACILITY

Guangdong Zhonghan Testing Technology Co., Ltd.  
Add. : Room 104, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District  
Shenzhen, Guangdong, China

FCC Registration Number:255941  
Designation Number: CN0325  
IC Registered No.: 29832  
CAB identifier: CN0143

## 2.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement  $y \pm U$ , where expanded uncertainty  $U$  is based on a standard uncertainty multiplied by a coverage factor of  $k=2$ , providing a level of confidence of approximately 95 %.

| No. | Item                             | Uncertainty               |
|-----|----------------------------------|---------------------------|
| 1   | Conducted Emission Test          | $\pm 1.38\text{dB}$       |
| 2   | RF power conducted               | $\pm 0.16\text{dB}$       |
| 3   | Spurious emissions conducted     | $\pm 0.21\text{dB}$       |
| 4   | All emissions radiated(9k-30MHz) | $\pm 4.68\text{dB}$       |
| 5   | All emissions radiated(<1G)      | $\pm 4.68\text{dB}$       |
| 6   | All emissions radiated(>1G)      | $\pm 4.89\text{dB}$       |
| 7   | Temperature                      | $\pm 0.5^{\circ}\text{C}$ |
| 8   | Humidity                         | $\pm 2\%$                 |
| 9   | Occupied Bandwidth               | $\pm 4.96\text{dB}$       |

### 3. GENERAL INFORMATION

#### 3.1 GENERAL DESCRIPTION OF EUT

|                      |                                     |
|----------------------|-------------------------------------|
| Product Name:        | Thunderobot three-mode gaming mouse |
| Test Model No.:      | ML903                               |
| Hardware Version:    | V1.0                                |
| Software Version:    | V1.0                                |
| Sample(s) Status:    | Engineer sample                     |
| Operation Frequency: | 2401MHz~2480MHz                     |
| Channel Numbers:     | 80                                  |
| Channel Separation:  | 1MHz                                |
| Modulation Type:     | GFSK                                |
| Antenna Type:        | Chip antenna                        |
| Antenna gain:        | 2.78dBi                             |
| Power supply:        | DC 3.7V by battery or DC 5V by USB  |



## Channel List

| CH No. | Frequency (MHz) | CH No. | Frequency (MHz) | CH No. | Frequency (MHz) | CH No. | Frequency (MHz) |
|--------|-----------------|--------|-----------------|--------|-----------------|--------|-----------------|
| 0      | 2401            | 20     | 2421            | 40     | 2441            | 60     | 2461            |
| 1      | 2402            | 21     | 2422            | 41     | 2442            | 61     | 2462            |
| 2      | 2403            | 22     | 2423            | 42     | 2443            | 62     | 2463            |
| 3      | 2404            | 23     | 2424            | 43     | 2444            | 63     | 2464            |
| 4      | 2405            | 24     | 2425            | 44     | 2445            | 64     | 2465            |
| 5      | 2406            | 25     | 2426            | 45     | 2446            | 65     | 2466            |
| 6      | 2407            | 26     | 2427            | 46     | 2447            | 66     | 2467            |
| 7      | 2408            | 27     | 2428            | 47     | 2448            | 67     | 2468            |
| 8      | 2409            | 28     | 2429            | 48     | 2449            | 68     | 2469            |
| 9      | 2410            | 29     | 2430            | 49     | 2450            | 69     | 2470            |
| 10     | 2411            | 30     | 2431            | 50     | 2451            | 70     | 2471            |
| 11     | 2412            | 31     | 2432            | 51     | 2452            | 71     | 2472            |
| 12     | 2413            | 32     | 2433            | 52     | 2453            | 72     | 2473            |
| 13     | 2414            | 33     | 2434            | 53     | 2454            | 73     | 2474            |
| 14     | 2415            | 34     | 2435            | 54     | 2455            | 74     | 2475            |
| 15     | 2416            | 35     | 2436            | 55     | 2456            | 75     | 2476            |
| 16     | 2417            | 36     | 2437            | 56     | 2457            | 76     | 2477            |
| 17     | 2418            | 37     | 2438            | 57     | 2458            | 77     | 2478            |
| 18     | 2419            | 38     | 2439            | 58     | 2459            | 78     | 2479            |
| 19     | 2420            | 39     | 2440            | 59     | 2460            | 79     | 2480            |

## Note:

In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test, and the selected channel see below:

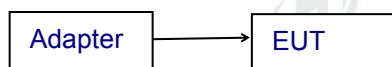
| Channel             | Frequency |
|---------------------|-----------|
| The lowest channel  | 2401MHz   |
| The middle channel  | 2440MHz   |
| The Highest channel | 2480MHz   |

### 3.2 DESCRIPTION OF TEST MODES

|                                                                                                                                                                                                                                                           |                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| Transmitting mode                                                                                                                                                                                                                                         | Keep the EUT in continuously transmitting mode |
| Remark: EUT use new battery during the test, the test voltage was tuned from 85% to 115% of the nominal rated supply voltage, and found that the worst case was under the nominal rated supply condition. So the report just shows that condition's data. |                                                |

### 3.3 BLOCK DIGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED

#### Radiated Emission



#### Conducted Spurious



### 3.4 DESCRIPTION OF SUPPORT UNITS(CONDUCTED MODE)

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

| Item | Equipment | Mfr/Brand | Model/Type No. | Series No. | Note |
|------|-----------|-----------|----------------|------------|------|
| E-1  | Adapter   | N/A       | HW-059200CHQ   | N/A        | AE   |
|      |           |           |                |            |      |

| Item | Shielded Type | Ferrite Core | Length | Note |
|------|---------------|--------------|--------|------|
|      |               |              |        |      |
|      |               |              |        |      |

#### Note:

- (1) The support equipment was authorized by Declaration of Confirmation.
- (2) For detachable type I/O cable should be specified the length in cm in 『Length』 column.



## 3.5 EQUIPMENTS LIST FOR ALL TEST ITEMS

## Radiation Test equipment

| Item | Equipment                          | Manufacturer | Model        | Last Cal.     | Next Cal.     |
|------|------------------------------------|--------------|--------------|---------------|---------------|
| 1    | Receiver                           | R&S          | ESCI         | May 12, 2023  | May 11, 2024  |
| 2    | Loop antenna                       | EMCI         | LAP600       | May 12, 2023  | May 11, 2024  |
| 3    | Amplifier                          | Schwarzbeck  | BBV 9743 B   | May 12, 2023  | May 11, 2024  |
| 4    | Amplifier                          | Schwarzbeck  | BBV 9718 B   | May 12, 2023  | May 11, 2024  |
| 5    | Bilog Antenna                      | Schwarzbeck  | VULB9162     | May 17, 2023  | May 16, 2024  |
| 6    | Horn Antenna                       | Schwarzbeck  | BBHA9120D    | May 17, 2023  | May 16, 2024  |
| 7    | Horn Antenna                       | A.H.SYSTEMS  | SAS574       | May 12, 2023  | May 11, 2024  |
| 8    | Amplifier                          | AEROFLEX     | 100KHz-40GHz | May 12, 2023  | May 11, 2024  |
| 9    | Spectrum Analyzer                  | R&S          | FSV40        | May 12, 2023  | May 11, 2024  |
| 11   | 966 Anechoic Chamber               | EMToni       | 9m6m6m       | Nov. 25, 2021 | Nov. 24, 2024 |
| 12   | Spectrum Analyzer                  | KEYSIGHT     | N9020A       | May 12, 2023  | May 11, 2024  |
| 13   | WIDBAND RADIO COMMUNICATION TESTER | R&S          | CMW500       | May 12, 2023  | May 11, 2024  |
| 14   | Single Generator                   | Agilent      | N5182A       | May 12, 2023  | May 11, 2024  |
| 15   | Power Sensor                       | MWRFTest     | MW100-RFCB   | May 12, 2023  | May 11, 2024  |
| 16   | Audio analyzer                     | R&S          | UPL          | May 12, 2023  | May 11, 2024  |
| 17   | Single Generator                   | R&S          | SMB100A      | May 12, 2023  | May 11, 2024  |
| 18   | Power Amplifier Shielding Room     | EMToni       | 2m3m3m       | Nov. 25, 2021 | Nov. 24, 2024 |



## Conduction Test equipment

| Equipment                 | Manufacturer | Model      | Last Cal.     | Next Cal.     |
|---------------------------|--------------|------------|---------------|---------------|
| Receiver                  | R&S          | ESCI       | May 12, 2023  | May 11, 2024  |
| LISN                      | R&S          | ENV216     | May 12, 2023  | May 11, 2024  |
| ISN CAT 6                 | Schwarzbeck  | NTFM 8158  | May 12, 2023  | May 11, 2024  |
| ISN CAT 5                 | Schwarzbeck  | CAT5 8158  | May 12, 2023  | May 11, 2024  |
| Capacitive Voltage Probe  | Schwarzbeck  | CVP 9222 C | May 12, 2023  | May 11, 2024  |
| Current Transformer Clamp | Schwarzbeck  | SW 9605    | May 12, 2023  | May 11, 2024  |
| CE Shielding Room         | EMToni       | 9m4m3m     | Nov. 25, 2021 | Nov. 24, 2024 |



#### 4. EMC EMISSION TEST

##### 4.1 CONDUCTED EMISSION MEASUREMENT

|                       |                                      |
|-----------------------|--------------------------------------|
| Test Requirement:     | FCC Part15 C Section 15.207          |
| Test Method:          | ANSI C63.10:2013                     |
| Test Frequency Range: | 150KHz to 30MHz                      |
| Receiver setup:       | RBW=9KHz, VBW=30KHz, Sweep time=auto |

##### 4.1.1 POWER LINE CONDUCTED EMISSION Limits

| FREQUENCY (MHz) | Limit (dBuV) |           | Standard |
|-----------------|--------------|-----------|----------|
|                 | QP           | AVG       |          |
| 0.15 -0.5       | 66 - 56 *    | 56 - 46 * | FCC      |
| 0.50 -5.0       | 56.00        | 46.00     | FCC      |
| 5.0 -30.0       | 60.00        | 50.00     | FCC      |

Note:

(1) \*Decreases with the logarithm of the frequency.

##### 4.1.2 TEST PROCEDURE

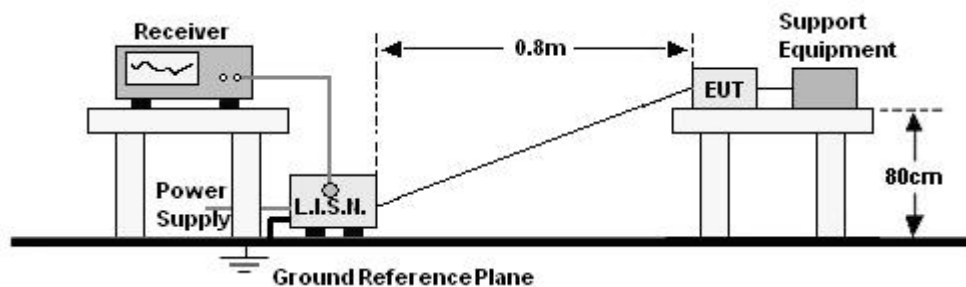
- The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
- I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
- LISN at least 80 cm from nearest part of EUT chassis.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

##### 4.1.3 DEVIATION FROM TEST STANDARD

No deviation



#### 4.1.4 TEST SETUP



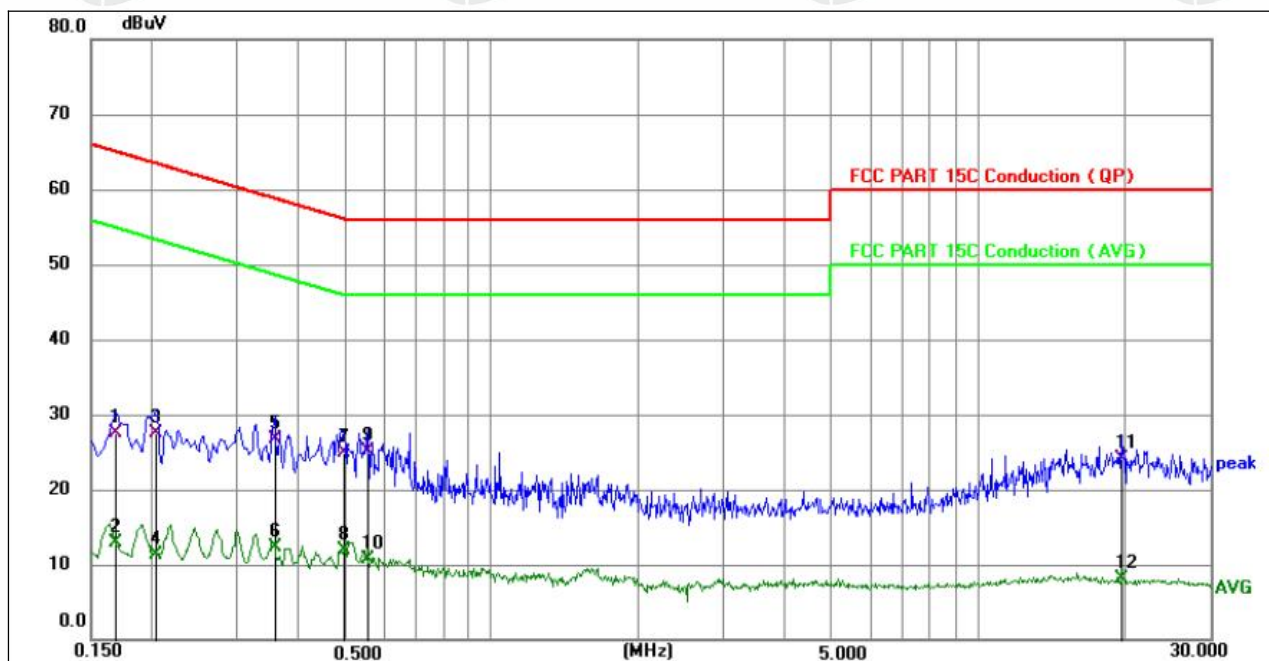
#### 4.1.5 EUT OPERATING CONDITIONS

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.



## 4.1.6 TEST RESULTS

|               |              |                     |     |
|---------------|--------------|---------------------|-----|
| Temperature:  | 25.1℃        | Relative Humidity : | 50% |
| Pressure:     | 101kPa       | Phase :             | L   |
| Test Voltage: | AC 120V/60Hz |                     |     |



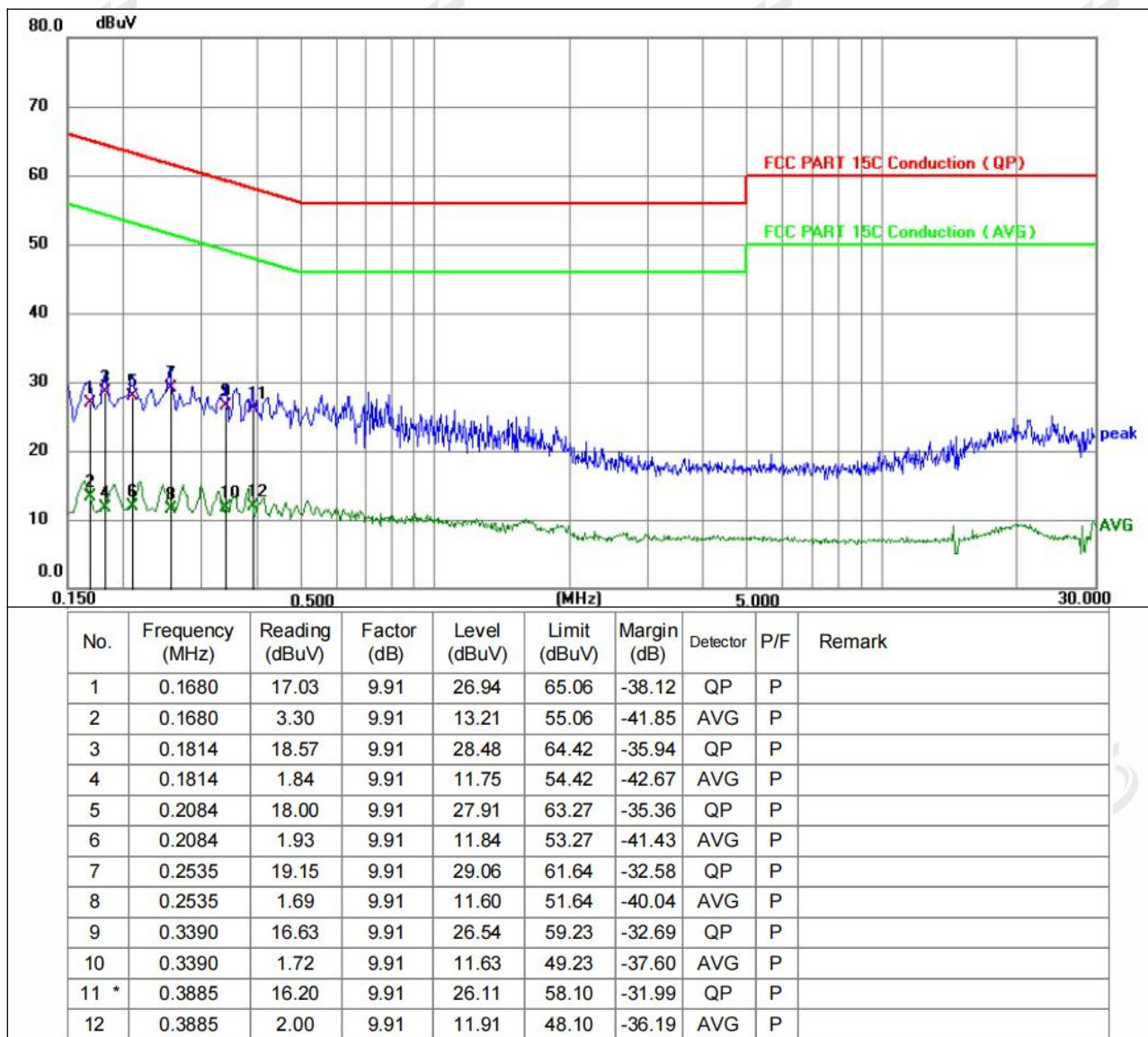
| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB) | Level (dBuV) | Limit (dBuV) | Margin (dB) | Detector | P/F | Remark |
|-----|-----------------|----------------|-------------|--------------|--------------|-------------|----------|-----|--------|
| 1   | 0.1680          | 17.53          | 9.91        | 27.44        | 65.06        | -37.62      | QP       | P   |        |
| 2   | 0.1680          | 3.04           | 9.91        | 12.95        | 55.06        | -42.11      | AVG      | P   |        |
| 3   | 0.2040          | 17.68          | 9.91        | 27.59        | 63.45        | -35.86      | QP       | P   |        |
| 4   | 0.2040          | 1.47           | 9.91        | 11.38        | 53.45        | -42.07      | AVG      | P   |        |
| 5   | 0.3570          | 16.83          | 9.91        | 26.74        | 58.80        | -32.06      | QP       | P   |        |
| 6   | 0.3570          | 2.34           | 9.91        | 12.25        | 48.80        | -36.55      | AVG      | P   |        |
| 7   | 0.4964          | 15.00          | 9.89        | 24.89        | 56.06        | -31.17      | QP       | P   |        |
| 8   | 0.4964          | 1.97           | 9.89        | 11.86        | 46.06        | -34.20      | AVG      | P   |        |
| 9 * | 0.5550          | 15.21          | 9.89        | 25.10        | 56.00        | -30.90      | QP       | P   |        |
| 10  | 0.5550          | 0.79           | 9.89        | 10.68        | 46.00        | -35.32      | AVG      | P   |        |
| 11  | 19.7160         | 14.24          | 9.94        | 24.18        | 60.00        | -35.82      | QP       | P   |        |
| 12  | 19.7160         | -1.83          | 9.94        | 8.11         | 50.00        | -41.89      | AVG      | P   |        |

## Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.
2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.
3. Measurement Level = Reading level + Correct Factor
4. The test data shows only the worst case GFSK-1M Low Channel:2401MHz.



|               |              |                     |     |
|---------------|--------------|---------------------|-----|
| Temperature:  | 25.1℃        | Relative Humidity : | 50% |
| Pressure:     | 101kPa       | Phase :             | N   |
| Test Voltage: | AC 120V/60Hz |                     |     |



## Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.
2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.
3. Measurement Level = Reading level + Correct Factor
4. The test data shows only the worst case GFSK-1M Low Channel:2401MHz.



## 4.2 RADIATED EMISSION MEASUREMENT

|                       |                             |            |        |        |            |
|-----------------------|-----------------------------|------------|--------|--------|------------|
| Test Requirement:     | FCC Part15 C Section 15.209 |            |        |        |            |
| Test Method:          | ANSI C63.10:2013            |            |        |        |            |
| Test Frequency Range: | 9kHz to 25GHz               |            |        |        |            |
| Test site:            | Measurement Distance: 3m    |            |        |        |            |
| Receiver setup:       | Frequency                   | Detector   | RBW    | VBW    | Value      |
|                       | 9KHz-150KHz                 | Quasi-peak | 200Hz  | 600Hz  | Quasi-peak |
|                       | 150KHz-30MHz                | Quasi-peak | 9KHz   | 30KHz  | Quasi-peak |
|                       | 30MHz-1GHz                  | Quasi-peak | 100KHz | 300KHz | Quasi-peak |
|                       | Above 1GHz                  | Peak       | 1MHz   | 3MHz   | Peak       |
|                       |                             | Peak       | 1MHz   | 10Hz   | Average    |

## 4.2.1 RADIATED EMISSION LIMITS

| Frequencies<br>(MHz) | Field Strength<br>(micorvolts/meter) | Measurement Distance<br>(meters) |
|----------------------|--------------------------------------|----------------------------------|
| 0.009~0.490          | 2400/F(KHz)                          | 300                              |
| 0.490~1.705          | 24000/F(KHz)                         | 30                               |
| 1.705~30.0           | 30                                   | 30                               |
| 30~88                | 100                                  | 3                                |
| 88~216               | 150                                  | 3                                |
| 216~960              | 200                                  | 3                                |
| Above 960            | 500                                  | 3                                |

## LIMITS OF RADIATED EMISSION MEASUREMENT

| FREQUENCY (MHz) | Limit (dBuV/m) (at 3M) |         |
|-----------------|------------------------|---------|
|                 | PEAK                   | AVERAGE |
| Above 1000      | 74                     | 54      |

## Notes:

- (1) The limit for radiated test was performed according to FCC PART 15C.
- (2) The tighter limit applies at the band edges.
- (3) Emission level (dBuV/m)=20log Emission level (uV/m).

According 15.249, the field strength of emissions from intentional radiators operated within 2400MHz-2483.5 MHz shall not exceed 94dB $\mu$ V/m (50mV/m).

FCC PART 15.249(a)Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:



| Fundamental Frequency | Field Strength of Fundamental<br>(millivolts/meter) | Field Strength of Harmonics<br>(microvolts/meter) |
|-----------------------|-----------------------------------------------------|---------------------------------------------------|
| 900-928MHz            | 50 (94dBuV/m @3m)                                   | 500 (54dBuV/m @3m)                                |
| 2400-2483.5MHz        | 50 (94dBuV/m @3m)                                   | 500 (54dBuV/m @3m)                                |
| 5725-5875MHz          | 50 (94dBuV/m @3m)                                   | 500 (54dBuV/m @3m)                                |
| 24.0-24.25GHz         | 250 (108dBuV/m @3m)                                 | 2500 (68dBuV/m @3m)                               |

#### 4.2.2 TEST PROCEDURE

- The measuring distance of at 3 m shall be used for measurements at frequency up to 25GHz. For frequencies above 1GHz, any suitable measuring distance may be used.
- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-chamber test. The table was rotated 360 degrees to determine the position of the highest radiation.
- The height of the equipment or of the substitution antenna shall be 0.8m; above 1GHz, the height was 1.5m, the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.
- For the radiated emission test above 1GHz:  
Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response.  
The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.  
Note:  
Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported

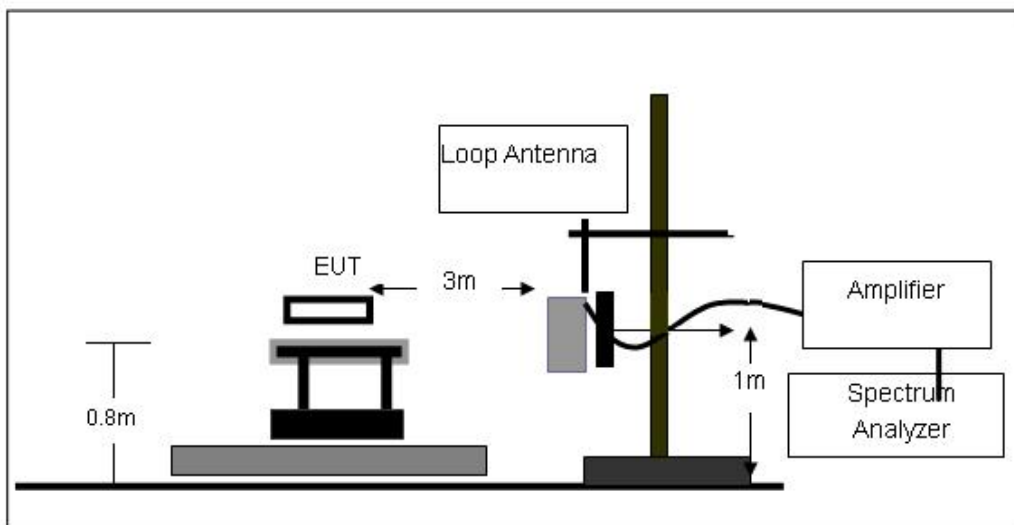
#### 4.2.3 DEVIATION FROM TEST STANDARD

No deviation

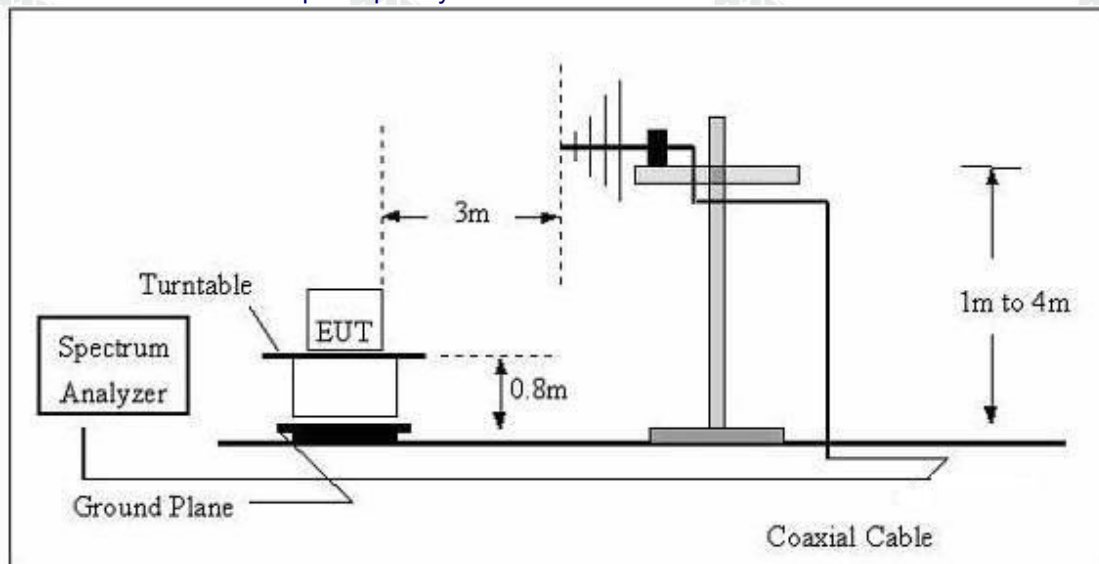


#### 4.2.4 TEST SETUP

##### (A) Radiated Emission Test-Up Frequency Below 30MHz

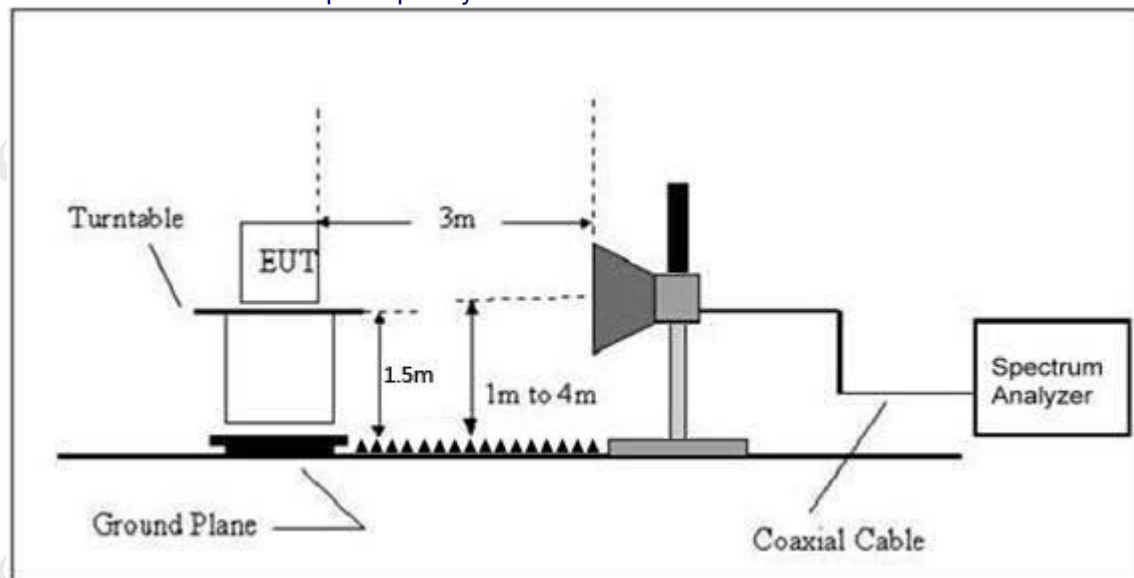


##### (B) Radiated Emission Test-Up Frequency 30MHz~1GHz





## (C) Radiated Emission Test-Up Frequency Above 1GHz



## 4.2.5 EUT OPERATING CONDITIONS

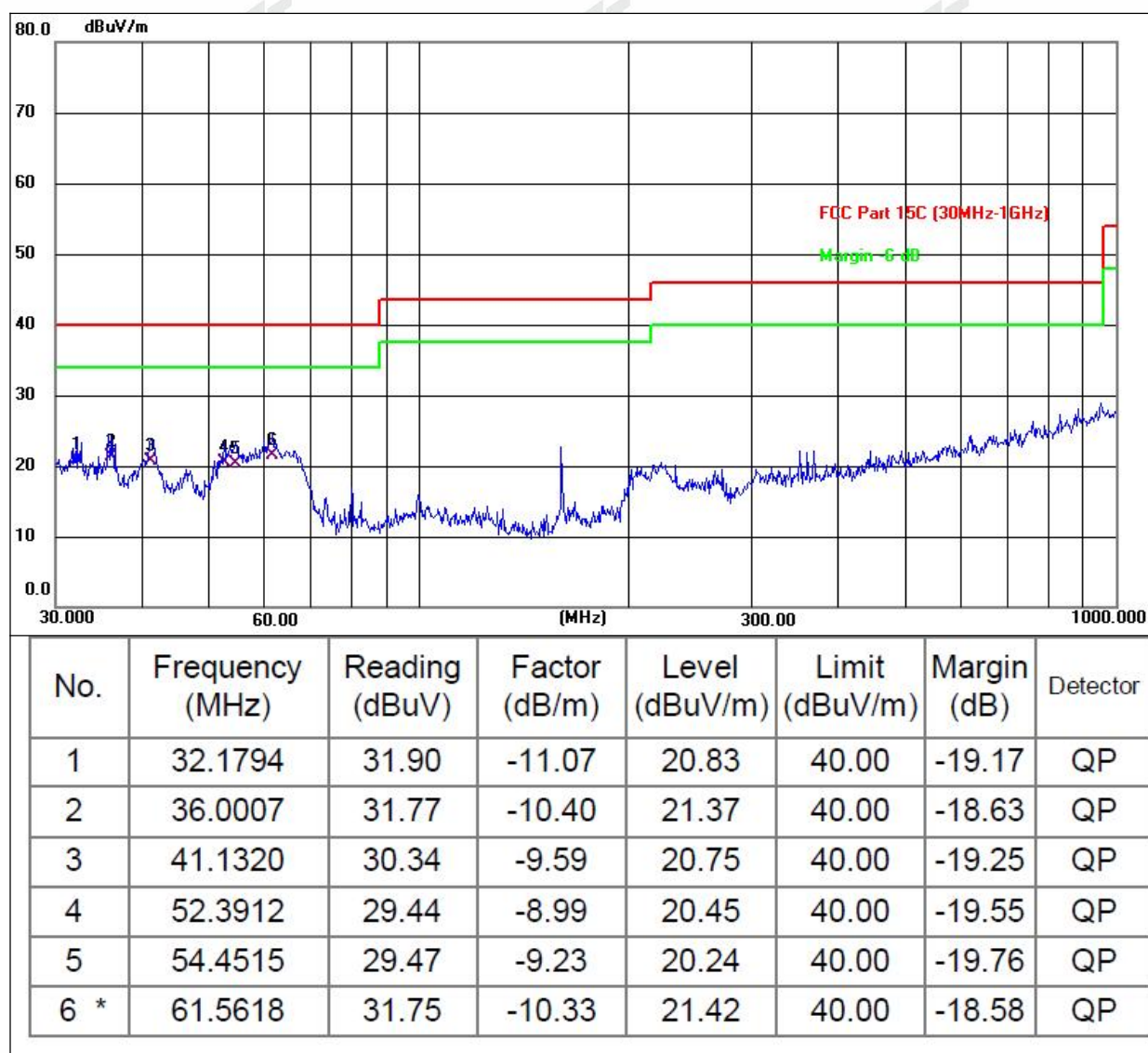
The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

## 4.2.6 TEST RESULTS (Between 9KHz – 30 MHz)

The emission from 9 kHz to 30MHz was pre-tested and found the result was 20dB lower than the limit, and according to 15.31(o) & RSS-Gen 6.13, the test result no need to reported.

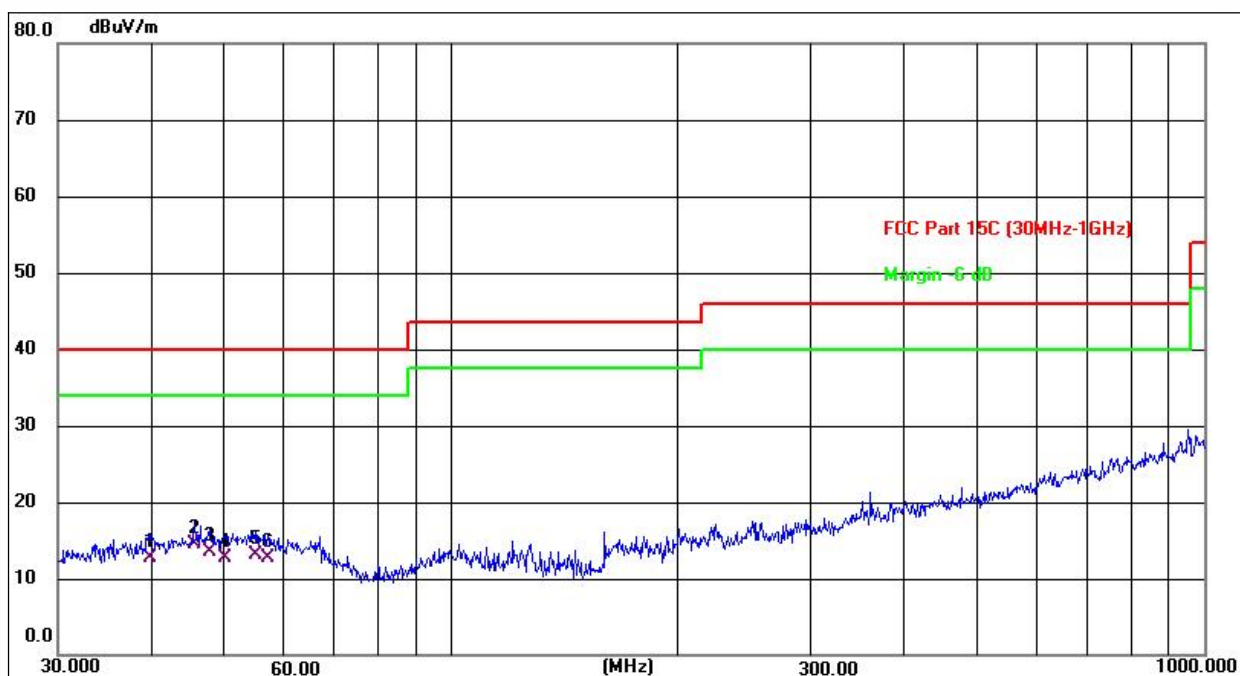
**Between 30MHz – 1GHz**

|               |              |                    |            |
|---------------|--------------|--------------------|------------|
| Temperature:  | 25.6°C       | Relative Humidity: | 47%        |
| Pressure:     | 101 kPa      | Polarization:      | Horizontal |
| Test Voltage: | AC 120V/60Hz |                    |            |





|               |              |                    |          |
|---------------|--------------|--------------------|----------|
| Temperature:  | 25.6°C       | Relative Humidity: | 47%      |
| Pressure:     | 101kPa       | Polarization:      | Vertical |
| Test Voltage: | AC 120V/60Hz |                    |          |



| No. | Frequency (MHz) | Reading (dBuV) | Factor (dB/m) | Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|-----|-----------------|----------------|---------------|----------------|----------------|-------------|----------|
| 1   | 39.8542         | 22.43          | -9.72         | 12.71          | 40.00          | -27.29      | QP       |
| 2 * | 45.5348         | 23.75          | -9.17         | 14.58          | 40.00          | -25.42      | QP       |
| 3   | 47.6584         | 22.36          | -8.95         | 13.41          | 40.00          | -26.59      | QP       |
| 4   | 50.0566         | 21.53          | -8.75         | 12.78          | 40.00          | -27.22      | QP       |
| 5   | 54.8348         | 22.47          | -9.27         | 13.20          | 40.00          | -26.80      | QP       |
| 6   | 56.9912         | 22.28          | -9.50         | 12.78          | 40.00          | -27.22      | QP       |

## Remarks:

1. Final Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor
2. The emission levels of other frequencies are very lower than the limit and not show in test report.



## Fundamental Test

| Mode     | Polar (H/V) | Frequency | Meter Reading | Pre-amplifier | Cable Loss | Antenna Factor | Emission Level | Limits   | Margin | Detector Type |
|----------|-------------|-----------|---------------|---------------|------------|----------------|----------------|----------|--------|---------------|
|          |             | (MHz)     | (dBuV)        | (dB)          | (dB)       | (dB)           | (dBuV/m)       | (dBuV/m) | (dB)   |               |
| GFS K-1M | V           | 2401      | 79.63         | 30.55         | 5.77       | 24.66          | 91.29          | 114      | -22.71 | Pk            |
|          | V           | 2401      | 66.32         | 30.55         | 5.77       | 24.66          | 77.98          | 94       | -16.02 | AV            |
|          | V           | 2440      | 70.52         | 30.33         | 6.32       | 24.55          | 82.62          | 114      | -31.38 | Pk            |
|          | V           | 2440      | 62.35         | 30.33         | 6.32       | 24.55          | 74.45          | 94       | -19.55 | AV            |
|          | V           | 2480      | 71.09         | 30.55         | 5.77       | 24.66          | 82.75          | 114      | -31.25 | Pk            |
|          | V           | 2480      | 60.28         | 30.55         | 5.77       | 24.66          | 71.94          | 94       | -22.06 | AV            |
|          | H           | 2401      | 76.96         | 30.55         | 5.77       | 24.66          | 88.62          | 114      | -25.38 | Pk            |
|          | H           | 2401      | 69.21         | 30.55         | 5.77       | 24.66          | 80.87          | 94       | -13.13 | AV            |
|          | H           | 2440      | 76.48         | 30.33         | 6.32       | 24.55          | 88.58          | 114      | -25.42 | Pk            |
|          | H           | 2440      | 62.21         | 30.33         | 6.32       | 24.55          | 74.31          | 94       | -19.69 | AV            |
|          | H           | 2480      | 75.36         | 30.55         | 5.77       | 24.66          | 87.02          | 114      | -26.98 | Pk            |
|          | H           | 2480      | 61.05         | 30.55         | 5.77       | 24.66          | 72.71          | 94       | -21.29 | AV            |



1GHz~25GHz

| Polar<br>(H/V)         | Frequency<br>(MHz) | Meter<br>Reading<br>(dBuV) | Pre-ampli<br>fier<br>(dB) | Cable<br>Loss<br>(dB) | Antenna<br>Factor<br>(dB) | Emission<br>Level<br>(dBuV/m) | Limits<br>(dBuV/m) | Margin<br>(dB) | Detector<br>Type |
|------------------------|--------------------|----------------------------|---------------------------|-----------------------|---------------------------|-------------------------------|--------------------|----------------|------------------|
| Low Channel:2401MHz    |                    |                            |                           |                       |                           |                               |                    |                |                  |
| V                      | 4802               | 56.84                      | 30.55                     | 5.77                  | 24.66                     | 56.72                         | 74                 | -17.28         | Pk               |
| V                      | 4802               | 42.88                      | 30.55                     | 5.77                  | 24.66                     | 42.76                         | 54                 | -11.24         | AV               |
| V                      | 7203               | 58.84                      | 30.33                     | 6.32                  | 24.55                     | 59.38                         | 74                 | -14.62         | Pk               |
| V                      | 7203               | 41.06                      | 30.33                     | 6.32                  | 24.55                     | 41.6                          | 54                 | -12.4          | AV               |
| H                      | 4802               | 59.79                      | 30.55                     | 5.77                  | 24.66                     | 59.67                         | 74                 | -14.33         | Pk               |
| H                      | 4802               | 42.63                      | 30.55                     | 5.77                  | 24.66                     | 42.51                         | 54                 | -11.49         | AV               |
| H                      | 7203               | 56.03                      | 30.33                     | 6.32                  | 24.55                     | 56.57                         | 74                 | -17.43         | Pk               |
| H                      | 7203               | 42.36                      | 30.33                     | 6.32                  | 24.55                     | 42.9                          | 54                 | -11.1          | AV               |
| Middle Channel:2440MHz |                    |                            |                           |                       |                           |                               |                    |                |                  |
| V                      | 4880               | 56.43                      | 30.55                     | 5.77                  | 24.66                     | 56.31                         | 74                 | -17.69         | Pk               |
| V                      | 4880               | 41.33                      | 30.55                     | 5.77                  | 24.66                     | 41.21                         | 54                 | -12.79         | AV               |
| V                      | 7320               | 58.64                      | 30.33                     | 6.32                  | 24.55                     | 59.18                         | 74                 | -14.82         | Pk               |
| V                      | 7320               | 43.66                      | 30.33                     | 6.32                  | 24.55                     | 44.2                          | 54                 | -9.8           | AV               |
| H                      | 4880               | 59.07                      | 30.55                     | 5.77                  | 24.66                     | 58.95                         | 74                 | -15.05         | AV               |
| H                      | 4880               | 41.2                       | 30.55                     | 5.77                  | 24.66                     | 41.08                         | 54                 | -12.92         | Pk               |
| H                      | 7320               | 56.88                      | 30.33                     | 6.32                  | 24.55                     | 57.42                         | 74                 | -16.58         | AV               |
| High Channel:2480MHz   |                    |                            |                           |                       |                           |                               |                    |                |                  |
| V                      | 4960               | 55.04                      | 30.55                     | 5.77                  | 24.66                     | 54.92                         | 74                 | -19.08         | Pk               |
| V                      | 4960               | 41.91                      | 30.55                     | 5.77                  | 24.66                     | 41.79                         | 54                 | -12.21         | AV               |
| V                      | 7440               | 57.99                      | 30.33                     | 6.32                  | 24.55                     | 58.53                         | 74                 | -15.47         | Pk               |
| V                      | 7440               | 44.37                      | 30.33                     | 6.32                  | 24.55                     | 44.91                         | 54                 | -9.09          | AV               |
| H                      | 4960               | 56.55                      | 30.55                     | 5.77                  | 24.66                     | 56.43                         | 74                 | -17.57         | Pk               |
| H                      | 4960               | 42.92                      | 30.55                     | 5.77                  | 24.66                     | 42.8                          | 54                 | -11.2          | AV               |
| H                      | 7440               | 55.39                      | 30.33                     | 6.32                  | 24.55                     | 55.93                         | 74                 | -18.07         | Pk               |
| H                      | 7440               | 44.03                      | 30.33                     | 6.32                  | 24.55                     | 44.57                         | 54                 | -9.43          | AV               |

Remark:

1. Emission Level = Meter Reading + Antenna Factor + Cable Loss – Pre-amplifier,  
Margin= Emission Level - Limit
2. If peak below the average limit, the average emission was no test.
3. The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.



## 5. RADIATED BAND EMISSION MEASUREMENT

### 5.1 TEST REQUIREMENT:

|                       |                                                                                                    |          |      |      |         |
|-----------------------|----------------------------------------------------------------------------------------------------|----------|------|------|---------|
| Test Requirement:     | FCC Part15 C Section 15.209 and 15.205                                                             |          |      |      |         |
| Test Method:          | ANSI C63.10: 2013                                                                                  |          |      |      |         |
| Test Frequency Range: | All of the restrict bands were tested, only the worst band's (2310MHz to 2500MHz) data was showed. |          |      |      |         |
| Test site:            | Measurement Distance: 3m                                                                           |          |      |      |         |
| Receiver setup:       | Frequency                                                                                          | Detector | RBW  | VBW  | Value   |
|                       | Above                                                                                              | Peak     | 1MHz | 3MHz | Peak    |
|                       | 1GHz                                                                                               | Average  | 1MHz | 3MHz | Average |

### LIMITS OF RADIATED EMISSION MEASUREMENT (Above 1000MHz)

| FREQUENCY (MHz) | Limit (dBuV/m) (at 3M) |         |
|-----------------|------------------------|---------|
|                 | PEAK                   | AVERAGE |
| Above 1000      | 74                     | 54      |

#### Notes:

- (1) The limit for radiated test was performed according to FCC PART 15C.
- (2) The tighter limit applies at the band edges.
- (3) Emission level (dBuV/m)=20log Emission level (uV/m).

### 5.2 TEST PROCEDURE

Above 1GHz test procedure as below:

- a. 1. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter 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 and the rota 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.
- g. Test the EUT in the lowest channel, the Highest channel

#### Note:

Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported

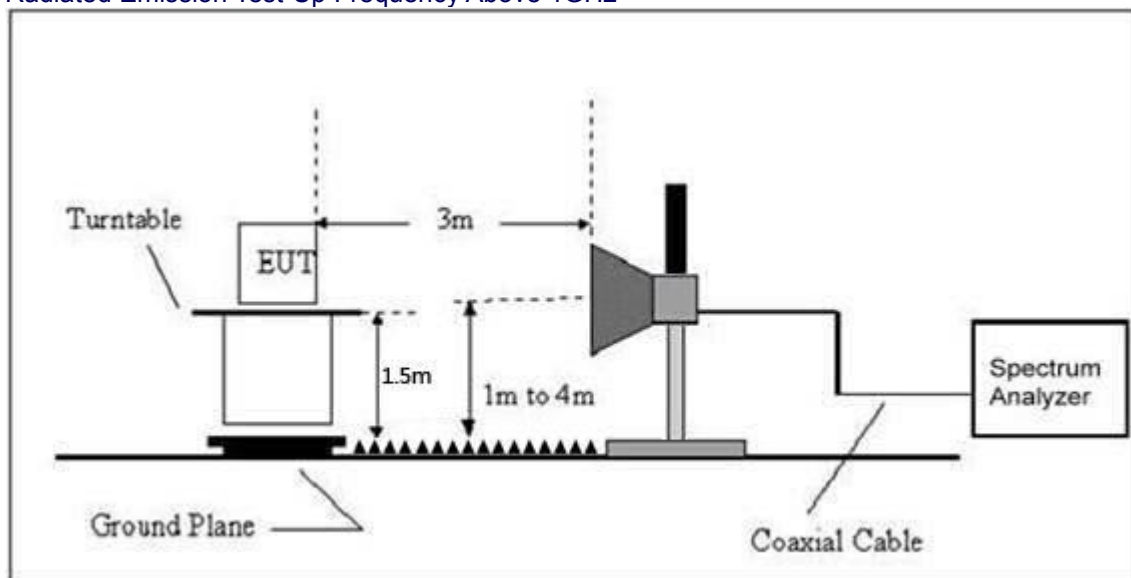
### 5.3 DEVIATION FROM TEST STANDARD

No deviation



## 5.4 TEST SETUP

### Radiated Emission Test-Up Frequency Above 1GHz

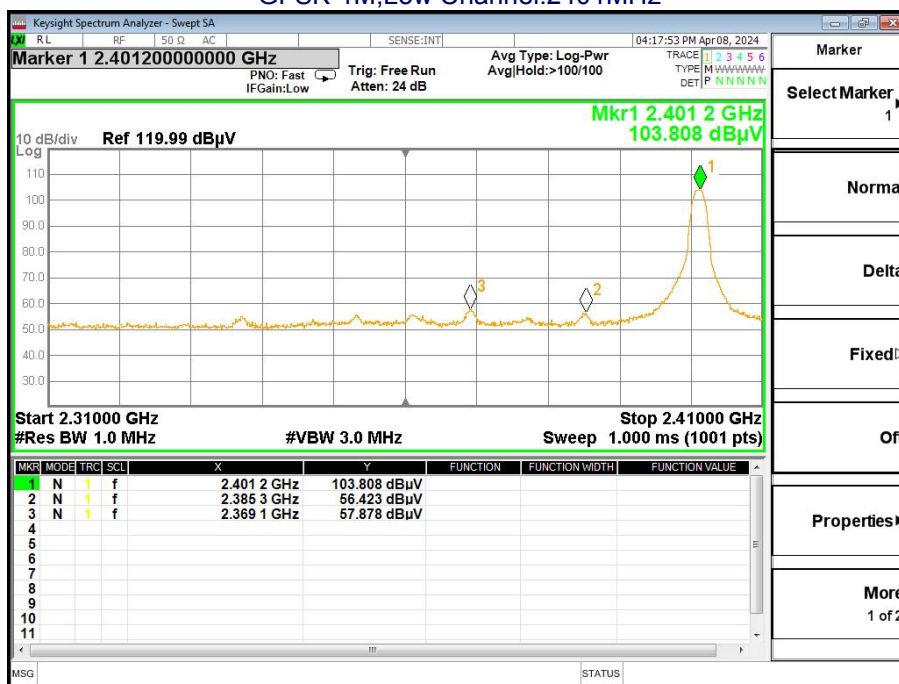


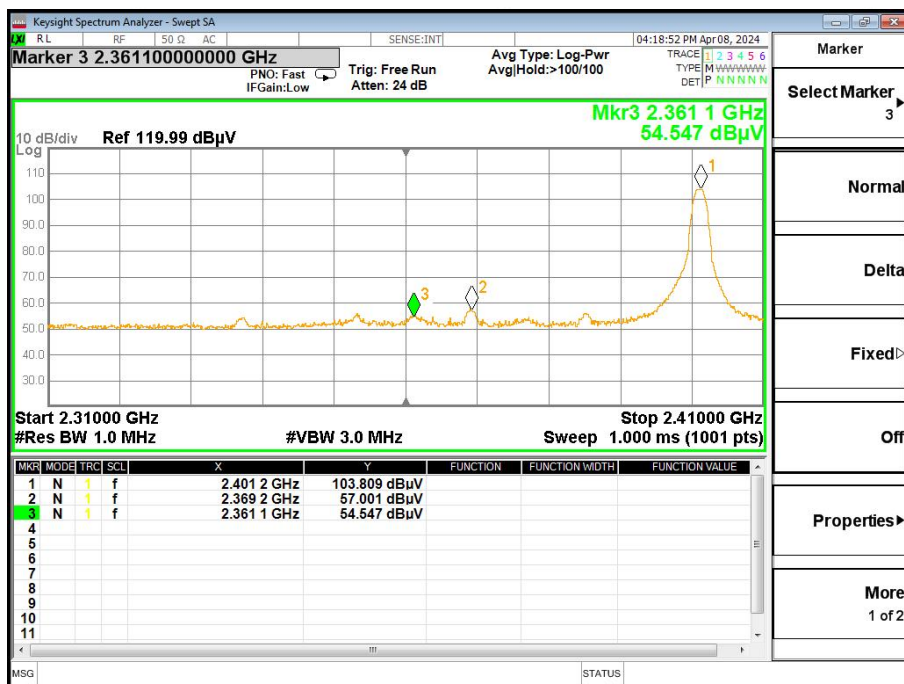
## 5.5 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of 2.3 Unless otherwise a special operating condition is specified in the follows during the testing.

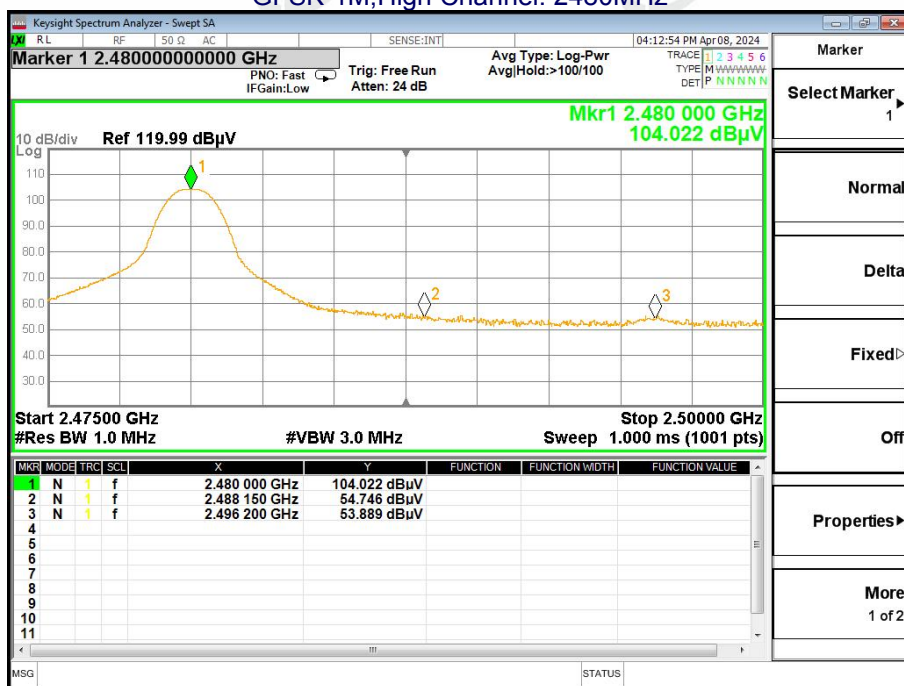
## 5.6 TEST RESULT

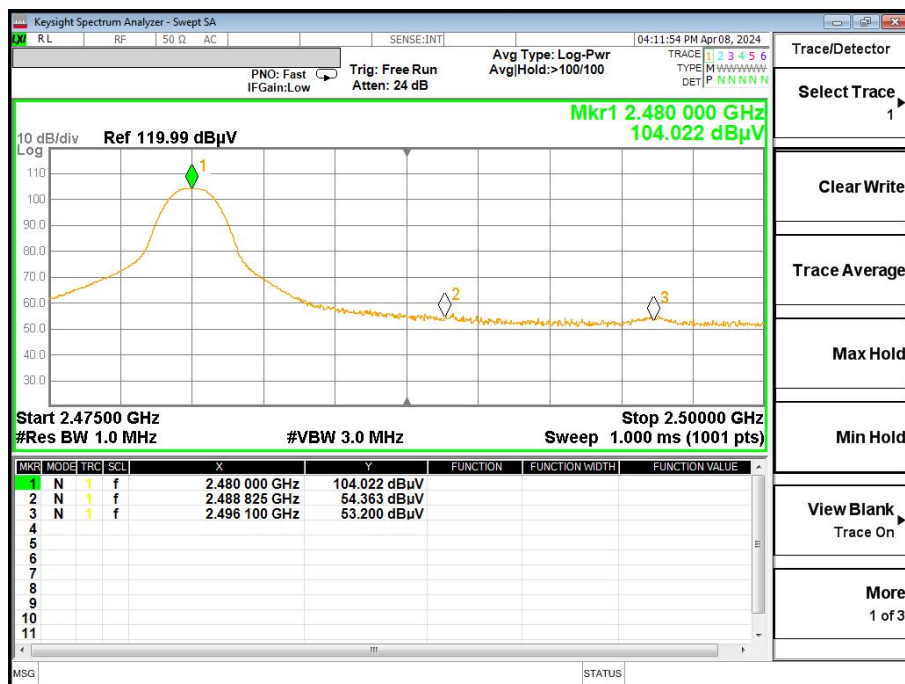
### GFSK-1M,Low Channel:2401MHz





GFSK-1M, High Channel: 2480MHz





## 7. CHANNEL BANDWIDTH

|                   |                             |
|-------------------|-----------------------------|
| Test Requirement: | FCC Part15 C Section 15.249 |
| Test Method:      | ANSI C63.10:2013            |

### 7.1 APPLIED PROCEDURES / LIMIT

| FCC Part15 (15.249) , Subpart C |           |                       |        |
|---------------------------------|-----------|-----------------------|--------|
| Section                         | Test Item | Frequency Range (MHz) | Result |
| 15.249(a)(2)                    | Bandwidth | 2400-2483.5           | PASS   |

### 7.2 TEST PROCEDURE

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW)  $\geq 3 \times$  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.

### 7.3 DEVIATION FROM STANDARD

No deviation.

### 7.4 TEST SETUP



### 7.5 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.



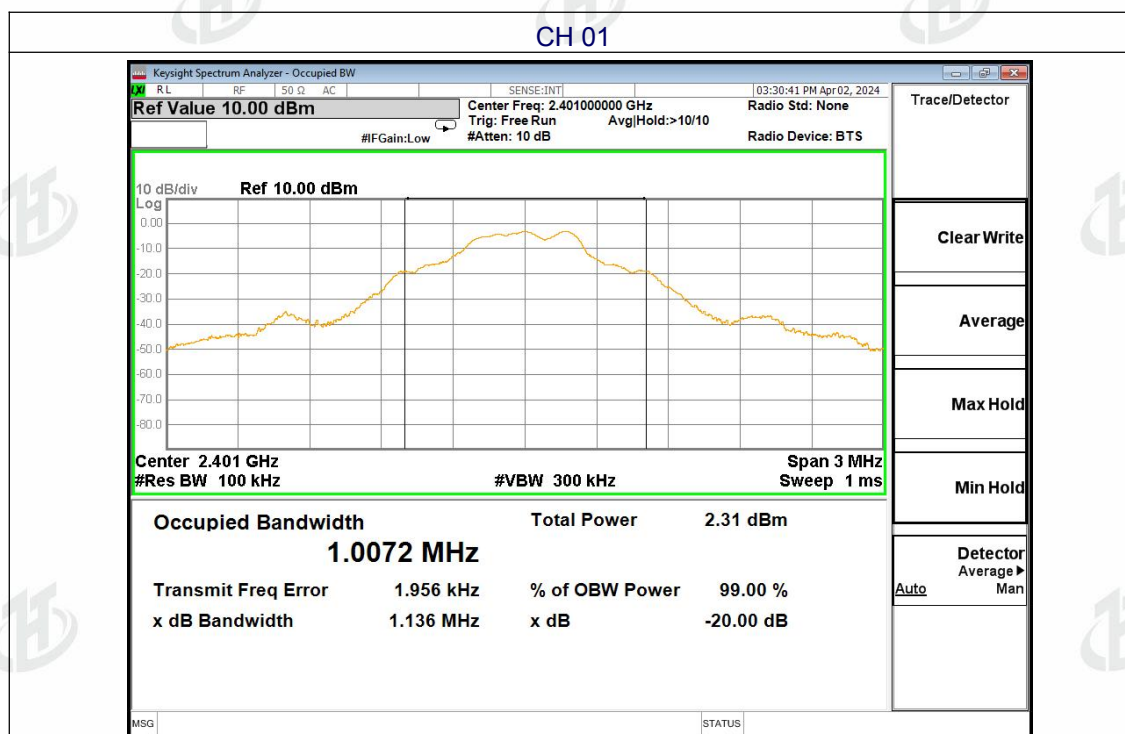
## 7.6 TEST RESULTS

|               |        |                     |         |
|---------------|--------|---------------------|---------|
| Temperature : | 25.6°C | Relative Humidity : | 51%     |
| Test Mode :   | GFSK   | Test Voltage :      | DC 3.7V |

| Mode    | Test channel | Channel Bandwidth (MHz) | Result |
|---------|--------------|-------------------------|--------|
| GFSK-1M | Lowest       | 1.136                   | Pass   |
|         | Middle       | 1.131                   |        |
|         | Highest      | 1.129                   |        |

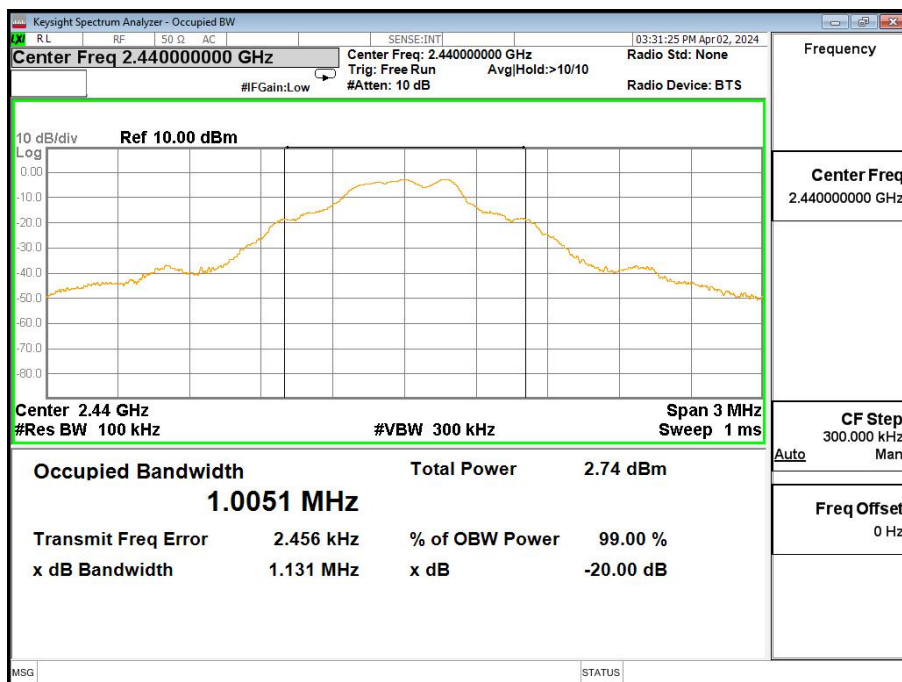
GFSK-1M

CH 01

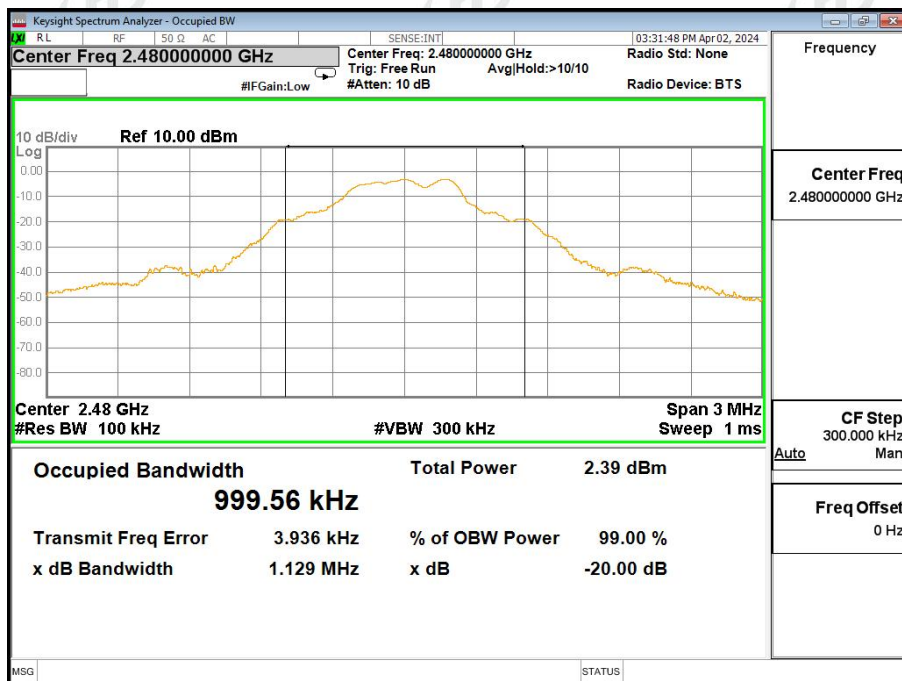




## CH20



## CH40



## 8.ANTENNA REQUIREMENT

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| Standard requirement:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | FCC Part15 C Section 15.203 /249(b)(4) |
| <p>15.203 requirement:<br/>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.</p> <p>15.249(b) (4) requirement:<br/>(4) 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.</p> |                                        |
| EUT Antenna:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                        |
| The antenna is Chip antenna, the best case gain of the antennas is 2.78dBi, reference to the appendix II for details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                        |



## 9. TEST SETUP PHOTOS

Reference to the appendix I for details.

## 10. EUT CONSTRUCTIONAL DETAILS

Reference to the appendix II for details.

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