



# JAPAN RADIO TEST REPORT

## Low Energy

**Product Name** : NFC Linear STD  
**Model Name** : ESP-241HZ-00B-6  
**Applicant** : Wacom Co., Ltd  
2-510-1 Toyonodai, Kazo-shi, Saitama,  
349-1148 Japan  
**Manufacturer** : Wacom Co., Ltd  
2-510-1 Toyonodai, Kazo-shi, Saitama,  
349-1148 Japan  
**Type Emissions** : 1M07F1D(LE\_1M)  
2M09F1D(LE\_2M)  
**Declaration** : 1.08 mW (LE\_1M)  
**Output Power** : 1.08 mW (LE\_2M)  
**Standard** : Article 49-20 and the relevant articles of the  
Ordinance Regulating Radio Equipment  
**Test Procedure** : MIC Notice No.88 Appendix No.43

The product was received on Jan. 12, 2024 and testing was performed from Jan. 22, 2024 to Jan. 22, 2024. We, Sporton International Inc. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in MIC Notice No.88 Appendix No.43 and shown to be compliant with the applicable technical standards. Article 2 Paragraph 1 Item 19 of the Certificate Ordinance of the Radio Law indicates the classification of the specified radio equipment.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

**Sporton International Inc. EMC & Wireless Communications Laboratory**

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)



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## History of This Test Report

| Report No. | Version | Description             | Issue Date    |
|------------|---------|-------------------------|---------------|
| JR3D2903   | 01      | Initial issue of report | Mar. 05, 2024 |
|            |         |                         |               |
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## Summary of Test Result

| Report Clause | Test Items  | Result (PASS/FAIL) |
|---------------|---|--------------------|
| 3.1           | Frequency Tolerance                                 | Pass               |
| 3.2           | Occupied Bandwidth                                  | Pass               |
| 3.3           | Unwanted Emission Intensity                         | Pass               |
| 3.4           | RF Output Power / Tolerance                         | Pass               |
| 3.5           | Limitation of Collateral Emission of Receiver       | Pass               |
| 3.6           | Transmission Antenna Gain (EIRP Antenna Power)      | NA                 |
| 3.7           | Transmission Radiation Angle Width (3dB Beam width) | NA                 |
| 3.8           | Radio Interference Prevention Capability            | Pass               |
| 3.9           | Hopping Frequency Dwell Time                        | NA                 |
| 3.10          | Construction Protection Confirmation                | Pass               |

**Conformity Assessment Condition:**

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacture who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section "Measurement Uncertainty".

**Disclaimer:**

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Benson Chen

Report Producer: Ming Chen



# 1 General Description

## 1.1 Feature of Equipment Under Test

| Product Feature & Specification    |   |                |
|------------------------------------|---|----------------|
| Product Name                       | NFC Linear STD  |                |
| Model Name                         | ESP-241HZ-00B-6   |                |
| Support Category / Frequency Range | Article 2-1-19 / 2400MHz ~ 2483.5MHz  |                |
| Type of Modulation                 | <input type="checkbox"/> Direct Spreading (DS)<br><input type="checkbox"/> Orthogonal frequency-division multiplexing (OFDM)<br><input type="checkbox"/> Frequency Hopping (FH)<br><input checked="" type="checkbox"/> Other : GFSK |                |
| Number of Channels                 | Other : Low Energy  | 40             |
| Channel Spacing                    | Other : Low Energy  | 2MHz           |
| Declaration RF Output Power        | 1.08 mW (LE_1M)<br>1.08 mW (LE_2M)  |                |
| Antenna Power (E.I.R.P)            | 1.434 dBm (LE_1M)<br>1.434 dBm (LE_2M)  |                |
| Modulation                         | <input type="checkbox"/> GFSK <input type="checkbox"/> $\pi/4$ -DQPSK <input type="checkbox"/> 8-DPSK<br><input checked="" type="checkbox"/> Other : GFSK   |                |
| Power Source <small>NOTE</small>   | <input type="checkbox"/> Commercial power   | AC 100 ~ 240 V |
|                                    | <input type="checkbox"/> External Power Source  | DC 5 V         |
|                                    | <input checked="" type="checkbox"/> Lithium battery   | DC 3.7 V       |
|                                    | <input type="checkbox"/> UM battery   | DC 1.2V        |

**NOTE:** Manufacturer declares that when the normal supply voltage of EUT varies to  $\pm 10\%$  extreme voltage, the input voltage of internal RF circuit can be controlled within  $\pm 1\%$  range.

Hence, all the rest of test cases were done only with the normal supply voltage.

| Antenna Information |                             |                         |
|---------------------|-----------------------------|-------------------------|
| Main Antenna        | Antenna Type : chip antenna | Antenna Gain : 1.10 dBi |

**Remark:** The above EUT's information was declared by manufacturer. Please refer to Disclaimer in report summary.

## 1.2 Modification of EUT

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





### 1.3 Testing Site

|                    |   |
|--------------------|---|
| Test Site          | Sporton International Inc. EMC & Wireless Communications Laboratory   |
| Test Site Location | No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)<br>TEL: +886-3-3273456 / FAX: +886-3-3284978 |
| Test Site No.      | Sporton Site No.:<br>TH02-HY  |

### 1.4 Measurement Uncertainty

| Test Items                 | Uncertainty   | Remark         |
|----------------------------|---------------|----------------|
| Occupied Channel Bandwidth | $\pm 3.27\%$  | Confidence 95% |
| RF output power, conducted | $\pm 0.55$ dB | Confidence 95% |
| Frequency Tolerance        | $\pm 5.3$ Hz  | Confidence 95% |
| Unwanted Emission          | $\pm 1.38$ dB | Confidence 95% |
| Temperature                | $\pm 0.8$ °C  | Confidence 95% |
| Humidity                   | $\pm 3$ %     | Confidence 95% |

### 1.5 Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- Article 49-20 and the relevant articles of the Ordinance Regulating Radio Equipment

**Remark:**

- All test items were verified and recorded according to the standards and without any deviation during the test.
- The measurement was implemented in accordance with MIC Notice No. 88 Appendix No. 43.

### 1.6 Ancillary Equipment List

None.

## 2 Test Configuration of Equipment Under Test

### 2.1 Carrier Frequency Channel

| LE Channel | Frequency (MHz) | LE Channel | Frequency (MHz) | LE Channel | Frequency (MHz) |
|------------|-----------------|------------|-----------------|------------|-----------------|
| 0          | 2402            | 14         | 2430            | 28         | 2458            |
| 1          | 2404            | 15         | 2432            | 29         | 2460            |
| 2          | 2406            | 16         | 2434            | 30         | 2462            |
| 3          | 2408            | 17         | 2436            | 31         | 2464            |
| 4          | 2410            | 18         | 2438            | 32         | 2466            |
| 5          | 2412            | 19         | 2440            | 33         | 2468            |
| 6          | 2414            | 20         | 2442            | 34         | 2470            |
| 7          | 2416            | 21         | 2444            | 35         | 2472            |
| 8          | 2418            | 22         | 2446            | 36         | 2474            |
| 9          | 2420            | 23         | 2448            | 37         | 2476            |
| 10         | 2422            | 24         | 2450            | 38         | 2478            |
| 11         | 2424            | 25         | 2452            | 39         | 2480            |
| 12         | 2426            | 26         | 2454            | -          | -               |
| 13         | 2428            | 27         | 2456            | -          | -               |

### 2.2 EUT Operation Test Setup

The equipment under test (EUT) was linked with Bluetooth simulator or operated by commands in order to make the EUT into the engineering modes for transmitting, receiving signals continuously, and hopping mode.

### 3 Test Result

#### 3.1 Frequency Tolerance Measurement

##### 3.1.1 Limit

| Item                | Limits                  |
|---------------------|-------------------------|
| Frequency Tolerance | $\leq \pm 50\text{ppm}$ |

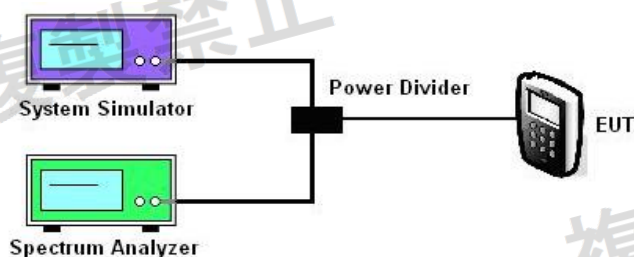
##### 3.1.2 Measuring Instruments

See list of measuring instruments of this test report.

##### 3.1.3 Test Procedure

1. Frequency accuracy of instrument shall be less than 10% of limits tolerance (5ppm).
2. Three testing methods
  - a. Measure frequency tolerance by the system simulator.
  - b. CW Tone method
    - i. Setting of SA is following as: RBW:1kHz / VBW:30kHz.
    - ii. Maker Max. level to get measuring frequency f.
  - c. 10dB down method
    - i. Setting of SA is following as: RBW:30kHz / VBW: 30kHz / Trace: MaxHold
    - ii. Display line Level = Max. level – 10dB to place two markers, highest(fH) and lowest(fL) frequency
    - iii. Determine measuring frequency  $f = (fH - fL)/2$
3. The frequency tolerance test case is directly measured using the frequency accuracy function of Bluetooth tester or spectrum analyzer. Then the frequency error formula is  $(f - f_c)/f_c \times 10^6 \text{ ppm}$  and the limit is less than  $\pm 50\text{ppm}$ .

##### 3.1.4 Test Setup



##### 3.1.5 Test Result of Frequency Tolerance

Please refer to Appendix B.



## 3.2 Occupied Bandwidth Measurement

### 3.2.1 Limit

| Item                | Limits                                    |
|---------------------|---|
| Occupied Band Width | $\leq 83.5\text{MHz}$ (FH)                |
|                     | $\leq 26\text{MHz}$ (OFDM, DS and Others) |

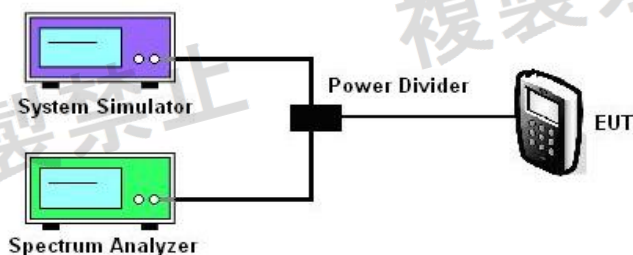
### 3.2.2 Measuring Instruments

See list of measuring instruments of this test report.

### 3.2.3 Test Procedures

- Setting of SA is following as: RBW  $\leq 3\%$  of bandwidth / VBW = RBW / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold.
- EUT have transmitted each modulation signal and fixed channelize (For DSSS or OFDM Device) or continuous maximum power of hopping mode (For FHSS Device). SA set to 99% of occupied bandwidth to measure occupied bandwidth. The limit is less than 26MHz (For DSSS or OFDM Device) or 83.5MHz (For FHSS Device).

### 3.2.4 Test Setup



### 3.2.5 Test Result of Occupied Bandwidth Measurement

Please refer to Appendix B.

### 3.3 Unwanted Emission Intensity Measurement

#### 3.3.1 Limit

| Item                 | Limits  |
|----------------------|---|
| Tx Spurious Emission | $\leq 2.5 \mu\text{W}$ ( $2387\text{MHz} > f ; 2496.5\text{MHz} < f$ )  |
|                      | $\leq 25 \mu\text{W}$ ( $2387\text{MHz} \leq f < 2400\text{MHz}$ ) and ( $2483.5\text{MHz} < f \leq 2496.5\text{MHz}$ ) |

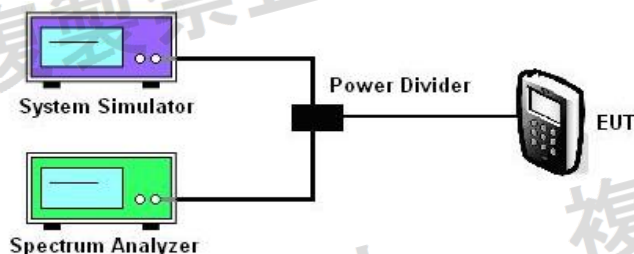
#### 3.3.2 Measuring Instruments

See list of measuring instruments of this test report.

#### 3.3.3 Test Procedures

1. EUT have transmitted the maximum power and fixed channelize.
2. Setting of SA is following as: RBW:1MHz / VBW:1MHz above 1GHz, Sweep time: Auto / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold.
3. Setting of SA is following as: RBW:100KHz / VBW:100KHz under 1GHz, Sweep time: Auto / Sweep Mode: Continuous sweep / Detect mode: Positive peak / Trace mode: Max hold.
4. Setting of SA is following as 30MHz and stop frequency 2387MHz Then to mark peak reading value + cable loss shall be less than 2.5 $\mu\text{W}$ .
5. SA adjusted to start frequency 2387MHz and stop frequency 2400MHz. Then to mark peak reading value + cable loss shall be less than 25 $\mu\text{W}$ .
6. SA adjusted to start frequency 2483.5MHz and stop frequency 2496.5MHz Then to mark peak reading value + cable loss shall be less than 25 $\mu\text{W}$ .
7. SA adjusted to start frequency 2496.5MHz and stop frequency 12500MHz Then to mark peak reading value + cable loss shall be less than 2.5 $\mu\text{W}$ .
8. If the Result\_Value is over the requirement, take total sum of 1MHz band centered at the spur frequency like ACLP measurement as Result\_Value.

#### 3.3.4 Test Setup



#### 3.3.5 Test Result of Unwanted Emission Intensity

Please refer to Appendix B.



### 3.4 RF Output Power / Tolerance

#### 3.4.1 Limit

| Item                  | Limits  |
|-----------------------|---|
| Antenna Power Density | $\leq 3\text{mW/MHz}$ (FH form 2400 ~ 2483.5MHz)          |
|                       | $\leq 10\text{mW/MHz}$ (OFDM,DS from 2400 ~ 2483.5MHz)    |
|                       | $\leq 10\text{mW}$ (Other from 2400 ~ 2483.5MHz)          |
| Antenna Power Error   | +20% (Base on manufacturer declare antenna power density) |

#### 3.4.2 Measuring Instruments

See list of measuring instruments of this test report.

#### 3.4.3 Test Procedures

1. EUT have transmitted continuous maximum power on hopping mode (For FHSS Device).
2. Frequency hopping system or combined systems of direct spread and frequency hopping:  
Test method 1:
  - i. Connect the high frequency power meter to the output of the attenuator and measure the total power (without bandwidth limitation)
  - ii. Divide the total power by the spread bandwidth to find the "average" power per MHz.  
The average power per MHz is equal to the power meter value dBm + cable loss dB +  $10 \log_{10} (1/\text{Duty Cycle})$  dB +  $10 \log_{10} (1/\text{Spread Bandwidth})$  dB.
  - iii. Confirm that frequency distribution of the hopping frequencies is homogeneous according to the supporting data.  
If frequency distribution of the frequencies is not homogeneous, consider other measurement or correction methods based on the supporting data.
  - iv. Set the antenna power as follows:  
- Continuous waves: value in ii.  
Test method 2:
    - i. Peak search by use setting of SA is following as:  
Span = 2 time of occupied bandwidth  
RBW = 1MHz / VBW = 3 time of RBW  
Sweep Mode: Continuous sweep  
Detect mode = Positive peak / Trace mode = Max hold.  
Mark the peak value
    - ii. Measure maximum average power per MHz by use setting of SA is following as:  
Center frequency = frequency of peak value  
Span = 0Hz  
RBW = 1MHz / VBW = RBW

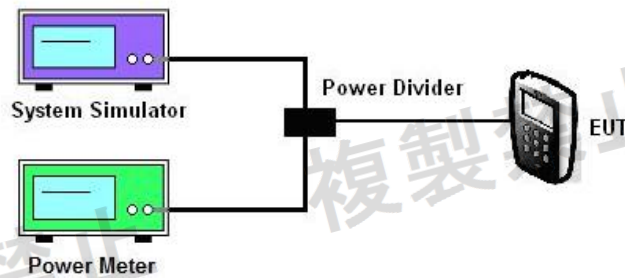
Sweep Mode: Continuous sweep

Detect mode = Sample / Trace mode = Max hold.

Calculated the mean power value

3. Antenna RF Output Power Tolerance is definition that actual measure antenna power tolerance is + 20% power range that manufacturer declare the conducted power density.

#### 3.4.4 Test Setup



#### 3.4.5 Test Result of RF Output Power / Tolerance

Please refer to Appendix B.

### 3.5 Limitation of Collateral Emission of Receiver Measurement

#### 3.5.1 Limit

| Item                 | Limits             |                          |
|----------------------|--------------------|--------------------------|
| Rx Spurious Emission | $\leq 4\text{nW}$  | ( $f < 1\text{GHz}$ )    |
|                      | $\leq 20\text{nW}$ | ( $1\text{GHz} \leq f$ ) |

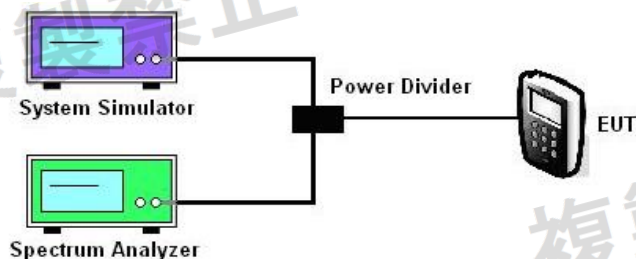
#### 3.5.2 Measuring Instruments

See list of measuring instruments of this test report.

#### 3.5.3 Test Procedures

1. EUT have the continuous reception mode and fixed only one channelize.
2. SA set RBW: 100KHz and VBW: 100KHz. Then adjust to start frequency 30MHz and stop frequency 1GHz. Search to mark peak reading value + cable loss shall be less than 4nW.
3. SA set RBW: 1MHz and VBW: 1MHz. Then adjust to start frequency 1000MHz and stop frequency 12.5GHz. Search to mark peak reading value + cable loss shall be less than 20nW.
4. If power level of lower emissions are more than 1/10 of limit (.0.4nW for  $f < 1\text{GHz}$ , 2nW for  $f \geq 1\text{GHz}$ ), all those are to be indicated in the 2nd and 3rd lines. If others are 1/10 or less more of the limit, no necessary to be indicated.

#### 3.5.4 Test Setup



#### 3.5.5 Test Result of Limitation of Collateral Emission of Receiver

Please refer to Appendix B.



### 3.6 Transmission Antenna Gain (EIRP Antenna Power) Measurement

#### 3.6.1 Limit

| Item   | Limits   |
|--|--|
| EIRP Power Density   | $\leq 6.91\text{dBm/MHz}$ (FH form 2400 ~ 2483.5MHz)       |
|  | $\leq 12.14\text{dBm/MHz}$ (OFDM,DS from 2400 ~ 2483.5MHz) |
|  | $\leq 12.14\text{dBm}$ (Other from 2400 ~ 2483.5MHz)       |
| Remark: This test item will not be applied to EIRP power of EUT is lower than 12.14 dBm/MHz. |  |

#### 3.6.2 Measuring Instruments

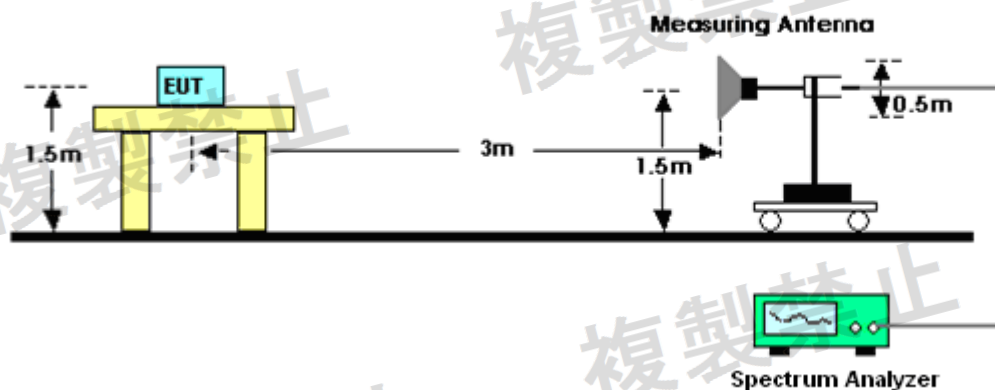
See list of measuring instruments of this test report.

#### 3.6.3 Test Procedures

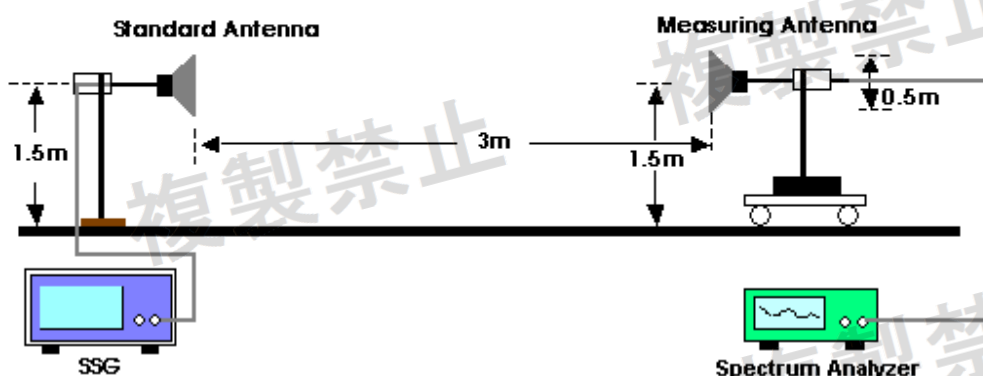
1. Set EUT ad measuring antenna at the same height and roughly facing each other.
2. Move the measuring antenna height up and down within  $\pm 50\text{cm}$  of EUT height and swing it to find the maximum output of the measuring antenna. The output level at the spectrum analyzer is read as "E".
3. Remove the EUT from the turn table and put the replacing antenna facing to measuring antenna at same height. Set the standard signal generator (SSG) at same frequency and transmit on then receive the signal.
4. Swing the replacing antenna give a maximum receiving level.
5. Move the measuring antenna height up and down within  $\pm 50\text{cm}$  of replacing antenna height and swing it to find the maximum receiving level.
6. Set SSG output power at  $P_t$  to give the equivalent output level of "E" or calculate  $P_t$  with SSG output which gives the nearest of "E" and difference ( $\pm 1\text{dB}$ ). Record the  $P_t$ .
7. Calculate EIRP by the formula below  $\text{EIRP} = G_t - L + P_t$ .  
 $G_t$ : gain of replacing antenna (dBi)  
 $L$ : feeder loss between SSG and replacing antenna  
 $P_t$ : Output power of the SSG
8. If the antenna for the EUT has circular polarization, sum of V-field and H-field will be result if measuring antenna is linear polarization.

### 3.6.4 Test Setup

<For EUT radiation measurement>



<For standard antenna measurement>



### 3.6.5 Test Result of Transmission Antenna Gain (EIRP Antenna Power)

Please refer to Appendix B. For the antenna gain, please refer to antenna test report.

Remark: This test item will not be applied to EIRP power of EUT is lower than 12.14dBm/MHz.

### 3.7 Transmission Radiation Angle Width (3dB Beam-width) Measurement

#### 3.7.1 Limit

| Item   | Limits  |
|--|---|
| 3dB antenna beam-width   | 360/A (If $A < 1$ ; then $A = 1$ )<br>$A = \{\text{EIRP Power [mW]} / 16.36 \text{ for DS, OFDM}\}$ or<br>$A = \{\text{EIRP Power [mW]} / 4.9 \text{ for FH}\}$ |
| Remark: This test item will not be applied to EIRP power of EUT is lower than 12.14 dBm/MHz. |   |

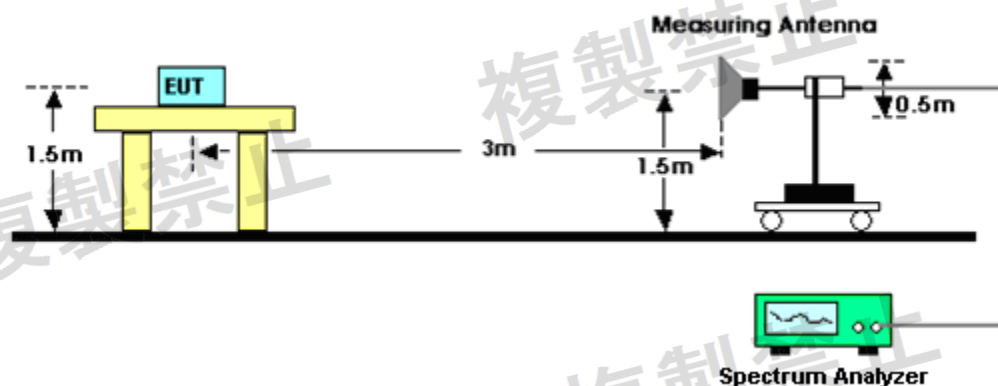
#### 3.7.2 Measuring Instruments

See list of measuring instruments of this test report.

#### 3.7.3 Test Procedures

1. Set EUT and measuring antenna at the same height and roughly facing each other.
2. Set spectrum analyzer with condition in section 3.7.2 and tune reference level to observe receiving signal position.
3. Rotate directions of the EUT horizontally and vertically to find the maximum receiving power.
4. Move the measuring antenna height up and down within  $\pm 50\text{cm}$  of EUT height and swing it to find the maximum output of measuring antenna. The output level at the spectrum analyzer is read as "E".
5. Calculate permitted radiation angle in horizontal and vertical using EIRP measured in another test method.
6. Calculate 3dB antenna beam width by the formula below  $360/A$  (If  $A < 1$ ; then  $A=1$ ).  
 $A = \{\text{EIRP Power [mW]} / 16.36 \text{ for DS, OFDM}\}$  or  
 $A = \{\text{EIRP Power [mW]} / 4.9 \text{ for FH}\}$

### 3.7.4 Test Setup



### 3.7.5 Test Result of Transmission Radiation Angle Width (3dB Beam-width)

Please refer to Appendix B.

For the antenna gain, please refer to antenna test report.

Remark: This test item will not be applied to EIRP power of EUT is lower than 12.14 dBm/MHz.

### 3.8 Radio Interference Prevention Capability Measurement

#### 3.8.1 Limit

| Item                | Limits         |
|---------------------|----------------|
| Identification code | $\geq 48$ bits |

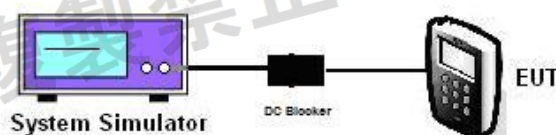
#### 3.8.2 Measuring Instruments

See list of measuring instruments of this test report.

#### 3.8.3 Test Procedures

1. In the case that the EUT has the function of automatically transmitting the identification code: a. Transmit the predetermined identification codes form EUT. b. Check the transmitted identification codes with the demodulator.
2. In the case of receiving the identification code: a. Transmit the predetermined identification codes form the counterpart. b . Check if communication is normal. c. Transmit the signals other than predetermined ID codes form the counterpart. d. check if the EUT stops the transmission, or if it displays that identification codes are different from the predetermined ones.

#### 3.8.4 Test Setup



#### 3.8.5 Test Result of Radio Interference Prevention Capability

Please refer to Appendix B.



### 3.9 Hopping Frequency Dwell Time Measurement

#### 3.9.1 Limit

| Item                     | Limits             |
|--------------------------|--------------------|
| Hopping Freq. Dwell Time | $\leq 0.4$ seconds |

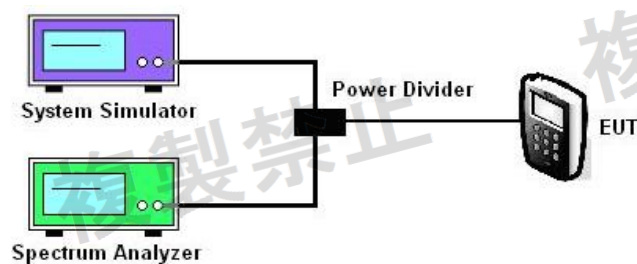
#### 3.9.2 Measuring Instruments

See list of measuring instruments of this test report.

#### 3.9.3 Test Procedures

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set RBW of spectrum analyzer to 1MHz and VBW to 1MHz.
3. Use a video trigger with the trigger level set to enable triggering only on full pulses.
4. Sweep Time is more than once pulse time.
5. Set the center frequency on any frequency would be measured and set the frequency span to zero span.
6. Measure the maximum time duration of one single pulse.
7. Set the EUT in continuous transmitting for each supported maximum packet format.
8. Measure the maximum time duration of one single pulse.
9. Use the marker-delta function to calculate the dwell time.
10. Dwell Time = Total Number of channels x 0.4(s) x Average Hopping Channel x package transfer time
11. Average Hopping Channel = Total Number of hopping / sweep time

#### 3.9.4 Test Setup



#### 3.9.5 Test Result of Hopping Frequency Dwell Time

Not Applicable.

### 3.10 Construction Protection Confirmation Method

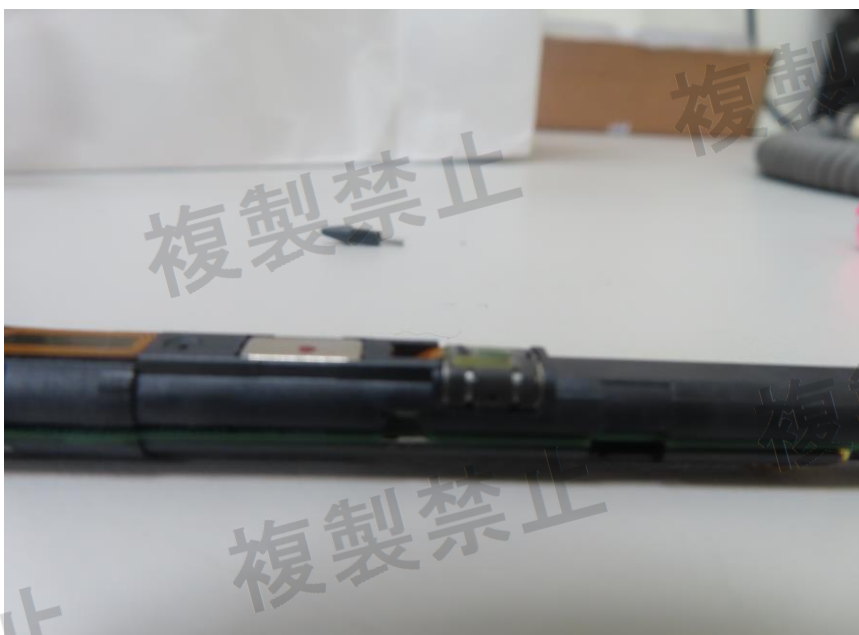
#### 3.10.1 Limit

The high-frequency section and modulation section of the radio equipment except for the antenna system shall not be capable of being opened easily.

#### 3.10.2 Confirmation Method

|                                     |  |
|-------------------------------------|--|
| <input type="checkbox"/>            | Sealed with special screws.  |
| <input type="checkbox"/>            | Plastic chassis is being welded using ultrasonic waves.  |
| <input checked="" type="checkbox"/> | Chassis is glued using a special adhesive.   |
| <input type="checkbox"/>            | Metal covers are spot-fused.   |
| <input type="checkbox"/>            | Cover is specially interlocked.  |
| <input type="checkbox"/>            | RF and Modulation components are covered with shielding case and this shielding case is soldered.              |
| <input type="checkbox"/>            | Shield case is welded at RF and modulation parts, and ID-ROM is welded using the BGA Method.                   |
| <input type="checkbox"/>            | Shield case is welded at RF and modulation parts, and ID-ROM is glued at its lead with a special adhesive.     |
| <input type="checkbox"/>            | Shield case is welded at RF and modulation parts, and ID-ROM is glued with a non-transparent laminating agent. |
| <input type="checkbox"/>            | Other :  |

#### 3.10.3 The Photos of Construction Protection





## 4 List of Measuring Equipment

| Instrument        | Brand Name      | Model No. | Serial No.                | Calibration Date | Test Periods  | Due Date      | Calibration Body | Calibration Method |
|-------------------|-----------------|-----------|---------------------------|------------------|---------------|---------------|------------------|--------------------|
| Spectrum Analyzer | Rohde & Schwarz | FSV 40    | 101909                    | Aug. 09, 2023    | Jan. 22, 2024 | Aug. 08, 2024 | ETC, R.O.C       | C                  |
| USB Power Sensor  | DARE            | RPR3006W  | 13I00030SNO<br>32 (NO:43) | Dec. 06, 2023    | Jan. 22, 2024 | Dec. 05, 2024 | ETC, R.O.C       | C                  |

Note: Above test equipment was used and kept valid calibration period during test.

### Calibration Method :

a) : Calibration conducted by the National Institute of Information and Communications Technology ~ NICT ~ or a designated calibration agency under Article 102-18 paragraph

(1) TELEC Engineering Center, Intertek Japan K.K., Keysight Technologies, Inc ~.

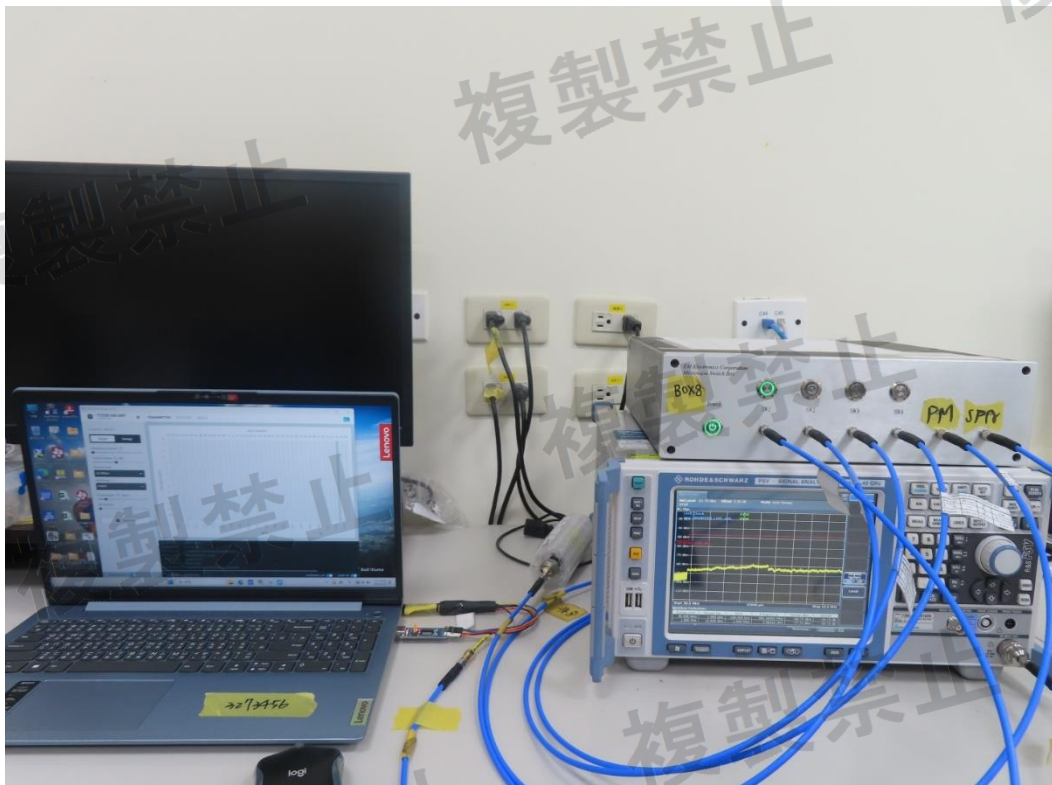
b) : Correction conducted pursuant to the provisions of Article 135 or Article 144 of the Measurement Law (Law No. 51 of 1992) ~ Japan Calibration Service System ~

c) : Calibration conducted in foreign countries, which shall be equivalent to the calibration conducted by the NICT or a designated calibration agency under Article 102-18 paragraph

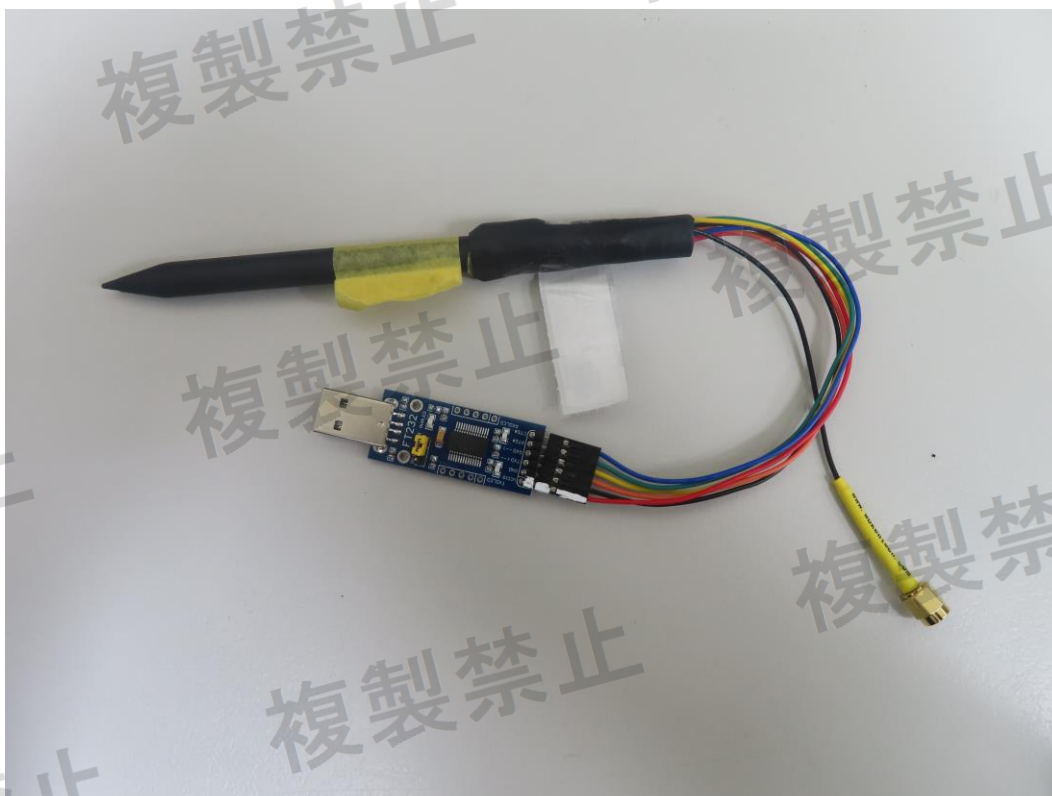
(1) ~ TELEC Engineering Center, Intertek Japan K.K., Keysight Technologies, Inc ~.

## Appendix A. Setup Photographs

Front View



Near View







## Appendix B. Test Results

Please refer to the following pages for test results.



**9. TEST RESULTS DATA**  
**Low Energy 1M (Normal Voltage) - Antenna 1**

|                          |                         |              |
|--------------------------|-------------------------|--------------|
| Environment of Test Room | Temperature             | 21.2~24.1 °C |
|                          | Humidity                | 52.9~59.7 %  |
| Tool & Version           | Direct Test Mode v2.2.0 |              |
| Test Engineer            | Benny Ku                |              |

|                    |         |
|--------------------|---------|
| Modulatoion Type : | GFSK    |
| Type Emissions :   | 1M07F1D |

|                          |       |     |
|--------------------------|-------|-----|
| Declaration Output Power | 1.080 | mW  |
| Declaration Output Power | 0.334 | dBm |
| Antenna Power (E.I.R.P)  | 1.434 | dBm |
| Input Power Voltage      | 3.700 | Vdc |

|                    |           |            |      |
|--------------------|-----------|------------|------|
| Burst              | Path Loss | 22.60      | dB   |
|                    | ON TIME   | 0.395      | msec |
|                    | OFF TIME  | 0.230      | msec |
|                    | Ratio     | 63.20      | %    |
| Packet Type (Mode) |           | Low Energy | mode |

**Antenna Information:**

|                         |              |           |
|-------------------------|--------------|-----------|
| Antenna Model           | Antenna Type | Gain(dBi) |
| Refer to antenna report | chip antenna | 1.10      |

**9.1. Test Results (Normal Voltage)**

| Measurement Frequency | MHz | 2402     | 2440     | 2480     | Limit                 | Result |      |      | Note |
|-----------------------|-----|----------|----------|----------|-----------------------|--------|------|------|------|
| Channel Number        | Ch. | 0        | 19       | 39       |                       | 0      | 19   | 39   |      |
| Reading Frequency     | MHz | 2401.977 | 2439.977 | 2479.976 |                       | ----   | ---- | ---- |      |
| Frequency Tolerance   | ppm | -9.742   | -9.262   | -9.839   | $-50 \leq x \leq +50$ | PASS   | PASS | PASS |      |

|                                 |     |        |         |        |       |      |  |
|---------------------------------|-----|--------|---------|--------|-------|------|--|
| Occupied Bandwidth              | MHz | 1.07   | 1.07    | 1.07   | 26    | PASS |  |
| RF Output Power                 | mW  | 1.047  | 0.912   | 1.072  | 10    | PASS |  |
| E.I.R.P                         | dBm | 1.300  | 0.700   | 1.400  | 12.14 | PASS |  |
| RF Output Power Tolerance       | %   | -3.044 | -15.555 | -0.785 | +20   | PASS |  |
| Output Power (With burst radio) | dBm | 0.20   | -0.40   | 0.30   |       | ---- |  |

|   |                       |             |          |          |          |     |       |       |       |  |
|---|-----------------------|-------------|----------|----------|----------|-----|-------|-------|-------|--|
| Unwanted Emission Intensity                   | Under 2387MHz         | $\mu$ W/MHz | 0.02051  | 0.02143  | 0.02618  | 2.5 | PASS  | PASS  | PASS  |  |
|   |                       | MHz         | 2386.653 | 872.506  | 735.750  |     | ----- | ----- | ----- |  |
|   | 2387MHz - 2400MHz     | $\mu$ W/MHz | 0.72277  | 0.01698  | 0.02148  | 25  | PASS  | PASS  | PASS  |  |
|   |                       | MHz         | 2394.169 | 2399.497 | 2391.824 |     | ----- | ----- | ----- |  |
|   | 2483.5MHz - 2496.5MHz | $\mu$ W/MHz | 0.01687  | 0.01618  | 0.88105  | 25  | PASS  | PASS  | PASS  |  |
|   |                       | MHz         | 2494.821 | 2496.185 | 2487.713 |     | ----- | ----- | ----- |  |
|   | 2496.5MHz -12.5GHz    | $\mu$ W/MHz | 0.02667  | 0.02564  | 0.02410  | 2.5 | PASS  | PASS  | PASS  |  |
|   |                       | MHz         | 4804.577 | 6698.050 | 5887.848 |     | ----- | ----- | ----- |  |
| Limitation of Collateral Emission of Receiver | Under 1GHz            | nW          | 0.005    | 0.012    | 0.002    | 4   | PASS  | PASS  | PASS  |  |
|   |                       | MHz         | 739.313  | 729.904  | 834.761  |     | ----- | ----- | ----- |  |
|   | 1 -12.5GHz            | nW          | 0.016    | 0.018    | 0.016    | 20  | PASS  | PASS  | PASS  |  |
|   |                       | MHz         | 6826.188 | 5822.813 | 6987.188 |     | ----- | ----- | ----- |  |
| Radio Interference Prevention Capability      |                       | -----       | good     |          |          |     | PASS  |       |       |  |

### 11. TEST RESULTS DATA

#### Low Energy 2M (Normal Voltage) - Antenna 1

|                          |                         |              |
|--------------------------|-------------------------|--------------|
| Environment of Test Room | Temperature             | 21.2~24.1 °C |
|                          | Humidity                | 52.9~59.7 %  |
| Tool & Version           | Direct Test Mode v2.2.0 |              |
| Test Engineer            | Benny Ku                |              |

|                   |         |
|-------------------|---------|
| Modulation Type : | GFSK    |
| Type Emissions :  | 2M09F1D |

|                          |       |     |
|--------------------------|-------|-----|
| Declaration Output Power | 1.080 | mW  |
| Declaration Output Power | 0.334 | dBm |
| Antenna Power (E.I.R.P)  | 1.434 | dBm |
| Input Power Voltage      | 3.700 | Vdc |

|                    |           |            |      |
|--------------------|-----------|------------|------|
| Burst              | Path Loss | 22.60      | dB   |
|                    | ON TIME   | 0.210      | msec |
|                    | OFF TIME  | 0.415      | msec |
|                    | Ratio     | 33.60      | %    |
| Packet Type (Mode) |           | Low Energy | mode |

#### Antenna Information:

|                         |              |           |
|-------------------------|--------------|-----------|
| Antenna Model           | Antenna Type | Gain(dBi) |
| Refer to antenna report | chip antenna | 1.10      |

#### 11.1. Test Results (Normal Voltage)

| Measurement Frequency | MHz | 2402     | 2440     | 2480     | Limit                 | Result |      |      | Note |
|-----------------------|-----|----------|----------|----------|-----------------------|--------|------|------|------|
| Channel Number        | Ch. | 0        | 19       | 39       |                       | 0      | 19   | 39   |      |
| Reading Frequency     | MHz | 2401.957 | 2439.960 | 2479.960 |                       | ----   | ---- | ---- |      |
| Frequency Tolerance   | ppm | -17.985  | -16.393  | -16.210  | $-50 \leq x \leq +50$ | PASS   | PASS | PASS |      |

|                                 |     |        |         |        |                       |      |  |
|---------------------------------|-----|--------|---------|--------|-----------------------|------|--|
| Occupied Bandwidth              | MHz | 2.09   | 2.09    | 2.09   | 26                    | PASS |  |
| RF Output Power                 | mW  | 1.047  | 0.912   | 1.072  | 10                    | PASS |  |
| E.I.R.P                         | dBm | 1.300  | 0.700   | 1.400  | 12.14                 | PASS |  |
| RF Output Power Tolerance       | %   | -3.044 | -15.555 | -0.785 | $-80 \leq x \leq +20$ | PASS |  |
| Output Power (With burst radio) | dBm | 0.20   | -0.40   | 0.30   |                       | ---- |  |

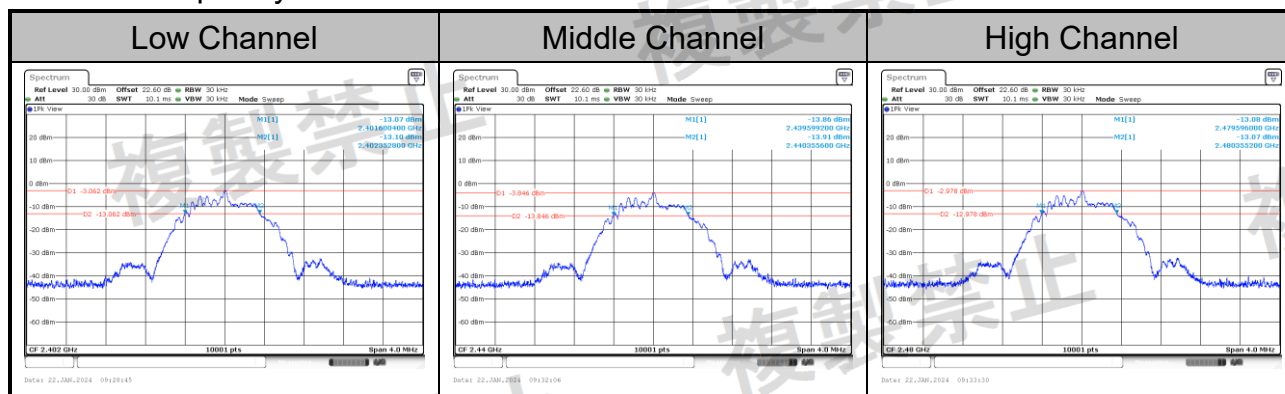
|   |                       |                   |          |          |          |      |      |      |      |  |
|---|-----------------------|-------------------|----------|----------|----------|------|------|------|------|--|
| Unwanted Emission Intensity                   | Under 2387MHz         | $\mu\text{W/MHz}$ | 0.02065  | 0.03148  | 0.02123  | 2.5  | PASS | PASS | PASS |  |
|   |                       | MHz               | 692.201  | 729.058  | 830.994  |      | ---- | ---- | ---- |  |
|   | 2387MHz - 2400MHz     | $\mu\text{W/MHz}$ | 5.29663  | 0.01941  | 0.01832  | 25   | PASS | PASS | PASS |  |
|   |                       | MHz               | 2399.997 | 2399.308 | 2388.290 |      | ---- | ---- | ---- |  |
|   | 2483.5MHz - 2496.5MHz | $\mu\text{W/MHz}$ | 0.02014  | 0.02089  | 0.83368  | 25   | PASS | PASS | PASS |  |
|   |                       | MHz               | 2483.783 | 2493.209 | 2488.070 |      | ---- | ---- | ---- |  |
| 2496.5MHz -12.5GHz                            | $\mu\text{W/MHz}$     | 0.02472           | 0.02773  | 0.02612  | 2.5      | PASS | PASS | PASS |      |  |
|   | MHz                   | 5841.836          | 6965.117 | 6983.121 |          | ---- | ---- | ---- |      |  |
| Limitation of Collateral Emission of Receiver | Under 1GHz            | nW                | 0.001    | 0.002    | 0.018    | 4    | PASS | PASS | PASS |  |
|   |                       | MHz               | 982.589  | 886.850  | 733.590  |      | ---- | ---- | ---- |  |
|   | 1 -12.5GHz            | nW                | 0.017    | 0.079    | 0.015    | 20   | PASS | PASS | PASS |  |
|   |                       | MHz               | 5862.104 | 2408.271 | 5885.104 |      | ---- | ---- | ---- |  |
| Radio Interference Prevention Capability      |                       | ----              | good     |          |          |      | PASS |      |      |  |



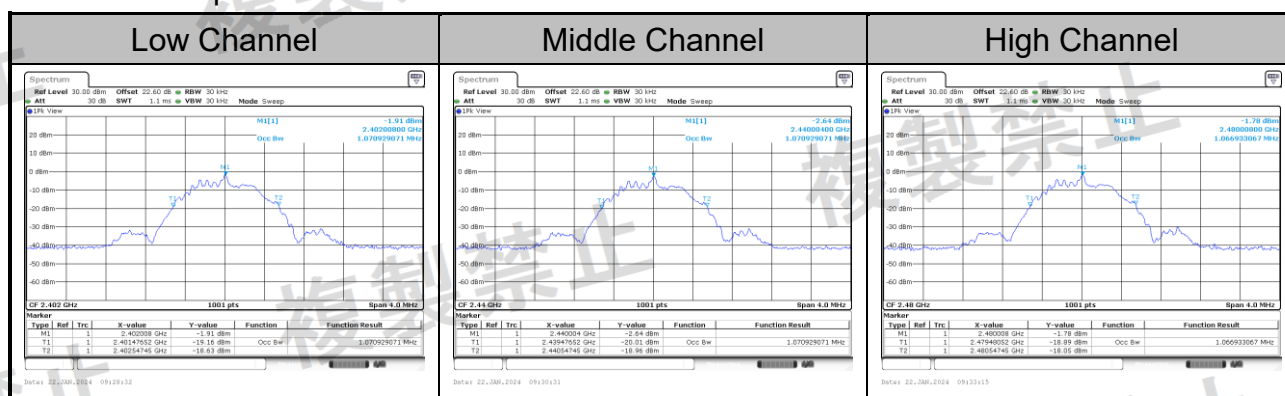
## Appendix C. Test Plots

### C.1. LE\_1M\_NV (Low Energy)

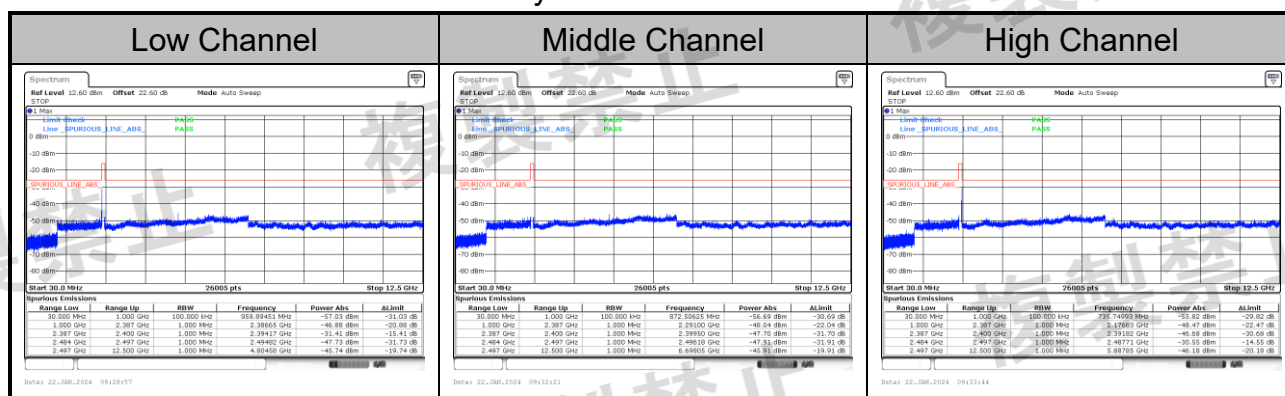
#### C.1.1. Frequency Tolerance



#### C.1.2. Occupied Bandwidth

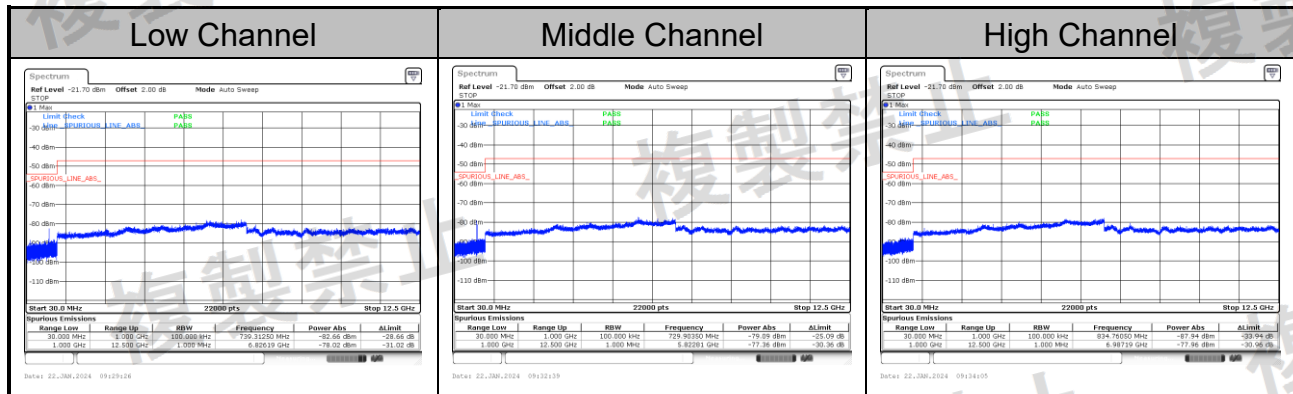


#### C.1.3. Unwanted Emission Intensity





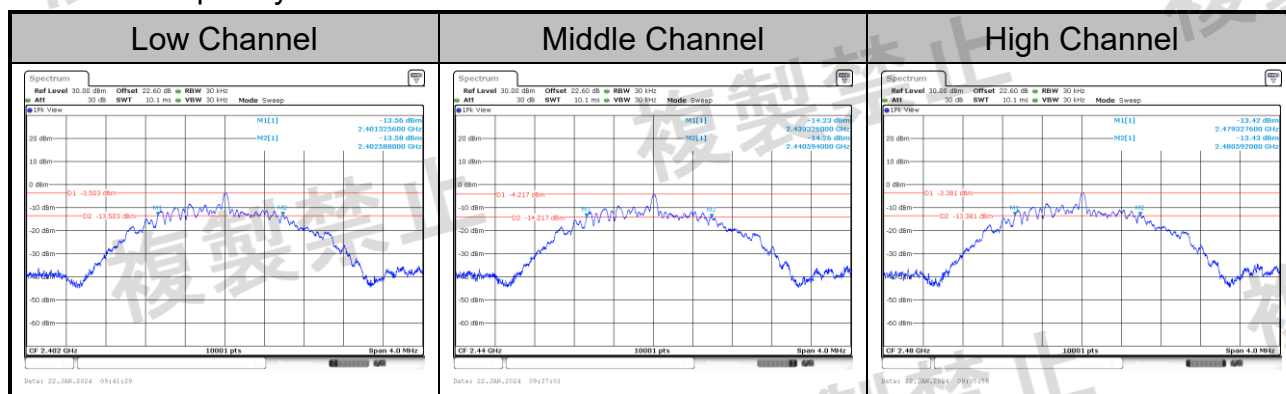
## C.1.4. Limitation of Collateral Emission of Receiver



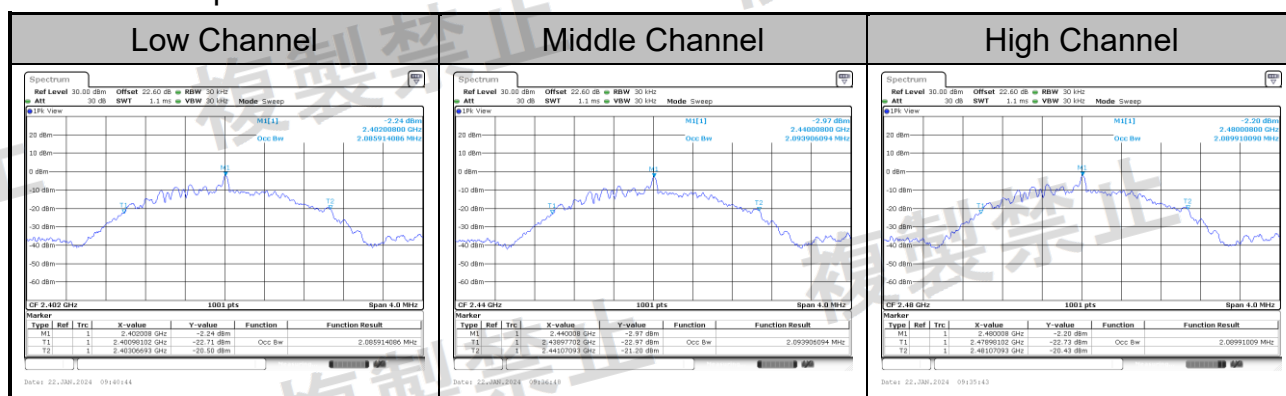


## C.2. LE\_2M\_NV (Low Energy)

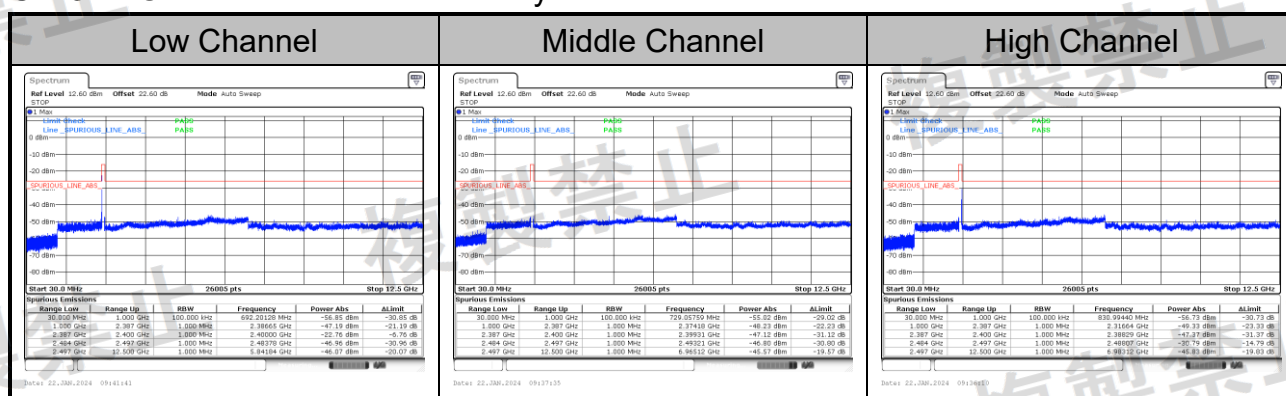
## C.2.1. Frequency Tolerance



## C.2.2. Occupied Bandwidth



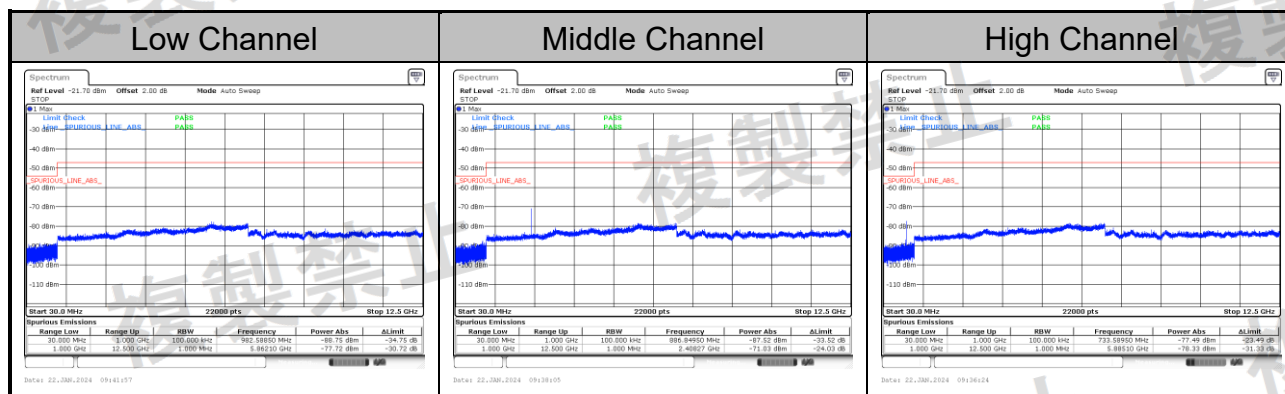
## C.2.3. Unwanted Emission Intensity







## C.2.4. Limitation of Collateral Emission of Receiver



—THE END—