

# TEST REPORT

## CERTIFICATE OF CONFORMITY

**Standard:** 47 CFR FCC Part 15, Subpart C (Section 15.247)

**Report No.:** RFBDKG-WTW-P24090192

**FCC ID:** JNZMR0117

**Product:** Wireless Mouse

**Brand:** Logitech, logi, logitech

**Model No.:** MR0117

**Received Date:** 2024/10/16

**Test Date:** 2024/10/23 ~ 2024/10/24

**Issued Date:** 2024/11/20

**Applicant:** LOGITECH FAR EAST LTD.

**Address:** #2 Creation Rd. 4, Science-Based Ind. Park Hsinchu Taiwan, R.O.C.

**Issued By:** Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch  
Hsin Chu Laboratory

**Lab Address:** E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan

**Test Location:** E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan

**FCC Registration /** 723255 / TW2022

**Designation Number:**

Approved by: \_\_\_\_\_



May Chen / Manager

, Date: \_\_\_\_\_

2024/11/20

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Prepared by: Vito Lung / Specialist

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## Release Control Record

| Issue No.            | Description       | Date Issued |
|----------------------|-------------------|-------------|
| RFBDKG-WTW-P24090192 | Original release. | 2024/11/20  |

## 1 Certificate

**Product:** Wireless Mouse

**Brand:** Logitech, logi, logitech

**Test Model:** MR0117

**Sample Status:** Engineering sample

**Applicant:** LOGITECH FAR EAST LTD.

**Test Date:** 2024/10/23 ~ 2024/10/24

**Standard:** 47 CFR FCC Part 15, Subpart C (Section 15.247)

**Measurement** ANSI C63.10-2013

**procedure:** KDB 558074 D01 15.247 Meas Guidance v05r02

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

## 2 Summary of Test Results

| 47 CFR FCC Part 15, Subpart C (Section 15.247) |                                 |        |  |
|--|---------------------------------|--------|--|
| Standard / Clause                              | Test Item                       | Result | Remark   |
| 15.247(b)                                      | RF Output Power                 | Pass   | Meet the requirement of limit.                   |
| 15.247(e)                                      | Power Spectral Density          | Pass   | Meet the requirement of limit.                   |
| 15.247(a)(2)                                   | 6 dB Bandwidth                  | Pass   | Meet the requirement of limit.                   |
| 15.247(d)                                      | Conducted Out of Band Emissions | Pass   | Meet the requirement of limit.                   |
| 15.207   | AC Power Conducted Emissions    | N/A    | Power supply is from battery.                    |
| 15.205 /<br>15.209 /<br>15.247(d)              | Unwanted Emissions below 1 GHz  | Pass   | Minimum passing margin is -12.6 dB at 33.52 MHz  |
| 15.205 /<br>15.209 /<br>15.247(d)              | Unwanted Emissions above 1 GHz  | Pass   | Minimum passing margin is -9.0 dB at 2483.50 MHz |
| 15.203   | Antenna Requirement             | Pass   | No antenna connector is used.                    |

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

### 2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

| Parameter                       | Specification   | Expanded Uncertainty<br>(k=2)<br>(±) |
|---------------------------------|-----------------|--------------------------------------|
| RF Output Power                 | -               | 1.1 dB                               |
| Power Spectral Density          | -               | 1.3 dB                               |
| 6 dB Bandwidth                  | -               | 1050.00 Hz                           |
| Conducted Out of Band Emissions | 9 kHz ~ 40 GHz  | 2.6 dB                               |
| Unwanted Emissions below 1 GHz  | 9 kHz ~ 30 MHz  | 3.1 dB                               |
|                                 | 30 MHz ~ 1 GHz  | 5.5 dB                               |
| Radiated Emissions above 1 GHz  | 1 GHz ~ 18 GHz  | 5.1 dB                               |
|                                 | 18 GHz ~ 40 GHz | 5.3 dB                               |

The other instruments specified are routine verified to remain within the calibrated levels, no measurement uncertainty is required to be calculated.

### 2.2 Supplementary Information

There is not any deviation from the test standards for the test method, and no modifications required for compliance.

### 3 General Information

#### 3.1 General Description

|                       |                          |
|-----------------------|--------------------------|
| Product               | Wireless Mouse           |
| Brand                 | Logitech, logi, logitech |
| Test Model            | MR0117                   |
| Status of EUT         | Engineering sample       |
| Power Supply Rating   | 1.5 Vdc from battery     |
| Modulation Type       | GFSK                     |
| Modulation Technology | DTS                      |
| Transfer Rate         | 2 Mbps                   |
| Operating Frequency   | 2.405 GHz ~ 2.474 GHz    |
| Number of Channel     | 70                       |
| Output Power          | 2.979 mW (4.74 dBm)      |

Note:

1. The EUT may have a lot of colors for marketing requirement.
2. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or User's Manual.

#### 3.2 Antenna Description of EUT

1. The antenna information is listed as below.

| Antenna Net Gain(dBi) | Frequency range (GHz) | Antenna Type     | Connector Type |
|-----------------------|-----------------------|------------------|----------------|
| 2.91                  | 2.4~2.4835            | Printed Monopole | None           |

\* Detail antenna specification please refer to antenna datasheet and/or antenna measurement report.

### 3.3 Channel List

70 channels are provided to this EUT:

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

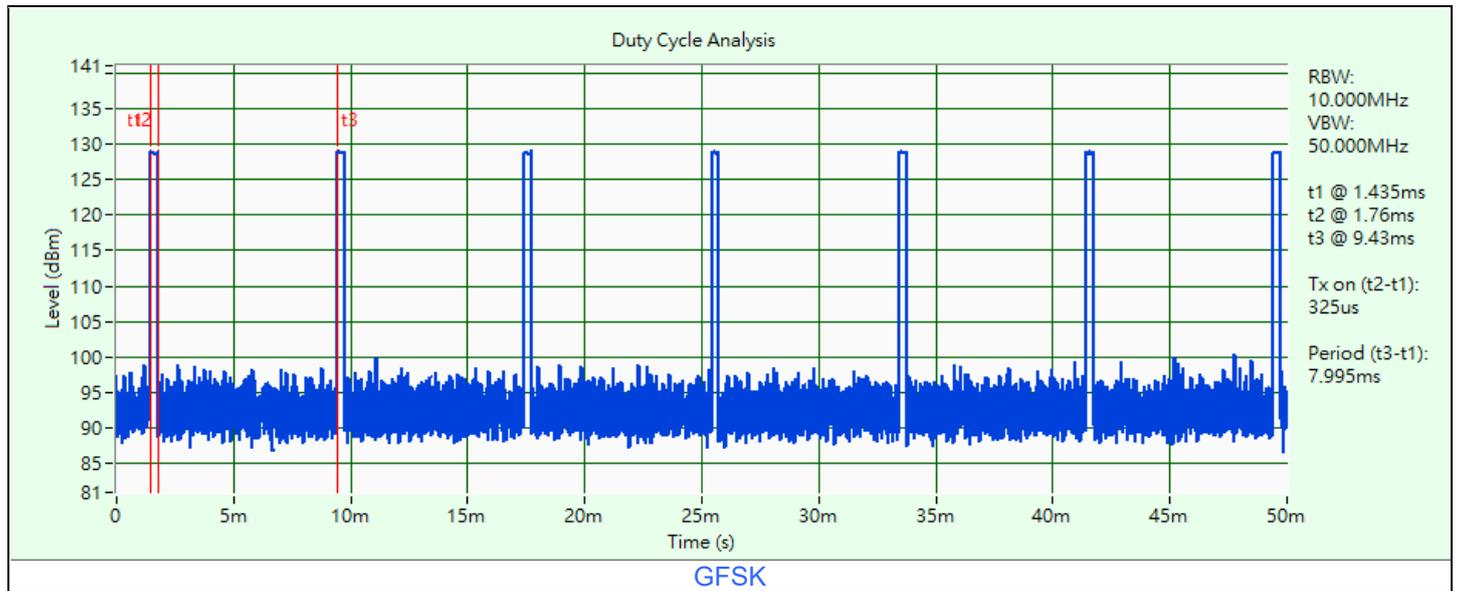
### 3.4 Test Mode Applicability and Tested Channel Detail

Following channel(s) was (were) selected for the final test as listed below:

| Test Item                       | Tested Channel | Modulation | Data Rate Parameter |
|---------------------------------|----------------|------------|---------------------|
| RF Output Power                 | 1, 40, 70      | GFSK       | 2Mb/s               |
| Power Spectral Density          | 1, 40, 70      | GFSK       | 2Mb/s               |
| 6 dB Bandwidth                  | 1, 40, 70      | GFSK       | 2Mb/s               |
| Conducted Out of Band Emissions | 1, 40, 70      | GFSK       | 2Mb/s               |
| Unwanted Emissions below 1 GHz  | 40             | GFSK       | 2Mb/s               |
| Unwanted Emissions above 1 GHz  | 1, 40, 70      | GFSK       | 2Mb/s               |

### 3.5 Duty Cycle of Test Signal

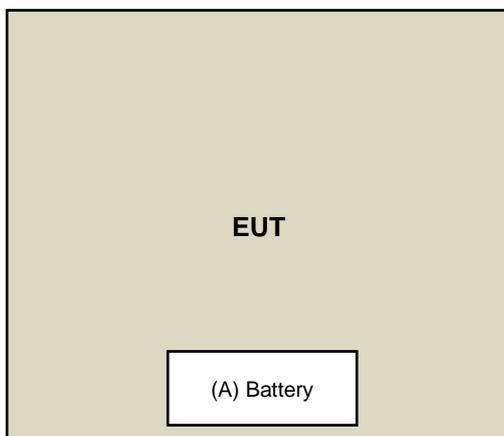
**GFSK:** Duty cycle =  $0.325 \text{ ms} / 7.995 \text{ ms} \times 100\% = 4.1\%$



### 3.6 Test Program Used and Operation Descriptions

Controlling software RF Sample [Press the button] has been activated to set the EUT under transmission condition continuously at specific channel frequency.

### 3.7 Connection Diagram of EUT and Peripheral Devices



### 3.8 Configuration of Peripheral Devices and Cable Connections

| ID | Product | Brand     | Model No. | Serial No. | FCC ID | Remarks         |
|----|---------|-----------|-----------|------------|--------|-----------------|
| A  | Battery | Energizer | AA        | N/A        | N/A    | Provided by Lab |

## 4 Test Instruments

The calibration interval of the all test instruments are 12 months and the calibrations are traceable to NML/ROC and NIST/USA.

### 4.1 RF Output Power

| Description<br>Manufacturer   | Model No. | Serial No. | Calibrated<br>Date | Calibrated<br>Until |
|-------------------------------|-----------|------------|--------------------|---------------------|
| Pulse Power Sensor<br>Anritsu | MA2411B   | 1726434    | 2024/6/7           | 2025/6/6            |
| RF Power Meter<br>Anritsu     | ML2495A   | 1529002    | 2024/6/7           | 2025/6/6            |

Notes:

1. The test was performed in Oven room 2.
2. Tested Date: 2024/10/24

### 4.2 Power Spectral Density

| Description<br>Manufacturer     | Model No.                        | Serial No. | Calibrated<br>Date | Calibrated<br>Until |
|---------------------------------|----------------------------------|------------|--------------------|---------------------|
| MXA Signal Analyzer<br>Keysight | N9020B                           | MY60112408 | 2024/3/7           | 2025/3/6            |
| Software                        | ADT_RF Test Software<br>V7.6.5.4 | N/A        | N/A                | N/A                 |

Notes:

1. The test was performed in Oven room 2.
2. Tested Date: 2024/10/24

### 4.3 6 dB Bandwidth

Refer to section 4.2 to get the tested date and information of the instruments.

### 4.4 Conducted Out of Band Emissions

Refer to section 4.2 to get the tested date and information of the instruments.

#### 4.5 Unwanted Emissions below 1 GHz

| Description<br>Manufacturer                         | Model No.            | Serial No.  | Calibrated<br>Date | Calibrated<br>Until |
|---|----------------------|-------------|--------------------|---------------------|
| Bi_Log Antenna<br>Schwarzbeck                       | VULB 9168            | 9168-406    | 2024/10/8          | 2025/10/7           |
| Boresight Antenna Tower & Turn<br>Table<br>Max-Full | MF-7802BS            | MF780208530 | N/A                | N/A                 |
| Fixed Attenuator<br>Mini-Circuits                   | UNAT-5+              | PAD-ATT5-03 | 2024/2/17          | 2025/2/16           |
| Loop Antenna<br>TESEQ                               | HLA 6121             | 63620       | 2024/10/17         | 2025/10/16          |
| MXE EMI Receiver<br>Agilent                         | N9038A               | MY51210202  | 2024/7/29          | 2025/7/28           |
| Preamplifier<br>EMCI                                | EMC330N              | 980701      | 2024/2/17          | 2025/2/16           |
|   | EMC001340            | 980142      | 2024/2/19          | 2025/2/18           |
| RF Coaxial Cable<br>JYEBAO                          | 5D-FB                | LOOPCAB-001 | 2024/2/19          | 2025/2/18           |
|   |                      | LOOPCAB-002 | 2024/2/19          | 2025/2/18           |
| RF Coaxial Cable<br>mTJ                             | 100100-CFD400LW-200  | CFD400-200  | 2024/2/17          | 2025/2/16           |
|   | 100100-CFD400LW-400  | CFD400-400  | 2024/2/17          | 2025/2/16           |
|   | 100100-CFD400LW-800  | CFD400-800  | 2024/2/17          | 2025/2/16           |
| Software  | ADT_Radiated_V8.7.08 | N/A         | N/A                | N/A                 |

Notes:

1. The test was performed in 966 Chamber No. 4.
2. Tested Date: 2024/10/23

#### 4.6 Unwanted Emissions above 1 GHz

| Description<br>Manufacturer                         | Model No.            | Serial No.  | Calibrated<br>Date | Calibrated<br>Until |
|---|----------------------|-------------|--------------------|---------------------|
| Boresight Antenna Tower & Turn<br>Table<br>Max-Full | MF-7802BS            | MF780208530 | N/A                | N/A                 |
| Horn Antenna<br>Schwarzbeck                         | BBHA 9120D           | 9120D-783   | 2023/11/12         | 2024/11/11          |
|   | BBHA 9170            | 9170-739    | 2023/11/12         | 2024/11/11          |
| MXA Signal Analyzer<br>Keysight                     | N9020B               | MY60112410  | 2024/3/13          | 2025/3/12           |
| Preamplifier<br>EMCI                                | EMC12630SE           | 980688      | 2024/8/8           | 2025/8/7            |
|   | EMC184045SE          | 980387      | 2024/8/8           | 2025/8/7            |
| RF Coaxial Cable<br>EMCI                            | EMC102-KM-KM-1200    | 160924      | 2024/1/29          | 2025/1/28           |
|   | EMC102-KM-KM-4000    | 200214      | 2024/1/29          | 2025/1/28           |
|   | EMC104-SM-SM-1200    | 160922      | 2024/1/29          | 2025/1/28           |
|   | EMC104-SM-SM-2000    | 180502      | 2024/1/29          | 2025/1/28           |
|   | EMC104-SM-SM-6000    | 210704      | 2023/11/2          | 2024/11/1           |
| Software  | ADT_Radiated_V8.7.08 | N/A         | N/A                | N/A                 |

Notes:

1. The test was performed in 966 Chamber No. 4.
2. Tested Date: 2024/10/23 ~ 2024/10/24

## 5 Limits of Test Items

### 5.1 RF Output Power

For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30 dBm)

### 5.2 Power Spectral Density

The Maximum of Power Spectral Density Measurement is 8 dBm in any 3 kHz.

### 5.3 6 dB Bandwidth

The minimum of 6 dB Bandwidth Measurement is 0.5 MHz.

### 5.4 Conducted Out of Band Emissions

Below 20 dB of the highest emission level of operating band (in 100 kHz Resolution Bandwidth).

### 5.5 Unwanted Emissions below 1 GHz

Radiated emissions up to 1 GHz which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20 dB below the highest level of the desired power:

| Frequencies (MHz) | Field Strength (microvolts/meter) | Measurement Distance (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                             |

Notes:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).

## 5.6 Unwanted Emissions above 1 GHz

Radiated emissions above 1 GHz which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20 dB below the highest level of the desired power:

| Frequencies<br>(MHz) | Field Strength<br>(microvolts/meter) | Measurement Distance<br>(meters) |
|----------------------|--------------------------------------|----------------------------------|
| Above 960            | 500                                  | 3                                |

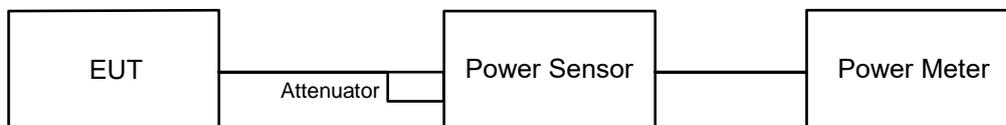
### Notes:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

## 6 Test Arrangements

### 6.1 RF Output Power

#### 6.1.1 Test Setup



#### 6.1.2 Test Procedure

##### Peak Power:

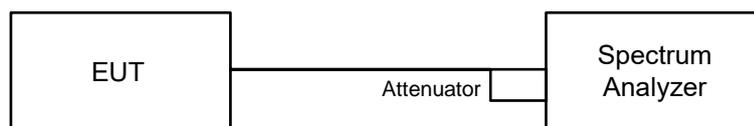
A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

##### Average Power:

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

### 6.2 Power Spectral Density

#### 6.2.1 Test Setup

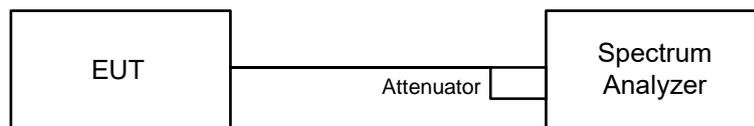


#### 6.2.2 Test Procedure

- a. Set analyzer center frequency to DTS channel center frequency.
- b. Set the span to 1.5 times the DTS bandwidth.
- c. Set the RBW to: 3 kHz.
- d. Set the VBW  $\geq 3 \times$  RBW.
- e. Detector = peak.
- f. Sweep time = auto couple.
- g. Trace mode = max hold.
- h. Allow trace to fully stabilize.
- i. Use the peak marker function to determine the maximum amplitude level within the RBW.

### 6.3 6 dB Bandwidth

#### 6.3.1 Test Setup

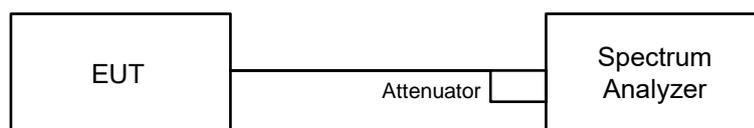


#### 6.3.2 Test Procedure

- Set resolution bandwidth (RBW) = 100 kHz.
- Set the video bandwidth (VBW)  $\geq 3 \times$  RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

### 6.4 Conducted Out of Band Emissions

#### 6.4.1 Test Setup



#### 6.4.2 Test Procedure

##### MEASUREMENT PROCEDURE REF

- Set the RBW = 100 kHz.
- Set the VBW  $\geq 300$  kHz.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

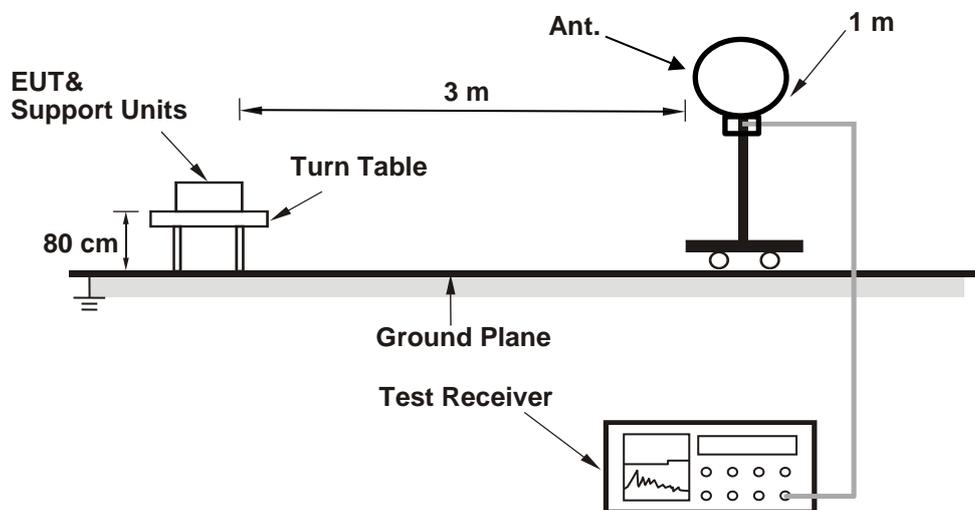
##### MEASUREMENT PROCEDURE OOB

- Set RBW = 100 kHz.
- Set VBW  $\geq 300$  kHz.
- Detector = peak.
- Sweep = auto couple.
- Trace Mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level.

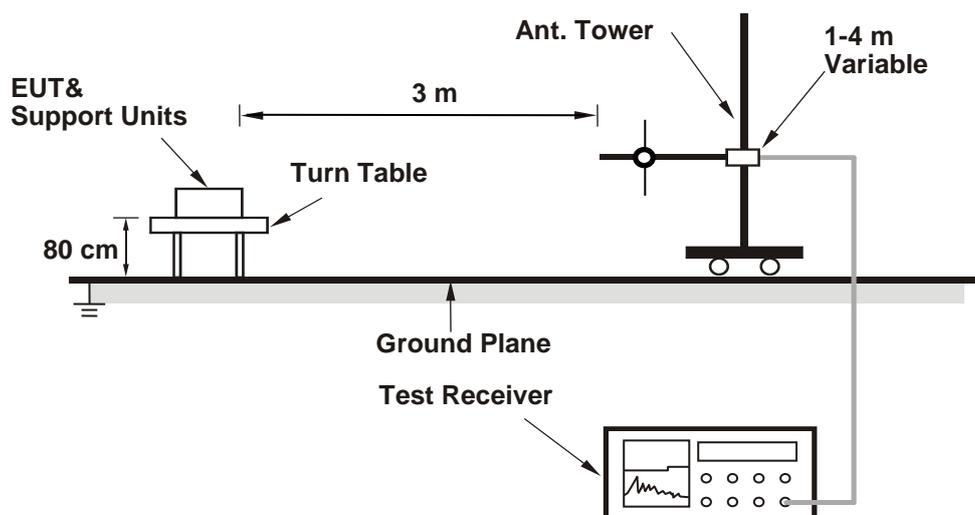
## 6.5 Unwanted Emissions below 1 GHz

### 6.5.1 Test Setup

#### For Radiated emission below 30 MHz



#### For Radiated emission above 30 MHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

## 6.5.2 Test Procedure

### For Radiated emission below 30 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at 3 meter chamber room for test. 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. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode, except for the frequency band (9 kHz to 90 kHz and 110 kHz to 490 kHz) set to average detect function and peak detect function.

#### Notes:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 200 Hz at frequency below 150 kHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9 kHz or 10 kHz at frequency (150 kHz to 30 MHz).
3. All modes of operation were investigated and the worst-case emissions are reported.

### For Radiated emission above 30 MHz

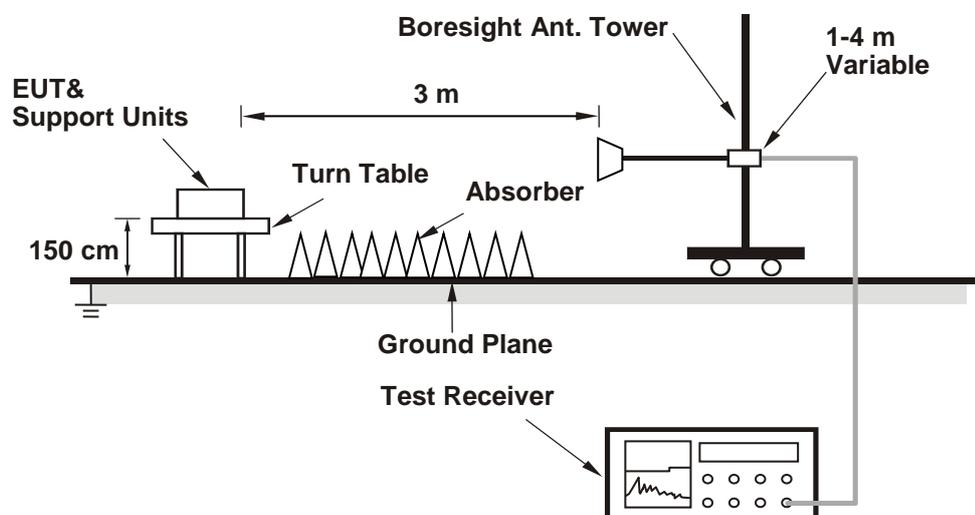
- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

#### Notes:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
2. All modes of operation were investigated and the worst-case emissions are reported.

## 6.6 Unwanted Emissions above 1 GHz

### 6.6.1 Test Setup



For the actual test configuration, please refer to the attached file (Test Setup Photo).

### 6.6.2 Test Procedure

- The EUT was placed on the top of a rotating table 1.5 meters above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The height of antenna 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.
- 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The test-receiver/spectrum analyzer was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

#### Notes:

- The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) and Average detection (AV) at frequency above 1 GHz.
- For fundamental and harmonic signal measurement, according to KDB 558074 D01 15.247 Meas Guidance v05r02 section 8.1(c)(3). The spectrum analyzer settings meet the requirements of 11.12.2.4 in ANSI C63.10 for making a Peak measurement, the average value = Peak value + duty cycle correction factor. The duty cycle measurement refers to FCC 47 CFR Part 15C section 15.35 (c). For duty cycle correction factor values, see the Test Signal Duty Cycle section in this report.
- All modes of operation were investigated and the worst-case emissions are reported.

## 7 Test Results of Test Item

### 7.1 RF Output Power

|              |         |                           |              |            |              |
|--------------|---------|---------------------------|--------------|------------|--------------|
| Input Power: | 1.5 Vdc | Environmental Conditions: | 25°C, 60% RH | Tested By: | Jyunchun Lin |
|--------------|---------|---------------------------|--------------|------------|--------------|

#### For Peak Power

| Chan. | Chan. Freq. (MHz) | Peak Power (mW) | Peak Power (dBm) | Power Limit (dBm) | Test Result |
|-------|-------------------|-----------------|------------------|-------------------|-------------|
| 1     | 2405              | 2.818           | 4.50             | 30                | Pass        |
| 40    | 2444              | 2.979           | 4.74             | 30                | Pass        |
| 70    | 2474              | 2.904           | 4.63             | 30                | Pass        |

Note: The antenna gain is 2.91 dBi < 6 dBi, so the output power limit shall not be reduced.

#### For Average Power

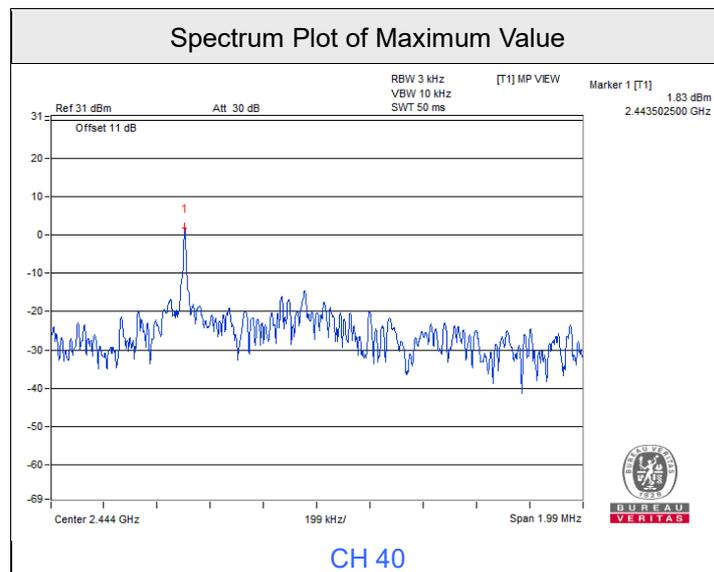
| Chan. | Chan. Freq. (MHz) | Average Power (mW) | Average Power (dBm) |
|-------|-------------------|--------------------|---------------------|
| 1     | 2405              | 2.773              | 4.43                |
| 40    | 2444              | 2.877              | 4.59                |
| 70    | 2474              | 2.799              | 4.47                |

## 7.2 Power Spectral Density

|              |         |                           |              |            |              |
|--------------|---------|---------------------------|--------------|------------|--------------|
| Input Power: | 1.5 Vdc | Environmental Conditions: | 25°C, 60% RH | Tested By: | Jyunchun Lin |
|--------------|---------|---------------------------|--------------|------------|--------------|

| Chan. | Chan. Freq. (MHz) | PSD (dBm/3kHz) | PSD Limit (dBm/3kHz) | Test Result |
|-------|-------------------|----------------|----------------------|-------------|
| 1     | 2405              | 1.72           | 8                    | Pass        |
| 40    | 2444              | 1.83           | 8                    | Pass        |
| 70    | 2474              | 1.79           | 8                    | Pass        |

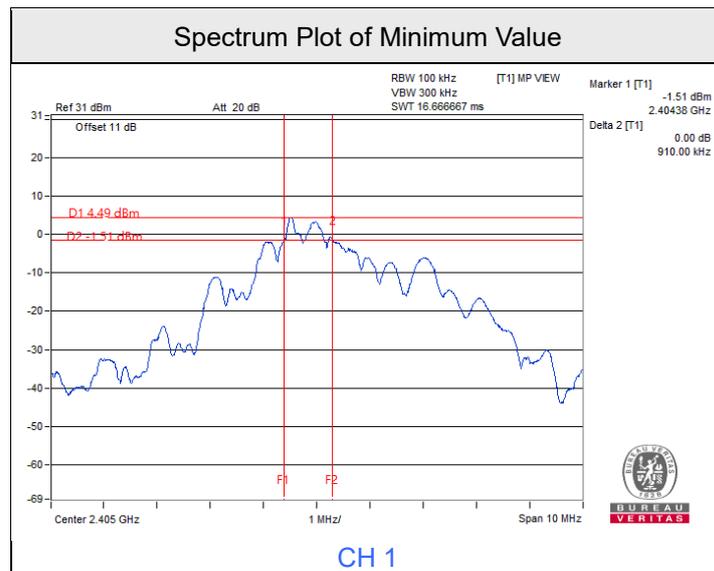
Note: The antenna gain is 2.91 dBi < 6 dBi, so the power density limit shall not be reduced.



### 7.3 6 dB Bandwidth

|              |         |                           |              |            |              |
|--------------|---------|---------------------------|--------------|------------|--------------|
| Input Power: | 1.5 Vdc | Environmental Conditions: | 25°C, 60% RH | Tested By: | Jyunchun Lin |
|--------------|---------|---------------------------|--------------|------------|--------------|

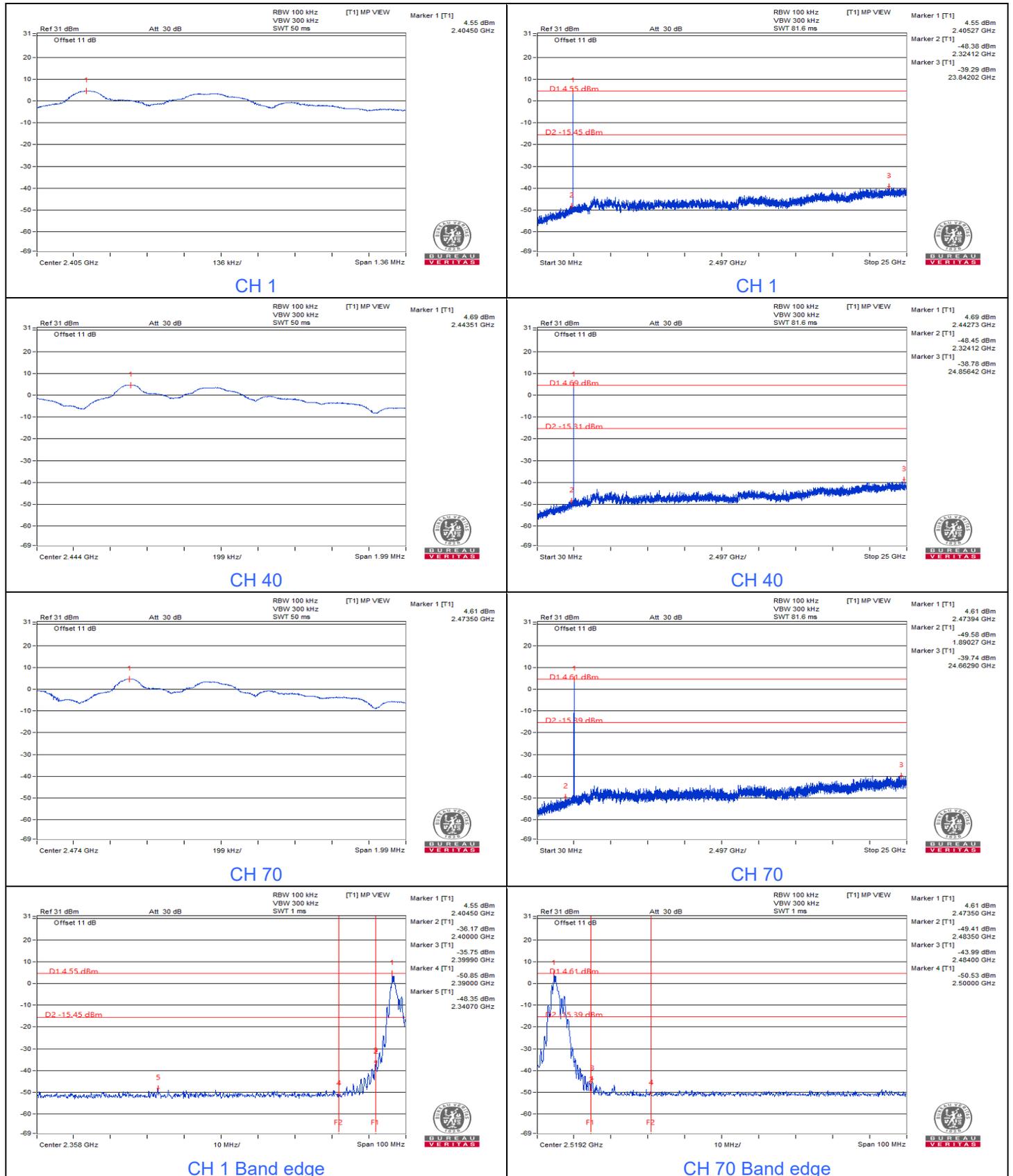
| Channel | Frequency (MHz) | 6 dB Bandwidth (MHz) | Minimum Limit (MHz) | Test Result |
|---------|-----------------|----------------------|---------------------|-------------|
| 1       | 2405            | 0.91                 | 0.5                 | Pass        |
| 40      | 2444            | 1.33                 | 0.5                 | Pass        |
| 70      | 2474            | 1.33                 | 0.5                 | Pass        |





### 7.4 Conducted Out of Band Emissions

|              |         |                           |              |            |              |
|--------------|---------|---------------------------|--------------|------------|--------------|
| Input Power: | 1.5 Vdc | Environmental Conditions: | 25°C, 60% RH | Tested By: | Jyunchun Lin |
|--------------|---------|---------------------------|--------------|------------|--------------|



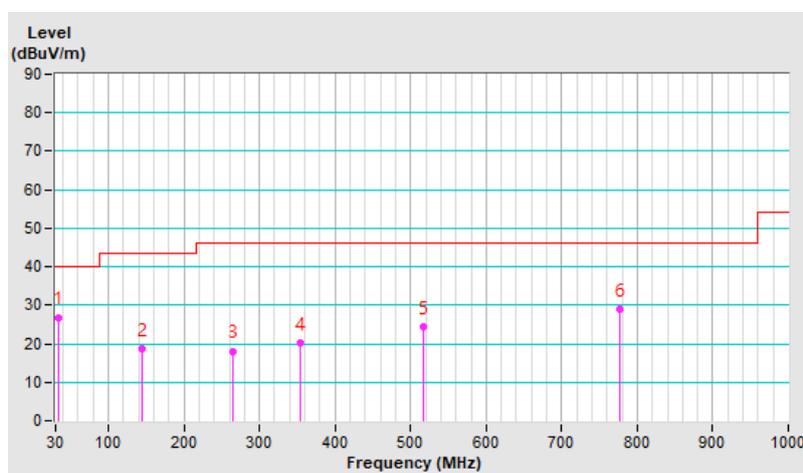
## 7.5 Unwanted Emissions below 1 GHz

|                 |                |                               |                               |
|-----------------|----------------|-------------------------------|-------------------------------|
| RF Mode         | GFSK           | Channel                       | CH 40 : 2444 MHz              |
| Frequency Range | 30 MHz ~ 1 GHz | Detector Function & Bandwidth | QP: RB=120kHz, DET=Quasi-Peak |
| Input Power     | 1.5 Vdc        | Environmental Conditions      | 23 °C, 67 % RH                |
| Tested By       | Andy Ho        |                               |                               |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|--|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No   | Frequency (MHz) | Emission Level (dBUV/m) | Limit (dBUV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBUV) | Correction Factor (dB/m) |
| 1  | 33.52           | 26.9 QP                 | 40.0           | -13.1       | 1.00 H             | 110                  | 40.7             | -13.8                    |
| 2  | 143.90          | 18.6 QP                 | 43.5           | -24.9       | 3.00 H             | 360                  | 31.6             | -13.0                    |
| 3  | 263.82          | 18.1 QP                 | 46.0           | -27.9       | 4.00 H             | 5                    | 31.7             | -13.6                    |
| 4  | 353.47          | 20.2 QP                 | 46.0           | -25.8       | 3.00 H             | 13                   | 31.4             | -11.2                    |
| 5  | 516.31          | 24.4 QP                 | 46.0           | -21.6       | 3.00 H             | 177                  | 31.3             | -6.9                     |
| 6  | 776.80          | 28.9 QP                 | 46.0           | -17.1       | 4.00 H             | 2                    | 30.6             | -1.7                     |

### Remarks:

1. Emission Level(dBUV/m) = Raw Value(dBUV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30 MHz ~ 1 GHz.
5. The frequency range 9 kHz ~ 30 MHz: all emissions are more than 20 dB below the limit, therefore do not be recorded in this report.

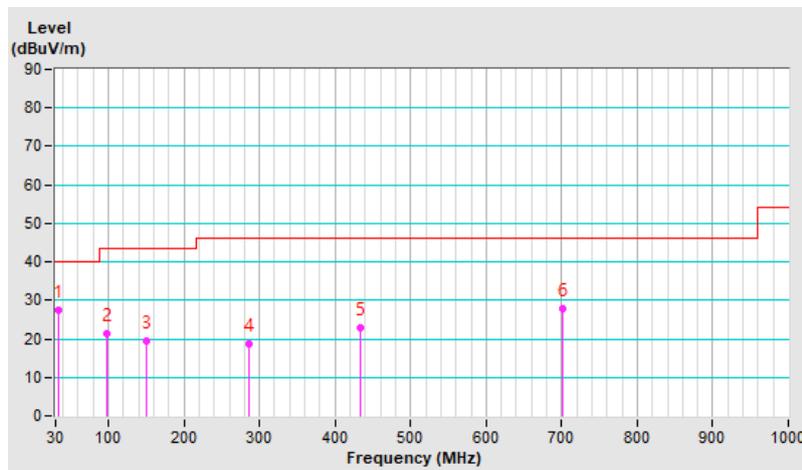


|                        |                |  |                               |
|------------------------|----------------|--|-------------------------------|
| <b>RF Mode</b>         | GFSK           | <b>Channel</b>                           | CH 40 : 2444 MHz              |
| <b>Frequency Range</b> | 30 MHz ~ 1 GHz | <b>Detector Function &amp; Bandwidth</b> | QP: RB=120kHz, DET=Quasi-Peak |
| <b>Input Power</b>     | 1.5 Vdc        | <b>Environmental Conditions</b>          | 23 °C, 67 % RH                |
| <b>Tested By</b>       | Andy Ho        |  |                               |

| Antenna Polarity & Test Distance : Vertical at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|--|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1  | 33.52           | 27.4 QP                 | 40.0           | -12.6       | 1.00 V             | 203                  | 41.2             | -13.8                    |
| 2  | 98.00           | 21.3 QP                 | 43.5           | -22.2       | 3.00 V             | 360                  | 38.9             | -17.6                    |
| 3  | 149.67          | 19.4 QP                 | 43.5           | -24.1       | 2.00 V             | 2                    | 32.2             | -12.8                    |
| 4  | 286.71          | 18.7 QP                 | 46.0           | -27.3       | 3.00 V             | 273                  | 31.4             | -12.7                    |
| 5  | 433.30          | 22.8 QP                 | 46.0           | -23.2       | 1.00 V             | 353                  | 31.5             | -8.7                     |
| 6  | 701.87          | 27.8 QP                 | 46.0           | -18.2       | 2.00 V             | 43                   | 31.1             | -3.3                     |

**Remarks:**

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30 MHz ~ 1 GHz.
5. The frequency range 9 kHz ~ 30 MHz: all emissions are more than 20 dB below the limit, therefore do not be recorded in this report.



## 7.6 Unwanted Emissions above 1 GHz

|                        |                |  |   |
|------------------------|----------------|--|---|
| <b>RF Mode</b>         | GFSK           | <b>Channel</b>                           | CH 1 : 2405 MHz   |
| <b>Frequency Range</b> | 1 GHz ~ 25 GHz | <b>Detector Function &amp; Bandwidth</b> | PK: RB=1 MHz, VB=3 MHz, DET=Peak<br>AV: RB=1 MHz, VB=3 MHz, DET=RMS |
| <b>Input Power</b>     | 1.5 Vdc        | <b>Environmental Conditions</b>          | 22 °C, 60 % RH  |
| <b>Tested By</b>       | Andy Ho        |  |   |

| Antenna Polarity & Test Distance : Horizontal at 3 m |                 |                         |                |             |                    |                      |                  |                          |
|--|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1  | 2390.00         | 55.1 PK                 | 74.0           | -18.9       | 1.00 H             | 78                   | 55.2             | -0.1                     |
| 2  | 2390.00         | 44.9 AV                 | 54.0           | -9.1        | 1.00 H             | 78                   | 45.0             | -0.1                     |
| 3  | *2405.00        | 100.2 PK                |                |             | 1.00 H             | 78                   | 100.4            | -0.2                     |
| 4  | *2405.00        | 72.4 AV                 |                |             | 1.00 H             | 78                   | 72.6             | -0.2                     |
| 5  | 4810.00         | 49.1 PK                 | 74.0           | -24.9       | 1.05 H             | 131                  | 44.7             | 4.4                      |
| 6  | 4810.00         | 21.3 AV                 | 54.0           | -32.7       | 1.05 H             | 131                  | 16.9             | 4.4                      |
| Antenna Polarity & Test Distance : Vertical at 3 m   |                 |                         |                |             |                    |                      |                  |                          |
| No   | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1  | 2390.00         | 51.9 PK                 | 74.0           | -22.1       | 3.71 V             | 115                  | 52.0             | -0.1                     |
| 2  | 2390.00         | 42.0 AV                 | 54.0           | -12.0       | 3.71 V             | 115                  | 42.1             | -0.1                     |
| 3  | *2405.00        | 95.4 PK                 |                |             | 3.71 V             | 115                  | 95.6             | -0.2                     |
| 4  | *2405.00        | 67.6 AV                 |                |             | 3.71 V             | 115                  | 67.8             | -0.2                     |
| 5  | 4810.00         | 47.4 PK                 | 74.0           | -26.6       | 1.01 V             | 174                  | 43.0             | 4.4                      |
| 6  | 4810.00         | 19.6 AV                 | 54.0           | -34.4       | 1.01 V             | 174                  | 15.2             | 4.4                      |

### Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " \* ": Fundamental frequency, the limit was restricted at the RF Output Power.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:  

$$20 \log(\text{Duty cycle}) = 20 \log(0.325 \text{ ms} / 7.995 \text{ ms}) = -27.8 \text{ dB}$$

|                        |                |  |   |
|------------------------|----------------|--|---|
| <b>RF Mode</b>         | GFSK           | <b>Channel</b>                           | CH 40 : 2444 MHz  |
| <b>Frequency Range</b> | 1 GHz ~ 25 GHz | <b>Detector Function &amp; Bandwidth</b> | PK: RB=1 MHz, VB=3 MHz, DET=Peak<br>AV: RB=1 MHz, VB=3 MHz, DET=RMS |
| <b>Input Power</b>     | 1.5 Vdc        | <b>Environmental Conditions</b>          | 22 °C, 60 % RH  |
| <b>Tested By</b>       | Andy Ho        |  |   |

**Antenna Polarity & Test Distance : Horizontal at 3 m**

| No | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|----|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1  | *2444.00        | 101.6 PK                |                |             | 1.00 H             | 87                   | 101.9            | -0.3                     |
| 2  | *2444.00        | 73.8 AV                 |                |             | 1.00 H             | 87                   | 74.1             | -0.3                     |
| 3  | 4888.00         | 50.6 PK                 | 74.0           | -23.4       | 1.04 H             | 134                  | 46.0             | 4.6                      |
| 4  | 4888.00         | 22.8 AV                 | 54.0           | -31.2       | 1.04 H             | 134                  | 18.2             | 4.6                      |
| 5  | 7332.00         | 48.5 PK                 | 74.0           | -25.5       | 1.00 H             | 37                   | 37.1             | 11.4                     |
| 6  | 7332.00         | 20.7 AV                 | 54.0           | -33.3       | 1.00 H             | 37                   | 9.3              | 11.4                     |

**Antenna Polarity & Test Distance : Vertical at 3 m**

| No | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
|----|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| 1  | *2444.00        | 97.5 PK                 |                |             | 3.66 V             | 137                  | 97.8             | -0.3                     |
| 2  | *2444.00        | 69.7 AV                 |                |             | 3.66 V             | 137                  | 70.0             | -0.3                     |
| 3  | 4888.00         | 49.6 PK                 | 74.0           | -24.4       | 1.00 V             | 173                  | 45.0             | 4.6                      |
| 4  | 4888.00         | 21.8 AV                 | 54.0           | -32.2       | 1.00 V             | 173                  | 17.2             | 4.6                      |
| 5  | 7332.00         | 47.1 PK                 | 74.0           | -26.9       | 1.02 V             | 190                  | 35.7             | 11.4                     |
| 6  | 7332.00         | 19.3 AV                 | 54.0           | -34.7       | 1.02 V             | 190                  | 7.9              | 11.4                     |

**Remarks:**

- Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
- Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
- Margin value = Emission Level – Limit value
- The other emission levels were very low against the limit.
- " \* ": Fundamental frequency, the limit was restricted at the RF Output Power.
- The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:  
 $20 \log(\text{Duty cycle}) = 20 \log(0.325 \text{ ms} / 7.995 \text{ ms}) = -27.8 \text{ dB}$

|                        |                |  |   |
|------------------------|----------------|--|---|
| <b>RF Mode</b>         | GFSK           | <b>Channel</b>                           | CH 70 : 2474 MHz  |
| <b>Frequency Range</b> | 1 GHz ~ 25 GHz | <b>Detector Function &amp; Bandwidth</b> | PK: RB=1 MHz, VB=3 MHz, DET=Peak<br>AV: RB=1 MHz, VB=3 MHz, DET=RMS |
| <b>Input Power</b>     | 1.5 Vdc        | <b>Environmental Conditions</b>          | 22 °C, 60 % RH  |
| <b>Tested By</b>       | Andy Ho        |  |   |

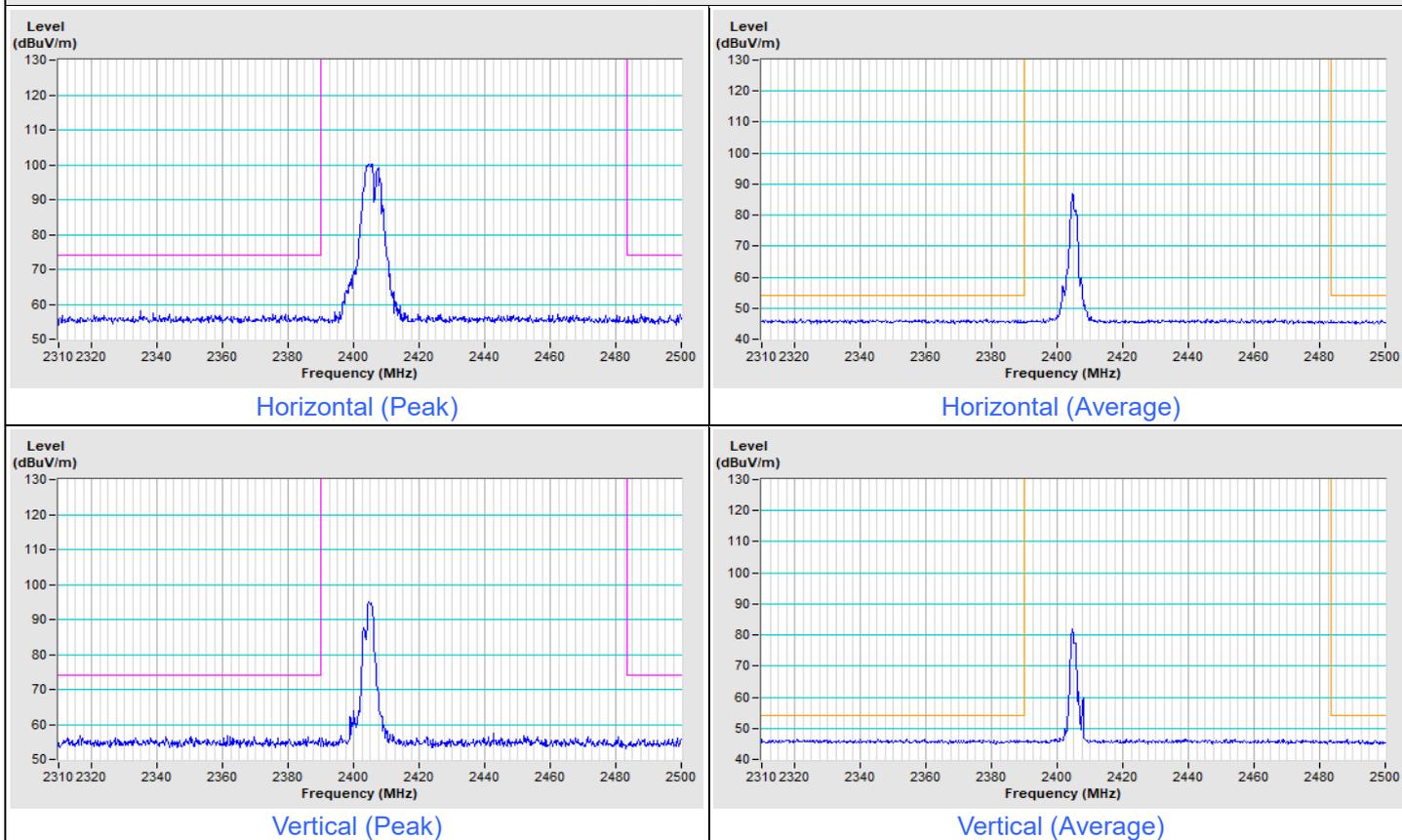
| <b>Antenna Polarity &amp; Test Distance : Horizontal at 3 m</b> |                 |                         |                |             |                    |                      |                  |                          |
|---|-----------------|-------------------------|----------------|-------------|--------------------|----------------------|------------------|--------------------------|
| No  | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1   | *2474.00        | 101.9 PK                |                |             | 1.01 H             | 92                   | 102.2            | -0.3                     |
| 2   | *2474.00        | 74.1 AV                 |                |             | 1.01 H             | 92                   | 74.4             | -0.3                     |
| 3   | 2483.50         | 55.3 PK                 | 74.0           | -18.7       | 1.01 H             | 92                   | 55.6             | -0.3                     |
| <b>4</b>  | <b>2483.50</b>  | <b>45.0 AV</b>          | <b>54.0</b>    | <b>-9.0</b> | <b>1.01 H</b>      | <b>92</b>            | <b>45.3</b>      | <b>-0.3</b>              |
| 5   | 4948.00         | 51.1 PK                 | 74.0           | -22.9       | 1.06 H             | 128                  | 46.3             | 4.8                      |
| 6   | 4948.00         | 23.3 AV                 | 54.0           | -30.7       | 1.06 H             | 128                  | 18.5             | 4.8                      |
| 7   | 7422.00         | 48.9 PK                 | 74.0           | -25.1       | 1.00 H             | 23                   | 36.9             | 12.0                     |
| 8   | 7422.00         | 21.1 AV                 | 54.0           | -32.9       | 1.00 H             | 23                   | 9.1              | 12.0                     |
| <b>Antenna Polarity &amp; Test Distance : Vertical at 3 m</b>   |                 |                         |                |             |                    |                      |                  |                          |
| No  | Frequency (MHz) | Emission Level (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Correction Factor (dB/m) |
| 1   | *2474.00        | 97.9 PK                 |                |             | 3.68 V             | 136                  | 98.2             | -0.3                     |
| 2   | *2474.00        | 70.1 AV                 |                |             | 3.68 V             | 136                  | 70.4             | -0.3                     |
| 3   | 2483.50         | 52.4 PK                 | 74.0           | -21.6       | 3.68 V             | 136                  | 52.7             | -0.3                     |
| 4   | 2483.50         | 42.4 AV                 | 54.0           | -11.6       | 3.68 V             | 136                  | 42.7             | -0.3                     |
| 5   | 4948.00         | 49.5 PK                 | 74.0           | -24.5       | 1.00 V             | 176                  | 44.7             | 4.8                      |
| 6   | 4948.00         | 21.7 AV                 | 54.0           | -32.3       | 1.00 V             | 176                  | 16.9             | 4.8                      |
| 7   | 7422.00         | 47.6 PK                 | 74.0           | -26.4       | 1.00 V             | 176                  | 35.6             | 12.0                     |
| 8   | 7422.00         | 19.8 AV                 | 54.0           | -34.2       | 1.00 V             | 176                  | 7.8              | 12.0                     |

**Remarks:**

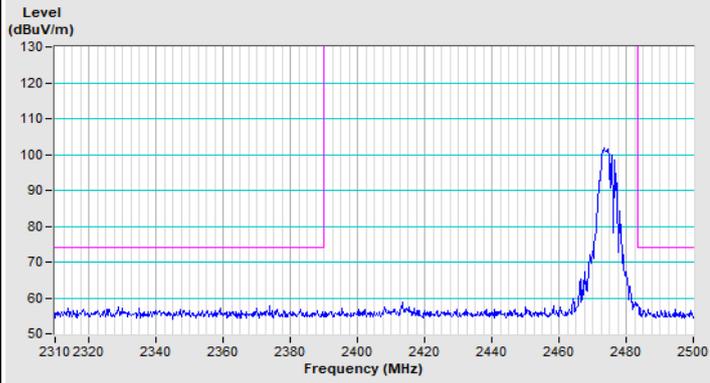
- Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
- Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
- Margin value = Emission Level – Limit value
- The other emission levels were very low against the limit.
- " \* " : Fundamental frequency, the limit was restricted at the RF Output Power.
- The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:  
 $20 \log(\text{Duty cycle}) = 20 \log(0.325 \text{ ms} / 7.995 \text{ ms}) = -27.8 \text{ dB}$

|                 |                    |                               |                                  |
|-----------------|--------------------|-------------------------------|----------------------------------|
| Frequency Range | 2.31 GHz ~ 2.5 GHz | Detector Function & Bandwidth | PK: RB=1 MHz, VB=3 MHz, DET=Peak |
|-----------------|--------------------|-------------------------------|----------------------------------|

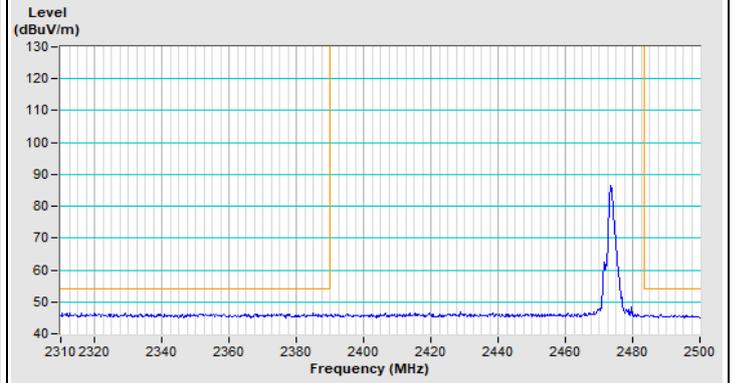
### GFSK Channel 1



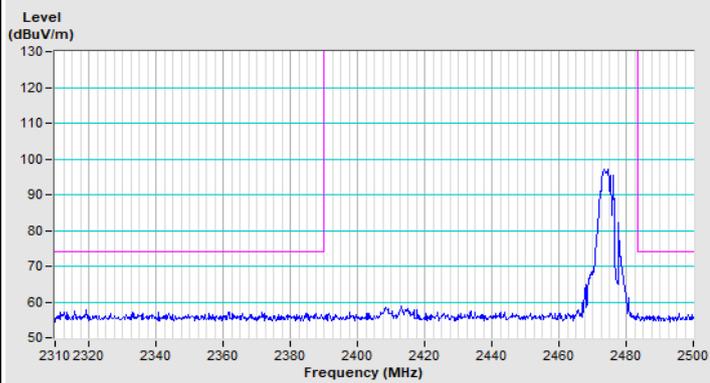
### GFSK Channel 70



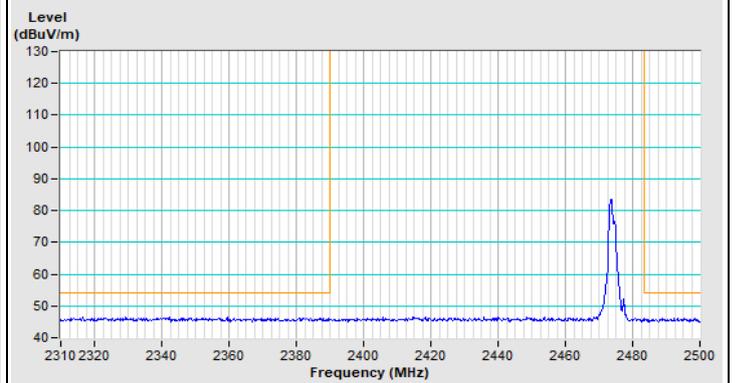
Horizontal (Peak)



Horizontal (Average)



Vertical (Peak)



Vertical (Average)

## 8 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo)

## 9 Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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The address and road map of all our labs can be found in our web site also.

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