

# FCC and ISED Test Report

Apple Inc  
Model: A3119



In accordance with FCC 47 CFR Part 15C,  
ISED RSS-247 and ISED RSS-GEN  
(2.4 GHz Bluetooth FHSS)

Prepared for: Apple Inc  
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California  
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FCC ID: BCGA3119 IC: 579C-A3119

## COMMERCIAL-IN-CONFIDENCE

Document 75960546-12 Issue 01

| SIGNATURE      |                 |                      |               |
|----------------|-----------------|----------------------|---------------|
|                |                 |                      |               |
| NAME           | JOB TITLE       | RESPONSIBLE FOR      | ISSUE DATE    |
| Steve Marshall | Senior Engineer | Authorised Signatory | 16 April 2024 |

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

### ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 15C, ISED RSS-247 and ISED RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

| RESPONSIBLE FOR   | NAME           | DATE          | SIGNATURE |
|-------------------|----------------|---------------|-----------|
| Report Generation | Lauren Walters | 16 April 2024 |           |

|                                                                           |                                                                    |
|---------------------------------------------------------------------------|--------------------------------------------------------------------|
| FCC Accreditation<br>553713/UK2026 Concorde Park, Fareham Test Laboratory | ISED Accreditation<br>28798 Concorde Park, Fareham Test Laboratory |
|---------------------------------------------------------------------------|--------------------------------------------------------------------|

### EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2022, ISED RSS-247: Issue 3 (08-2023) and ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021) for the tests detailed in section 1.3.

|  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|



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# 1 Report Summary

## 1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

| Issue | Description of Change | Date of Issue |
|-------|-----------------------|---------------|
| 1     | First Issue           | 16-April-2024 |

Table 1

## 1.2 Introduction

|                               |                                                                                                                |
|-------------------------------|----------------------------------------------------------------------------------------------------------------|
| Applicant                     | Apple Inc                                                                                                      |
| Manufacturer                  | Apple Inc                                                                                                      |
| EUT/Sample Identification     | Refer to section 1.6                                                                                           |
| Test Specification/Issue/Date | FCC 47 CFR Part 15C: 2022<br>ISED RSS-247: Issue 3 (08-2023)<br>ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021) |
| Start of Test                 | 12-March-2024                                                                                                  |
| Finish of Test                | 22-March-2024                                                                                                  |
| Name of Engineer(s)           | Elliot Callender, Ian Hart and Jayvir Makwana                                                                  |
| Related Document(s)           | ANSI C63.10 (2020)                                                                                             |



### 1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15C, ISSED RSS-247 and ISSED RSS-GEN is shown below.

| Section                                        | Specification Clause  |             |              | Test Description                                       | Result | Comments/Base Standard                                                                                      |
|------------------------------------------------|-----------------------|-------------|--------------|--------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------|
|                                                | Part 15C              | RSS-247     | RSS-GEN      |                                                        |        |                                                                                                             |
| Configuration and Mode: 2.4 GHz Bluetooth FHSS |                       |             |              |                                                        |        |                                                                                                             |
| -                                              | 15.203                | -           | -            | Antenna Requirement                                    | N/T    | The device complies with the provisions of this section, as it uses permanently attached integral antennas. |
| 2.1                                            | 15.205                | 3.3         | 8.10         | Restricted Band Edges                                  | Pass   | ANSI C63.10 (2020)                                                                                          |
| 2.2                                            | 15.247 (a)(1)         | 5.1         | -            | Frequency Hopping Systems - Average Time of Occupancy  | Pass   | ANSI C63.10 (2020)                                                                                          |
| 2.3                                            | 15.247 (a)(1)         | 5.1         | -            | Frequency Hopping Systems - Channel Separation         | Pass   | ANSI C63.10 (2020)                                                                                          |
| 2.4                                            | 15.247 (a)(1)         | 5.1         | -            | Frequency Hopping Systems - Number of Hopping Channels | Pass   | ANSI C63.10 (2020)                                                                                          |
| 2.5                                            | 15.247 (a)(1)         | 5.1         | 6.7          | Frequency Hopping Systems - 99% & 20 dB Bandwidth      | Pass   | ANSI C63.10 (2020)                                                                                          |
| 2.6                                            | 15.247 (b)            | 5.4         | 6.12         | Maximum Conducted Output Power                         | Pass   | ANSI C63.10 (2020)                                                                                          |
| 2.7                                            | 15.247 (d)            | 5.5         | -            | Authorised Band Edges                                  | Pass   | ANSI C63.10 (2020)                                                                                          |
| 2.8                                            | 15.209 and 15.247 (d) | 3.3 and 5.5 | 6.13 and 8.9 | Spurious Radiated Emissions                            | Pass   | ANSI C63.10 (2020)                                                                                          |

**Table 2**



## 1.4 Product Information

### 1.4.1 Technical Description

The equipment under test (EUT) was a wireless Keyboard with Touch ID and Numeric Keypad.

### 1.4.2 Test Modes

Bluetooth BDR/EDR was assessed as a FHSS system.  
The EUT was tested in the following mode of operations:

- Bluetooth BDR: DH5
- Bluetooth EDR: 2-DH5 & 3-DH5

### 1.4.3 Test Setup

For conducted tests, a conducted test point was provided by the manufacturer via a PCB RF connector and cable. The loss of the test cable was known and compensated for in any conducted measurements.

For all tests the EUT was put into a continuous transmit or receive test mode with the manufacturer's test commands. These were sent from a script running on a test laptop connected to the EUT's USB port. The EUT then transmitted the required type of modulation and packet type on either a static channel selected within the test script, or frequency hopping over the maximum number of supported channels.

All testing was performed with the EUT powered via its internal battery.

### 1.4.4 Antenna Gain Table

| Frequency Range (MHz) | Peak Gain (dBi) | Conducted Cable Loss (dB) |
|-----------------------|-----------------|---------------------------|
| 2402                  | 2.10            | 0.4                       |
| 2441                  | 2.96            | 0.4                       |
| 2480                  | 2.89            | 0.4                       |

**Table 3**

## 1.5 Deviations from the Standard

No deviations from the applicable test standard were made during testing.



## 1.6 Identification of the EUT

The table below details identification of the EUT(s) that have been used to carry out the testing within this report.

|                    |                  |                  |          |
|--------------------|------------------|------------------|----------|
| Model: A3119       |                  |                  |          |
| Serial Number      | Hardware Version | Software Version | Firmware |
| F0TH2X001F30000N1B | REV1.0           | 2.50             | -        |
| F0TH2S002M30000N1B | REV1.0           | 2.50             | -        |

**Table 4**

## 1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

| Modification State                              | Description of Modification still fitted to EUT | Modification Fitted By | Date Modification Fitted |
|-------------------------------------------------|-------------------------------------------------|------------------------|--------------------------|
| Model: A3119, Serial Number: F0TH2X001F30000N1B |                                                 |                        |                          |
| 0                                               | As supplied by the customer                     | Not Applicable         | Not Applicable           |
| Model: A3119, Serial Number: F0TH2S002M30000N1B |                                                 |                        |                          |
| 0                                               | As supplied by the customer                     | Not Applicable         | Not Applicable           |

**Table 5**



## 1.8 Test Location

TÜV SÜD conducted the following tests at our Concorde Park Test Laboratory.

| Test Name                                              | Name of Engineer(s)           | Accreditation |
|--------------------------------------------------------|-------------------------------|---------------|
| Configuration and Mode: 2.4 GHz Bluetooth FHSS         |                               |               |
| Restricted Band Edges                                  | Elliot Callender and Ian Hart | UKAS          |
| Frequency Hopping Systems - Average Time of Occupancy  | Jayvir Makwana                | UKAS          |
| Frequency Hopping Systems - Channel Separation         | Jayvir Makwana                | UKAS          |
| Frequency Hopping Systems - Number of Hopping Channels | Jayvir Makwana                | UKAS          |
| Frequency Hopping Systems - 99% & 20 dB Bandwidth      | Jayvir Makwana                | UKAS          |
| Maximum Conducted Output Power                         | Jayvir Makwana                | UKAS          |
| Authorised Band Edges                                  | Elliot Callender and Ian Hart | UKAS          |
| Spurious Radiated Emissions                            | Elliot Callender and Ian Hart | UKAS          |

**Table 6**

Office Address:

TÜV SÜD  
Concorde Park  
Concorde Way  
Fareham  
Hampshire  
PO15 5FG  
United Kingdom



## 2 Test Details

### 2.1 Restricted Band Edges

#### 2.1.1 Specification Reference

FCC 47 CFR Part 15C, Clause 15.205  
ISED RSS-247, Clause 3.3  
ISED RSS-GEN, Clause 8.10

#### 2.1.2 Equipment Under Test and Modification State

A3119, S/N: F0TH2S002M30000N1B - Modification State 0

#### 2.1.3 Date of Test

15-March-2024

#### 2.1.4 Test Method

This test was performed in accordance with ANSI C63.10, clause 6.10.5.

Plots for average measurements were taken in accordance with ANSI C63.10, clause 4.1.5.2.6.

These are shown for information purposes and were used to determine the worst-case measurement point. Final average measurements were then taken in accordance with ANSI C63.10, clause 4.1.4.2.2 to obtain the measurement result recorded in the test results tables.

The following conversion can be applied to convert from dB $\mu$ V/m to  $\mu$ V/m:

$10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$ .

#### 2.1.5 Environmental Conditions

|                     |         |
|---------------------|---------|
| Ambient Temperature | 22.6 °C |
| Relative Humidity   | 46.0 %  |



2.1.6 Test Results

2.4 GHz Bluetooth FHSS

iPA - Core 0 (SISO)

| Mode   | Packet Type | TX Frequency (MHz) | Band Edge Frequency (MHz) | Peak Level (dBμV/m) | Average Level (dBμV/m) |
|--------|-------------|--------------------|---------------------------|---------------------|------------------------|
| Static | DH5         | 2402               | 2390                      | 55.32               | 41.81                  |
| Static | 2-DH5       | 2402               | 2390                      | 54.77               | 40.89                  |
| Static | 3-DH5       | 2402               | 2390                      | 54.35               | 40.96                  |
| Static | DH5         | 2480               | 2483.5                    | 54.53               | 43.34                  |
| Static | 2-DH5       | 2480               | 2483.5                    | 53.56               | 41.78                  |
| Static | 3-DH5       | 2480               | 2483.5                    | 53.58               | 41.78                  |

Table 7 - SISO Restricted Band Edge Results

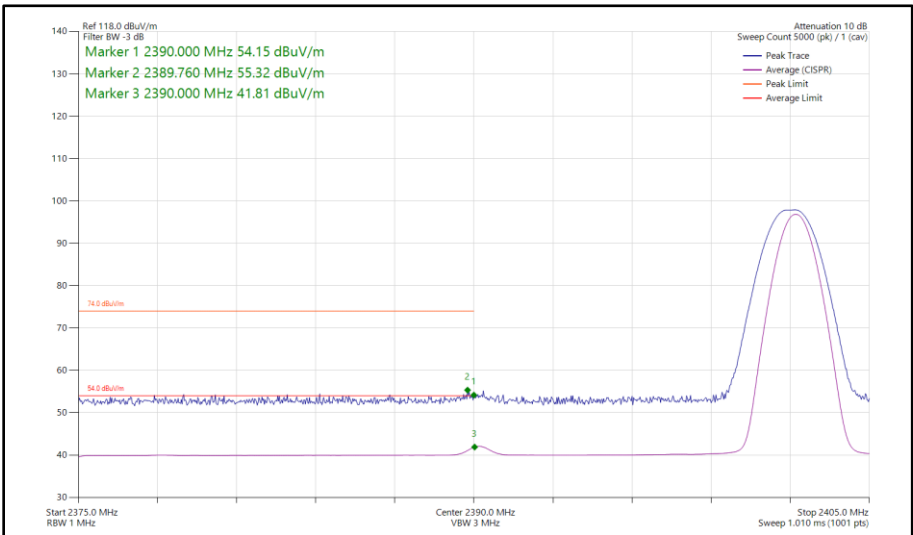


Figure 1 - Bluetooth DH5, SISO, Core 0 - 2402 MHz  
Band Edge Frequency 2390 MHz

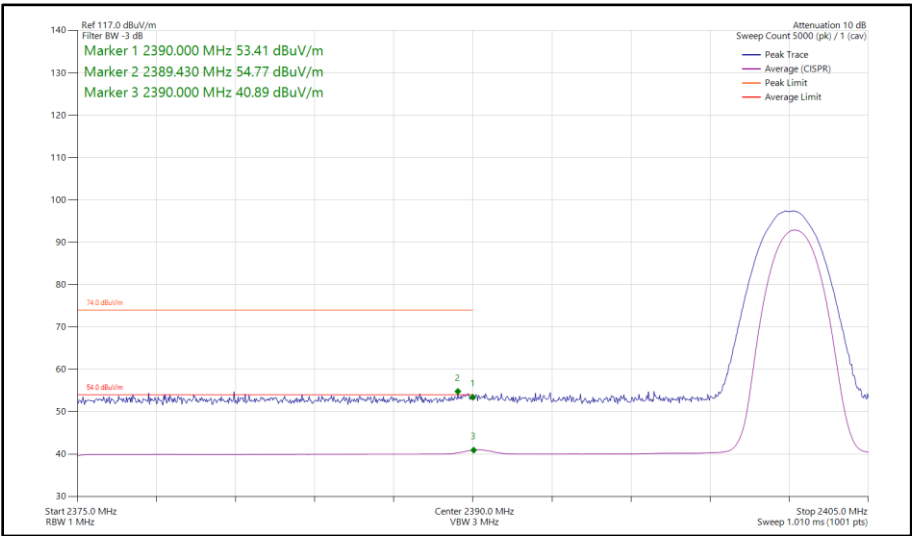


Figure 2 - Bluetooth 2-DH5, SISO, Core 0 - 2402 MHz  
Band Edge Frequency 2390 MHz

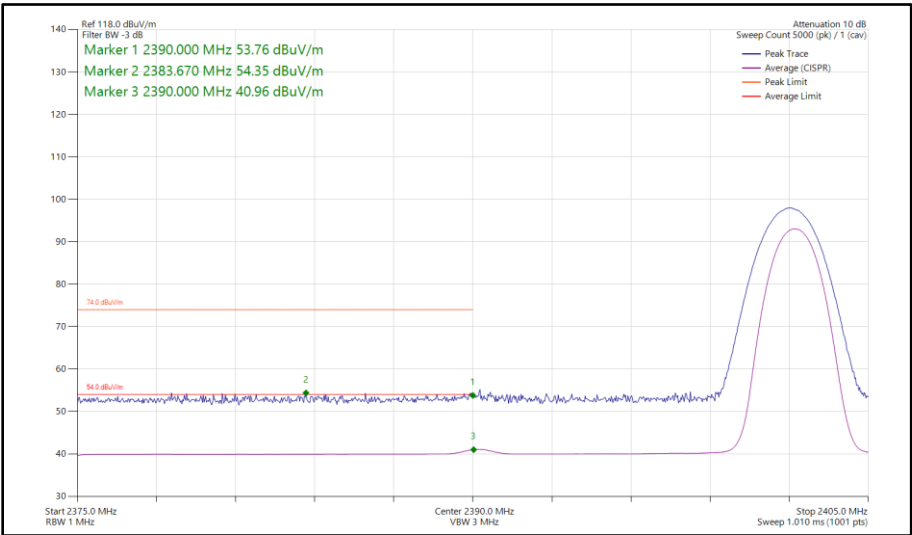


Figure 3 - Bluetooth 3-DH5, SISO, Core 0 - 2402 MHz  
Band Edge Frequency 2390 MHz

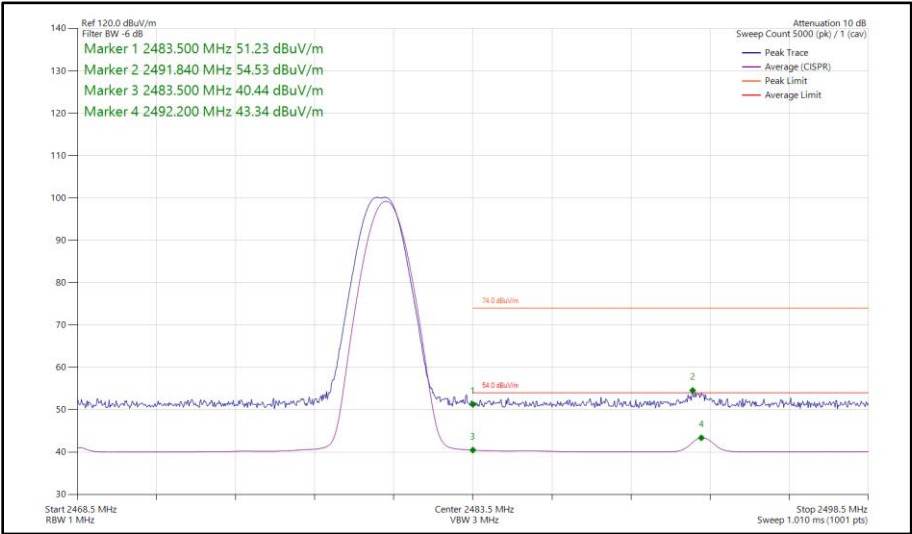


Figure 4 - Bluetooth DH5, SISO, Core 0 - 2480 MHz  
Band Edge Frequency 2483.5 MHz

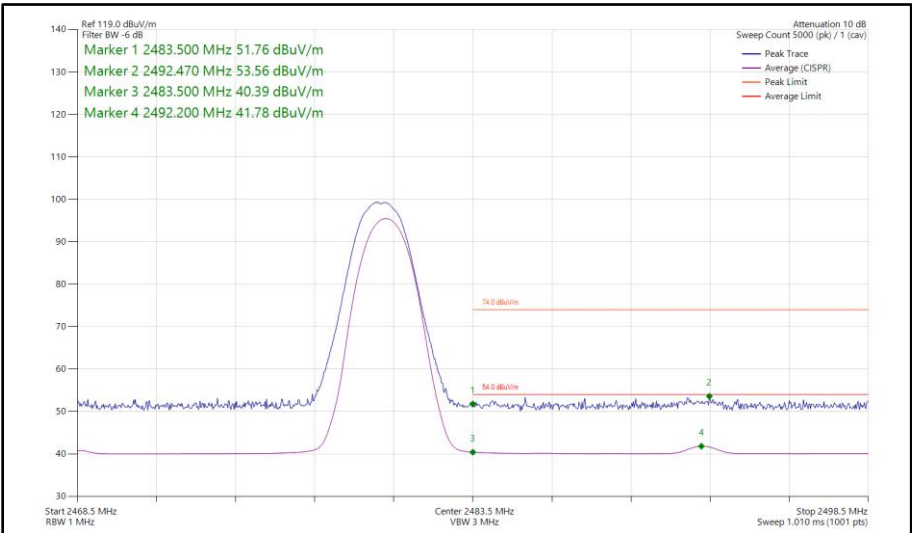
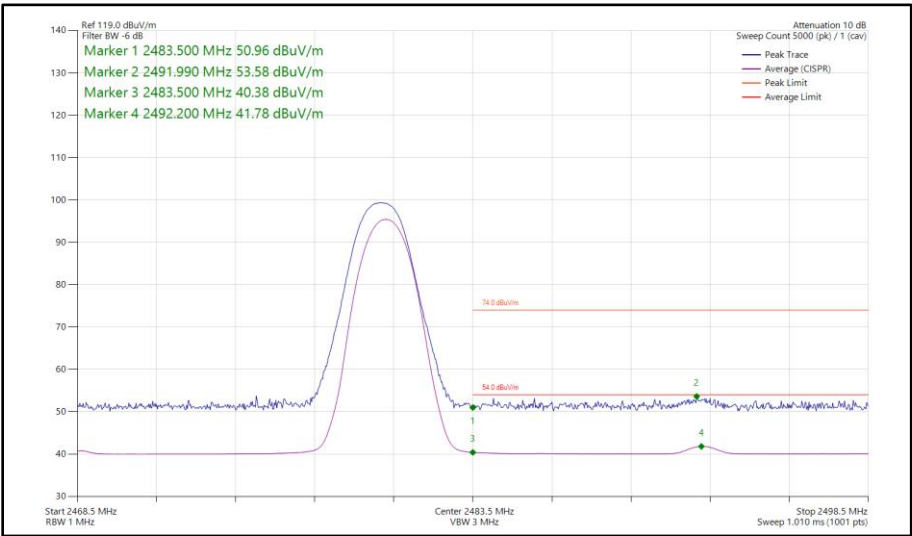


Figure 5 - Bluetooth 2-DH5, SISO, Core 0 - 2480 MHz  
Band Edge Frequency 2483.5 MHz



**Figure 6 - Bluetooth 3-DH5, SISO, Core 0 - 2480 MHz  
Band Edge Frequency 2483.5 MHz**

FCC 47 CFR Part 15, Limit Clause 15.209

| Frequency (MHz) | Field Strength (µV/m at 3 m) |
|-----------------|------------------------------|
| 30 to 88        | 100                          |
| 88 to 216       | 150                          |
| 216 to 960      | 200                          |
| Above 960       | 500                          |

**Table 8**

ISED RSS-GEN, Limit Clause 8.9

| Frequency (MHz) | Field Strength (µV/m at 3 m) |
|-----------------|------------------------------|
| 30 to 88        | 100                          |
| 88 to 216       | 150                          |
| 216 to 960      | 200                          |
| Above 960*      | 500                          |

**Table 9**

\*Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.



## 2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Chamber 16.

| Instrument                          | Manufacturer       | Type No.             | TE No. | Calibration Period (months) | Calibration Expiry Date |
|-------------------------------------|--------------------|----------------------|--------|-----------------------------|-------------------------|
| Emissions Software                  | TUV SUD            | EmX V3.2.0           | 5125   | -                           | Software                |
| 1500W (300V 12A) AC Power Supply    | iTech              | IT7324               | 5957   | -                           | O/P Mon                 |
| 3m Semi-Anechoic Chamber, Chamber16 | Albatross Projects | RF Chamber 16        | 5972   | 36                          | 24-May-2025             |
| Mast & Turntable Controller         | Maturo Gmbh        | FCU3.0               | 5973   | -                           | TU                      |
| Tilt Antenna Mast                   | Maturo Gmbh        | BAM4.5-P             | 5974   | -                           | TU                      |
| Turntable                           | Maturo Gmbh        | TT1.5SI              | 5975   | -                           | TU                      |
| Cable (SMA to SMA 1m)               | Junkosha           | MWX221-01000AMSAMS/A | 6018   | 12                          | 05-Jun-2024             |
| Horn Antenna (1-10 GHz)             | Schwarzbeck        | BBHA9120B            | 6142   | 12                          | 26-Aug-2024             |
| Digital Multimeter                  | Fluke              | 115                  | 6146   | 12                          | 15-Jun-2024             |
| Humidity & Temperature meter        | R.S Components     | 1364                 | 6148   | 12                          | 21-Jul-2024             |
| SAC Switch Unit                     | TUV SUD            | TUV_SSU_001          | 6190   | 12                          | 22-Dec-2024             |
| EMI Test Receiver                   | Rohde & Schwarz    | ESW44                | 6294   | 12                          | 29-Nov-2024             |
| Cable (SMA to SMA 8m)               | Junkosha           | MWX221-08000AMSAMS/B | 6318   | 12                          | 18-Feb-2025             |

**Table 10**

TU - Traceability Unscheduled

O/P Mon - Output Monitored using calibrated equipment



## **2.2 Frequency Hopping Systems - Average Time of Occupancy**

### **2.2.1 Specification Reference**

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)  
ISED RSS-247, Clause 5.1

### **2.2.2 Equipment Under Test and Modification State**

A3119, S/N: F0TH2X001F30000N1B - Modification State 0

### **2.2.3 Date of Test**

12-March-2024

### **2.2.4 Test Method**

The test was performed in accordance with ANSI C63.10, clause 7.8.4.

### **2.2.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 21.7 °C |
| Relative Humidity   | 42.0 %  |



2.2.6 Test Results

2.4 GHz Bluetooth FHSS

| Test Configuration       |                                          |                 |              |
|--------------------------|------------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                          | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247 (a)(1)(iii)<br>RSS-247 5.1 d) | Test Method(s): | C63.10 7.8.4 |
| Additional Reference(s): | -                                        |                 |              |

| DUT Configuration      |                |                          |      |
|------------------------|----------------|--------------------------|------|
| Mode:                  | iPA GFSK (DH5) | Duty Cycle (%):          | 76.7 |
| Antenna Configuration: | SISO           | DCCF (dB):               | -    |
| Active Port(s):        | A (Core 0)     | Peak Antenna Gain (dBi): | -    |

| Test Frequency<br>(MHz) | Time of Occupancy  |                         |                           | Limit<br>(ms) |
|-------------------------|--------------------|-------------------------|---------------------------|---------------|
|                         | Dwell Time<br>(ms) | Number of Transmissions | Time of Occupancy<br>(ms) |               |
| 2402                    | 2.888              | 109                     | 314.8                     | 400.0         |

Table 11 - Time of Occupancy Results



Figure 7 - GFSK - 2402 MHz Accumulated Transmit Time



| Test Configuration       |                                          |                 |              |
|--------------------------|------------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                          | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247 (a)(1)(iii)<br>RSS-247 5.1 d) | Test Method(s): | C63.10 7.8.4 |
| Additional Reference(s): | -                                        |                 |              |

| DUT Configuration      |                           |                          |      |
|------------------------|---------------------------|--------------------------|------|
| Mode:                  | iPA $\pi/4$ DQPSK (2-DH5) | Duty Cycle (%):          | 77.1 |
| Antenna Configuration: | SISO                      | DCCF (dB):               | -    |
| Active Port(s):        | A (Core 0)                | Peak Antenna Gain (dBi): | -    |

| Test Frequency<br>(MHz) | Time of Occupancy  |                         |                           | Limit<br>(ms) |
|-------------------------|--------------------|-------------------------|---------------------------|---------------|
|                         | Dwell Time<br>(ms) | Number of Transmissions | Time of Occupancy<br>(ms) |               |
| 2402                    | 2.891              | 99                      | 286.2                     | 400.0         |

Table 12 - Time of Occupancy Results



Figure 8 -  $\pi/4$  DQPSK - 2402 MHz Accumulated Transmit Time



| Test Configuration       |                                          |                 |              |
|--------------------------|------------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                          | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247 (a)(1)(iii)<br>RSS-247 5.1 d) | Test Method(s): | C63.10 7.8.4 |
| Additional Reference(s): | -                                        |                 |              |

| DUT Configuration      |                    |                          |      |
|------------------------|--------------------|--------------------------|------|
| Mode:                  | iPA 8-DPSK (3-DH5) | Duty Cycle (%):          | 76.8 |
| Antenna Configuration: | SISO               | DCCF (dB):               | -    |
| Active Port(s):        | A (Core 0)         | Peak Antenna Gain (dBi): | -    |

| Test Frequency<br>(MHz) | Time of Occupancy  |                         |                           | Limit<br>(ms) |
|-------------------------|--------------------|-------------------------|---------------------------|---------------|
|                         | Dwell Time<br>(ms) | Number of Transmissions | Time of Occupancy<br>(ms) |               |
| 2402                    | 2.893              | 109                     | 315.4                     | 400.0         |

Table 13 - Time of Occupancy Results



Figure 9 - 8-DPSK - 2402 MHz Accumulated Transmit Time

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(iii)

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Industry Canada RSS-247, Limit Clause 5.1 (d)

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.



### 2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 14.

| Instrument               | Manufacturer          | Type No.        | TE No. | Calibration Period (months) | Calibration Expiry Date |
|--------------------------|-----------------------|-----------------|--------|-----------------------------|-------------------------|
| Hygrometer               | Rotronic              | I-1000          | 3068   | 12                          | 07-Nov-2024             |
| Digital Multimeter       | Fluke                 | 115             | 6145   | 12                          | 15-Jun-2024             |
| MXA Signal Analyser      | Keysight Technologies | N9020B          | 6417   | 24                          | 26-Feb-2025             |
| Signal Conditioning Unit | TUV SUD               | SPECTRUM_SCU001 | 6518   | 12                          | 16-Feb-2025             |
| SCU Cable Assembly       | TUV SUD               | SPECTRUM_SCU_CA | 6529   | 12                          | 16-Feb-2025             |

**Table 14**



## **2.3 Frequency Hopping Systems - Channel Separation**

### **2.3.1 Specification Reference**

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)  
ISED RSS-247, Clause 5.1

### **2.3.2 Equipment Under Test and Modification State**

A3119, S/N: F0TH2X001F30000N1B - Modification State 0

### **2.3.3 Date of Test**

12-March-2024

### **2.3.4 Test Method**

The test was performed in accordance with ANSI C63.10, clause 7.8.2.

### **2.3.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 21.7 °C |
| Relative Humidity   | 42.0 %  |



2.3.6 Test Results

2.4 GHz Bluetooth FHSS

| Test Configuration       |                                    |                 |              |
|--------------------------|------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                    | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247(a)(1)<br>RSS-247 5.1 b) | Test Method(s): | C63.10 7.8.2 |
| Additional Reference(s): | -                                  |                 |              |

| DUT Configuration      |                |                          |   |
|------------------------|----------------|--------------------------|---|
| Mode:                  | iPA GFSK (DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO           | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)     | Peak Antenna Gain (dBi): | - |

| Test Frequency<br>(MHz) | 20 dB Bandwidth<br>(MHz) | Carrier Frequency Separation (MHz) |          |       | Limit<br>(kHz) |
|-------------------------|--------------------------|------------------------------------|----------|-------|----------------|
|                         |                          | F1C                                | F2C      | FHS   |                |
| 2441                    | 1.010                    | 2441.004                           | 2442.004 | 1.000 | ≥673.6         |

Table 15 - Carrier Frequency Separation Results

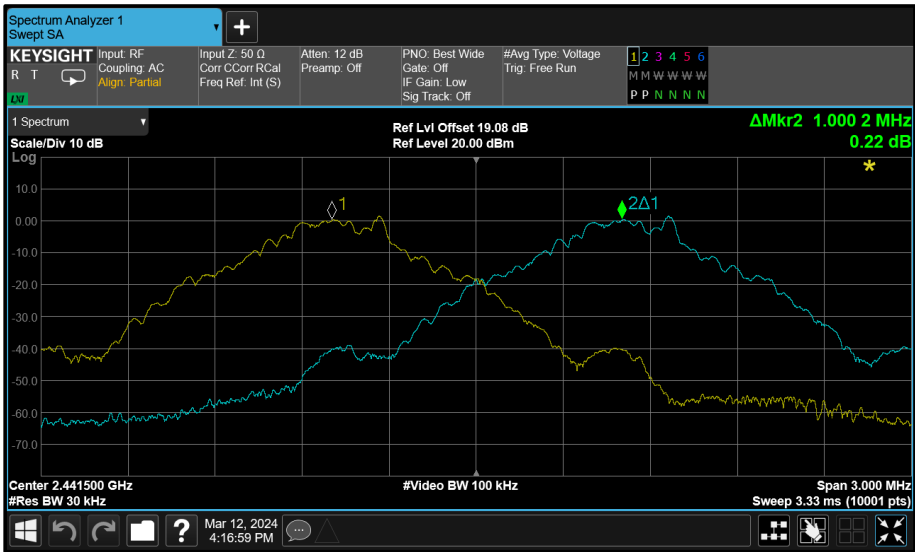


Figure 10 - GFSK - 2441 MHz (CH39)



| Test Configuration       |                                    |                 |              |
|--------------------------|------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                    | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247(a)(1)<br>RSS-247 5.1 b) | Test Method(s): | C63.10 7.8.2 |
| Additional Reference(s): | -                                  |                 |              |

| DUT Configuration      |                           |                          |   |
|------------------------|---------------------------|--------------------------|---|
| Mode:                  | iPA $\pi/4$ DQPSK (2-DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO                      | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)                | Peak Antenna Gain (dBi): | - |

| Test Frequency<br>(MHz) | 20 dB Bandwidth<br>(MHz) | Carrier Frequency Separation (MHz) |          |       | Limit<br>(kHz) |
|-------------------------|--------------------------|------------------------------------|----------|-------|----------------|
|                         |                          | F1C                                | F2C      | FHS   |                |
| 2441                    | 1.287                    | 2441.015                           | 2442.015 | 1.000 | $\geq 857.9$   |

Table 16 - Carrier Frequency Separation Results



Figure 11 -  $\pi/4$  DQPSK - 2441 MHz (CH39)



| Test Configuration       |                                    |                 |              |
|--------------------------|------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                    | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247(a)(1)<br>RSS-247 5.1 b) | Test Method(s): | C63.10 7.8.2 |
| Additional Reference(s): | -                                  |                 |              |

| DUT Configuration      |                    |                          |   |
|------------------------|--------------------|--------------------------|---|
| Mode:                  | iPA 8-DPSK (3-DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO               | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)         | Peak Antenna Gain (dBi): | - |

| Test Frequency<br>(MHz) | 20 dB Bandwidth<br>(MHz) | Carrier Frequency Separation (MHz) |          |       | Limit<br>(kHz) |
|-------------------------|--------------------------|------------------------------------|----------|-------|----------------|
|                         |                          | F1C                                | F2C      | FHS   |                |
| 2441                    | 1.277                    | 2441.013                           | 2442.013 | 1.000 | ≥851.5         |

Table 17 - Carrier Frequency Separation Results

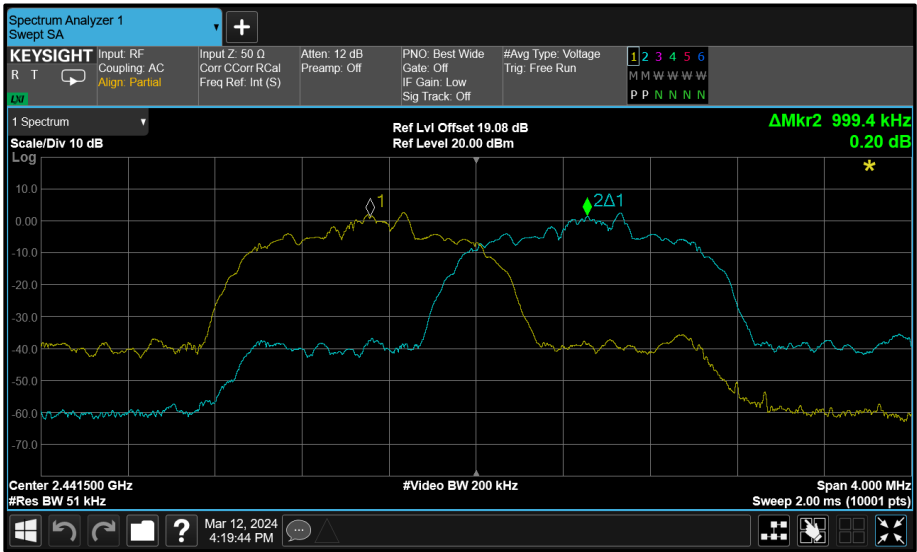


Figure 12 - 8-DPSK - 2441 MHz (CH39)



FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 0.125 W.

ISED RSS-247, Limit Clause 5.1 (b)

FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

**2.3.7 Test Location and Test Equipment Used**

This test was carried out in RF Laboratory 14.

| Instrument               | Manufacturer          | Type No.        | TE No. | Calibration Period (months) | Calibration Expiry Date |
|--------------------------|-----------------------|-----------------|--------|-----------------------------|-------------------------|
| Hygrometer               | Rotronic              | I-1000          | 3068   | 12                          | 07-Nov-2024             |
| Digital Multimeter       | Fluke                 | 115             | 6145   | 12                          | 15-Jun-2024             |
| MXA Signal Analyser      | Keysight Technologies | N9020B          | 6417   | 24                          | 26-Feb-2025             |
| Signal Conditioning Unit | TUV SUD               | SPECTRUM_SCU001 | 6518   | 12                          | 16-Feb-2025             |
| SCU Cable Assembly       | TUV SUD               | SPECTRUM_SCU_CA | 6529   | 12                          | 16-Feb-2025             |

**Table 18**



## **2.4 Frequency Hopping Systems - Number of Hopping Channels**

### **2.4.1 Specification Reference**

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)  
ISED RSS-247, Clause 5.1

### **2.4.2 Equipment Under Test and Modification State**

A3119, S/N: F0TH2X001F30000N1B - Modification State 0

### **2.4.3 Date of Test**

12-March-2024

### **2.4.4 Test Method**

The test was performed in accordance with ANSI C63.10, clause 7.8.3.

### **2.4.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 21.7 °C |
| Relative Humidity   | 42.0 %  |



2.4.6 Test Results

2.4 GHz Bluetooth FHSS

| Test Configuration       |                                         |                 |              |
|--------------------------|-----------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                         | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247(a)(1)(iii)<br>RSS-247 5.1 d) | Test Method(s): | C63.10 7.8.3 |
| Additional Reference(s): | -                                       |                 |              |

| DUT Configuration      |                |                          |   |
|------------------------|----------------|--------------------------|---|
| Mode:                  | iPA GFSK (DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO           | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)     | Peak Antenna Gain (dBi): | - |

| Number of Hopping Frequencies | Limit |
|-------------------------------|-------|
| 79                            | ≥15.0 |

Table 19 - Number of Hopping Frequencies Results

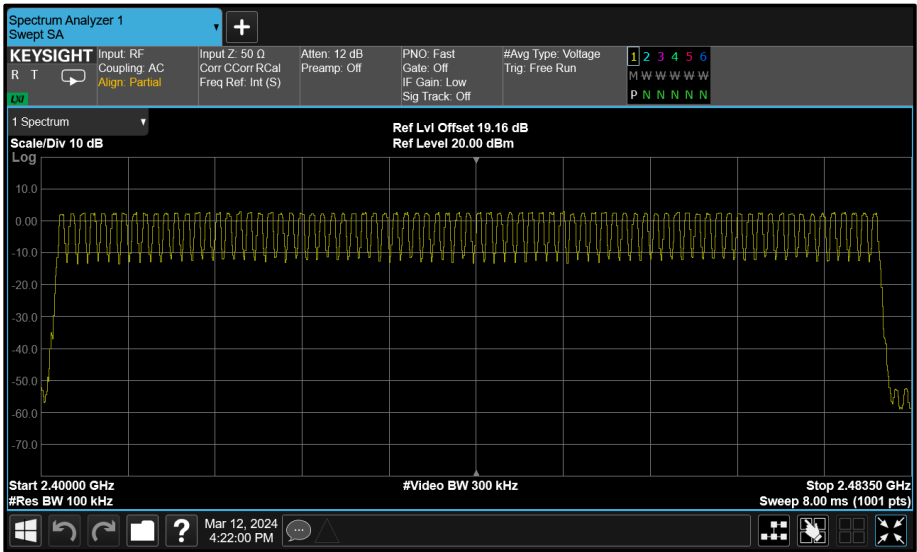


Figure 13 - GFSK (DH5) - Number of Hopping Channels



| Test Configuration       |                                         |                 |              |
|--------------------------|-----------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                         | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247(a)(1)(iii)<br>RSS-247 5.1 d) | Test Method(s): | C63.10 7.8.3 |
| Additional Reference(s): | -                                       |                 |              |

| DUT Configuration      |                           |                          |   |
|------------------------|---------------------------|--------------------------|---|
| Mode:                  | iPA $\pi/4$ DQPSK (2-DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO                      | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)                | Peak Antenna Gain (dBi): | - |

| Number of Hopping Frequencies | Limit       |
|-------------------------------|-------------|
| 79                            | $\geq 15.0$ |

Table 20 - Number of Hopping Frequencies Results

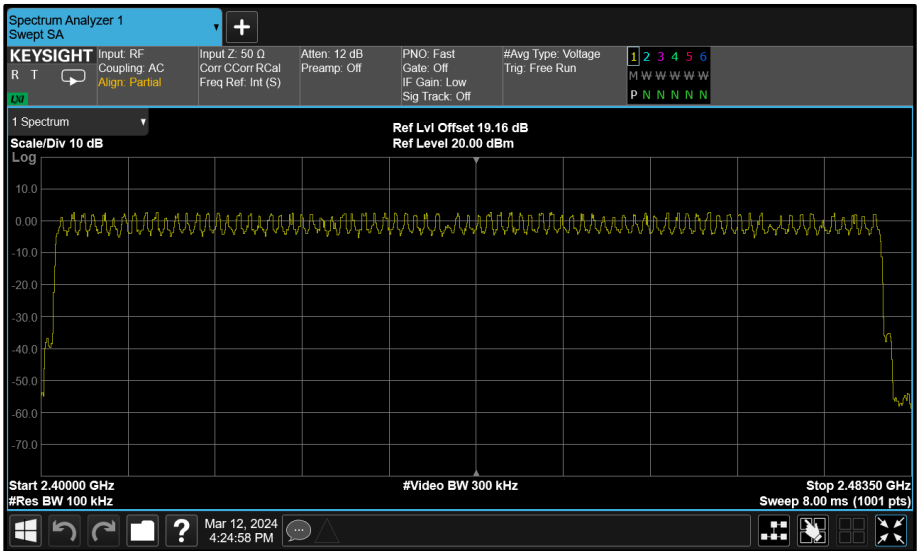


Figure 14 -  $\pi/4$  DQPSK (2-DH5) - Number of Hopping Channels



| Test Configuration       |                                         |                 |              |
|--------------------------|-----------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                         | Band:           | 2.4 GHz      |
| Limit Clause(s):         | FCC 15.247(a)(1)(iii)<br>RSS-247 5.1 d) | Test Method(s): | C63.10 7.8.3 |
| Additional Reference(s): | -                                       |                 |              |

| DUT Configuration      |                    |                          |   |
|------------------------|--------------------|--------------------------|---|
| Mode:                  | iPA 8-DPSK (3-DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO               | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)         | Peak Antenna Gain (dBi): | - |

| Number of Hopping Frequencies |  | Limit |
|-------------------------------|--|-------|
| 79                            |  | ≥15.0 |

Table 21 - Number of Hopping Frequencies Results

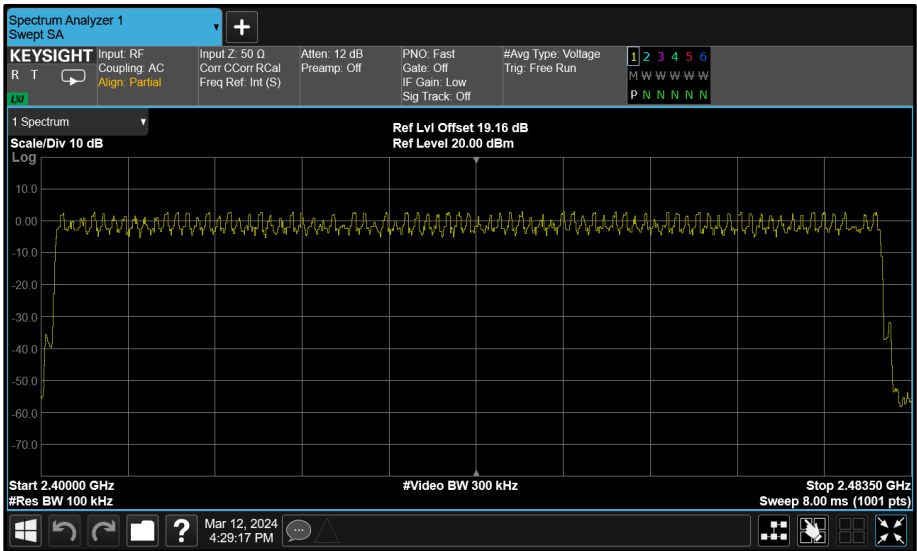


Figure 15 - 8-DPSK (3-DH5) - Number of Hopping Channels

FCC 47 CFR Part 15, Limit Clause 15.247 (a)(1)(iii)

≥ 15 channels

ISED RSS-247, Limit Clause 5.1 (d)

FHSSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.



#### 2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 14.

| Instrument               | Manufacturer          | Type No.        | TE No. | Calibration Period (months) | Calibration Expiry Date |
|--------------------------|-----------------------|-----------------|--------|-----------------------------|-------------------------|
| Hygrometer               | Rotronic              | I-1000          | 3068   | 12                          | 07-Nov-2024             |
| Digital Multimeter       | Fluke                 | 115             | 6145   | 12                          | 15-Jun-2024             |
| MXA Signal Analyser      | Keysight Technologies | N9020B          | 6417   | 24                          | 26-Feb-2025             |
| Signal Conditioning Unit | TUV SUD               | SPECTRUM_SCU001 | 6518   | 12                          | 16-Feb-2025             |
| SCU Cable Assembly       | TUV SUD               | SPECTRUM_SCU_CA | 6529   | 12                          | 16-Feb-2025             |

**Table 22**



## **2.5 Frequency Hopping Systems - 99% & 20 dB Bandwidth**

### **2.5.1 Specification Reference**

FCC 47 CFR Part 15C, Clause 15.247 (a)(1)  
ISED RSS-247, Clause 5.1  
ISED RSS-GEN, Clause 6.7

### **2.5.2 Equipment Under Test and Modification State**

A3119, S/N: F0TH2X001F30000N1B - Modification State 0

### **2.5.3 Date of Test**

12-March-2024

### **2.5.4 Test Method**

The test was performed in accordance with ANSI C63.10, clause 6.9.2 and 6.9.3.

### **2.5.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 21.7 °C |
| Relative Humidity   | 42.0 %  |



## 2.5.6 Test Results

### 2.4 GHz Bluetooth FHSS

| Test Configuration       |                                  |                 |                              |
|--------------------------|----------------------------------|-----------------|------------------------------|
| Frequency Range:         | 2400-2483.5 MHz                  | Band:           | 2.4 GHz                      |
| Limit Clause(s):         | FCC 15.247 (a)(1)<br>RSS-247 5.1 | Test Method(s): | C63.10 6.9.2<br>C63.10 6.9.3 |
| Additional Reference(s): | -                                |                 |                              |

| DUT Configuration      |                |                          |   |
|------------------------|----------------|--------------------------|---|
| Mode:                  | iPA GFSK (DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO           | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)     | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) |   |   |   |
|----------------------|-----------------------|---|---|---|
|                      | A                     | B | C | D |
| 2402                 | 0.984                 | - | - | - |
| 2441                 | 0.984                 | - | - | - |
| 2480                 | 0.987                 | - | - | - |

**Table 23 - 20 dB Bandwidth Results**

| Test Frequency (MHz) | 99% Bandwidth (MHz) |   |   |   | Limit (kHz) |
|----------------------|---------------------|---|---|---|-------------|
|                      | A                   | B | C | D |             |
| 2402                 | 0.888               | - | - | - | -           |
| 2441                 | 0.885               | - | - | - | -           |
| 2480                 | 0.885               | - | - | - | -           |

**Table 24 - 99% Bandwidth Results**



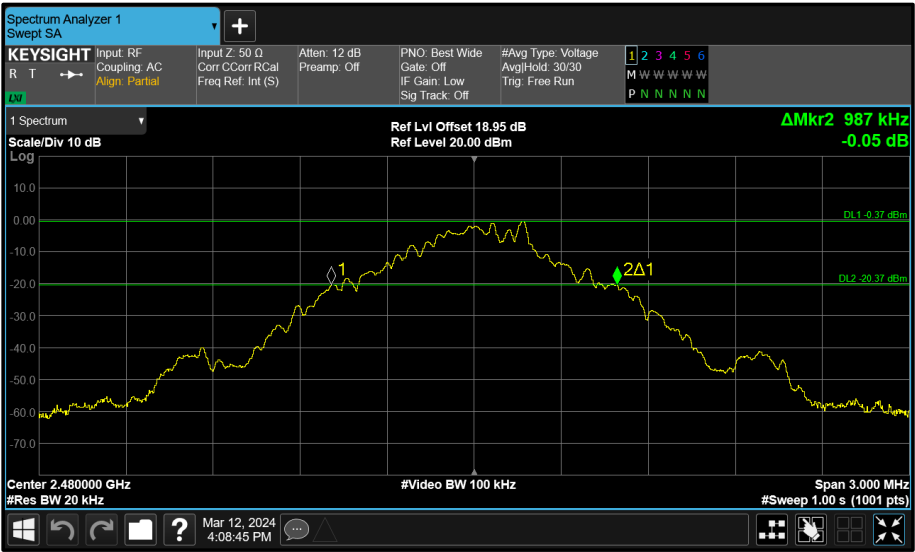


Figure 18 - Core 0 (A) 2480 MHz (CH78) 20 dB Bandwidth

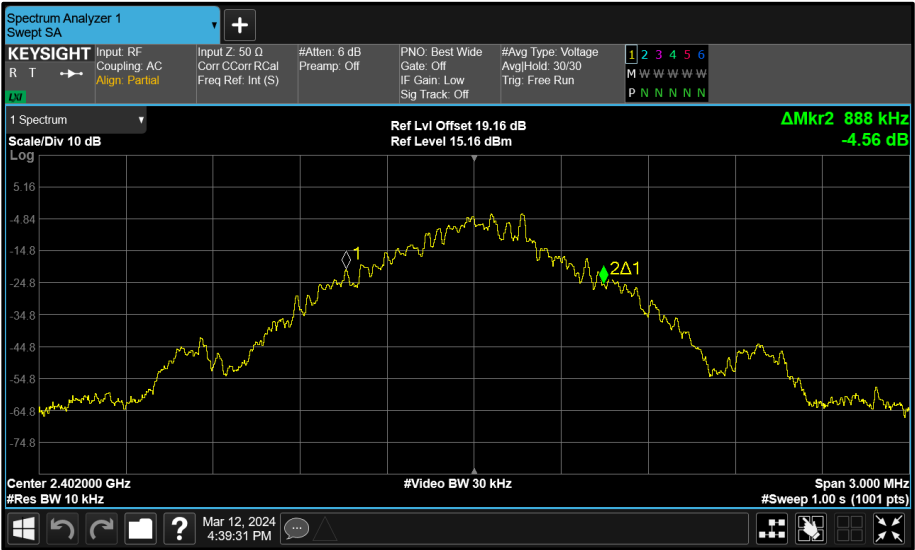


Figure 19 - Core 0 (A) 2402 MHz (CH0) 99% Bandwidth

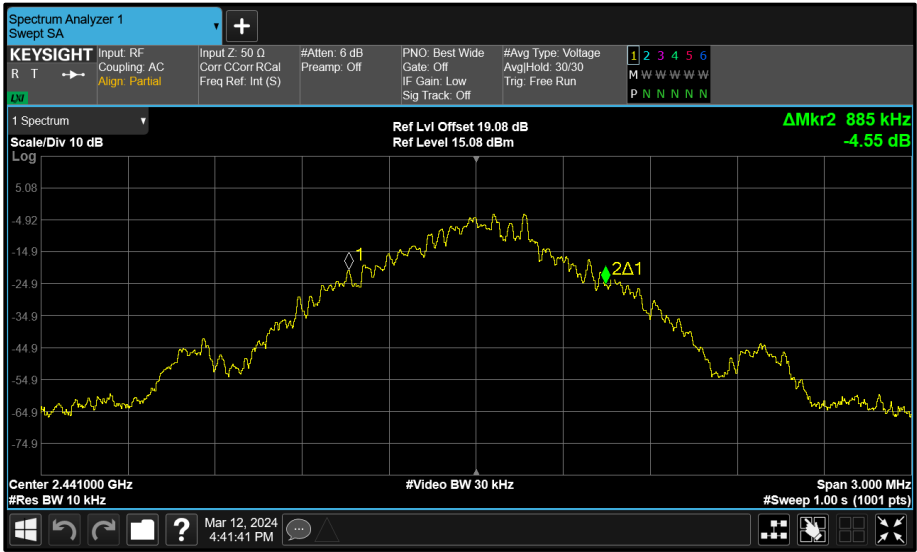


Figure 20 - Core 0 (A) 2441 MHz (CH39) 99% Bandwidth

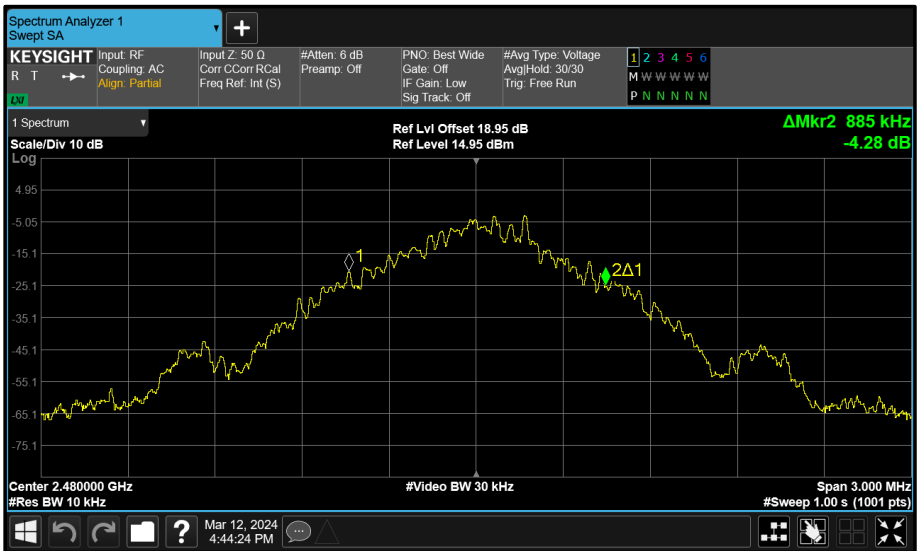


Figure 21 - Core 0 (A) 2480 MHz (CH78) 99% Bandwidth



| Test Configuration       |                                  |                 |                              |
|--------------------------|----------------------------------|-----------------|------------------------------|
| Frequency Range:         | 2400-2483.5 MHz                  | Band:           | 2.4 GHz                      |
| Limit Clause(s):         | FCC 15.247 (a)(1)<br>RSS-247 5.1 | Test Method(s): | C63.10 6.9.2<br>C63.10 6.9.3 |
| Additional Reference(s): | -                                |                 |                              |

| DUT Configuration      |                           |                          |   |
|------------------------|---------------------------|--------------------------|---|
| Mode:                  | iPA $\pi/4$ DQPSK (2-DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO                      | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)                | Peak Antenna Gain (dBi): | - |

| Test Frequency<br>(MHz) | 20 dB Bandwidth (MHz) |   |   |   |
|-------------------------|-----------------------|---|---|---|
|                         | A                     | B | C | D |
| 2402                    | 1.250                 | - | - | - |
| 2441                    | 1.255                 | - | - | - |
| 2480                    | 1.250                 | - | - | - |

Table 25 - 20 dB Bandwidth Results

| Test Frequency<br>(MHz) | 99% Bandwidth (MHz) |   |   |   | Limit<br>(kHz) |
|-------------------------|---------------------|---|---|---|----------------|
|                         | A                   | B | C | D |                |
| 2402                    | 1.160               | - | - | - | -              |
| 2441                    | 1.156               | - | - | - | -              |
| 2480                    | 1.160               | - | - | - | -              |

Table 26 - 99% Bandwidth Results

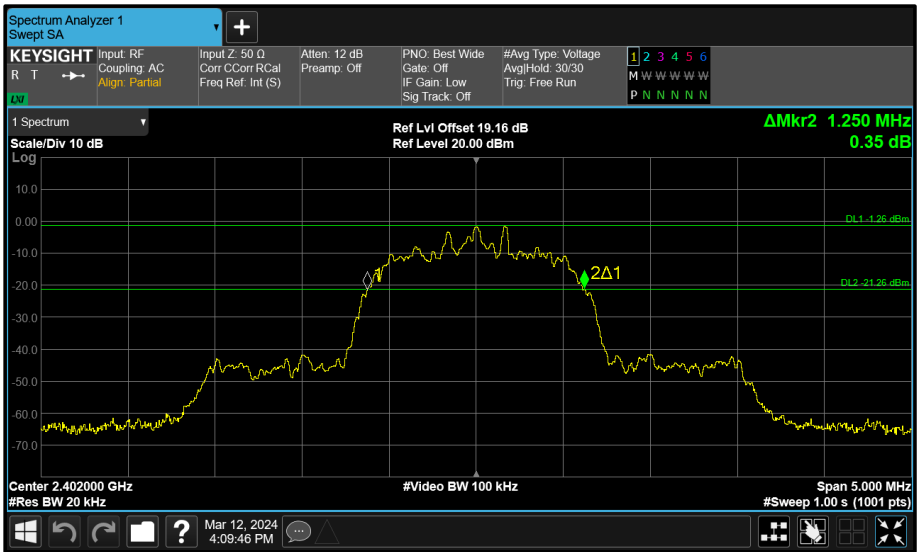


Figure 22 - Core 0 (A) 2402 MHz (CH0) 20 dB Bandwidth

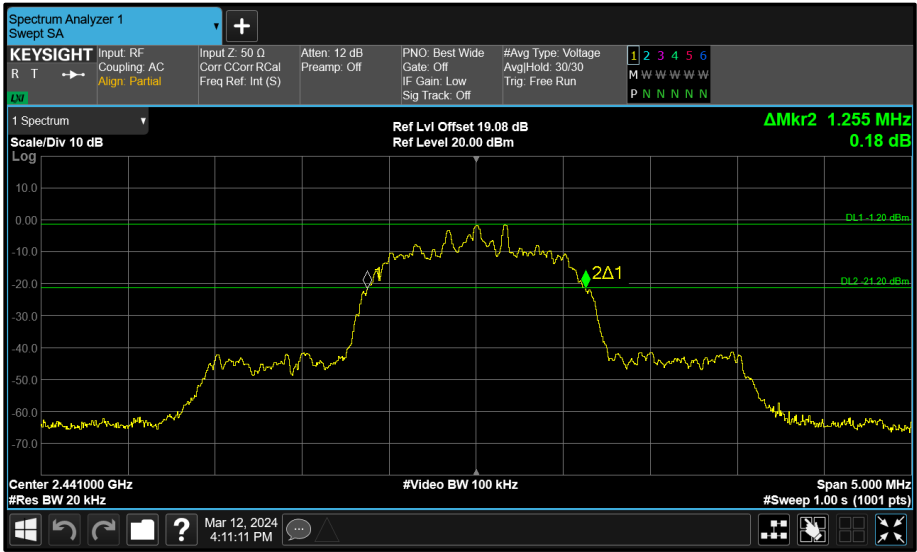


Figure 23 - Core 0 (A) 2441 MHz (CH39) 20 dB Bandwidth

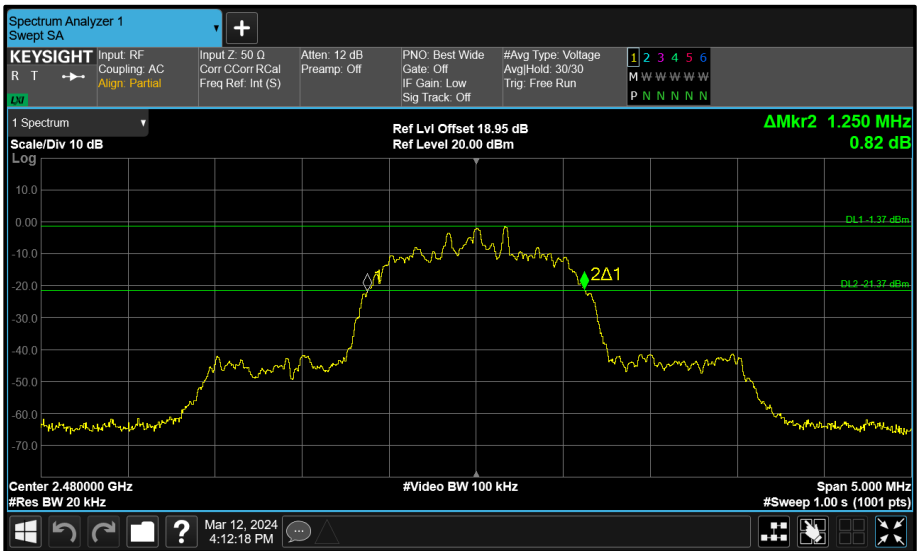


Figure 24 - Core 0 (A) 2480 MHz (CH78) 20 dB Bandwidth



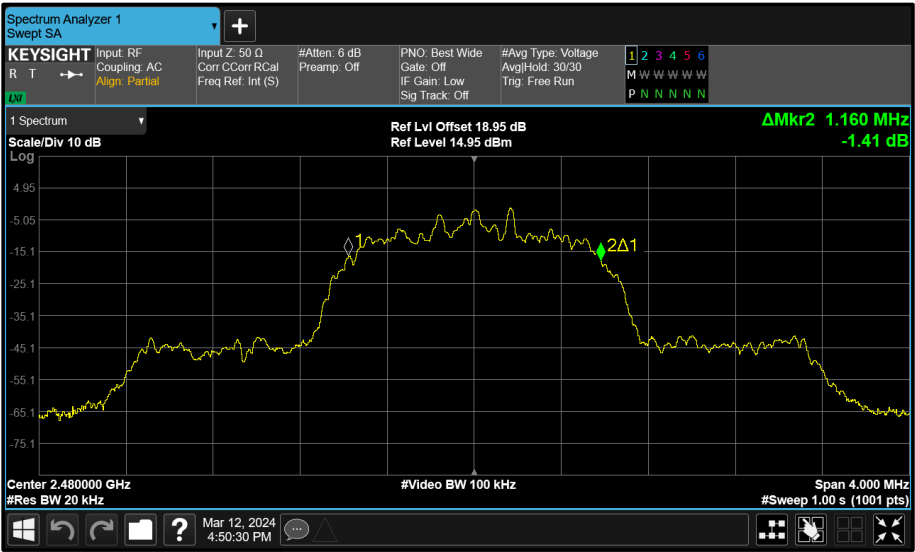


Figure 27 - Core 0 (A) 2480 MHz (CH78) 99% Bandwidth



| Test Configuration       |                                  |                 |                              |
|--------------------------|----------------------------------|-----------------|------------------------------|
| Frequency Range:         | 2400-2483.5 MHz                  | Band:           | 2.4 GHz                      |
| Limit Clause(s):         | FCC 15.247 (a)(1)<br>RSS-247 5.1 | Test Method(s): | C63.10 6.9.2<br>C63.10 6.9.3 |
| Additional Reference(s): | -                                |                 |                              |

| DUT Configuration      |                    |                          |   |
|------------------------|--------------------|--------------------------|---|
| Mode:                  | iPA 8-DPSK (3-DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO               | DCCF (dB):               | - |
| Active Port(s):        | A (Core 0)         | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) |   |   |   |
|----------------------|-----------------------|---|---|---|
|                      | A                     | B | C | D |
| 2402                 | 1.250                 | - | - | - |
| 2441                 | 1.250                 | - | - | - |
| 2480                 | 1.245                 | - | - | - |

Table 27 - 20 dB Bandwidth Results

| Test Frequency (MHz) | 99% Bandwidth (MHz) |   |   |   | Limit (kHz) |
|----------------------|---------------------|---|---|---|-------------|
|                      | A                   | B | C | D |             |
| 2402                 | 1.156               | - | - | - | -           |
| 2441                 | 1.156               | - | - | - | -           |
| 2480                 | 1.156               | - | - | - | -           |

Table 28 - 99% Bandwidth Results

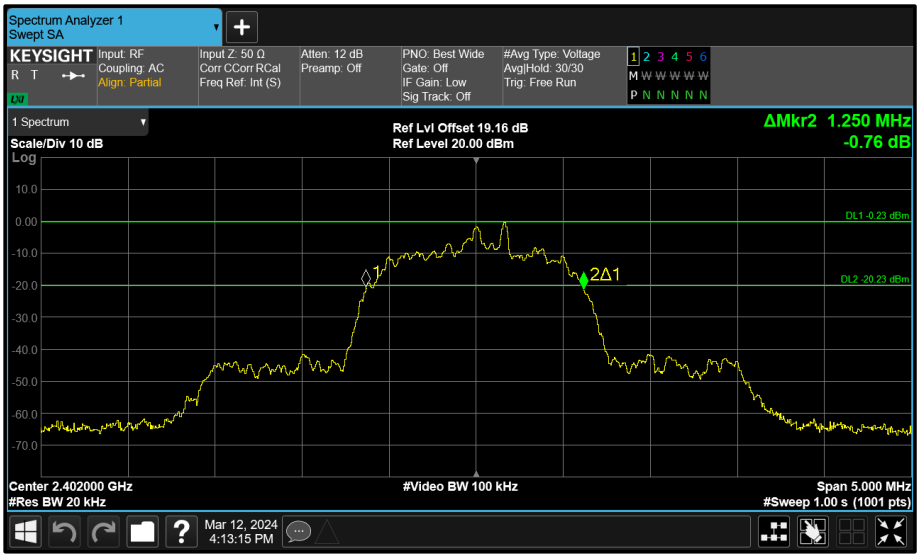


Figure 28 - Core 0 (A) 2402 MHz (CH0) 20 dB Bandwidth

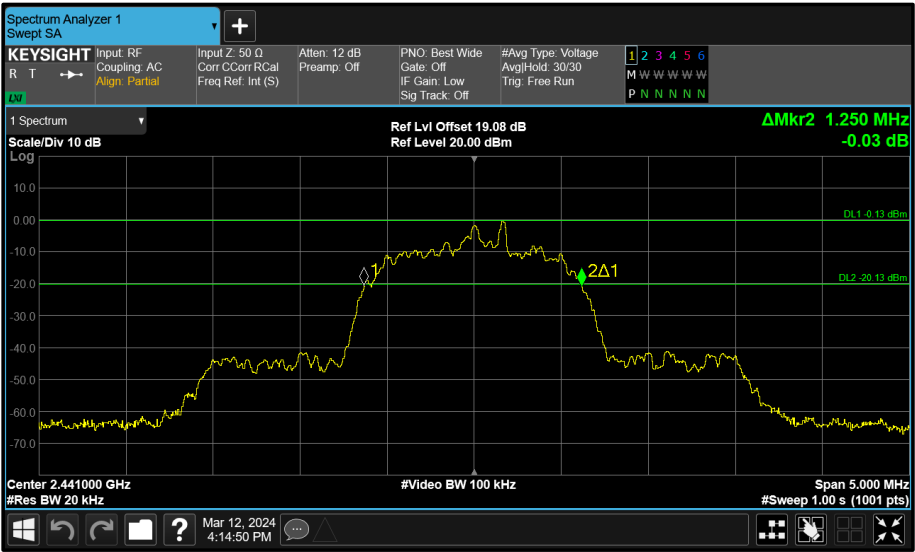


Figure 29 - Core 0 (A) 2441 MHz (CH39) 20 dB Bandwidth

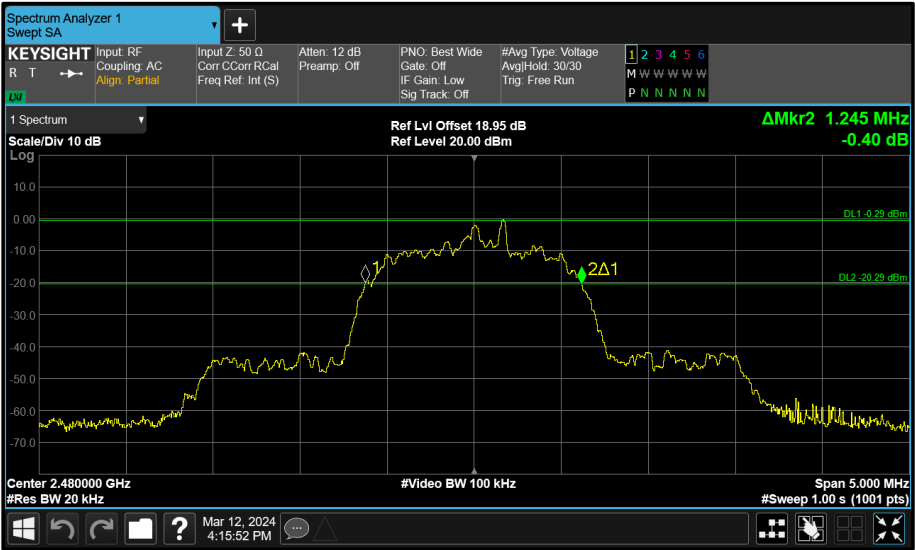


Figure 30 - Core 0 (A) 2480 MHz (CH78) 20 dB Bandwidth

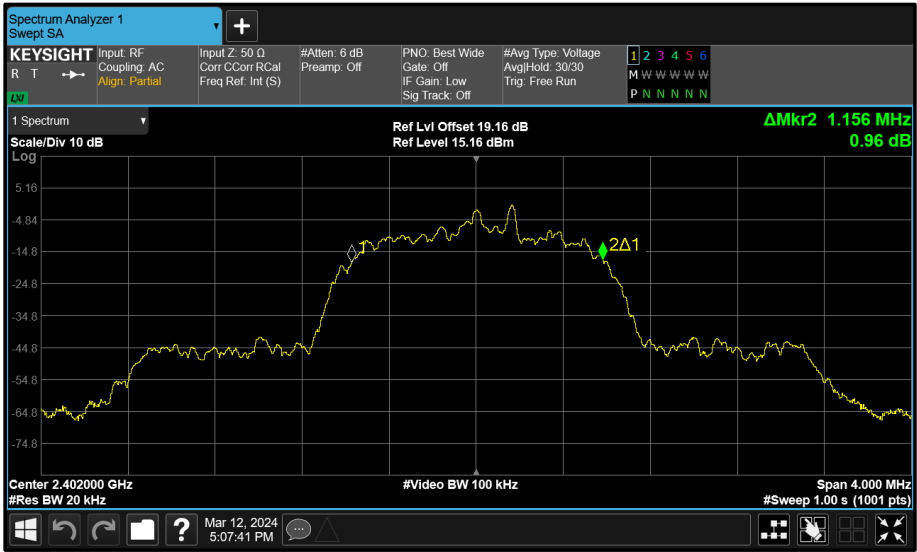


Figure 31 - Core 0 (A) 2402 MHz (CH0) 99% Bandwidth

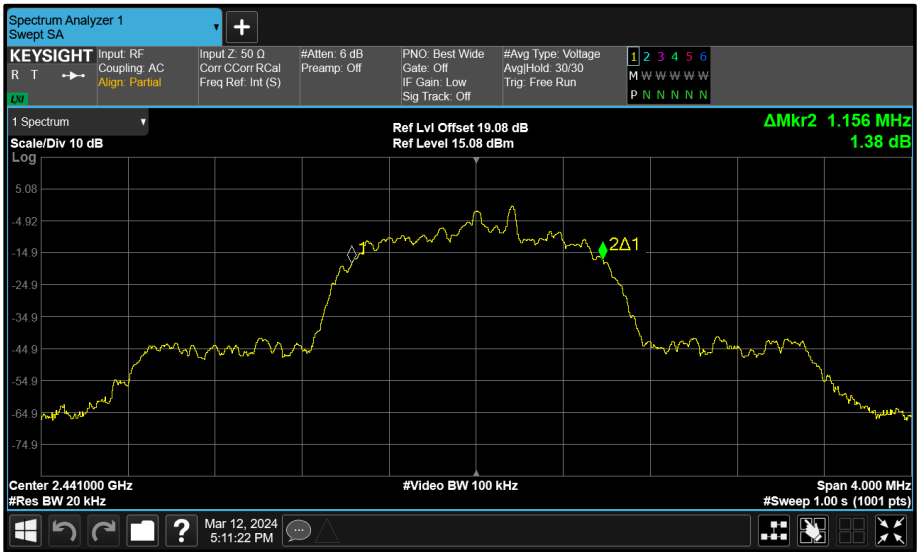


Figure 32 - Core 0 (A) 2441 MHz (CH39) 99% Bandwidth

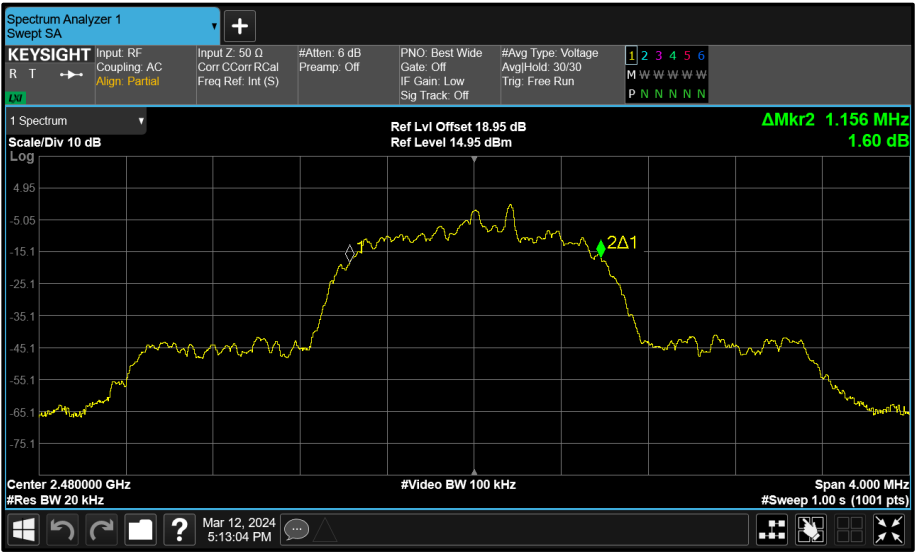


Figure 33 - Core 0 (A) 2480 MHz (CH78) 99% Bandwidth

FCC 47 CFR Part 15 and ISED RSS-247 Limit Clause

None specified.

2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 14.

| Instrument               | Manufacturer          | Type No.        | TE No. | Calibration Period (months) | Calibration Expiry Date |
|--------------------------|-----------------------|-----------------|--------|-----------------------------|-------------------------|
| Hygrometer               | Rotronic              | I-1000          | 3068   | 12                          | 07-Nov-2024             |
| Digital Multimeter       | Fluke                 | 115             | 6145   | 12                          | 15-Jun-2024             |
| MXA Signal Analyser      | Keysight Technologies | N9020B          | 6417   | 24                          | 26-Feb-2025             |
| Signal Conditioning Unit | TUV SUD               | SPECTRUM_SCU001 | 6518   | 12                          | 16-Feb-2025             |
| SCU Cable Assembly       | TUV SUD               | SPECTRUM_SCU_CA | 6529   | 12                          | 16-Feb-2025             |

Table 29



## **2.6 Maximum Conducted Output Power**

### **2.6.1 Specification Reference**

FCC 47 CFR Part 15C, Clause 15.247 (b)  
ISED RSS-247, Clause 5.4  
ISED RSS-GEN, Clause 6.12

### **2.6.2 Equipment Under Test and Modification State**

A3119, S/N: F0TH2X001F30000N1B - Modification State 0

### **2.6.3 Date of Test**

13-March-2024

### **2.6.4 Test Method**

The test was performed in accordance with ANSI C63.10 clause 7.8.5 using a power meter.

### **2.6.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 21.9 °C |
| Relative Humidity   | 43.2 %  |



## 2.6.6 Test Results

### 2.4 GHz Bluetooth FHSS

| Test Configuration       |                                 |                 |              |
|--------------------------|---------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                 | Band:           | 2.4 GHz      |
| Limit Clause(s):         | 15.247 (b)(1)<br>RSS-247 5.4 b) | Test Method(s): | C63.10 7.8.5 |
| Additional Reference(s): | -                               |                 |              |

| DUT Configuration      |                |                          |      |
|------------------------|----------------|--------------------------|------|
| Mode:                  | iPA GFSK (DH5) | Duty Cycle (%):          | 76.5 |
| Antenna Configuration: | SISO           | DCCF (dB):               | -    |
| Active Port(s):        | A (Core 0)     | Peak Antenna Gain (dBi): | 2.96 |

| Test Frequency (MHz) | Maximum Conducted Output Power (dBm) |   |   |   |          | Limit (dBm) | Margin (dB) |
|----------------------|--------------------------------------|---|---|---|----------|-------------|-------------|
|                      | A                                    | B | C | D | $\Sigma$ |             |             |
| 2402                 | 5.25                                 | - | - | - | -        | 30.00       | -24.75      |
| 2441                 | 5.61                                 | - | - | - | -        | 30.00       | -24.39      |
| 2480                 | 5.56                                 | - | - | - | -        | 30.00       | -24.44      |

**Table 30 - FCC Maximum Conducted (peak) Output Power Results**

| Test Frequency (MHz) | Maximum Conducted Output Power (dBm) |   |   |   |          | Limit (dBm) | Margin (dB) | EIRP (dBm) | EIRP Limit (dBm) | EIRP Margin (dB) |
|----------------------|--------------------------------------|---|---|---|----------|-------------|-------------|------------|------------------|------------------|
|                      | A                                    | B | C | D | $\Sigma$ |             |             |            |                  |                  |
| 2402                 | 5.25                                 | - | - | - | -        | 30.00       | -24.75      | 7.35       | 36.00            | -28.65           |
| 2441                 | 5.61                                 | - | - | - | -        | 30.00       | -24.39      | 8.57       | 36.00            | -27.43           |
| 2480                 | 5.56                                 | - | - | - | -        | 30.00       | -24.44      | 8.45       | 36.00            | -27.55           |

**Table 31 - ISED Maximum Conducted (peak) Output Power Results**



| Test Configuration       |                                 |                 |              |
|--------------------------|---------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                 | Band:           | 2.4 GHz      |
| Limit Clause(s):         | 15.247 (b)(1)<br>RSS-247 5.4 b) | Test Method(s): | C63.10 7.8.5 |
| Additional Reference(s): | -                               |                 |              |

| DUT Configuration      |                           |                          |      |
|------------------------|---------------------------|--------------------------|------|
| Mode:                  | iPA $\pi/4$ DQPSK (2-DH5) | Duty Cycle (%):          | 77.0 |
| Antenna Configuration: | SISO                      | DCCF (dB):               | -    |
| Active Port(s):        | A (Core 0)                | Peak Antenna Gain (dBi): | 2.96 |

| Test Frequency (MHz) | Maximum Conducted Output Power (dBm) |   |   |   |          | Limit (dBm) | Margin (dB) |
|----------------------|--------------------------------------|---|---|---|----------|-------------|-------------|
|                      | A                                    | B | C | D | $\Sigma$ |             |             |
| 2402                 | 5.29                                 | - | - | - | -        | 21.00       | 15.71       |
| 2441                 | 5.66                                 | - | - | - | -        | 21.00       | 15.34       |
| 2480                 | 5.70                                 | - | - | - | -        | 21.00       | 15.30       |

**Table 32 - FCC Maximum Conducted (peak) Output Power Results**

| Test Frequency (MHz) | Maximum Conducted Output Power (dBm) |   |   |   |          | Limit (dBm) | Margin (dB) | EIRP (dBm) | EIRP Limit (dBm) | EIRP Margin (dB) |
|----------------------|--------------------------------------|---|---|---|----------|-------------|-------------|------------|------------------|------------------|
|                      | A                                    | B | C | D | $\Sigma$ |             |             |            |                  |                  |
| 2402                 | 5.29                                 | - | - | - | -        | 21.00       | 15.71       | 7.39       | 36.00            | -28.61           |
| 2441                 | 5.66                                 | - | - | - | -        | 21.00       | 15.34       | 8.62       | 36.00            | -27.38           |
| 2480                 | 5.70                                 | - | - | - | -        | 21.00       | 15.30       | 8.59       | 36.00            | -27.41           |

**Table 33 - ISSED Maximum Conducted (peak) Output Power Results**



| Test Configuration       |                                 |                 |              |
|--------------------------|---------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                 | Band:           | 2.4 GHz      |
| Limit Clause(s):         | 15.247 (b)(1)<br>RSS-247 5.4 b) | Test Method(s): | C63.10 7.8.5 |
| Additional Reference(s): | -                               |                 |              |

| DUT Configuration      |                    |                          |      |
|------------------------|--------------------|--------------------------|------|
| Mode:                  | iPA 8-DPSK (3-DH5) | Duty Cycle (%):          | 76.8 |
| Antenna Configuration: | SISO               | DCCF (dB):               | -    |
| Active Port(s):        | A (Core 0)         | Peak Antenna Gain (dBi): | 2.96 |

| Test Frequency (MHz) | Maximum Conducted Output Power (dBm) |   |   |   |          | Limit (dBm) | Margin (dB) |
|----------------------|--------------------------------------|---|---|---|----------|-------------|-------------|
|                      | A                                    | B | C | D | $\Sigma$ |             |             |
| 2402                 | 5.63                                 | - | - | - | -        | 21.00       | 15.37       |
| 2441                 | 5.97                                 | - | - | - | -        | 21.00       | 15.03       |
| 2480                 | 6.02                                 | - | - | - | -        | 21.00       | 14.98       |

**Table 34 - FCC Maximum Conducted (peak) Output Power Results**

| Test Frequency (MHz) | Maximum Conducted Output Power (dBm) |   |   |   |          | Limit (dBm) | Margin (dB) | EIRP (dBm) | EIRP Limit (dBm) | EIRP Margin (dB) |
|----------------------|--------------------------------------|---|---|---|----------|-------------|-------------|------------|------------------|------------------|
|                      | A                                    | B | C | D | $\Sigma$ |             |             |            |                  |                  |
| 2402                 | 5.63                                 | - | - | - | -        | 21.00       | 15.37       | 7.73       | 36.00            | -28.27           |
| 2441                 | 5.97                                 | - | - | - | -        | 21.00       | 15.03       | 8.93       | 36.00            | -27.07           |
| 2480                 | 6.02                                 | - | - | - | -        | 21.00       | 14.98       | 8.91       | 36.00            | -27.09           |

**Table 35 - ISED Maximum Conducted (peak) Output Power Results**

FCC 47 CFR Part 15, Limit Clause 15.247 (b)(1)

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

ISED RSS-247, Limit Clause 5.4 (b)

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channel; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channel. The e.i.r.p. shall not exceed 4 W except as provided in section 5.4(e) of the specification.



### 2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 14.

| Instrument                | Manufacturer | Type No.        | TE No. | Calibration Period (months) | Calibration Expiry Date |
|---------------------------|--------------|-----------------|--------|-----------------------------|-------------------------|
| Hygrometer                | Rotronic     | I-1000          | 3068   | 12                          | 07-Nov-2024             |
| Digital Multimeter        | Fluke        | 115             | 6145   | 12                          | 15-Jun-2024             |
| Signal Conditioning Unit  | TUV SUD      | SPECTRUM_SCU001 | 6518   | 12                          | 16-Feb-2025             |
| SCU Cable Assembly        | TUV SUD      | SPECTRUM_SCU_CA | 6529   | 12                          | 16-Feb-2025             |
| USB Wideband Power Sensor | Boonton      | RTP5008         | 6587   | 12                          | 13-Feb-2025             |

**Table 36**



## **2.7 Authorised Band Edges**

### **2.7.1 Specification Reference**

FCC 47 CFR Part 15C, Clause 15.247 (d)  
ISED RSS-247, Clause 5.5

### **2.7.2 Equipment Under Test and Modification State**

A3119, S/N: F0TH2S002M30000N1B - Modification State 0

### **2.7.3 Date of Test**

15-March-2024

### **2.7.4 Test Method**

The test was performed in accordance with ANSI C63.10, clause 6.10.4.

### **2.7.5 Environmental Conditions**

|                     |         |
|---------------------|---------|
| Ambient Temperature | 22.6 °C |
| Relative Humidity   | 46.0 %  |



2.7.6 Test Results

2.4 GHz Bluetooth FHSS

iPA - Core 0 (SISO)

| Mode    | Packet Type | TX Frequency (MHz) | Band Edge Frequency (MHz) | Level (dBc) |
|---------|-------------|--------------------|---------------------------|-------------|
| Static  | DH5         | 2402               | 2400                      | -50.76      |
| Static  | 2-DH5       | 2402               | 2400                      | -48.19      |
| Static  | 3-DH5       | 2402               | 2400                      | -48.24      |
| Hopping | DH5         | Hopping            | 2400                      | -54.95      |
| Hopping | 2-DH5       | Hopping            | 2400                      | -54.85      |
| Hopping | 3-DH5       | Hopping            | 2400                      | -53.99      |

Table 37 - SISO Authorised Band Edge Results

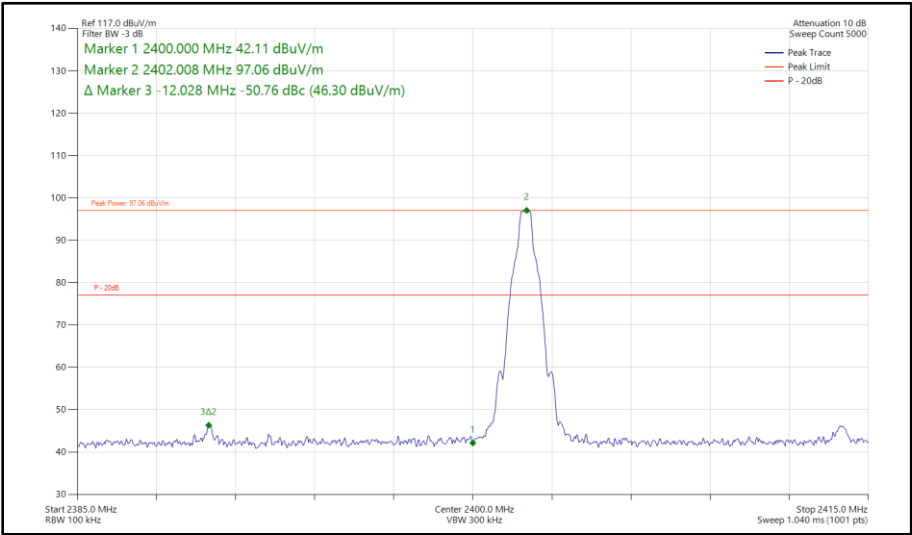
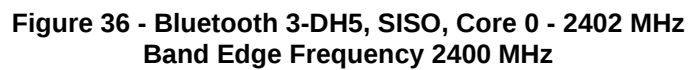
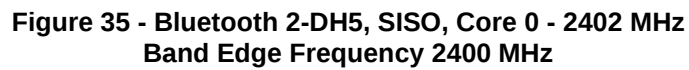


Figure 34 - Bluetooth DH5, SISO, Core 0 - 2402 MHz  
Band Edge Frequency 2400 MHz



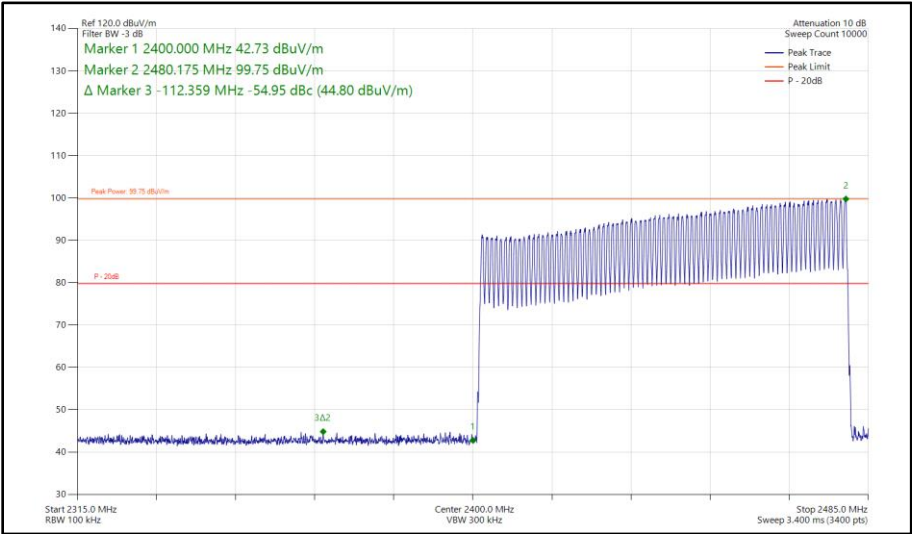


Figure 37 - Bluetooth DH5, SISO, Core 0 - Hopping  
Band Edge Frequency 2400 MHz

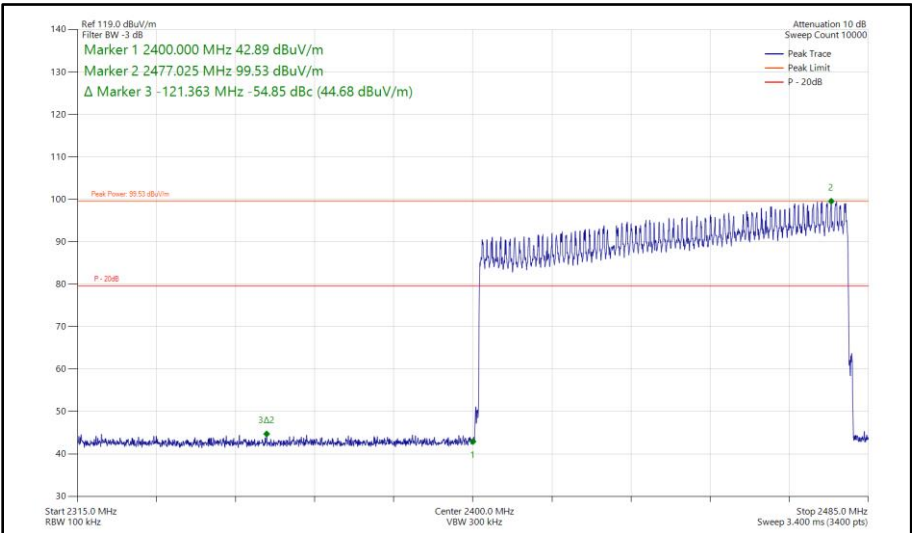
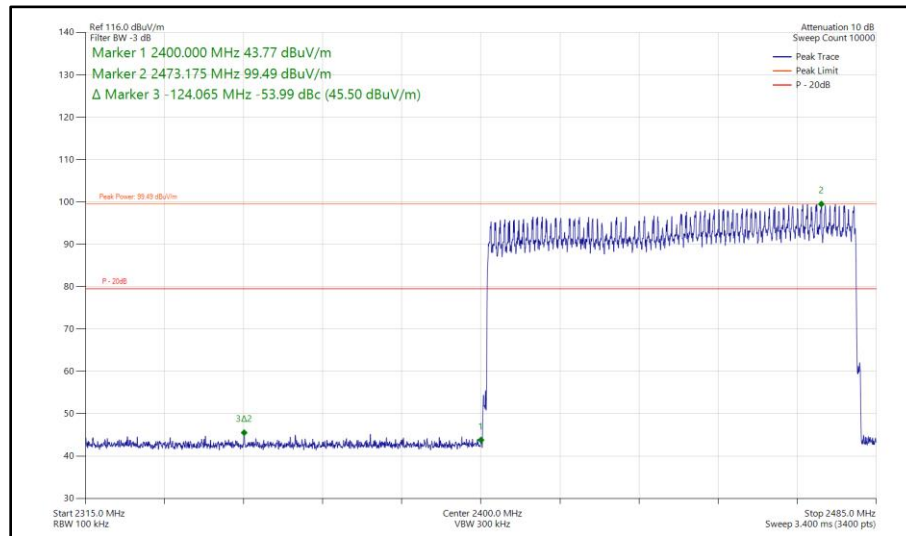


Figure 38 - Bluetooth 2-DH5, SISO, Core 0 - Hopping  
Band Edge Frequency 2400 MHz



**Figure 39 - Bluetooth 3-DH5, SISO, Core 0 - Hopping  
Band Edge Frequency 2400 MHz**

FCC 47 CFR Part 15, Limit Clause 15.247 (d)

20 dB below the fundamental measured in a 100 kHz bandwidth using a peak detector. If the transmitter complies with the conducted power limits, based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB below the fundamental instead of 20 dB.

ISED RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.



## 2.7.7 Test Location and Test Equipment Used

This test was carried out in RF Chamber 16.

| Instrument                          | Manufacturer       | Type No.             | TE No. | Calibration Period (months) | Calibration Expiry Date |
|-------------------------------------|--------------------|----------------------|--------|-----------------------------|-------------------------|
| Emissions Software                  | TUV SUD            | EmX V3.2.0           | 5125   | -                           | Software                |
| 1500W (300V 12A) AC Power Supply    | iTech              | IT7324               | 5957   | -                           | O/P Mon                 |
| 3m Semi-Anechoic Chamber, Chamber16 | Albatross Projects | RF Chamber 16        | 5972   | 36                          | 24-May-2025             |
| Mast & Turntable Controller         | Maturo Gmbh        | FCU3.0               | 5973   | -                           | TU                      |
| Tilt Antenna Mast                   | Maturo Gmbh        | BAM4.5-P             | 5974   | -                           | TU                      |
| Turntable                           | Maturo Gmbh        | TT1.5SI              | 5975   | -                           | TU                      |
| Cable (SMA to SMA 1m)               | Junkosha           | MWX221-01000AMSAMS/A | 6018   | 12                          | 05-Jun-2024             |
| Horn Antenna (1-10 GHz)             | Schwarzbeck        | BBHA9120B            | 6142   | 12                          | 26-Aug-2024             |
| Digital Multimeter                  | Fluke              | 115                  | 6146   | 12                          | 15-Jun-2024             |
| Humidity & Temperature meter        | R.S Components     | 1364                 | 6148   | 12                          | 21-Jul-2024             |
| SAC Switch Unit                     | TUV SUD            | TUV_SSU_001          | 6190   | 12                          | 22-Dec-2024             |
| EMI Test Receiver                   | Rohde & Schwarz    | ESW44                | 6294   | 12                          | 29-Nov-2024             |
| Cable (SMA to SMA 8m)               | Junkosha           | MWX221-08000AMSAMS/B | 6318   | 12                          | 18-Feb-2025             |

**Table 38**

TU - Traceability Unscheduled

O/P Mon - Output Monitored using calibrated equipment



## **2.8 Spurious Radiated Emissions**

### **2.8.1 Specification Reference**

FCC 47 CFR Part 15C, Clause 15.209 and 15.247 (d)  
ISED RSS-247, Clause 3.3 and 5.5  
ISED RSS-GEN, Clause 6.13 and 8.9

### **2.8.2 Equipment Under Test and Modification State**

A3119, S/N: F0TH2S002M30000N1B - Modification State 0

### **2.8.3 Date of Test**

21-March-2024 to 22-March-2024

### **2.8.4 Test Method**

This test was performed in accordance with ANSI C63.10, clause 6.3, 6.5 and 6.6.

For frequencies > 1 GHz, plots for average measurements were taken in accordance with ANSI C63.10 (2020) clause 4.1.5.2.6 to characterize the EUT.

Where emissions were detected, final average measurements were taken in accordance with ANSI C63.10 (2020) clause 4.1.5.2.2.

The EUT was placed on the non-conducting platform in a manner typical of a normal installation.

Ports on the EUT were terminated with loads as described in ANSI C63.10 clause 5.10.

In the 30 MHz to 1 GHz range pre-scans were only performed on the mid channel (2441 MHz) only.

The plots shown are the characterisation of the EUT. The limits on the plots represent the most stringent case for restricted bands, (74/54 dBuV/m) when compared to 20 dBc outside restricted bands. The limits shown have been used as a threshold to determine where further measurements are necessary. Where results are within 10 dB of the limits shown on the plots, further investigation was carried out and reported in results tables.

The following conversion can be applied to convert from dBμV/m to μV/m:  
 $10^{(\text{Field Strength in dB}\mu\text{V/m}/20)}$

To determine the emission characteristic of the EUT above 18 GHz, the test antenna was swept over all faces of the EUT whilst observing a spectral display. The frequency of any emissions of interest was noted for formal measurement at the correct measurement distance of 1m. This procedure was repeated for all relevant transmit operating channels.

Above 18 GHz, the measurement distance was reduced to 1 m. The limit line was increased by  $20 \cdot \text{LOG}(3/1) = 9.54$  dB.

At a measurement distance of 1 meter the limit line was increased by  $20 \cdot \text{LOG}(3/1) = 9.54$  dB.

Where formal measurements have been necessary, the results have been presented in the emissions table.

The initial results for average measurements at carrier harmonics were found to be close to the limit. Since Bluetooth is hopping and has a protocol-limited duty cycle, the final average result were therefore calculated from the peak value using the method described in ANSI C63.10 section 7.8.8.2. The dwell time per hop was calculated to be 11.25 ms per 100 ms. This resulted in a duty cycle correction of -18.98 dB for non-overlapping channels (BDR), -12.96 dB for overlapping channels (EDR).

### 2.8.5 Example Test Setup Diagram

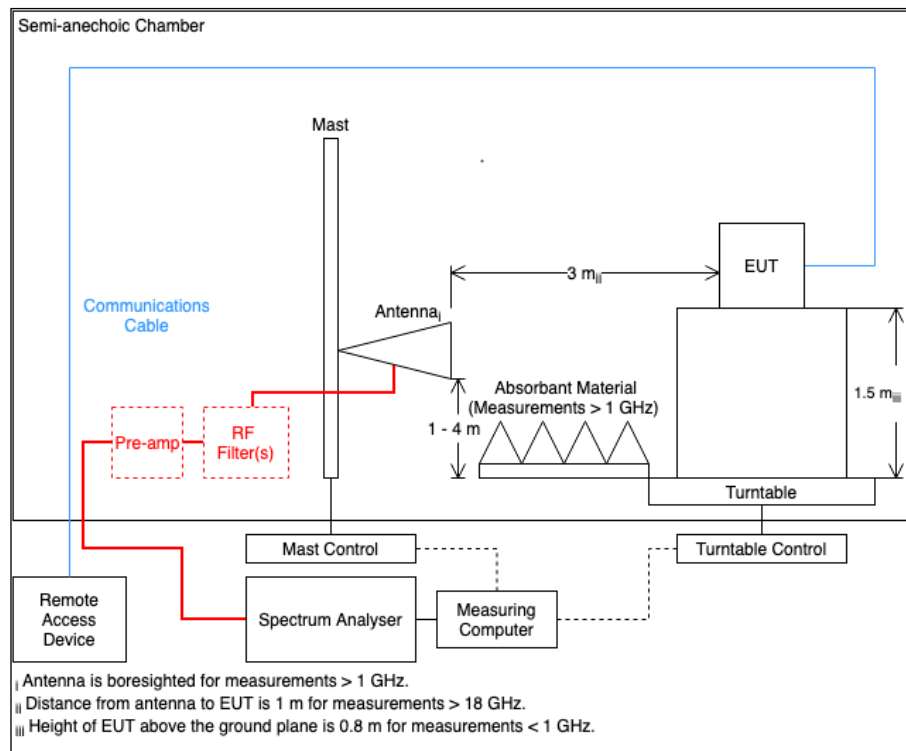


Figure 40

### 2.8.6 Environmental Conditions

|                     |                |
|---------------------|----------------|
| Ambient Temperature | 22.5 - 22.6 °C |
| Relative Humidity   | 46.0 - 48.1 %  |



2.8.7 Test Results

2.4 GHz Bluetooth FHSS

| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector  | Angle (°) | Height (cm) | Polarisation |
|-----------------|----------------|----------------|-------------|-----------|-----------|-------------|--------------|
| 4803.895        | 49.86          | 74.00          | -24.14      | Peak      | 109       | 118         | Horizontal   |
| 4803.895        | 30.88          | 54.00          | -23.12      | CISPR Avg | 109       | 118         | Horizontal   |
| 4804.185        | 52.47          | 74.00          | -21.53      | Peak      | 75        | 100         | Vertical     |
| 4804.185        | 33.49          | 54.00          | -20.51      | CISPR Avg | 75        | 100         | Vertical     |

Table 39 - 2402 MHz (CH0), DH5, iPA, Core 0, 1 GHz to 26 GHz

No other emissions found within 20 dB of the limit.

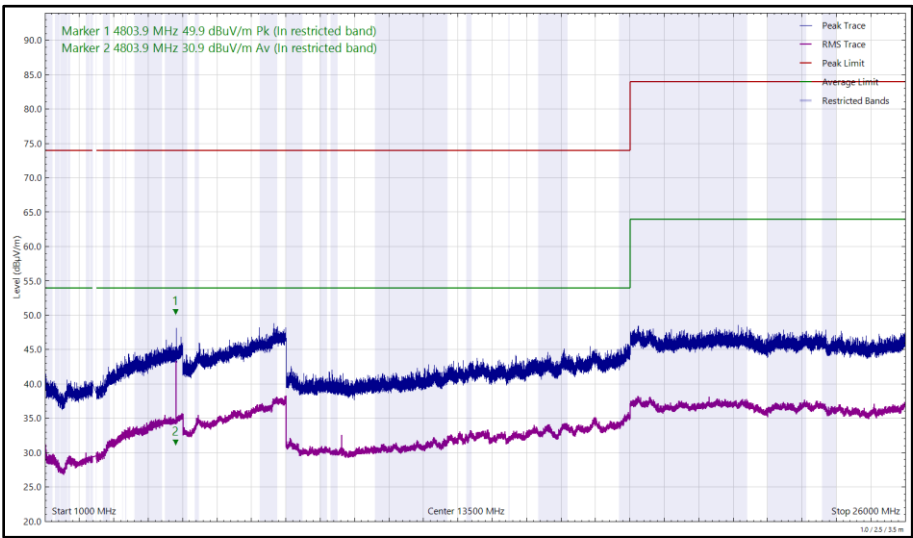


Figure 41 - 2402 MHz (CH0), DH5, iPA, Core 0, 1 GHz to 26 GHz, Horizontal

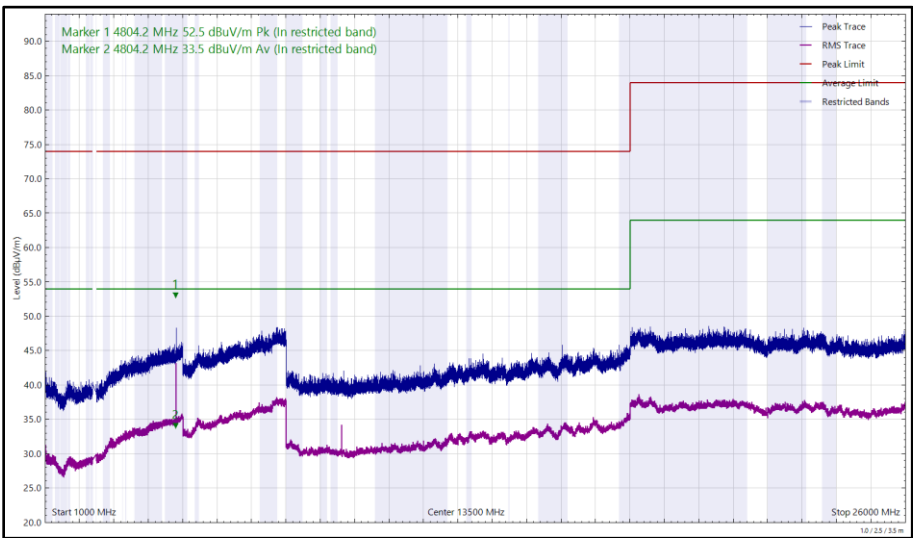


Figure 42 - 2402 MHz (CH0), DH5, iPA, Core 0, 1 GHz to 26 GHz, Vertical



| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector  | Angle (°) | Height (cm) | Polarisation |
|-----------------|----------------|----------------|-------------|-----------|-----------|-------------|--------------|
| 4881.730        | 51.21          | 74.00          | -22.79      | Peak      | 109       | 100         | Horizontal   |
| 4881.730        | 32.23          | 54.00          | -21.77      | CISPR Avg | 109       | 100         | Horizontal   |
| 4882.205        | 54.10          | 74.00          | -19.90      | Peak      | 74        | 100         | Vertical     |
| 4882.205        | 35.12          | 54.00          | -18.88      | CISPR Avg | 74        | 100         | Vertical     |

Table 40 - 2441 MHz (CH39), DH5, iPA, Core 0, 30 MHz to 26 GHz

No other emissions found within 20 dB of the limit.

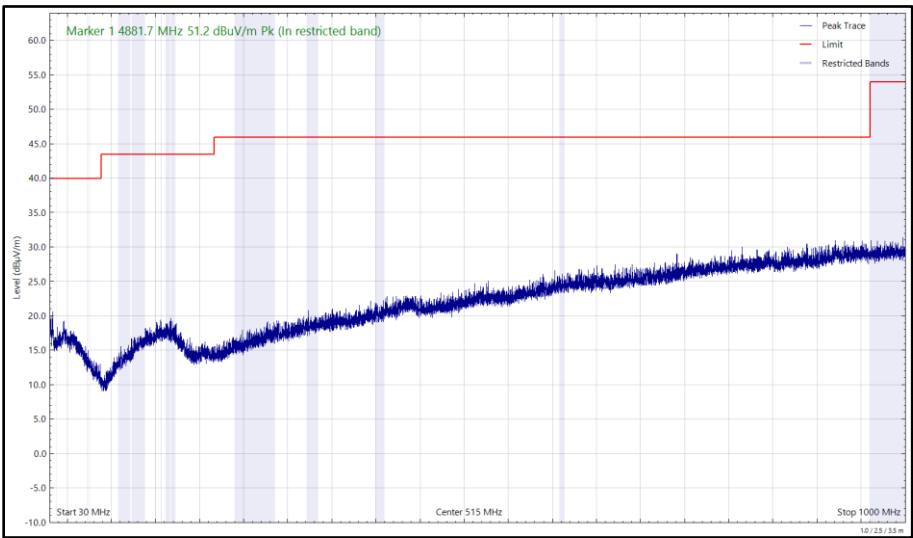


Figure 43 - 2441 MHz (CH39), DH5, iPA, Core 0, 30 MHz to 1 GHz, Horizontal (Peak)

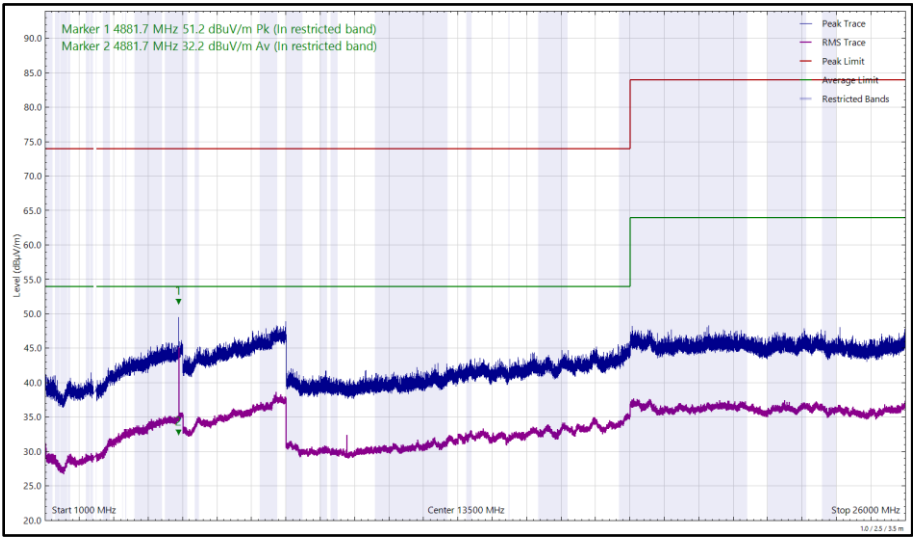


Figure 44 - 2441 MHz (CH39), DH5, iPA, Core 0, 1 GHz to 26 GHz, Horizontal

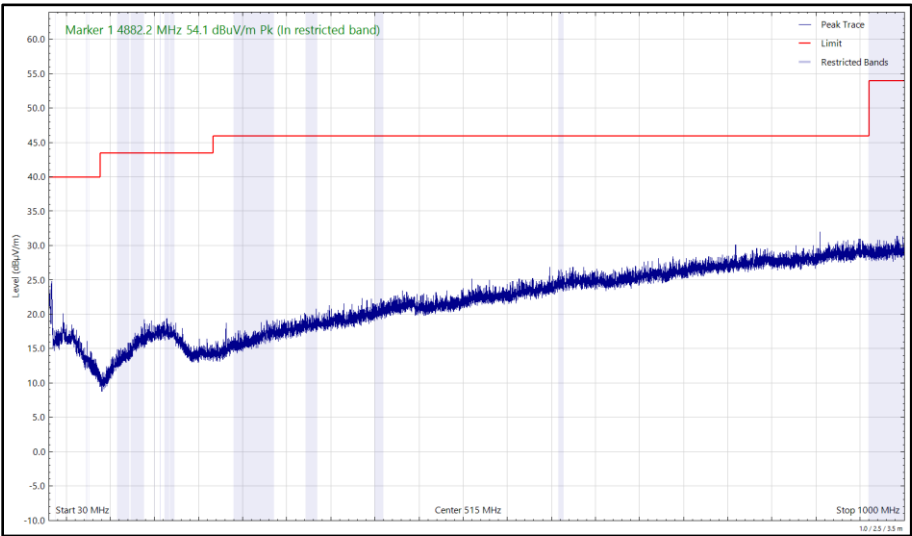


Figure 45 - 2441 MHz (CH39), DH5, iPA, Core 0, 30 MHz to 1 GHz, Vertical (Peak)

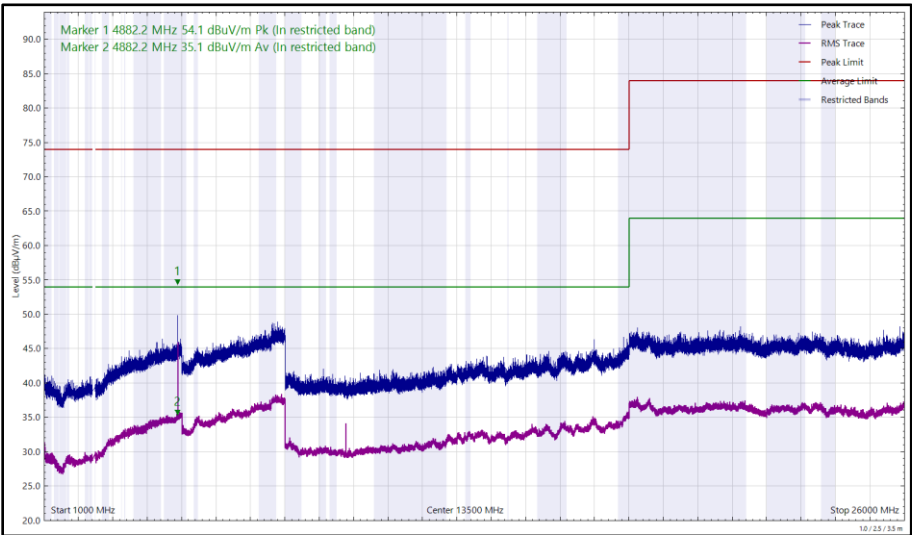


Figure 46 - 2441 MHz (CH39), DH5, iPA, Core 0, 1 GHz to 26 GHz, Vertical



| Frequency (MHz) | Level (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Detector  | Angle (°) | Height (cm) | Polarisation |
|-----------------|----------------|----------------|-------------|-----------|-----------|-------------|--------------|
| 4959.715        | 51.96          | 74.00          | -22.04      | Peak      | 109       | 162         | Horizontal   |
| 4959.715        | 32.98          | 54.00          | -21.02      | CISPR Avg | 109       | 162         | Horizontal   |
| 4960.090        | 53.73          | 74.00          | -20.27      | Peak      | 81        | 108         | Vertical     |
| 4960.090        | 34.75          | 54.00          | -19.25      | CISPR Avg | 81        | 108         | Vertical     |

Table 41 - 2480 MHz (CH78), DH5, iPA, Core 0, 1 GHz to 26 GHz

No other emissions found within 20 dB of the limit.

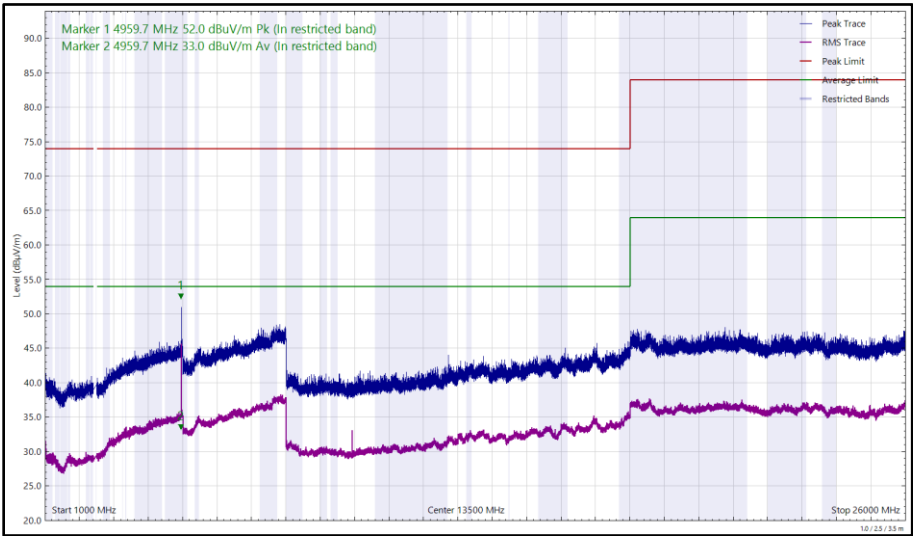


Figure 47 - 2480 MHz (CH78), DH5, iPA, Core 0, 1 GHz to 26 GHz, Horizontal

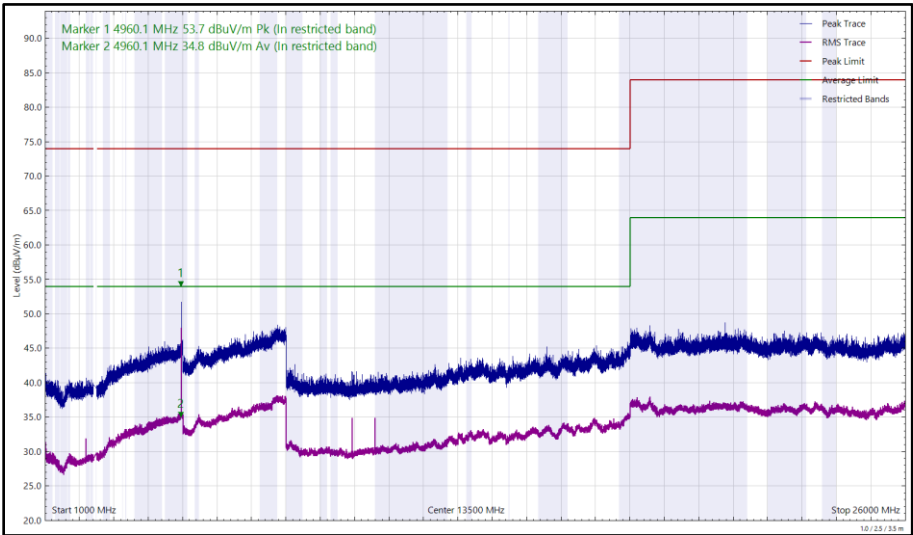


Figure 48 - 2480 MHz (CH78), DH5, iPA, Core 0, 1 GHz to 26 GHz, Vertical



FCC 47 CFR Part 15, Limit Clause 15.247 (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in 15.209(a)

ISED RSS-247, Limit Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

In addition, radiated emissions which fall in the restricted bands, as defined in RSS-GEN, clause 8.10, must also comply with the radiated emission limits specified in RSS-GEN clause 8.9.



## 2.8.8 Test Location and Test Equipment Used

This test was carried out in RF Chamber 16.

| Instrument                                   | Manufacturer        | Type No.                  | TE No. | Calibration Period (months) | Calibration Expiry Date |
|----------------------------------------------|---------------------|---------------------------|--------|-----------------------------|-------------------------|
| Emissions Software                           | TUV SUD             | EmX V3.2.0                | 5125   | -                           | Software                |
| Cable (K Type 2m)                            | Junkosha            | MWX241-02000KMSKMS/B      | 5935   | 12                          | 05-Jun-2024             |
| DRG Horn Antenna (7.5-18GHz)                 | Schwarzbeck         | HWRD750                   | 5940   | 12                          | 09-Jul-2024             |
| 1500W (300V 12A) AC Power Supply             | iTech               | IT7324                    | 5957   | -                           | O/P Mon                 |
| 3m Semi-Anechoic Chamber, Chamber16          | Albatross Projects  | RF Chamber 16             | 5972   | 36                          | 24-May-2025             |
| Mast & Turntable Controller                  | Maturo Gmbh         | FCU3.0                    | 5973   | -                           | TU                      |
| Tilt Antenna Mast                            | Maturo Gmbh         | BAM4.5-P                  | 5974   | -                           | TU                      |
| Turntable                                    | Maturo Gmbh         | TT1.5SI                   | 5975   | -                           | TU                      |
| Cable (SMA to SMA 1m)                        | Junkosha            | MWX221-01000AMSAMS/A      | 6018   | 12                          | 05-Jun-2024             |
| Horn Antenna (1-10 GHz)                      | Schwarzbeck         | BBHA9120B                 | 6142   | 12                          | 26-Aug-2024             |
| Digital Multimeter                           | Fluke               | 115                       | 6146   | 12                          | 15-Jun-2024             |
| Humidity & Temperature meter                 | R.S Components      | 1364                      | 6148   | 12                          | 21-Jul-2024             |
| Double Ridge Active Horn Antenna (18-40 GHz) | Com-Power           | AHA-840                   | 6188   | 24                          | 02-Jun-2024             |
| SAC Switch Unit                              | TUV SUD             | TUV_SSU_001               | 6190   | 12                          | 22-Dec-2024             |
| 8 GHz Highpass Filter                        | Wainwright          | WHKX 7150 8000 18000 50SS | 6196   | 12                          | 24-Jul-2024             |
| Pre Amp 8 - 18 GHz                           | Wright Technologies | APS06 0061                | 6198   | 12                          | 14-Jul-2024             |
| Attenuator (4 dB)                            | Pasternack          | PE7074-4                  | 6202   | 24                          | 16-Jul-2024             |
| Cable (SMA to SMA 20cm)                      | TUV SUD             | MH-FH 8-18                | 6220   | 12                          | 24-Jul-2024             |
| EMI Test Receiver                            | Rohde & Schwarz     | ESW44                     | 6294   | 12                          | 29-Nov-2024             |
| Cable (SMA to SMA 8m)                        | Junkosha            | MWX221-08000AMSAMS/B      | 6318   | 12                          | 18-Feb-2025             |
| Trilog Super Broadband Test Antenna          | Schwarzbeck         | VULB 9168                 | 6456   | 24                          | 10-Feb-2025             |
| DRG Horn Antenna                             | Schwarzbeck         | HWRD750                   | 6458   | 12                          | 09-Jul-2024             |

**Table 42**

TU - Traceability Unscheduled

O/P Mon - Output Monitored using calibrated equipment



### 3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

| Test Name                                              | Measurement Uncertainty                                        |
|--------------------------------------------------------|----------------------------------------------------------------|
| Restricted Band Edges                                  | 30 MHz to 1 GHz: $\pm 5.2$ dB<br>1 GHz to 40 GHz: $\pm 6.3$ dB |
| Frequency Hopping Systems - Average Time of Occupancy  | -                                                              |
| Frequency Hopping Systems - Channel Separation         | $\pm 50.86$ kHz                                                |
| Frequency Hopping Systems - Number of Hopping Channels | -                                                              |
| Frequency Hopping Systems - 99% & 20 dB Bandwidth      | $\pm 45.99$ kHz                                                |
| Maximum Conducted Output Power                         | $\pm 1.38$ dB                                                  |
| Authorised Band Edges                                  | 30 MHz to 1 GHz: $\pm 5.2$ dB<br>1 GHz to 40 GHz: $\pm 6.3$ dB |
| Spurious Radiated Emissions                            | 30 MHz to 1 GHz: $\pm 5.2$ dB<br>1 GHz to 40 GHz: $\pm 6.3$ dB |

**Table 43**

#### Measurement Uncertainty Decision Rule – Accuracy Method

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115:2021, Clause 4.4.3 (Procedure 2). The measurement results are directly compared with the test limit to determine conformance with the requirements of the standard.

Risk: The uncertainty of measurement about the measured result is negligible with regard to the final pass/fail decision. The measurement result can be directly compared with the test limit to determine conformance with the requirement (compare IEC Guide 115). The level of risk to falsely accept and falsely reject items is further described in ILAC-G8.