



# MEASUREMENT REPORT

## FCC PART 15.247 Bluetooth

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**FCC ID:** 2AO3C-MSYBT  
**APPLICANT:** Tivoli Audio, Inc.  
**Application Type:** Certification  
**Product:** AM/FM/Bluetooth HiFi Radio  
**Model No.:** Music System BT, Music System +  
**Brand Name:** Tivoli  
**FCC Classification:** FCC Part 15 Spread Spectrum Transmitter (DSS)  
**FCC Rule Part(s):** Part 15 Subpart C (Section 15.247)  
**Test Procedure(s):** ANSI C63.10-2013  
**Test Date:** October 28 ~ December 11, 2020

Reviewed By:

*Kevin Guo*

Kevin Guo

Approved By:

*Robin Wu*

Robin Wu



The test results relate only to the samples tested.

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013. Test results reported herein relate only to the item(s) tested.

The test report shall not be reproduced except in full without the written approval of MRT Technology (Suzhou) Co., Ltd.

### Revision History

| Report No.    | Version | Description    | Issue Date | Note  |
|---------------|---------|----------------|------------|-------|
| 2008RSU016-U1 | Rev. 01 | Initial Report | 12-18-2020 | Valid |
|               |         |                |            |       |

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## 1. General Information

### 1.1. Applicant

Tivoli Audio, Inc.  
218 Newbury Street Boston, MA 02116, USA

### 1.2. Manufacturer

Tivoli Audio, Inc.  
218 Newbury Street Boston, MA 02116, USA

### 1.3. Testing Facility

|                                     |                                                                                                 |
|-------------------------------------|-------------------------------------------------------------------------------------------------|
| <input checked="" type="checkbox"/> | <b>Test Site – MRT Suzhou Laboratory</b>                                                        |
|                                     | <b>Laboratory Location (Suzhou - Wuzhong)</b>                                                   |
|                                     | D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China              |
|                                     | <b>Laboratory Location (Suzhou - SIP)</b>                                                       |
|                                     | 4b Building, Liando U Valley, No.200 Xingpu Rd., Shengpu Town, Suzhou Industrial Park, China    |
|                                     | <b>Laboratory Accreditations</b>                                                                |
|                                     | A2LA: 3628.01 CNAS: L10551                                                                      |
|                                     | FCC: CN1166 ISED: CN0001                                                                        |
|                                     | VCCI: R-20025, G-20034, C-20020, T-20020                                                        |
| <input type="checkbox"/>            | <b>Test Site – MRT Shenzhen Laboratory</b>                                                      |
|                                     | <b>Laboratory Location (Shenzhen)</b>                                                           |
|                                     | 1G, Building A, Junxiangda Building, Zhongshanyuan Road West, Nanshan District, Shenzhen, China |
|                                     | <b>Laboratory Accreditations</b>                                                                |
|                                     | A2LA: 3628.02 CNAS: L10551                                                                      |
|                                     | FCC: CN1284 ISED: CN0105                                                                        |
| <input type="checkbox"/>            | <b>Test Site – MRT Taiwan Laboratory</b>                                                        |
|                                     | <b>Laboratory Location (Taiwan)</b>                                                             |
|                                     | No. 38, Fuxing 2nd Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)                        |
|                                     | <b>Laboratory Accreditations</b>                                                                |
|                                     | TAF: L3261-190725                                                                               |
|                                     | FCC: 291082, TW3261 ISED: TW3261                                                                |

## 2. PRODUCT INFORMATION

### 2.1. Equipment Description

|                      |                                                       |
|----------------------|-------------------------------------------------------|
| Product:             | AM/FM/Bluetooth HiFi Radio                            |
| Model No.:           | Music System BT, Music System +                       |
| Brand Name:          | Tivoli                                                |
| Radio Specification: | AM / FM / DAB / Bluetooth                             |
| Bluetooth Version:   | V5.0 (Single mode for BR/EDR)                         |
| Software Version:    | VM1.0 for Music System BT<br>VM2.0 for Music System + |
| Hardware Version:    | VM1.0                                                 |
| Test Device S/N:     | H100370920                                            |
| Power Supply:        | AC 120V, 60Hz                                         |

Note: "Music System BT" supports AM/FM/Bluetooth, and "Music System +" supports FM/DAB/Bluetooth. The difference between the models is only the software version, the others are the same. Music System BT was selected for all testing.

### 2.2. Product Specification Subjective to this Report

|                      |                                                      |
|----------------------|------------------------------------------------------|
| Operating Frequency: | 2402~2480MHz                                         |
| Channel Number:      | 79                                                   |
| Type of modulation:  | GFSK, $\pi/4$ -DQPSK, 8DPSK                          |
| Data Rate:           | 1Mbps (GFSK), 2Mbps ( $\pi/4$ -DQPSK), 3Mbps (8DPSK) |
| Antenna Type:        | PCB Antenna                                          |
| Antenna Gain:        | 2.0dBi                                               |

The test data contained in this report pertains only to the emissions due to the EUT's Bluetooth transmitter.

- 15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) stream.
- 15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate its channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.
- 15.247(h): The EUT employs Adaptive Frequency Hopping (AFH) which identifies sources of interference namely devices operating in 802.11 WLAN and excludes them from the list of available channels. The process of re-mapping reduces the number of test channels from 79 channels to a minimum number of 20 channels.

### 2.3. Operation Frequency / Channel List

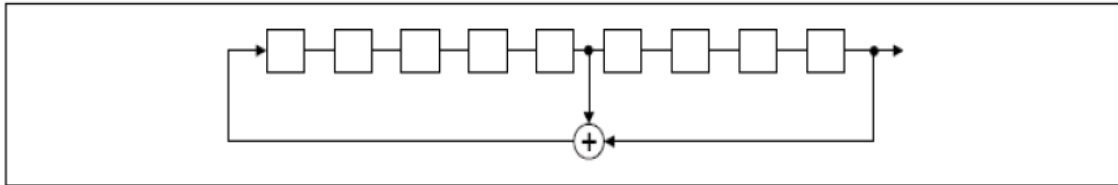
#### Bluetooth-BR/EDR

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

## 2.4. Pseudorandom Frequency Hopping Sequence

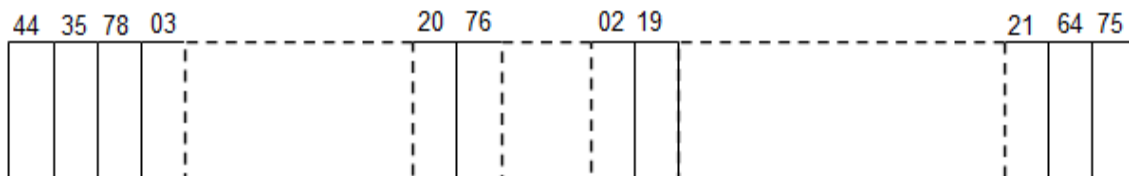
The pseudorandom sequence may be generated in a nine-stage shift register whose 5<sup>th</sup> and 9<sup>th</sup> stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONES; i.e. the 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 follow:



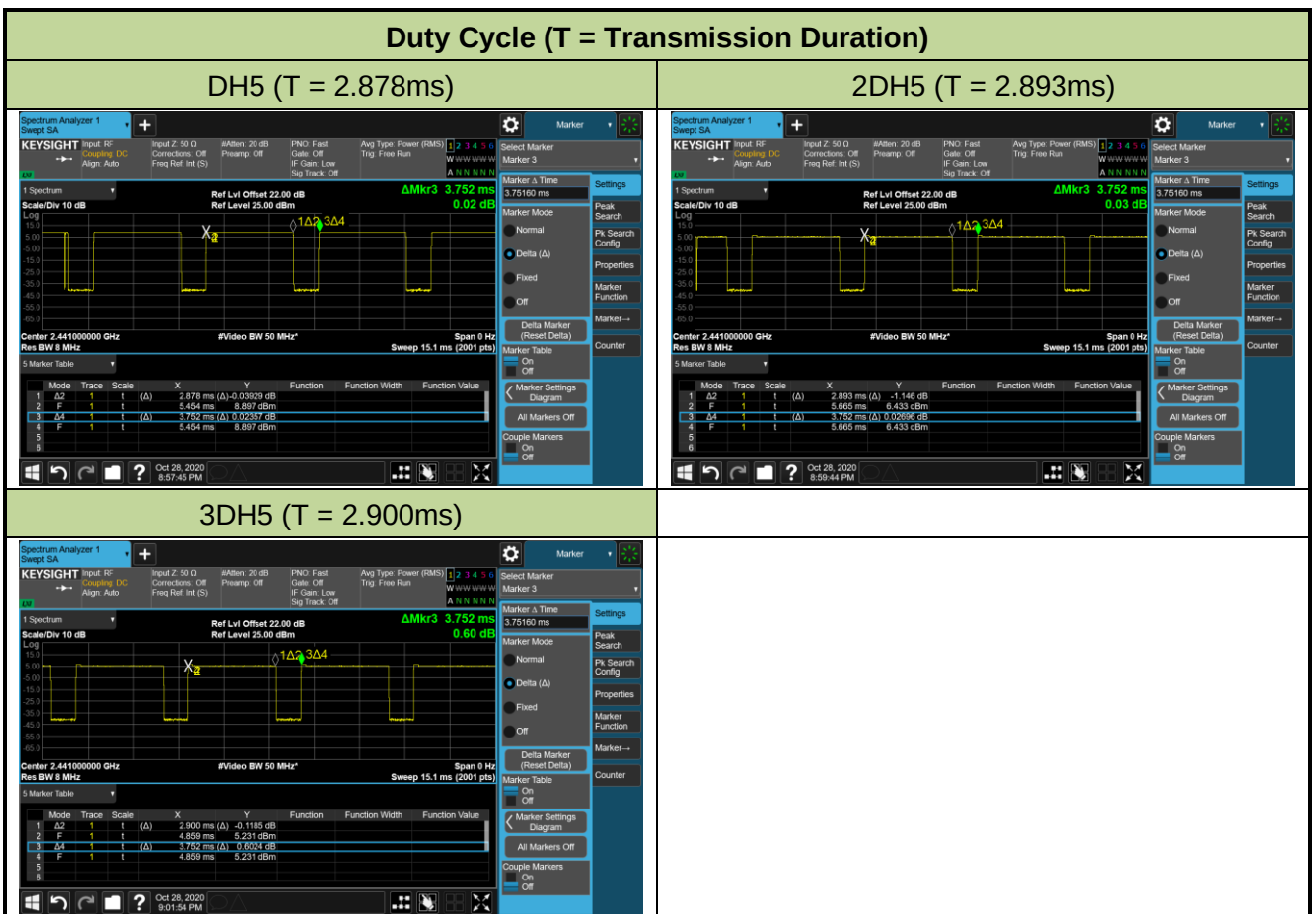
Each frequency used equally on the average by each transmitter.

The system receivers have input bandwidths that match the hopping channel bandwidths of their Corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

## 2.5. Duty Cycle

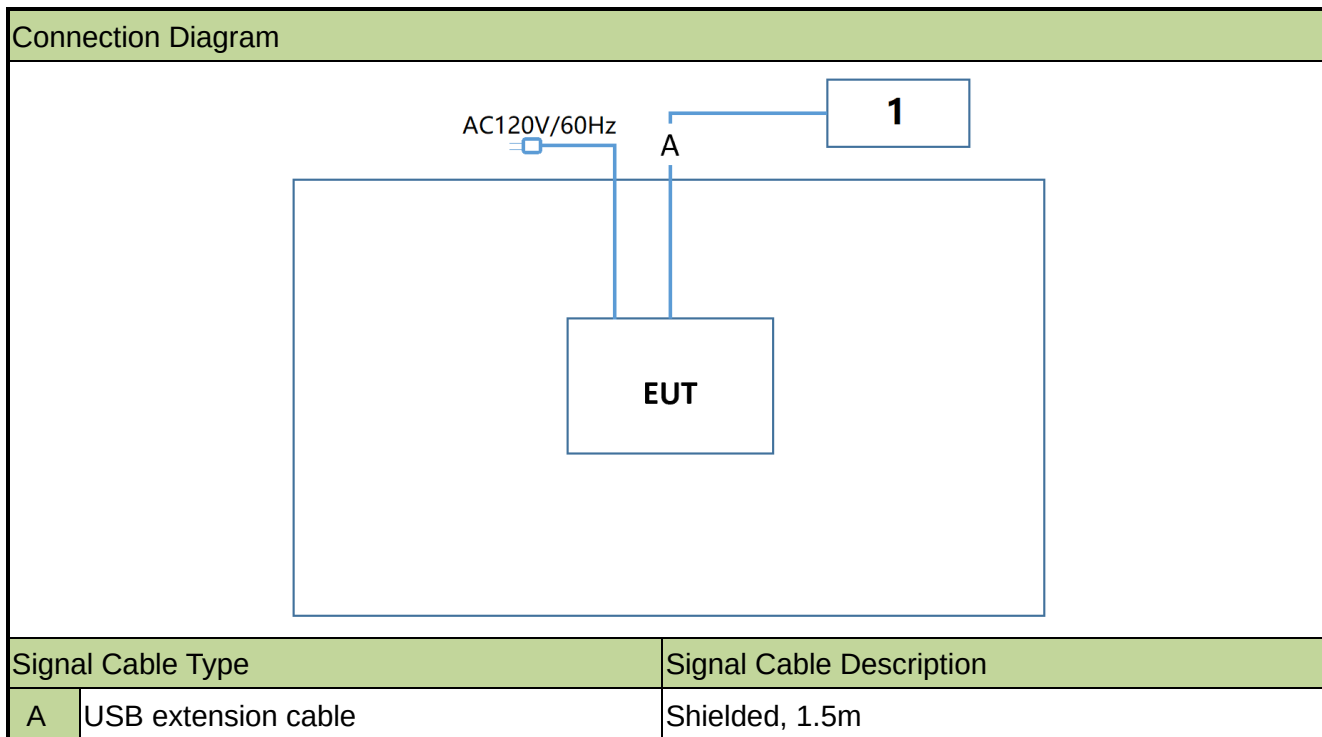
The maximum achievable duty cycle was determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

| Test Mode | Duty Cycle |
|-----------|------------|
| DH5       | 76.71%     |
| 2DH5      | 77.11%     |
| 3DH5      | 77.29%     |



## 2.6. Configuration of Test System

The device was tested per the guidance ANSI C63.10: 2013 was used to reference the appropriate EUT setup for radiated emissions testing and AC line conducted testing.



## 2.7. Test System Details

The types for all equipments, plus descriptions of all cables used in the tested system (including inserted cards) are:

| Product |          | Manufacturer | Model No.   | Serial No. | Description        |
|---------|----------|--------------|-------------|------------|--------------------|
| 1       | Notebook | DELL         | Vostro 3300 | DN62SP1    | Non-Shielded, 1.8m |

## 2.8. Test Software

The test utility software used during testing was “BlueTest3”, and the version was V2.6.9.

## 2.9. EMI Suppression Device(s) / Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

## 2.10. Test Environment Condition

|                     |              |
|---------------------|--------------|
| Ambient Temperature | 15°C ~ 35°C  |
| Relative Humidity   | 20%RH ~75%RH |

### **3. ANTENNA REQUIREMENTS**

#### **Excerpt from §15.203 of the FCC Rules/Regulations:**

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

- The antenna of the device is permanently attached.
- There are no provisions for connection to an external antenna.

#### **Conclusion:**

The unit complies with the requirement of §15.203.

#### 4. TEST EQUIPMENT CALIBRATION DATE

##### Conducted Emission (WZ-SR2)

| Instrument                 | Manufacturer | Type No.    | Asset No.   | Cali. Interval | Cali. Due Date |
|----------------------------|--------------|-------------|-------------|----------------|----------------|
| EMI Test Receiver          | R&S          | ESR3        | MRTSUE06185 | 1 year         | 2021/01/18     |
| Two-Line V-Network         | R&S          | ENV216      | MRTSUE06002 | 1 year         | 2021/06/11     |
| Temperature Humidity Meter | testo        | 608-H1      | MRTSUE06404 | 1 year         | 2021/07/26     |
| Shielding Room             | MIX-BEP      | Chamber-SR2 | MRTSUE06215 | N/A            | N/A            |

##### Conducted Emission (SIP-SR2)

| Instrument                 | Manufacturer | Type No. | Asset No.   | Cali. Interval | Cali. Due Date |
|----------------------------|--------------|----------|-------------|----------------|----------------|
| EMI Test Receiver          | R&S          | ESR3     | MRTSUE06613 | 1 year         | 2021/07/02     |
| Two-Line V-Network         | R&S          | ENV216   | MRTSUE06003 | 1 year         | 2021/06/11     |
| Temperature Humidity Meter | testo        | 608-H1   | MRTSUE06621 | 1 year         | 2020/12/29     |

##### Radiated Emission (WZ-AC1)

| Instrument                 | Manufacturer | Type No.    | Asset No.   | Cali. Interval | Cali. Due Date |
|----------------------------|--------------|-------------|-------------|----------------|----------------|
| EMI Test Receiver          | R&S          | ESR7        | MRTSUE06001 | 1 year         | 2021/01/18     |
| PXA Signal Analyzer        | Keysight     | N9030B      | MRTSUE06395 | 1 year         | 2021/08/30     |
| Loop Antenna               | Schwarzbeck  | FMZB 1519   | MRTSUE06025 | 1 year         | 2021/10/22     |
| Bilog Period Antenna       | Schwarzbeck  | VULB 9168   | MRTSUE06172 | 1 year         | 2021/08/08     |
| Horn Antenna               | Schwarzbeck  | BBHA 9120D  | MRTSUE06023 | 1 year         | 2021/09/27     |
| Horn Antenna               | Schwarzbeck  | BBHA9170    | MRTSUE06597 | 1 year         | 2020/12/17     |
| Microwave System Amplifier | Agilent      | 83017A      | MRTSUE06076 | 1 year         | 2021/11/14     |
| Preamplifier               | Schwarzbeck  | BBV 9721    | MRTSUE06121 | 1 year         | 2021/06/11     |
| Temperature Humidity Meter | testo        | 608-H1      | MRTSUE06403 | 1 year         | 2021/07/26     |
| Anechoic Chamber           | TDK          | Chamber-AC1 | MRTSUE06212 | 1 year         | 2021/04/30     |

## Radiated Emission (WZ-AC2)

| Instrument                     | Manufacturer | Type No.    | Asset No.   | Cali. Interval | Cali. Due Date |
|--------------------------------|--------------|-------------|-------------|----------------|----------------|
| MXE EMI Receiver               | Keysight     | N9038A      | MRTSUE06125 | 1 year         | 2021/07/02     |
| Loop Antenna                   | Schwarzbeck  | FMZB 1519   | MRTSUE06025 | 1 year         | 2021/10/22     |
| Bilog Period Antenna           | Schwarzbeck  | VULB 9162   | MRTSUE06022 | 1 year         | 2021/05/26     |
| Broad-Band Horn Antenna        | Schwarzbeck  | BBHA 9120D  | MRTSUE06171 | 1 year         | 2021/10/25     |
| Horn Antenna                   | Schwarzbeck  | BBHA9170    | MRTSUE06597 | 1 year         | 2020/12/17     |
| Broadband Coaxial Preamplifier | Schwarzbeck  | BBV 9718    | MRTSUE06176 | 1 year         | 2021/11/14     |
| Preamplifier                   | Schwarzbeck  | BBV 9721    | MRTSUE06121 | 1 year         | 2021/06/11     |
| Temperature Humidity Meter     | Minggao      | ETH529      | MRTSUE06170 | 1 year         | 2020/12/15     |
| Anechoic Chamber               | RIKEN        | Chamber-AC2 | MRTSUE06213 | 1 year         | 2021/04/30     |

## Radiated Emission (SIP-AC1)

| Instrument                 | Manufacturer | Type No.    | Asset No.   | Cali. Interval | Cali. Due Date |
|----------------------------|--------------|-------------|-------------|----------------|----------------|
| EMI Test Receiver          | R&S          | ESR3        | MRTSUE06612 | 1 year         | 2021/07/02     |
| EXA Signal Analyzer        | Keysight     | N9010B      | MRTSUE06559 | 1 year         | 2021/07/23     |
| Loop Antenna               | Schwarzbeck  | FMZB 1519   | MRTSUE06025 | 1 year         | 2021/10/22     |
| Bilog Period Antenna       | Schwarzbeck  | VULB9168    | MRTSUE06645 | 1 year         | 2021/08/30     |
| Double Ridged Horn Antenna | R&S          | HF907       | MRTSUE06610 | 1 year         | 2021/08/30     |
| Preamplifier               | EMCI         | EMC051845SE | MRTSUE06600 | 1 year         | 2021/11/09     |
| Temperature Humidity Meter | testo        | 608-H1      | MRTSUE06620 | 1 year         | 2020/12/29     |
| Anechoic Chamber           | RIKEN        | SIP-AC1     | MRTSUE06554 | 1 year         | 2020/12/25     |

## Radiated Emission (SIP-AC2)

| Instrument                 | Manufacturer | Type No.    | Asset No.   | Cali. Interval | Cali. Due Date |
|----------------------------|--------------|-------------|-------------|----------------|----------------|
| EMI Test Receiver          | R&S          | ESR3        | MRTSUE06613 | 1 year         | 2021/07/02     |
| MXA Signal Analyzer        | Keysight     | N9020B      | MRTSUE06604 | 1 year         | 2021/09/26     |
| Loop Antenna               | Schwarzbeck  | FMZB 1519   | MRTSUE06025 | 1 year         | 2021/10/22     |
| Bilog Period Antenna       | Schwarzbeck  | VULB9168    | MRTSUE06646 | 1 year         | 2021/08/30     |
| Horn Antenna               | Schwarzbeck  | BBHA9120D   | MRTSUE06648 | 1 year         | 2020/12/17     |
| Horn Antenna               | Schwarzbeck  | BBHA9170    | MRTSUE06599 | 1 year         | 2020/12/17     |
| Preamplifier               | EMCI         | EMC051845SE | MRTSUE06644 | 1 year         | 2021/11/09     |
| Preamplifier               | EMCI         | EMC184045SE | MRTSUE06602 | 1 year         | 2021/10/12     |
| Temperature Humidity Meter | testo        | 608-H1      | MRTSUE06624 | 1 year         | 2020/12/29     |
| Anechoic Chamber           | RIKEN        | SIP-AC2     | MRTSUE06781 | 1 year         | 2020/12/25     |

## Radiated Emission (SIP-AC3)

| Instrument                 | Manufacturer | Type No.    | Asset No.   | Cali. Interval | Cali. Due Date |
|----------------------------|--------------|-------------|-------------|----------------|----------------|
| EMI Test Receiver          | R&S          | ESR3        | MRTSUE06612 | 1 year         | 2021/07/02     |
| EXA Signal Analyzer        | Keysight     | N9010B      | MRTSUE06559 | 1 year         | 2021/07/23     |
| Loop Antenna               | Schwarzbeck  | FMZB 1519   | MRTSUE06025 | 1 year         | 2021/10/22     |
| Bilog Period Antenna       | Schwarzbeck  | VULB9168    | MRTSUE06647 | 1 year         | 2021/08/08     |
| Double Ridged Horn Antenna | R&S          | HF907       | MRTSUE06611 | 1 year         | 2021/09/13     |
| Horn Antenna               | Schwarzbeck  | BBHA9170    | MRTSUE06598 | 1 year         | 2020/12/17     |
| Preamplifier               | EMCI         | EMC012645SE | MRTSUE06642 | 1 year         | 2021/01/16     |
| Preamplifier               | EMCI         | EMC184045SE | MRTSUE06641 | 1 year         | 2021/01/16     |
| Temperature Humidity Meter | testo        | 608-H1      | MRTSUE06622 | 1 year         | 2020/12/29     |
| Anechoic Chamber           | RIKEN        | SIP-AC3     | MRTSUE06782 | 1 year         | 2020/12/25     |

## Conducted Test Equipment (WZ-TR3)

| Instrument                             | Manufacturer | Type No.    | Asset No.   | Cali. Interval | Cali. Due Date |
|----------------------------------------|--------------|-------------|-------------|----------------|----------------|
| EXA Signal Analyzer                    | Agilent      | N9020A      | MRTSUE06106 | 1 year         | 2021/04/14     |
| EXA Signal Analyzer                    | Keysight     | N9010B      | MRTSUE06607 | 1 year         | 2021/01/08     |
| Signal Analyzer                        | R&S          | FSV40       | MRTSUE06218 | 1 year         | 2021/04/14     |
| Power Meter                            | Agilent      | U2021XA     | MRTSUE06030 | 1 year         | 2021/10/22     |
| USB wideband power sensor              | Keysight     | U2021XA     | MRTSUE06446 | 1 year         | 2021/06/11     |
| USB wideband power sensor              | Keysight     | U2021XA     | MRTSUE06447 | 1 year         | 2021/06/11     |
| Bluetooth Test Set                     | Anritsu      | MT8852B-042 | MRTSUE06389 | 1 year         | 2021/06/11     |
| Audio Analyzer                         | Agilent      | U8903B      | MRTSUE06143 | 1 year         | 2021/06/11     |
| Modulation Analyzer                    | HP           | HP8901A     | MRTSUE06098 | 1 year         | 2021/09/26     |
| Wideband Radio<br>Communication Tester | R&S          | CMW 500     | MRTSUE06243 | 1 year         | 2021/10/20     |
| DC Power Supply                        | GWINSTEK     | DPS-3303C   | MRTSUE06064 | N/A            | N/A            |
| Temperature & Humidity<br>Chamber      | BAOYT        | BYH-150CL   | MRTSUE06051 | 1 year         | 2021/10/22     |
| Temperature Humidity Meter             | testo        | 608-H1      | MRTSUE06401 | 1 year         | 2021/07/26     |

## Conducted Test Equipment (SIP-SR5)

| Instrument                             | Manufacturer | Type No.    | Asset No.   | Cali. Interval | Cali. Due Date |
|----------------------------------------|--------------|-------------|-------------|----------------|----------------|
| Signal Analyzer                        | R&S          | FSV40       | MRTSUE06218 | 1 year         | 2021/04/14     |
| PXA Signal Analyzer                    | Keysight     | N9030B      | MRTSUE06395 | 1 year         | 2021/08/30     |
| USB wideband power sensor              | Agilent      | U2021XA     | MRTSUE06595 | 1 year         | 2021/09/26     |
| USB wideband power sensor              | Agilent      | U2021XA     | MRTSUE06596 | 1 year         | 2021/09/26     |
| Wideband Radio<br>Communication Tester | R&S          | CMW 500     | MRTSUE06243 | 1 year         | 2021/10/20     |
| Bluetooth Test Set                     | Anritsu      | MT8852B-042 | MRTSUE06389 | 1 year         | 2021/06/11     |
| Temperature Chamber                    | BAOYT        | BYG-408CS   | MRTSUE06847 | 1 year         | 2021/03/31     |
| Temperature Humidity Meter             | testo        | 622         | MRTSUE06629 | 1 year         | 2020/12/30     |

| Software     | Version | Function          |
|--------------|---------|-------------------|
| EMI Software | V3      | EMI Test Software |

## 5. MEASUREMENT UNCERTAINTY

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k = 2$ .

|                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Conducted Emission Measurement</b>                                                                                                                                                                                                                             |
| <p>The maximum measurement uncertainty is evaluated as:</p> <p>9kHz~150kHz: 3.74dB</p> <p>150kHz~30MHz: 3.44dB</p>                                                                                                                                                |
| <b>Radiated Emission Measurement</b>                                                                                                                                                                                                                              |
| <p>The maximum measurement uncertainty is evaluated as:</p> <p>Horizontal:</p> <p>30MHz~300MHz: 5.04dB</p> <p>300MHz~1GHz: 4.95dB</p> <p>1GHz~40GHz: 6.40dB</p> <p>Vertical:</p> <p>30MHz~300MHz: 5.24dB</p> <p>300MHz~1GHz: 6.03dB</p> <p>1GHz~40GHz: 6.40dB</p> |
| <b>Spurious Emissions, Conducted</b>                                                                                                                                                                                                                              |
| <p>Measuring Uncertainty for a Level of Confidence of 95% (<math>U=2Uc(y)</math>):</p> <p>0.78dB</p>                                                                                                                                                              |
| <b>Output Power</b>                                                                                                                                                                                                                                               |
| <p>Measuring Uncertainty for a Level of Confidence of 95% (<math>U=2Uc(y)</math>):</p> <p>1.13dB</p>                                                                                                                                                              |
| <b>Power Spectrum Density</b>                                                                                                                                                                                                                                     |
| <p>Measuring Uncertainty for a Level of Confidence of 95% (<math>U=2Uc(y)</math>):</p> <p>1.15dB</p>                                                                                                                                                              |
| <b>Occupied Bandwidth</b>                                                                                                                                                                                                                                         |
| <p>Measuring Uncertainty for a Level of Confidence of 95% (<math>U=2Uc(y)</math>):</p> <p>0.28%</p>                                                                                                                                                               |

## 6. TEST RESULT

### 6.1. Summary

| FCC Part Section(s) | Test Description                                                              | Test Limit                                                                     | Test Condition | Test Result | Reference                   |
|---------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------|-------------|-----------------------------|
| 15.247(a)(1)        | 20dB Bandwidth                                                                | N/A                                                                            | Conducted      | Pass        | Section 6.2                 |
| 15.247(b)(1)        | Peak Transmitter Output Power                                                 | <1 Watt                                                                        |                | Pass        | Section 6.3                 |
| 15.247(a)(1)        | Channel Separation                                                            | > 2/3 of 20 dB BW for systems with Output Power < 125mW                        |                | Pass        | Section 6.4                 |
| 15.247(a)(1) (iii)  | Number of Channels                                                            | > 15 Channels                                                                  |                | Pass        | Section 6.5                 |
| 15.247(a)(1) (iii)  | Time of Occupancy                                                             | < 0.4 sec in 31.6 sec period                                                   |                | Pass        | Section 6.6                 |
| 15.247(d)           | Band Edge / Out- of-Band Emissions                                            | Conducted $\geq$ 20dBc                                                         |                | Pass        | Section 6.7<br>Section 6.8  |
| 15.205, 15.209      | General Field Strength Limits (Restricted Bands and Radiated Emission Limits) | Emissions in restricted bands must meet the radiated limits detailed in 15.209 | Radiated       | Pass        | Section 6.9<br>Section 6.10 |
| 15.207              | AC Conducted Emissions 150kHz - 30MHz                                         | < FCC 15.207 limits                                                            | Line Conducted | Pass        | Section 6.11                |

#### Notes:

- The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.

## 6.2. 20dB Bandwidth Measurement

### 6.2.1. Test Limit

N/A

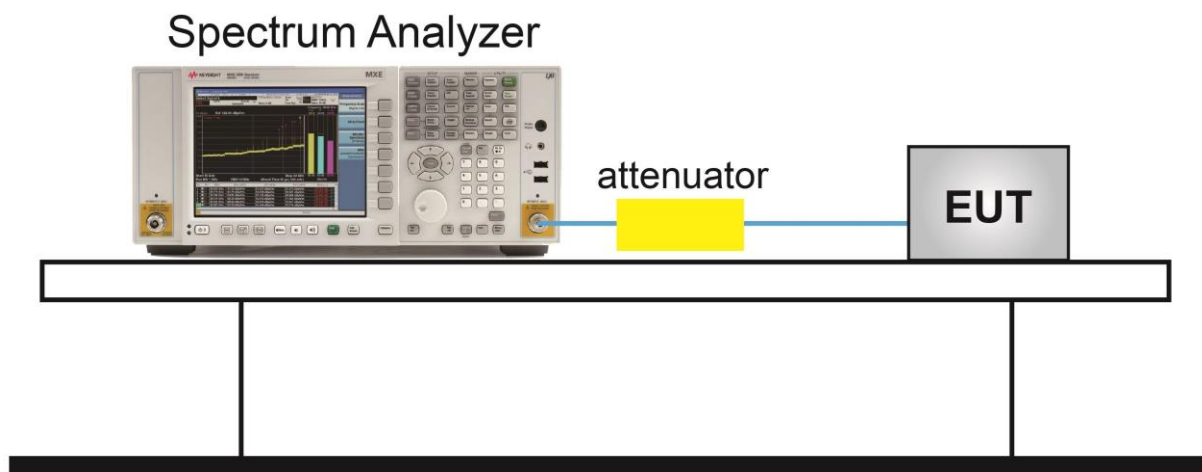
### 6.2.2. Test Procedure Used

ANSI C63.10-2013 - Section 6.9.2

### 6.2.3. Test Setting

1. Set RBW  $\geq$  1% to 5% of the 20dB bandwidth
2. VBW = Approximately three times RBW
3. Span = Approximately 2 to 5 times the 20dB bandwidth, centered on a hopping channel
4. Detector = Peak
5. Trace mode = Max hold
6. Sweep = Auto couple
7. Allow the trace to stabilize
8. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

### 6.2.4. Test Setup



### 6.2.5. Test Result

|           |                            |               |            |
|-----------|----------------------------|---------------|------------|
| Product   | AM/FM/Bluetooth HiFi Radio | Test Engineer | Bella Chen |
| Test Site | WZ-TR3                     | Test Date     | 2020/10/28 |

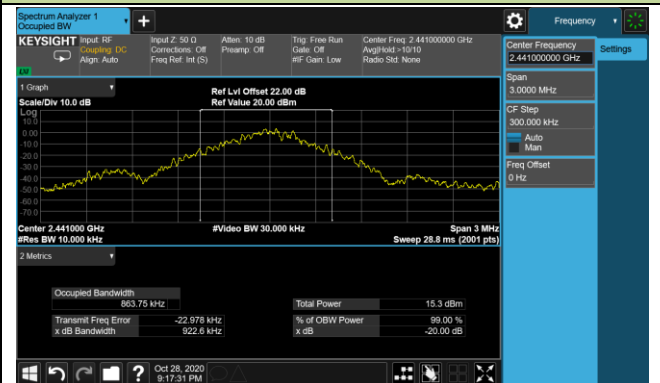
| Test Mode | Channel No. | Frequency (MHz) | 20dB Bandwidth (kHz) | Result |
|-----------|-------------|-----------------|----------------------|--------|
| DH5       | 00          | 2402            | 921.9                | Pass   |
| DH5       | 39          | 2441            | 922.6                | Pass   |
| DH5       | 78          | 2480            | 921.9                | Pass   |
| 2DH5      | 00          | 2402            | 1261.0               | Pass   |
| 2DH5      | 39          | 2441            | 1307.0               | Pass   |
| 2DH5      | 78          | 2480            | 1276.0               | Pass   |
| 3DH5      | 00          | 2402            | 1264.0               | Pass   |
| 3DH5      | 39          | 2441            | 1263.0               | Pass   |
| 3DH5      | 78          | 2480            | 1261.0               | Pass   |

## DH5 20dB Bandwidth

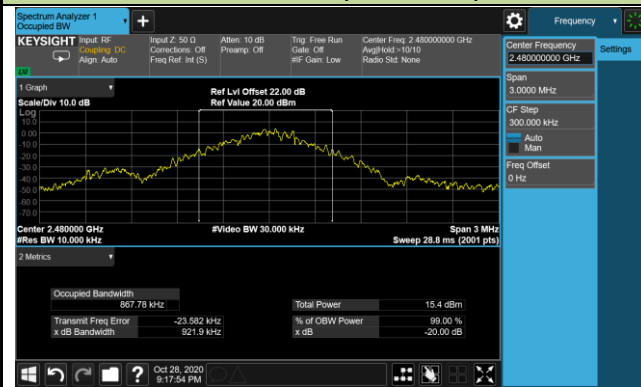
### Channel 00 (2402MHz)



### Channel 39 (2441MHz)

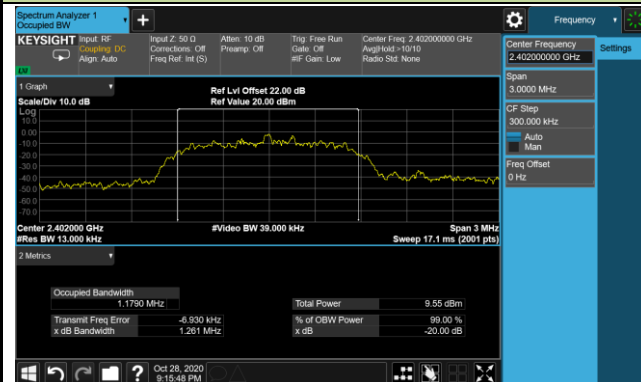


### Channel 78 (2480MHz)



## 2DH5 20dB Bandwidth

## Channel 00 (2402MHz)



## Channel 39 (2441MHz)



## Channel 78 (2480MHz)



## 3DH5 20dB Bandwidth

## Channel 00 (2402MHz)



## Channel 39 (2441MHz)



## Channel 78 (2480MHz)



### 6.3. Output Power Measurement

#### 6.3.1. Test Limit

For frequency hopping systems operating in the 2400-2483.5MHz band employing at least 75 non-overlapping hopping channels: 1watt.

For all other frequency hopping systems in the 2400-2483.5MHz band: 0.125 watt

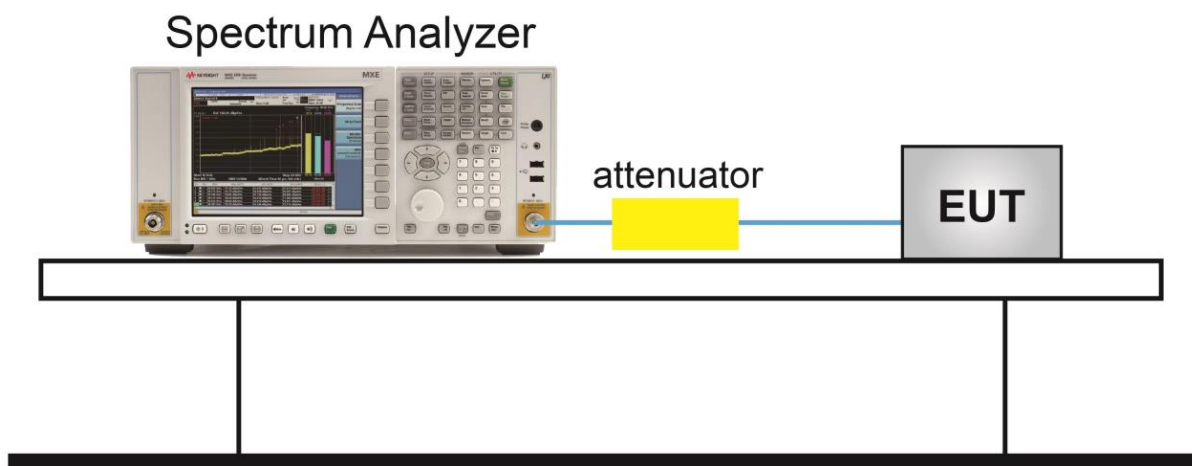
#### 6.3.2. Test Procedure Used

ANSI C63.10-2013 - Section 7.8.5

#### 6.3.3. Test Setting

1. Set RBW  $\geq$  the 20dB bandwidth of the emission being measured.
2. VBW  $\geq$  RBW
3. Span = approximately five times the 20dB bandwidth, centered on a hopping channel
4. Detector = Peak
5. Trace mode = Max hold
6. Sweep = Auto couple
7. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (don't forget added the external attenuation and cable loss)

#### 6.3.4. Test Setup



### 6.3.5. Test Result

|           |                            |               |            |
|-----------|----------------------------|---------------|------------|
| Product   | AM/FM/Bluetooth HiFi Radio | Test Engineer | Bella Chen |
| Test Site | WZ-TR3                     | Test Date     | 2020/10/29 |

| Test Mode | Channel No. | Frequency (MHz) | Peak Power (dBm) | Peak Power Limit (dBm) |
|-----------|-------------|-----------------|------------------|------------------------|
| DH5       | 00          | 2402            | 7.03             | ≤ 20.97                |
| DH5       | 39          | 2441            | 9.12             | ≤ 20.97                |
| DH5       | 78          | 2480            | 9.56             | ≤ 20.97                |
| 2DH5      | 00          | 2402            | 4.88             | ≤ 20.97                |
| 2DH5      | 39          | 2441            | 7.81             | ≤ 20.97                |
| 2DH5      | 78          | 2480            | 8.17             | ≤ 20.97                |
| 3DH5      | 00          | 2402            | 5.16             | ≤ 20.97                |
| 3DH5      | 39          | 2441            | 8.04             | ≤ 20.97                |
| 3DH5      | 78          | 2480            | 8.41             | ≤ 20.97                |

## DH5 Output Power

### Channel 00 (2402MHz)



### Channel 39 (2441MHz)



### Channel 78 (2480MHz)



## 2DH5 Output Power

### Channel 00 (2402MHz)



### Channel 39 (2441MHz)



### Channel 78 (2480MHz)



### 3DH5 Output Power

#### Channel 00 (2402MHz)



#### Channel 39 (2441MHz)



#### Channel 78 (2480MHz)



## 6.4. Carrier Frequency Separation Measurement

### 6.4.1. Test Limit

The minimum permissible channel separation for this system is  $\frac{2}{3}$  the value of the 20dB BW.

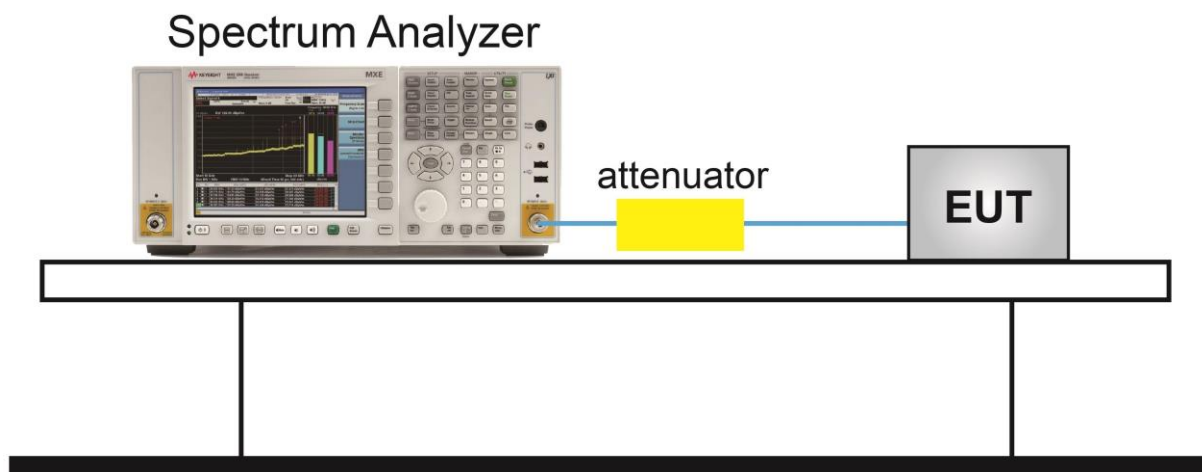
### 6.4.2. Test Procedure Used

ANSI C63.10-2013 - Section 7.8.2

### 6.4.3. Test Setting

1. Span = Wide enough to capture the peaks of two adjacent channels.
2. Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
3. VBW  $\geq$  RBW
4. Sweep time = Auto couple
5. Detector = Peak
6. Trace mode = Max hold
7. Allowed the trace to stabilize
8. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

### 6.4.4. Test Setup



#### 6.4.5. Test Result

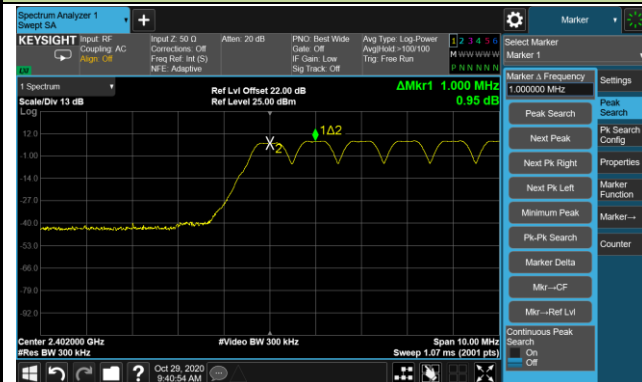
|           |                            |               |            |
|-----------|----------------------------|---------------|------------|
| Product   | AM/FM/Bluetooth HiFi Radio | Test Engineer | Bella Chen |
| Test Site | WZ-TR3                     | Test Date     | 2020/10/29 |

| Test Mode | Channel No. | Frequency (MHz) | Limit (kHz)  | Result |
|-----------|-------------|-----------------|--------------|--------|
| DH5       | 00          | 2402            | $\geq 614.6$ | Pass   |
| DH5       | 39          | 2441            | $\geq 615.1$ | Pass   |
| DH5       | 78          | 2480            | $\geq 614.6$ | Pass   |
| 2DH5      | 00          | 2402            | $\geq 840.7$ | Pass   |
| 2DH5      | 39          | 2441            | $\geq 871.3$ | Pass   |
| 2DH5      | 78          | 2480            | $\geq 850.7$ | Pass   |
| 3DH5      | 00          | 2402            | $\geq 842.7$ | Pass   |
| 3DH5      | 39          | 2441            | $\geq 842.0$ | Pass   |
| 3DH5      | 78          | 2480            | $\geq 840.7$ | Pass   |

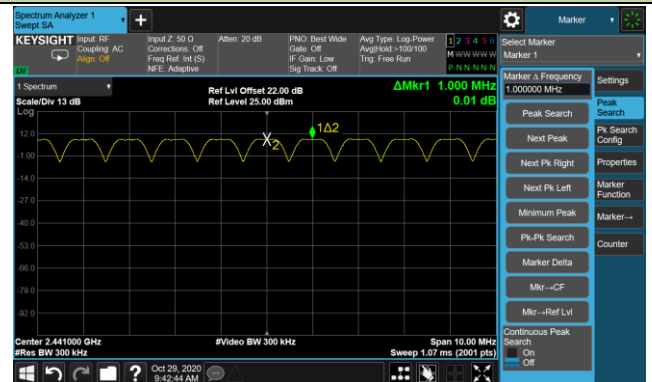
Note: The Limit is 2/3 the value of the 20dB BW.

## DH5 Carrier Frequency Separation

### Channel 00 (2402MHz)



### Channel 39 (2441MHz)

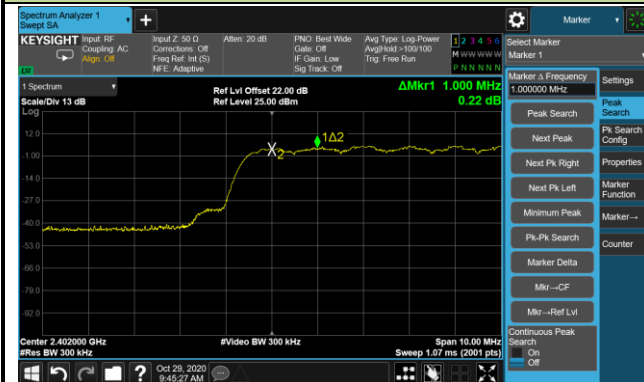


### Channel 78 (2480MHz)

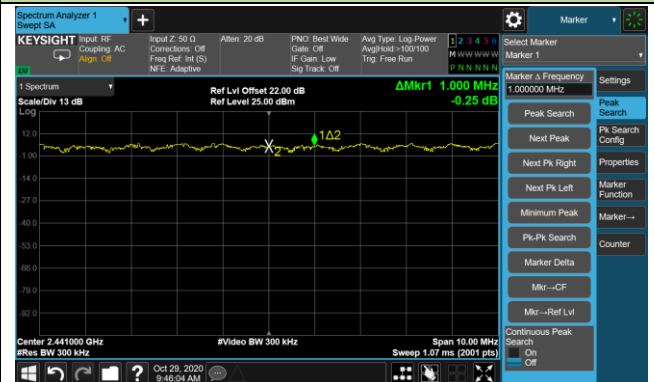


## 2DH5 Carrier Frequency Separation

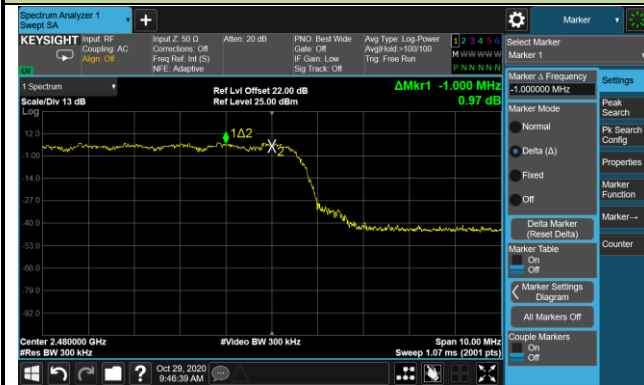
### Channel 00 (2402MHz)



### Channel 39 (2441MHz)

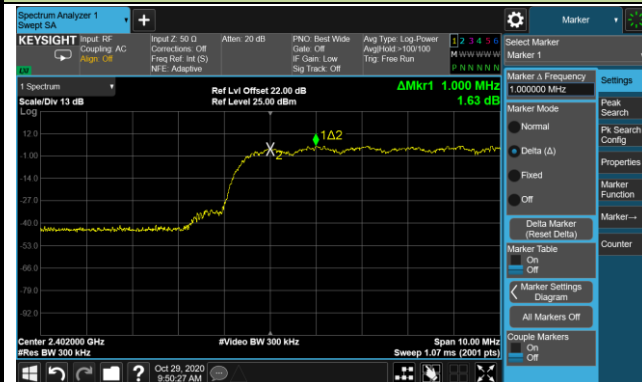


### Channel 78 (2480MHz)

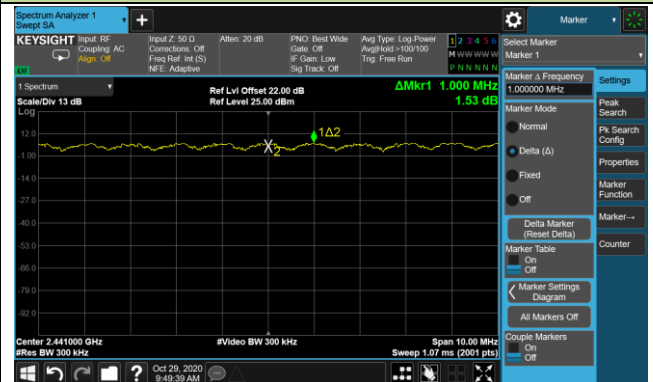


### 3DH5 Carrier Frequency Separation

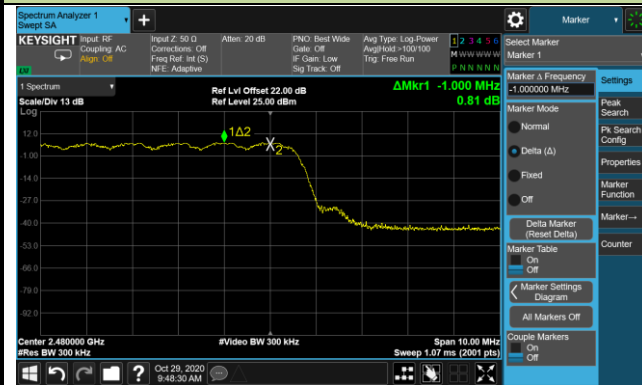
Channel 00 (2402MHz)



Channel 39 (2441MHz)



Channel 78 (2480MHz)



## 6.5. Number of Hopping Channels Measurement

### 6.5.1. Test Limit

This frequency hopping system must employ a minimum of 15 hopping channels.

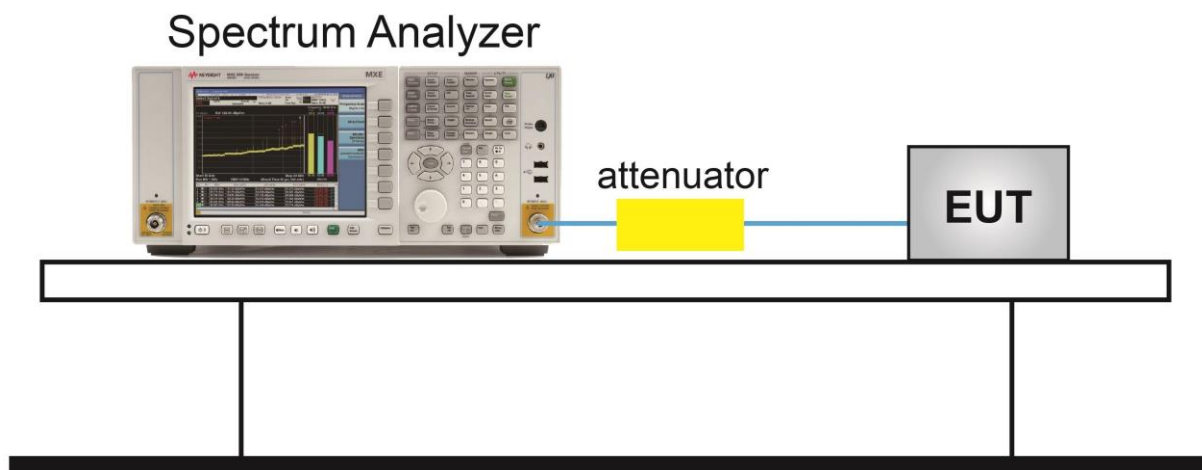
### 6.5.2. Test Procedure Used

ANSI C63.10-2013 - Section 7.8.3

### 6.5.3. Test Setting

1. 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.
2. RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3. VBW  $\geq$  RBW
4. Sweep time = Auto couple
5. Detector = Peak
6. Trace mode = Max hold
7. Allow the trace to stabilize

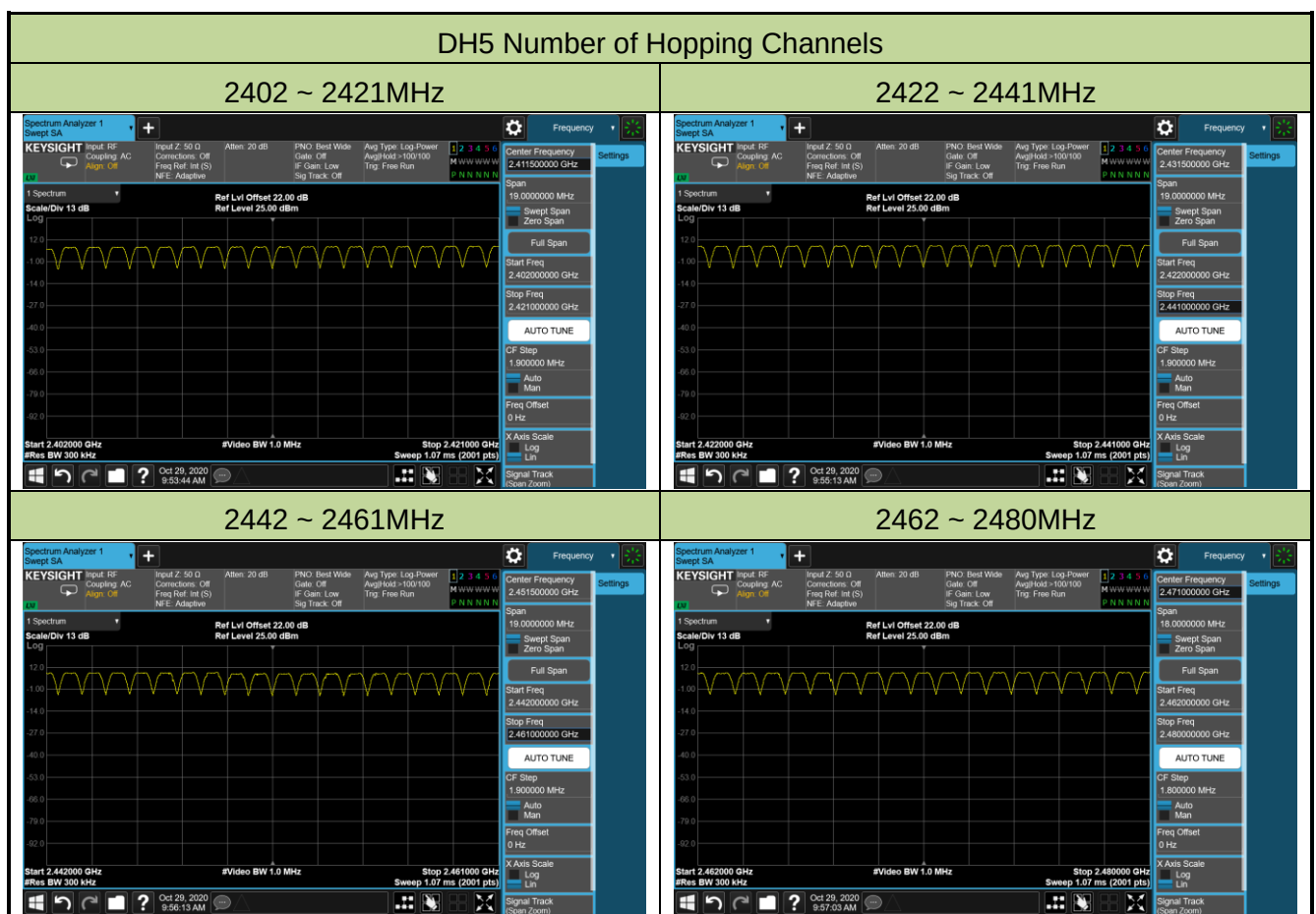
### 6.5.4. Test Setup



### 6.5.5. Test Result

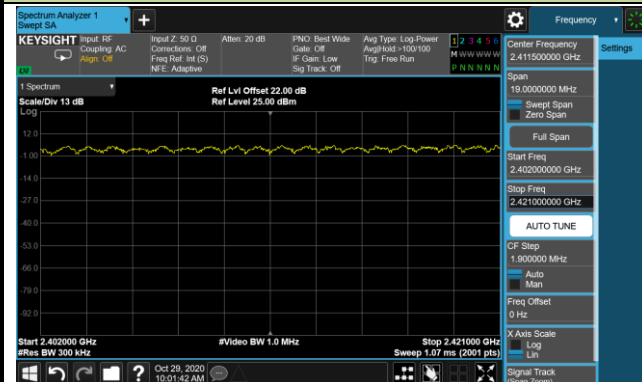
|           |                            |               |            |
|-----------|----------------------------|---------------|------------|
| Product   | AM/FM/Bluetooth HiFi Radio | Test Engineer | Bella Chen |
| Test Site | WZ-TR3                     | Test Date     | 2020/10/29 |

| Test Mode<br>(Hopping) | Channel<br>Numbers | Frequency<br>(MHz) | Limit<br>(Hopping Channels) | Result |
|------------------------|--------------------|--------------------|-----------------------------|--------|
| DH5                    | 79                 | 2402 ~ 2480        | $\geq 15$                   | Pass   |
| 2DH5                   | 79                 | 2402 ~ 2480        | $\geq 15$                   | Pass   |
| 3DH5                   | 79                 | 2402 ~ 2480        | $\geq 15$                   | Pass   |

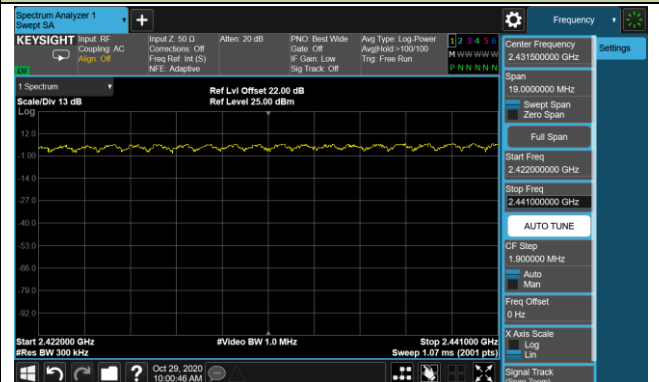


## 2DH5 Number of Hopping Channels

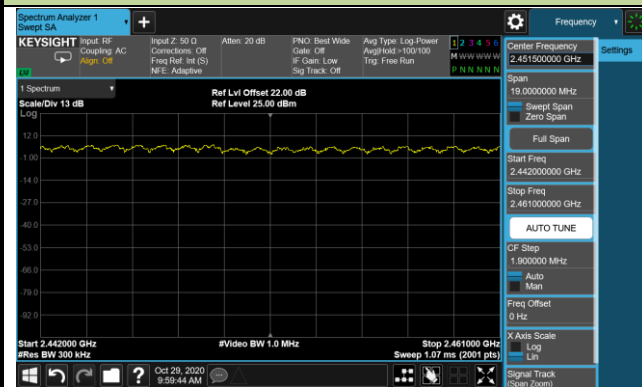
2402 ~ 2421MHz



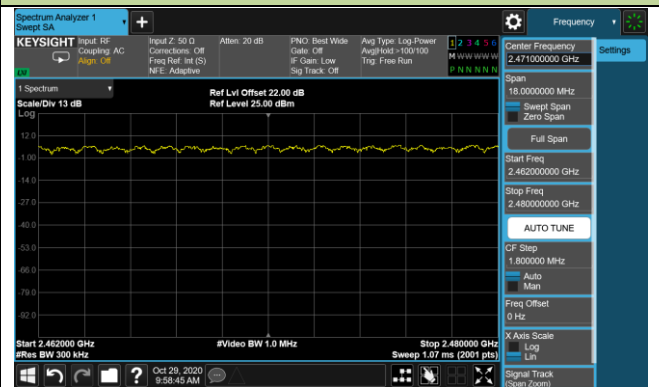
2422 ~ 2441MHz



2442 ~ 2461MHz

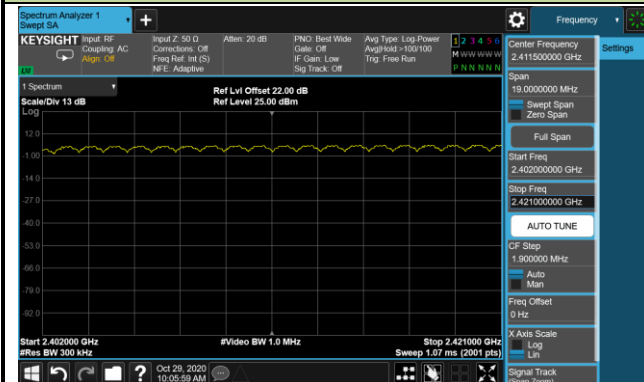


2462 ~ 2480MHz

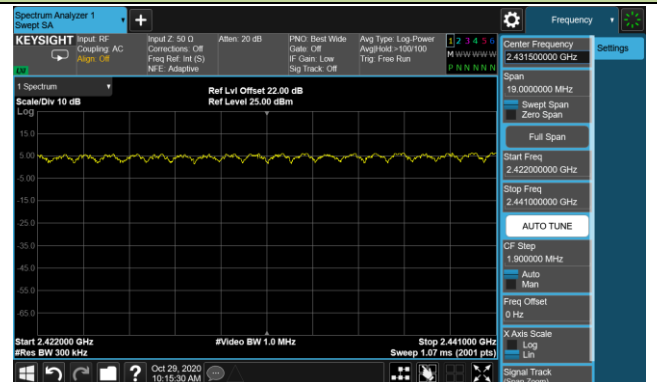


### 3DH5 Number of Hopping Channels

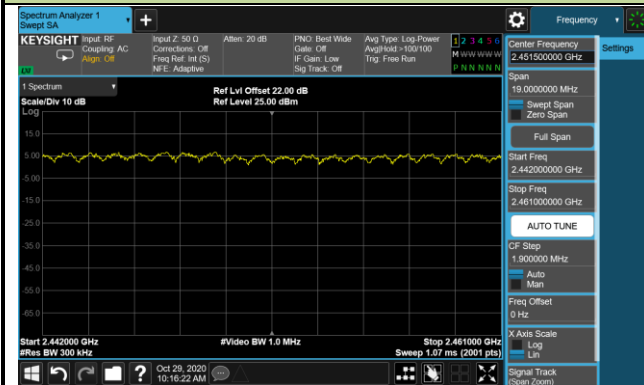
2402 ~ 2421MHz



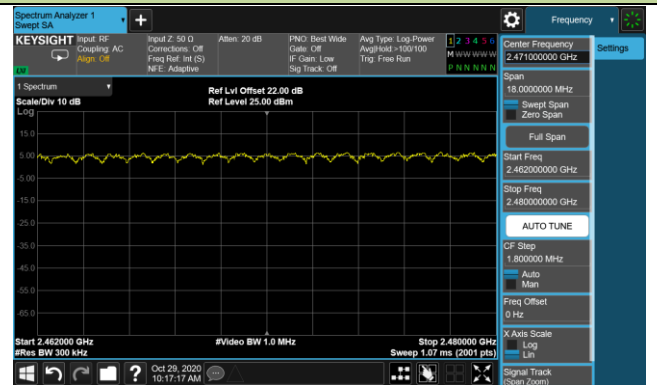
2422 ~ 2441MHz



2442 ~ 2461MHz



2462 ~ 2480MHz



## 6.6. Time of Occupancy Measurement

### 6.6.1. Test Limit

The maximum permissible time of occupancy is 400ms within a period of 400ms multiplied by the number of hopping channels employed.

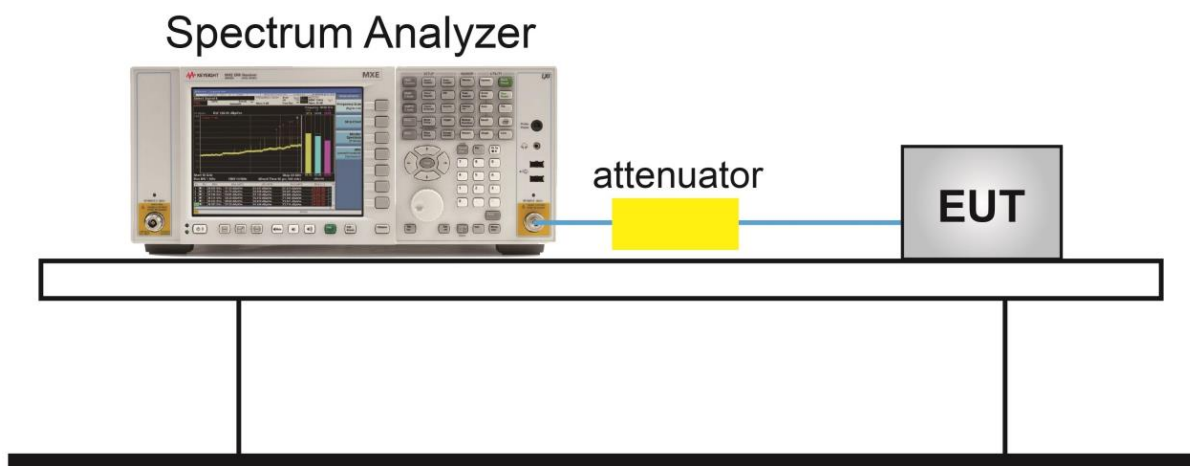
### 6.6.2. Test Procedure Used

ANSI C63.10-2013 - Section 7.8.4

### 6.6.3. Test Setting

1. Span = Zero span, centered on a hopping channel.
2. RBW shall be  $\leq$  channel spacing and where possible RBW should be set  $\gg 1/T$ , where T is the expected dwell time per channel.
3. VBW  $\geq$  RBW
4. Sweep time = As necessary to capture the entire dwell time per hopping channel
5. Detector = Peak
6. Trace mode = Free run
7. Use the marker-delta function to determine the transmit time per hop. 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.

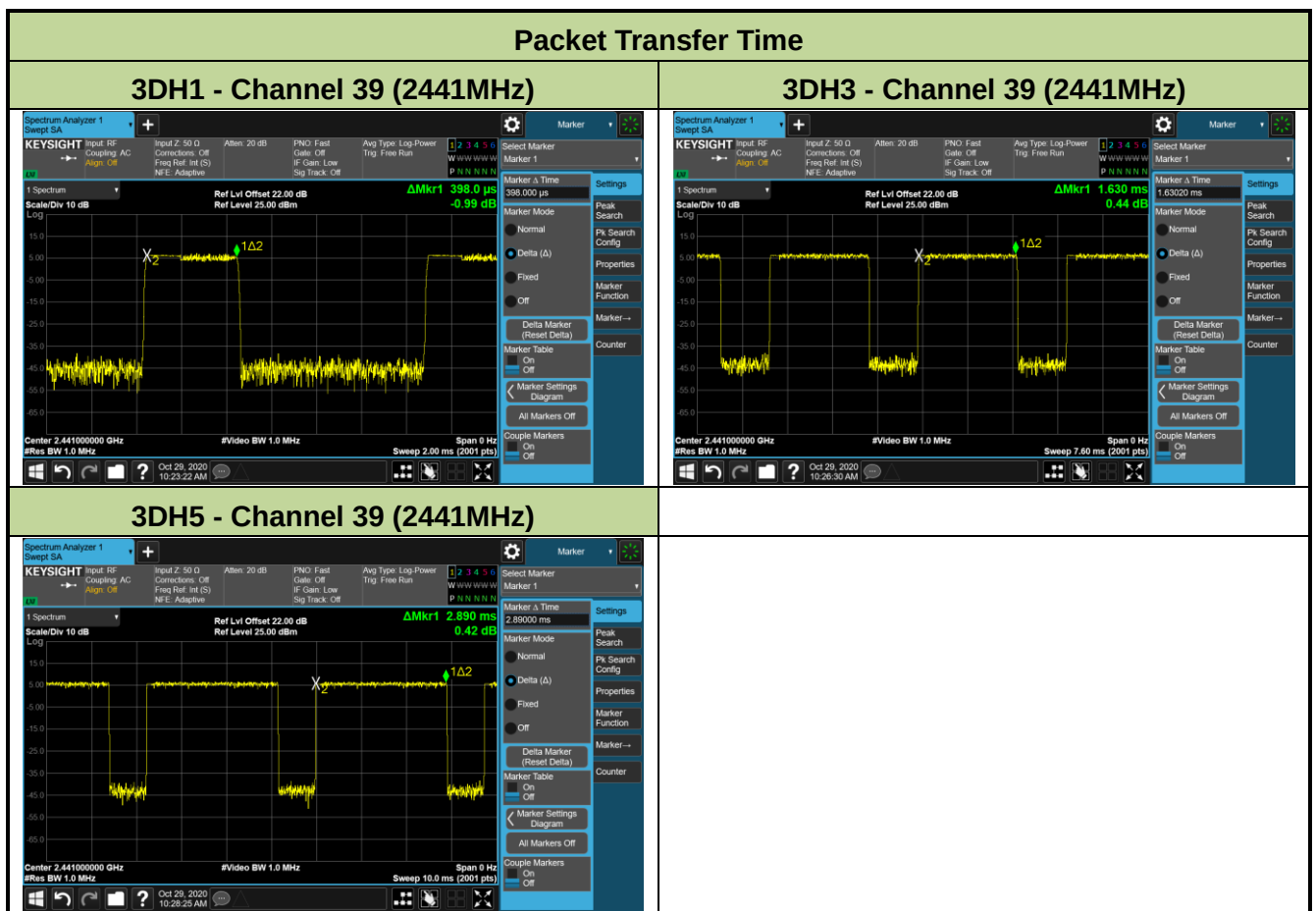
### 6.6.4. Test Setup



### 6.6.5. Test Result

|           |                            |               |            |
|-----------|----------------------------|---------------|------------|
| Product   | AM/FM/Bluetooth HiFi Radio | Test Engineer | Bella Chen |
| Test Site | WZ-TR3                     | Test Date     | 2020/10/29 |

| Test Mode | Channel No. | Frequency (MHz) | Hops Over Occupancy Time (Hops) | Packet Transfer Time (ms) | Time of Occupancy (ms) | Limit (ms) | Result |
|-----------|-------------|-----------------|---------------------------------|---------------------------|------------------------|------------|--------|
| 3DH1      | 39          | 2441            | 320                             | 0.40                      | 128.0                  | ≤ 400      | Pass   |
| 3DH3      | 39          | 2441            | 160                             | 1.63                      | 260.8                  | ≤ 400      | Pass   |
| 3DH5      | 39          | 2441            | 107                             | 2.89                      | 309.2                  | ≤ 400      | Pass   |



Note 1: According the Bluetooth Standard Specification, the nominal hop rate is 1600 hops/s. All Bluetooth unit participating in the piconet are time and hop synchronized to the channel.

Hops Over Occupancy Time in 31.6s for 3DH1 =  $1600 / 2 / 79 * 31.6 = 320$ .

Hops Over Occupancy Time in 31.6s for 3DH3 =  $1600 / 4 / 79 * 31.6 = 160$ .

Hops Over Occupancy Time in 31.6s for 3DH5 =  $1600 / 6 / 79 * 31.6 = 107$ .

Note 2: Time of Occupancy = Packet Transfer Time \* Hops Over Occupancy Time in 31.6s.

## **6.7. Band-edge Compliance Measurement**

### **6.7.1. Test Limit**

The maximum permissible emission level is 20dBc. Any emissions were lying outside of the emission bandwidth and in authorized band edges to a field strength limit specified in Section 15.209 of the Title 47 CFR.

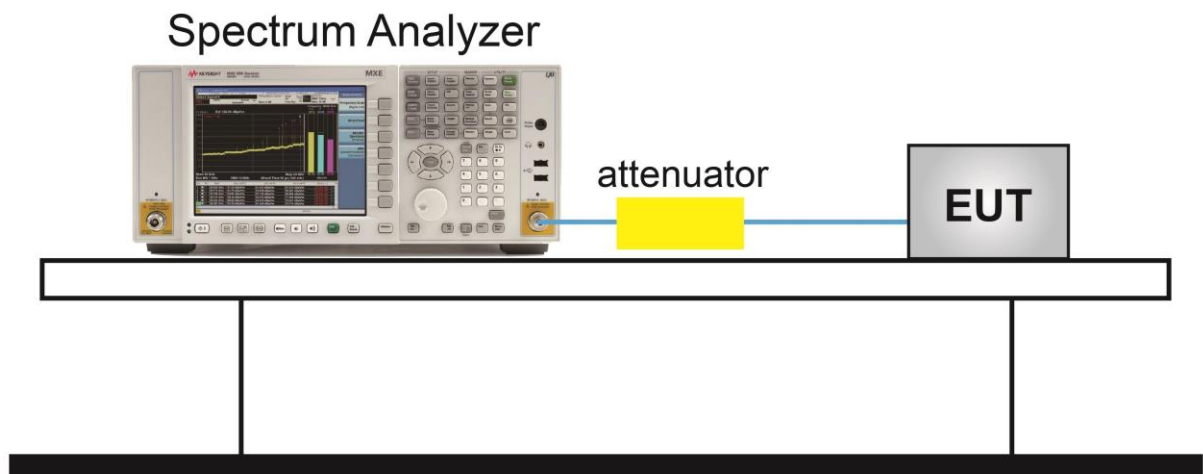
### **6.7.2. Test Procedure Used**

ANSI C63.10-2013 - Section 6.10.4

### **6.7.3. Test Setting**

1. Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.
2. RBW = 100kHz
3. VBW = 300kHz
4. Detector = Peak
5. Sweep time = Auto couple
6. Trace mode = Max hold
7. Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission.

#### 6.7.4. Test Setup



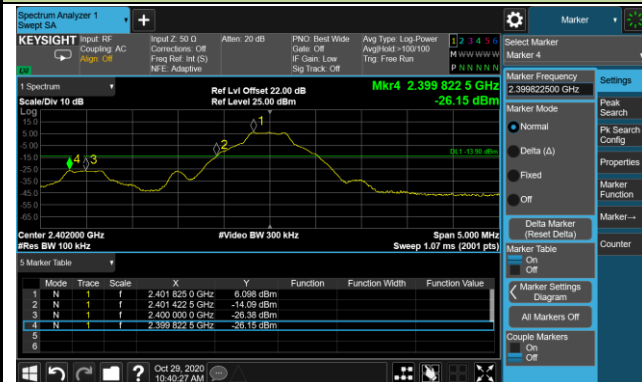
### 6.7.5. Test Result

|           |                            |               |            |
|-----------|----------------------------|---------------|------------|
| Product   | AM/FM/Bluetooth HiFi Radio | Test Engineer | Bella Chen |
| Test Site | WZ-TR3                     | Test Date     | 2020/10/29 |

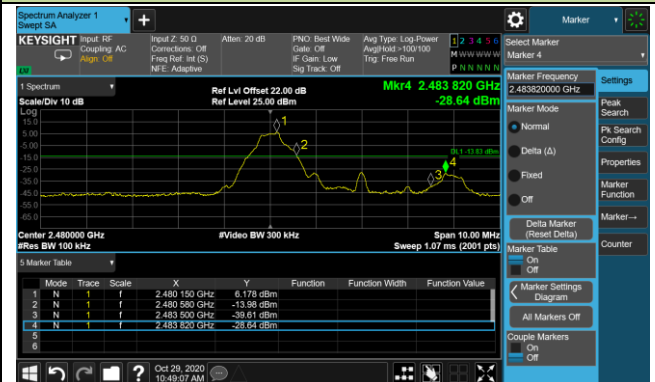
| Test Mode | Channel No. | Frequency (MHz) | Limit | Result |
|-----------|-------------|-----------------|-------|--------|
| DH5       | 00          | 2402            | 20dBc | Pass   |
| DH5       | 78          | 2480            | 20dBc | Pass   |
| 2DH5      | 00          | 2402            | 20dBc | Pass   |
| 2DH5      | 78          | 2480            | 20dBc | Pass   |
| 3DH5      | 00          | 2402            | 20dBc | Pass   |
| 3DH5      | 78          | 2480            | 20dBc | Pass   |
| DH5       | 00 ~ 78     | 2402 ~ 2480     | 20dBc | Pass   |
| 2DH5      | 00 ~ 78     | 2402 ~ 2480     | 20dBc | Pass   |
| 3DH5      | 00 ~ 78     | 2402 ~ 2480     | 20dBc | Pass   |

## Band-edge Compliance

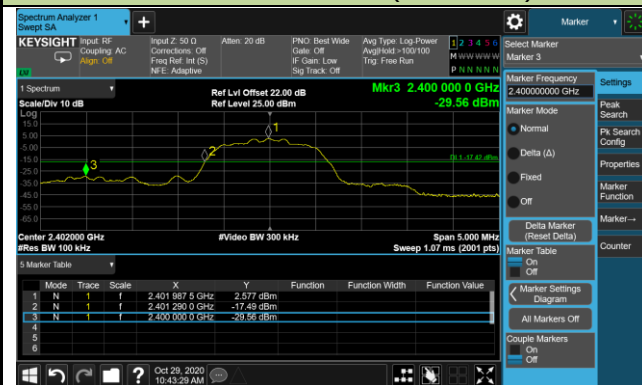
### DH5 - Channel 00 (2402MHz)



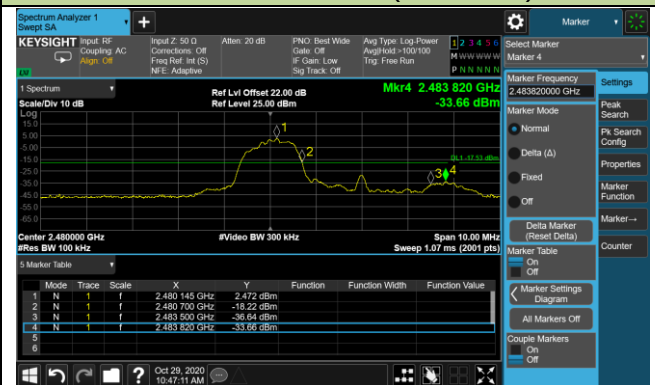
### DH5 - Channel 78 (2480MHz)



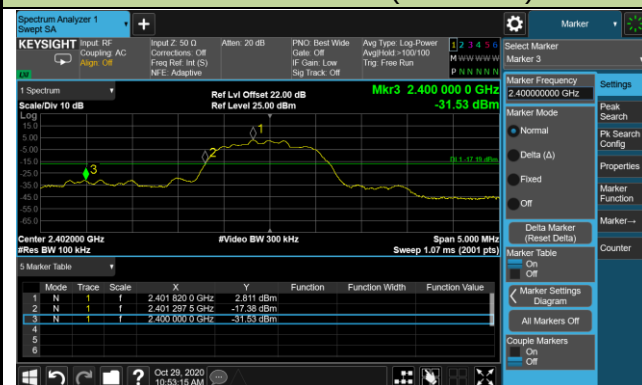
### 2DH5 - Channel 00 (2402MHz)



### 2DH5 - Channel 78 (2480MHz)



### 3DH5 - Channel 00 (2402MHz)

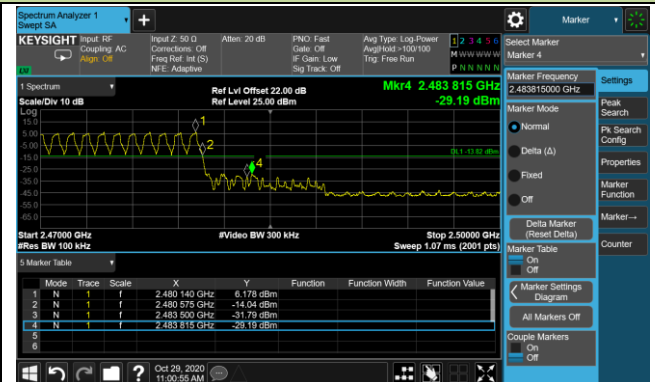
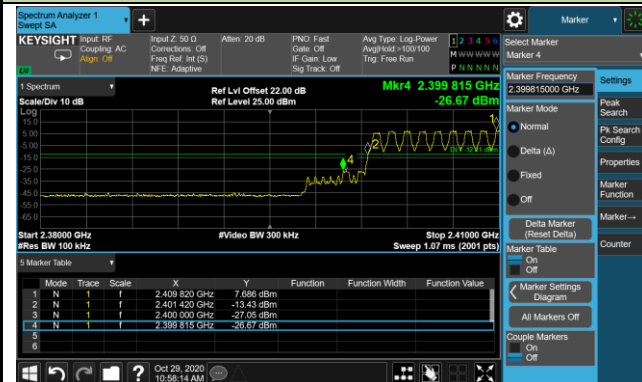


### 3DH5 - Channel 78 (2480MHz)

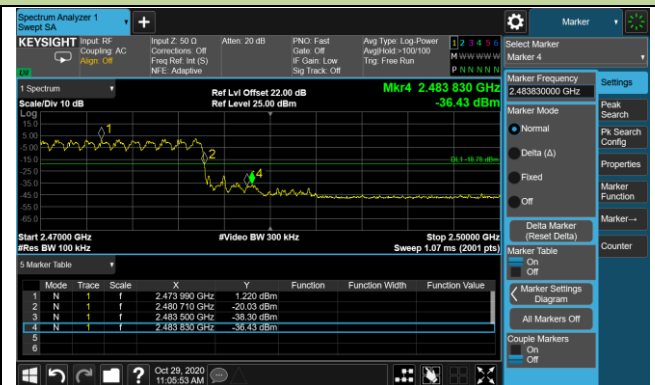
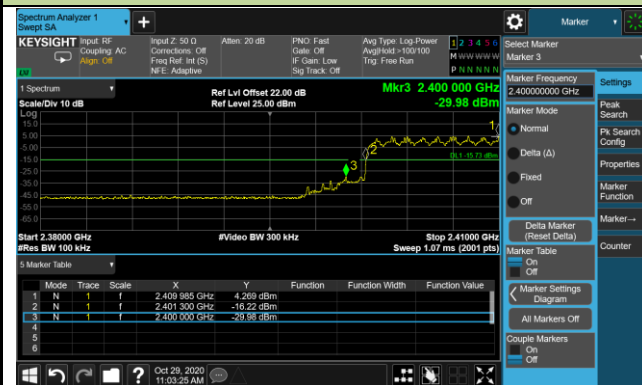


## Operation Frequency Range of 20dB Bandwidth within Hopping Mode

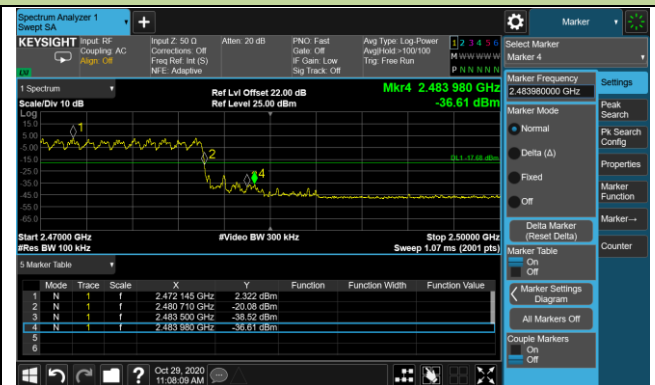
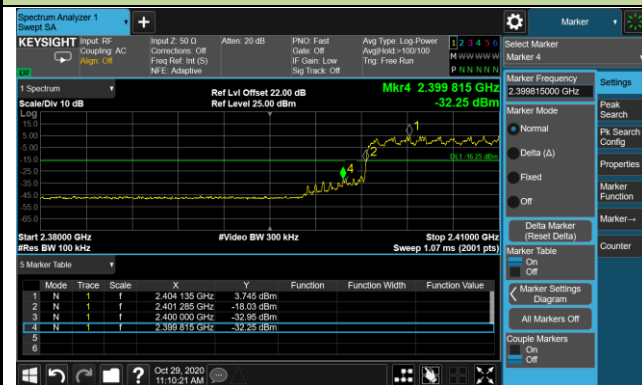
### DH5



### 2DH5



### 3DH5



## **6.8. Conducted Spurious Emissions Measurement**

### **6.8.1. Test Limit**

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 or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

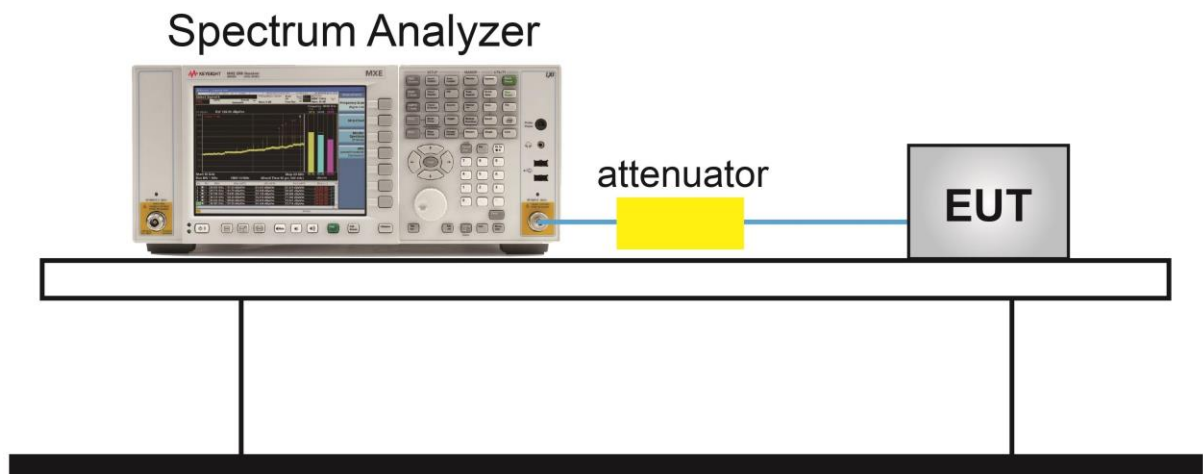
### **6.8.2. Test Procedure Used**

ANSI C63.10-2013 - Section 7.8.8

### **6.8.3. Test Setting**

1. Span = Wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
2. RBW = 100kHz
3. VBW = 300kHz
4. Detector = Peak
5. Sweep time = Auto couple
6. Trace mode = Max hold
7. Trace was allowed to stabilize
8. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this section.

#### 6.8.4. Test Setup



### 6.8.5. Test Result

|           |                            |               |            |
|-----------|----------------------------|---------------|------------|
| Product   | AM/FM/Bluetooth HiFi Radio | Test Engineer | Bella Chen |
| Test Site | WZ-TR3                     | Test Date     | 2020/10/29 |

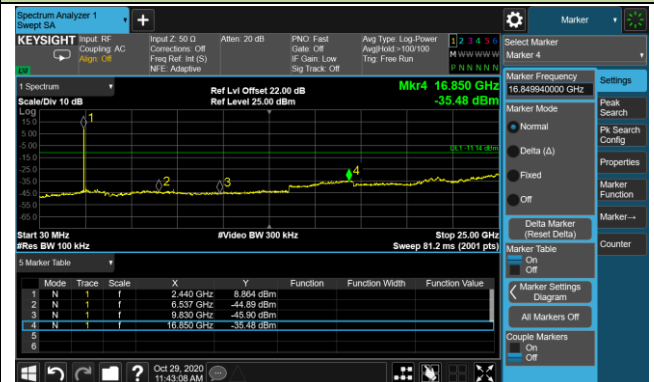
| Test Mode | Channel No. | Frequency (MHz) | Limit (MHz) | Result |
|-----------|-------------|-----------------|-------------|--------|
| DH5       | 00          | 2402            | 20dBc       | Pass   |
| DH5       | 39          | 2441            | 20dBc       | Pass   |
| DH5       | 78          | 2480            | 20dBc       | Pass   |
| 2DH5      | 00          | 2402            | 20dBc       | Pass   |
| 2DH5      | 39          | 2441            | 20dBc       | Pass   |
| 2DH5      | 78          | 2480            | 20dBc       | Pass   |
| 3DH5      | 00          | 2402            | 20dBc       | Pass   |
| 3DH5      | 39          | 2441            | 20dBc       | Pass   |
| 3DH5      | 78          | 2480            | 20dBc       | Pass   |

## DH5 Conducted Spurious Emissions

### Channel 00 (2402MHz)



### Channel 39 (2441MHz)



### Channel 78 (2480MHz)

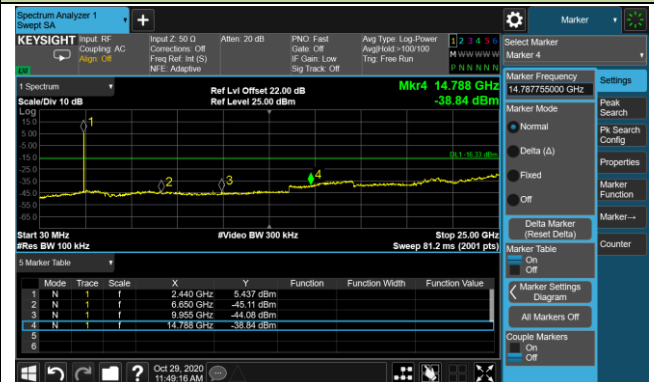


## 2DH5 Conducted Spurious Emissions

### Channel 00 (2402MHz)



### Channel 39 (2441MHz)



### Channel 78 (2480MHz)

