

# **TEST REPORT**

| Product Name                | : TURE WIRELESS EARBUD  |
|-----------------------------|---|
| Model Number                | : MZX637, MZX637-BLK-SA, MZX637-WHT-SA,<br>19TW05, MZX637-BLK, MZX637-WHT,<br>MZX637-BLK-SA-6, MZX637-WHT-SA-6  |
| FCC ID                      | : 2AKI8-MZX637  |
| Prepared for :<br>Address : | TOPWAY EM ENTERPRISE LIMITED<br>8F., Block B, Building 6, Baoneng Science and technology<br>park, Qingxiang RD., Qinghu Industrial Park, Longhua New<br>District, Shenzhen, GD, China |
| Prepared by :<br>Address :  | EMTEK (SHENZHEN) CO., LTD.<br>Building 69, Majialong Industry Zone, Nanshan District,<br>Shenzhen, Guangdong, China   |
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| Report Number    | : | ES200508025W                 |
|------------------|---|------------------------------|
| Date(s) of Tests | : | May 08, 2020 to May 20, 2020 |
| Date of issue    | : | May 20, 2020                 |

**深圳信测标准技术服务股份有限公司**。地址:广东省深圳市南山区马家龙工业区69栋。网址:Http://www.emtek.com.cn 邮箱:cs.rep@emtek.com.cn



## **VERIFICATION OF COMPLIANCE**

| Applicant:           | TOPWAY EM ENTERPRISE LIMITED<br>8F., Block B, Building 6, Baoneng Science and technology park,<br>Qingxiang RD., Qinghu Industrial Park, Longhua New District,<br>Shenzhen, GD, China |
|----------------------|---|
| Manufacturer:        | TOPWAY EM ENTERPRISE LIMITED<br>8F., Block B, Building 6, Baoneng Science and technology park,<br>Qingxiang RD., Qinghu Industrial Park, Longhua New District,<br>Shenzhen, GD, China |
| Product Description: | TURE WIRELESS EARBUD  |
| Trade Mark:          | N/A   |
| Model Number:        | MZX637, MZX637-BLK-SA, MZX637-WHT-SA, 19TW05,<br>MZX637-BLK, MZX637-WHT, MZX637-BLK-SA-6,<br>MZX637-WHT-SA-6  |

## We hereby certify that:

The above equipment was tested by EMTEK(SHENZHEN) CO., LTD. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10-2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits of FCC Rules Part 15.247(2018).

| Date of Test _                   | May 08, 2020 to May 20, 2020   |
|----------------------------------|--------------------------------|
| Prepared by : _                  | Loren Luo<br>Loren Luo /Editor |
| Reviewer : _                     | Tim Dong /SupervisorENZHEN     |
| Approved & Authorized Signer : _ | Lisa Wang /Manager ESTING      |

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# **Modified Information**

| Version | Summary         | Revision Date | Report No.   |
|---------|-----------------|---------------|--------------|
| Ver.1.0 | Original Report | /             | ES200508025W |
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## 1. GENERAL INFORMATION

## 1.1 Product Description

| Characteristics              | Description  |  |
|------------------------------|--|--|
| Product Name                 | TURE WIRELESS EARBUD   |  |
| Model number                 | MZX637, MZX637-BLK-SA, MZX637-WHT-SA, 19TW05,<br>MZX637-BLK, MZX637-WHT, MZX637-BLK-SA-6,<br>MZX637-WHT-SA-6<br>Note: The models are the same except color of appearance<br>and model number, here we prepare MZX637 for the all test) |  |
| Power Supply                 | DC 3.7V Battery  |  |
| Kind of Device               | Bluetooth Ver.5.0  |  |
| Modulation                   | GFSK, π/4-DQPSK, 8DPSK   |  |
| Operating Frequency<br>Range | 2402-2480MHz   |  |
| Number of Channels           | 79   |  |
| Transmit Power Max(PK)       | 1.82dBm(0.001521W)   |  |
| Antenna Type                 | Internal antenna   |  |
| Antenna Gain                 | 0dBi   |  |

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## **1.2Test Methodology**

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10-2013. Radiated testing was performed at an antenna to EUT distance 3 meters.



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## **1.3Test Facility**

| Site Description |   |
|------------------|---|
| EMC Lab. :       | Accredited by CNAS, 2016.10.24<br>The certificate is valid until 2022.10.28<br>The Laboratory has been assessed and proved to be in<br>compliance with CNAS-CL01:2006 (identical to ISO/IEC<br>17025:2005)<br>The Certificate Registration Number is L2291. |
|                  | Accredited by TUV Rheinland Shenzhen 2018.3.30<br>The Laboratory has been assessed according to the<br>requirements ISO/IEC 17025.  |
|                  | Accredited by FCC, August 06, 2018<br>The certificate is valid until August 07, 2020<br>Designation Number: CN1204<br>Test Firm Registration Number: 882943   |
| Name of Firm :   | Accredited by Industry Canada, November 09, 2018<br>The Conformity Assessment Body Identifier is CN0008<br>EMTEK(SHENZHEN) CO., LTD.  |
| Site Location :  | Building 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China  |

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## 2. System Test Configuration

#### 2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

#### 2.2 EUT Exercise

The Transmitter was operated in the normal operating mode. The Tx frequency was fixed which was for the purpose of the measurements.

#### 2.3 Test Procedure

#### 2.3.1 Conducted Emissions

The EUT is a placed on as turn table which is 0.8 m above ground plane. According to the requirements in Section 13.1.4.1 of ANSI C63.10-2013. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-Peak and average detector mode.

#### 2.3.2 Radiated Emissions

Below 1000MHz, The EUT was placed on a turn table which is 0.8m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 1.5m above ground plane. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of EUT was fixed in a particular direction according to the requirements in Section 13.1.4.1 of ANSI C63.10-2013.

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## 2.4 Configuration of Tested System

## Fig. 2-1 Configuration of Tested System

EUT

## Table 2-1 Equipment Used in Tested System

| Item | Equipment               | Trademar<br>k | Model No. | FCC ID       | Note |
|------|-------------------------|---------------|-----------|--------------|------|
| 1.   | TURE WIRELESS<br>EARBUD | N/A           | MZX637    | 2AKI8-MZX637 | EUT  |

#### Note:

(1) Unless otherwise denoted as EUT in Remark column , device(s) used in tested system is a support equipment.

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| FCC Rules          | Description Of Test                     | Result    |
|--------------------|---|-----------|
| §15.207            | AC Power Conducted<br>Emission          | N/A       |
| §15.247(d),§15.209 | Radiated Emission                       | Compliant |
| §15.247(a)(1)      | Channel Separation test                 | Compliant |
| §15.247(a)(1)      | 20dB Bandwidth                          | Compliant |
| §15.247(a)(1)(iii) | Quantity of Hopping Channel             | Compliant |
| §15.247(a)(1)(iii) | Time of Occupancy(Dwell Compliant Time) |           |
| §15.247(b)         | Max Peak output Power test              | Compliant |
| §15.247(d)         | Band edge test                          | Compliant |
| §15.203            | Antenna Requirement Compliant           |           |

# 3. Summary of Test Results

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## 4. Description of test modes

The EUT has been tested under its typical operating condition and fully-charged battery for EUT tested alone. Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting. Only the worst case data were reported.

The EUT has been associated with peripherals pursuant to ANSI C63.10-2013 and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation (9 KHz to the 10th harmonics of the highest fundamental frequency or to 40 GHz, whichever is lower).

The EUT has been tested under TX operating condition.

This EUT is a FHSS system, were conducted to determine the final configuration from all possible combinations. We use software control the EUT, Let EUT hopping on and transmit with highest power, all the modes GFSK,  $\Pi/4$ -DQPSK have been tested. 79 Channels are provided by EUT. The 3 channels of lower, medium and higher were chosen for test.

| Channel | Frequency(MHz) |
|---------|----------------|
| 1       | 2402           |
| 40      | 2441           |
| 79      | 2480           |

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## **5. TEST SYSTEM UNCERTAINTY**

The following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| Parameter                      | Uncertainty |
|--------------------------------|-------------|
| Radio Frequency                | ±1x10^-5    |
| Maximum Peak Output Power Test | ±1.0dB      |
| Conducted Emissions Test       | ±2.0dB      |
| Radiated Emission Test         | ±2.0dB      |
| Power Density                  | ±2.0dB      |
| Occupied Bandwidth Test        | ±1.0dB      |
| Band Edge Test                 | ±3dB        |
| All emission, radiated         | ±3dB        |
| Antenna Port Emission          | ±3dB        |
| Temperature                    | ±0.5℃       |
| Humidity                       | ±3%         |

Remark: The coverage Factor (k=2), and measurement Uncertainty for a level of Confidence of 95%

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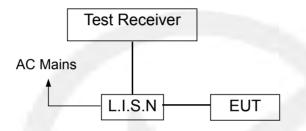


## 6. Conducted Emissions Test

#### 6.1 Measurement Procedure:

- 1. The EUT was placed on a table, which is 0.8m above ground plane.
- 2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 3. Repeat above procedures until all frequency measured was complete.

## 6.2 Test SET-UP (Block Diagram of Configuration)



## 6.3 Measurement Equipment Used:

|                      |                 | Conducted       | Emission Te      | est Site        | _          |            |
|----------------------|-----------------|-----------------|------------------|-----------------|------------|------------|
| EQUIPMENT<br>TYPE    | MFR             | MODEL<br>NUMBER | SERIAL<br>NUMBER | Characteristics | Last Cal.  | Due date   |
| Test Receiver        | Rohde & Schwarz | ESCS30          | 100018           | 9kHz~3GHz       | 05/23/2019 | 05/22/2020 |
| L.I.S.N              | Rohde & Schwarz | ENV216          | 100017           | 9KHz-300MHz     | 05/23/2019 | 05/22/2020 |
| RF Switching<br>Unit | CDS             | RSU-M2          | 38401            | 9KHz-300MHz     | 05/23/2019 | 05/22/2020 |
| Coaxial Cable        | CDS             | 79254           | 46107086         | 9kHz~3GHz       | 05/23/2019 | 05/22/2020 |

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## 6.4 Measurement Result:

N/A.

Note: Bluetooth does not work while charging



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## 7. Radiated Emission Test

## 7.1 Measurement Procedure

- 1. The testing follows the guidelines in Spurious Radiated Emissions of ANSI C63.10-2013.
- 2. Below 1000MHz, The EUT was placed on a turn table which is 0.8m above ground plane. And above 1000MHz, The EUT was placed on a styrofoam table which is 1.5m above ground plane.
- 3. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
- 4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (From 1m to 4m) and turntable (from 0 degree to 360 degree) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
- 5. Set to the maximum power setting and enable the EUT transmit continuously.
- 6. Final measurement (Above 1GHz): The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1MHz. The measurement will be performed in horizontal and vertical polarization of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 degree to 360 degree in order to have the antenna inside the cone of radiation.
- 7. Test Procedure of measurement (For Above 1GHz):
  - 1) Monitor the frequency range at horizontal polarization and move the antenna over all sides of the EUT(if necessary move the EUT to another orthogonal axis).
  - 2) Change the antenna polarization and repeat 1) with vertical polarization.
  - 3) Make a hardcopy of the spectrum.
  - 4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
  - 5) Change the analyser mode to Clear/ Write and found the cone of emission.
  - 6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3m and the antenna will be still inside the cone of emission.
  - 7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarization and azimuth and the peak and average detector, which causes the maximum emission.
  - 8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

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Use the following spectrum analyzer settings:

When spectrum scanned from 30MHz to 1GHz setting resolution bandwidth 120KHz and video bandwidth 300KHz:

| EMI Test Receiver | Setting  |
|-------------------|----------|
| Attenuation       | Auto     |
| RB                | 120KHz   |
| VB                | 300KHz   |
| Detector          | QP       |
| Trace             | Max hold |

When spectrum scanned above 1GHz setting resolution bandwidth 1MHz, video bandwidth 3MHz:

| EMI Test Receiver | Setting  |
|-------------------|----------|
| Attenuation       | Auto     |
| RB                | 1MHz     |
| VB                | 3MHz     |
| Detector          | Peak     |
| Trace             | Max hold |

When spectrum scanned above 1GHz setting resolution bandwidth 1MHz, video bandwidth 10Hz:

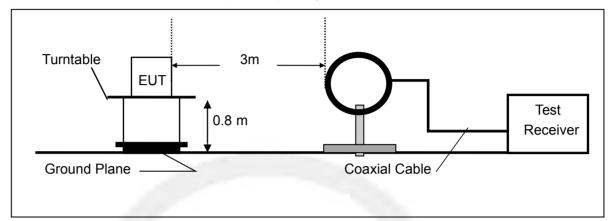
| EMI Test Receiver | Setting  |
|-------------------|----------|
| Attenuation       | Auto     |
| RB                | 1MHz     |
| VB                | 10Hz     |
| Detector          | Average  |
| Trace             | Max hold |

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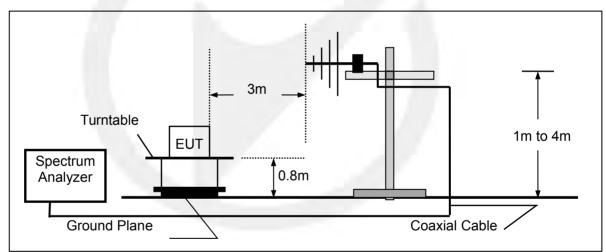


## 7.2 Test SET-UP (Block Diagram of Configuration)

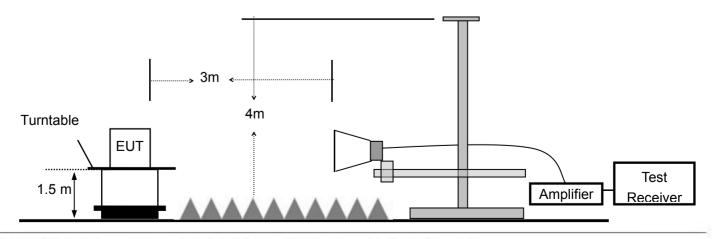
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



(B) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(C) Radiated Emission Test Set-Up, Frequency above 1000MHz



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## 7.3 Measurement Equipment Used:

| Item | Equipment                         | Manufacturer       | Model No.      | Serial No.       | Characteristics | Last Cal.  | Cal.<br>Interval |
|------|-----------------------------------|--------------------|----------------|------------------|-----------------|------------|------------------|
| 1.   | Test Receiver                     | Rohde &<br>Schwarz | ESCI           | 1166.5950.0<br>3 | 9KHz-3GHz       | 05/23/2019 | 1 Year           |
| 2.   | Loop Antenna                      | Schwarzbeck        | FMZB 1519      | 012              | 9 KHz -30MHz    | 05/23/2019 | 1 Year           |
| 3.   | Bilog Antenna                     | Schwarzbeck        | VULB9163       | 000141           | 25MHz-2GHz      | 05/23/2019 | 1 Year           |
| 4.   | Power Amplifier                   | CDS                | RSU-M352       | 818              | 1MHz-1GHz       | 05/23/2019 | 1 Year           |
| 5.   | Power Amplifier                   | HP                 | 8447F          | OPT H64          | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |
| 6.   | Color Monitor                     | SUNSPO             | SP-140A        | N/A              |                 | 05/23/2019 | 1 Year           |
| 7.   | Single Line Filter                | JIANLI             | XL-3           | N/A              |                 | 05/23/2019 | 1 Year           |
| 8.   | Single Phase<br>Power Line Filter | JIANLI             | DL-2X100B      | N/A              |                 | 05/23/2019 | 1 Year           |
| 9.   | 3 Phase Power<br>Line Filter      | JIANLI             | DL-4X100B      | N/A              |                 | 05/23/2019 | 1 Year           |
| 10.  | DC Power Filter                   | JIANLI             | DL-2X50B       | N/A              |                 | 05/23/2019 | 1 Year           |
| 11.  | Cable                             | Schwarzbeck        | PLF-100        | 549489           | 9KHz-3GHz       | 05/23/2019 | 1 Year           |
| 12.  | Cable                             | Rosenberger        | CIL02          | A0783566         | 9KHz-3GHz       | 05/23/2019 | 1 Year           |
| 13.  | Cable                             | Rosenberger        | RG 233/U       | 525178           | 9KHz-3GHz       | 05/23/2019 | 1 Year           |
| 14.  | Signal Analyzer                   | Rohde & Schwarz    | FSV30          | 103040           | 9KHz-40GHz      | 05/23/2019 | 1 Year           |
| 15.  | Horn Antenna                      | Schwarzbeck        | BBHA9120D      | 9120D-1272       | 1GHz-18GHz      | 05/23/2019 | 1 Year           |
| 16.  | Horn Antenna                      | Schwarzbeck        | BBHA 9170      | BBHA91703<br>99  | 14GHz -26.5GHz  | 05/23/2019 | 1 Year           |
| 17.  | Power Amplifier                   | LUNAR EM           | LNA1G18-4<br>0 | J101000000<br>81 | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |
| 18.  | Cable                             | H+S                | CBL-26         | N/A              | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |
| 19.  | Cable                             | H+S                | CBL-26         | N/A              | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |
| 20.  | Cable                             | H+S                | CBL-26         | N/A              | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |

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## 7.4 Radiated Emission Limit

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table 15.209(a):

| Frequencies | Field Strength     | Measurement Distance |
|-------------|--------------------|----------------------|
| (MHz)       | (micorvolts/meter) | (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                    |

## 15.205 Restricted bands of operation

| MHz                        | MHz                   | MHz             | GHz           |  |
|----------------------------|-----------------------|-----------------|---------------|--|
| 0.090 - 0.110              | 16.42 - 16.423        | 399.9 - 410     | 4.5 - 5.15    |  |
| <sup>1</sup> 0.495 - 0.505 | 16.69475 - 16.69525   | 608 - 614       | 5.35 - 5.46   |  |
| 2.1735 - 2.1905            | 16.80425 - 16.80475   | 960 - 1240      | 7.25 - 7.75   |  |
| 4.125 - 4.128              | 25.5 - 25.67          | 1300 - 1427     | 8.025 - 8.5   |  |
| 4.17725 - 4.17775          | 37.5 - 38.25          | 1435 - 1626.5   | 9.0 - 9.2     |  |
| 4.20725 - 4.20775          | 73 - 74.6             | 1645.5 - 1646.5 | 9.3 - 9.5     |  |
| 6.215 - 6.218              | 74.8 - 75.2           | 1660 - 1710     | 10.6 - 12.7   |  |
| 6.26775 - 6.26825          | 108 - 121.94          | 1718.8 - 1722.2 | 13.25 - 13.4  |  |
| 6.31175 - 6.31225          | 123 - 138             | 2200 - 2300     | 14.47 - 14.5  |  |
| 8.291 - 8.294              | 149.9 - 150.05        | 2310 - 2390     | 15.35 - 16.2  |  |
| 8.362 - 8.366              | 156.52475 - 156.52525 | 2483.5 - 2500   | 17.7 - 21.4   |  |
| 8.37625 - 8.38675          | 156.7 - 156.9         | 2690 - 2900     | 22.01 - 23.12 |  |
| 8.41425 - 8.41475          | 162.0125 - 167.17     | 3260 - 3267     | 23.6 - 24.0   |  |
| 12.29 - 12.293             | 167.72 - 173.2        | 3332 - 3339     | 31.2 - 31.8   |  |
| 12.51975 - 12.52025        | 240 - 285             | 3345.8 - 3358   | 36.43 - 36.5  |  |
| 12.57675 - 12.57725        | 322 - 335.4           | 3600 - 4400     | (2)           |  |

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## Remark 1. Emission level in dBuV/m=20 log (uV/m)

2. Measurement was performed at an antenna to the closed point of EUT distance of meters.

3. Only spurious frequency is permitted to locate within the Restricted Bands specified in provision of  $\xi$  15.205, and the emissions located in restricted bands also comply with 15.209 limit.

## 7.5 Measurement Result

| Operation Mode:    | ТХ    | Test Date :   | May 14, 2020 |
|--------------------|-------|---------------|--------------|
| Test By:           | Loren | Temperature : | <b>27</b> ℃  |
| Test Result:       | PASS  | Humidity :    | 63 %         |
| Measured Distance: | 3m    |               |              |

#### Below 30MHz:

| Freq. | Ant.Pol. | Emission | Limit 3m | Over |
|-------|----------|----------|----------|------|
|       |          | Level    |          |      |
| (MHz) | H/V      | (dBuV/m) | (dBuV/m) | (dB) |
|       |          |          |          |      |

Note: The low frequency, which started from 9KHz-30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

## Below 1000MHz:

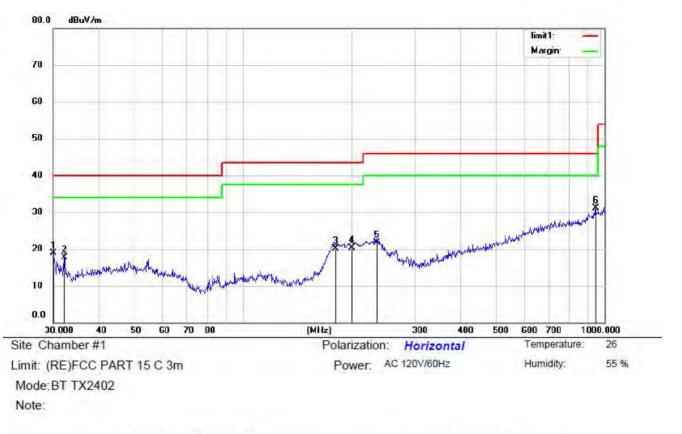
Pass.

All modulation modes have been tested, the worst mode is (GFSK TX 2402MHz), the data is recorded on the following page, other modulation modes do not exceed this limit.

Please refer to the following data.

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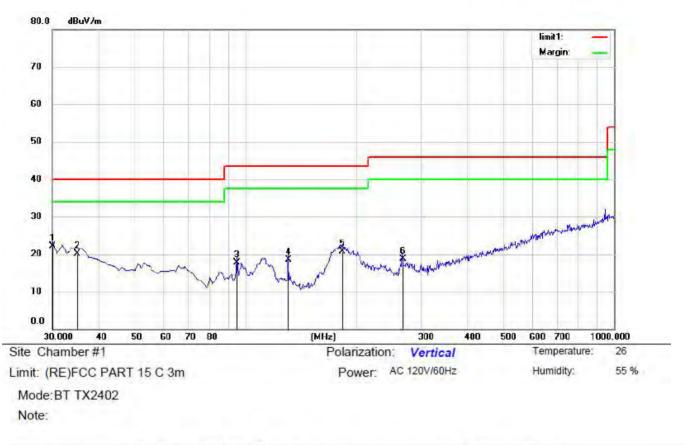
| No. | Mk. | Freq.    | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|-----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |     | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   | 12  | 30.0000  | 37.58            | -18.76            | 18.82            | 40.00  | -21.18 | QP       |                   |                 |         |
| 2   | -   | 32.2925  | 36.74            | -19.00            | 17.74            | 40.00  | -22.26 | QP       |                   |                 |         |
| 3   |     | 181.2834 | 39.50            | -19.31            | 20.19            | 43.50  | -23.31 | QP       |                   |                 |         |
| 4   |     | 199.9856 | 37.54            | -17.25            | 20.29            | 43.50  | -23.21 | QP       |                   |                 |         |
| 5   | -   | 234.1684 | 37.80            | -16.14            | 21.66            | 46.00  | -24.34 | QP       |                   |                 |         |
| 6   | *   | 945.4400 | 31.63            | -0.62             | 31.01            | 46.00  | -14.99 | QP       |                   |                 |         |

\*:Maximum data x:Over limit I:over margin

Operator: Lian

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| No. | Mk. | Freq.    | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|-----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |     | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   | *   | 30.0000  | 40.85            | -18.76            | 22.09            | 40.00  | -17.91 | QP       |                   |                 |         |
| 2   |     | 34.8823  | 38.65            | -18.62            | 20.03            | 40.00  | -19.97 | QP       |                   |                 |         |
| 3   |     | 94.9900  | 36.70            | -18.98            | 17.72            | 43.50  | -25.78 | QP       |                   |                 |         |
| 4   | 1   | 130.8800 | 39.84            | -21.36            | 18.48            | 43.50  | -25.02 | QP       |                   |                 |         |
| 5   |     | 183.2600 | 39.80            | -19.13            | 20.67            | 43.50  | -22.83 | QP       |                   |                 |         |
| 6   |     | 266.6800 | 33.65            | -14.85            | 18.80            | 46.00  | -27.20 | QP       |                   |                 |         |

\*:Maximum data x:Over limit I:over margin

Operator: Lian

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## Above 1000MHz~10<sup>th</sup> Harmonics:

All modulation modes have been tested, the worst mode is (GFSK), the data is recorded on the following page, other modulation modes do not exceed this limit.Please refer to the following data.

| Operation Mode: GFSK (CH1: 2402MHz) |  |
|-------------------------------------|--|
|-------------------------------------|--|

Test Date : May 14, 2020

| Freq. | Ant.<br>Pol. | Rea<br>Level(d | 0     | Correct<br>Factor | Emis<br>Level(d |       | Lim<br>3n |    | Margin(d | B)     |
|-------|--------------|----------------|-------|-------------------|-----------------|-------|-----------|----|----------|--------|
| (MHz) | H/V          | PK             | AV    | dB                | PK              | AV    | PK        | AV | PK       | AV     |
| 4804  | V            | 92.60          | 76.85 | -32.3             | 60.30           | 44.55 | 74        | 54 | -13.70   | -9.45  |
| 7206  | V            | 96.16          | 73.62 | -37.2             | 58.96           | 36.42 | 74        | 54 | -15.04   | -17.58 |
| 9608  | V            | 97.99          | 72.04 | -39.8             | 58.19           | 32.24 | 74        | 54 | -15.81   | -21.76 |
| 12010 | V            | 97.98          | 71.44 | -40.5             | 57.48           | 30.94 | 74        | 54 | -16.52   | -23.06 |
| 14412 | V            | 96.15          | 71.61 | -41.7             | 54.45           | 29.91 | 74        | 54 | -19.55   | -24.09 |
| 16814 | V            | 92.90          | 72.66 | -40.0             | 52.90           | 32.66 | 74        | 54 | -21.10   | -21.34 |
| 4804  | Н            | 97.07          | 71.97 | -31.6             | 65.47           | 40.37 | 74        | 54 | -8.53    | -13.63 |
| 7206  | Н            | 96.93          | 76.52 | -35.5             | 61.43           | 41.02 | 74        | 54 | -12.57   | -12.98 |
| 9608  | Н            | 98.19          | 70.97 | -38.3             | 59.89           | 32.67 | 74        | 54 | -14.11   | -21.33 |
| 12010 | Н            | 96.24          | 76.19 | -39.0             | 57.24           | 37.19 | 74        | 54 | -16.76   | -16.81 |
| 14412 | Н            | 92.95          | 75.22 | -42.0             | 50.95           | 33.22 | 74        | 54 | -23.05   | -20.78 |
| 16814 | Н            | 97.43          | 76.12 | -39.3             | 58.13           | 36.82 | 74        | 54 | -15.87   | -17.18 |

## Operation Mode: GFSK (CH40: 2441MHz)

Test Date : May 14, 2020

|       |      |         |        |         |         |        | 1     |        |        |        |
|-------|------|---------|--------|---------|---------|--------|-------|--------|--------|--------|
| Freq. | Ant. | Rea     | ding   | Correct | Emis    | ssion  | Lii   | mit    | Marg   | in(dB) |
|       | Pol. | Level(d | BuV/m) | Factor  | Level(d | BuV/m) | 3m(dE | 3uV/m) |        |        |
| (MHz) | H/V  | PK      | AV     | dB      | PK      | AV     | PK    | AV     | PK     | AV     |
| 4882  | V    | 94.77   | 76.76  | -32.3   | 62.47   | 44.46  | 74    | 54     | -11.53 | -9.54  |
| 7323  | V    | 96.69   | 71.22  | -37.2   | 59.49   | 34.02  | 74    | 54     | -14.51 | -19.98 |
| 9764  | V    | 91.41   | 73.89  | -39.8   | 51.61   | 34.09  | 74    | 54     | -22.39 | -19.91 |
| 12205 | V    | 93.47   | 73.30  | -40.5   | 52.97   | 32.8   | 74    | 54     | -21.03 | -21.20 |
| 14646 | V    | 94.36   | 73.94  | -41.0   | 53.36   | 32.94  | 74    | 54     | -20.64 | -21.06 |
| 17087 | V    | 93.49   | 75.08  | -41.1   | 52.39   | 33.98  | 74    | 54     | -21.61 | -20.02 |
| 4882  | Н    | 95.64   | 72.88  | -31.6   | 64.04   | 41.28  | 74    | 54     | -9.96  | -12.72 |
| 7323  | Н    | 96.18   | 76.31  | -35.5   | 60.68   | 40.81  | 74    | 54     | -13.32 | -13.19 |
| 9764  | н    | 97.63   | 76.47  | -38.3   | 59.33   | 38.17  | 74    | 54     | -14.67 | -15.83 |
| 12205 | н    | 98.34   | 74.93  | -39.0   | 59.34   | 35.93  | 74    | 54     | -14.66 | -18.07 |
| 14646 | Н    | 91.57   | 76.66  | -42.0   | 49.57   | 34.66  | 74    | 54     | -24.43 | -19.34 |
| 17087 | Н    | 97.96   | 71.41  | -41.5   | 56.46   | 29.91  | 74    | 54     | -17.54 | -24.09 |

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| Freq. | Ant. | Rea     | ding   | Correct | Correct Emission |        | Limit      |    | Margin(dB) |        |
|-------|------|---------|--------|---------|------------------|--------|------------|----|------------|--------|
|       | Pol. | Level(d | BuV/m) | Factor  | Level(d          | BuV/m) | 3m(dBuV/m) |    |            |        |
| (MHz) | H/V  | PK      | AV     | dB      | PK               | AV     | PK         | AV | PK         | AV     |
| 4960  | V    | 94.92   | 72.47  | -32.3   | 62.62            | 40.17  | 74         | 54 | -11.38     | -13.83 |
| 7440  | V    | 98.94   | 72.56  | -37.2   | 61.74            | 35.36  | 74         | 54 | -12.26     | -18.64 |
| 9920  | V    | 98.27   | 74.20  | -39.8   | 58.47            | 34.4   | 74         | 54 | -15.53     | -19.60 |
| 12400 | V    | 95.61   | 73.23  | -40.5   | 55.11            | 32.73  | 74         | 54 | -18.89     | -21.27 |
| 14880 | V    | 96.47   | 76.13  | -41.0   | 55.47            | 35.13  | 74         | 54 | -18.53     | -18.87 |
| 17360 | V    | 96.25   | 75.50  | -41.1   | 55.15            | 34.4   | 74         | 54 | -18.85     | -19.60 |
| 4960  | Н    | 95.96   | 76.61  | -31.6   | 64.36            | 45.01  | 74         | 54 | -9.64      | -8.99  |
| 7440  | Н    | 93.44   | 72.20  | -35.5   | 57.94            | 36.7   | 74         | 54 | -16.06     | -17.30 |
| 9920  | Н    | 97.11   | 72.65  | -38.3   | 58.81            | 34.35  | 74         | 54 | -15.19     | -19.65 |
| 12400 | Н    | 96.80   | 73.92  | -39.0   | 57.8             | 34.92  | 74         | 54 | -16.20     | -19.08 |
| 14880 | Н    | 93.94   | 71.20  | -42.0   | 51.94            | 29.2   | 74         | 54 | -22.06     | -24.80 |
| 17360 | Н    | 92.03   | 73.87  | -41.5   | 50.53            | 32.37  | 74         | 54 | -23.47     | -21.63 |
|       |      |         |        |         |                  |        |            |    |            |        |

#### Operation Mode: GFSK (CH79: 2480MHz)

#### Test Date : May 14, 2020

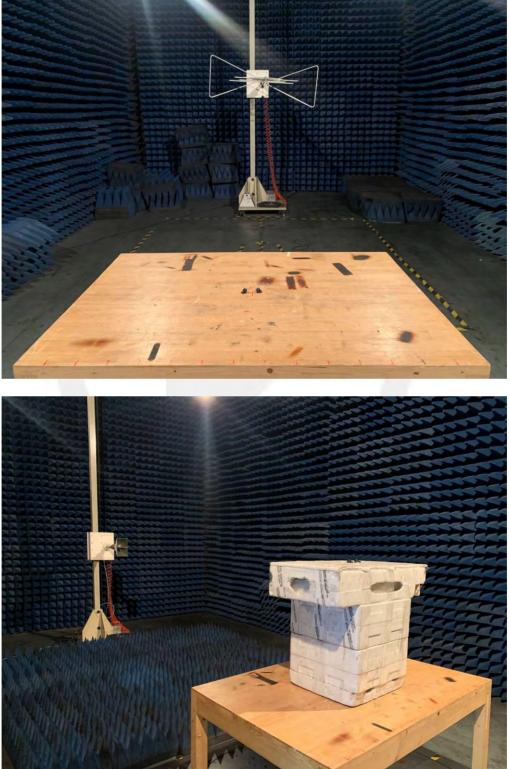
#### Other harmonics emissions are lower than 20dB below the allowable limit.

- **Note:** (1) All Readings are Peak Value and AV.
  - (2) Emission Level= Reading Level+ Probe Factor +Cable Loss.
  - (3) The average measurement was not performed when the peak measured data under the limit of average detection.
  - (4) Measuring frequencies from 1GHz to 25GHz.

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## 7.5 Radiated Measurement Photos:



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Report No.ES200508025W



## 8. Channel Separation test

#### 8.1 Measurement Procedure

The EUT was operating in hopping mode or could be controlled its channel. Printed out the test result from the spectrum by hard copy function.

## 8.2 Test SET-UP (Block Diagram of Configuration)

EUT Spectrum Analyzer

#### 8.3 Measurement Equipment Used:

| EQUIPMENT<br>TYPE | MFR             | MODEL<br>NUMBER | SERIAL<br>NUMBER | Characteristics | LAST<br>CAL. | CAL DUE.   |
|-------------------|-----------------|-----------------|------------------|-----------------|--------------|------------|
| Spectrum Analyzer | Rohde & Schwarz | FSV30           | 1321.3008K       | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |
| Coaxial Cable     | CDS             | 79254           | 46107086         | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |
| Antenna Connector | ARTHUR-YANG     | 2244-N1TG1      | N/A              | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

## 8.4 Measurement Results:

Refer to attached data chart.

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>750

. . . . . .

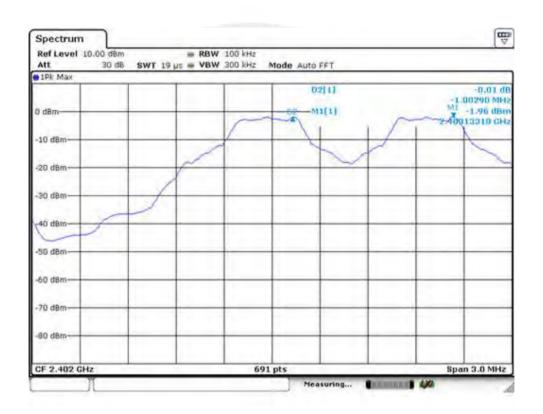
- -

| Spectrum Detector:<br>Test By:<br>Test Result:<br>Modulation: | PK<br>Loren<br>PASS<br>GFSK | Test Date :<br>Temperature :<br>Humidity : | May 14, 2020<br>25℃<br>55 %               |
|---|-----------------------------|--|---|
| Channel number  | Channel<br>frequency (MHz)  | Separation Read<br>Value (kHz)             | Separation Limit<br>2/3 20dB Down BW(kHz) |
| 1   | 2402                        | 1003                                       | >750                                      |
| 40  | 2441                        | 1003                                       | >750                                      |

- . .

2480

79



1003

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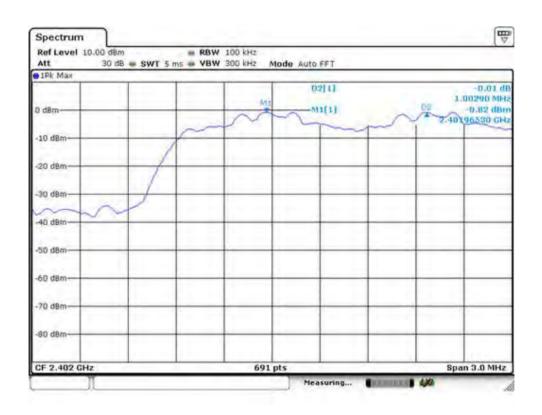
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Report No.ES200508025W

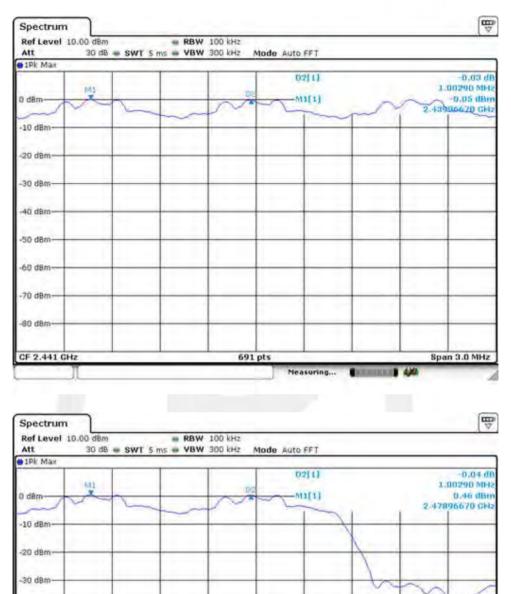


| Spectrum Detector:<br>Test By:<br>Test Result:<br>Modulation: | РК<br>Loren<br>PASS<br>П/4-DQPSK | Test Date :<br>Temperature :<br>Humidity : | May 14, 2020<br>25℃<br>55 %               |
|---|----------------------------------|--|---|
| Channel number  | Channel<br>frequency (MHz)       | Separation Read<br>Value (kHz)             | Separation Limit<br>2/3 20dB Down BW(kHz) |
| 1   | 2402                             | 1003                                       | >915                                      |
| 40  | 2441                             | 1003                                       | >915                                      |
| 79  | 2480                             | 1003                                       | >915                                      |



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Report No.ES200508025W

-40 dBm

-50 d8m

-60 d8m

-70 dBm

-80 dBm

CF 2.48 GHz

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691 pts

Measuring...

STATISTICS.

430

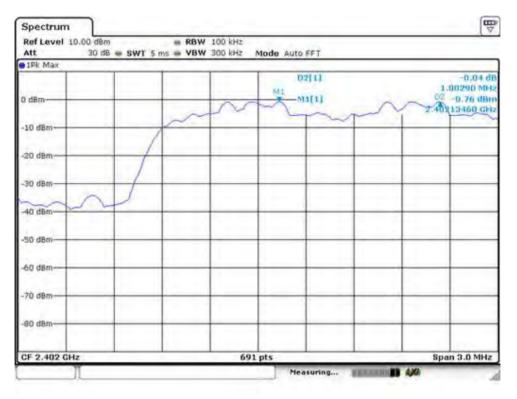
Span 3.0 MHz



| Spectrum Detector:          | PK            | Test Date :   |
|-----------------------------|---------------|---------------|
| Test By:                    | Loren         | Temperature : |
| Test Result:<br>Modulation: | PASS<br>8DPSK | Humidity :    |

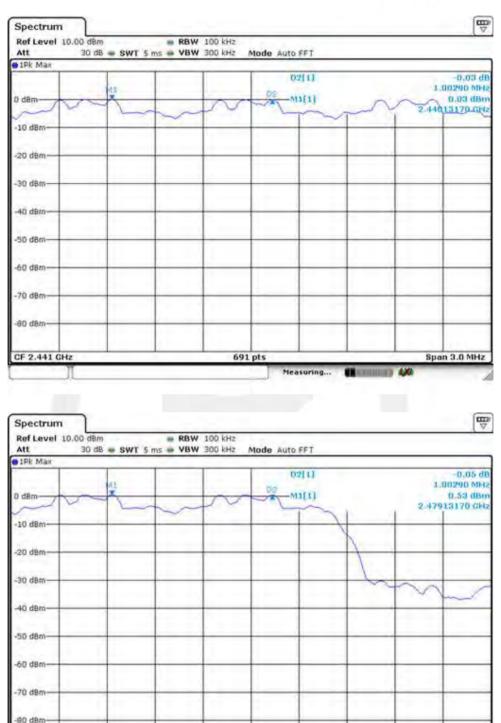
May 14, 2020 25℃ 55 %

| Channel number | Channel<br>frequency (MHz) | Separation Read<br>Value (kHz) | Separation Limit<br>2/3 20dB Down BW(kHz) |
|----------------|----------------------------|--------------------------------|---|
| 1              | 2402                       | 1003                           | >921                                      |
| 40             | 2441                       | 1003                           | >917                                      |
| 79             | 2480                       | 1003                           | >915                                      |



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CF 2.48 GHz

691 pts

Measuring...

STATISTICS.

430

Span 3.0 MHz



## 9. 20dB Bandwidth test

#### 9.1 Measurement Procedure

The EUT was operating in hopping mode or could be controlled its channel. Printed out the test result from the spectrum by hard copy function.

## 9.2 Test SET-UP (Block Diagram of Configuration)

EUT Spectrum Analyzer

## 9.3 Measurement Equipment Used:

| EQUIPMENT<br>TYPE | MFR             | MODEL<br>NUMBER | SERIAL<br>NUMBER | Characteristics | LAST<br>CAL. | CAL DUE.   |
|-------------------|-----------------|-----------------|------------------|-----------------|--------------|------------|
| Spectrum Analyzer | Rohde & Schwarz | FSV30           | 1321.3008K       | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |
| Coaxial Cable     | CDS             | 79254           | 46107086         | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |
| Antenna Connector | ARTHUR-YANG     | 2244-N1TG1      | N/A              | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

## 9.4 Measurement Results:

Refer to attached data chart.

| Spectrum Detector: | PK    | Test Date :   | May 14, 2020 |
|--------------------|-------|---------------|--------------|
| Test By:           | Loren | Temperature : | <b>25</b> ℃  |
| Test Result:       | PASS  | Humidity :    | 53 %         |
| Modulation:        | GFSK  |               |              |

| Channel number | Channel frequency<br>(MHz) | 20dB Down<br>BW(kHz) |
|----------------|----------------------------|----------------------|
| 1              | 2402                       | 1125                 |
| 40             | 2441                       | 1125                 |
| 79             | 2480                       | 1125                 |

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| • IPk Max         1.35 dB           0 dBm         0.10 dBm         2.40213020 dF           -10 dBm         9.50ctor         20.00 (           -20 dBm         9.50ctor         2136           -20 dBm         9.50ctor         2136           -30 dBm         -60 dBm         -60 dBm         -60 dBm           -50 dBm         -60 dBm         -60 dBm         -70 dBm           -70 dBm         -70 dBm         -70 dBm         -70 dBm           -10 dBm         -1.1245 MH         -1.1245 MH           -10 dBm         -1.1245 MH         2.4021302 GHz           -10 dBm         -2.402 GHz         591 pts         Span 3.0 MH  | Spectrum<br>Ref Level 1<br>Att | 0.00 dBm<br>30 dB |              | 100 kHz<br>300 kHz Mod | e Auto FFT  | ₩                                      |  |
|--|--------------------------------|-------------------|--------------|------------------------|-------------|--|--|
| 0 dBm 2.40213020 G<br>20.00 0<br>3.124500000 M<br>20.00 0<br>3.124500000 M<br>2136<br>20 dBm 2<br>20   | 1Pk Max                        |                   |              |                        |             |  |  |
| -10 dBm<br>-20 dBm<br>-30 dBm<br>-30 dBm<br>-30 dBm<br>-30 dBm<br>-50 dBm<br>-60 dBm<br>-70 | 0 d8m                          | _                 |              |                        | MY          | -1.95 dBa<br>2.40219020 GH<br>20.00 db |  |
| -20 dBm<br>-30 dBm<br>-40 dBm<br>-50 dBm<br>-50 dBm<br>-60 dBm<br>-70 | -10 dBm                        |                   |              |                        | 1           | 1.124500000 MH<br>2136,                |  |
| 40 dBm         50 dBm         50 dBm         50 dBm         60 dBm<  | -20 dBm                        | -                 | - The second |                        | 1           |  |  |
| -50 dBm<br>-60 dBm<br>-70 | -30 dBm                        | -                 | 1            |                        |             |  |  |
| 60 dBm         60 dBm           -70 dBm         -70 dBm           -80 dBm         -70 dBm           -70 dBm         -70 dBm           -70 dBm         -70 dBm           M1         1           1         2.4014096 GHz           -72.02 dBm         ndB           20.00 d3   | 40 dBm                         | 1                 |              |                        |             |  |  |
| -70 dBm<br>-80 dBm<br>-80 dBm<br>-80 dBm<br>-70 dBm<br>-80 dBm<br>-80 dBm<br>-70 dBm<br>-80 dBm<br>-80 dBm<br>-80 dBm<br>-70 dBm<br>-80 dBm<br>-70 dBm<br>-80 | -S0 dBm-                       | _                 |              | -                      | -           |  |  |
| B0 dBm         691 pts         Span 3.0 MH           OF 2.402 GHz         691 pts         Span 3.0 MH           Marker         Yourker         Function         Function Result           M1         1         2.4021302 GHz         -1.95 dBm         ndB down         1.1245 MH           T1         1         2.4014096 GHz         -22.02 dBm         ndB         20.00 dBm  | -60 d8m                        | -                 |              | -                      |             |  |  |
| CF 2.402 GHz         691 pts         Span 3.0 MH           Marker         Your Ref         Trc         X-value         Y-value         Function         Function Result           M1         1         2.4021302 GHz         -1.95 dBm         ndB down         1.1245 MH.           T1         1         2.4014096 GHz         -22.02 dBm         ndB         20.00 dBm   | -70 d8m-                       | -                 |              |                        |             |  |  |
| Marker         Yube         Ref         Trc         X-value         Y-value         Function         Function Result           M1         1         2.4021302 GHz         -1.95 dBm         ndB down         1.1245 MH.           T1         1         2.4014096 GHz         -22.02 dBm         ndB         20.00 dB   | -80 d8m                        |                   |              |                        | -           |  |  |
| Type         Ref         Trc         X-value         Y-value         Function         Function Result           M1         1         2.4021302 GHz         -1.95 dBm         ndB down         1.1245 MH.           T1         1         2.4014096 GHz         -22.02 dBm         ndB         20.00 dB  | CF 2.402 GH                    | łz                |              | 691 pts                |             | Span 3.0 MHz                           |  |
| M1         1         2.4021302 GHz         -1.95 dBm         ndB down         1.1245 MH.           T1         1         2.4014096 GHz         -22.02 dBm         ndB         20.00 dB  |                                | Incl              | Manakan I    | Mushing 1              | Furnition 1 | Furnishing Resputs                     |  |
| T1 1 2.4014096 GHz -22.02 dBm ndB 20.00 d  |                                |                   |              |                        |             | Function Result<br>1.1245 MHz          |  |
| T2 1 2.402534 GHz -21.84 dBm 0 factor 2136.3   | T1                             | -                 |              |                        |             | 20.00 dB                               |  |
|  | T2                             | 1                 | 2.402534 GHz | -21.84 d8m             | Q factor    | 2136.3                                 |  |

| 10.00 dBn<br>30 dB |         | JS VBW   | 100 kHz<br>300 kHz Mt | de Auto FFT  | _        |  |  |  |
|--------------------|---------|--|-----------------------|--|----------|--|--|--|
| _                  |         |  |                       |  |          |  |  |  |
|                    |         | /  |                       | Mi ndb<br>Bw<br>Q-Locto  | r<br>and | -1.16 dBr<br>2.44113460 GH<br>20.00 d<br>1.124500000 MH<br>2170. |  |  |
|                    |         | -  |                       |  | 9        |  |  |  |
| -                  | 1       |  |                       | -  | 1        |  |  |  |
| 1                  |         | -  |                       |  | -        |  |  |  |
|                    | -       | -  | -                     |  |          |  |  |  |
| -                  | -       | -  |                       |  | -        |  |  |  |
| _                  | -       | _  |                       |  |          | -  |  |  |
|                    | -       |  |                       |  |          |  |  |  |
| Hz                 |         |  | 691 p                 | ts   | -        | Span 3.0 MHz   |  |  |
|                    |         |  |                       |  |          |  |  |  |
| Trc                | X-value |  | Y-value               | Function   |          | Function Result  |  |  |
| 1                  | 2.44113 | and the second | -1.16 dBm             |  |          | 1.1245 MHz   |  |  |
| 1                  | 2.44040 |  | -21.07 d8m            | the Research of the Research o |          | 20.00 dB<br>2170.9   |  |  |

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| Ref Level 1<br>Att | 10.00 dBm<br>30 dB |               | BW 100 kHz<br>BW 300 kHz Mo | de Auto FFT                           |      |  |  |  |
|--------------------|--------------------|---------------|-----------------------------|---------------------------------------|------|--|--|--|
| 1Pk Max            |                    |               |                             | · · · · · · · · · · · · · · · · · · · |      |  |  |  |
| 0 d8m              |                    |               |                             | M1 nd0                                |      | -0.65 dBo<br>2.48013460 GH<br>20.00 dt |  |  |
| -10 d8m            | _                  |               |                             | C-Lactor                              |      | 1.124500000 MH<br>2205.4               |  |  |
| -20 dBm            | -                  | K             |                             | 1                                     | 2    |  |  |  |
| -30 dBm            | -                  |               |                             |                                       | K    |  |  |  |
| 40 dBm             | 5                  |               | _                           |                                       | -    |  |  |  |
| -S0 dBm-           | _                  |               | _                           |                                       | -    |  |  |  |
| -60 d8m            | _                  |               | -                           |                                       | -    |  |  |  |
| -70 dBm-           | -                  |               |                             |                                       |      |  |  |  |
| -80 d8m-           | -                  |               | _                           | _                                     | -    |  |  |  |
| CF 2.48 GH         | ,                  |               | 691 pt                      |                                       |      | Span 3.0 MHz                           |  |  |
| Marker             |                    |               | ass pr                      |                                       |      | opun one ranc                          |  |  |
| Type   Ref         | Trc                | X-value       | Y-value                     | Function                              | Fund | Function Result                        |  |  |
| MI                 | 1                  | 2.4801346 GHz | -0.65 dBm                   | ndB down                              |      | 1.1245 MHz                             |  |  |
| T1                 | 1                  | 2.4794096 GHz | -20.77 d8m                  | ndB                                   |      | 20.00 dB                               |  |  |
| T2                 | 1                  | 2.480534 GHz  | -20.79 d8m                  | Q factor                              |      | 2205.6                                 |  |  |

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| pectrum Detecto<br>est By:<br>est Result:<br>lodulation: | or:       | РК<br>Loren<br>PASS<br>П/4-DQPSK | Ter<br>Hu                 | st Date :<br>mperature :<br>midity : | 2       | /lay 14, 2<br>25℃<br>53 %   | 020               |  |
|--|-----------|----------------------------------|---------------------------|--------------------------------------|---------|-----------------------------|-------------------|--|
| С  |           | l number                         | ()                        | el frequency<br>MHz)                 |         | )dB Dowr<br>3W(kHz)         | ١                 |  |
|  |           | 1                                |                           | 2402                                 |         | 1372                        |                   |  |
|  | 4         | -0                               |                           | 2441                                 |         | 1372                        |                   |  |
|  | 79        |                                  |                           | 2480                                 |         | 1372                        |                   |  |
|  |           |                                  |                           |                                      |         |                             | _                 |  |
| Spectrum<br>Ref Level<br>Att                             | 10.00 dBm | SWT 5 ms WB                      | W 100 kHz<br>W 300 kHz Mo | de Auto FFT                          |         |                             | (W)               |  |
| • IPK Max  | -         |                                  | 1                         | Mil[1]                               |         | -0                          | .82 dBm           |  |
| 0 d8m  |           |                                  | 242                       |                                      |         | 2.40196                     | 530 GHz           |  |
| U GOM  |           | -                                | ndo                       |                                      |         | 20.00 d8<br>1.371900000 MHz |                   |  |
| -10 d8m  |           |                                  |                           | Q factor                             | -       |                             | 1750,0            |  |
| -20 dBm-   |           | W.                               | -                         |                                      | N2      | -                           | -                 |  |
|  |           |                                  |                           |                                      | 1       |                             |                   |  |
| -30 dBm  | -         |                                  |                           |                                      |         |                             | 1                 |  |
| -40 dBm-   | ~         |                                  |                           |                                      |         |                             | 1                 |  |
|  |           |                                  |                           |                                      |         |                             |                   |  |
| -SD dBm  |           |                                  | -                         |                                      |         |                             | -                 |  |
| -60 d8m  | _         |                                  | -                         |                                      | -       |                             |                   |  |
|  |           |                                  |                           |                                      |         |                             |                   |  |
| -70 dBm  |           |                                  | + +                       |                                      | -       |                             |                   |  |
| -80 d8m  |           |                                  |                           |                                      |         |                             |                   |  |
|  |           |                                  |                           |                                      |         |                             |                   |  |
| CF 2.402 0   | Hz        |                                  | 691 pt                    | s                                    | -       | Span 3                      | .0 MHz            |  |
| Marker   |           |                                  |                           |                                      |         |                             |                   |  |
| Type Re  |           | X-value                          | Y-value                   | Function                             | Fun     | ction Result                | 10 6015           |  |
| MI   | 1         | 2.4019653 GHz<br>2.4012836 GHz   | -0.82 dBm<br>-20.81 dBm   | ndB down<br>ndB                      |         |                             | 19 MHz<br>0.00 dB |  |
| T2   | 1         | 2.4026556 GHz                    | -20.97 d8m                | Q factor                             |         |                             | 1750.8            |  |
|  | N         |                                  |                           | Measuring                            | (in the | 4,00                        | 1                 |  |

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| Ref Level 1<br>Att |     | - SWT 5 ms  |     | 100 kHz<br>300 kHz Mo    | de Auto FFT     |          |                                       |
|--------------------|-----|-------------|-----|--------------------------|-----------------|----------|---------------------------------------|
| • 1Pk Max          | -   |             | -   |                          |                 |          | and the second second                 |
| 0 d8m              |     |             |     | NU                       | Mi[1]           |          | -0.07 dBr<br>2.44096960 GH<br>20.00 d |
| -10 d8m            |     | 1           | ~   |                          | Bw<br>Q factor  | 1        | 1.371900000 MH<br>1779.               |
| -20 dBm            |     | 1           |     | + +                      |                 | 13       |                                       |
| -30 dBm            |     |             |     |                          |                 | 15       | h 7                                   |
| -40 dBm            |     |             |     |                          |                 | -        |                                       |
| -SD dBm-           | _   |             |     |                          |                 | -        | -                                     |
| -60 dBm            | -   |             | -   |                          |                 | -        | -                                     |
| -70 dBm            | -   |             | -   | -                        |                 |          |                                       |
| -80 d8m-           | -   |             |     |                          |                 |          |                                       |
| CF 2.441 G         | -lz |             | _   | 691 pt                   | s               | 1        | Span 3.0 MHz                          |
| Marker             | Trc | X-value     | 1   | Y-value                  | Function        |          | nction Result                         |
| Type Ref<br>M1     | 1   | 2.4409695 0 | iH2 | -0.07 dBm                | ndB down        | Fu       | 1.3719 MHz                            |
| T1<br>T2           | 1   | 2.4402836 G | Hz  | -20.11 d8m<br>-20.23 d8m | ndB<br>Q factor |          | 20.00 dB<br>1779.2                    |
|                    | 19  |             |     |                          | Measuring.      | . Shanaa |                                       |

| PIPk Max   |     |               |            |                                |                             |        |
|------------|-----|---------------|------------|--------------------------------|-----------------------------|--------|
| 0 d8m      |     | V             | Ma         | Mi[1]<br>ndb<br>Bw<br>Q factor | 2,479969<br>20<br>1,3719000 | 0.00 d |
| -20 dBm-   |     |               |            |                                |                             | /      |
| -50 dBm    |     |               |            |                                |                             | _      |
| -70 dBm    |     |               |            |                                |                             |        |
| CF 2.48 GH | z   |               | 691 pt     |                                | Span 3.                     | 0 MHz  |
| Type   Ref | Trc | X-value       | Y-value    | Function                       | Function Result             |        |
| M1         | 1   | 2.4799695 GHz | 0.43 d8m   | ndB down                       |                             | 9 MHz  |
| T1         | 1   | 2.4792836 GHz | -19.53 d8m | ndB                            | 20                          | 00 dB  |
| T2         | 1   | 2.4806556 GHz | -19.70 d8m | Q factor                       | 1                           | 807.7  |



| Spectrum Detector:          | PK            | Test Date :   | May 14, 2020 |
|-----------------------------|---------------|---------------|--------------|
| Test By:                    | Loren         | Temperature : | 25℃          |
| Test Result:<br>Modulation: | PASS<br>8DPSK | Humidity :    | 53 %         |

| Channel number | Channel frequency | 20dB Down |
|----------------|-------------------|-----------|
| Charmer number | (MHz)             | BW(kHz)   |
| 1              | 2402              | 1381      |
| 40             | 2441              | 1376      |
| 79             | 2480              | 1372      |

| Att            | 10.00 dBn<br>30 dB | = RI   | BW 100 kHz<br>BW 300 kHz Mor          | de Auto FFT                    |     |  |
|----------------|--------------------|--|---------------------------------------|--------------------------------|-----|--|
| 1Pk Max        |                    |  |                                       |                                |     |  |
| 0 d8m          |                    | ~  | ~                                     | MI[1]<br>ndB<br>Bw<br>Q factor |     | -0.75 dBr<br>2.40210020 GH<br>20.00 d<br>1.380600000 MH<br>1739, |
| -20 dBm        |                    | 1  |                                       | -                              | As  |  |
| -40 dBm        |                    | 2  | _                                     |                                | ~   |  |
| -S0 dBm        | -                  |  | -                                     | _                              | -   |  |
| -60 dBm        |                    |  |                                       |                                |     |  |
| -70 dBm        |                    |  |                                       |                                |     |  |
|                |                    |  |                                       |                                |     | in the   |
| CF 2.402 G     | -lz                |  | 691 pt                                | 5                              |     | Span 3.0 MHz   |
| Type   Ref     | Trc                | X-value  | Y-value                               | Function                       | Fun | ction Result   |
| M1<br>T1<br>T2 | 1                  | 2.4021302 GHz<br>2.401288 GHz<br>2.4026686 GHz | -0.75 dBm<br>-20.76 dBm<br>-21.02 dBm | ndB down<br>ndB<br>Q factor    |     | 1.3806 MHz<br>20.00 dB<br>1739.9                                 |



| Ref Level :<br>Att |      |                     |                       | 100 kHz<br>1 300 kHz Mi | de Auto FFT          |      |   |
|--------------------|------|---------------------|-----------------------|-------------------------|----------------------|------|---|
| • 1Pk Max          | _    |                     | _                     |                         |                      |      | 1000  |
| 0 d8m              | -    |                     | ~                     | w                       | MI nd0               |      | 0.01 dB<br>2.44113460 G<br>20.00<br>1.376300000 M |
| -10 d8m            |      | -                   |                       |                         | Q factor             | here | 1773  |
| -20 dBm            | -    | 1                   | -                     | + +                     |                      | A3   | -   |
| -30 dBm            | _    | 1                   |                       |                         |                      |      |   |
| -40 dBm            | ~~~~ |                     |                       |                         |                      |      |   |
| -50 dBm            | _    |                     |                       |                         | _                    | _    |   |
| -60 d8m            | -    |                     | -                     |                         |                      | -    |   |
| -70 dBm            | -    | -                   |                       | -                       |                      | -    |   |
| -80 d8m            |      |                     |                       |                         |                      | -    |   |
| CF 2.441 G         | Hz   |                     | _                     | 691 p                   | ts                   |      | Span 3.0 MH                                       |
| Marker             | Incl | M. contern          |                       | M under                 | I constant I         | Pres | dation Process                                    |
| Type Ref<br>M1     | Trc  | X-value<br>2.441134 | 6 GHz                 | Y-value<br>0.01 dBm     | Function<br>ndB down | Fun  | ction Result<br>1.3763 MH                         |
| T1                 | 1    | 2.440292            | and the second second | -19.94 d8m              |                      |      | 20.00 di  |
| T2                 | 1    | 2.441668            | 6 GHz                 | -20.27 dam              | Q factor             |      | 1773.7  |

| Att<br>1Pk Max       | 30 dt | 3 - SWT 5 ms - V | BW 300 kHz Mo | de Auto FFT                      |      |   |
|----------------------|-------|------------------|---------------|----------------------------------|------|---|
| 0 d8m                | -     | -                |               | Mi[1]<br>I nd0<br>Bw<br>O factor |      | 0.49 dB/<br>2.48015020 dF<br>20.00 d<br>1.373900000 MH<br>1807. |
| -20 dBm              | _     | ¥.               | _             |                                  | Ne   |   |
| -30 dBm              | -     |                  |               |                                  | 16   |   |
| -40 dBm              |       |                  |               |                                  | -    |   |
| -S0 dBm              | -     | -                | -             |                                  | -    |   |
| 60 d8m-              | -     | -                | -             |                                  | -    |   |
| -70 dBm              | -     |                  | -             |                                  | -    |   |
| -80 d8m              |       |                  | -             | _                                | -    |   |
| CF 2.48 GH           | 2     |                  | 691 pt        | s                                | -    | Span 3.0 MH   |
| larker<br>Type   Ref | ITes  | X-value          | Y-value       | Function                         | Free | ction Result  |
| MI                   | 1     | 2.4801302 GHz    | 0.49 d8m      | ndB down                         | Fui  | 1.3719 MH.  |
| T1                   | 1     | 2.4792923 GHz    | -19.28 d8m    | ndB                              |      | 20.00 de  |
| T2                   | 1     | 2.4806643 GHz    | -19.21 d8m    | Q factor                         |      | 1807.8  |



# **10.** Quantity of Hopping Channel Test

## **10.1 Measurement Procedure**

The EUT was operating in hopping mode or could be controlled its channel. Printed out the test result from the spectrum by hard copy function.

#### 10.2Test SET-UP (Block Diagram of Configuration)

EUT Spectrum Analyzer

#### 10.3Measurement Equipment Used:

| EQUIPMENT         | MFR             | MODEL      | SERIAL     | Characteristics | LAST       | CAL DUE.   |
|-------------------|-----------------|------------|------------|-----------------|------------|------------|
| TYPE              |                 | NUMBER     | NUMBER     |                 | CAL.       |            |
| Spectrum Analyzer | Rohde & Schwarz | FSV30      | 1321.3008K | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |
| Coaxial Cable     | CDS             | 79254      | 46107086   | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |
| Antenna Connector | ARTHUR-YANG     | 2244-N1TG1 | N/A        | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

#### **10.4 Measurement Results:**

| Refer to attached | l data chart |
|-------------------|--------------|
| Worst Test Mode   | GFSK         |
| Test By:          | Loren        |
| Test Result:      | PASS         |

Test Date : Temperature : Humidity :

May 14, 2020 25 ℃ 50 %

| Hopping Channel | Quantity of Hopping | Quantity of Hopping |
|-----------------|---------------------|---------------------|
| Frequency Range | Channel             | Channel             |
| 2402-2480       | 79                  | >15                 |

| 1Pk Max   |         |      |          |           |         |           |               |                   |                      |
|-----------|---------|------|----------|-----------|---------|-----------|---------------|-------------------|----------------------|
|           | 1.7     |      |          |           | Ď       | 2[1]      |               |                   | 1.20 de<br>8.360 MHz |
| d dBm-    |         | -    | 80005000 | ABBAABBAA | bonagan | Athanna   |               | cana hony         | 2.12 BB              |
| INNIN     | WANNA   | WWWW | MWWW     | WWWW      | WWWW (  | ADALANDAA | WWWW          | n n i n n i fitte | EXABLACED            |
| -19 BBm+1 | Hickory | hand | -H-th    | the He    | 1.11.1  | terthe at | tuto          | titr.a            | - m                  |
| -20 d8m-  |         |      | _        | -         |         |           |               | _                 |                      |
|           | 1 1     | 1    |          |           |         |           | 1             |                   |                      |
| -30 dBm   |         |      |          |           |         | -         |               |                   |                      |
| 40 d8m-   |         | 1    | _        |           |         |           |               |                   | N                    |
| TO GEN    | D1      | 1000 |          |           | 1       |           | 1             |                   |                      |
| -50 d8m   |         | -    |          |           |         | -         |               |                   |                      |
|           |         |      |          |           |         |           | 1.000         |                   |                      |
| -60 dBm   |         |      |          |           |         |           |               |                   |                      |
| -70 dBm-  | -       | -    | -        | -         | -       | -         | -             | -                 |                      |
|           |         |      |          | -         | ·       |           |               |                   |                      |
| -80 dBm   |         |      |          |           |         |           |               |                   |                      |
|           | GHz     |      |          |           | pts     |           | at the factor |                   | 4835 GHz             |

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# 11. Time of Occupancy (Dwell Time) test

### **11.1 Test Description**

The Equipment Under Test (EUT) was set up to perform the dwell time measurements. The EUT was connected to the spectrum analyzer via a short coax cable. The dwell time is calculated by:

Dwell time = time slot length \* hop rate / number of hopping channels \* 31.6s

with:

- hop rate =  $1600 \times 1/s$  for DH1 packets =  $1600 \text{ s}^{-1}$ 

- hop rate = 1600/3 \* 1/s for DH3 packets =  $533.33 s^{-1}$ 

- number of hopping channels = 79

- 31.6 s = 0.4 seconds multiplied by the number of hopping channels = 0.4 s \* 79

The highest value of the dwell time is reported.

## 11.2 Test SET-UP (Block Diagram of Configuration)

EUT

Spectrum Analyzer

## **11.3 Measurement Equipment Used:**

| EQUIPMENT<br>TYPE | MFR             | MODEL<br>NUMBER | SERIAL<br>NUMBER | Characteristics | LAST<br>CAL. | CAL DUE.   |
|-------------------|-----------------|-----------------|------------------|-----------------|--------------|------------|
| Spectrum Analyzer | Rohde & Schwarz | FSV30           | 1321.3008K       | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |
| Coaxial Cable     | CDS             | 79254           | 46107086         | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |
| Antenna Connector | ARTHUR-YANG     | 2244-N1TG1      | N/A              | 10Hz-30GHz      | 05/23/2019   | 05/22/2020 |

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

## 11.4 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (1) (iii)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Since the Bluetooth technology uses 79 channels this period is calculated to be 31.6seconds. Refer to

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attached data chart.

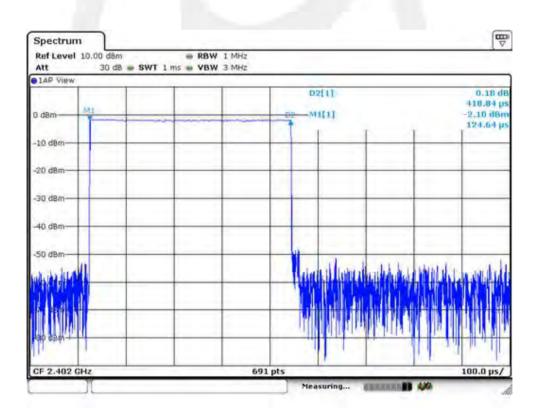
| Modulation:  | GFSK  | Test Date :   | May 14, 2020 |
|--------------|-------|---------------|--------------|
| Test By:     | Loren | Temperature : | <b>25</b> ℃  |
| Test Result: | PASS  | Humidity :    | 50 %         |

#### 11.5 Test result

| Mode | Number of transmission in a 31.6( 79 Hopping*0.4) | Length of<br>transmissions<br>time(msec) | Result<br>(msec) | Limit<br>(msec) |
|------|---|--|------------------|-----------------|
| DH1  | 1600/(2*79) x 31.6 = 320                          | 0.419                                    | 134.08           | 400             |
| DH3  | 1600/(4*79) x 31.6 =160                           | 1.678                                    | 268.48           | 400             |
| DH5  | 1600/(6*79) x 31.6 =106.67                        | 2.920                                    | 311.48           | 400             |

Remark: The results of worst cased was recorded.

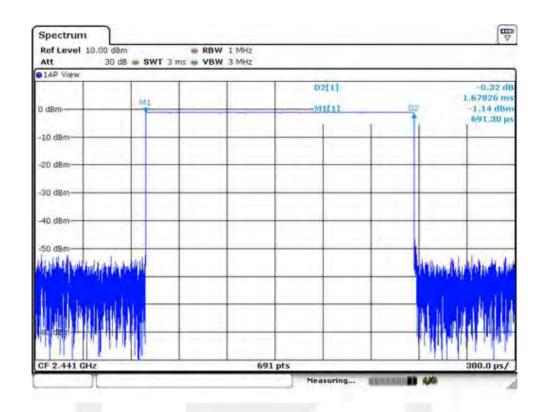
#### DH1:



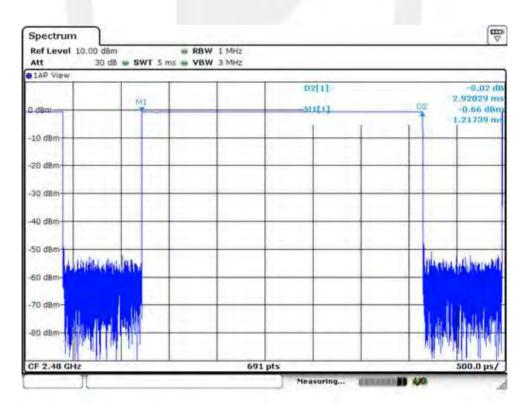
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DH3:



#### DH5:



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## 12. MAXIMUM PEAK OUTPUT POWER TEST

#### **12.1 Measurement Procedure**

a. Check the calibration of the measuring instrument(SA) using either an internal calibrator or a known signal from an external generator.

b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.

c. The center frequency of the spectrum analyzer is set to the fundamental frequency and using proper RBW and VBW setting.

d. Measure the captured power within the band and recording the plot.

e. Repeat above procedures until all frequencies required were complete.

## 12.2 Test SET-UP (Block Diagram of Configuration)



## **12.3 Measurement Equipment Used:**

| EQUIPMENT         | MFR             | MODEL      | SERIAL     | Characteristics | LAST       | CAL DUE.   |
|-------------------|-----------------|------------|------------|-----------------|------------|------------|
| TYPE              |                 | NUMBER     | NUMBER     |                 | CAL.       |            |
| Spectrum Analyzer | Rohde & Schwarz | FSV30      | 1321.3008K | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |
| Coaxial Cable     | CDS             | 79254      | 46107086   | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |
| Antenna Connector | ARTHUR-YANG     | 2244-N1TG1 | N/A        | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

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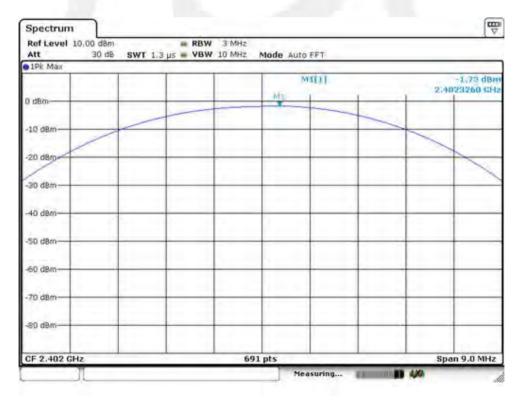


## 12.4Measurement Results:

Refer to attached data chart.

| Spectrum Detector: | PK    | Test Date :   | May 14, 2020 |
|--------------------|-------|---------------|--------------|
| Test By:           | Loren | Temperature : | <b>25</b> ℃  |
| Test Result:       | PASS  | Humidity :    | 50 %         |
| Modulation:        | GFSK  | -             |              |

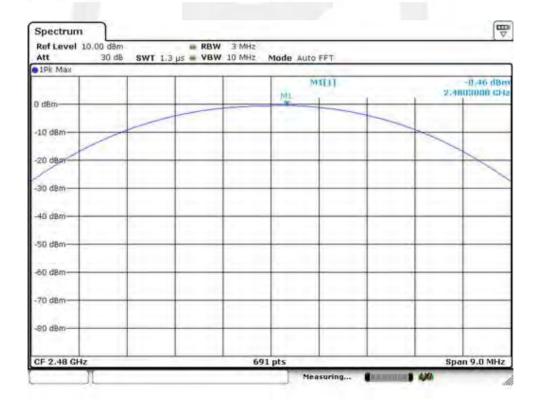
| Channel<br>number | Channel<br>Frequency<br>(MHz) | Peak Power<br>output(dBm) | Peak Power<br>output(mW) | Peak Power<br>Limit(mW) | Pass/Fail |
|-------------------|-------------------------------|---------------------------|--------------------------|-------------------------|-----------|
| 01                | 2402                          | -1.73                     | 0.671                    | 1000                    | PASS      |
| 40                | 2441                          | -0.95                     | 0.804                    | 1000                    | PASS      |
| 79                | 2480                          | -0.46                     | 0.899                    | 1000                    | PASS      |



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| Spectrum<br>Ref Level 10.00 di |                    |                |           |  |  | ₩<br>V                 |
|--------------------------------|--------------------|----------------|-----------|--|--|------------------------|
| Att 30<br>1Pk Max              | dB SWT 1.3 µs = VB | W 10 IMHZ MODE | Auto FFT  |  |  |                        |
|                                |                    | 841            | M1[1]     |  |  | -0.95 dBm<br>12740 GHz |
| 0 dBm                          |                    | -              |           | -  |  |                        |
| -10 dBm                        |                    |                | -         |  | <  |                        |
| -20 d8m                        |                    |                |           |  |  | 1                      |
| -30 dBm                        | -                  |                | -         | -  |  |                        |
| -40 dBm-                       |                    |                | -         | -  |  |                        |
| -S0 d8m                        |                    |                | -         | -  |  |                        |
| -60 dBm                        |                    |                |           | -  |  |                        |
| -70 dBm                        |                    |                | -         | -  | _  |                        |
| -SD dBm                        |                    |                | _         |  |  |                        |
| CF 2.441 GHz                   |                    | 691 pts        |           |  | Spar   | n 9.0 MHz              |
| T                              |                    |                | Measuring | annua an | the second s |                        |



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Report No.ES200508025W



Spectrum Detector: Test By: Test Result: Modulation: РК Loren PASS П/4-DQPSK Test Date : Temperature : Humidity : May 14, 2020 25 ℃ 50 %

| Channel<br>number | Channel<br>Frequency<br>(MHz) | Peak Power<br>output(dBm) | Peak Power<br>output(mW) | Peak Power<br>Limit(mW) | Pass/Fail |
|-------------------|-------------------------------|---------------------------|--------------------------|-------------------------|-----------|
| 01                | 2402                          | 0.49                      | 1.119                    | 125                     | PASS      |
| 40                | 2441                          | 1.20                      | 1.318                    | 125                     | PASS      |
| 79                | 2480                          | 1.67                      | 1.469                    | 125                     | PASS      |

| 1Pk Max  |      |   |    |       |          | _              |
|----------|------|---|----|-------|----------|----------------|
| 1        |      |   | ME | M1[1] | 2,402156 | 9 dBn<br>10 GH |
| 0 dBm-   |      |   |    |       |          | _              |
| 10 dBm   |      | - | -  |       |          |                |
| 28 0Bm   |      | - |    | -     |          | >              |
| -30 dBm  |      |   |    |       |          |                |
| -40 dBm- |      |   |    |       |          |                |
| -50 d8m  | - 1. |   |    |       |          | _              |
| -60 dBm  |      |   | -  |       |          |                |
| -70 dBm  |      |   |    |       |          |                |
| -so dBm  | -    |   |    |       |          |                |

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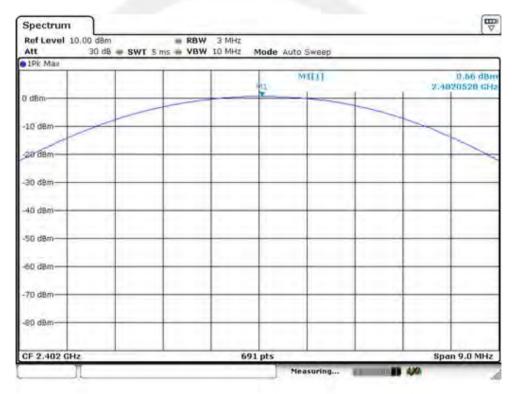
| Spectrum  |                |         |             |          |                    |                     |       | ₩<br>V   |
|---|----------------|---------|-------------|----------|--------------------|---------------------|-------|--|
| Ref Level 1   |                | Sad.    | = RBW       |          | and the second     |                     |       |  |
| Att   | 30 dB          | SWT 5   | s mis 🖷 VBW | 10 MHz 1 | Mode Auto Sweep    | -                   |       |  |
| 1Pk Max   |                |         | -           | -        | North 1            |                     |       | 1 nn dna   |
|   |                |         |             |          | MI                 |                     | 2.4   | 1,20 dBn<br>411690 GH:   |
| 0 dBm   |                | -       |             | -        |                    | -                   | 1     | 1  |
|   |                | -       | -           |          |                    |                     |       |  |
| 10 dBm  | /              | -       | -           |          |                    |                     |       |  |
| 1   |                |         |             | 1        |                    |                     |       | 1  |
| 20 dBm-   | _              | -       | -           |          |                    | _                   |       |  |
|   |                |         | 1           |          | 1                  |                     |       |  |
| 30 d8m-   |                | 1       |             | 1        |                    |                     |       | -  |
| SO GOM  |                |         |             |          |                    |                     |       |  |
| 40 dBm  |                |         |             |          |                    |                     |       |  |
| 40 dem  | 1              | Sec. 11 |             | 1.1.1.1  | 1                  |                     | (     |  |
|   |                |         |             | -        |                    | -                   |       |  |
| S0 d8m  |                |         |             |          |                    |                     |       |  |
|   |                |         |             |          |                    |                     |       |  |
| 60 dBm-   |                |         |             |          |                    |                     |       |  |
|   |                | 1.      |             | 1.       |                    |                     | 1.0   | -  |
| 70 dBm  |                |         |             |          |                    |                     |       |  |
| 1.2   |                |         | -           |          |                    |                     |       |  |
| 80 dBm  |                |         | 1           | -        |                    |                     | -     | 1  |
|   |                |         |             |          |                    |                     |       |  |
| CF 2.441 GH   | 1              |         |             |          |                    | _                   |       | an 9.0 MHz   |
|   | л              |         |             | 691      | l pts<br>Measuring | . <b>(</b> 1.1.111) |       |  |
| Spectrum<br>Ref Level 1   | )]<br>0.00 d8m |         | # RBW       | 3 MHz    | Measuring.         | . <b>B</b> anole    |       |  |
| Spectrum<br>Ref Level 1<br>Att  | )]<br>0.00 d8m |         |             | 3 MHz    |                    | . <b>C</b> armelia  |       |  |
| Spectrum<br>Ref Level 1<br>Att  | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         | . <b>P</b> arantin  |       | (The second seco |
| Spectrum<br>Ref Level 1<br>Att  | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         | . Cannolin          | 1 440 | 1.67 dBr   |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max   | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 | 1.67 dBr   |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max   | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 | 1.67 dBr   |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max   | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 | 1.67 dBr   |
| Spectrum<br>Ref Level 1<br>Att<br>19k Max   | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 | 1.67 dBr   |
| Spectrum<br>Ref Level 1<br>Att<br>19k Max<br>I dBm<br>10 dBm  | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 | 1.67 dBr   |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max<br>1 dBm<br>10 dBm  | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 |  |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max<br>1 dBm<br>10 dBm<br>20 dBm  | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 |  |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max<br>1 dBm<br>10 dBm<br>20 dBm  | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 |  |
| Spectrum<br>Ref Level 1<br>Att<br>11Pk Max<br>0 dBm<br>10 dBm<br>20 dBm<br>30 dBm   | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 440 | 1.67 dBr   |
| Spectrum<br>Ref Level 1<br>Att<br>11Pk Max<br>0 dBm<br>10 dBm<br>20 dBm<br>30 dBm   | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 449 | 1.67 dBr   |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max<br>1 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm                                | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 449 |  |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max<br>1 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm                                | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 449 |  |
| Spectrum<br>Ref Level 1<br>Att<br>11Pk Max<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm<br>50 dBm                    | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 449 |  |
| Spectrum<br>Ref Level 1<br>Att<br>11Pk Max<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm<br>50 dBm                    | )]<br>0.00 d8m |         | t mis 🖶 VBW | 3 MHz    | Measuring.         |                     | 1 449 |  |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm<br>60 dBm                     | )]<br>0.00 d8m |         |             | 3 MHz    | Measuring.         |                     | 1 449 |  |
| Spectrum  | )]<br>0.00 d8m |         | t mis 🖶 VBW | 3 MHz    | Measuring.         |                     | 1 449 |  |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm<br>50 dBm<br>60 dBm<br>70 dBm | )]<br>0.00 d8m |         | t mis a VBW | 3 MHz    | Measuring.         |                     | 1 449 |  |
| Spectrum<br>Ref Level 1<br>Att<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm<br>60 dBm                                | )]<br>0.00 d8m |         | t mis a VBW | 3 MHz    | Measuring.         |                     | 1 449 | 1.67 dBn   |
| Spectrum<br>Ref Level 1<br>Att<br>1Pk Max<br>1 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm<br>50 dBm<br>60 dBm<br>70 dBm  | )]<br>0.00 d8m |         | t mis a VBW | 3 MHz    | Measuring.         |                     | 1 449 |  |



| Spectrum Detector: | ΡK   |
|--------------------|------|
| Test By:           | Lore |
| Test Result:       | PAS  |
| Modulation:        | 8DF  |

K oren ASS DPSK Test Date : Temperature : Humidity : May 14, 2020 25 ℃ 50 %

| Channel<br>number | Channel<br>Frequency<br>(MHz) | Peak Power<br>output(dBm) | Peak Power<br>output(mW) | Peak Power<br>Limit(mW) | Pass/Fail |
|-------------------|-------------------------------|---------------------------|--------------------------|-------------------------|-----------|
| 01                | 2402                          | 0.66                      | 1.164                    | 125                     | PASS      |
| 40                | 2441                          | 1.35                      | 1.365                    | 125                     | PASS      |
| 79                | 2480                          | 1.82                      | 1.521                    | 125                     | PASS      |



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| Spectrum   | -          |            |        |                              |            |      | u<br>v<br>v                                 |
|--|------------|------------|--------|------------------------------|------------|------|---|
| Ref Level 10.0   |            |            |        |                              |            |      |   |
| Att<br>1Pk Max   | 30 08 - SW | 5 ms - VBW | 10 MH2 | Mode Auto Sweep              |            |      |   |
| LP & FIERD   |            |            |        | MILL                         |            |      | 1.35 dBn                                    |
|  |            |            |        | Ma                           |            | 2.44 | 19970 GH                                    |
| ) dBm  |            |            |        |                              | -          |      |   |
|  | -          | -          |        |                              |            |      |   |
| 10 dBm   |            |            | _      |                              |            |      |   |
|  | 5          |            |        |                              |            |      | ~   |
| 20 d8m   |            |            |        |                              |            |      | 1   |
| SCO GIDITI   |            |            |        |                              |            |      |   |
| -  |            |            |        |                              |            |      |   |
| 30 dBm   |            |            |        |                              |            |      |   |
| 20.00  |            |            |        |                              | 1.1        |      | -   |
| 40 dBm   |            |            |        |                              | -          |      |   |
|  |            |            |        |                              |            |      |   |
| -SD d8m-   |            |            | -      |                              | -          | -    |   |
|  |            |            |        |                              |            |      |   |
| 60 d8m-  |            | _          |        |                              |            | -    |   |
|  |            |            |        |                              |            |      |   |
| 70 dBm   |            | _          | -      |                              | -          | -    |   |
|  |            |            | 1      |                              |            |      | 1   |
| SD dBm   |            |            |        |                              |            | -    |   |
| op apin  |            |            |        |                              |            |      |   |
|  |            |            |        |                              |            |      | 0.00  |
|  | <u>ר</u>   |            | 69     | 1 pts<br>Measuring           | annun)     |      |   |
| Spectrum<br>Ref Level 10.0   |            | RBW        | 3 MHz  | Measuring                    | anna a     |      |   |
| Spectrum<br>Ref Level 10,0<br>Att  |            |            | 3 MHz  |                              | anna a     |      |   |
| Spectrum<br>Ref Level 10,0<br>Att  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep | . Constant |      | (T  |
| Spectrum   |            |            | 3 MHz  | Measuring                    |            | 490  | n 9.0 MHz<br>[<br>↓<br>1.82 dBn<br>99970 GH |
| Spectrum<br>Ref Level 10.0<br>Att<br>1Pk Max   |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>p1Pk Max  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10,0<br>Att<br>1Pk Max   |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10,0<br>Att<br>1Pk Max   |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>10 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>10 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>11 dBm<br>10 dBm<br>20 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>11 dBm<br>10 dBm<br>20 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>11Pk Max<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>11Pk Max<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm<br>50 dBm  |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>10 dBm<br>10 dBm<br>20 dBm<br>30 dBm<br>40 dBm<br>50 dBm  |            | r sms webw | 3 MHz  | Measuring                    |            | 490  | .82 dBn                                     |
| Spectrum           Ref Level 10.0           Att           10 dBm           10 dBm           20 dBm           30 dBm           30 dBm           50 dBm           60 dBm   |            |            | 3 MHz  | Measuring<br>Mode Auto Sweep |            | 490  | .82 dBn                                     |
| Spectrum<br>Ref Level 10.0<br>Att<br>1Pk Max<br>0 dBm<br>10 dBm<br>20 dBm<br>30 dBm  |            | r sms webw | 3 MHz  | Measuring                    |            | 490  | .82 dBn                                     |
| Spectrum           Ref Level 10.0           Att           10 dBm           10 dBm           20 dBm           30 dBm           30 dBm           30 dBm           50 dBm           30 dBm           40 dBm           50 dBm           70 dBm |            | r sms webw | 3 MHz  | Measuring                    |            | 490  | .82 dBn                                     |
| Spectrum           Ref Level 10.0           Att           10 dBm           10 dBm           20 dBm           30 dBm           30 dBm           50 dBm           60 dBm   |            | r sms webw | 3 MHz  | Measuring                    |            | 2:47 | .82 dBn                                     |
| Spectrum           Ref Level 10.0           Att           10 dBm           10 dBm           20 dBm           30 dBm           30 dBm           50 dBm           60 dBm           70 dBm  |            | r sms webw | 3 MHz  | Measuring                    |            | 490  | .82 dBn                                     |



# 13. Band EDGE test

### **13.1 Measurement Procedure**

## For Conducted Test

- 1. The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100KHz. The video bandwidth is set to 300KHz.
- 2. The spectrum from 30MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

| EMI Test Receiver | Setting  |
|-------------------|----------|
| Attenuation       | Auto     |
| RBW               | 100KHz   |
| VBW               | 300KHz   |
| Detector          | Peak     |
| Trace             | Max hold |

## For Radiated emission Test

The EUT was placed on a styrofoam table which is 1.5m above ground plane.

The measurement procedure at the ban edges was simplified by performing the measurement in just one plot. Both, the in-band-emission and the unwanted emission were be encompassed by the span. After trace stabilization, the maximum peak was be determined by a peak detector and the value was marked by an appropriate limit line. The second limit line, which is 20dB below the first, marks the limit for the emissions in the unrestricted band. A maximum-peak-detector marks the highest emission in the unrestricted band next to the band edge.

The measurements were performed at the lower end of the 2.4GHz band. Use the following spectrum analyzer settings:

For Restricted Band, When spectrum scanned above 1GHz setting resolution bandwidth 1MHz, video bandwidth 3MHz:

| EMI Test Receiver | Setting  |
|-------------------|----------|
| Attenuation       | Auto     |
| RBW               | 1MHz     |
| VBW               | 3MHz     |
| Detector          | Peak     |
| Trace             | Max hold |

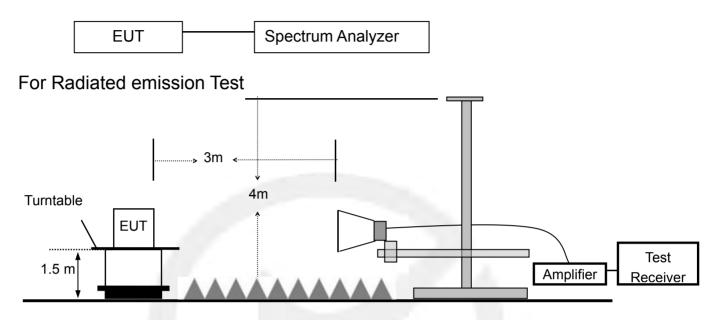
For Non-Restricted Band, When spectrum scanned above 1GHz setting resolution bandwidth 100KHz, video bandwidth 300KHz:

| EMI Test Receiver | Setting  |
|-------------------|----------|
| Attenuation       | Auto     |
| RBW               | 100KHz   |
| VBW               | 300KHz   |
| Detector          | Peak     |
| Trace             | Max hold |

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## **13.2 Test SET-UP (Block Diagram of Configuration)** For Conducted Test



## 13.3 Measurement Equipment Used:

## For Conducted Test

| Γ | EQUIPMENT         | MFR             | MODEL      | SERIAL     | Characteristics | LAST       | CAL DUE.   |
|---|-------------------|-----------------|------------|------------|-----------------|------------|------------|
|   | TYPE              |                 | NUMBER     | NUMBER     |                 | CAL.       |            |
|   | Spectrum Analyzer | Rohde & Schwarz | FSV30      | 1321.3008K | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |
|   | Coaxial Cable     | CDS             | 79254      | 46107086   | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |
|   | Antenna Connector | ARTHUR-YANG     | 2244-N1TG1 | N/A        | 10Hz-30GHz      | 05/23/2019 | 05/22/2020 |

Remark: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list. For Radiated emission Test

| Item | Equipment          | Manufacturer       | Model No.  | Serial No.       | Characteristics | Last Cal.  | Cal.<br>Interval |
|------|--------------------|--------------------|------------|------------------|-----------------|------------|------------------|
| 1    | Signal<br>Analyzer | Rohde &<br>Schwarz | FSV30      | 103040           | 9KHz-40GHz      | 05/23/2019 | 1 Year           |
| 2    | Horn Antenna       | Schwarzbeck        | BBHA9120D  | 9120D-12<br>72   | 1GHz-18GHz      | 05/23/2019 | 1 Year           |
| 3    | Power<br>Amplifier | LUNAR EM           | LNA1G18-40 | J1010000<br>0081 | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |
| 4    | Cable              | H+S                | CBL-26     | N/A              | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |
| 5    | Cable              | H+S                | CBL-26     | N/A              | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |
| 6    | Cable              | H+S                | CBL-26     | N/A              | 1GHz-26.5GHz    | 05/23/2019 | 1 Year           |

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## **13.4 Measurement Results:**

Refer to attached data chart.

| Spectrum Detector: | PK    | Test Date :   | May 14, 2020 |
|--------------------|-------|---------------|--------------|
| Test By:           | Loren | Temperature : | <b>25</b> ℃  |
| Test Result:       | PASS  | Humidity :    | 50 %         |

#### 1. Conducted Test

For Non-Hopping Mode:

| Frequency<br>(MHz) | Modulation | Peak Power Output(dBm) | Result of Band<br>edge(dBc) | Band edge<br>Limit(dBc) |
|--------------------|------------|------------------------|-----------------------------|-------------------------|
| 2397.32            | GFSK       | -3.98                  | 50.9                        | >20dBc                  |
| 2399.86            | pi/4-DQPSK | -3.96                  | 52.59                       | >20dBc                  |
| 2399.8             | 8DPSK      | -3.93                  | 51.76                       | >20dBc                  |
| 2484.56            | GFSK       | -0.97                  | 52.79                       | >20dBc                  |
| 2484.51            | pi/4-DQPSK | -1.04                  | 53.12                       | >20dBc                  |
| 2484.56            | 8DPSK      | -0.97                  | 52.79                       | >20dBc                  |

# Test plots of GFSK

| Att      |     | 15 dB | SWT 19 µs i             | VBW 300 kHz | Mode Auto FF | т     |  |
|----------|-----|-------|-------------------------|-------------|--------------|-------|--|
| 1Pk Ma   | ×   |       |                         |             |              |       |  |
| 0 dBm—   | +   |       |                         |             | D3[1]        | MI    | -50.90 d<br>-4,5010 MF<br>-3,98 dB<br>2,4019230 GF |
| -10 dBm- |     |       |                         | -           |              |       |  |
| -20 d8m- | +   | -     |                         | -           |              |       |  |
| -30 dBm- | +   | -     |                         | -           |              |       |  |
| -40 dBm- | +   |       |                         |             | X            |       |  |
| -50 d8m- | +   | _     | 03                      | DE          | 1            |       |  |
| -50 USm- | +   |       | 1 man                   | m           |              |       | 5-0  |
| -70 dBm- | +   |       |                         | -           |              | -     | _  |
| -80 dBm- | +   | -     |                         | -           |              |       |  |
| CF 2.4 ( | Hz  |       |                         | 691 pt      | s            |       | Span 10.0 MH:                                      |
| tarker   |     | A     |                         |             | Function     |       | ion Result   |
| Type M1  | Ket | 1     | X-value<br>2.401823 GHz | -3.98 dBm   | Function     | Funct | ION RESUIC   |
| D2       | MI  | 1     | -1.8234 MHz             | -50.44 dB   |              |       |  |
| D3       | M1  | 1     | -4.501 MHz              | -50,90 dB   |              |       |  |

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| Ref Level<br>Att | 15 di | a strate a second of the |           | Mode Auto FFT |      |                        |
|------------------|-------|--------------------------|-----------|---------------|------|------------------------|
| PiPk Max         | _     |                          |           | Balta         |      | F. 1. 10               |
| 1.1.1            | MI    |                          |           | D3[1]         |      | -52.79 d<br>-4.7020 MF |
| 0 dBm            | The   |                          |           | 347[1]        |      | -0.97 dB               |
|                  | 11    |                          |           | and a second  |      | 2.4798240 G            |
| -10 d8m-         | 1     | 5                        |           |               |      |                        |
| -20 d8m-         | -     | 4                        |           |               |      |                        |
| 20 00111         |       | N                        |           |               |      |                        |
| -30 d8m          | _     | 1                        | -         |               | -    |                        |
| 2                |       |                          |           |               |      |                        |
| -10 dem-         | _     |                          | -         |               | -    |                        |
|                  |       |                          |           |               |      |                        |
| -50 d8m-         |       | 1                        |           | 03            | 1 1  |                        |
| 10.0             |       |                          | mile      | and has       |      | al an and              |
| -60 dBm-         | -     |                          |           |               |      |                        |
| -70 d8m-         |       |                          |           |               |      |                        |
| -/u ubiii        |       |                          |           |               |      |                        |
| -80 dBm-         | _     |                          |           |               | -    |                        |
| (                |       |                          |           |               |      |                        |
| CF 2.4835        | GHz   | 1 1                      | 691 pts   | 1             |      | Span 10.0 MH           |
| Marker           |       |                          |           | A             |      |                        |
| Type   Ref       | Trc   | X-value                  | Y-value   | Function      | Fund | tion Result            |
| M1               | 1     | 2.479824 GHz             | -0.97 dBm |               | -    |                        |
| D2 M             | 1 1   | 3.6758 MHz               | -57.12 dB |               |      |                        |

# Test plots of pi/4-DQPSK

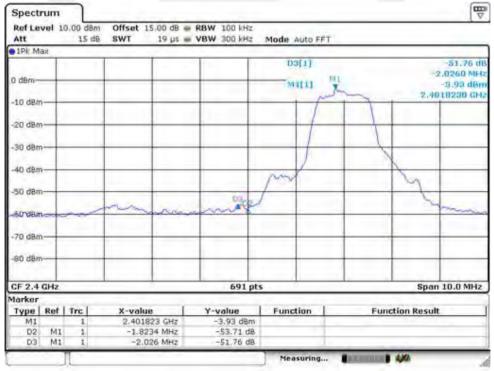
| Ref Level 1<br>Att | 0.00 dBm<br>15 dB |                           | VBW 300 kHz            | Mode Auto FFT | 4         |  |
|--------------------|-------------------|---------------------------|------------------------|---------------|-----------|--|
| 1Pk Max            |                   |                           |                        |               |           |  |
| 0 dBm              |                   |                           |                        | D3[1]         | MI Marine | -52,59 di<br>-1,9680 MH<br>-0,96 dBn<br>7,4018230 GH |
| -10 d8m-           |                   |                           |                        | 1             |           |  |
| -20 d8m            | -                 |                           | -                      |               |           |  |
| -30 d8m            | -                 |                           | -                      |               |           |  |
| -40 d8m            | -                 |                           | + +                    | not           |           | ~~   |
| -50 d8m            | _                 |                           | DEC                    |               |           |  |
| -60'd8m            | -                 | man                       | month                  |               | -         | m  |
| -70 dBm            |                   |                           |                        |               | -         | _  |
| -80 dBm            | -                 |                           |                        |               |           |  |
| CF 2.4 GHz         |                   |                           | 691 pt                 | 5             |           | Span 10.0 MHz  |
| Marker             |                   |                           | 10.0                   | 1             |           |  |
| Type   Ref         | Trc               | X-value                   | Y-value                | Function      | Funct     | ion Result   |
| MI                 | 1                 | 2.401823 GHz              | -3.96 dBm              |               |           |  |
| D2 M1<br>D3 M1     | 1                 | -1.8234 MHz<br>-1.968 MHz | -52.28 d8<br>-52.59 d8 |               |           |  |

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| Ref Leve<br>Att | 10.00 d8m<br>15 d8 |                         |                        | Mode Auto FFT | 4.   |
|-----------------|--------------------|-------------------------|------------------------|---------------|--|
| • 1Pk Max       |                    |                         |                        |               |  |
| 0 dBm           | IN1                |                         |                        | D3[1]         | -53.12 (<br>4.6090 Mi<br>-1.04 dB<br>2.4798240 G |
| -10 d8m-        | -                  | A                       |                        | 1             | 1 1 1  |
| -20 d8m-        |                    | 1                       |                        |               |  |
| -20 08117       |                    |                         |                        |               |  |
| -30 d8m         |                    |                         | -                      |               |  |
| n/              |                    | 1                       |                        |               |  |
| 40 dBm-         | -                  | 1 mg                    | -                      |               |  |
| -50 d8m-        | -                  |                         | -                      |               |  |
| -20.0600-       | 1                  | Ser                     | 0                      |               |  |
| -60 d8m-        | -                  |                         | minis                  |               | Mangara and                                      |
|                 |                    | The second second       | 1                      |               |  |
| -70 dBm-        | -                  | -                       | -                      |               |  |
| -90 dBm         |                    |                         |                        |               |  |
| -ou upin        |                    |                         |                        |               |  |
| CF 2.483        | 5 GHz              | <u> </u>                | 691 pts                |               | Span 10.0 MH                                     |
| Marker          |                    |                         |                        | 1             |  |
| Type   R        | ef   Trc           | X-value                 | Y-value                | Function      | Function Result                                  |
| MI              | 1                  | 2.479824 GHz            | -1.04 dBm              |               |  |
|                 | M1 1<br>M1 1       | 3.6758 MHz<br>4.689 MHz | -57.21 dB<br>-53.12 dB |               |  |
| 0.5             |                    | TOTAL PROPERTY OF       | Voltage UD             | Measuring     | 1  |

## **Test plots of 8DPSK**



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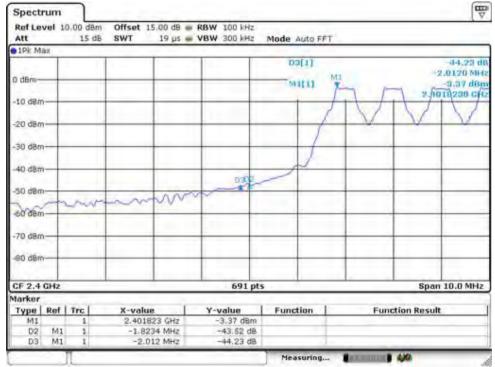
| Att                              | _        | 15 di           | SWT | 19 µs 🖷                       | VBW 300 kHz  | Mode Aut     | to FFT |      |            |  |
|----------------------------------|----------|-----------------|-----|-------------------------------|--|--------------|--------|------|------------|--|
| 0 d8m                            | T        | MJ-1            |     |                               |  | D3[1<br>31(1 |        | _    |            | -52.79 di<br>4.7020 MH<br>-0.97 dBn<br>798240 GH |
| -20 dBm<br>-30 dBm<br>-40 dBm-   |          |                 | E   | 1                             |  |              |        |      |            |  |
| -50 d8m-<br>-60 d8m-<br>-70 d8m- |          |                 |     |                               | The state of the s |              | m      |      | -          |  |
| -80 d8m-                         |          |                 |     |                               |  |              |        |      |            |  |
| CF 2.48                          | 35 G     | Hz              |     |                               | 691 pt   | s            |        | _    | Spar       | 10.0 MHz   |
| Marker<br>Type<br>M1<br>D2<br>D3 | M1<br>M1 | Trc  <br>1<br>1 | 3.6 | ue 0824 GHz 0758 MHz 0732 MHz | Y-value<br>-0.97 dBm<br>-56.60 dB<br>-52.79 dB   | Functio      | n      | Func | tion Resul |  |



## For Hopping Mode:

| Frequency<br>(MHz) | Modulation | Peak Power<br>Output(dBm) | Result of Band edge(dBc) | Band edge<br>Limit(dBc) |
|--------------------|------------|---------------------------|--------------------------|-------------------------|
| 2399.81            | GFSK       | -3.37                     | 44.23                    | >20dBc                  |
| 2398.84            | pi/4-DQPSK | -4                        | 51.93                    | >20dBc                  |
| 2397.84            | 8DPSK      | -3.98                     | 51.26                    | >20dBc                  |
| 2483.92            | GFSK       | -0.52                     | 54.1                     | >20dBc                  |
| 2484.5             | pi/4-DQPSK | -1.08                     | 53.81                    | >20dBc                  |
| 2484.51            | 8DPSK      | -1.08                     | 54                       | >20dBc                  |

## Test plots of GFSK



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| Att     | _     | 15 dB | SWT    | 19 µs = | VBW 300 k | Hz    | Mode Au  | to FFT | ·  |             |   |
|---------|-------|-------|--------|---------|-----------|-------|--|--------|----|-------------|---|
| 0 dam   |       | h     |        |         |           |       | nation of the second se |        |    | 2.4         | -54,10 d<br>4,0960 MF<br>-0.52 dB<br>1798240 GF |
| -10 dBm | 1     | 4     |        |         |           | -     | 1  |        |    | 1           |   |
| -20 dBm | 4     |       | 1      | -       | -         | -     | -  |        | -  | -           | -   |
| -30 dBm | +     | _     | 1      | -       | -         | -     | _  | _      |    | -           | -   |
| -40 dBm | -     | -     | 1      |         | -         | +     |  |        |    | -           |   |
| -50 d8m | +     | _     | -      | 1       | -         |       | oa i   |        | -  | -           | -   |
| -60 d8m | -     | _     | -      | -       | m         | and   | m  | 2      | m  | m           | -m  |
| -70 dBm | +     |       | -      | -       | -         |       | -  | _      | -  | -           | -   |
| -90 dBm | +     | -     |        | -       | -         | -     | _  |        | -  | -           | -   |
| CF 2.48 | 135 G | Hz    |        | -       | 691       | L pts |  |        |    | Spa         | in 10.0 MH:                                     |
| Marker  | not l | the l | X-valu |         | Y-value   | -     | Functio  | . 1    |    | nction Resu |   |
| Type M1 | REL   | 1     |        | 824 GHz | -0.52 d   | Bmi   | Functio  | m      | FU | nction kest | int.  |
| D2      | M1    | 1     | 3.6    | 758 MHz | -57.57    | dB    |  | -      |    |             |   |
| D3      | M1    | 1     | 4,     | 096 MHz | -54.10    | dB    |  |        |    |             |   |

# Test plots of pi/4-DQPSK

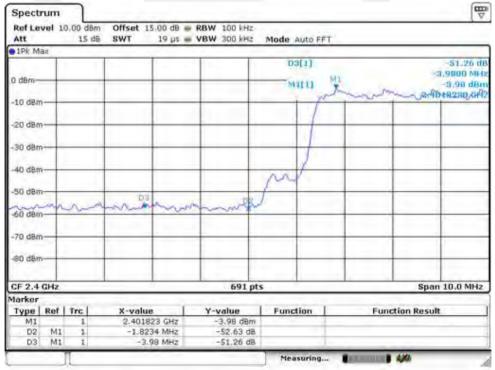
| Att      | /ei 10 | 0.00 d8m<br>15 d8 | Offset 15.00 dB =<br>SWT 19 µs =       | RBW 100 kHz<br>VBW 300 kHz | Mode Auto FFT | 1     |  |
|----------|--------|-------------------|--|----------------------------|---------------|-------|--|
| • 1Pk Ma | 3X     |                   |  |                            |               |       |  |
| 0 dBm—   |        |                   |  |                            | D3[1]         | Jan m | 51,93 di<br>2,9810 MH<br>-4,00 dBn<br>-4,00 dBn<br>-4,00 dBn |
| -10 dBm  |        |                   |  |                            |               |       |  |
| -20 dBm  | -      | _                 |  | -                          |               |       |  |
| -30 dBm  | -      | -                 |  | -                          |               |       |  |
| -40 dBm  | -      | -                 |  |                            | m             | -     |  |
| -50 d8m  | _      | _                 |  |                            | Jan           | -     |  |
| -60 dBm  | h      | John              | ······································ | 2 minut                    |               |       |  |
|          |        |                   |  |                            |               |       |  |
| -70 dBm  | -      |                   |  | -                          |               | -     |  |
| -S0 dBm  | -      | -                 |  | -                          |               | -     |  |
|          |        |                   |  |                            |               |       |  |
| CF 2.4   | GHz    |                   |  | 691 pt                     | 5             |       | Span 10.0 MHz  |
| Marker   |        |                   |  |                            |               |       |  |
| Type M1  | Ref    |                   | 2.401823 GHz                           | -4.00 dBm                  | Function      | Fund  | tion Result  |
| D2       | MI     | 1                 | -1.8234 MHz                            | -52.16 d8                  |               | -     |  |
| D3       | MI     | 1                 | -2.981 MHz                             | -51,93 dB                  |               |       |  |

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| Att           | 10.00 d8n<br>15 d |              | Contract and a second | Mode Auto FFT | 1     |                       |
|---------------|-------------------|--------------|-----------------------|---------------|-------|-----------------------|
| 1Pk Max       |                   |              |                       |               |       |                       |
| Mi            | 1                 |              |                       | D3[1]         |       | -53,81 c<br>5,6730 Mi |
| 0 48m-        | (Phone)           |              |                       | MILLI         |       | -1.08 dB              |
| 10 100        | -                 | 1            |                       |               |       | 2.4788260 G           |
| -10 d8m-      |                   |              |                       |               |       |                       |
| -20 d8m-      |                   | 1            |                       |               |       |                       |
| 20 0011       |                   |              |                       |               |       |                       |
| -30 d8m-      |                   | 1            | -                     |               | + +   |                       |
|               |                   |              |                       |               |       |                       |
| -40 dBm       |                   |              | -                     |               |       |                       |
|               |                   |              |                       |               |       |                       |
| -50 d8m       |                   | hin          | manie                 | DB            |       |                       |
| -60 d8m       | _                 |              | man                   | monin         | mm    |                       |
|               |                   |              |                       |               |       |                       |
| -70 dBm-      |                   |              | -                     |               | -     |                       |
| 1.200.000     |                   |              |                       |               |       |                       |
| -80 d8m       |                   |              |                       |               |       |                       |
| 1.            |                   |              | -                     |               | 1. A  |                       |
| CF 2.4835     | GHz               |              | 691 pts               |               |       | Span 10.0 MH          |
| Marker        |                   |              |                       |               |       | 1110 C                |
| Type Re<br>MI | f Trc             | 2.478826 GHz | Y-value<br>-1.08 dBm  | Function      | Funct | ion Result            |
|               | 11 1              | 4.6744 MHz   | -57.34 d8             |               |       |                       |
|               | 11 1              | 5.673 MHz    | -53.81 dB             |               |       |                       |

## Test plots of 8DPSK



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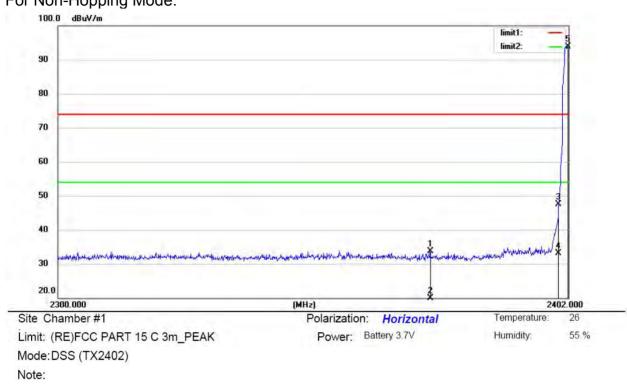
| Att            | A61 T    | 0.00 d8m<br>15 d8 |         |       | RBW 100 kHz<br>VBW 300 kHz          | Mode | Auto FFT | c'  |            |   |
|----------------|----------|-------------------|---------|-------|-------------------------------------|------|----------|-----|------------|---|
| • 1Pk M        | ах       |                   |         | _     |                                     |      |          |     |            |   |
| 0 dBm-         | ~        | Mi                | -       |       |                                     |      | 3[1]     |     |            | -54.00 d<br>4,6090 MH<br>-1,08 dBr<br>798240 GH |
| -10 dBm        | -        |                   | A       |       |                                     | -    | 1        | 1   |            | A APR - IN MA                                   |
| -20 d8m        | +        | -                 | 1       | _     | -                                   | _    | -        | -   |            | -   |
| -30 dBm        | -        | _                 | 1       | _     |                                     |      |          |     |            | -   |
| -40 d8m        |          |                   | has     |       |                                     |      |          |     |            |   |
| -50 d8n        |          |                   |         |       |                                     |      |          |     |            |   |
| -60 dBn        |          | 1                 |         | his   | mar                                 | mar  | in       | in  | m          | m   |
| -50 000        |          |                   |         |       |                                     |      |          |     | -          | -   |
| -70 dBn        | -        |                   | -       | -     | + +                                 | -    | -        | -   |            |   |
| -S0 dBm        | -        | -                 |         |       | -                                   | _    | -        |     |            | -   |
| CF 2.4         | 835 G    | Hz                |         | -     | 691 pt                              | 5    |          | -   | Spa        | n 10.0 MHz                                      |
| larker         |          |                   |         |       |                                     |      |          |     |            |   |
| Туре           | Ref      |                   | X-value |       | Y-value                             | Fund | tion     | Fun | tion Resul | lt  |
| D2             | MI       | 1                 | 3.675   | 8 MHz | -57.71 d8                           | _    |          |     |            |   |
| M1<br>D2<br>D3 | MI<br>MI | 1                 |         |       | -1.08 dBm<br>-57.71 dB<br>-54.00 dB | 1 10 | asuring  | -   | 430        | -   |

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Report No.ES200508025W



#### 2. Radiated emission Test Worst test modulation GFSK For Non-Hopping Mode:



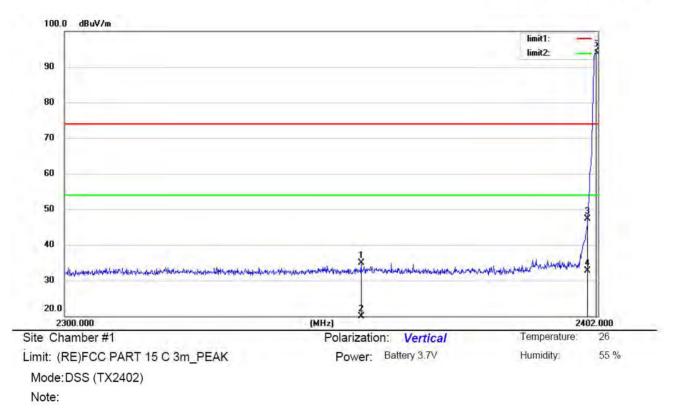
| No. | Mk. | . Freq.  | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|-----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |     | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   |     | 2373.950 | 54.70            | -21.00            | 33.70            | 74.00  | -40.30 | peak     |                   | 0               |         |
| 2   |     | 2373.950 | 38.54            | -21.00            | 17.54            | 54.00  | -36.46 | AVG      |                   | 0               |         |
| 3   | 2   | 2400.000 | 68.52            | -20.93            | 47.59            | 74.00  | -26.41 | peak     |                   | 0               |         |
| 4   |     | 2400.000 | 54.10            | -20.93            | 33.17            | 54.00  | -20.83 | AVG      |                   | 0               |         |
| 5   | *   | 2401.796 | 114.90           | -20.93            | 93.97            | 74.00  | 19.97  | peak     |                   | 0               |         |

\*:Maximum data x:Over limit 1:over margin

Operator: Lian

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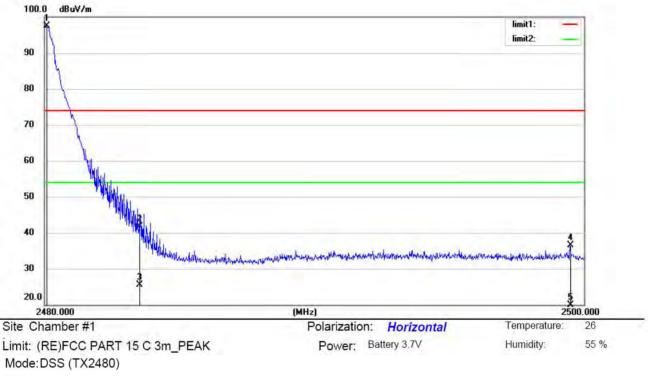
| No. | Mk | . Freq.  | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   | :        | Antenna<br>Height | Table<br>Degree |         |
|-----|----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |    | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   |    | 2356.202 | 54.98            | -20.04            | 34.94            | 74.00  | -39.06 | peak     |                   | 0               |         |
| 2   |    | 2356.202 | 37.15            | -20.04            | 17.11            | 54.00  | -36.89 | AVG      |                   | 0               |         |
| 3   |    | 2400.000 | 67.12            | -19.77            | 47.35            | 74.00  | -26.65 | peak     |                   | 0               |         |
| 4   |    | 2400.000 | 52.44            | -19.77            | 32.67            | 54.00  | -21.33 | AVG      |                   | 0               |         |
| 5   | *  | 2401.592 | 114.03           | -19.76            | 94.27            | 74.00  | 20.27  | peak     |                   | 0               |         |

\*:Maximum data x:Over limit !:over margin

Operator: Lian

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Note:

| No. | Mk | . Freq.  | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |    | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   | *  | 2480.060 | 118.21           | -20.71            | 97.50            | 74.00  | 23.50  | peak     |                   | 0               |         |
| 2   |    | 2483.500 | 62.49            | -20.72            | 41.77            | 74.00  | -32.23 | peak     |                   | 0               |         |
| 3   |    | 2483.500 | 46.25            | -20.72            | 25.53            | 54.00  | -28.47 | AVG      |                   | 0               |         |
| 4   |    | 2499.480 | 57.22            | -20.66            | 36.56            | 74.00  | -37.44 | peak     |                   | 0               |         |
| 5   | 3  | 2499.480 | 40.15            | -20.66            | 19.49            | 54.00  | -34.51 | AVG      |                   | 0               |         |

\*:Maximum data x:Over limit !:over margin

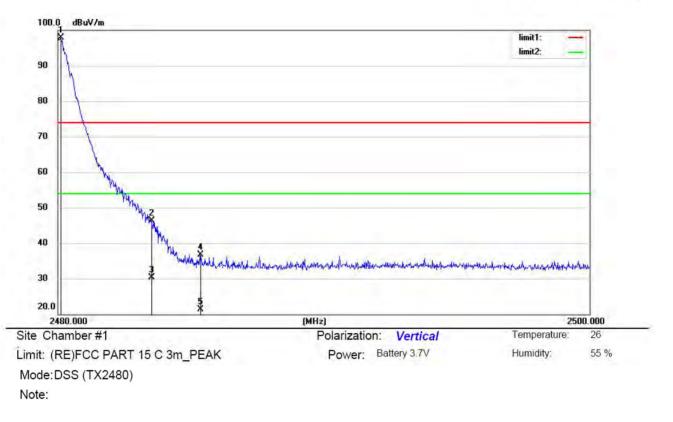
Operator: Lian

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| No. | Mk  | . Freq.  | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|-----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |     | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   | *   | 2480.100 | 117.22           | -19.28            | 97.94            | 74.00  | 23.94  | peak     |                   | 0               |         |
| 2   |     | 2483.500 | 65.64            | -19.27            | 46.37            | 74.00  | -27.63 | peak     |                   | 0               |         |
| 3   |     | 2483.500 | 49.58            | -19.27            | 30.31            | 54.00  | -23.69 | AVG      |                   | 0               |         |
| 4   |     | 2485.340 | 56.03            | -19.25            | 36.78            | 74.00  | -37.22 | peak     |                   | 0               |         |
| 5   | i i | 2485.340 | 40.50            | -19.25            | 21.25            | 54.00  | -32.75 | AVG      |                   | 0               |         |

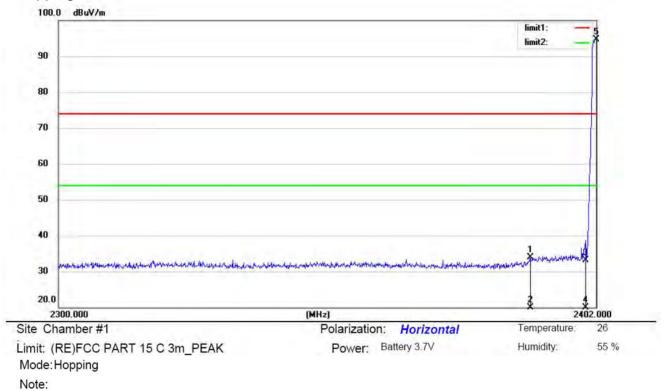
\*:Maximum data x:Over limit 1:over margin

Operator: Lian

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#### For Hopping Mode:



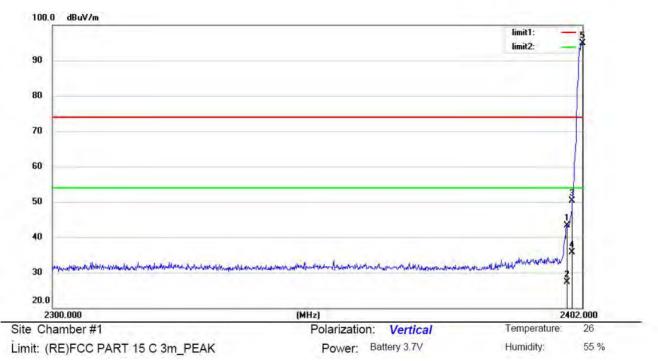
| No. | Mk | . Freq.  | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |    | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   |    | 2389.250 | 54.77            | -20.96            | 33.81            | 74.00  | -40.19 | peak     |                   | 0               |         |
| 2   |    | 2389.250 | 38.15            | -20.96            | 17.19            | 54.00  | -36.81 | AVG      |                   | 0               |         |
| 3   | ş  | 2400.000 | 54.05            | -20.93            | 33.12            | 74.00  | -40.88 | peak     |                   | 0               |         |
| 4   | 8  | 2400.000 | 37.89            | -20.93            | 16.96            | 54.00  | -37.04 | AVG      |                   | 0               |         |
| 5   | *  | 2402.000 | 115.65           | -20.93            | 94.72            | 74.00  | 20.72  | peak     |                   | 0               |         |

\*:Maximum data x:Over limit 1:over margin

Operator: Lian

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Mode:Hopping Note:

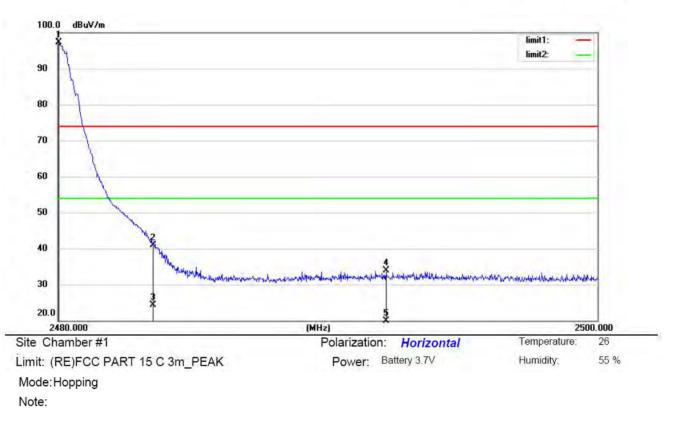
| No. | Mk. | Freq.    | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|-----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |     | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   |     | 2398.940 | 64.14            | -20.93            | 43.21            | 74.00  | -30.79 | peak     |                   | 0               |         |
| 2   |     | 2398.940 | 48.15            | -20.93            | 27.22            | 54.00  | -26.78 | AVG      |                   | 0               |         |
| 3   |     | 2400.000 | 71.15            | -20.93            | 50.22            | 74.00  | -23.78 | peak     |                   | 0               |         |
| 4   |     | 2400.000 | 56.69            | -20.93            | 35.76            | 54.00  | -18.24 | AVG      |                   | 0               |         |
| 5   | *   | 2401.898 | 115.80           | -20.93            | 94.87            | 74.00  | 20.87  | peak     |                   | 0               |         |

\*:Maximum data x:Over limit 1:over margin

Operator: Lian

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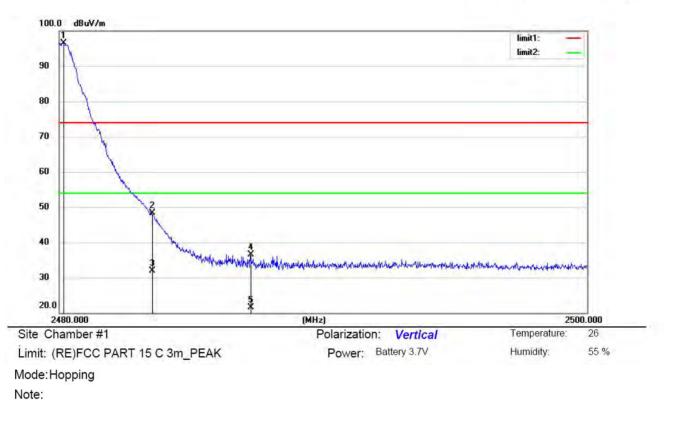
| No. | Mk | . Freq.  | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
| (†  |    | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   | *  | 2480.020 | 117.97           | -20.71            | 97.26            | 74.00  | 23.26  | peak     |                   | 0               |         |
| 2   |    | 2483.500 | 61.72            | -20.72            | 41.00            | 74.00  | -33.00 | peak     |                   | 0               |         |
| 3   |    | 2483.500 | 45.12            | -20.72            | 24.40            | 54.00  | -29.60 | AVG      |                   | 0               |         |
| 4   |    | 2492.160 | 54.54            | -20.69            | 33.85            | 74.00  | -40.15 | peak     |                   | 0               |         |
| 5   |    | 2492.160 | 38.14            | -20.69            | 17.45            | 54.00  | -36.55 | AVG      |                   | 0               |         |

\*:Maximum data x:Over limit I:over margin

Operator: Lian

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| No. | Mk | . Freq.  | Reading<br>Level | Correct<br>Factor | Measure-<br>ment | Limit  | Over   |          | Antenna<br>Height | Table<br>Degree |         |
|-----|----|----------|------------------|-------------------|------------------|--------|--------|----------|-------------------|-----------------|---------|
|     |    | MHz      | dBuV             | dB                | dBuV/m           | dBuV/m | dB     | Detector | cm                | degree          | Comment |
| 1   | *  | 2480.160 | 115.74           | -19.28            | 96.46            | 74.00  | 22.46  | peak     |                   | 0               |         |
| 2   |    | 2483.500 | 67.62            | -19.27            | 48.35            | 74.00  | -25.65 | peak     |                   | 0               |         |
| 3   |    | 2483.500 | 51.20            | -19.27            | 31.93            | 54.00  | -22.07 | AVG      |                   | 0               |         |
| 4   |    | 2487.240 | 55.65            | -19.24            | 36.41            | 74.00  | -37.59 | peak     |                   | 0               |         |
| 5   |    | 2487.240 | 40.69            | -19.24            | 21.45            | 54.00  | -32.55 | AVG      |                   | 0               |         |

\*:Maximum data x:Over limit 1:over margin

Operator: Lian

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# 14. Antenna Application

## 14.1 Antenna requirement

The EUT'S antenna is met the requirement of FCC part 15C section 15.203 and 15.247.

FCC part 15C section 15.247 requirements:

Systems operating in the 2402-2480MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

## 14.2 Result

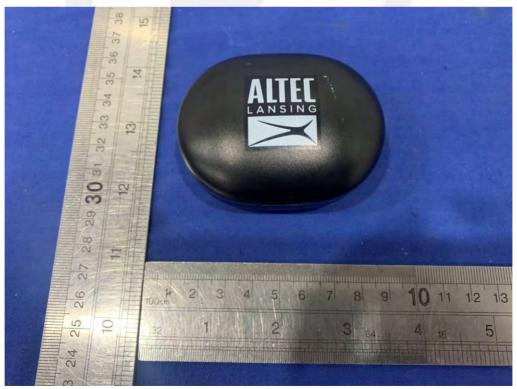
The EUT's antenna, permanent attached antenna, used a PCB antenna and integrated on PCB, The antenna's gain is 0 Bi and meets the requirement.





# 15. Photos of EUT





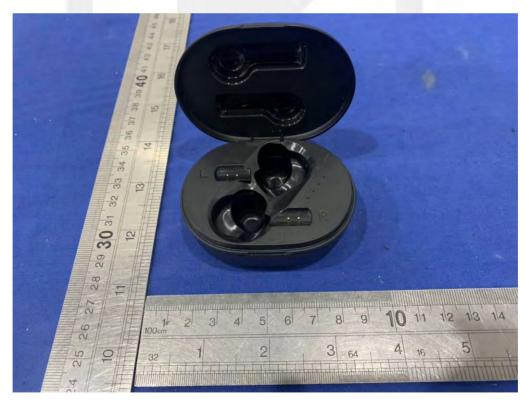
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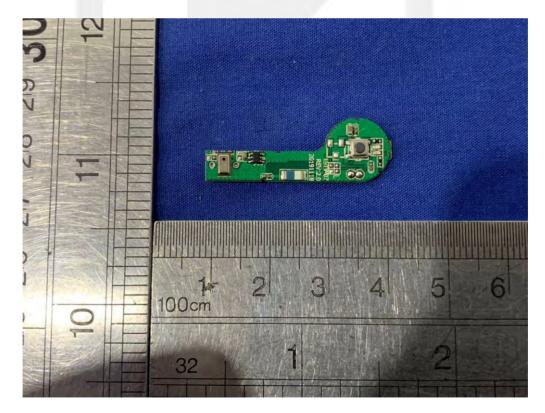
Report No.ES200508025W



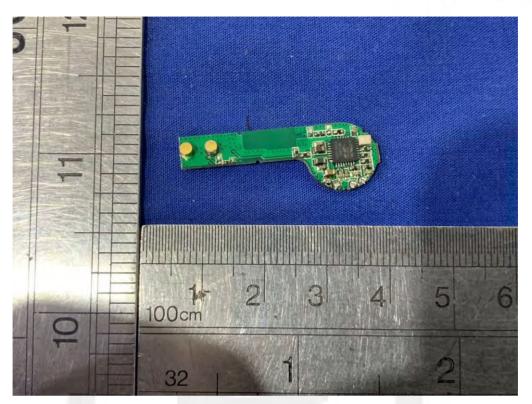


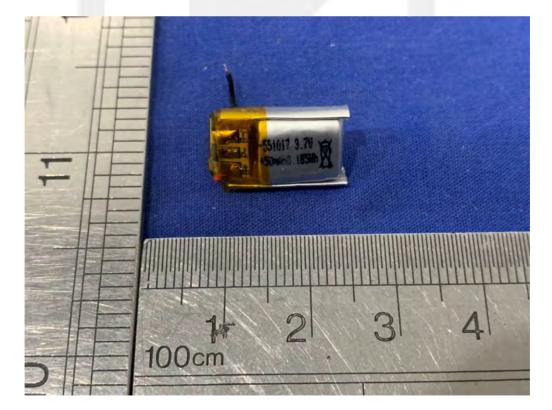
















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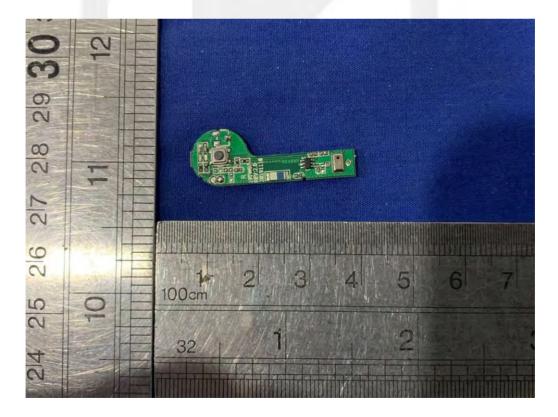
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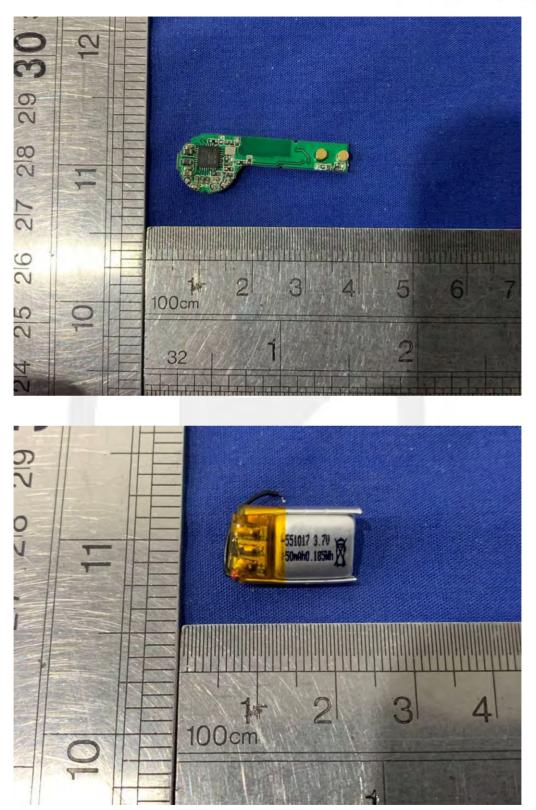












\*\*\* End of Report \*\*\*

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Report No.ES200508025W



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