



**Shenzhen CTA Testing Technology Co., Ltd.**

Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, China

## FCC PART 15 SUBPART C TEST REPORT FCC PART 15.247

Report Reference No.....: CTA24051700201

FCC ID.....: 2BGZJ-CUBEMAX

Compiled by

( position+printed name+signature)...: File administrators Jinghua Xiao

*Jinghua Xiao*

Supervised by

( position+printed name+signature)...: Test Engineer Lushan Kong

*Lushan Kong*

Approved by

( position+printed name+signature)...: Manager Eric Wang



Date of issue.....: May. 31, 2024

**Representative Laboratory Name.:** Shenzhen CTA Testing Technology Co., Ltd.

Address .....: Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, China

**Applicant's name.....:** SHENZHEN MOREJOY INNOVATION TECHNOLOGY CO.,LTD

Address .....: 1907A6K, International Culture Building, No. 3039, Shennan Middle Road, Funan Community, Futian Street, Futian District, Shenzhen, China

**Test specification .....**

Standard .....: **FCC Part 15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz**

TRF Originator.....: Shenzhen Global Test Service Co.,Ltd.

Master TRF.....: Dated 2014-12

**Shenzhen CTA Testing Technology Co., Ltd. All rights reserved.**

This publication may be reproduced in whole or in part for non-commercial purposes as long as the Shenzhen CTA Testing Technology Co., Ltd. is acknowledged as copyright owner and source of the material. Shenzhen CTA Testing Technology Co., Ltd. takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

**Test item description .....** projector

Trade Mark .....: Morejoy

Manufacturer .....: Chongqing Unication Electronic Technology Co., Ltd.

Model/Type reference .....: CUBE MAX

List Models .....: N/A

Modulation Type.....: GFSK,  $\pi/4$ -DQPSK, 8-DPSK

Operation Frequency.....: From 2402MHz to 2480MHz

Hardware Version .....: N/A

Software Version .....: N/A

Rating .....: AC 100-240V, 50/60Hz, 1.5A, 75W

Result .....: **PASS**

TEST REPORT

|                   |                |               |
|-------------------|----------------|---------------|
| Test Report No. : | CTA24051700201 | May. 31, 2024 |
|                   |                | Date of issue |

Equipment under Test : projector

Model /Type : CUBE MAX

Listed model : N/A

**Applicant** : **SHENZHEN MOREJOY INNOVATION TECHNOLOGY CO.,LTD**

Address : 1907A6K, International Culture Building, No. 3039, Shennan Middle Road, Funan Community, Futian Street, Futian District, Shenzhen, China

**Manufacturer** : **Chongqing Unication Electronic Technology Co., Ltd.**

Address : 2nd Floor, Building 2, Mengxun, No. 6, Electromechanical Road, Chayuan New District, Nan'an District, Chongqing

|              |      |
|--------------|------|
| Test Result: | PASS |
|--------------|------|

The test report merely corresponds to the test sample.  
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

## Contents

|  |           |
|--|-----------|
| <b>1. TEST STANDARDS .....</b>   | <b>4</b>  |
| <b>2. SUMMARY .....</b>  | <b>5</b>  |
| 2.1. General Remarks .....   | 5         |
| 2.2. Product Description .....   | 5         |
| 2.3. Equipment Under Test .....  | 5         |
| 2.4. Short description of the Equipment under Test (EUT) .....                 | 7         |
| 2.5. EUT operation mode .....  | 7         |
| 2.6. Block Diagram of Test Setup .....   | 8         |
| 2.7. Related Submittal(s) / Grant (s) .....                                    | 8         |
| 2.8. EUT Exercise Software .....   | 8         |
| 2.9. Special Accessories .....   | 8         |
| 2.10. External I/O Cable .....   | 8         |
| 2.11. Modifications .....  | 8         |
| <b>3. TEST ENVIRONMENT .....</b>   | <b>9</b>  |
| 3.1. Address of the test laboratory .....                                      | 9         |
| 3.2. Test Facility .....   | 9         |
| 3.3. Environmental conditions .....  | 9         |
| 3.4. Statement of the measurement uncertainty .....                            | 9         |
| 3.5. Summary of measurement results .....                                      | 10        |
| 3.6. Equipments Used during the Test.....                                      | 11        |
| <b>4. TEST CONDITIONS AND RESULTS .....</b>                                    | <b>12</b> |
| 4.1. AC Power Conducted Emission .....   | 12        |
| 4.2. Radiated Emission .....   | 15        |
| 4.3. Maximum Peak Output Power .....   | 20        |
| 4.4. 99% and 20dB Bandwidth .....  | 21        |
| 4.5. Frequency Separation .....  | 22        |
| 4.6. Conducted Spurious Emissions and Band Edge Compliance of RF Emission..... | 23        |
| 4.7. Number of hopping frequency .....   | 25        |
| 4.8. Time Of Occupancy(Dwell Time) .....                                       | 26        |
| 4.9. Pseudorandom Frequency Hopping Sequence .....                             | 27        |
| 4.10. Antenna Requirement .....  | 28        |
| <b>5. TEST SETUP PHOTOS OF THE EUT.....</b>                                    | <b>29</b> |
| <b>6. EXTERNAL AND INTERNAL PHOTOS OF THE EUT .....</b>                        | <b>31</b> |
| 6.1. External photos of the EUT .....  | 31        |
| 6.2. Internal photos of the EUT .....  | 35        |

## 1. TEST STANDARDS

The tests were performed according to following standards:

[FCC Rules Part 15.247](#): Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

[ANSI C63.10-2020](#): American National Standard for Testing Unlicensed Wireless Devices

[KDB 558074 D01 15.247 Meas Guidance](#): Digital Transmission Systems (DTS) and Frequency Hopping measurement procedures

## 2. SUMMARY

### 2.1. General Remarks

|                                |   |               |
|--------------------------------|---|---------------|
| Date of receipt of test sample | : | May. 14, 2024 |
|                                |   |               |
| Testing commenced on           | : | May. 15, 2024 |
|                                |   |               |
| Testing concluded on           | : | May. 31, 2024 |

### 2.2. Product Description

|                          |   |
|--------------------------|---|
| Product Name:            | projector   |
| Trade Mark:              | N/A   |
| Model/Type reference:    | CUBE MAX  |
| List Model:              | N/A   |
| Model Declaration        | N/A   |
| Power supply:            | AC 100-240V, 50/60Hz, 1.5A, 75W   |
| Hardware Version         | N/A   |
| Software Version         | N/A   |
| Sample ID                | CTA240517002-S0001-1#, CTA240517002-S0001-2#  |
| Bluetooth                |   |
| Frequency Range          | 2402MHz ~ 2480MHz   |
| Channel Number           | 79 channels for Bluetooth (DSS)<br>40 channels for Bluetooth (DTS)  |
| Channel Spacing          | 1MHz for Bluetooth (DSS)<br>2MHz for Bluetooth (DTS)  |
| Modulation Type          | GFSK, $\pi/4$ -DQPSK, 8-DPSK for Bluetooth (DSS)<br>GFSK for Bluetooth (DTS)  |
| 2.4GWLAN                 |   |
| WLAN Operation frequency | IEEE 802.11b:2412-2462MHz<br>IEEE 802.11g:2412-2462MHz<br>IEEE 802.11n HT20:2412-2462MHz<br>IEEE 802.11n HT40:2422-2452MHz<br>IEEE 802.11ax HE20:2412-2462MHz<br>IEEE 802.11ax HE40:2422-2452MHz  |
| WLAN Modulation Type     | IEEE 802.11b: DSSS(CCK,DQPSK,DBPSK)<br>IEEE 802.11g: OFDM(64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11n HT20: OFDM (64QAM, 16QAM, QPSK,BPSK)<br>IEEE 802.11n HT40: OFDM (64QAM, 16QAM, QPSK,BPSK)<br>IEEE 802.11ax HE20: OFDMA (1024QAM,256QAM,64QAM, 16QAM, QPSK,BPSK)<br>IEEE 802.11ax HE40: OFDMA (1024QAM,256QAM,64QAM, 16QAM, QPSK,BPSK) |
| Channel number:          | 11 Channel for IEEE 802.11b/g/n/ax (HT20)<br>7 Channel for IEEE 802.11n/ax (HT40)   |
| Channel separation:      | 5MHz  |
| WIFI (5.2G/5.8G Band)    |   |
| Frequency Range          | 5180-5240MHz/ 5745MHz to 5825MHz  |
| Channel Number           | 4 Channels for 20MHz bandwidth(5180-5240MHz)<br>5 channels for 20MHz bandwidth(5745-5825MHz)<br>2 channels for 40MHz bandwidth(5190~5230MHz)<br>2 channels for 40MHz bandwidth(5755~5795MHz)  |
| Modulation Type          | IEEE 802.11a: OFDM (64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11n HT20: OFDM (64QAM, 16QAM, QPSK, BPSK)   |

|                     |  |
|---------------------|--|
|                     | IEEE 802.11n HT40: OFDM (64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11ac VHT20: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11ac VHT40: OFDM (256QAM, 64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11ax HE20: OFDMA (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK)<br>IEEE 802.11ax HE40: OFDMA (1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK) |
| Antenna Description | Two Internal antenna respectively. WLAN not support 2*2MIMO technology.<br>ANT0 used for BT TX/RX, -1.22 dBi(Max.)<br>ANT1 used for WIFI TX/RX, 1.41 dBi(Max.) for 2.4G WLAN and 2.39dBi (Max.) for 5G WLAN  |

## 2.3. Equipment Under Test

### Power supply system utilised

|                      |   |                       |                                  |                                  |           |
|----------------------|---|-----------------------|----------------------------------|----------------------------------|-----------|
| Power supply voltage | : | <input type="radio"/> | 230V/ 50 Hz                      | <input checked="" type="radio"/> | 120V/60Hz |
|                      |   | <input type="radio"/> | 12 V DC                          | <input type="radio"/>            | 24 V DC   |
|                      |   | <input type="radio"/> | Other (specified in blank below) |                                  |           |

AC 120.0V

## 2.4. Short description of the Equipment under Test (EUT)

This is a projector.

For more details, refer to the user's manual of the EUT.

## 2.5. EUT operation mode

The Applicant provides communication tools software to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing .There are 79 channels provided to the EUT.

Channel 00/39/78 was selected to test.

| Mode of Operations     | Frequency Range<br>(MHz) | Data Rate<br>(Mbps) |
|------------------------|--------------------------|---------------------|
| (BDR/EDR)              | 2402                     | 1/2/3               |
|                        | 2441                     | 1/2/3               |
|                        | 2480                     | 1/2/3               |
| For Conducted Emission |                          |                     |
| Test Mode              |                          | TX Mode             |
| For Radiated Emission  |                          |                     |
| Test Mode              |                          | TX Mode             |

| Channel   | Frequency (MHz) | Channel   | Frequency (MHz) |
|-----------|-----------------|-----------|-----------------|
| <b>00</b> | <b>2402</b>     | 40        | 2442            |
| 01        | 2403            | 41        | 2443            |
| 02        | 2404            | 42        | 2444            |
| --        | --              | --        | --              |
| --        | --              | --        | --              |
| <b>38</b> | 2440            | <b>78</b> | <b>2480</b>     |
| 39        | 2441            |           |                 |

AC conducted emission pre-test at both at AC 120V/60Hz and AC 240V/50Hz modes, recorded worst case(AC 120V/60Hz).

Worst-case mode and channel used for 150 KHz-30 MHz power line conducted emissions was the mode and channel with the highest output power that was determined to be TX (1Mbps).

Worst-case mode and channel used for 9 KHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be TX(1Mbps-MCH).

## 2.6. Block Diagram of Test Setup



## 2.7. Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for **FCC ID: 2BGZJ-CUBEMAX** filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

## 2.8. EUT Exercise Software

The system enters the engineering mode through the instructions provided by the application (MTK Mode), tests under continuous transmission conditions, and changes the test channel.

## 2.9. Special Accessories

| Manufacturer | Description | Model | Serial Number | Certificate |
|--------------|-------------|-------|---------------|-------------|
| --           | --          | --    | --            | --          |

## 2.10. External I/O Cable

| I/O Port Description | Quantity | Cable                  |
|----------------------|----------|------------------------|
| AC IN Port           | 1        | 1.0M, Unscreened Cable |
| USB                  | 2        | U330                   |
| HDMI                 | 2        | 1.0M, Unscreened Cable |
| Earphone             | 1        | MDR-XB550AP            |
| AV                   | 1        | 1.0M, Unscreened Cable |
| RJ45                 | 1        | 1.0M, Unscreened Cable |

## 2.11. Modifications

No modifications were implemented to meet testing criteria.



### 3. TEST ENVIRONMENT

#### 3.1. Address of the test laboratory

##### **Shenzhen CTA Testing Technology Co., Ltd.**

Room 106, Building 1, Yibaolai Industrial Park, Qiaotou Community, Fuhai Street, Bao'an District, Shenzhen, China

#### 3.2. Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

##### **FCC-Registration No.: 517856 Designation Number: CN1318**

Shenzhen CTA Testing Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

##### **A2LA-Lab Cert. No.: 6534.01**

Shenzhen CTA Testing Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.

#### 3.3. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

|                       |              |
|-----------------------|--------------|
| Temperature:          | 15-35 ° C    |
|                       |              |
| Humidity:             | 30-60 %      |
|                       |              |
| Atmospheric pressure: | 950-1050mbar |

#### 3.4. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2 " and is documented in the Shenzhen CTA Testing Technology Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Shenzhen CTA Testing Technology Co., Ltd. :

| Test                                     | Range       | Measurement Uncertainty | Notes |
|--|-------------|-------------------------|-------|
| Radiated Emission                        | 9KHz~30MHz  | 3.02 dB                 | (1)   |
| Radiated Emission                        | 30~1000MHz  | 4.06 dB                 | (1)   |
| Radiated Emission                        | 1~18GHz     | 5.14 dB                 | (1)   |
| Radiated Emission                        | 18-40GHz    | 5.38 dB                 | (1)   |
| Conducted Disturbance                    | 0.15~30MHz  | 2.14 dB                 | (1)   |
| Output Peak power                        | 30MHz~18GHz | 0.55 dB                 | (1)   |
| Power spectral density                   | /           | 0.57 dB                 | (1)   |
| Spectrum bandwidth                       | /           | 1.1%                    | (1)   |
| Radiated spurious emission (30MHz-1GHz)  | 30~1000MHz  | 4.10 dB                 | (1)   |
| Radiated spurious emission (1GHz-18GHz)  | 1~18GHz     | 4.32 dB                 | (1)   |
| Radiated spurious emission (18GHz-40GHz) | 18-40GHz    | 5.54 dB                 | (1)   |

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

### 3.5. Summary of measurement results

| Applied Standard: FCC Part 15 Subpart C |  |  |           |            |
|---|--|--|-----------|------------|
| FCC Rules                               | Description of Test                              | Test Sample                                    | Result    | Remark     |
| §15.247(b)(1)                           | Maximum Conducted Output Power                   | CTA240517002-S0001-1#                          | Compliant | Appendix A |
| §15.247(c)                              | Frequency Separation                             | CTA240517002-S0001-1#                          | Compliant | Appendix A |
| §15.247(c)                              | 99% and 20 dB Bandwidth                          | CTA240517002-S0001-1#                          | Compliant | Appendix A |
| §15.247(a)(1)(ii)                       | Number of Hopping Frequency                      | CTA240517002-S0001-1#                          | Compliant | Appendix A |
| §15.247(a)(1)(iii)                      | Time Of Occupancy (Dwell Time)                   | CTA240517002-S0001-1#                          | Compliant | Appendix A |
| §15.209,<br>§15.205                     | Conducted Spurious Emissions and Band Edges Test | CTA240517002-S0001-1#                          | Compliant | Appendix A |
| §15.209,<br>§15.247(d)                  | Radiated Spurious Emissions                      | CTA240517002-S0001-1#<br>CTA240517002-S0001-2# | Compliant | Note 1     |
| §15.205                                 | Emissions at Restricted Band                     | CTA240517002-S0001-1#                          | Compliant | Appendix A |
| §15.207(a)                              | AC Conducted Emissions                           | CTA240517002-S0001-2#                          | Compliant | Note 1     |
| §15.203<br>§15.247(c)                   | Antenna Requirements                             | CTA240517002-S0001-1#                          | Compliant | Note 1     |
| §15.247(i)§2.10<br>91                   | RF Exposure                                      | /  | Compliant | Note 2     |

**Remark:**

1. The measurement uncertainty is not included in the test result.
2. NA = Not Applicable; NP = Not Performed
3. Note 1 – Test results inside test report;
4. Note 2 – Test results in other test report (MPE Report).
5. We tested all test mode and recorded worst case in report

### 3.6. Equipments Used during the Test

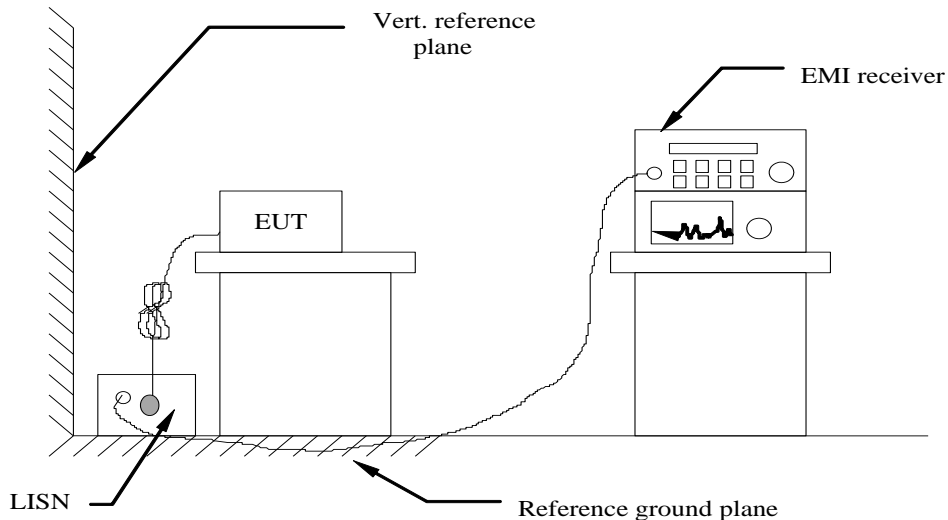
| Test Equipment                 | Manufacturer                                  | Model No.   | Equipment No. | Calibration Date | Calibration Due Date |
|--------------------------------|---|-------------|---------------|------------------|----------------------|
| LISN                           | R&S   | ENV216      | CTA-308       | 2023/08/02       | 2024/08/01           |
| LISN                           | R&S   | ENV216      | CTA-314       | 2023/08/02       | 2024/08/01           |
| EMI Test Receiver              | R&S   | ESPI        | CTA-307       | 2023/08/02       | 2024/08/01           |
| EMI Test Receiver              | R&S   | ESCI        | CTA-306       | 2023/08/02       | 2024/08/01           |
| Spectrum Analyzer              | Agilent                                       | N9020A      | CTA-301       | 2023/08/02       | 2024/08/01           |
| Spectrum Analyzer              | R&S   | FSP         | CTA-337       | 2023/08/02       | 2024/08/01           |
| Vector Signal generator        | Agilent                                       | N5182A      | CTA-305       | 2023/08/02       | 2024/08/01           |
| Analog Signal Generator        | R&S   | SML03       | CTA-304       | 2023/08/02       | 2024/08/01           |
| Universal Radio Communication  | CMW500  | R&S         | CTA-302       | 2023/08/02       | 2024/08/01           |
| Temperature and humidity meter | Chigo   | ZG-7020     | CTA-326       | 2023/08/02       | 2024/08/01           |
| Ultra-Broadband Antenna        | Schwarzbeck                                   | VULB9163    | CTA-310       | 2023/10/17       | 2024/10/16           |
| Horn Antenna                   | Schwarzbeck                                   | BBHA 9120D  | CTA-309       | 2023/10/13       | 2024/10/12           |
| Loop Antenna                   | Zhinan  | ZN30900C    | CTA-311       | 2023/10/17       | 2024/10/16           |
| Horn Antenna                   | Beijing Hangwei Dayang                        | OBH100400   | CTA-336       | 2021/08/07       | 2024/08/06           |
| Antenna Tower                  | Suzhou Keletuo electronic Technology Co., LTD | BK-*AT-BS   | N/A           | N/A              | N/A                  |
| Amplifier                      | Schwarzbeck                                   | BBV 9745    | CTA-312       | 2023/08/02       | 2024/08/01           |
| Amplifier                      | Taiwan chengyi                                | EMC051845B  | CTA-313       | 2023/08/02       | 2024/08/01           |
| Directional coupler            | NARDA   | 4226-10     | CTA-303       | 2023/08/02       | 2024/08/01           |
| High-Pass Filter               | XingBo  | XBLBQ-GTA18 | CTA-402       | 2023/08/02       | 2024/08/01           |
| High-Pass Filter               | XingBo  | XBLBQ-GTA27 | CTA-403       | 2023/08/02       | 2024/08/01           |
| Automated filter bank          | Tonscend                                      | JS0806-F    | CTA-404       | 2023/08/02       | 2024/08/01           |
| Power Sensor                   | Agilent                                       | U2021XA     | CTA-405       | 2023/08/02       | 2024/08/01           |
| Amplifier                      | Schwarzbeck                                   | BBV9719     | CTA-406       | 2023/08/02       | 2024/08/01           |

Note: The Cal.Interval was one year.

## 4. TEST CONDITIONS AND RESULTS

### 4.1. AC Power Conducted Emission

#### TEST CONFIGURATION



#### TEST PROCEDURE

- 1 The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2020.
- 2 Support equipment, if needed, was placed as per ANSI C63.10-2020.
- 3 All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2020.
- 4 The EUT received AC120V power, the received AC120V/60Hz or AC 240V/50Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
- 6 The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
- 7 Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
- 8 During the above scans, the emissions were maximized by cable manipulation.

#### AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following :

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

\* Decreases with the logarithm of the frequency.

#### DISTURBANCE Calculation

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

$$CD \text{ (dBuV)} = RA \text{ (dBuV)} + PL \text{ (dB)} + CL \text{ (dB)}$$

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

**TEST RESULTS**

Remark: We measured Conducted Emission at GFSK,  $\pi/4$ -DQPSK and 8-DPSK mode in AC 120V/60Hz and AC 240V/50Hz, the worst case was recorded(GFSK 1Mbps-MCH) .

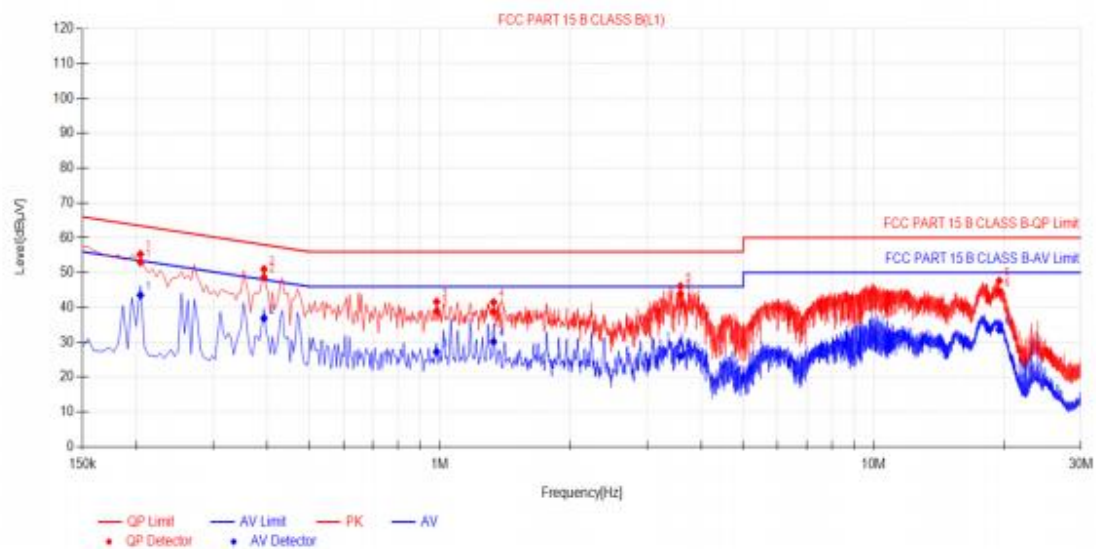
|               |             |                |     |
|---------------|-------------|----------------|-----|
| Temperature   | 25℃         | Humidity       | 60% |
| Test Engineer | Lushan Kong | Configurations | BT  |

Power supply:

AC 120V/60Hz

Polarization

L

**Suspected List**

| NO. | Freq. [MHz] | Reading [dBμV] | Level [dBμV] | Factor [dB] | Limit [dBμV] | Margin [dB] | Detector | Type | Verdict |
|-----|-------------|----------------|--------------|-------------|--------------|-------------|----------|------|---------|
| 1   | 0.204       | 45.23          | 55.32        | 10.09       | 63.45        | 8.13        | PK       | L1   | PASS    |
| 2   | 0.393       | 41.13          | 51.00        | 9.87        | 58.00        | 7.00        | PK       | L1   | PASS    |
| 3   | 0.9825      | 31.71          | 41.64        | 9.93        | 56.00        | 14.36       | PK       | L1   | PASS    |
| 4   | 1.329       | 31.61          | 41.51        | 9.90        | 56.00        | 14.49       | PK       | L1   | PASS    |
| 5   | 3.5835      | 36.14          | 46.10        | 9.96        | 56.00        | 9.90        | PK       | L1   | PASS    |
| 6   | 19.464      | 37.27          | 47.68        | 10.41       | 60.00        | 12.32       | PK       | L1   | PASS    |

Note:1).QP Value (dBμV)= QP Reading (dBμV)+ Factor (dB)

2). Factor (dB)=insertion loss of LISN (dB) + Cable loss (dB)

3). QPMargin(dB) = QP Limit (dBμV) - QP Value (dBμV)

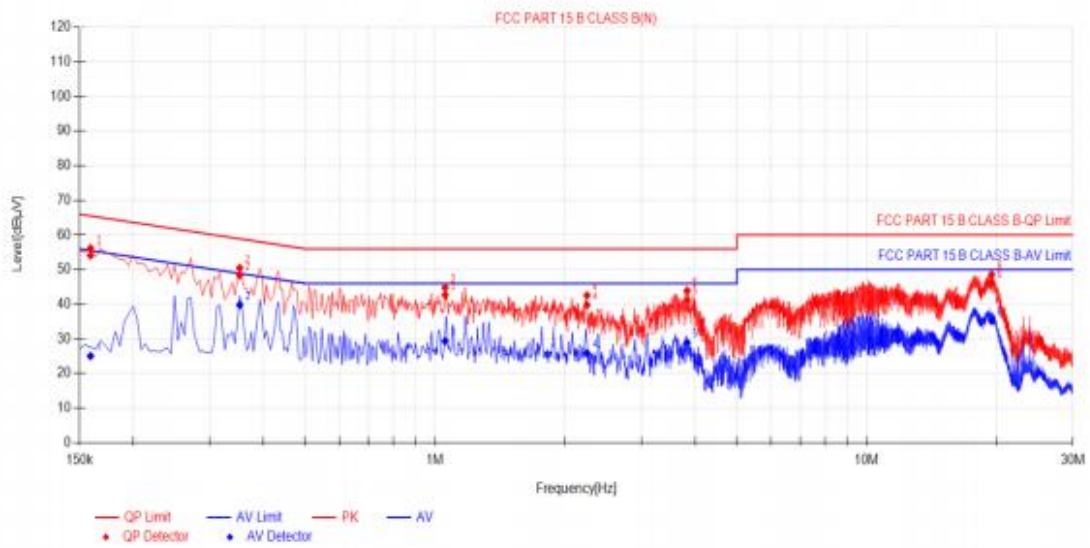
4). AVMargin(dB) = AV Limit (dBμV) - AV Value (dBμV)

Power supply:

AC 120V/60Hz

Polarization

N



### Suspected List

| NO. | Freq. [MHz] | Reading [dBμV] | Level [dBμV] | Factor [dB] | Limit [dBμV] | Margin [dB] | Detector | Type | Verdict |
|-----|-------------|----------------|--------------|-------------|--------------|-------------|----------|------|---------|
| 1   | 0.159       | 46.15          | 56.18        | 10.03       | 65.52        | 9.34        | PK       | N    | PASS    |
| 2   | 0.3525      | 40.61          | 50.47        | 9.86        | 58.90        | 8.43        | PK       | N    | PASS    |
| 3   | 1.0545      | 34.64          | 44.78        | 10.14       | 56.00        | 11.22       | PK       | N    | PASS    |
| 4   | 2.247       | 32.41          | 42.56        | 10.15       | 56.00        | 13.44       | PK       | N    | PASS    |
| 5   | 3.8355      | 33.80          | 43.94        | 10.14       | 56.00        | 12.06       | PK       | N    | PASS    |
| 6   | 19.4595     | 38.03          | 48.59        | 10.56       | 60.00        | 11.41       | PK       | N    | PASS    |

Note:1).QP Value (dBμV)= QP Reading (dBμV)+ Factor (dB)

2). Factor (dB)=insertion loss of LISN (dB) + Cable loss (dB)

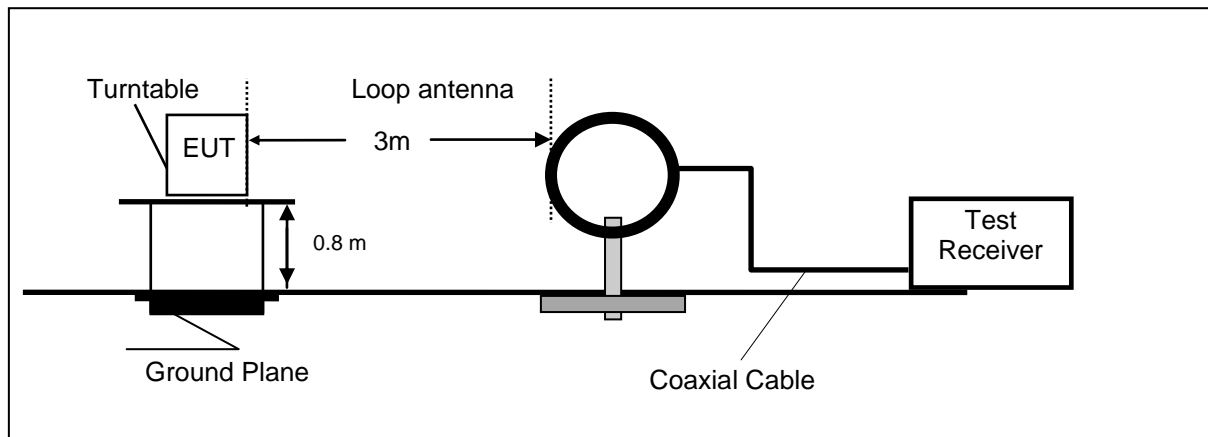
3). QPMargin(dB) = QP Limit (dBμV) - QP Value (dBμV)

4). AVMargin(dB) = AV Limit (dBμV) - AV Value (dBμV)

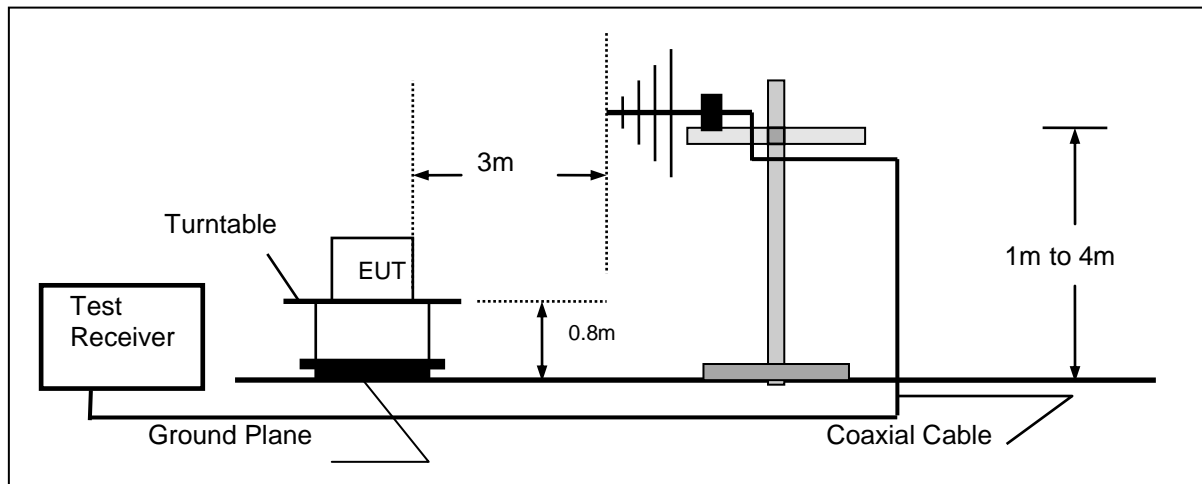
## 4.2. Radiated Emission

### TEST CONFIGURATION

Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



**TEST PROCEDURE**

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz;the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 25GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0°C to 360°C to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768KHz and maximum operation frequency was 2480MHz.so radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

| Test Frequency range | Test Antenna Type          | Test Distance |
|----------------------|----------------------------|---------------|
| 9KHz-30MHz           | Active Loop Antenna        | 3             |
| 30MHz-1GHz           | Ultra-Broadband Antenna    | 3             |
| 1GHz-18GHz           | Double Ridged Horn Antenna | 3             |
| 18GHz-25GHz          | Horn Antenna               | 1             |

7. Setting test receiver/spectrum as following table states:

| Test Frequency range | Test Receiver/Spectrum Setting  | Detector |
|----------------------|---|----------|
| 9KHz-150KHz          | RBW=200Hz/VBW=3KHz, Sweep time=Auto   | QP       |
| 150KHz-30MHz         | RBW=9KHz/VBW=100KHz, Sweep time=Auto  | QP       |
| 30MHz-1GHz           | RBW=120KHz/VBW=1000KHz, Sweep time=Auto   | QP       |
| 1GHz-40GHz           | Peak Value: RBW=1MHz/VBW=3MHz,<br>Sweep time=Auto<br>Average Value: RBW=1MHz/VBW=10Hz,<br>Sweep time=Auto | Peak     |

**Field Strength Calculation**

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

$$FS = RA + AF + CL - AG$$

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

$$Transd=AF +CL-AG$$

**RADIATION LIMIT**

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

| Frequency (MHz) | Distance (Meters) | Radiated (dBµV/m)                   | Radiated (µV/m) |
|-----------------|-------------------|-------------------------------------|-----------------|
| 0.009-0.49      | 3                 | $20\log(2400/F(KHz))+40\log(300/3)$ | $2400/F(KHz)$   |
| 0.49-1.705      | 3                 | $20\log(24000/F(KHz))+40\log(30/3)$ | $24000/F(KHz)$  |
| 1.705-30        | 3                 | $20\log(30)+40\log(30/3)$           | 30              |
| 30-88           | 3                 | 40.0                                | 100             |
| 88-216          | 3                 | 43.5                                | 150             |
| 216-960         | 3                 | 46.0                                | 200             |
| Above 960       | 3                 | 54.0                                | 500             |



**TEST RESULTS**

Remark: We measured Radiated Emission at GFSK,  $\pi/4$ -DQPSK and 8-DPSK mode from 9KHz to 25GHz and recorded worst case at GFSK(1Mbps-MCH) mode.

|               |             |                |     |
|---------------|-------------|----------------|-----|
| Temperature   | 25℃         | Humidity       | 60% |
| Test Engineer | Lushan Kong | Configurations | BT  |

**For 9 KHz~30MHz**

| Freq.<br>(MHz) | Level<br>(dBuV) | Over Limit<br>(dB) | Over Limit<br>(dBuV) | Remark   |
|----------------|-----------------|--------------------|----------------------|----------|
| -              | -               | -                  | -                    | See Note |

**Note:**

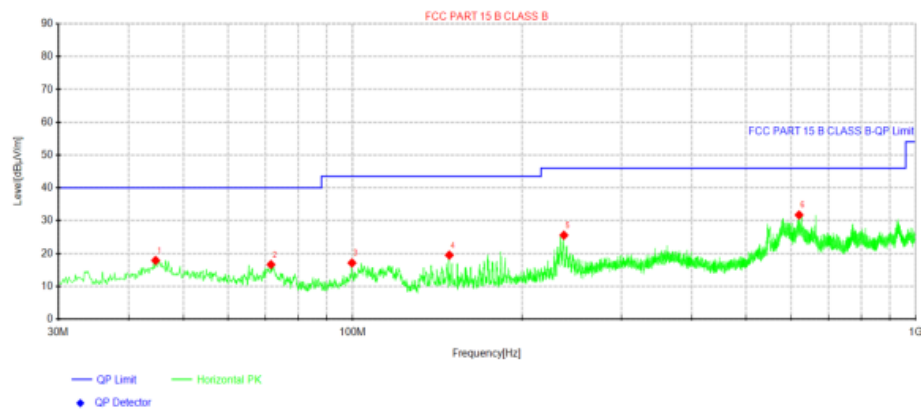
The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor =  $40 \log (\text{specific distance} / \text{test distance})$  (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor.

## For 30MHz-1GHz

## Horizontal



## Suspected Data List

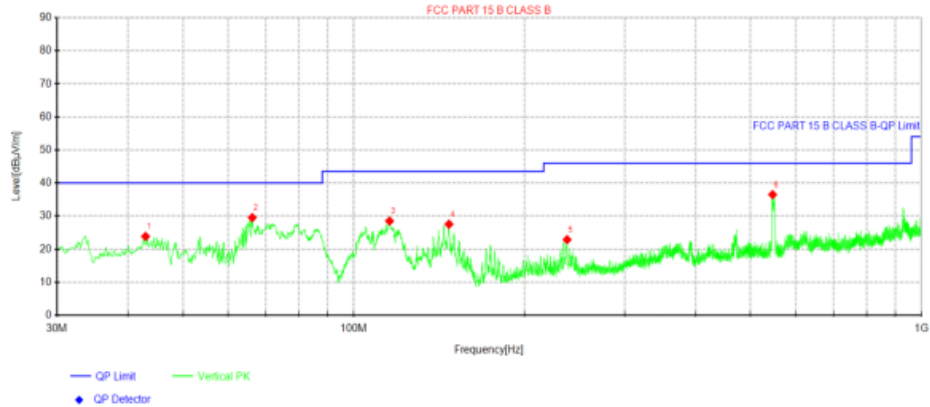
| NO. | Freq. [MHz] | Reading [dBμV] | Level [dBμV/m] | Factor [dB/m] | Limit [dBμV/m] | Margin [dB] | Height [cm] | Angle [°] | Polarity   |
|-----|-------------|----------------|----------------|---------------|----------------|-------------|-------------|-----------|------------|
| 1   | 44.6712     | 29.67          | 17.90          | -11.77        | 40.00          | 22.10       | 100         | 313       | Horizontal |
| 2   | 71.5888     | 31.98          | 16.65          | -15.33        | 40.00          | 23.35       | 100         | 45        | Horizontal |
| 3   | 99.7188     | 30.54          | 17.14          | -13.40        | 43.50          | 26.36       | 100         | 313       | Horizontal |
| 4   | 148.461     | 35.50          | 19.52          | -15.98        | 43.50          | 23.98       | 100         | 325       | Horizontal |
| 5   | 237.216     | 38.47          | 25.58          | -12.89        | 46.00          | 20.42       | 100         | 79        | Horizontal |
| 6   | 620.73      | 37.02          | 31.75          | -5.27         | 46.00          | 14.25       | 100         | 3         | Horizontal |

Note:1).Level (dBμV/m)= Reading (dBμV)+ Factor (dB/m)

2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)

3). Margin(dB) = Limit (dBμV/m) - Level (dBμV/m)

## Vertical



## Suspected Data List

| NO. | Freq. [MHz] | Reading [dBμV] | Level [dBμV/m] | Factor [dB/m] | Limit [dBμV/m] | Margin [dB] | Height [cm] | Angle [°] | Polarity |
|-----|-------------|----------------|----------------|---------------|----------------|-------------|-------------|-----------|----------|
| 1   | 42.9738     | 35.80          | 23.86          | -11.94        | 40.00          | 16.14       | 100         | 117       | Vertical |
| 2   | 66.2538     | 43.98          | 29.54          | -14.44        | 40.00          | 10.46       | 100         | 357       | Vertical |
| 3   | 115.602     | 42.57          | 28.52          | -14.05        | 43.50          | 14.98       | 100         | 337       | Vertical |
| 4   | 147.127     | 43.58          | 27.56          | -16.02        | 43.50          | 15.94       | 100         | 0         | Vertical |
| 5   | 237.58      | 35.77          | 22.89          | -12.88        | 46.00          | 23.11       | 100         | 163       | Vertical |
| 6   | 546.646     | 45.25          | 36.52          | -8.73         | 46.00          | 9.48        | 100         | 4         | Vertical |

Note:1).Level (dBμV/m)= Reading (dBμV)+ Factor (dB/m)

2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)

3). Margin(dB) = Limit (dBμV/m) - Level (dBμV/m)

## For 1GHz to 25GHz

## GFSK /Channel 0 / 2402 MHz

| Freq. MHz | Reading dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark  | Pol.       |
|-----------|--------------|----------------|--------------|--------------|-----------------|--------------|-----------|---------|------------|
| 4804.00   | 50.52        | 32.44          | 30.25        | 7.95         | 60.66           | 74.00        | -13.34    | Peak    | Horizontal |
| 4804.00   | 35.52        | 32.44          | 30.25        | 7.95         | 45.66           | 54.00        | -8.34     | Average | Horizontal |
| 4804.00   | 50.33        | 31.60          | 36.50        | 7.00         | 52.43           | 74.00        | -21.57    | Peak    | Vertical   |
| 4804.00   | 36.69        | 31.60          | 36.50        | 7.00         | 38.79           | 54.00        | -15.21    | Average | Vertical   |

## Channel 39 / 2441 MHz

| Freq. MHz | Reading dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark  | Pol.       |
|-----------|--------------|----------------|--------------|--------------|-----------------|--------------|-----------|---------|------------|
| 4882.00   | 50.67        | 32.52          | 30.31        | 8.12         | 61.00           | 74.00        | -13.00    | Peak    | Horizontal |
| 4882.00   | 37.88        | 32.52          | 30.31        | 8.12         | 48.21           | 54.00        | -5.79     | Average | Horizontal |
| 4882.00   | 50.45        | 31.02          | 36.50        | 7.60         | 52.57           | 74.00        | -21.43    | Peak    | Vertical   |
| 4882.00   | 35.33        | 31.02          | 36.50        | 7.60         | 37.45           | 54.00        | -16.55    | Average | Vertical   |

## Channel 78 / 2480 MHz

| Freq. MHz | Reading dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark  | Pol.       |
|-----------|--------------|----------------|--------------|--------------|-----------------|--------------|-----------|---------|------------|
| 4960.00   | 51.13        | 32.68          | 30.27        | 7.88         | 61.42           | 74.00        | -12.58    | Peak    | Horizontal |
| 4960.00   | 35.44        | 32.68          | 30.27        | 7.88         | 45.73           | 54.00        | -8.27     | Average | Horizontal |
| 4960.00   | 51.81        | 31.58          | 36.20        | 7.82         | 55.01           | 74.00        | -18.99    | Peak    | Vertical   |
| 4960.00   | 38.09        | 31.58          | 36.20        | 7.82         | 41.29           | 54.00        | -12.71    | Average | Vertical   |

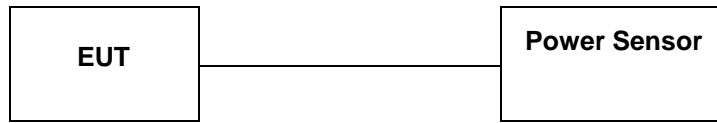
## Notes:

- 1). Measuring frequencies from 9 KHz~10<sup>th</sup> harmonic or 26.5GHz (which is less), No emission found between lowest internal used/generated frequency to 30MHz.
- 2). Radiated emissions measured in frequency range from 9 KHz~10<sup>th</sup> harmonic or 26.5GHz (which is less) were made with an instrument using Peak detector mode.
- 3). Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- 4). Measured= Reading- Pre. Fac.+ Ant. Fac.+ Cab. Loss
- 5). Margin = Measured- Limit

**NOTE: All the modes have been tested and recorded worst mode in the report.**

### 4.3. Maximum Peak Output Power

#### TEST CONFIGURATION



#### TEST PROCEDURE

According to ANSI C63.10:2013 Maximum peak conducted output power for HFSS devices:

The maximum peak conducted output power may be measured using a broadband peak RF power meter.

The power meter shall have a video bandwidth that is greater than or equal to the HFSS bandwidth and shall utilize a fast-responding diode detector.

The maximum Average conducted output power may be measured using a wideband RF power meter with a thermocouple detector or equivalent. The power meter shall have a video bandwidth that is greater than or equal to the HFSS bandwidth and shall utilize a fast-responding diode detector.

#### LIMIT

For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

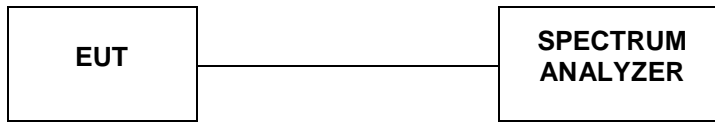
#### TEST RESULTS

For reporting purpose only.

Please refer to Appendix A.3.

#### 4.4. 99% and 20dB Bandwidth

##### TEST CONFIGURATION



##### TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=30KHz and VBW=100KHz. The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

##### LIMIT

For frequency hopping systems operating in the 2400MHz-2483.5MHz no limit for 20dB bandwidth.

##### TEST RESULTS

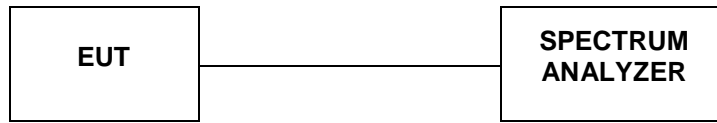
For reporting purpose only.

Please refer to Appendix A.1.

Please refer to Appendix A.2.

## 4.5. Frequency Separation

### TEST CONFIGURATION



### TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with RBW=100KHz and VBW=300KHz.

### LIMIT

According to 15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25KHz or the  $\frac{2}{3} \times 20\text{dB}$  bandwidth of the hopping channel, whichever is greater.

### TEST RESULTS

For reporting purpose only.

Please refer to Appendix A.4.

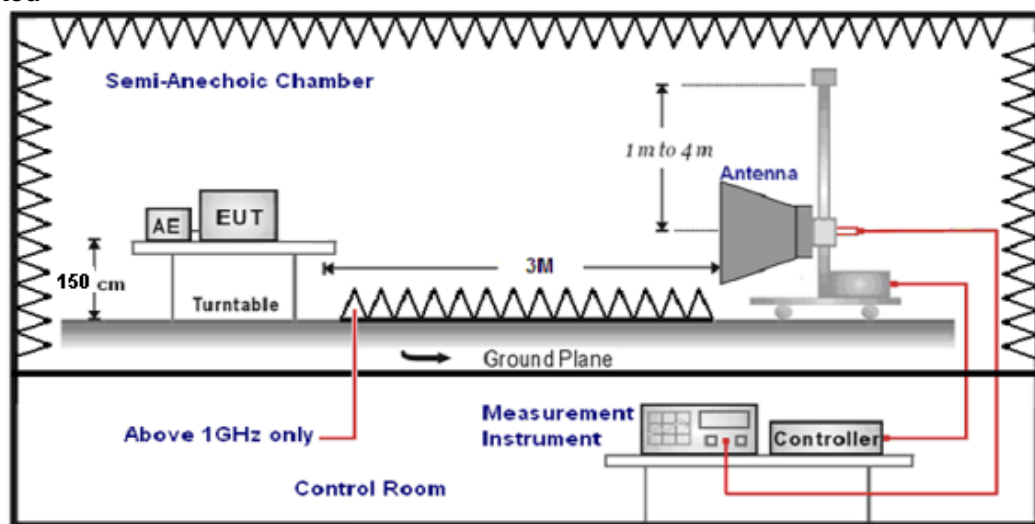
#### 4.6. Conducted Spurious Emissions and Band Edge Compliance of RF Emission

##### TEST REQUIREMENT

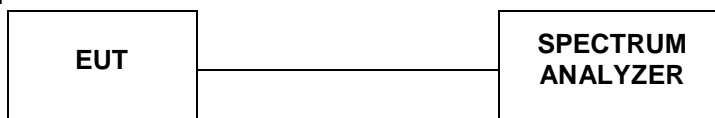
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

##### TEST CONFIGURATION

###### For Radiated



###### For Conducted



##### TEST PROCEDURE

1. The EUT was placed on a turn table which is 1.5m above ground plane.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0° to 360° to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed..
5. The distance between test antenna and EUT was 3 meter:
6. Setting test receiver/spectrum as following table states:

| Test Frequency range | Test Receiver/Spectrum Setting  | Detector |
|----------------------|---|----------|
| 1GHz-40GHz           | Peak Value: RBW=1MHz/VBW=3MHz,<br>Sweep time=Auto<br>Average Value: RBW=1MHz/VBW=10Hz,<br>Sweep time=Auto | Peak     |

##### LIMIT

Below -20dB of the highest emission level in operating band.

Radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a)

## **TEST RESULTS**

### **4.6.1 For Conducted at Restricted Band Measurement**

For reporting purpose only.

Please refer to Appendix A.9.

### **4.6.2 For Conducted Bandedge Measurement**

For reporting purpose only.

Please refer to Appendix A.7.

### **4.6.3 For Conducted Spurious Emissions Measurement**

For reporting purpose only.

Please refer to Appendix A.8.



#### 4.7. Number of hopping frequency

##### TEST CONFIGURATION



##### TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 2400MHz to 2483.5MHz with RBW=100KHz and VBW=300KHz.

##### LIMIT

Frequency hopping systems in the 2400–2483.5MHz band shall use at least 15 channels.

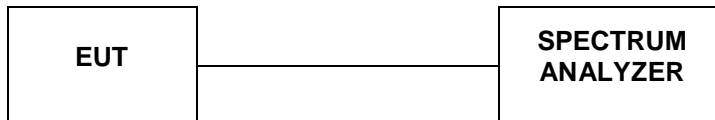
##### TEST RESULTS

For reporting purpose only.

Please refer to Appendix A.6.

#### 4.8. Time Of Occupancy(Dwell Time)

##### TEST CONFIGURATION



##### TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with RBW=1MHz and VBW=3MHz, Span=0Hz.

##### LIMIT

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a pe-riod of 0.4 seconds multiplied by the number of hopping channels employed.

##### TEST RESULTS

For reporting purpose only.

Please refer to Appendix A.5.

## 4.9. Pseudorandom Frequency Hopping Sequence

### TEST APPLICABLE

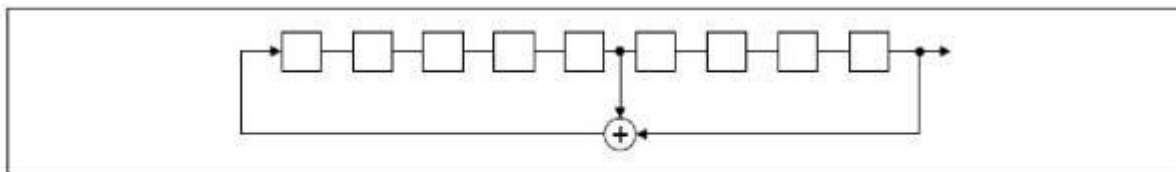
For 47 CFR Part 15C section 15.247 (a)(1) requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

### EUT Pseudorandom Frequency Hopping Sequence Requirement

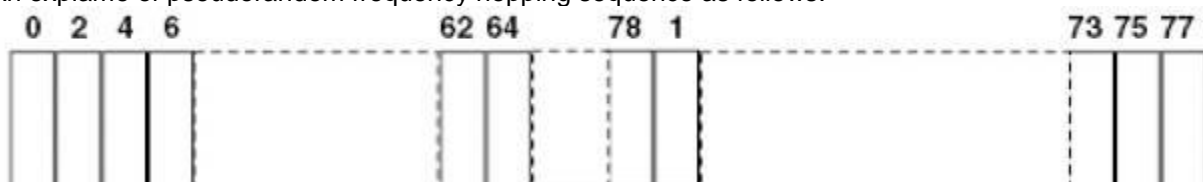
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive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

- Number of shift register stages: 9
- Length of pseudo-random sequence:  $2^9 - 1 = 511$  bits
- Longest sequence of zeros: 8 (non-inverted signal)



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

An example of pseudorandom frequency hopping sequence as follows:



Each frequency used equally on the average by each transmitter.

The system receiver has input bandwidths that match the hopping channel bandwidths of their corresponding transmitter and shifts frequencies in synchronization with the transmitted signals.

#### **4.10. Antenna Requirement**

##### **Standard Applicable**

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

And according to FCC 47 CFR Section 15.247 (c), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

##### **Test Result**

The antenna used for this product is Internal Antenna and that no antenna other than that furnished by the responsible party shall be used with the device, the maximum peak gain of the transmit antenna is only -1.22dBi.

Reference to the **Internal photos**.

## 5. TEST SETUP PHOTOS OF THE EUT

Photo of Radiated Emissions Measurement



Fig. 1

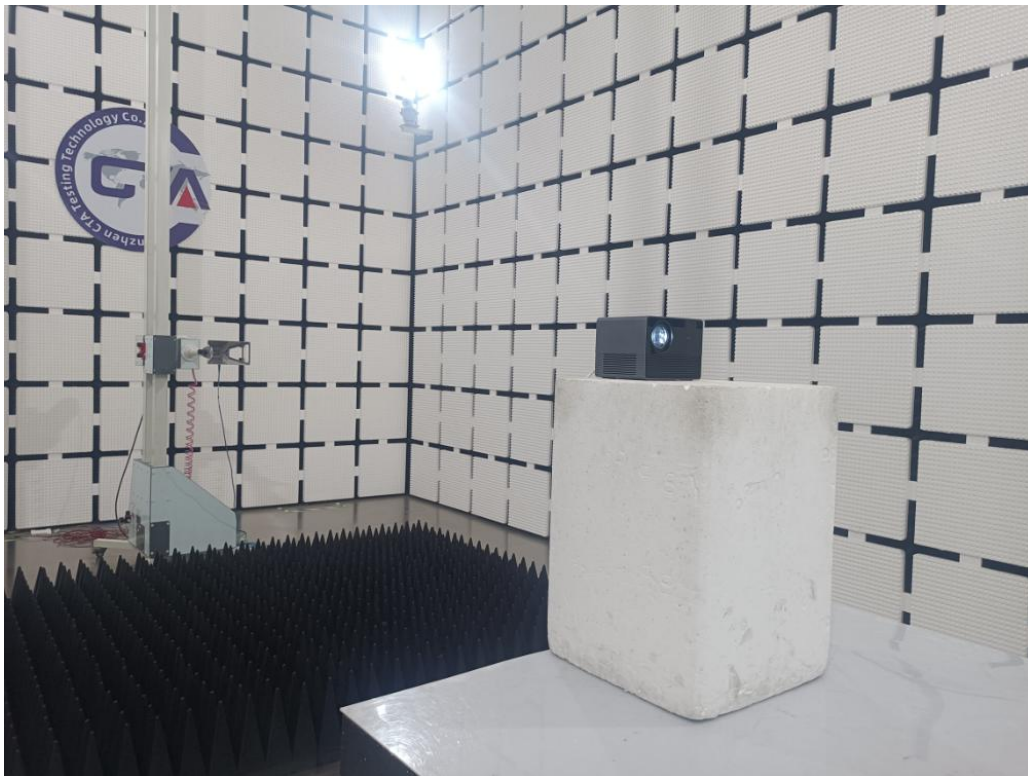


Fig. 2

Photo of Conducted Emission Measurement



Fig. 3

## 6. EXTERNAL AND INTERNAL PHOTOS OF THE EUT

### 6.1.External photos of the EUT



Fig. 1

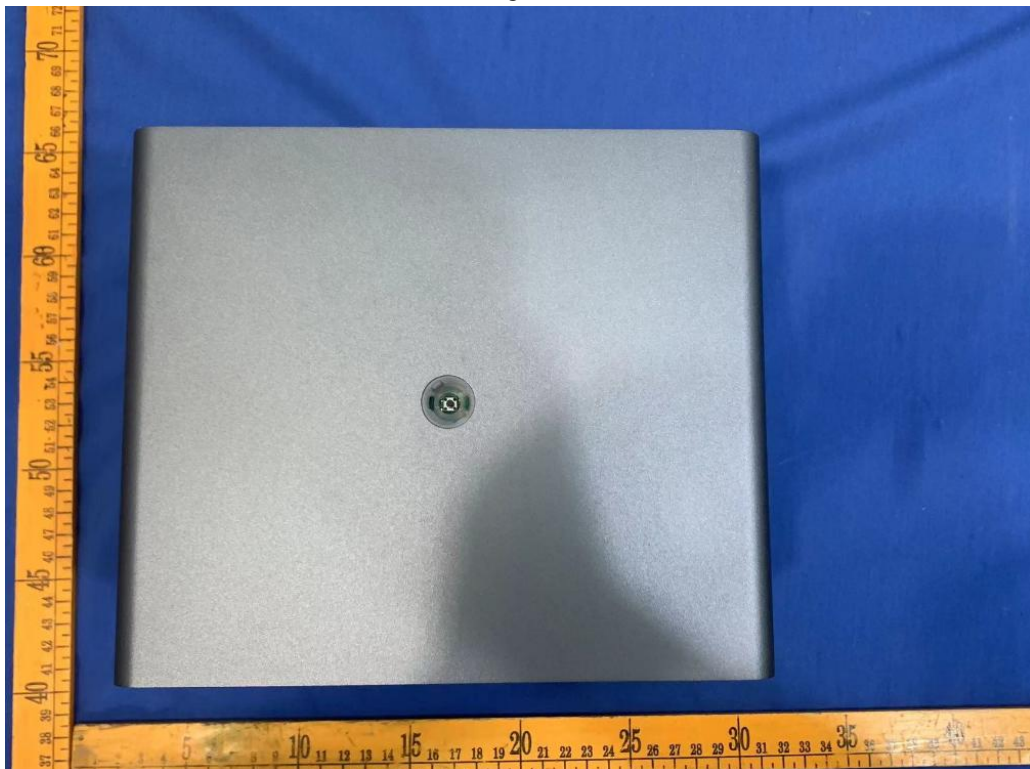


Fig. 2



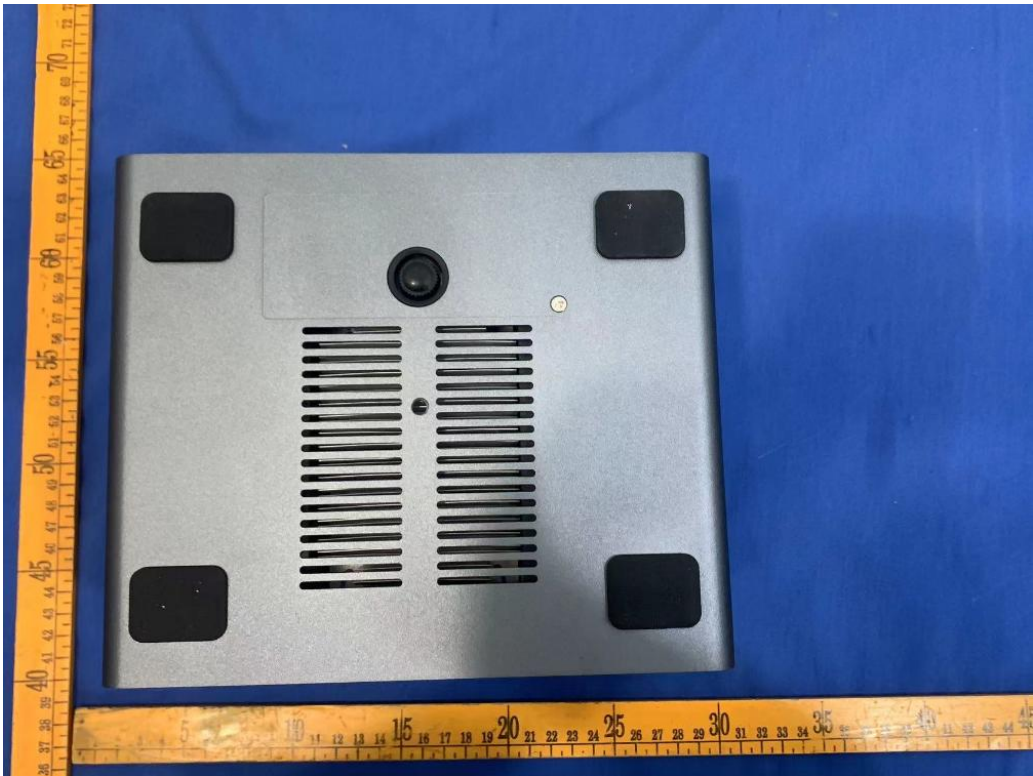


Fig. 3



Fig. 4





Fig. 5

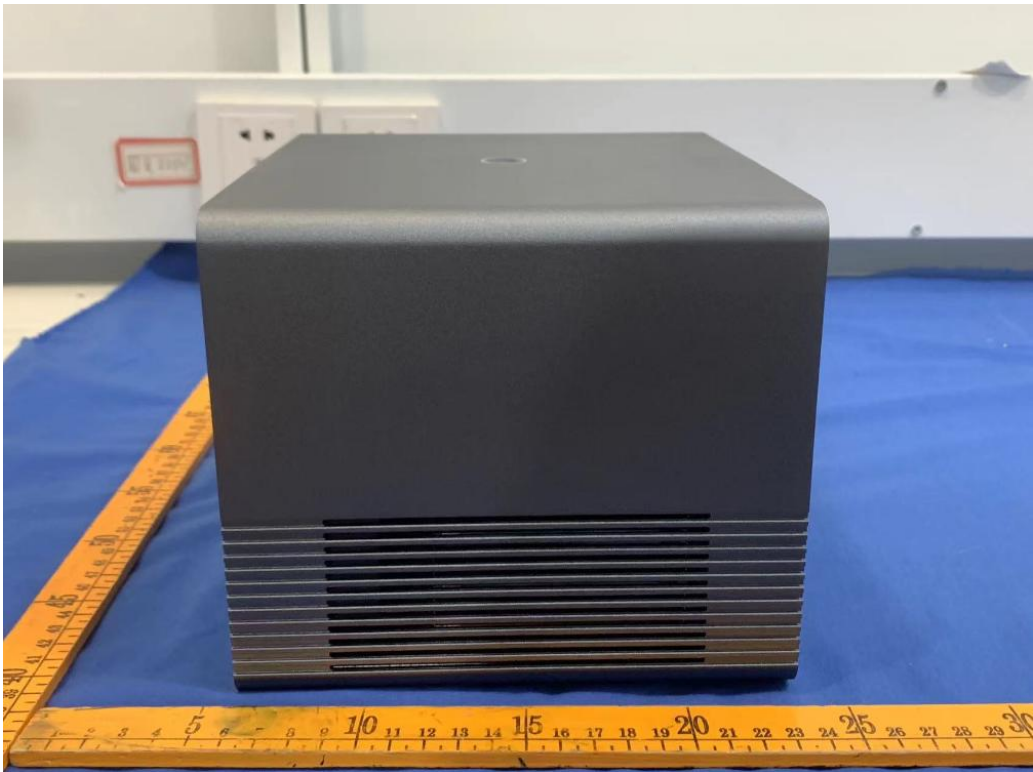


Fig. 6

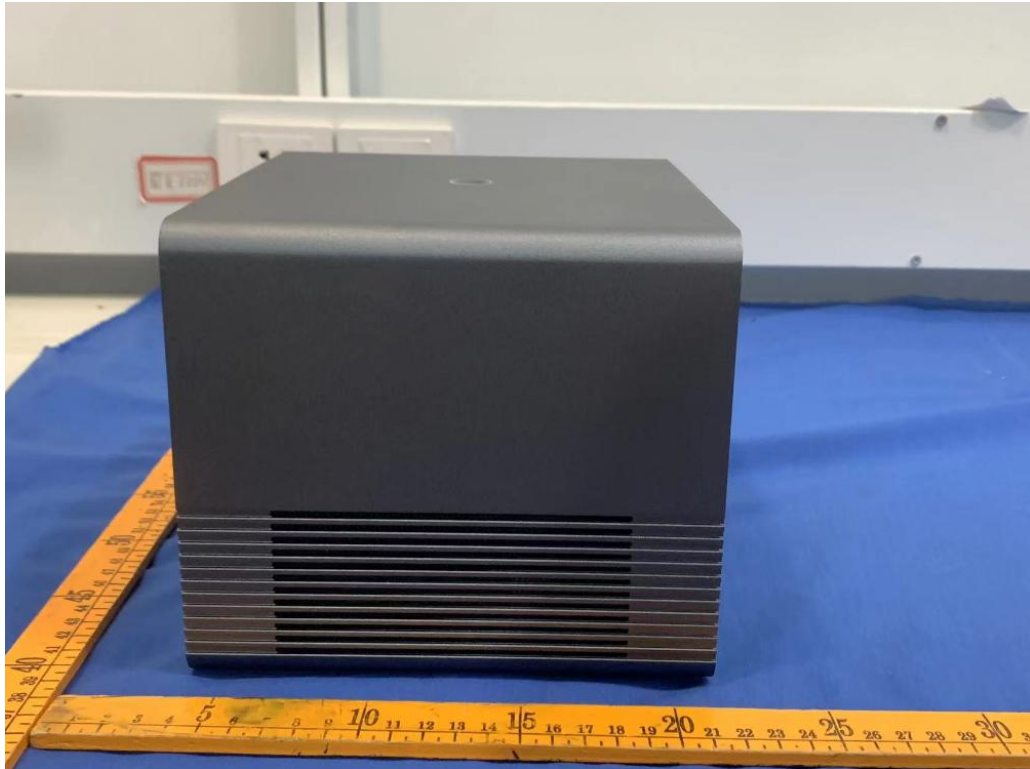


Fig. 7

## 6.2. Internal photos of the EUT

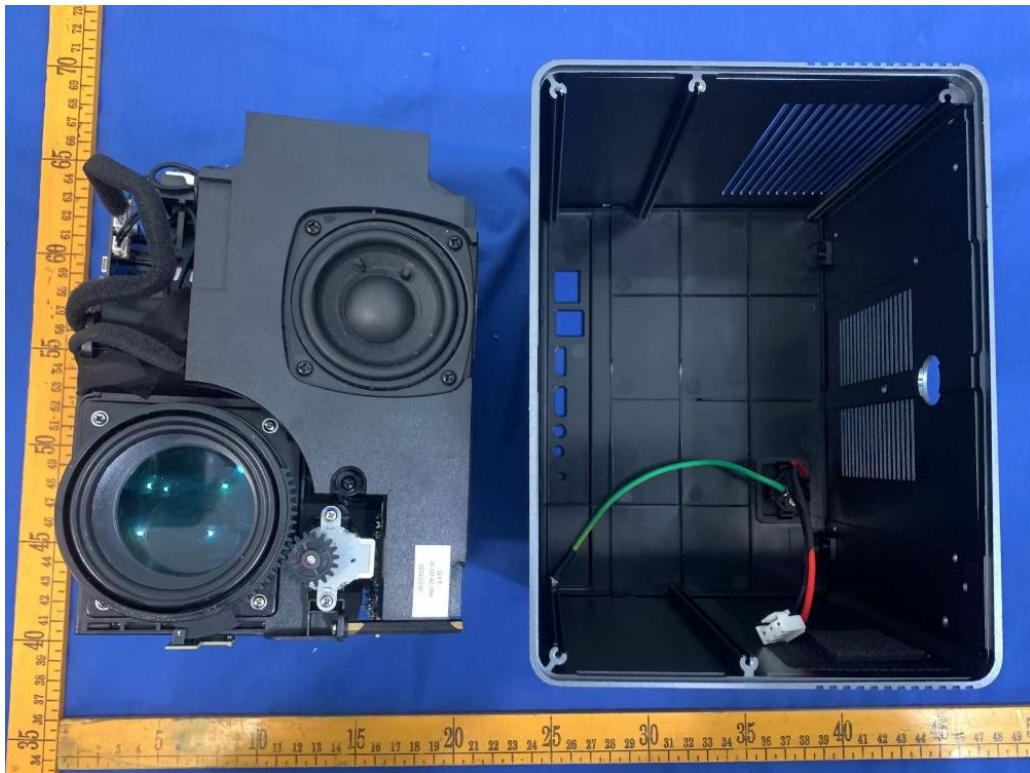


Fig. 8

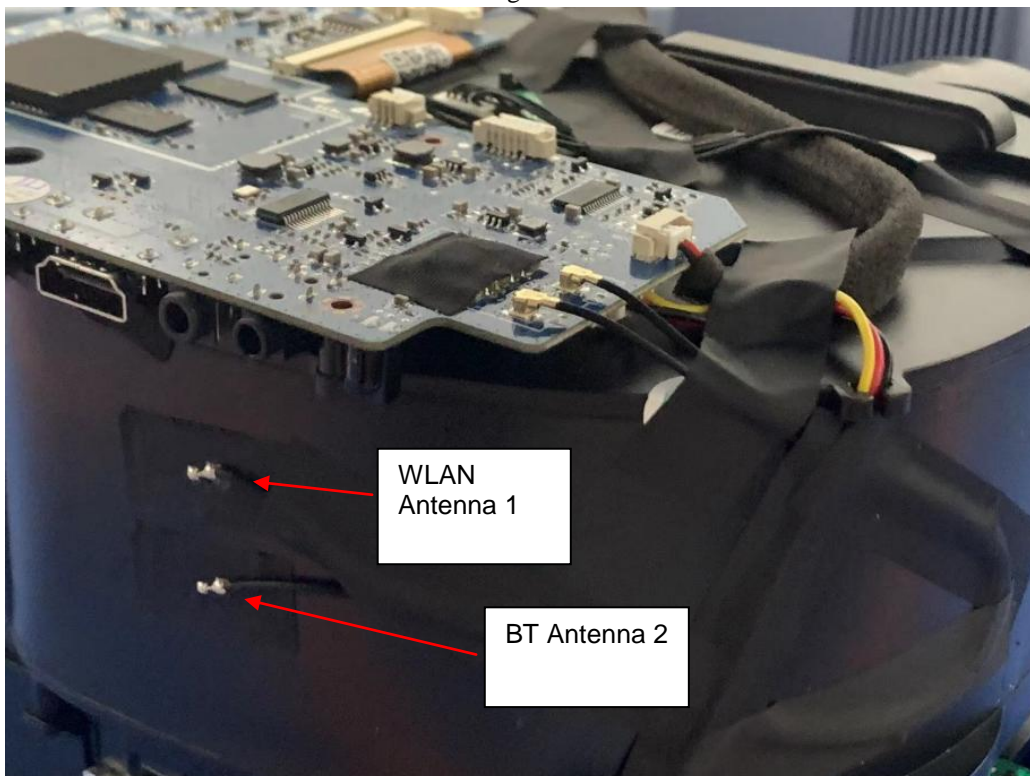


Fig. 9



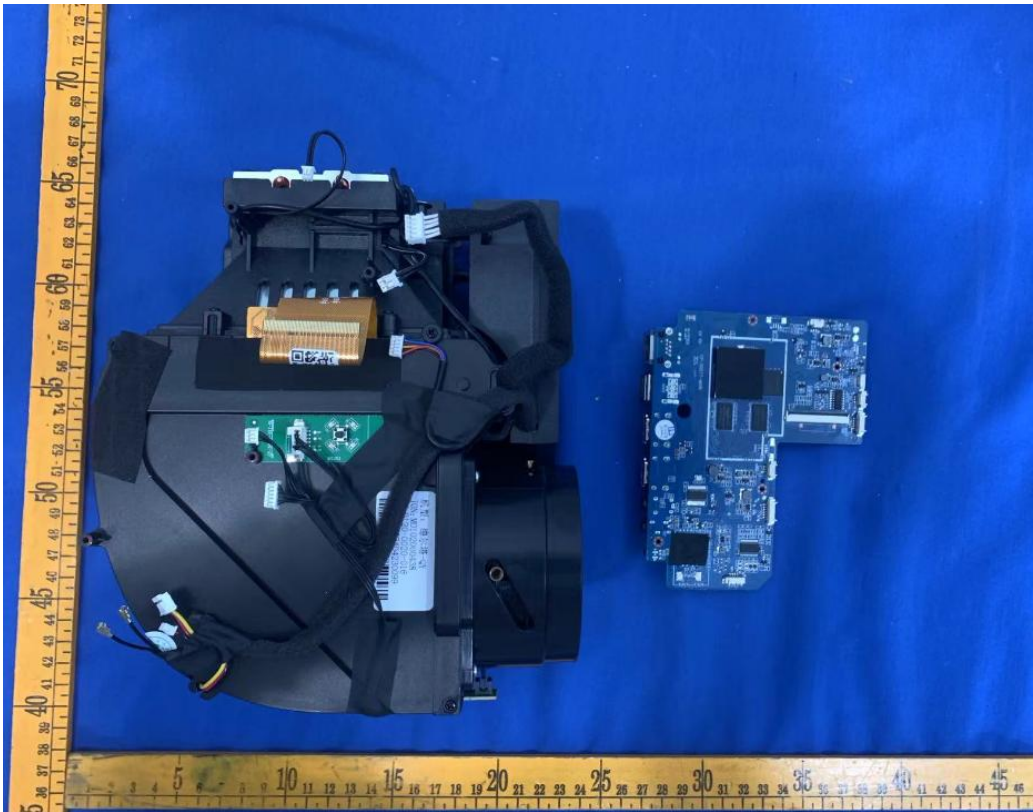


Fig. 10

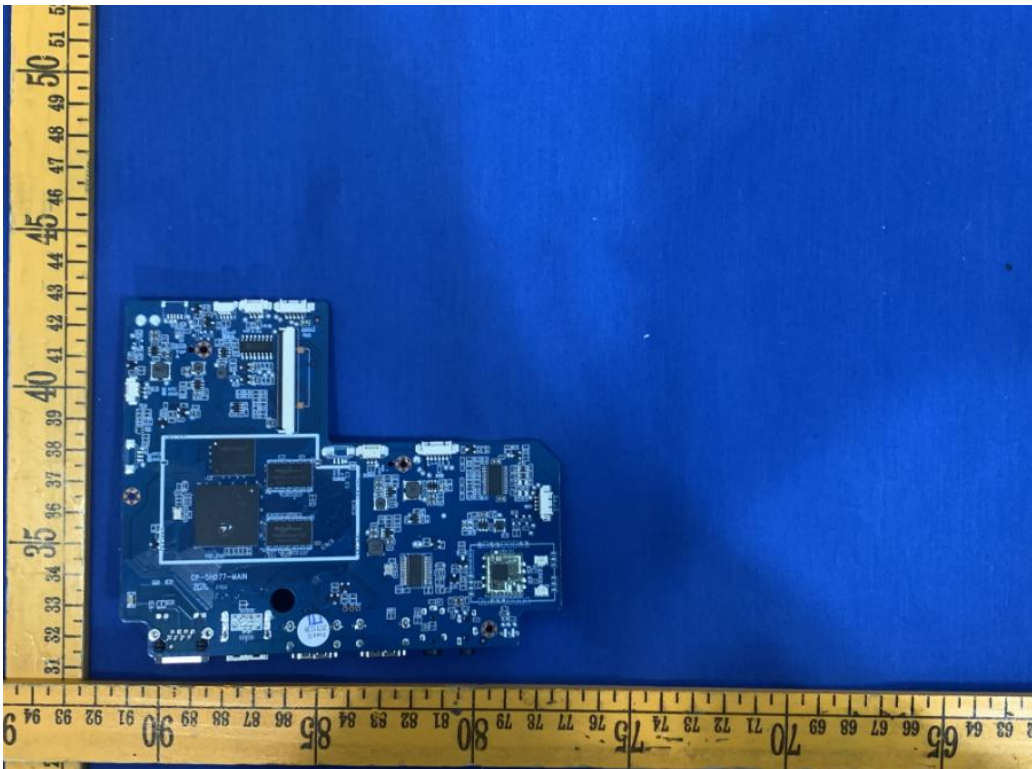


Fig. 11

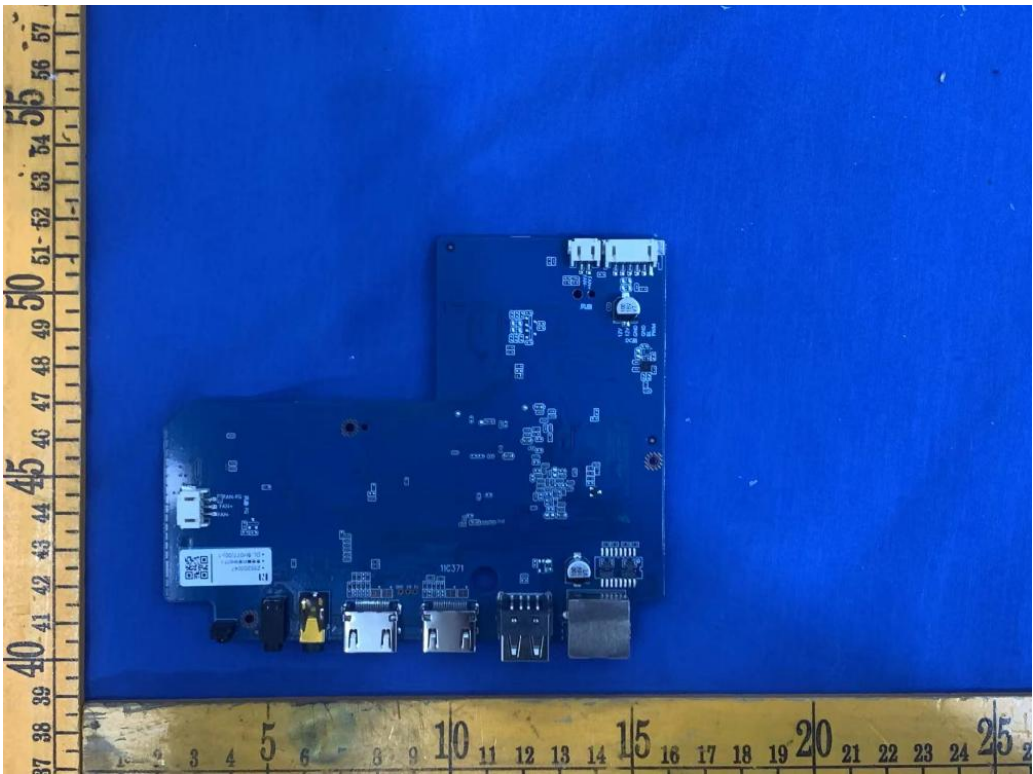


Fig. 12

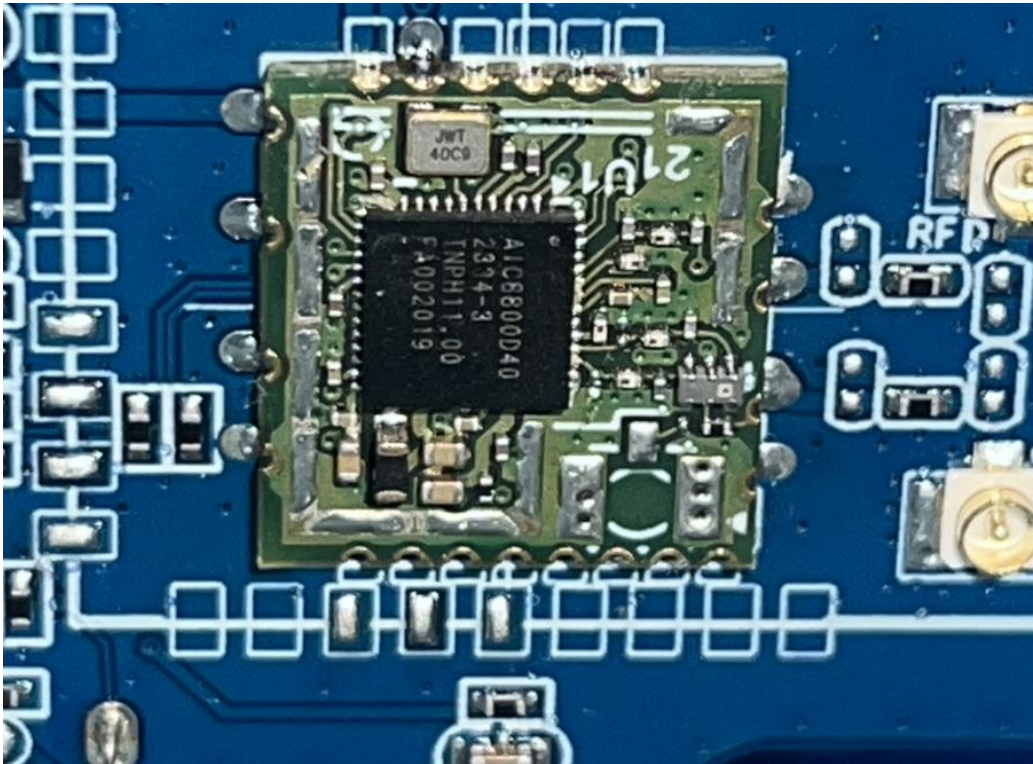


Fig. 13



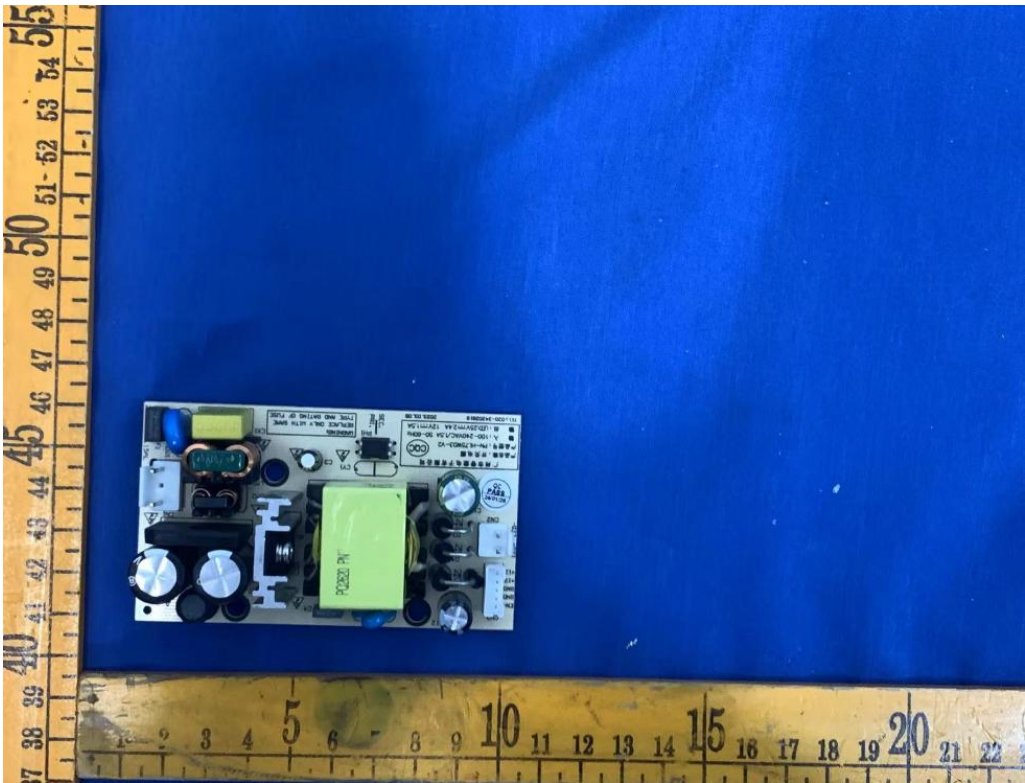


Fig. 14

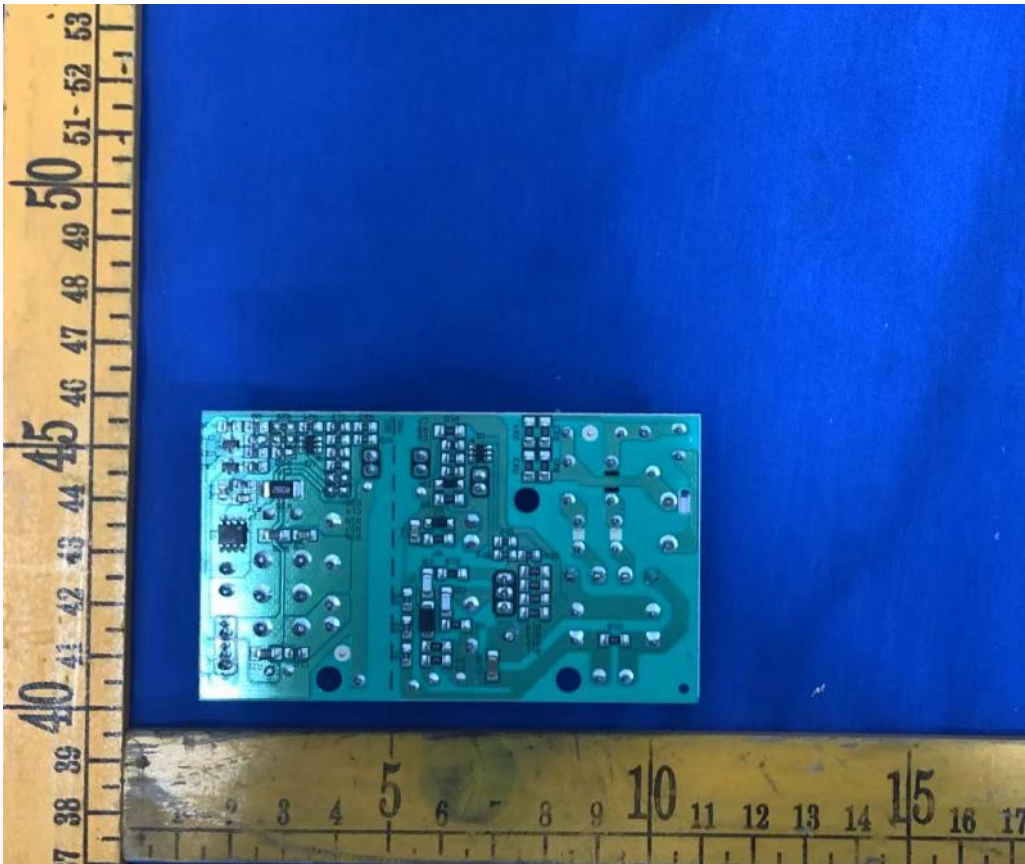


Fig. 15

.....End of Report.....