



**Shenzhen Global Test Service Co.,Ltd.**

No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong

## FCC PART 15 SUBPART C TEST REPORT

### FCC PART 15.247

**Report Reference No.**.....: **GTS20220224002-1-1**

**FCC ID**.....: **2AQAA-EZBOOKX1S**

Compiled by

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

Supervised by

( position+printed name+signature)...: Test Engineer Jenny Zeng

Approved by

( position+printed name+signature)...: Manager Simon Hu



Date of issue.....: Apr.13, 2022

**Representative Laboratory Name**..: **Shenzhen Global Test Service Co.,Ltd.**

Address .....: No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong, China

**Applicant's name**.....: **Shenzhen Jumper Technology Co.,Ltd**

Address .....: Room B601, C601, JMD Industrial Park, No. 39 Qingfeng Blvd., Baolong Community, Baolong Street, Longgang 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

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

Trade Mark .....: N/A

Manufacturer .....: Shenzhen Jumper Technology Co.,Ltd

Model/Type reference .....: EZbook X1s

List Models .....: EZbook X1s PRO, EZbook X1s plus, EZbook X1s MAX

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

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

Hardware Version .....: N/A

Software Version .....: N/A

Rating .....: DC 7.6V by battery

Recharged by DC 12.0V

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

**TEST REPORT**

|                                                    |                               |
|----------------------------------------------------|-------------------------------|
| <b>Test Report No. :</b> <b>GTS20220224002-1-1</b> | Apr.13, 2022<br>Date of issue |
|----------------------------------------------------|-------------------------------|

Equipment under Test            :        Laptop

Model /Type                        :        EZbook X1s

Listed model                        :        EZbook X1s PRO, EZbook X1s plus, EZbook X1s MAX

**Applicant**                         :        **Shenzhen Jumper Technology Co.,Ltd**

Address                              :        Room B601, C601, JMD Industrial Park, No. 39 Qingfeng Blvd.,  
Baolong Community, Baolong Street, Longgang District, Shenzhen,  
China

**Manufacturer**                    :        **Shenzhen Jumper Technology Co.,Ltd**

Address                              :        Room B601, C601, JMD Industrial Park, No. 39 Qingfeng Blvd.,  
Baolong Community, Baolong Street, Longgang District, Shenzhen,  
China

|                     |             |
|---------------------|-------------|
| <b>Test Result:</b> | <b>PASS</b> |
|---------------------|-------------|

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.

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## 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 C63.10-2013](#): American National Standard for Testing Unlicensed Wireless Devices

[KDB558074 D01 15.247 Meas Guidance v05r02](#): Digital Transmission Systems (DTS) and Frequency Hopping measurement procedures

## 2. SUMMARY

### 2.1. General Remarks

|                                |   |               |
|--------------------------------|---|---------------|
| Date of receipt of test sample | : | Mar. 23, 2022 |
|                                | : |               |
| Testing commenced on           | : | Mar. 23, 2022 |
|                                | : |               |
| Testing concluded on           | : | Apr.12, 2022  |

### 2.2. Product Description

|                      |                                                                                                                                        |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Product Name         | Laptop                                                                                                                                 |
| Trade Mark           | N/A                                                                                                                                    |
| Model/Type reference | EZbook X1s                                                                                                                             |
| List Models          | EZbook X1s PRO, EZbook X1s plus, EZbook X1s MAX                                                                                        |
| Model Declaration    | PCB board, structure and internal of these model(s) are the same, Only the model name different , So no additional models were tested. |
| Power supply:        | DC 7.6V by battery<br>Recharged by DC 12.0V                                                                                            |
| Sample ID            | GTS20220224002-1-1#&GTS20220224002-1-2#                                                                                                |
| Bluetooth            |                                                                                                                                        |
| Operation frequency  | 2402-2480MHz                                                                                                                           |
| 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, 8DPSK for Bluetooth (DSS)<br>GFSK for Bluetooth (DTS)                                                            |
| WIFI(2.4G Band)      |                                                                                                                                        |
| Frequency Range      | 2412MHz ~ 2462MHz                                                                                                                      |
| Channel Spacing      | 5MHz                                                                                                                                   |
| Channel Number       | 11 Channel for 20MHz bandwidth(2412~2462MHz)<br>7 Channel for 40MHz bandwidth(2422~2452MHz)                                            |
| Modulation Type      | 802.11b: DSSS; 802.11g/n: OFDM                                                                                                         |
| Antenna Description  | Internal Antenna, 2.00dBi(Max.) for 2.4G Band                                                                                          |

## 2.3. Equipment Under Test

### Power supply system utilised

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

DC 12.0V

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

This is a Laptop .

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) |
|---------|----------------|---------|----------------|
| 00      | 2402           | 40      | 2442           |
| 01      | 2403           | 41      | 2443           |
| 02      | 2404           | 42      | 2444           |
| --      | --             | --      | --             |
| --      | --             | --      | --             |
| 38      | 2440           | 78      | 2480           |
| 39      | 2441           |         |                |

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

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: 2AQAA-EZBOOKX1S** 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 (MP\_Kit\_RTL11n\_8723DU\_USB\_v1.16\_20180821), tests under continuous transmission conditions, and changes the test channel.

## 2.9. Special Accessories

| Manufacturer                                    | Description | Model           | Serial Number | Certificate |
|-------------------------------------------------|-------------|-----------------|---------------|-------------|
| SHENZHEN SHI YING<br>YUAN ELECTRONICS CO<br>LTD | Adapter     | ICP30A-120-2000 | --            | SDOC        |

## 2.10. External I/O Cable

| I/O Port Description | Quantity | Cable                  |
|----------------------|----------|------------------------|
| DC IN Port           | 1        | 1.0M, Unscreened Cable |
| USB Port             | 2        | N/A                    |
| HDMI Port            | 1        | N/A                    |
| Earphone Port        | 1        | N/A                    |

## 2.11. Modifications

No modifications were implemented to meet testing criteria.

### 3. TEST ENVIRONMENT

#### 3.1. Address of the test laboratory

##### **Shenzhen Global Test Service Co.,Ltd.**

No.7-101 and 8A-104, Building 7 and 8, DCC Cultural and Creative Garden, No.98, Pingxin North Road, Shangmugu Community, Pinghu Street, Longgang District, Shenzhen, Guangdong, China.

#### 3.2. Test Facility

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

CNAS (No. CNAS L8169)

Shenzhen Global Test Service Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2019 General Requirements) for the Competence of Testing and Calibration Laboratories.

A2LA (Certificate No. 4758.01)

Shenzhen Global Test Service Co., Ltd. has been assessed by the American Association for Laboratory Accreditation (A2LA). Certificate No. 4758.01.

Industry Canada Registration Number. is 24189.

FCC Designation Number is CN1234.

FCC Registered Test Site Number is 165725.

#### 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 CISPR 16 - 4 „Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the Shenzhen Global Test Service 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 GTS laboratory is reported:

| Test                  | Range      | Measurement Uncertainty | Notes |
|-----------------------|------------|-------------------------|-------|
| Radiated Emission     | 30~1000MHz | 4.10 dB                 | (1)   |
| Radiated Emission     | 1~18GHz    | 4.32 dB                 | (1)   |
| Radiated Emission     | 18-40GHz   | 5.54 dB                 | (1)   |
| Conducted Disturbance | 0.15~30MHz | 3.12 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                   | GTS20220224002-1-1#                        | Compliant | Note 1 |
| §15.247(c)                              | Frequency Separation                             | GTS20220224002-1-1#                        | Compliant | Note 1 |
| §15.247(c)                              | 99% and 20 dB Bandwidth                          | GTS20220224002-1-1#                        | Compliant | Note 1 |
| §15.247(a)(1)(ii)                       | Number of Hopping Frequency                      | GTS20220224002-1-1#                        | Compliant | Note 1 |
| §15.247(a)(1)(iii)                      | Time Of Occupancy (Dwell Time)                   | GTS20220224002-1-1#                        | Compliant | Note 1 |
| §15.209, §15.205                        | Conducted Spurious Emissions and Band Edges Test | GTS20220224002-1-1#<br>GTS20220224002-1-2# | Compliant | Note 1 |
| §15.209, §15.247(d)                     | Radiated Spurious Emissions                      | GTS20220224002-1-1#<br>GTS20220224002-1-2# | Compliant | Note 1 |
| §15.205                                 | Emissions at Restricted Band                     | GTS20220224002-1-1#<br>GTS20220224002-1-2# | Compliant | Note 1 |
| §15.207(a)                              | AC Conducted Emissions                           | GTS20220224002-1-2#                        | Compliant | Note 1 |
| §15.203<br>§15.247(c)                   | Antenna Requirements                             | GTS20220224002-1-1#                        | Compliant | Note 1 |
| §15.247(i)§2.1091                       | 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

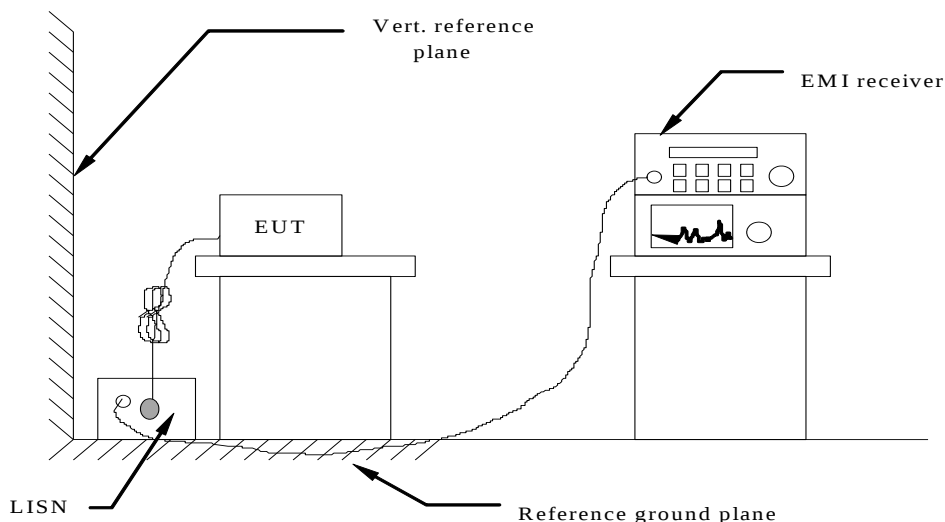
| Test Equipment             | Manufacturer                      | Model No.             | Serial No.      | Calibration Date | Calibration Due Date |
|----------------------------|-----------------------------------|-----------------------|-----------------|------------------|----------------------|
| LISN                       | CYBERTEK                          | EM5040A               | E1850400105     | 2021/07/17       | 2022/07/16           |
| LISN                       | R&S                               | ESH2-Z5               | 893606/008      | 2021/07/17       | 2022/07/16           |
| EMI Test Receiver          | R&S                               | ESPI3                 | 101841-cd       | 2021/07/17       | 2022/07/16           |
| EMI Test Receiver          | R&S                               | ESCI7                 | 101102          | 2021/09/19       | 2022/09/18           |
| Spectrum Analyzer          | Agilent                           | N9020A                | MY48010425      | 2021/09/19       | 2022/09/18           |
| Spectrum Analyzer          | R&S                               | FSV40                 | 100019          | 2021/07/17       | 2022/07/16           |
| Vector Signal generator    | Agilent                           | N5181A                | MY49060502      | 2021/07/17       | 2022/07/16           |
| Signal generator           | Agilent                           | N5182A                | 3610AO1069      | 2021/09/19       | 2022/09/18           |
| Climate Chamber            | ESPEC                             | EL-10KA               | A20120523       | 2021/09/19       | 2022/09/18           |
| Controller                 | EM Electronics                    | Controller EM 1000    | N/A             | N/A              | N/A                  |
| Horn Antenna               | Schwarzbeck                       | BBHA 9120D            | 01622           | 2021/11/07       | 2022/11/06           |
| Active Loop Antenna        | Beijing Da Ze Technology Co.,Ltd. | ZN30900C              | 15006           | 2021/10/10       | 2022/11/09           |
| Bilog Antenna              | Schwarzbeck                       | VULB9163              | 000976          | 2021/07/23       | 2022/07/22           |
| Broadband Horn Antenna     | SCHWARZBECK                       | BBHA 9170             | 791             | 2021/11/07       | 2022/11/06           |
| Amplifier                  | Schwarzbeck                       | BBV 9743              | #202            | 2021/08/08       | 2022/08/07           |
| Amplifier                  | Schwarzbeck                       | BBV9179               | 9719-025        | 2021/07/17       | 2022/07/16           |
| Amplifier                  | EMCI                              | EMC051845B            | 980355          | 2021/07/17       | 2022/07/16           |
| Temperature/Humidity Meter | Gangxing                          | CTH-608               | 02              | 2021/07/17       | 2022/07/16           |
| High-Pass Filter           | K&L                               | 9SH10-2700/X12750-O/O | KL142031        | 2021/07/17       | 2022/07/16           |
| High-Pass Filter           | K&L                               | 41H10-1375/U12750-O/O | KL142032        | 2021/07/17       | 2022/07/16           |
| RF Cable(below 1GHz)       | HUBER+SUHNER                      | RG214                 | RE01            | 2021/07/17       | 2022/07/16           |
| RF Cable(above 1GHz)       | HUBER+SUHNER                      | RG214                 | RE02            | 2021/07/17       | 2022/07/16           |
| Data acquisition card      | Agilent                           | U2531A                | TW53323507      | 2021/07/17       | 2022/07/16           |
| Power Sensor               | Agilent                           | U2021XA               | MY5365004       | 2021/07/17       | 2022/07/16           |
| Test Control Unit          | Tonscend                          | JS0806-1              | 178060067       | 2021/07/17       | 2022/07/16           |
| Automated filter bank      | Tonscend                          | JS0806-F              | 19F8060177      | 2021/07/17       | 2022/07/16           |
| EMI Test Software          | Tonscend                          | JS1120-1              | Ver 2.6.8.0518  | /                | /                    |
| EMI Test Software          | Tonscend                          | JS1120-3              | Ver 2.5.77.0418 | /                | /                    |
| EMI Test Software          | Tonscend                          | JS32-CE               | Ver 2.5         | /                | /                    |
| EMI Test Software          | Tonscend                          | JS32-RE               | Ver 2.5.1.8     | /                | /                    |

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 C63.10-2013.
- 2 Support equipment, if needed, was placed as per ANSI C63.10-2013.
- 3 All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013.
- 4 The EUT received DC 12V power, the adapter received AC120V/60Hz or AC 240V/60Hz 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.

#### TEST RESULTS

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

|               |            |                |     |
|---------------|------------|----------------|-----|
| Temperature   | 25°C       | Humidity       | 60% |
| Test Engineer | Jenny Zeng | Configurations | BT  |

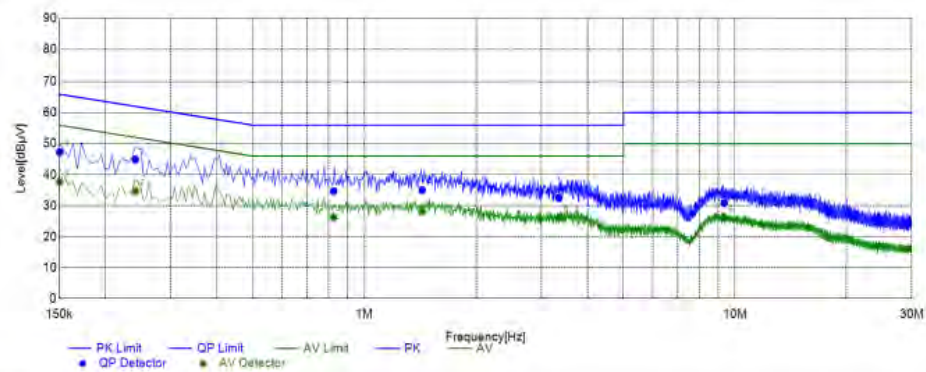
Power supply:

AC 120V/60Hz

Polarization

L

Test Graph



Final Data List

| NO. | Frequency<br>[MHz] | QP<br>Reading<br>[dBμV] | AVG.<br>Reading<br>[dBμV] | Factor<br>[dB] | QP<br>Result<br>[dBμV] | AVG.<br>Result<br>[dBμV] | QP<br>Limit<br>[dBμV] | AVG.<br>Limit<br>[dBμV] | QP<br>Margin<br>[dB] | AVG.<br>Margin<br>[dB] | Line | Remark |
|-----|--------------------|-------------------------|---------------------------|----------------|------------------------|--------------------------|-----------------------|-------------------------|----------------------|------------------------|------|--------|
| 1   | 0.1506             | 37.66                   | 28.15                     | 9.60           | 47.26                  | 37.75                    | 65.97                 | 55.97                   | 18.71                | 18.22                  | L1   | PASS   |
| 2   | 0.2408             | 35.44                   | 25.19                     | 9.50           | 44.94                  | 34.69                    | 62.07                 | 52.07                   | 17.13                | 17.38                  | L1   | PASS   |
| 3   | 0.8265             | 25.30                   | 16.79                     | 9.40           | 34.70                  | 26.19                    | 56.00                 | 46.00                   | 21.30                | 19.81                  | L1   | PASS   |
| 4   | 1.4325             | 25.68                   | 18.77                     | 9.38           | 35.06                  | 28.15                    | 56.00                 | 46.00                   | 20.94                | 17.85                  | L1   | PASS   |
| 5   | 3.3508             | 23.17                   | 16.59                     | 9.37           | 32.54                  | 25.96                    | 56.00                 | 46.00                   | 23.46                | 20.04                  | L1   | PASS   |
| 6   | 9.3537             | 21.68                   | 16.74                     | 9.21           | 30.89                  | 25.95                    | 60.00                 | 50.00                   | 29.11                | 24.05                  | L1   | PASS   |

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

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

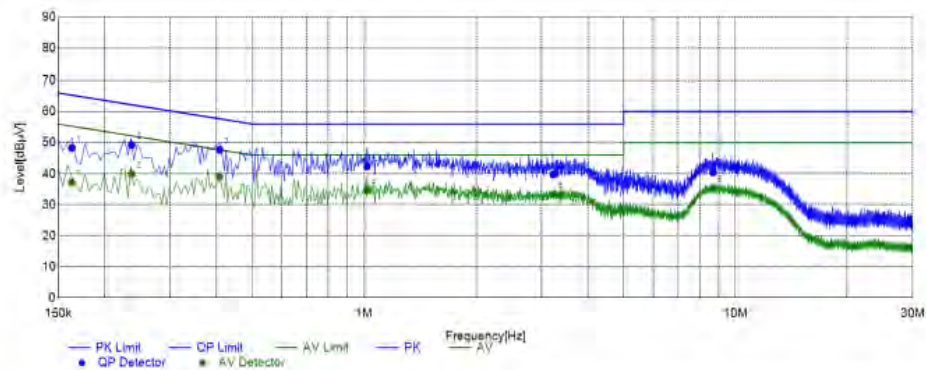
Power supply:

AC 120V/60Hz

Polarization

N

Test Graph



Final Data List

| NO. | Frequency<br>[MHz] | QP<br>Reading<br>[dBμV] | AVG.<br>Reading<br>[dBμV] | Factor<br>[dB] | QP<br>Result<br>[dBμV] | AVG.<br>Result<br>[dBμV] | QP<br>Limit<br>[dBμV] | AVG.<br>Limit<br>[dBμV] | QP<br>Margin<br>[dB] | AVG.<br>Margin<br>[dB] | Line | Remark |
|-----|--------------------|-------------------------|---------------------------|----------------|------------------------|--------------------------|-----------------------|-------------------------|----------------------|------------------------|------|--------|
| 1   | 0.1632             | 38.73                   | 27.63                     | 9.60           | 48.33                  | 37.23                    | 65.30                 | 55.30                   | 16.97                | 18.07                  | N    | PASS   |
| 2   | 0.2366             | 39.71                   | 30.34                     | 9.55           | 49.26                  | 39.89                    | 62.21                 | 52.21                   | 12.95                | 12.32                  | N    | PASS   |
| 3   | 0.4078             | 38.25                   | 29.58                     | 9.47           | 47.72                  | 39.05                    | 57.69                 | 47.69                   | 9.97                 | 8.64                   | N    | PASS   |
| 4   | 1.0178             | 33.01                   | 25.14                     | 9.36           | 42.37                  | 34.50                    | 56.00                 | 46.00                   | 13.63                | 11.50                  | N    | PASS   |
| 5   | 3.2325             | 30.40                   | 23.95                     | 9.34           | 39.74                  | 33.29                    | 56.00                 | 46.00                   | 16.26                | 12.71                  | N    | PASS   |
| 6   | 8.7002             | 31.17                   | 25.95                     | 9.30           | 40.47                  | 35.25                    | 60.00                 | 50.00                   | 19.53                | 14.75                  | N    | PASS   |

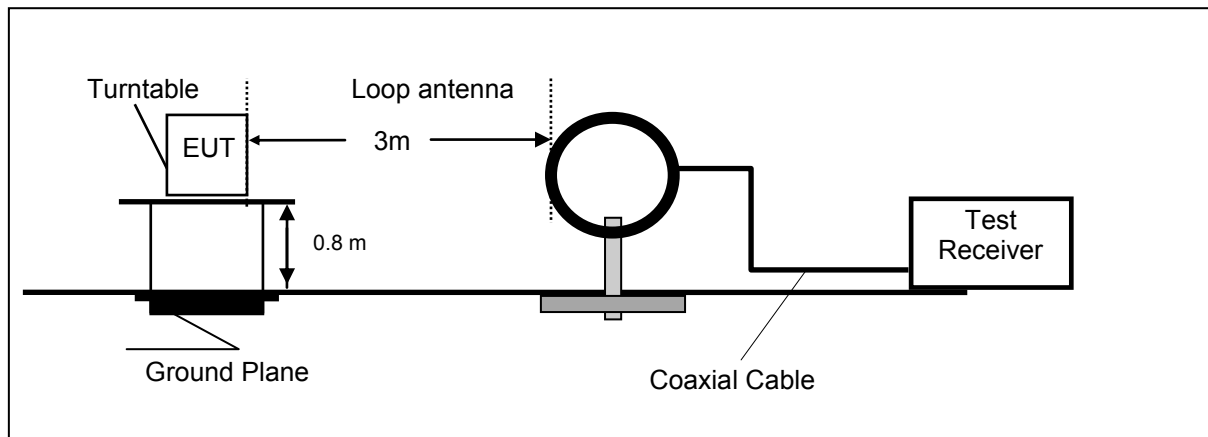
Note: 1. Result (dBμV) = Reading (dBμV) + Factor (dB).

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

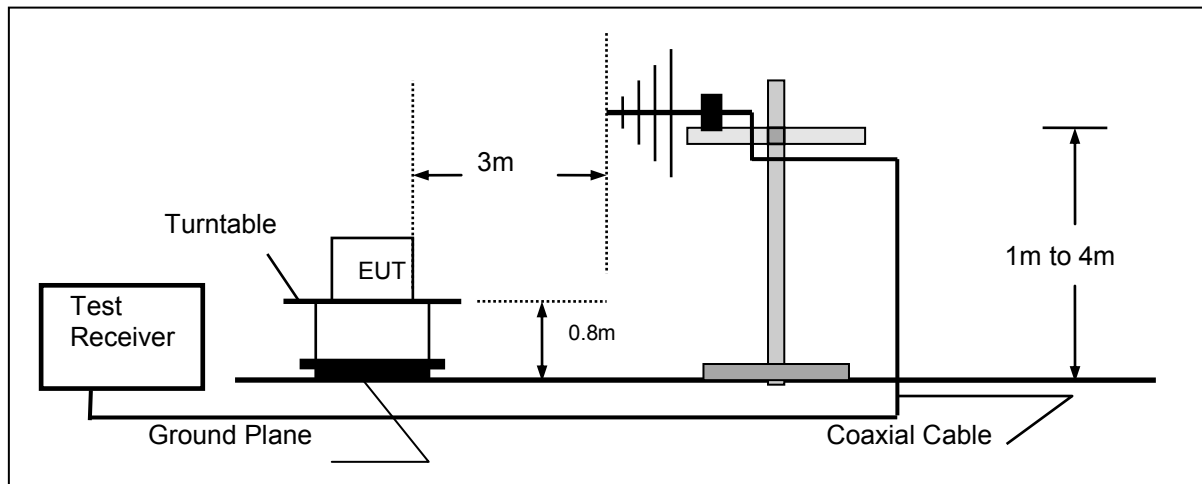
## 4.2. Radiated Emission

### TEST CONFIGURATION

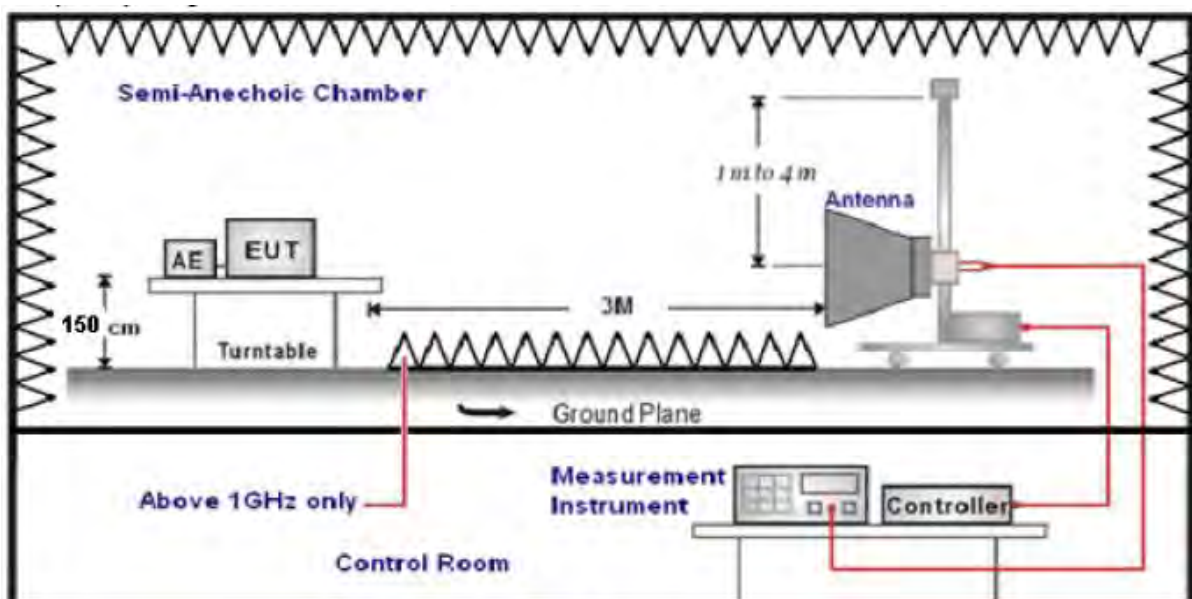
Frequency range 9 KHz – 30MHz



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                 | $20\log(2400/F(\text{KHz}))+40\log(300/3)$ | $2400/F(\text{KHz})$  |
| 0.49-1.705      | 3                 | $20\log(24000/F(\text{KHz}))+40\log(30/3)$ | $24000/F(\text{KHz})$ |
| 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, π/4-DQPSK and 8DPSK mode from 30MHz to 25GHz and recorded worst case at GFSK(1Mbps-MCH) mode.

|               |            |                |     |
|---------------|------------|----------------|-----|
| Temperature   | 25℃        | Humidity       | 60% |
| Test Engineer | Jenny Zeng | Configurations | BT  |

**For 9 KHz~30MHz**

| Freq. (MHz) | Level (dBμV) | Over Limit (dB) | Over Limit (dBμV) | 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.

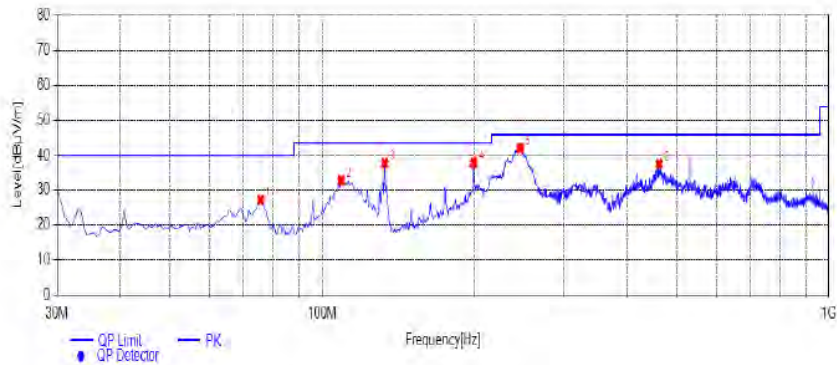
Distance extrapolation factor =  $40 \log (\text{specific distance} / \text{test distance})$  (dB);

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

## For 30MHz-1GHz

## Horizontal

## Test Graph



## Suspected List

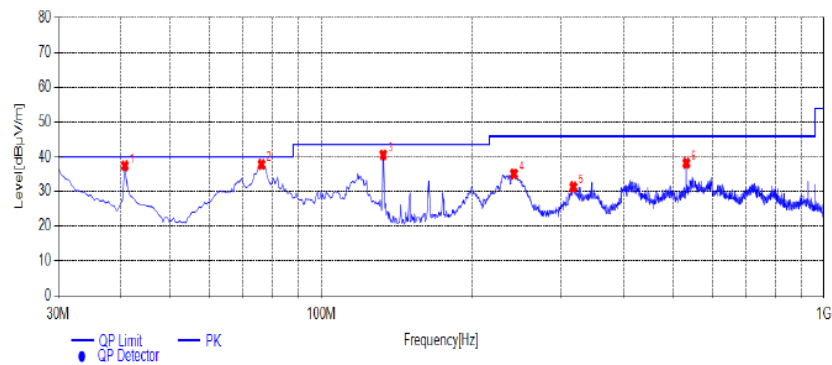
| NO. | Frequency [MHz] | Reading [dBμV/m] | Factor [dB] | Result [dBμV/m] | Limit [dBμV/m] | Margin [dB] | Height [cm] | Angle [°] | Detector | Polarity   | Remark |
|-----|-----------------|------------------|-------------|-----------------|----------------|-------------|-------------|-----------|----------|------------|--------|
| 1   | 75.5900         | -39.69           | -12.46      | 27.23           | 40.00          | 12.77       | 100         | 69        | PK       | Horizontal | PASS   |
| 2   | 109.0650        | 41.11            | -8.32       | 32.79           | 43.50          | 10.71       | 100         | 156       | PK       | Horizontal | PASS   |
| 3   | 132.8200        | 50.14            | -12.38      | 37.76           | 43.50          | 5.74        | 100         | 55        | PK       | Horizontal | PASS   |
| 4   | 199.2650        | 46.92            | -9.06       | 37.86           | 43.50          | 5.64        | 100         | 289       | PK       | Horizontal | PASS   |
| 5   | 246.3100        | 50.48            | -8.33       | 42.15           | 46.00          | 3.85        | 100         | 2         | PK       | Horizontal | PASS   |
| 6   | 462.6200        | 41.67            | -4.17       | 37.50           | 46.00          | 8.50        | 100         | 238       | PK       | Horizontal | PASS   |

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

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

## Vertical

## Test Graph



## Suspected List

| NO. | Frequency [MHz] | Reading [dBμV/m] | Factor [dB] | Result [dBμV/m] | Limit [dBμV/m] | Margin [dB] | Height [cm] | Angle [°] | Detector | Polarity | Remark |
|-----|-----------------|------------------|-------------|-----------------|----------------|-------------|-------------|-----------|----------|----------|--------|
| 1   | 40.6700         | 44.89            | -7.45       | 37.44           | 40.00          | 2.56        | 100         | 305       | PK       | Vertical | PASS   |
| 2   | 76.0750         | 50.23            | -12.43      | 37.80           | 40.00          | 2.20        | 100         | 63        | PK       | Vertical | PASS   |
| 3   | 132.8200        | 52.97            | -12.38      | 40.59           | 43.50          | 2.91        | 100         | 44        | PK       | Vertical | PASS   |
| 4   | 241.9450        | 43.60            | -8.50       | 35.10           | 46.00          | 10.90       | 100         | 151       | PK       | Vertical | PASS   |
| 5   | 317.6050        | 38.34            | -7.07       | 31.27           | 46.00          | 14.73       | 100         | 28        | PK       | Vertical | PASS   |
| 6   | 532.9450        | 41.22            | -3.04       | 38.18           | 46.00          | 7.82        | 100         | 134       | PK       | Vertical | PASS   |

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

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

## 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   | 51.28        | 32.44          | 30.25        | 7.95         | 61.42           | 74.00        | -12.58    | Peak    | Horizontal |
| 4804.00   | 34.97        | 32.44          | 30.25        | 7.95         | 45.11           | 54.00        | -8.89     | Average | Horizontal |
| 4804.00   | 53.71        | 32.44          | 30.25        | 7.95         | 63.85           | 74.00        | -10.15    | Peak    | Vertical   |
| 4804.00   | 36.18        | 32.44          | 30.25        | 7.95         | 46.32           | 54.00        | -7.68     | 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   | 50.65        | 32.52          | 30.31        | 8.12         | 60.98           | 74.00        | -13.02    | Peak    | Horizontal |
| 4882.00   | 37.03        | 32.52          | 30.31        | 8.12         | 47.36           | 54.00        | -6.64     | Average | Horizontal |
| 4882.00   | 50.91        | 32.52          | 30.31        | 8.12         | 61.24           | 74.00        | -12.76    | Peak    | Vertical   |
| 4882.00   | 36.29        | 32.52          | 30.31        | 8.12         | 46.62           | 54.00        | -7.38     | 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   | 50.08        | 32.68          | 30.27        | 7.88         | 60.37           | 74.00        | -13.63    | Peak    | Horizontal |
| 4960.00   | 36.22        | 32.68          | 30.27        | 7.88         | 46.51           | 54.00        | -7.49     | Average | Horizontal |
| 4960.00   | 48.67        | 32.68          | 30.27        | 7.88         | 58.96           | 74.00        | -15.04    | Peak    | Vertical   |
| 4960.00   | 31.00        | 32.68          | 30.27        | 7.88         | 41.29           | 54.00        | -12.71    | Average | Vertical   |

 $\pi/4$ -DQPSK /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   | 50.33        | 32.44          | 30.25        | 7.95         | 60.47           | 74.00        | -13.53    | Peak    | Horizontal |
| 4804.00   | 36.39        | 32.44          | 30.25        | 7.95         | 46.53           | 54.00        | -7.47     | Average | Horizontal |
| 4804.00   | 53.16        | 32.44          | 30.25        | 7.95         | 63.30           | 74.00        | -10.70    | Peak    | Vertical   |
| 4804.00   | 35.98        | 32.44          | 30.25        | 7.95         | 46.12           | 54.00        | -7.88     | 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   | 49.62        | 32.52          | 30.31        | 8.12         | 59.95           | 74.00        | -14.05    | Peak    | Horizontal |
| 4882.00   | 37.48        | 32.52          | 30.31        | 8.12         | 47.81           | 54.00        | -6.19     | Average | Horizontal |
| 4882.00   | 52.76        | 32.52          | 30.31        | 8.12         | 63.09           | 74.00        | -10.91    | Peak    | Vertical   |
| 4882.00   | 36.35        | 32.52          | 30.31        | 8.12         | 46.68           | 54.00        | -7.32     | 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   | 50.42        | 32.68          | 30.27        | 7.88         | 60.71           | 74.00        | -13.29    | Peak    | Horizontal |
| 4960.00   | 36.73        | 32.68          | 30.27        | 7.88         | 47.02           | 54.00        | -6.98     | Average | Horizontal |
| 4960.00   | 49.43        | 32.68          | 30.27        | 7.88         | 59.72           | 74.00        | -14.28    | Peak    | Vertical   |
| 4960.00   | 31.39        | 32.68          | 30.27        | 7.88         | 41.68           | 54.00        | -12.32    | Average | Vertical   |

## 8-DPSK /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   | 50.81        | 32.44          | 30.25        | 7.95         | 60.95           | 74.00        | -13.05    | Peak    | Horizontal |
| 4804.00   | 35.48        | 32.44          | 30.25        | 7.95         | 45.62           | 54.00        | -8.38     | Average | Horizontal |
| 4804.00   | 53.67        | 32.44          | 30.25        | 7.95         | 63.81           | 74.00        | -10.19    | Peak    | Vertical   |
| 4804.00   | 36.07        | 32.44          | 30.25        | 7.95         | 46.21           | 54.00        | -7.79     | 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   | 50.15        | 32.52          | 30.31        | 8.12         | 60.48           | 74.00        | -13.52    | Peak    | Horizontal |
| 4882.00   | 37.53        | 32.52          | 30.31        | 8.12         | 47.86           | 54.00        | -6.14     | Average | Horizontal |
| 4882.00   | 51.19        | 32.52          | 30.31        | 8.12         | 61.52           | 74.00        | -12.48    | Peak    | Vertical   |
| 4882.00   | 35.15        | 32.52          | 30.31        | 8.12         | 45.48           | 54.00        | -8.52     | Average | Vertical   |

## Channel 78 / 2480 MHz

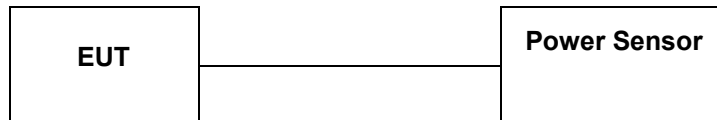
| Freq. MHz | Reading dBuV | Ant. Fac. dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuV/m | Limit dBuV/m | Margin dB | Remark  | Pol.       |
|-----------|--------------|----------------|--------------|--------------|-----------------|--------------|-----------|---------|------------|
| 4960.00   | 50.52        | 32.68          | 30.27        | 7.88         | 60.81           | 74.00        | -13.19    | Peak    | Horizontal |
| 4960.00   | 35.06        | 32.68          | 30.27        | 7.88         | 45.35           | 54.00        | -8.65     | Average | Horizontal |
| 4960.00   | 49.59        | 32.68          | 30.27        | 7.88         | 59.88           | 74.00        | -14.12    | Peak    | Vertical   |
| 4960.00   | 31.07        | 32.68          | 30.27        | 7.88         | 41.36           | 54.00        | -12.64    | 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

### 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 derector 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

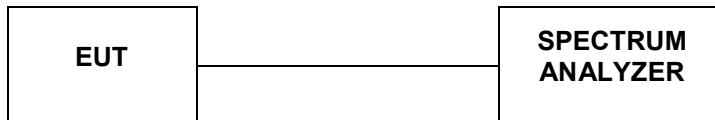
|               |            |                |       |
|---------------|------------|----------------|-------|
| Temperature   | 22.6°C     | Humidity       | 52.3% |
| Test Engineer | Jenny Zeng | Configurations | BT    |

| Modulation     | Channel | Peak Output power (dBm) | Limit (dBm) | Result |
|----------------|---------|-------------------------|-------------|--------|
| GFSK           | 00      | 2.89                    | 21          | Pass   |
|                | 39      | 3.75                    |             |        |
|                | 78      | 3.19                    |             |        |
| $\pi/4$ -DQPSK | 00      | 4.15                    | 21          | Pass   |
|                | 39      | 5.01                    |             |        |
|                | 78      | 4.52                    |             |        |
| 8DPSK          | 00      | 4.31                    | 21          | Pass   |
|                | 39      | 5.32                    |             |        |
|                | 78      | 4.38                    |             |        |

Note: The test results including the cable lose.

#### 4.4. 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

|               |            |                |       |
|---------------|------------|----------------|-------|
| Temperature   | 22.6℃      | Humidity       | 52.3% |
| Test Engineer | Jenny Zeng | Configurations | BT    |

| Modulation     | Frequency | 20dB Bandwidth (MHz) | Result |
|----------------|-----------|----------------------|--------|
| GFSK           | 2402 MHz  | 1.041                | PASS   |
|                | 2441 MHz  | 1.041                | PASS   |
|                | 2480 MHz  | 1.041                | PASS   |
| $\pi/4$ -DQPSK | 2402 MHz  | 1.365                | PASS   |
|                | 2441 MHz  | 1.359                | PASS   |
|                | 2480 MHz  | 1.365                | PASS   |
| 8-DPSK         | 2402 MHz  | 1.302                | PASS   |
|                | 2441 MHz  | 1.302                | PASS   |
|                | 2480 MHz  | 1.302                | PASS   |

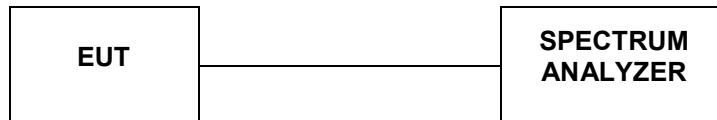
Test plot as follows:



| 8-DPSK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |      |                |                        |            |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|----------------|------------------------|------------|----------|----------------|----------------|----------------|---|---|---|---|--------------|------------|--|--|--|---|---|---|---|--------------|-----------|--|--|--|---|------------|---|----------------|------------------------|----------|--|--|--|--|
| <div><div>KeySight Spectrum Analyzer - Swept SA</div><div><div>Center Freq 2.40200000 GHz</div><div>Ref Offset 9.23 dB<br/>Ref 19.23 dBm</div><div><math>\Delta</math>Mkr3 1.302 MHz<br/>0.11 dB</div></div><div><div>Center 2.402000 GHz</div><div>#Res BW 30 kHz</div><div>#VBW 100 kHz</div><div>Sweep 3.200 ms (1001 pts)</div></div><table><thead><tr><th>MKR</th><th>MODE</th><th>TRC</th><th>SCL</th><th>X</th><th>Y</th><th>FUNCTION</th><th>FUNCTION WIDTH</th><th>FUNCTION VALUE</th></tr></thead><tbody><tr><td>1</td><td>N</td><td>1</td><td>f</td><td>2.401340 GHz</td><td>-25.26 dBm</td><td></td><td></td><td></td></tr><tr><td>2</td><td>N</td><td>1</td><td>f</td><td>2.401883 GHz</td><td>-5.02 dBm</td><td></td><td></td><td></td></tr><tr><td>3</td><td><math>\Delta</math>1</td><td>1</td><td>f (<math>\Delta</math>)</td><td>1.302 MHz (<math>\Delta</math>)</td><td>0.11 dB</td><td></td><td></td><td></td></tr></tbody></table></div>   | MKR        | MODE | TRC            | SCL                    | X          | Y        | FUNCTION       | FUNCTION WIDTH | FUNCTION VALUE | 1 | N | 1 | f | 2.401340 GHz | -25.26 dBm |  |  |  | 2 | N | 1 | f | 2.401883 GHz | -5.02 dBm |  |  |  | 3 | $\Delta$ 1 | 1 | f ( $\Delta$ ) | 1.302 MHz ( $\Delta$ ) | 0.11 dB  |  |  |  |  |
| MKR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MODE       | TRC  | SCL            | X                      | Y          | FUNCTION | FUNCTION WIDTH | FUNCTION VALUE |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | N          | 1    | f              | 2.401340 GHz           | -25.26 dBm |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | N          | 1    | f              | 2.401883 GHz           | -5.02 dBm  |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $\Delta$ 1 | 1    | f ( $\Delta$ ) | 1.302 MHz ( $\Delta$ ) | 0.11 dB    |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| CH00                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |      |                |                        |            |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| <div><div>KeySight Spectrum Analyzer - Swept SA</div><div><div>Center Freq 2.44100000 GHz</div><div>Ref Offset 9.35 dB<br/>Ref 19.35 dBm</div><div><math>\Delta</math>Mkr3 1.302 MHz<br/>-0.27 dB</div></div><div><div>Center 2.441000 GHz</div><div>#Res BW 30 kHz</div><div>#VBW 100 kHz</div><div>Sweep 3.200 ms (1001 pts)</div></div><table><thead><tr><th>MKR</th><th>MODE</th><th>TRC</th><th>SCL</th><th>X</th><th>Y</th><th>FUNCTION</th><th>FUNCTION WIDTH</th><th>FUNCTION VALUE</th></tr></thead><tbody><tr><td>1</td><td>N</td><td>1</td><td>f</td><td>2.440340 GHz</td><td>-24.23 dBm</td><td></td><td></td><td></td></tr><tr><td>2</td><td>N</td><td>1</td><td>f</td><td>2.440883 GHz</td><td>-4.10 dBm</td><td></td><td></td><td></td></tr><tr><td>3</td><td><math>\Delta</math>1</td><td>1</td><td>f (<math>\Delta</math>)</td><td>1.302 MHz (<math>\Delta</math>)</td><td>-0.27 dB</td><td></td><td></td><td></td></tr></tbody></table></div> | MKR        | MODE | TRC            | SCL                    | X          | Y        | FUNCTION       | FUNCTION WIDTH | FUNCTION VALUE | 1 | N | 1 | f | 2.440340 GHz | -24.23 dBm |  |  |  | 2 | N | 1 | f | 2.440883 GHz | -4.10 dBm |  |  |  | 3 | $\Delta$ 1 | 1 | f ( $\Delta$ ) | 1.302 MHz ( $\Delta$ ) | -0.27 dB |  |  |  |  |
| MKR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MODE       | TRC  | SCL            | X                      | Y          | FUNCTION | FUNCTION WIDTH | FUNCTION VALUE |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | N          | 1    | f              | 2.440340 GHz           | -24.23 dBm |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | N          | 1    | f              | 2.440883 GHz           | -4.10 dBm  |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $\Delta$ 1 | 1    | f ( $\Delta$ ) | 1.302 MHz ( $\Delta$ ) | -0.27 dB   |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| CH39                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |      |                |                        |            |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| <div><div>KeySight Spectrum Analyzer - Swept SA</div><div><div>Center Freq 2.48000000 GHz</div><div>Ref Offset 9.35 dB<br/>Ref 19.35 dBm</div><div><math>\Delta</math>Mkr3 1.302 MHz<br/>-0.18 dB</div></div><div><div>Center 2.480000 GHz</div><div>#Res BW 30 kHz</div><div>#VBW 100 kHz</div><div>Sweep 3.200 ms (1001 pts)</div></div><table><thead><tr><th>MKR</th><th>MODE</th><th>TRC</th><th>SCL</th><th>X</th><th>Y</th><th>FUNCTION</th><th>FUNCTION WIDTH</th><th>FUNCTION VALUE</th></tr></thead><tbody><tr><td>1</td><td>N</td><td>1</td><td>f</td><td>2.479337 GHz</td><td>-25.15 dBm</td><td></td><td></td><td></td></tr><tr><td>2</td><td>N</td><td>1</td><td>f</td><td>2.479877 GHz</td><td>-5.14 dBm</td><td></td><td></td><td></td></tr><tr><td>3</td><td><math>\Delta</math>1</td><td>1</td><td>f (<math>\Delta</math>)</td><td>1.302 MHz (<math>\Delta</math>)</td><td>-0.18 dB</td><td></td><td></td><td></td></tr></tbody></table></div> | MKR        | MODE | TRC            | SCL                    | X          | Y        | FUNCTION       | FUNCTION WIDTH | FUNCTION VALUE | 1 | N | 1 | f | 2.479337 GHz | -25.15 dBm |  |  |  | 2 | N | 1 | f | 2.479877 GHz | -5.14 dBm |  |  |  | 3 | $\Delta$ 1 | 1 | f ( $\Delta$ ) | 1.302 MHz ( $\Delta$ ) | -0.18 dB |  |  |  |  |
| MKR                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MODE       | TRC  | SCL            | X                      | Y          | FUNCTION | FUNCTION WIDTH | FUNCTION VALUE |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | N          | 1    | f              | 2.479337 GHz           | -25.15 dBm |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | N          | 1    | f              | 2.479877 GHz           | -5.14 dBm  |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $\Delta$ 1 | 1    | f ( $\Delta$ ) | 1.302 MHz ( $\Delta$ ) | -0.18 dB   |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |
| CH78                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |      |                |                        |            |          |                |                |                |   |   |   |   |              |            |  |  |  |   |   |   |   |              |           |  |  |  |   |            |   |                |                        |          |  |  |  |  |

## 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

|               |            |                |       |
|---------------|------------|----------------|-------|
| Temperature   | 22.6°C     | Humidity       | 52.3% |
| Test Engineer | Jenny Zeng | Configurations | BT    |

| Modulation     | Channel | Ch. Separation (MHz) | Limit (MHz)  | Result   |
|----------------|---------|----------------------|--------------|----------|
| GFSK           | Hopping | 1.006                | $\geq 0.694$ | Complies |
| $\pi/4$ -DQPSK | Hopping | 1.004                | $\geq 0.910$ | Complies |
| 8-DPSK         | Hopping | 1.000                | $\geq 0.868$ | Complies |

**Ch. Separation Limits:  $> \frac{2}{3}$  of 20dB bandwidth**



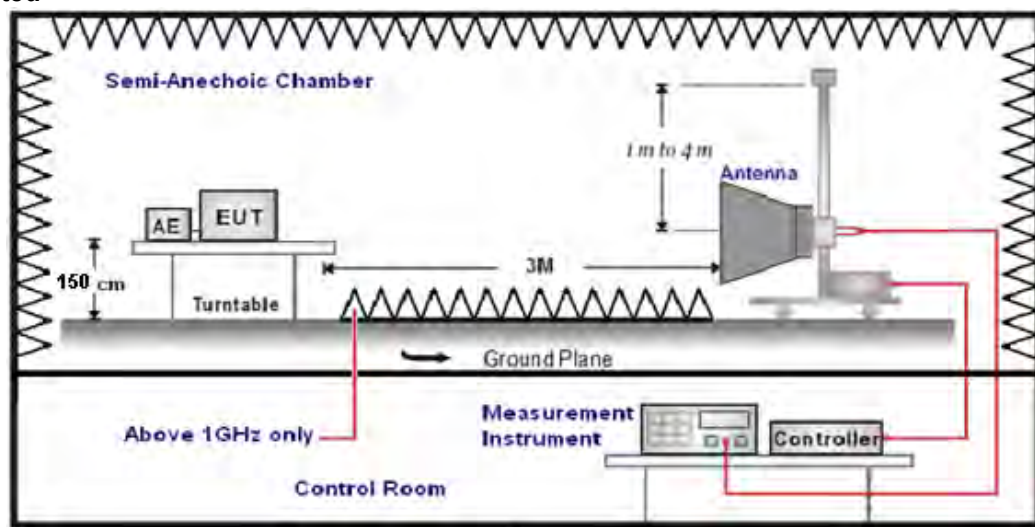
## 4.6. Band Edge Compliance of RF Emission

### TEST REQUIREMENT

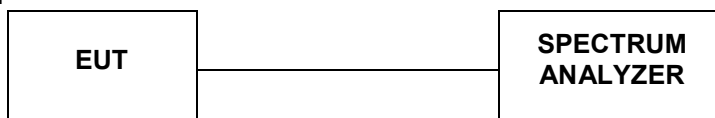
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the 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**

Remark: we measured all conditions(DH1,DH3,DH5) and recorded worst case at DH1.

**4.6.1 For Radiated Bandedge Measurement**

Remark: we tested radiated bandedge at both hopping and no-hopping modes,recorded worst case at no-hopping mode

|               |            |                |       |
|---------------|------------|----------------|-------|
| Temperature   | 23.8℃      | Humidity       | 53.7% |
| Test Engineer | Jenny Zeng | Configurations | BT    |

**GFSK**

| Frequency(MHz): |                         |    | 2402           |             |                    | Polarity:            |                  |                       | HORIZONTAL        |               |                          |
|-----------------|-------------------------|----|----------------|-------------|--------------------|----------------------|------------------|-----------------------|-------------------|---------------|--------------------------|
| Frequency (MHz) | Emission Level (dBuV/m) |    | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier | Correction Factor (dB/m) |
| 2390.00         | 46.98                   | PK | 74.00          | -27.02      | 1                  | 106                  | 52.29            | 27.49                 | 3.32              | 36.12         | -5.31                    |
| 2390.00         | 35.45                   | AV | 54.00          | -18.55      | 1                  | 106                  | 40.76            | 27.49                 | 3.32              | 36.12         | -5.31                    |
| Frequency(MHz): |                         |    | 2402           |             |                    | Polarity:            |                  |                       | VERTICAL          |               |                          |
| Frequency (MHz) | Emission Level (dBuV/m) |    | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier | Correction Factor (dB/m) |
| 2390.00         | 50.34                   | PK | 74.00          | -23.66      | 1                  | 289                  | 55.65            | 27.49                 | 3.32              | 36.12         | -5.31                    |
| 2390.00         | 30.60                   | AV | 54.00          | -23.40      | 1                  | 289                  | 35.91            | 27.49                 | 3.32              | 36.12         | -5.31                    |
| Frequency(MHz): |                         |    | 2480           |             |                    | Polarity:            |                  |                       | HORIZONTAL        |               |                          |
| Frequency (MHz) | Emission Level (dBuV/m) |    | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier | Correction Factor (dB/m) |
| 2483.50         | 46.67                   | PK | 74.00          | -27.33      | 1                  | 157                  | 52.39            | 27.45                 | 3.38              | 36.55         | -5.72                    |
| 2483.50         | 34.77                   | AV | 54.00          | -19.23      | 1                  | 157                  | 40.49            | 27.45                 | 3.38              | 36.55         | -5.72                    |
| Frequency(MHz): |                         |    | 2480           |             |                    | Polarity:            |                  |                       | VERTICAL          |               |                          |
| Frequency (MHz) | Emission Level (dBuV/m) |    | Limit (dBuV/m) | Margin (dB) | Antenna Height (m) | Table Angle (Degree) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier | Correction Factor (dB/m) |
| 2483.50         | 48.78                   | PK | 74.00          | -25.22      | 1                  | 101                  | 54.50            | 27.45                 | 3.38              | 36.55         | -5.72                    |
| 2483.50         | 30.15                   | AV | 54.00          | -23.85      | 1                  | 101                  | 35.87            | 27.45                 | 3.38              | 36.55         | -5.72                    |

**REMARKS:**

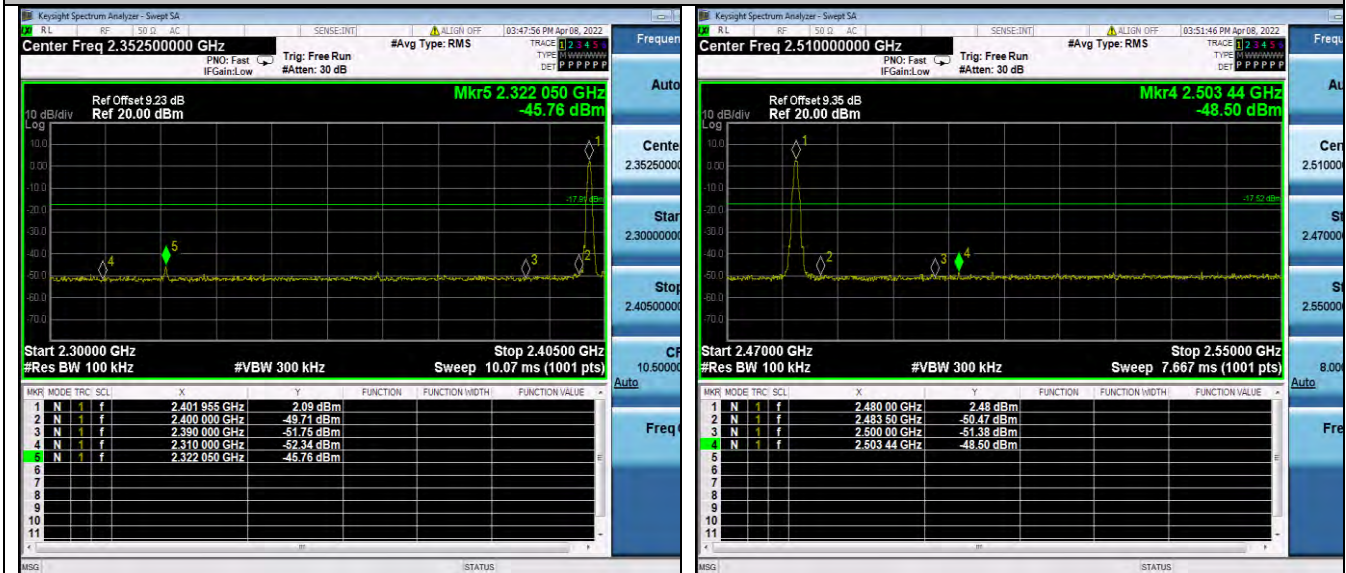
1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

## 4.6.2 For Conducted Bandedge Measurement

|               |            |                |       |
|---------------|------------|----------------|-------|
| Temperature   | 22.6°C     | Humidity       | 52.3% |
| Test Engineer | Jenny Zeng | Configurations | BT    |

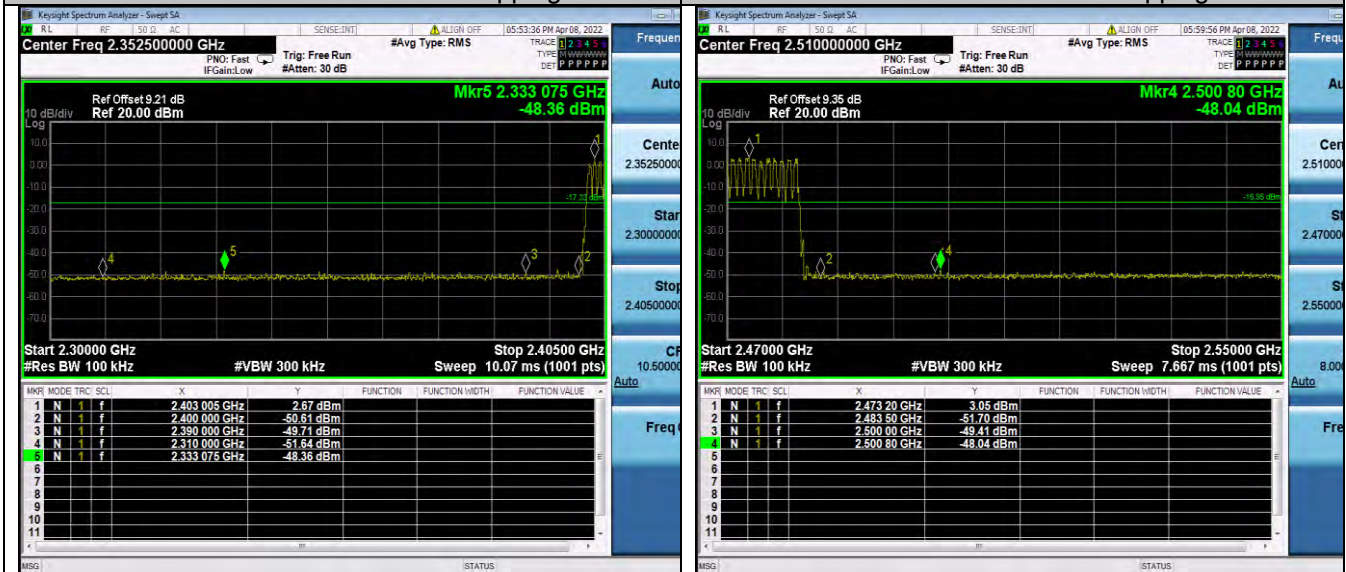
## Band-edge for RF conducted emissions

## GFSK



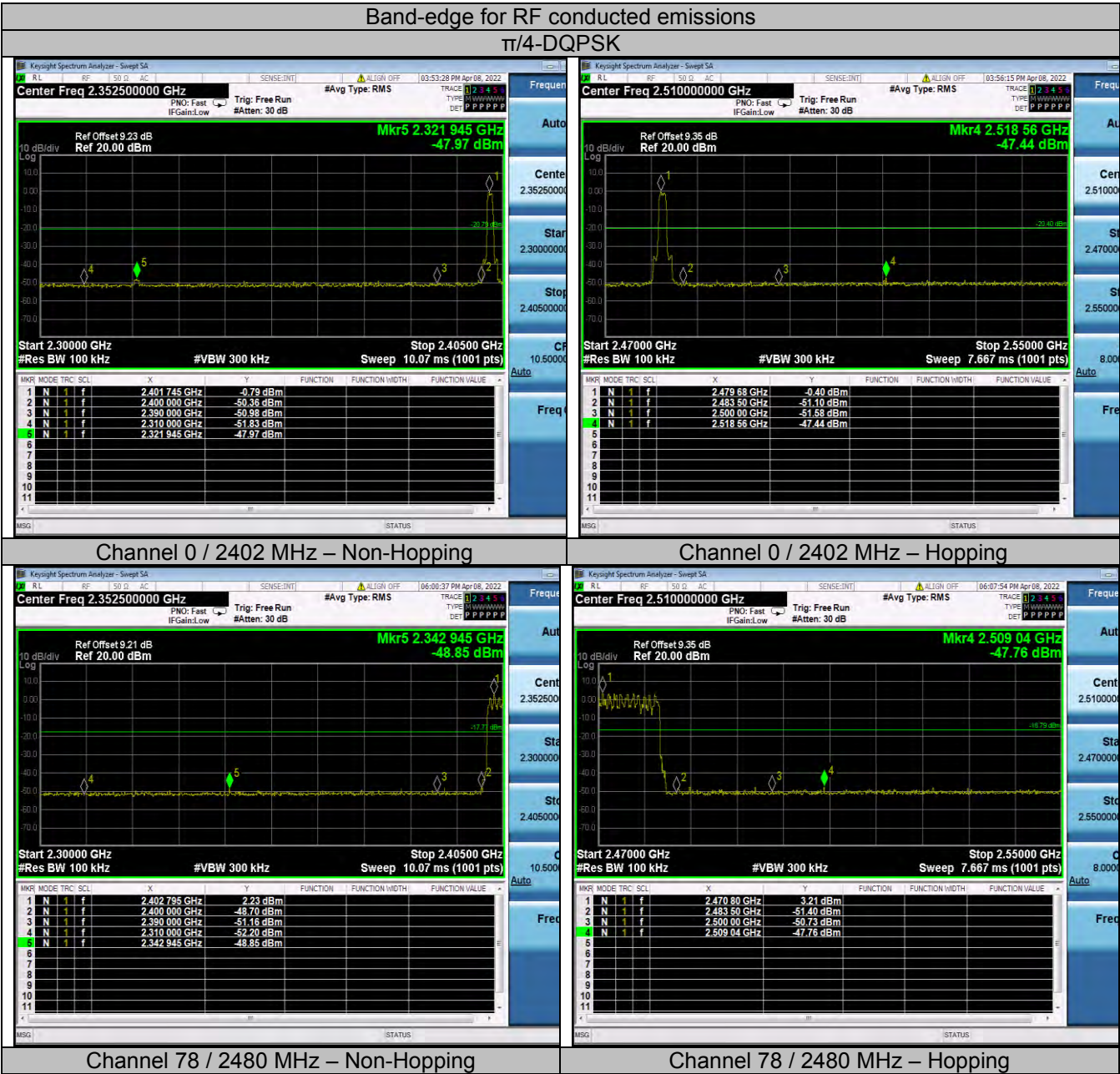
## Channel 0 / 2402 MHz – Non-Hopping

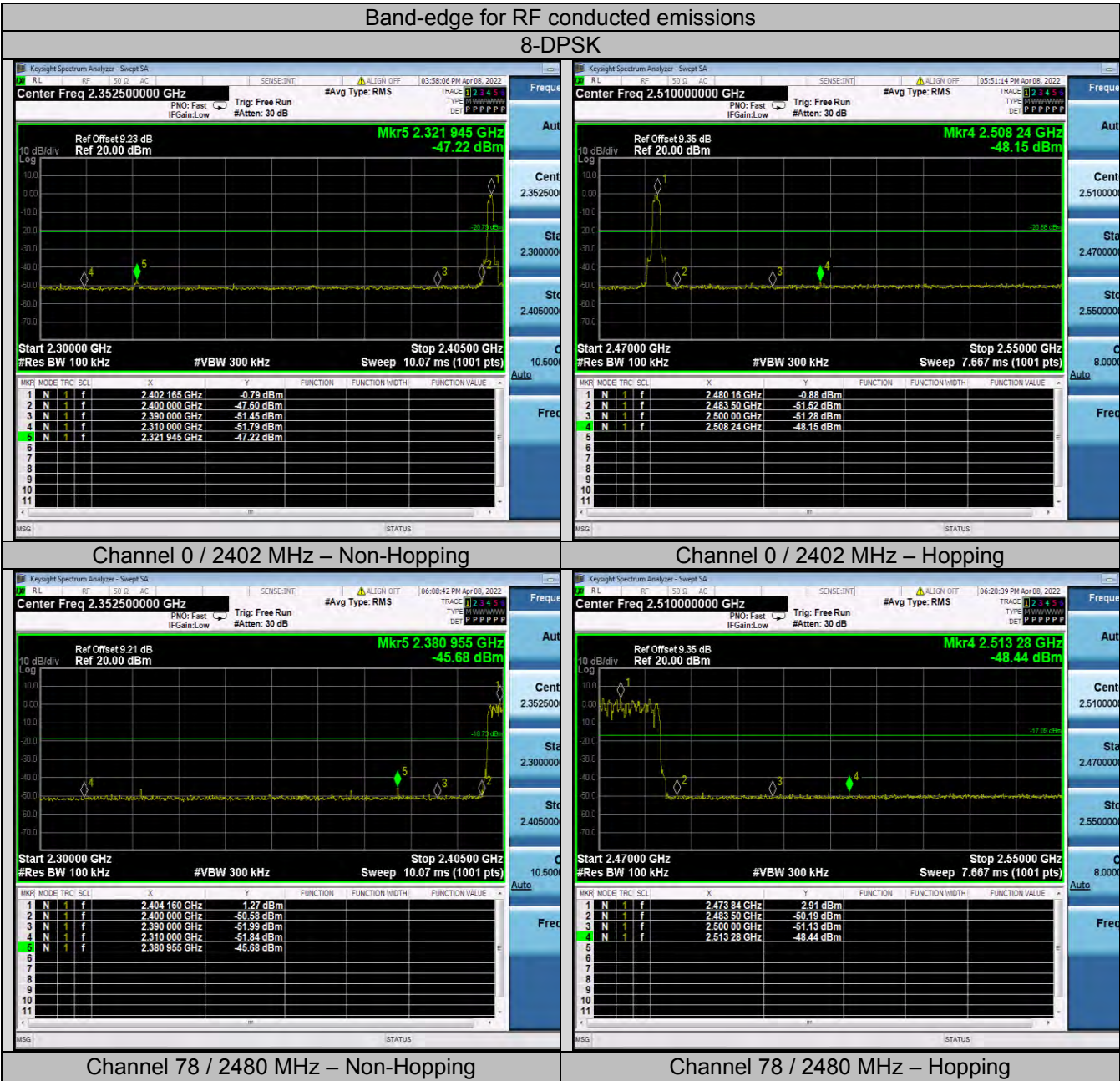
## Channel 0 / 2402 MHz – Hopping



## Channel 78 / 2480 MHz – Non-Hopping

## Channel 78 / 2480 MHz – Hopping

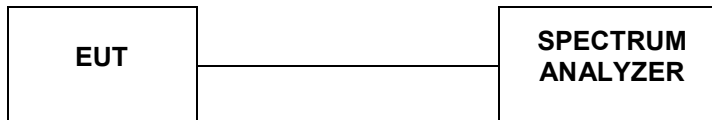




NOTE: Hopping enabled and disabled have evaluated, and the worst data was reported.

## 4.7. Number of hopping frequency

### TEST CONFIGURATION



### TEST PROCEDURE

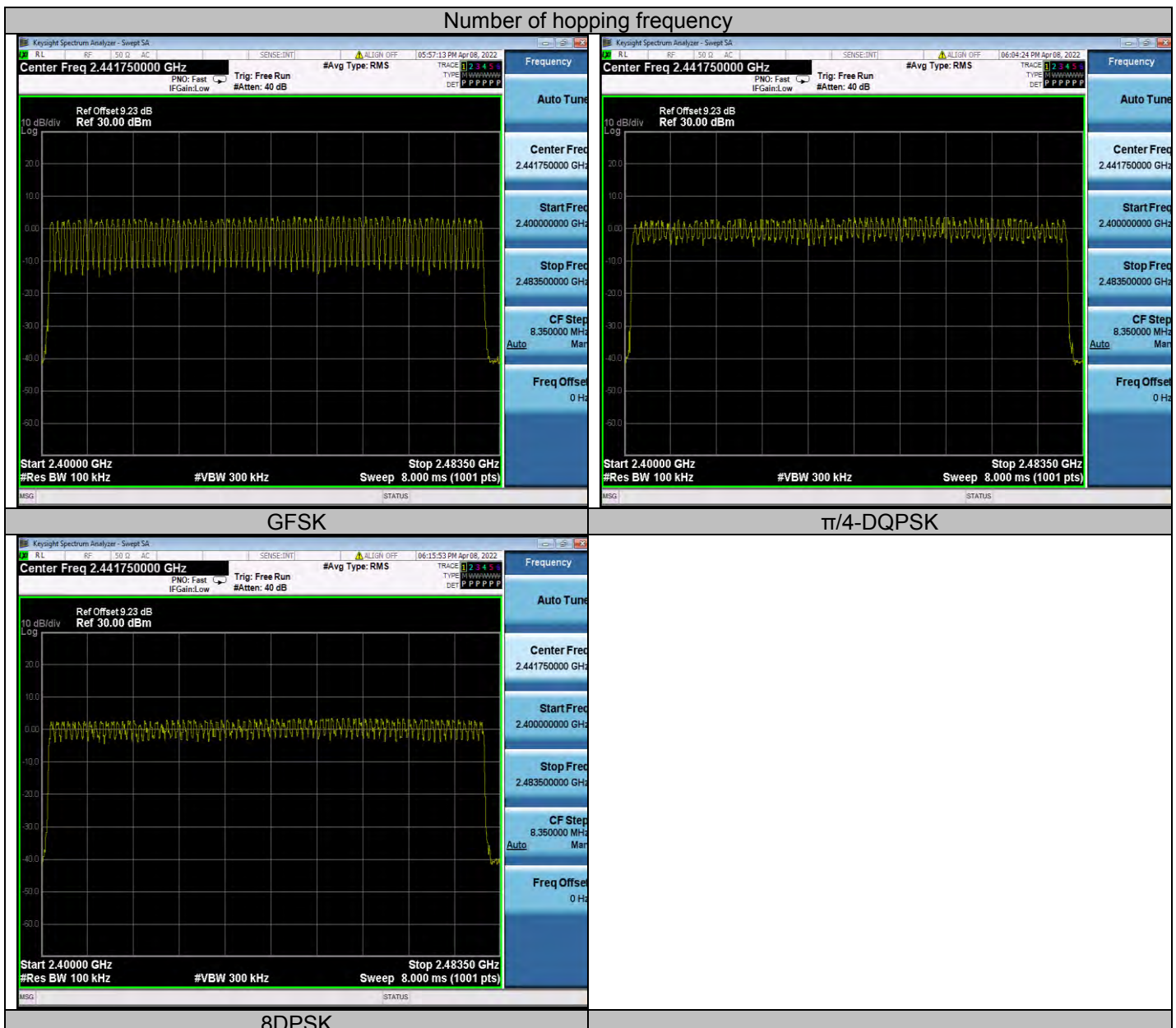
The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 2400MHz to 2483.5MHz with RBW=100KHz and VBW=300KHz.

### LIMIT

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

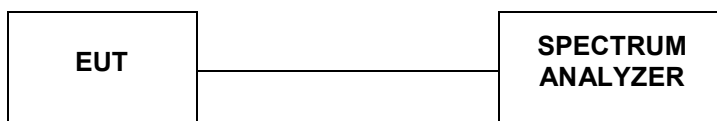
|               |            |                |       |
|---------------|------------|----------------|-------|
| Temperature   | 22.6°C     | Humidity       | 52.3% |
| Test Engineer | Jenny Zeng | Configurations | BT    |

| Modulation     | Number of Hopping Channel | Limit | Result |
|----------------|---------------------------|-------|--------|
| GFSK           | 79                        | ≥15   | Pass   |
| $\pi/4$ -DQPSK | 79                        | ≥15   | Pass   |
| 8DPSK          | 79                        | ≥15   | Pass   |



#### 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

|               |            |                |       |
|---------------|------------|----------------|-------|
| Temperature   | 22.6℃      | Humidity       | 52.3% |
| Test Engineer | Jenny Zeng | Configurations | BT    |

| Modulation | Data Packet | Frequency | Pulse Duration | Dwell Time | Limits |
|------------|-------------|-----------|----------------|------------|--------|
|            |             |           | (ms)           | (s)        | (s)    |
| GFSK       | DH1         | 2441 MHz  | 0.37           | 0.12       | 0.40   |
|            | DH3         | 2441 MHz  | 1.63           | 0.26       | 0.40   |
|            | DH5         | 2441 MHz  | 2.87           | 0.31       | 0.40   |
| π/4-DQPSK  | 2DH1        | 2441 MHz  | 0.38           | 0.12       | 0.40   |
|            | 2DH3        | 2441 MHz  | 1.63           | 0.26       | 0.40   |
|            | 2DH5        | 2441 MHz  | 2.88           | 0.31       | 0.40   |
| 8-DPSK     | 3DH1        | 2441 MHz  | 0.36           | 0.12       | 0.40   |
|            | 3DH3        | 2441 MHz  | 1.63           | 0.26       | 0.40   |
|            | 3DH5        | 2441 MHz  | 2.88           | 0.31       | 0.40   |

The Dwell Time=Burst Width\*Total Hops. The detailed calculations are showed as follows:

The duration for dwell time calculation:  $0.4[s] \times \text{hopping number} = 0.4[s] \times 79[\text{ch}] = 31.6[s \cdot \text{ch}]$ ;

The burst width [ms/hop/ch], which is directly measured, refers to the duration on one channel hop.

The hops per second for all channels: The selected EUT Conf uses a slot type of 5-Tx&1-Rx and a hopping rate of 1600 [ch\*hop/s] for all channels. So the final hopping rate for all channels is  $1600/6=266.67$  [ch\*hop/s]

The hops per second on one channel:  $266.67 [\text{ch} \cdot \text{hops/s}] / 79 [\text{ch}] = 3.38$  [hop/s];

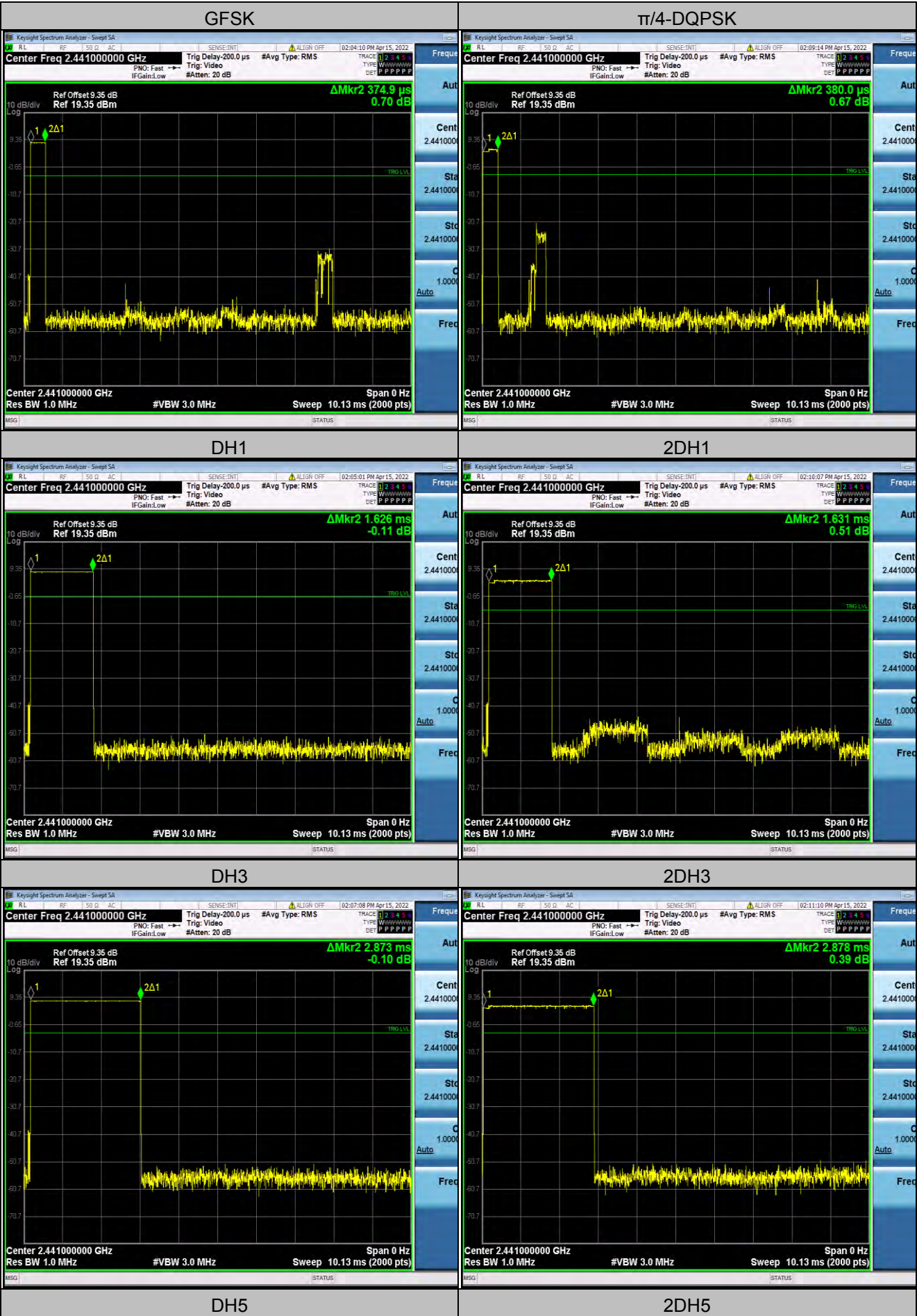
The total hops for all channels within the dwell time calculation duration:  $3.38 [\text{hop/s}] \times 31.6[s \cdot \text{ch}] = 106.67$  [hop\*ch];

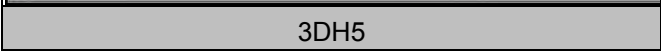
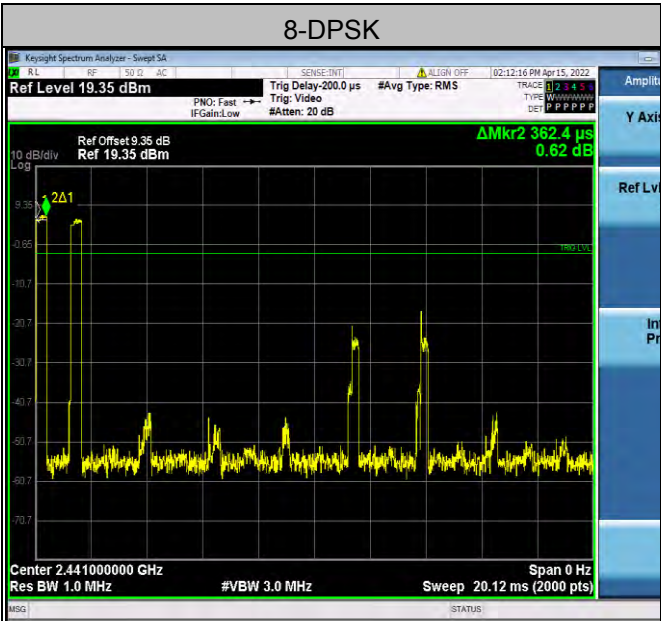
The dwell time for all channels hopping:  $106.67 [\text{hop} \cdot \text{ch}] \times \text{Burst Width} [\text{ms/hop/ch}]$ .

Remark:

1. Test results including cable loss;
2. Measured at difference Packet Type for each mode and recorded worst case for each mode.
3. Dwell Time Calculate formula:  
 DH1: Dwell time=Pulse Time (ms)  $\times (1600 \div 2 \div 79) \times 31.6$  Second  
 DH3: Dwell time=Pulse Time (ms)  $\times (1600 \div 4 \div 79) \times 31.6$  Second  
 DH5: Dwell time=Pulse Time (ms)  $\times (1600 \div 6 \div 79) \times 31.6$  Second

Test plot as follows:





## 4.9. Pseudorandom Frequency Hopping Sequence

### TEST APPLICABLE

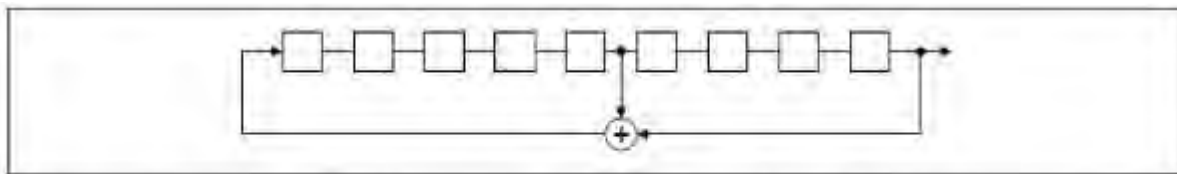
For 47 CFR Part 15C section 15.247 (a)(1) requirement:

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

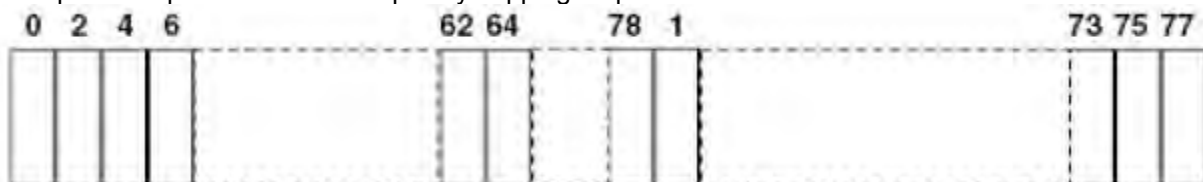
The pseudorandom frequency hopping sequence may be generated in a nine-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first one of 9 consecutive 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 2.00dBi.

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

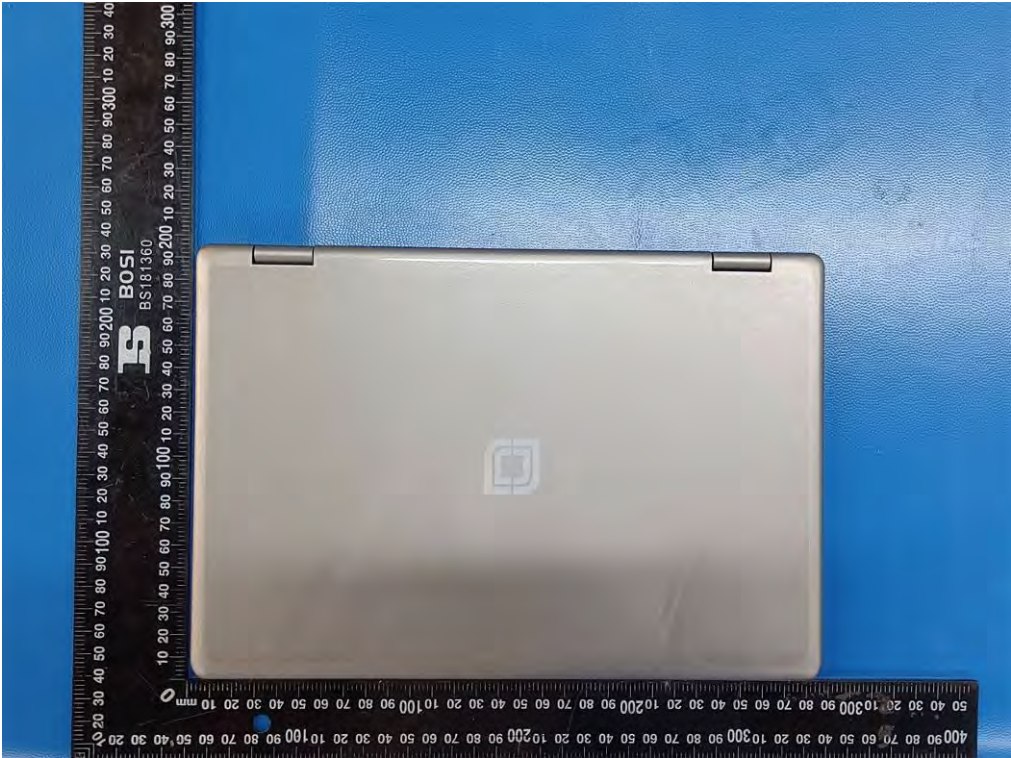


Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11

## 6.2. Internal photos of the EUT



Fig. 12



Fig. 13



Fig. 14

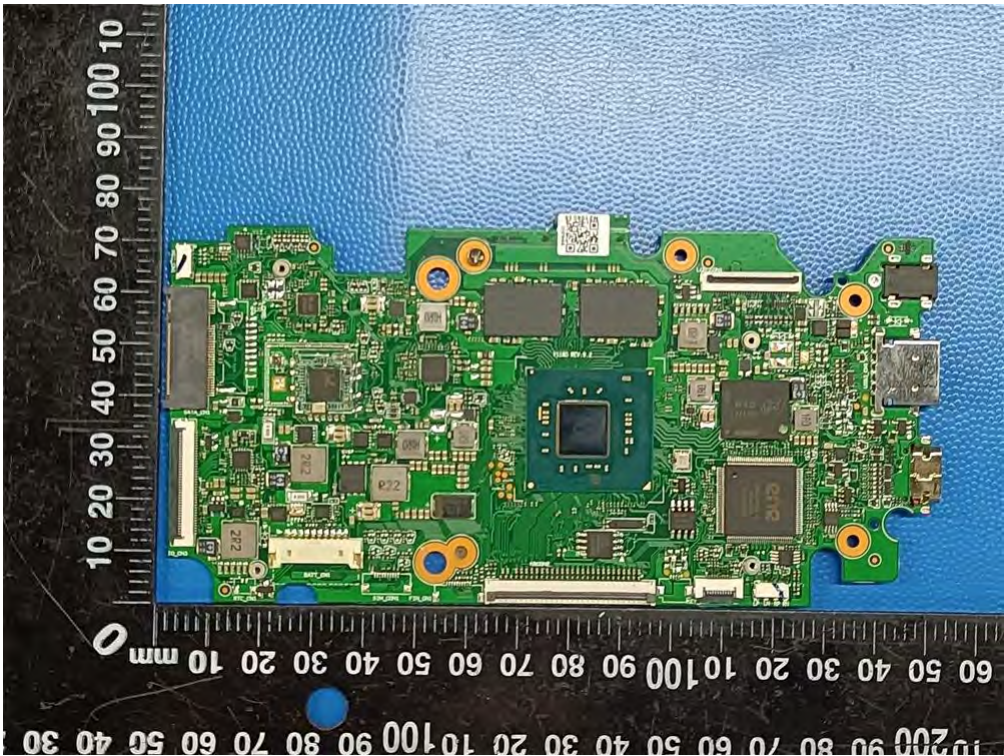


Fig. 15

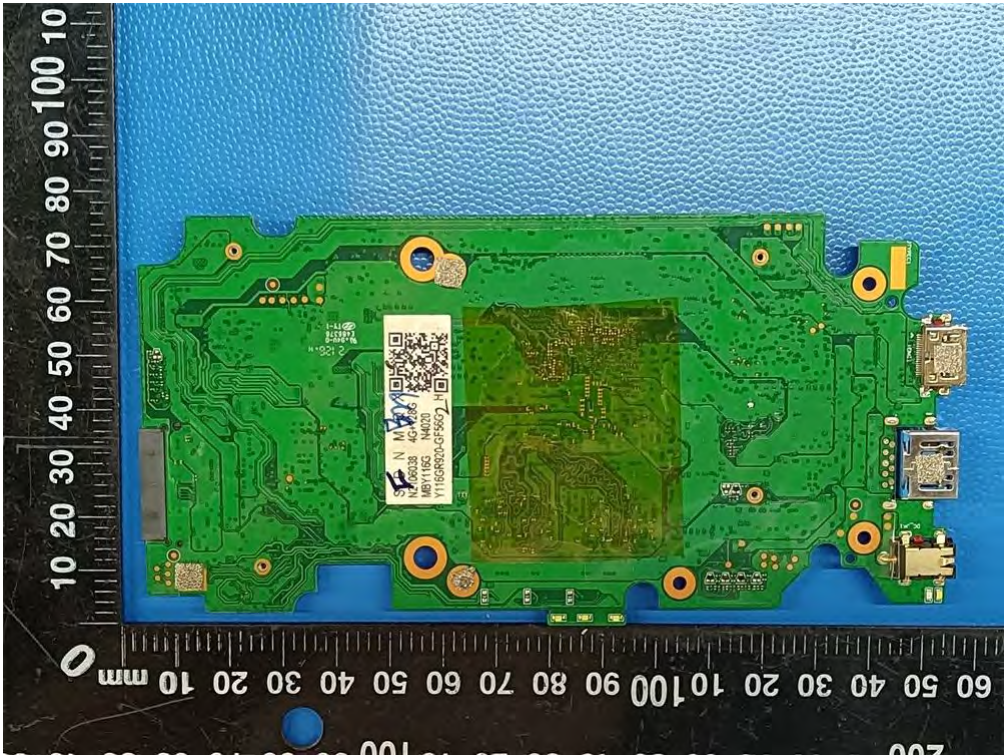


Fig. 16



Fig. 17



Fig. 18



Fig. 19

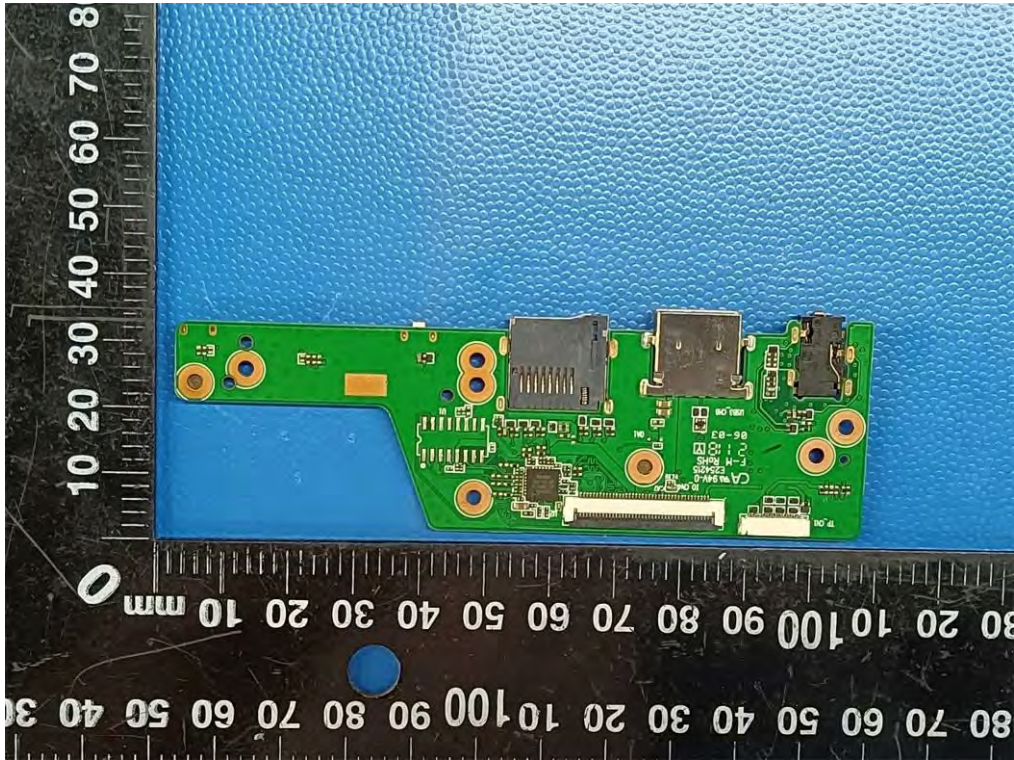


Fig. 20

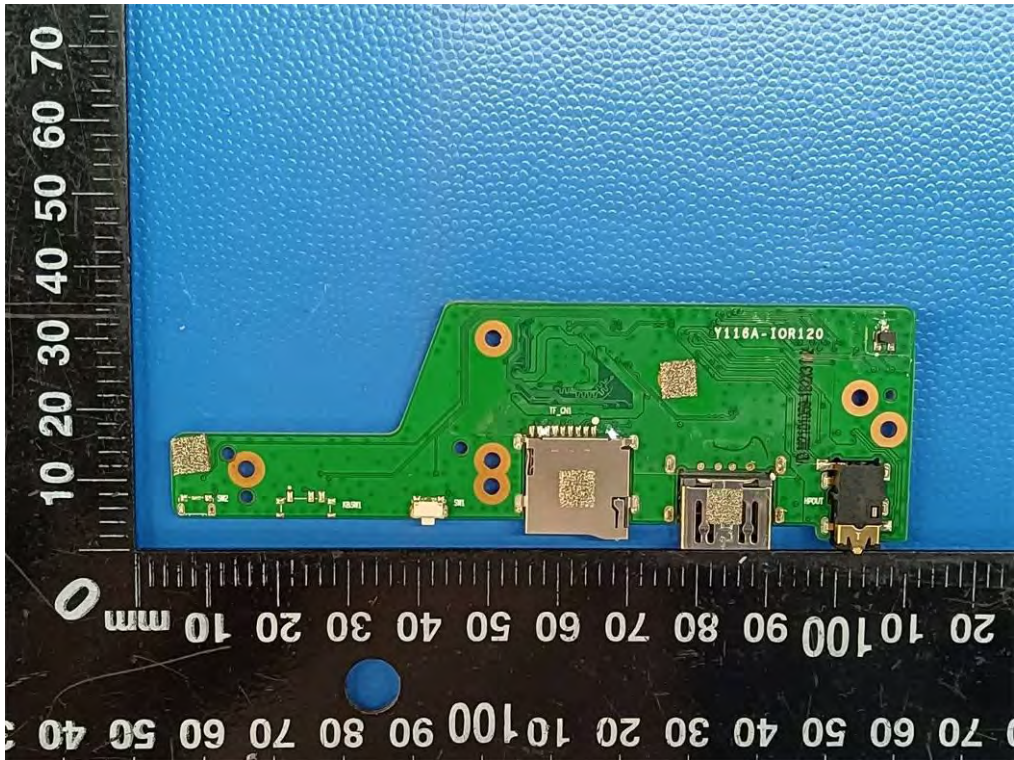


Fig. 21

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