



**FCC 47 CFR PART 15 SUBPART C  
ISED RSS-247 Issue 2**

**CERTIFICATION TEST REPORT**

*For*

**WLAN+Bluetooth Module**

**MODEL NUMBER: LBEE5PK2AE**

**PROJECT NUMBER: 4790016144.1**

**REPORT NUMBER: 4790016144.1-AE-2**

**FCC ID: VPYLB2AE**

**IC: 772C-LB2AE**

**ISSUE DATE: Jun. 28, 2022**

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Revision History

| Rev. | Issue Date | Revisions     | Revised By |
|------|------------|---------------|------------|
| V0   | 06/28/2022 | Initial Issue |            |



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## 1. ATTESTATION OF TEST RESULTS

### Applicant Information

Company Name: Murata Manufacturing Co., Ltd.  
Address: 10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555, Japan

### Manufacturer Information

Company Name: Murata Manufacturing Co., Ltd.  
Address: 10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555, Japan

### EUT Description

Product Name: WLAN+Bluetooth Module  
Model Name: LBEE5PK2AE  
Sample Number: 4059724  
Data of Receipt Sample: Jul. 12, 2021  
Date Tested: Jul. 23, 2021 ~ Jun. 27, 2022

| APPLICABLE STANDARDS     |              |
|--------------------------|--------------|
| STANDARD                 | TEST RESULTS |
| CFR 47 Part 15 Subpart C | PASS         |
| ISED RSS-247 Issue 2     | PASS         |
| ISED RSS-GEN Issue 5     | PASS         |



| Summary of Test Results                                                                                                                                                                                                                           |                                           |                                                                                                               |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------------------------------------------------------------------------------------------------|--------------|
| Clause                                                                                                                                                                                                                                            | Test Items                                | FCC/ISED Rules                                                                                                | Test Results |
| 1                                                                                                                                                                                                                                                 | 20dB Bandwidth and 99% Occupied Bandwidth | FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (a)<br>RSS-Gen Clause 6.7                                            | Pass         |
| 2                                                                                                                                                                                                                                                 | Conducted Output Power                    | FCC 15.247 (b) (1)<br>RSS-247 Clause 5.1 (b)                                                                  | Pass         |
| 3                                                                                                                                                                                                                                                 | Carrier Hopping Channel Separation        | FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (b)                                                                  | Pass         |
| 4                                                                                                                                                                                                                                                 | Number of Hopping Frequency               | 15.247 (a) (1) III<br>RSS-247 Clause 5.1 (d)                                                                  | Pass         |
| 5                                                                                                                                                                                                                                                 | Time of Occupancy (Dwell Time)            | 15.247 (a) (1) III<br>RSS-247 Clause 5.1 (d)                                                                  | Pass         |
| 6                                                                                                                                                                                                                                                 | Conducted Bandedge                        | FCC 15.247 (d)<br>RSS-247 Clause 5.5                                                                          | Pass         |
| 7                                                                                                                                                                                                                                                 | Radiated Bandedge and Spurious            | FCC 15.247 (d)<br>FCC 15.209<br>FCC 15.205<br>RSS-247 Clause 5.5<br>RSS-GEN Clause 8.9<br>RSS-GEN Clause 8.10 | Pass         |
| 8                                                                                                                                                                                                                                                 | Conducted Emission Test for AC Power Port | FCC 15.207<br>RSS-GEN Clause 8.8                                                                              | Pass         |
| 9                                                                                                                                                                                                                                                 | Antenna Requirement                       | FCC 15.203<br>RSS-GEN Clause 6.8                                                                              | Pass         |
| <p>Note:<br/>The measurement result for the sample received is &lt;Pass&gt; according to &lt; ANSI C63.10-2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15C, ISED RSS-GEN, ISED RSS-247&gt; when &lt;Accuracy Method&gt; decision rule is applied.</p> |                                           |                                                                                                               |              |

Prepared By:

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Reviewed By:

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Leon Wu

Authorized By:

*Chris Zhong*

Chris Zhong  
Laboratory Leader



## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with KDB 558074 D01 15.247 Meas Guidance v05r02, 414788 D01 Radiated Test Site v01r01, CFR 47 FCC Part 2, CFR 47 FCC Part 15, ANSI C63.10-2013, ISED RSS-247 Issue 2 and ISED RSS-GEN Issue 5.

## 3. FACILITIES AND ACCREDITATION

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accreditation<br>Certificate | <b>A2LA (Certificate No.: 4829.01)</b><br><b>UL-CCIC COMPANY LIMITED has been assessed and proved to be in compliance with A2LA.</b><br><b>FCC (FCC Designation No.: CN1247)</b><br><b>UL-CCIC COMPANY LIMITED has been recognized to perform compliance testing on equipment subject to the Commission's Declaration of Conformity (DoC) and Certification rules.</b><br><b>IC (IC Designation No.: 25056; CAB No.: CN0073)</b><br><b>UL-CCIC COMPANY LIMITED has been recognized to perform compliance testing on equipment subject to the Commission's Declaration of Conformity (DoC) and Certification rules.</b> |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Note 1: All tests measurement facilities use to collect the measurement data are located at No. 2, Chengwan Road, Suzhou Industrial Park, Suzhou 215122, People's Republic of China

Note 2: For below 30MHz, lab had performed measurements at test anechoic chamber and comparing to measurements obtained on an open field site. These measurements below 30MHz had been correlated to measurements performed on an OFS.

Note 3: The test anechoic chamber in UL-CCIC COMPANY LIMITED had been calibrated and compared to the open field sites and the test anechoic chamber is shown to be equivalent to or worst case from the open field site.



## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations and is traceable to recognized national standards.

### 4.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| Test Item                                                                                                                                     | Uncertainty           |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Conduction emission                                                                                                                           | 3.1dB                 |
| Radiation Emission test (include Fundamental emission)<br>(9kHz-30MHz)                                                                        | 3.4dB                 |
| Radiation Emission test (include Fundamental emission)<br>(30MHz-1GHz)                                                                        | 3.4dB                 |
| Radiation Emission test<br>(1GHz to 26GHz) (include Fundamental emission)                                                                     | 3.9dB (1GHz-18GHz)    |
|                                                                                                                                               | 4.2dB (18GHz-26.5GHz) |
| Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2. |                       |



## 5. EQUIPMENT UNDER TEST

### 5.1. DESCRIPTION OF EUT

|                                   |                                                                                                                                                                                  |           |                    |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------|
| Product Name:                     | WLAN+Bluetooth Module                                                                                                                                                            |           |                    |
| Model No.:                        | LBEE5PK2AE                                                                                                                                                                       |           |                    |
| Technology                        | Bluetooth – BR & EDR                                                                                                                                                             |           |                    |
| Transmit Frequency Range          | 2402 MHz ~ 2480 MHz                                                                                                                                                              |           |                    |
| Mode                              | Basic Rate                                                                                                                                                                       |           | Enhanced Data Rate |
| Modulation                        | GFSK                                                                                                                                                                             | π/4-DQPSK | 8DPSK              |
| Packet Type<br>(Maximum Payload): | DH5                                                                                                                                                                              | 2DH5      | 3DH5               |
| Data Rate                         | 1 Mbps                                                                                                                                                                           | 2 Mbps    | 3 Mbps             |
| Rated Input                       | DC 3.3V                                                                                                                                                                          |           |                    |
| Test software of EUT:             | Cybluetool (manufacturer declare)                                                                                                                                                |           |                    |
| Antenna Type:                     | Type 1: PCB Antenna<br>Type 2: External Dipole Antenna                                                                                                                           |           |                    |
| Antenna Gain:                     | Type 1: 3.0 dBi for 2.4G band; 3.3 dBi for 5G band<br>Type 2: 3.4 dBi for 2.4G band; 4.75 dBi for 5G band                                                                        |           |                    |
|                                   | Note:<br>1. The product has only one transmission chain and two antenna types are provided.<br>2. This data is provided by customer and our lab isn't responsible for this data. |           |                    |





## 5.2. MAXIMUM OUTPUT POWER

| Test Mode | Frequency (MHz) | Channel Number | Maximum Output Power (dBm) |
|-----------|-----------------|----------------|----------------------------|
| GFSK      | 2402 ~ 2480     | 0-78[79]       | 6.77                       |
| π/4-DQPSK | 2402 ~ 2480     | 0-78[79]       | 4.29                       |
| 8DPSK     | 2402 ~ 2480     | 0-78[79]       | 6.25                       |

## 5.3. PACKET TYPE CONFIGURATION

| Test Mode | Packet Type | Setting (Packet Length) |
|-----------|-------------|-------------------------|
| GFSK      | DH1         | 27                      |
|           | DH3         | 183                     |
|           | DH5         | 339                     |
| π/4-DQPSK | 2-DH1       | 54                      |
|           | 2-DH3       | 367                     |
|           | 2-DH5       | 679                     |
| 8DPSK     | 3-DH1       | 83                      |
|           | 3-DH3       | 552                     |
|           | 3-DH5       | 1021                    |

## 5.4. CHANNEL LIST

| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| 00      | 2402            | 20      | 2422            | 40      | 2442            | 60      | 2462            |
| 01      | 2403            | 21      | 2423            | 41      | 2443            | 61      | 2463            |
| 02      | 2404            | 22      | 2424            | 42      | 2444            | 62      | 2464            |
| 03      | 2405            | 23      | 2425            | 43      | 2445            | 63      | 2465            |
| 04      | 2406            | 24      | 2426            | 44      | 2446            | 64      | 2466            |
| 05      | 2407            | 25      | 2427            | 45      | 2447            | 65      | 2467            |
| 06      | 2408            | 26      | 2428            | 46      | 2448            | 66      | 2468            |
| 07      | 2409            | 27      | 2429            | 47      | 2449            | 67      | 2469            |
| 08      | 2410            | 28      | 2430            | 48      | 2450            | 68      | 2470            |
| 09      | 2411            | 29      | 2431            | 49      | 2451            | 69      | 2471            |
| 10      | 2412            | 30      | 2432            | 50      | 2452            | 70      | 2472            |
| 11      | 2413            | 31      | 2433            | 51      | 2453            | 71      | 2473            |
| 12      | 2414            | 32      | 2434            | 52      | 2454            | 72      | 2474            |
| 13      | 2415            | 33      | 2435            | 53      | 2455            | 73      | 2475            |
| 14      | 2416            | 34      | 2436            | 54      | 2456            | 74      | 2476            |
| 15      | 2417            | 35      | 2437            | 55      | 2457            | 75      | 2477            |
| 16      | 2418            | 36      | 2438            | 56      | 2458            | 76      | 2478            |
| 17      | 2419            | 37      | 2439            | 57      | 2459            | 77      | 2479            |
| 18      | 2420            | 38      | 2440            | 58      | 2460            | 78      | 2480            |
| 19      | 2421            | 39      | 2441            | 59      | 2461            | /       | /               |



### 5.5. TEST CHANNEL CONFIGURATION

| Test Mode | Test Channel                                               | Frequency                    |
|-----------|------------------------------------------------------------|------------------------------|
| GFSK      | CH 0(Low Channel), CH 39(MID Channel), CH 78(High Channel) | 2402 MHz, 2441 MHz, 2480 MHz |
| π/4-DQPSK | CH 0(Low Channel), CH 39(MID Channel), CH 78(High Channel) | 2402 MHz, 2441 MHz, 2480 MHz |
| 8DPSK     | CH 0(Low Channel), CH 39(MID Channel), CH 78(High Channel) | 2402 MHz, 2441 MHz, 2480 MHz |
| GFSK      | Hopping                                                    | 2402 MHz ~ 2480 MHz          |
| π/4-DQPSK | Hopping                                                    | 2402 MHz ~ 2480 MHz          |
| 8DPSK     | Hopping                                                    | 2402 MHz ~ 2480 MHz          |

### 5.6. WORST-CASE CONFIGURATIONS

| Test Mode | Modulation Technology | Modulation Type | Data Rate | Packet Type |
|-----------|-----------------------|-----------------|-----------|-------------|
| BR        | FHSS                  | GFSK            | 1Mbit/s   | DH5         |
| EDR       | FHSS                  | π/4-DQPSK       | 2Mbit/s   | 2DH5        |
| EDR       | FHSS                  | 8DPSK           | 3Mbit/s   | 3-DH5       |

### 5.7. THE WORSE CASE POWER SETTING PARAMETER

| The Worse Case Power Setting Parameter under 2400 ~ 2483.5 MHz Band |                         |                             |         |         |
|---------------------------------------------------------------------|-------------------------|-----------------------------|---------|---------|
| Test Software                                                       |                         | Cybluetool                  |         |         |
| Test Mode                                                           | Transmit Antenna Number | Test Software Setting Value |         |         |
|                                                                     |                         | CH 00                       | CH 39   | CH 78   |
| GFSK                                                                | 1                       | Index 0                     | Index 0 | Index 0 |
| π/4-DQPSK                                                           | 1                       | Index 0                     | Index 0 | Index 0 |
| 8DPSK                                                               | 1                       | Index 0                     | Index 0 | Index 0 |



## 5.8. DESCRIPTION OF AVAILABLE ANTENNAS

| Ant. | Frequency (MHz) | Antenna Type            | Antenna Gain (dBi) |
|------|-----------------|-------------------------|--------------------|
| 1    | 2400-2483.5     | PCB Antenna             | 3.0                |
|      |                 | External Dipole Antenna | 3.4                |

Note: This data is provided by customer and our lab isn't responsible for this data.

| Test Mode | Transmit and Receive Mode                    | Description                                              |
|-----------|----------------------------------------------|----------------------------------------------------------|
| GFSK      | <input checked="" type="checkbox"/> 1TX, 1RX | Antenna 1 can be used as transmitting/receiving antenna. |
| 8DPSK     | <input checked="" type="checkbox"/> 1TX, 1RX | Antenna 1 can be used as transmitting/receiving antenna. |

## 5.9. TEST ENVIRONMENT

| Environment Parameter | Selected Values During Tests |           |
|-----------------------|------------------------------|-----------|
| Relative Humidity     | 55 ~ 65%                     |           |
| Atmospheric Pressure: | 101kPa                       |           |
| Temperature           | TN                           | 23 ~ 28°C |
| Voltage:              | VL                           | N/A       |
|                       | VN                           | DC 3.3V   |
|                       | VH                           | N/A       |

Note: VL= Lower Extreme Test Voltage  
VN= Nominal Voltage  
VH= Upper Extreme Test Voltage  
TN= Normal Temperature



## 5.10. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

| Item | Equipment       | Brand Name | Model Name | Description                         |
|------|-----------------|------------|------------|-------------------------------------|
| 1    | Laptop          | ThinkPad   | E590       | /                                   |
| 2    | DC Power Supply | Tektronix  | PWS2326    | INPUT: AC 230V<br>OUTPUT: 0-32V, 6A |

### I/O PORT

| Cable No | Port | Connector Type | Cable Type | Cable Length(m) | Remarks |
|----------|------|----------------|------------|-----------------|---------|
| 1        | RJ45 | RJ45           | LAN        | 100cm Length    | /       |

### ACCESSORY

| Item | Accessory | Brand Name | Model Name | Description |
|------|-----------|------------|------------|-------------|
| 1    | /         | /          | /          | /           |

### TEST SETUP

The EUT can work in an engineer mode with a software through a table PC.

### SETUP DIAGRAM FOR TESTS





### 5.11. MEASURING INSTRUMENT AND SOFTWARE USED

| Conducted Emissions (Instrument)    |                                         |                                  |                                     |            |                 |            |            |  |
|-------------------------------------|-----------------------------------------|----------------------------------|-------------------------------------|------------|-----------------|------------|------------|--|
| Used                                | Equipment                               | Manufacturer                     | Model No.                           | Serial No. | Upper Last Cal. | Last Cal.  | Next Cal.  |  |
| <input checked="" type="checkbox"/> | EMI Test Receiver                       | R&S                              | ESR3                                | 126700     | 2020-12-05      | 2021-12-04 | 2022-12-03 |  |
| <input checked="" type="checkbox"/> | Two-Line V-Network                      | R&S                              | ENV216                              | 126701     | 2020-12-05      | 2021-12-04 | 2022-12-03 |  |
| <input checked="" type="checkbox"/> | Artificial Mains Networks               | R&S                              | ENY81                               | 126711     | 2020-10-13      | 2021-10-12 | 2022-10-11 |  |
| Software                            |                                         |                                  |                                     |            |                 |            |            |  |
| Used                                | Description                             |                                  | Manufacturer                        |            | Name            | Version    |            |  |
| <input checked="" type="checkbox"/> | Test Software for Conducted disturbance |                                  | R&S                                 |            | EMC32           | Ver. 9.25  |            |  |
| Radiated Emissions (Instrument)     |                                         |                                  |                                     |            |                 |            |            |  |
| Used                                | Equipment                               | Manufacturer                     | Model No.                           | Serial No. | Upper Last Cal. | Last Cal.  | Next Cal.  |  |
| <input checked="" type="checkbox"/> | Spectrum Analyzer                       | Keysight                         | N9010B                              | 155727     | 2021-05-09      | 2022-04-09 | 2023-04-08 |  |
| <input checked="" type="checkbox"/> | EMI test receiver                       | R&S                              | ESR26                               | 126703     | 2020-12-05      | 2021-12-04 | 2022-12-03 |  |
| <input checked="" type="checkbox"/> | Receiver Antenna (9kHz-30MHz)           | Schwarzbeck                      | FMZB 1513                           | 155456     | 2018-06-15      | 2021-06-03 | 2024-06-02 |  |
| <input checked="" type="checkbox"/> | Receiver Antenna (30MHz-1GHz)           | SunAR RF Motion                  | JB1                                 | 177821     | 2019-01-19      | 2022-01-18 | 2025-01-17 |  |
| <input checked="" type="checkbox"/> | Receiver Antenna (1GHz-18GHz)           | R&S                              | HF907                               | 126705     | 2019-01-27      | 2022-02-28 | 2025-02-27 |  |
| <input checked="" type="checkbox"/> | Receiver Antenna (18GHz-26.5GHz)        | Schwarzbeck                      | BBHA9170                            | 126706     | 2019-02-29      | 2022-02-28 | 2025-02-27 |  |
| <input checked="" type="checkbox"/> | Pre-amplification (To 18GHz)            | Compliance Direction System Inc. | PAP-1G18-50                         | 178825     | 2021-03-26      | 2022-03-01 | 2023-02-28 |  |
| <input checked="" type="checkbox"/> | Pre-amplification (To 26.5GHz)          | R&S                              | SCU-26D                             | 135391     | 2020-12-05      | 2021-12-04 | 2022-12-03 |  |
| <input checked="" type="checkbox"/> | Band Reject Filter                      | Wainwright                       | WRCJV8-2350-2400-2483.5-2533.5-40SS | 1          | 2021-05-09      | 2022-05-08 | 2023-05-07 |  |
| <input checked="" type="checkbox"/> | Highpass Filter                         | Wainwright                       | WHKX10-2700-3000-18000-40SS         | 2          | 2021-05-09      | 2022-05-08 | 2023-05-07 |  |
| Software                            |                                         |                                  |                                     |            |                 |            |            |  |
| Used                                | Description                             |                                  | Manufacturer                        |            | Name            |            | Version    |  |
| <input checked="" type="checkbox"/> | Test Software for Radiated disturbance  |                                  | Tonscend                            |            | TS+             |            | Ver. 2.5   |  |
| Other instruments                   |                                         |                                  |                                     |            |                 |            |            |  |
| Used                                | Equipment                               | Manufacturer                     | Model No.                           | Serial No. | Upper Last Cal. | Last Cal.  | Next Cal.  |  |
| <input checked="" type="checkbox"/> | Spectrum Analyzer                       | Keysight                         | N9010B                              | 155368     | 2021-05-09      | 2022-05-08 | 2023-05-07 |  |
| <input checked="" type="checkbox"/> | Power Meter                             | Keysight                         | U2021XA                             | 155370     | 2021-05-09      | 2022-05-08 | 2023-05-07 |  |



## 6. ANTENNA PORT TEST RESULTS

### 6.1. ON TIME AND DUTY CYCLE

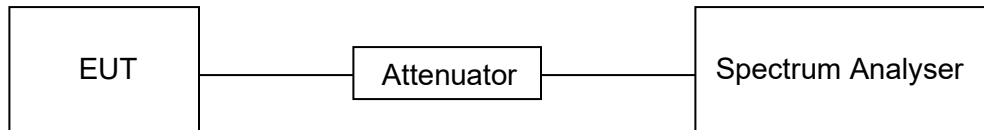
#### LIMITS

None; for reporting purposes only

#### PROCEDURE

Refer to ANSI C63.10-2013 Zero – Span Spectrum Analyzer method.

#### TEST SETUP



#### TEST ENVIRONMENT

|                     |        |                   |         |
|---------------------|--------|-------------------|---------|
| Temperature         | 22°C   | Relative Humidity | 56%     |
| Atmosphere Pressure | 101kPa | Test Voltage      | DC 3.3V |

#### TEST RESULTS TABLE

| Mode | On Time (msec) | Period (msec) | Duty Cycle x (Linear) | Duty Cycle (%) | Duty Cycle Correction Factor (db) | 1/T Minimum VBW (kHz) | Final VBW (kHz) |
|------|----------------|---------------|-----------------------|----------------|-----------------------------------|-----------------------|-----------------|
| DH5  | 2.89           | 3.75          | 0.7707                | 77.07          | 1.13                              | 0.35                  | 0.5             |
| 2DH5 | 1.98           | 3.75          | 0.5280                | 52.80          | 2.77                              | 0.51                  | 1.0             |
| 3DH5 | 2.89           | 3.75          | 0.7707                | 77.07          | 1.13                              | 0.35                  | 0.5             |

Note: 1) Duty Cycle Correction Factor= $10\log(1/x)$ .  
2) Where: x is Duty Cycle (Linear)  
3) Where: T is On Time (transmit duration)



## TEST GRAPHS

### DH5 ON TIME AND DUTY CYCLE MID CH (WORSE CASE)



### 2DH5 ON TIME AND DUTY CYCLE MID CH (WORSE CASE)





### 3DH5 ON TIME AND DUTY CYCLE MID CH (WORSE CASE)







## 6.2. 20 dB BANDWIDTH AND 99 % OCCUPIED BANDWIDTH

### LIMITS

| FCC Part15 (15.247), Subpart C                      |                         |                                    |                       |
|-----------------------------------------------------|-------------------------|------------------------------------|-----------------------|
| Section                                             | Test Item               | Limit                              | Frequency Range (MHz) |
| CFR 47 FCC 15.247 (a) (1)<br>RSS-247 Clause 5.1 (a) | 20 dB Bandwidth         | None; for reporting purposes only. | 2400-2483.5           |
| ISED RSS-Gen Clause 6.7                             | 99 % Occupied Bandwidth | None; for reporting purposes only. | 2400-2483.5           |

### TEST PROCEDURE

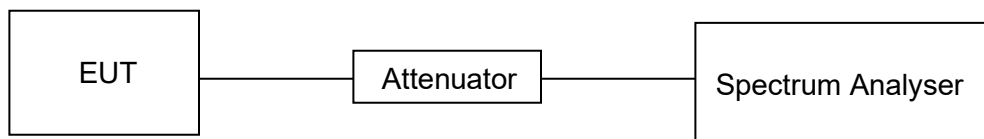
Refer to ANSI C63.10-2013 clause 6.9.2.

Connect the EUT to the spectrum analyser and use the following settings:

|                  |                                                                                                                             |
|------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Center Frequency | The centre frequency of the channel under test                                                                              |
| Detector         | Peak                                                                                                                        |
| RBW              | For 20 dB Bandwidth: 1 % to 5 % of the 20 dB bandwidth<br>For 99 % Occupied Bandwidth: 1 % to 5 % of the occupied bandwidth |
| VBW              | For 20 dB Bandwidth: approximately 3×RBW<br>For 99 % Occupied Bandwidth: ≥ 3×RBW                                            |
| Span             | Approximately 2 to 5 times the OBW                                                                                          |
| Trace            | Max hold                                                                                                                    |
| Sweep            | Auto couple                                                                                                                 |

Use the occupied bandwidth function of the instrument, allow the trace to stabilize and report the measured 99 % occupied bandwidth and 20 dB Bandwidth.

### TEST SETUP





### **TEST ENVIRONMENT**

|                     |        |                   |         |
|---------------------|--------|-------------------|---------|
| Temperature         | 22°C   | Relative Humidity | 56%     |
| Atmosphere Pressure | 101kPa | Test Voltage      | DC 3.3V |

### **TEST RESULTS TABLE**

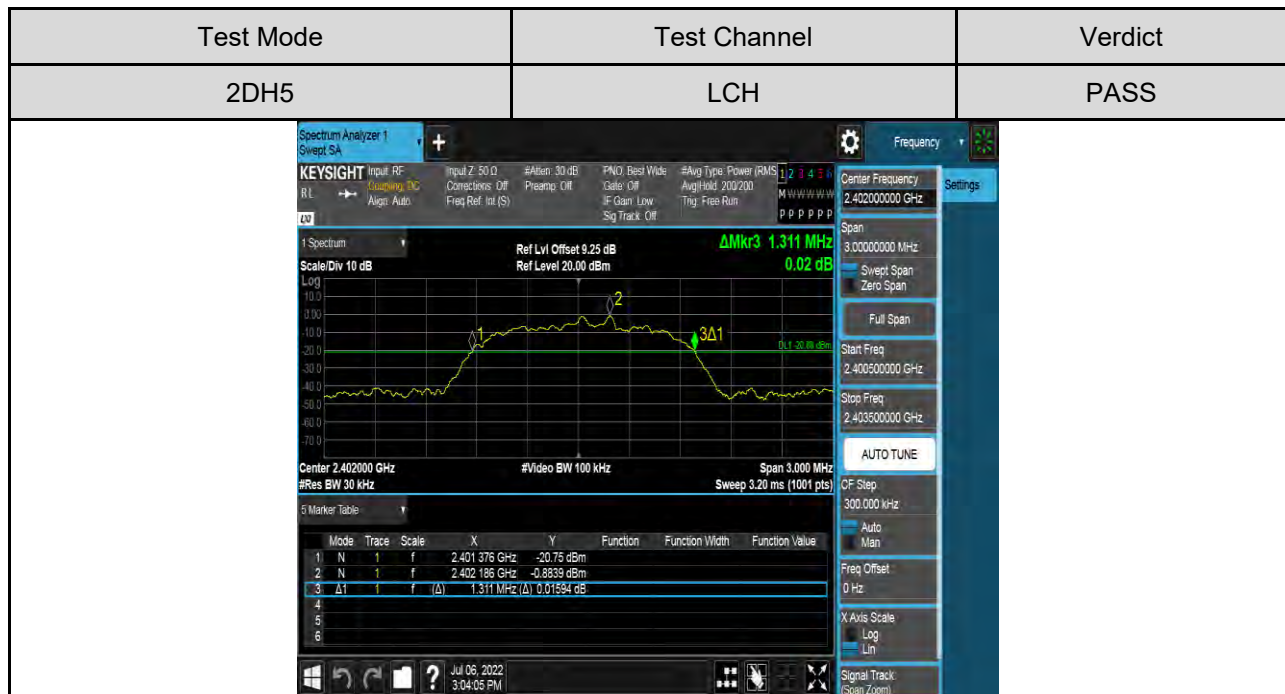
| Test Mode | Test Channel (MHz) | 20dB bandwidth (MHz) | 99% bandwidth (MHz) | Result |
|-----------|--------------------|----------------------|---------------------|--------|
| DH5       | 2412               | 1.035                | 0.92138             | Pass   |
|           | 2457               | 1.029                | 0.93356             | Pass   |
|           | 2462               | 1.029                | 0.93484             | Pass   |
| 2DH5      | 2412               | 1.311                | 1.2020              | Pass   |
|           | 2447               | 1.314                | 1.2017              | Pass   |
|           | 2462               | 1.311                | 1.2036              | Pass   |
| 3DH5      | 2412               | 1.311                | 1.2032              | Pass   |
|           | 2447               | 1.311                | 1.2038              | Pass   |
|           | 2462               | 1.314                | 1.2045              | Pass   |

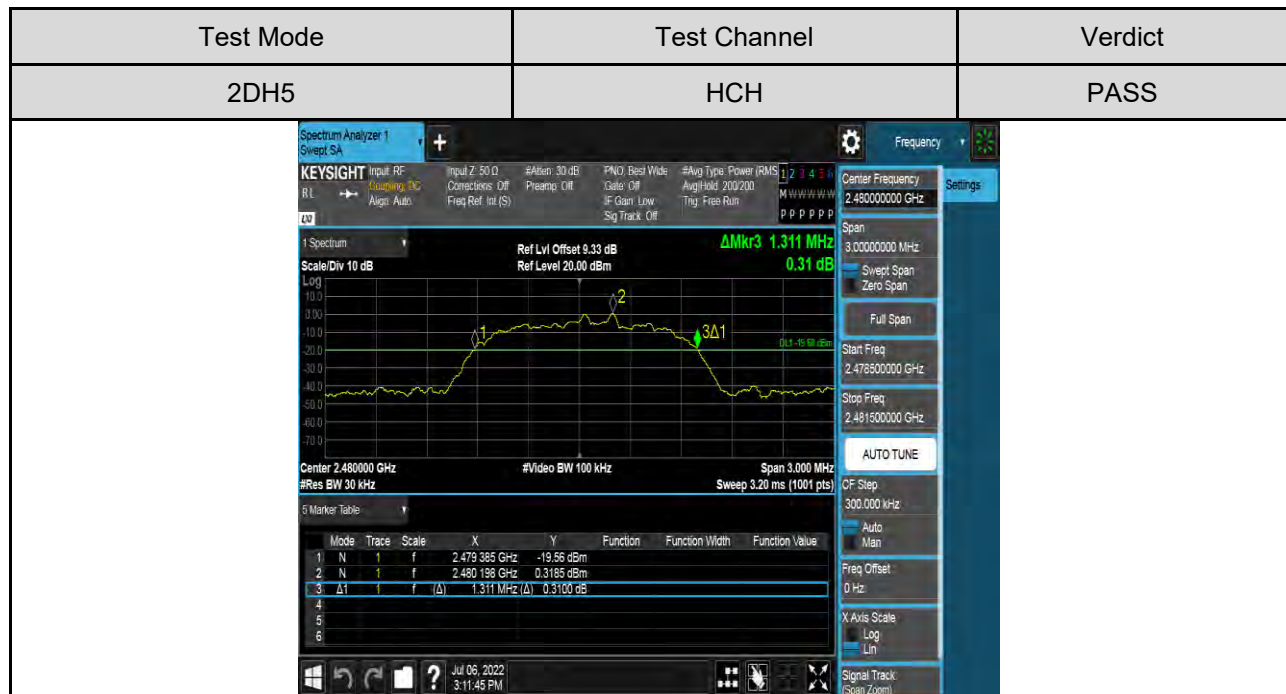
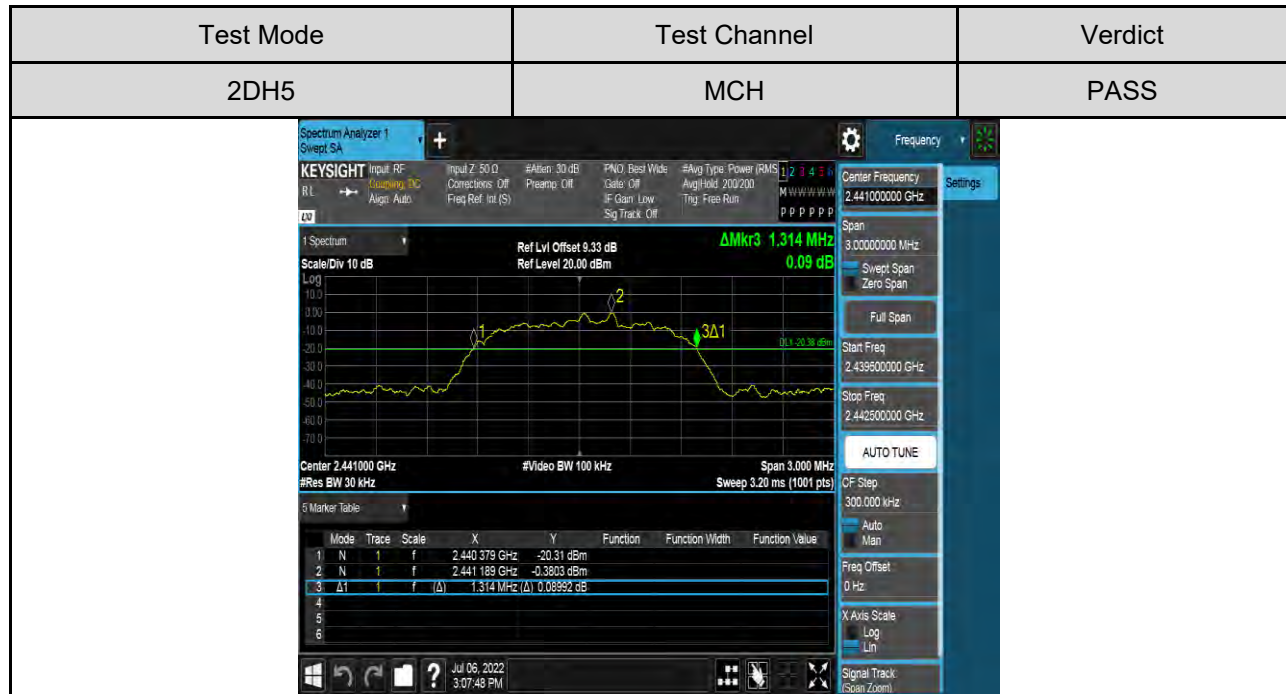


## TEST GRAPHS

### 20dB Bandwidth:













#### 99% Bandwidth:









| Test Mode                                                                          | Test Channel | Verdict |
|------------------------------------------------------------------------------------|--------------|---------|
| 2DH5                                                                               | LCH          | PASS    |
|  |              |         |

| Test Mode                                                                            | Test Channel | Verdict |
|--------------------------------------------------------------------------------------|--------------|---------|
| 2DH5                                                                                 | MCH          | PASS    |
|  |              |         |



| Test Mode                                                                          | Test Channel | Verdict |
|------------------------------------------------------------------------------------|--------------|---------|
| 2DH5                                                                               | HCH          | PASS    |
|  |              |         |

| Test Mode                                                                            | Test Channel | Verdict |
|--------------------------------------------------------------------------------------|--------------|---------|
| 3DH5                                                                                 | LCH          | PASS    |
|  |              |         |



| Test Mode                                                                          | Test Channel | Verdict |
|------------------------------------------------------------------------------------|--------------|---------|
| 3DH5                                                                               | MCH          | PASS    |
|  |              |         |

| Test Mode                                                                            | Test Channel | Verdict |
|--------------------------------------------------------------------------------------|--------------|---------|
| 3DH5                                                                                 | HCH          | PASS    |
|  |              |         |



### 6.3. CONDUCTED OUTPUT POWER

#### LIMITS

| FCC Part15 (15.247), Subpart C                                 |              |                                                                                                                                                                                                                                                                                        |                       |
|----------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Section                                                        | Test Item    | Limit                                                                                                                                                                                                                                                                                  | Frequency Range (MHz) |
| CFR 47 FCC<br>15.247 (b) (1)<br>ISED RSS-247<br>Clause 5.4 (b) | Output Power | Hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel: 1 watt or 30 dBm;<br>Hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel: 125 mW or 21 dBm | 2400-2483.5           |

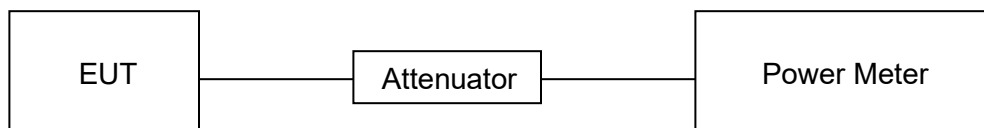
#### TEST PROCEDURE

Place the EUT on the table and set it in the transmitting mode.  
Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Power sensor.  
Measure the power of each channel.  
PK Detector used for PK result.

#### TEST ENVIRONMENT

|                     |        |                   |         |
|---------------------|--------|-------------------|---------|
| Temperature         | 22°C   | Relative Humidity | 56%     |
| Atmosphere Pressure | 101kPa | Test Voltage      | DC 3.3V |

#### TEST SETUP





**TEST RESULTS TABLE**

| Test Mode | Test Channel | Maximum Conducted Output Power (PK) | LIMIT |
|-----------|--------------|-------------------------------------|-------|
|           |              | dBm                                 | dBm   |
| DH5       | LCH          | 5.20                                | 21    |
|           | MCH          | 5.77                                | 21    |
|           | HCH          | 6.77                                | 21    |
| 2DH5      | LCH          | 3.25                                | 21    |
|           | MCH          | 3.81                                | 21    |
|           | HCH          | 4.29                                | 21    |
| 3DH5      | LCH          | 3.10                                | 21    |
|           | MCH          | 3.76                                | 21    |
|           | HCH          | 4.25                                | 21    |



## 6.4. CARRIER FREQUENCY SEPARATION

### LIMITS

| CFR 47 FCC Part15 (15.247),<br>Subpart C ISSED RSS-247 ISSUE 2  |                                    |                                                                                                                                                                                                                                                                                                                                                                                                         |                       |
|-----------------------------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Section                                                         | Test Item                          | Limit                                                                                                                                                                                                                                                                                                                                                                                                   | Frequency Range (MHz) |
| CFR 47 FCC<br>15.247 (a) (1)<br>ISSED RSS-247<br>Clause 5.1 (b) | Carrier<br>Frequency<br>Separation | 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.<br>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. | 2400-2483.5           |

### TEST PROCEDURE

Refer to ANSI C63.10-2013 clause 7.8.2.

Connect the EUT to the spectrum analyzer and use the following settings:

|                  |                                                                                                                                                  |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Center Frequency | The center frequency of the channel under test                                                                                                   |
| Span             | wide enough to capture the peaks of two adjacent channels                                                                                        |
| Detector         | Peak                                                                                                                                             |
| RBW              | Start with the RBW set to approximately 30 % of the channel spacing; adjust as necessary to best identify the center of each individual channel. |
| VBW              | ≥RBW                                                                                                                                             |
| Trace            | Max hold                                                                                                                                         |
| Sweep time       | Auto couple                                                                                                                                      |

Allow the trace to stabilize and use the marker-delta function to determine the separation between the peaks of the adjacent channels.

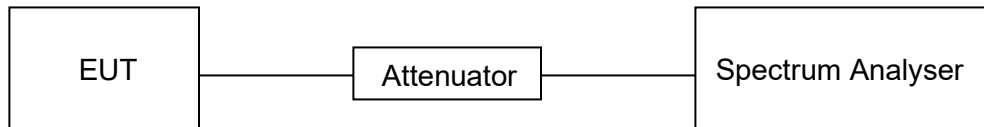
Compliance of an EUT with the appropriate regulatory limit shall be determined.



### **TEST ENVIRONMENT**

|                     |        |                   |         |
|---------------------|--------|-------------------|---------|
| Temperature         | 22°C   | Relative Humidity | 56%     |
| Atmosphere Pressure | 101kPa | Test Voltage      | DC 3.3V |

### **TEST SETUP**



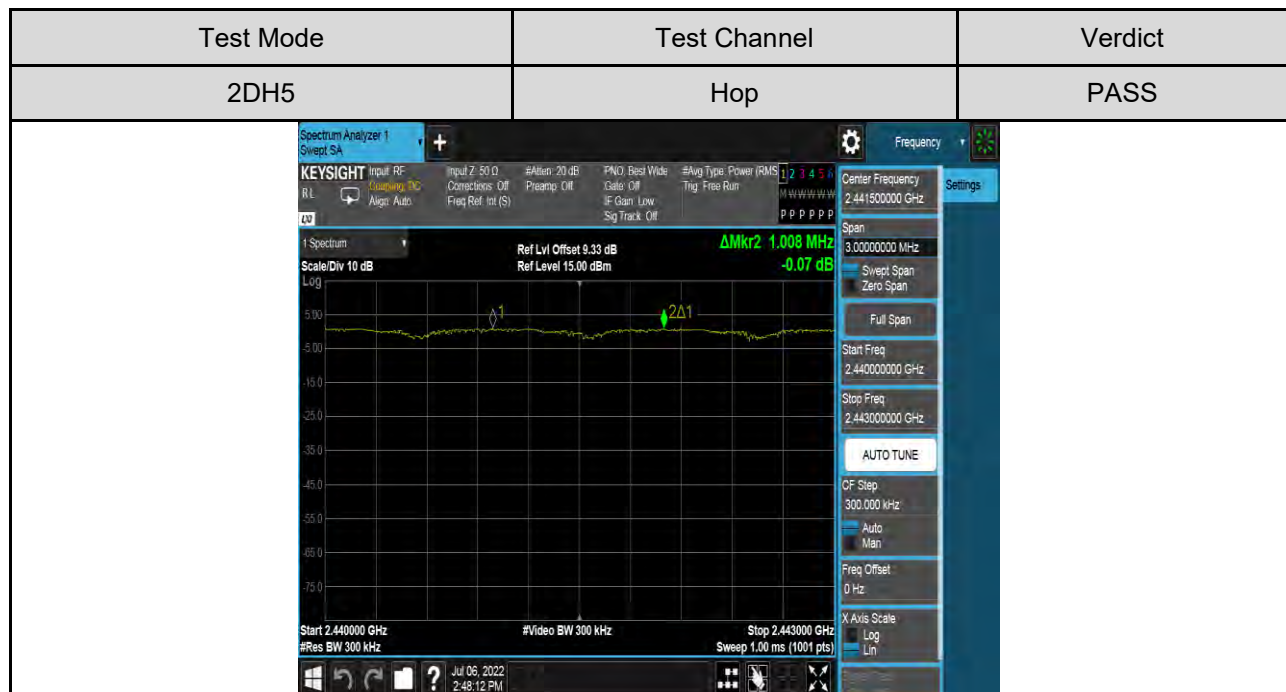
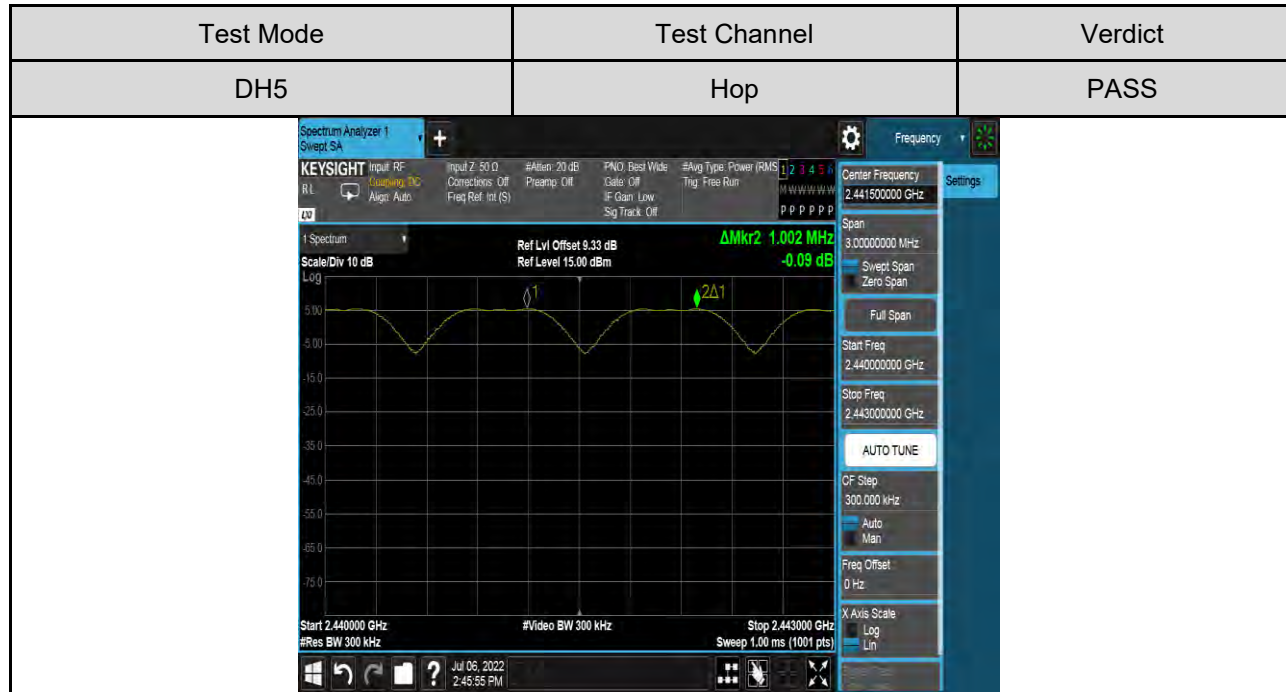
### **TEST RESULTS TABLE**

| Test Mode | Test Channel | Result (MHz) | Result |
|-----------|--------------|--------------|--------|
| DH5       | Hop          | 1.002        | Pass   |
| 2DH5      | Hop          | 1.008        | Pass   |
| 3DH5      | Hop          | 1.029        | Pass   |





## TEST GRAPHS







## 6.5. NUMBER OF HOPPING FREQUENCIES

### LIMITS

| CFR 47 FCC Part15 (15.247), Subpart C<br>ISED RSS-247 ISSUE 2 |                             |                              |
|---------------------------------------------------------------|-----------------------------|------------------------------|
| Section                                                       | Test Item                   | Limit                        |
| CFR 47 15.247 (a) (1) III<br>ISED RSS-247 Clause 5.1 (d)      | Number of Hopping Frequency | at least 15 hopping channels |

### TEST PROCEDURE

Refer to ANSI C63.10-2013 clause 7.8.3.

Connect the EUT to the spectrum Analyzer and use the following settings:

|            |                                                                                                                                                                                                                                      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Detector   | Peak                                                                                                                                                                                                                                 |
| RBW        | To clearly identify the individual channels, set the RBW to less than 30 % of the channel spacing or the 20 dB bandwidth, whichever is smaller.                                                                                      |
| VBW        | ≥RBW                                                                                                                                                                                                                                 |
| Span       | The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen. |
| Trace      | Max hold                                                                                                                                                                                                                             |
| Sweep time | Auto couple                                                                                                                                                                                                                          |

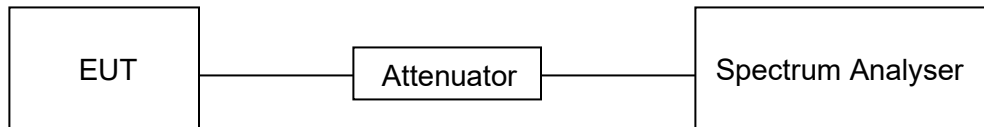
Set EUT to transmit maximum output power and switch on frequency hopping function. then set enough count time (larger than 5000 times) to get all the hopping frequency channel displayed on the screen of spectrum analyzer, count the quantity of peaks to get the number of hopping channels.



### **TEST ENVIRONMENT**

|                     |        |                   |         |
|---------------------|--------|-------------------|---------|
| Temperature         | 22°C   | Relative Humidity | 56%     |
| Atmosphere Pressure | 101kPa | Test Voltage      | DC 3.3V |

### **TEST SETUP**

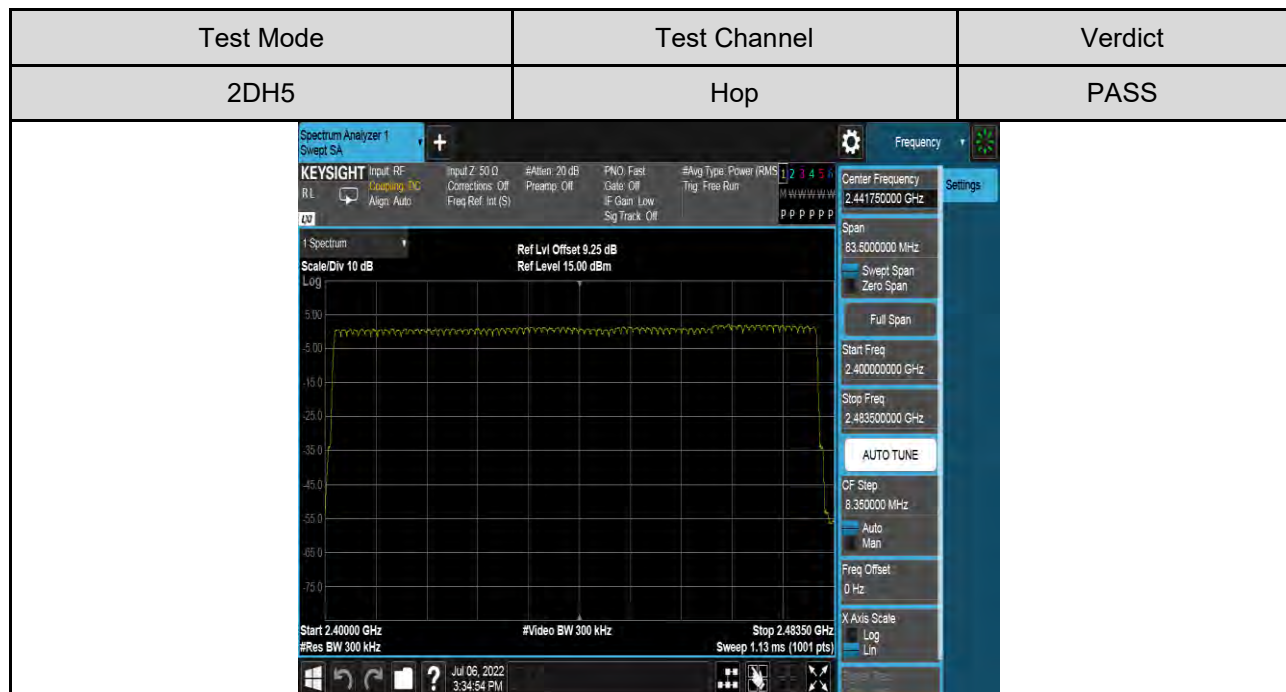
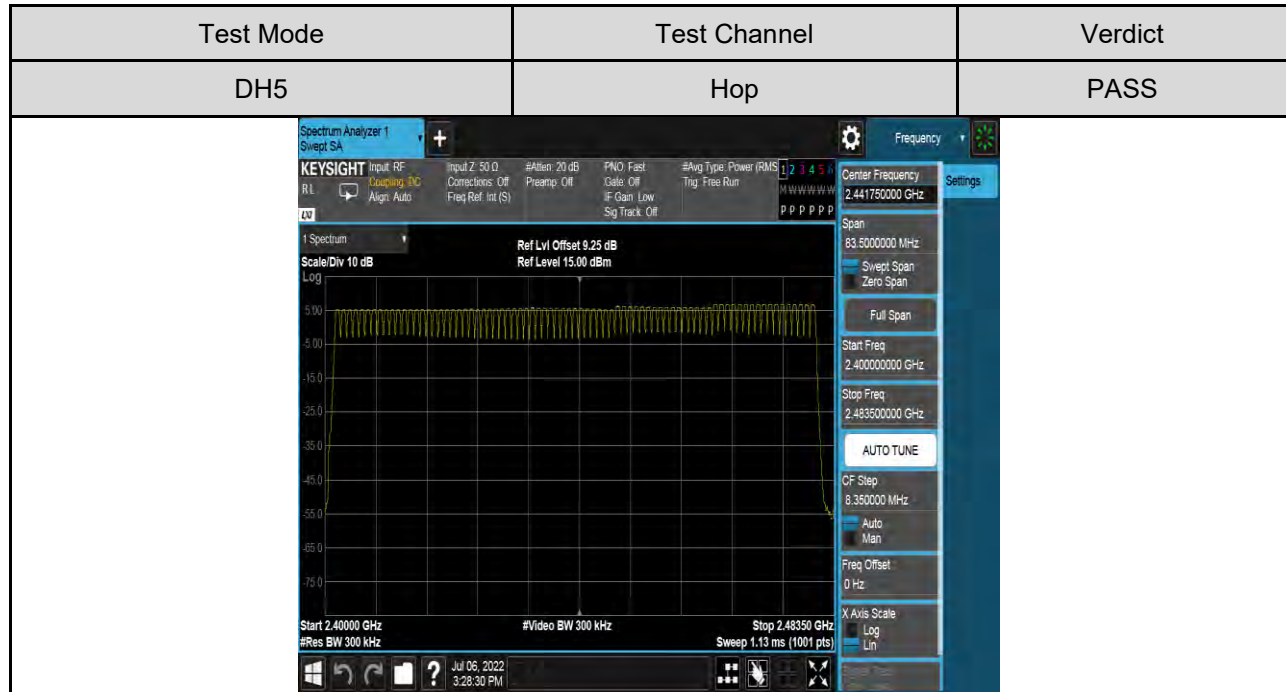


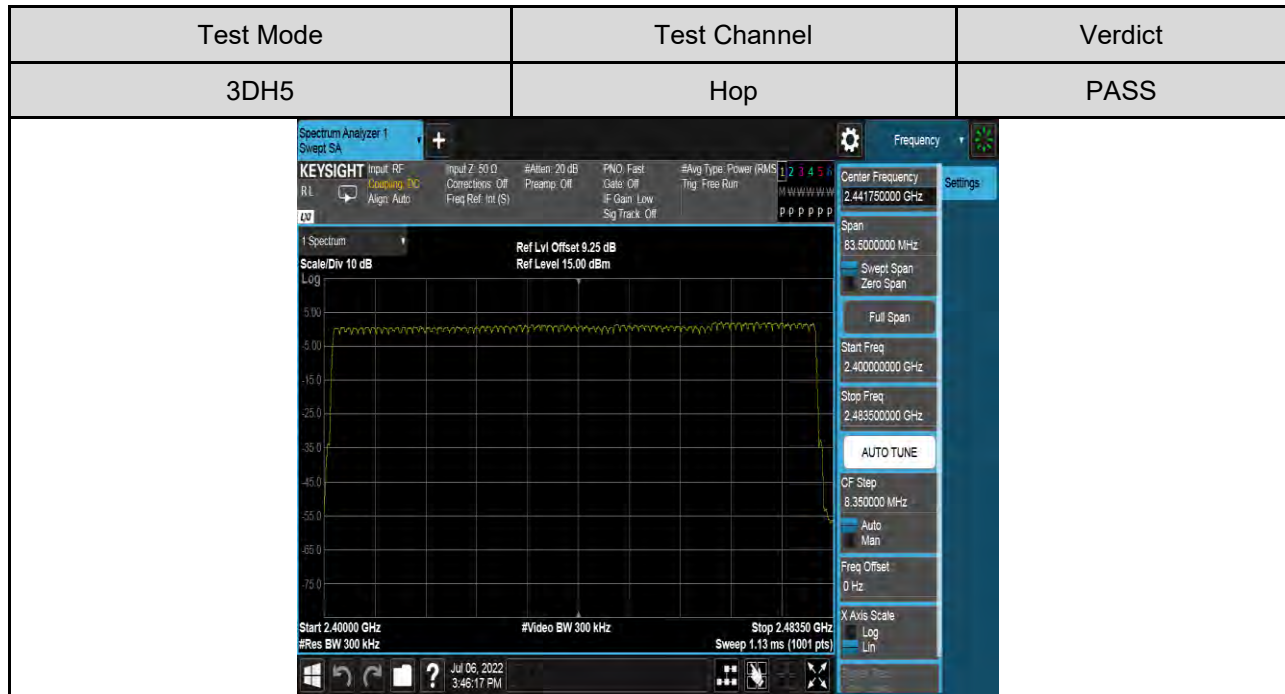
### **TEST RESULTS TABLE**

| Test Mode | Test Channel | Result (Num) | Result |
|-----------|--------------|--------------|--------|
| DH5       | Hop          | 79           | Pass   |
| 2DH5      | Hop          | 79           | Pass   |
| 3DH5      | Hop          | 79           | Pass   |



## TEST GRAPHS







## 6.6. TIME OF OCCUPANCY (DWELL TIME)

### LIMITS

| CFR 47 FCC Part15 (15.247), Subpart C<br>ISED RSS-247 ISSUE 2 |                                   |                                                                                                                                                                           |
|---------------------------------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Section                                                       | Test Item                         | Limit                                                                                                                                                                     |
| CFR 47 15.247 (a) (1) III<br>ISED RSS-247 Clause<br>5.1 (d)   | Time of Occupancy<br>(Dwell Time) | The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. |

### TEST PROCEDURE

Refer to ANSI C63.10-2013 clause 7.8.4.

Connect the EUT to the spectrum Analyzer and use the following settings:

|                  |                                                                                                                                                                                                                                                                                                                                |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Center Frequency | The center frequency of the channel under test                                                                                                                                                                                                                                                                                 |
| Detector         | Peak                                                                                                                                                                                                                                                                                                                           |
| RBW              | 1 MHz                                                                                                                                                                                                                                                                                                                          |
| VBW              | ≥RBW                                                                                                                                                                                                                                                                                                                           |
| Span             | Zero span, centered on a hopping channel                                                                                                                                                                                                                                                                                       |
| Trace            | Max hold                                                                                                                                                                                                                                                                                                                       |
| Sweep time       | As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel |

Use the marker-delta function to determine the transmit time per hop (Burst Width). If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

For FHSS Mode (79 Channel):

DH1/3DH1 Dwell Time:  $\text{Burst Width} * (1600/2) * 31.6 / (\text{channel number})$

DH3/3DH3 Dwell Time:  $\text{Burst Width} * (1600/4) * 31.6 / (\text{channel number})$

DH5/3DH5 Dwell Time:  $\text{Burst Width} * (1600/6) * 31.6 / (\text{channel number})$

For AFHSS Mode (20 Channel):

DH1/3DH1 Dwell Time:  $\text{Burst Width} * (800/2) * 8 / (\text{channel number})$

DH3/3DH3 Dwell Time:  $\text{Burst Width} * (800/4) * 8 / (\text{channel number})$

DH5/3DH5 Dwell Time:  $\text{Burst Width} * (800/6) * 8 / (\text{channel number})$

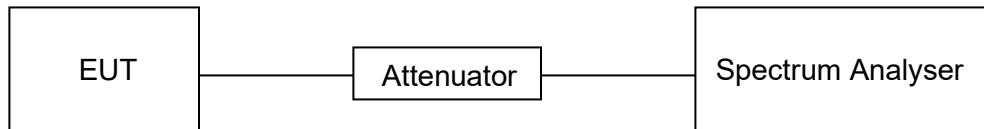




### TEST ENVIRONMENT

|                     |        |                   |         |
|---------------------|--------|-------------------|---------|
| Temperature         | 22°C   | Relative Humidity | 56%     |
| Atmosphere Pressure | 101kPa | Test Voltage      | DC 3.3V |

### TEST SETUP



### TEST RESULTS TABLE

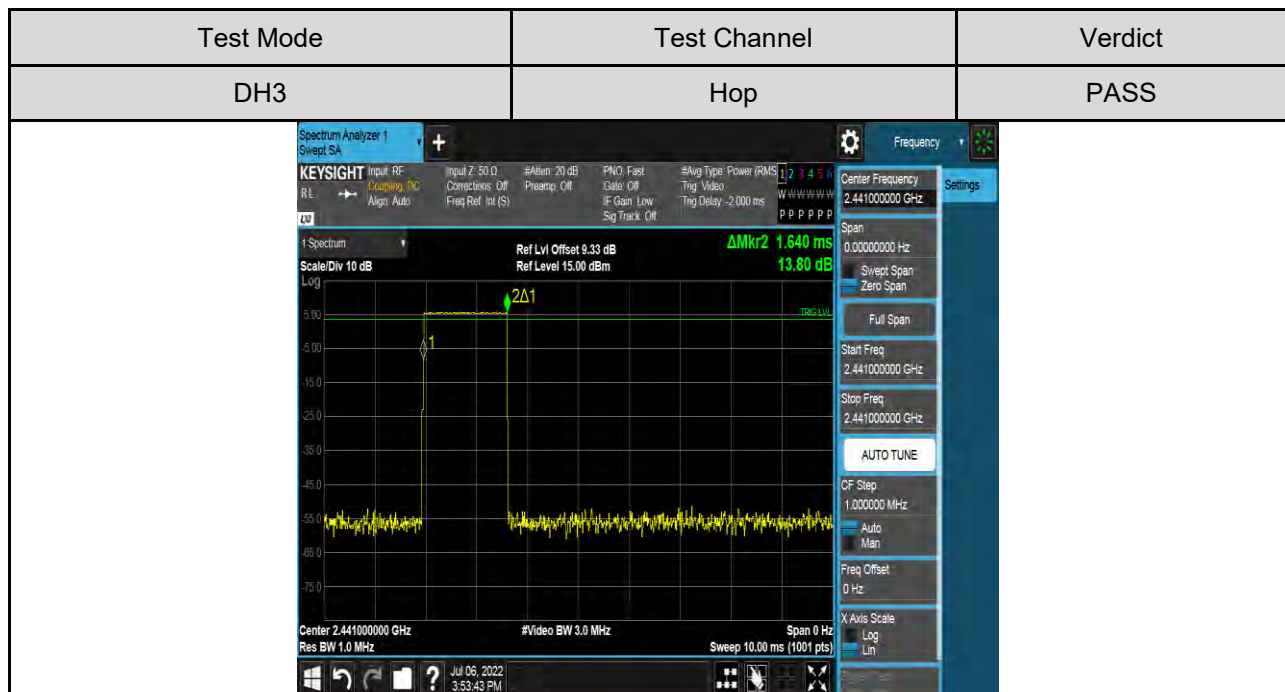
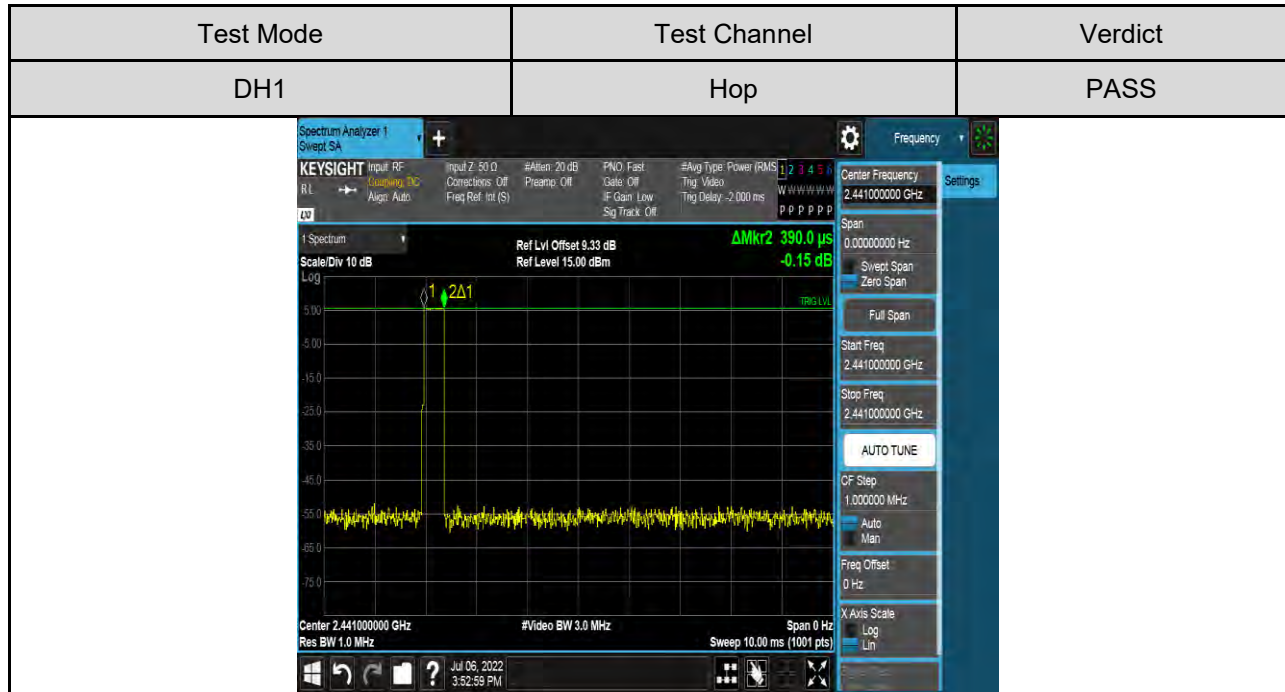
| FHSS Mode  |         |                            |                    |         |
|------------|---------|----------------------------|--------------------|---------|
| Packet     | Channel | Burst Width<br>[ms/hop/ch] | Dwell Time<br>[ms] | Results |
| DH1        | Hop     | 0.37                       | 118.40             | PASS    |
| DH3        | Hop     | 1.62                       | 259.20             | PASS    |
| DH5        | Hop     | 2.87                       | 306.13             | PASS    |
| 3DH1       | Hop     | 0.37                       | 118.40             | PASS    |
| 3DH3       | Hop     | 1.62                       | 259.20             | PASS    |
| 3DH5       | Hop     | 2.87                       | 306.13             | PASS    |
| AFHSS Mode |         |                            |                    |         |
| DH1        | Hop     | 0.37                       | 14.99              | PASS    |
| DH3        | Hop     | 1.62                       | 32.81              | PASS    |
| DH5        | Hop     | 2.87                       | 38.75              | PASS    |
| 3DH1       | Hop     | 0.37                       | 14.99              | PASS    |
| 3DH3       | Hop     | 1.62                       | 32.81              | PASS    |
| 3DH5       | Hop     | 2.87                       | 38.75              | PASS    |

Note:

Through pre-testing all the test modes, but only the data of the worst case is included in this test report.



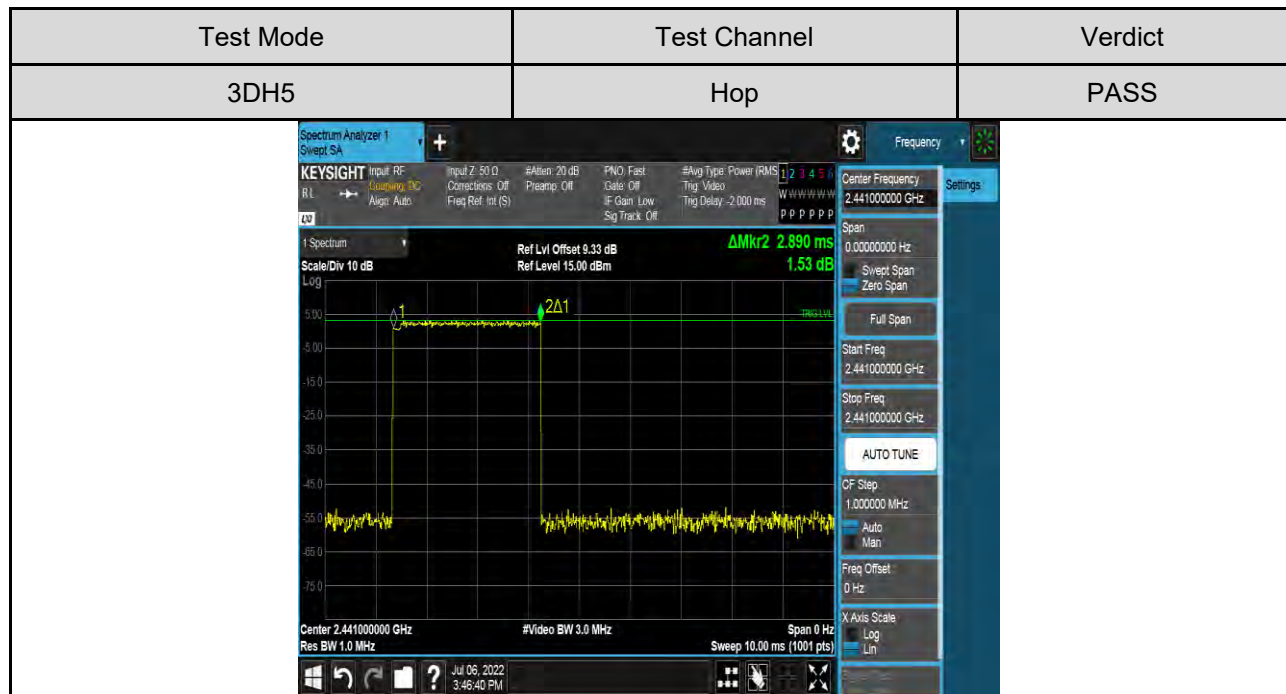
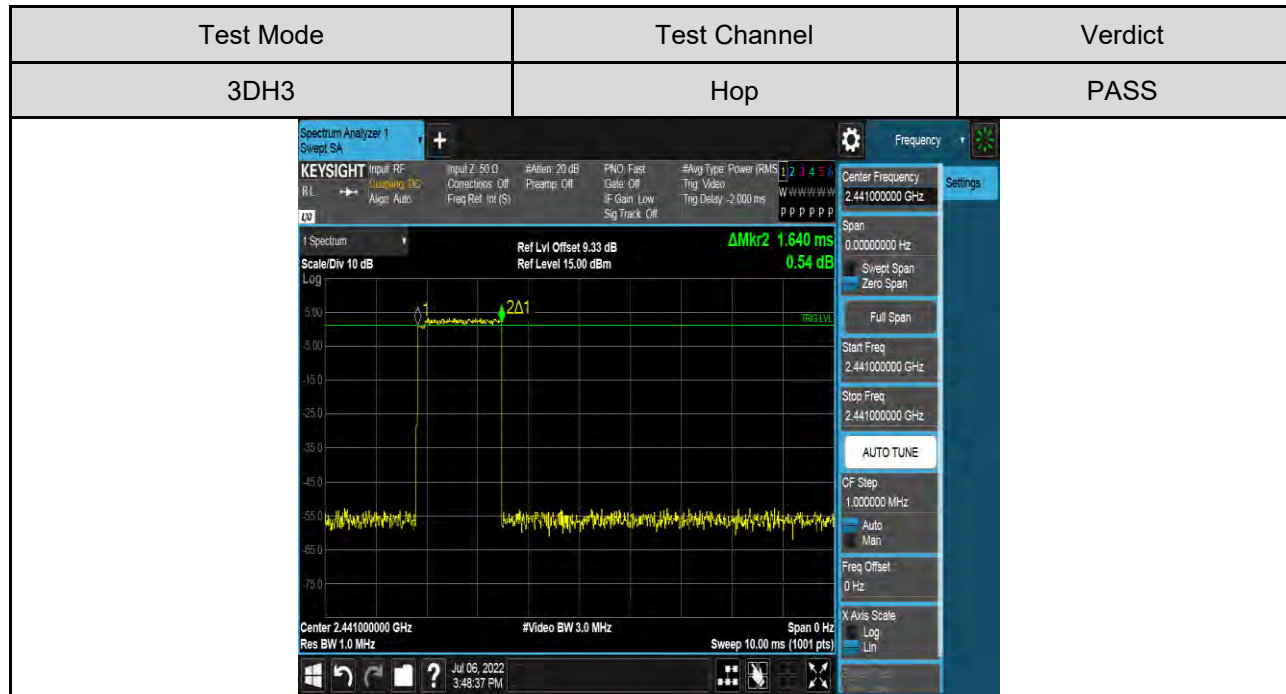
## TEST GRAPHS





| Test Mode                                                                          | Test Channel | Verdict |
|------------------------------------------------------------------------------------|--------------|---------|
| DH5                                                                                | Hop          | PASS    |
|  |              |         |

| Test Mode                                                                            | Test Channel | Verdict |
|--------------------------------------------------------------------------------------|--------------|---------|
| 3DH1                                                                                 | Hop          | PASS    |
|  |              |         |





## 6.7. CONDUCTED BANDEDGE AND SPURIOUS EMISSIONS

### LIMITS

| FCC Part15 (15.247), Subpart C                |                                                 |                                                                                                                      |
|-----------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Section                                       | Test Item                                       | Limit                                                                                                                |
| CFR 47 FCC<br>§15.247 (d)<br>ISED RSS-247 5.5 | Conducted<br>Bandedge and<br>Spurious Emissions | 20 dB below that in the 100 kHz bandwidth<br>within the band that contains the highest level of<br>the desired power |

### TEST PROCEDURE

Refer to FCC KDB 558074, connect the UUT to the spectrum analyser and use the following settings:

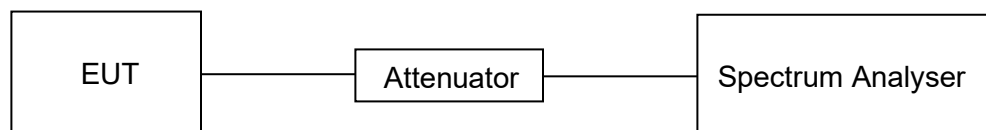
|                  |                                                |
|------------------|------------------------------------------------|
| Center Frequency | The centre frequency of the channel under test |
| Detector         | Peak                                           |
| RBW              | 100 kHz                                        |
| VBW              | $\geq 3 \times \text{RBW}$                     |
| Span             | 1.5 x DTS bandwidth                            |
| Trace            | Max hold                                       |
| Sweep time       | Auto couple.                                   |

Use the peak marker function to determine the maximum PSD level.

|                    |                                                                               |
|--------------------|-------------------------------------------------------------------------------|
| Span               | Set the center frequency and span to encompass frequency range to be measured |
| Detector           | Peak                                                                          |
| RBW                | 100 kHz                                                                       |
| VBW                | $\geq 3 \times \text{RBW}$                                                    |
| measurement points | $\geq \text{span}/\text{RBW}$                                                 |
| Trace              | Max hold                                                                      |
| Sweep time         | Auto couple.                                                                  |

Use the peak marker function to determine the maximum amplitude level.

### TEST SETUP





**TEST ENVIRONMENT**

|                     |        |                   |         |
|---------------------|--------|-------------------|---------|
| Temperature         | 22°C   | Relative Humidity | 56%     |
| Atmosphere Pressure | 101kPa | Test Voltage      | DC 3.3V |

**PART 1: REFERENCE LEVEL MEASUREMENT**

**TEST RESULTS TABLE**

| Test Mode | Test Channel | Result[dBm] |
|-----------|--------------|-------------|
| DH5       | LCH          | 5.07        |
|           | MCH          | 5.57        |
|           | HCH          | 6.56        |
| 2DH5      | LCH          | 0.22        |
|           | MCH          | 0.81        |
|           | HCH          | 1.34        |
| 3DH5      | LCH          | 0.19        |
|           | MCH          | 0.76        |
|           | HCH          | 1.30        |





## TEST GRAPHS















**PART 2: CONDUCTED BANDEDGE**

**TEST RESULTS TABLE**

| Test Mode | Test Channel | Result                  | Verdict |
|-----------|--------------|-------------------------|---------|
| DH5       | LCH          | Refer to the Test Graph | PASS    |
|           | HCH          | Refer to the Test Graph | PASS    |
| 2DH5      | LCH          | Refer to the Test Graph | PASS    |
|           | HCH          | Refer to the Test Graph | PASS    |
| 3DH5      | LCH          | Refer to the Test Graph | PASS    |
|           | HCH          | Refer to the Test Graph | PASS    |





## TEST GRAPHS

