

# FCC and ISED Test Report

Apple Inc. Model: A2615

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

Prepared for: Apple Inc  
One Apple Park Way, Cupertino, California  
95014, USA

FCC ID: BCGA2615 IC: 579C-A2615

**COMMERCIAL-IN-CONFIDENCE**

Document 75952325-09 Issue 01



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## SIGNATURE

| NAME           | JOB TITLE       | RESPONSIBLE FOR      | ISSUE DATE       |
|----------------|-----------------|----------------------|------------------|
| Steve Marshall | Senior Engineer | Authorised Signatory | 02 February 2022 |

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 |
|-----------------|------------------------|------------------|-----------|
| Testing         | Faisal Malyar          | 02 February 2022 |           |
| Testing         | Danial Shafique        | 02 February 2022 |           |
| Testing         | Jaiyanth Balendrarajah | 02 February 2022 |           |
| Testing         | Liang Tian             | 02 February 2022 |           |
| Testing         | Colin Brain            | 02 February 2022 |           |
| Testing         | Daniel Cameron         | 02 February 2022 |           |

FCC Accreditation  
90987 Octagon House, Fareham Test Laboratory

ISED Accreditation  
12669A Octagon House, Fareham Test Laboratory

## EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15C: 2020, ISED RSS-247: Issue 2 (02-2017) and ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021) for the tests detailed in section 1.3.



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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           | 02-February-2022 |

**Table 1**

## 1.2 Introduction

|                               |                                                                                                                |
|-------------------------------|----------------------------------------------------------------------------------------------------------------|
| Applicant                     | Apple Inc                                                                                                      |
| Manufacturer                  | Apple Inc                                                                                                      |
| Model Number(s)               | A2615                                                                                                          |
| Serial Number(s)              | P1F4F29DL4 and H617C20363                                                                                      |
| Hardware Version(s)           | REV1.0                                                                                                         |
| Software Version(s)           | 21B30220I                                                                                                      |
| Number of Samples Tested      | 2                                                                                                              |
| Test Specification/Issue/Date | FCC 47 CFR Part 15C: 2020<br>ISED RSS-247: Issue 2 (02-2017)<br>ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021) |
| Order Number                  | 0540220896                                                                                                     |
| Date                          | 25-May-2021                                                                                                    |
| Date of Receipt of EUT        | 25-October-2021                                                                                                |
| Start of Test                 | 25-October-2021                                                                                                |
| Finish of Test                | 04-January-2022                                                                                                |
| Name of Engineer(s)           | Faisal Malyar, Danial Shafique, Jaiyanth Balendrarah, Liang Tian, Colin Brain and Daniel Cameron               |
| Related Document(s)           | ANSI C63.4 (2014)<br>ANSI C63.10 (2013)<br>KDB 662911 D01 v02r01                                               |



### 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                | -           | 8.10         | Restricted Band Edges                                  | Pass   |                                                                                                             |
| 2.2                                              | 15.247 (a)(1)         | 5.1         | -            | Frequency Hopping Systems - Average Time of Occupancy  | Pass   |                                                                                                             |
| 2.3                                              | 15.247 (a)(1)         | 5.1         | -            | Frequency Hopping Systems - Channel Separation         | Pass   |                                                                                                             |
| 2.4                                              | 15.247 (a)(1)         | 5.1         | -            | Frequency Hopping Systems - Number of Hopping Channels | Pass   |                                                                                                             |
| 2.5                                              | 15.247 (a)(1)         | 5.1         | 6.7          | Frequency Hopping Systems - 20 dB Bandwidth            | Pass   |                                                                                                             |
| 2.6                                              | 15.247 (b)            | 5.4         | 6.12         | Maximum Conducted Output Power                         | Pass   |                                                                                                             |
| 2.7                                              | 15.247 (d) and 15.209 | 3.3 and 5.5 | 6.13 and 8.9 | Spurious Radiated Emissions                            | Pass   |                                                                                                             |
| 2.8                                              | 15.247 (d)            | 5.5         | -            | Authorised Band Edges                                  | Pass   |                                                                                                             |

**Table 2**



## 1.4 Product Information

### 1.4.1 Technical Description

The Equipment under test (EUT) was a desktop computer with Bluetooth, Bluetooth Low Energy and 802.11 a/b/g/n/ac/ax capabilities in the 2.4 GHz and 5 GHz bands.

### 1.4.2 Test Setup

For conducted tests, a conducted test point was provided by the manufacturer via a flex strip and UFL connector and cable. The loss of these test cables were known and compensated for in any conducted measurements.

For tests in SISO operation, conducted tests were performed on the BT Dedicated Core as well as the Core with the highest antenna gain as Core 0 and Core 1 are identical but with unequal antenna gains. The EUT supports TxBF on Core 0 + Core 1.

Bluetooth BDR/EDR was assessed as a FHSS system. The EUT supports Bluetooth on the following mode of operations across its antenna ports:

BT Dedicated Core (Core 2) – SISO (iPA)  
BT Core 0 – SISO (iPA and ePA), TxBF (iPA and ePA)  
BT Core 1 – SISO (iPA and ePA), TxBF (iPA and ePA)

For all tests, the EUT was put into a continuous transmit test mode with the manufacturer's test commands via a script running in the EUTs terminal application. The EUT then transmitted the required type of modulation/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 a 120 V AC, 60 Hz source.

### 1.4.3 Antenna Gain Table

| Antenna Port               | Frequency Range (MHz) | Peak Gain (dBi) | Conducted Cable Loss (dB) |
|----------------------------|-----------------------|-----------------|---------------------------|
| BT Dedicated Core (Core 2) | 2400 to 2480          | 1.70            | 1.00                      |
| BT Core 0                  | 2400 to 2480          | 2.20            | 1.00                      |
| BT Core 1                  | 2400 to 2480          | 1.40            | 1.00                      |

**Table 3**

## 1.5 Deviations from the Standard

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



## 1.6 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: A2615, Serial Number: P1F4F29DL4 |                                                 |                        |                          |
| 0                                       | As supplied by the customer                     | Not Applicable         | Not Applicable           |
| Model: A2615, Serial Number: H617C20363 |                                                 |                        |                          |
| 0                                       | As supplied by the customer                     | Not Applicable         | Not Applicable           |

**Table 4**

## 1.7 Test Location

TÜV SÜD conducted the following tests at our Fareham Test Laboratory.

| Test Name                                              | Name of Engineer(s)                                                    | Accreditation |
|--------------------------------------------------------|------------------------------------------------------------------------|---------------|
| Configuration and Mode: 2.4 GHz Bluetooth - FHSS       |                                                                        |               |
| Restricted Band Edges                                  | Faisal Malyar, Danial Shafique, Jaiyanth Balendrarajah and Liang Tian  | UKAS          |
| Frequency Hopping Systems - Average Time of Occupancy  | Daniel Cameron                                                         | UKAS          |
| Frequency Hopping Systems - Channel Separation         | Daniel Cameron                                                         | UKAS          |
| Frequency Hopping Systems - Number of Hopping Channels | Daniel Cameron                                                         | UKAS          |
| Frequency Hopping Systems - 20 dB Bandwidth            | Daniel Cameron                                                         | UKAS          |
| Maximum Conducted Output Power                         | Daniel Cameron                                                         | UKAS          |
| Spurious Radiated Emissions                            | Jaiyanth Balendrarajah, Danial Shafique, Colin Brain and Taha Shafique | UKAS          |
| Authorised Band Edges                                  | Faisal Malyar, Danial Shafique, Jaiyanth Balendrarajah and Liang Tian  | UKAS          |

**Table 5**

Office Address:

TÜV SÜD  
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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-GEN, Clause 8.10

#### 2.1.2 Equipment Under Test and Modification State

A2615, S/N: P1F4F29DL4 - Modification State 0

#### 2.1.3 Date of Test

25-October-2021 to 27-October-2021

#### 2.1.4 Test Method

The 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 4.1.4.2.5. 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 | 20.8 - 22.8 °C |
| Relative Humidity   | 46.9 – 52.5 %  |

## 2.1.6 Test Results

### 2.4 GHz Bluetooth (FHSS)

#### iPA

| Mode   | Modulation    | Core | Packet Type | Tx Frequency (MHz) | Band Edge Frequency (MHz) | Peak Level (dBμV/m) | Average Level (dBμV/m) |
|--------|---------------|------|-------------|--------------------|---------------------------|---------------------|------------------------|
| Static | GFSK          | 0    | DH5         | 2402               | 2390.0                    | 54.27               | 39.71                  |
| Static | $\pi/4$ DQPSK | 0    | 2DH5        | 2402               | 2390.0                    | 54.40               | 39.77                  |
| Static | 8-DPSK        | 0    | 3DH5        | 2402               | 2390.0                    | 54.26               | 39.76                  |
| Static | GFSK          | 0    | DH5         | 2480               | 2483.5                    | 53.83               | 40.41                  |
| Static | $\pi/4$ DQPSK | 0    | 2DH5        | 2480               | 2483.5                    | 52.94               | 41.04                  |
| Static | 8-DPSK        | 0    | 3DH5        | 2480               | 2483.5                    | 53.43               | 41.22                  |

Table 6 - Restricted Band Edge Results

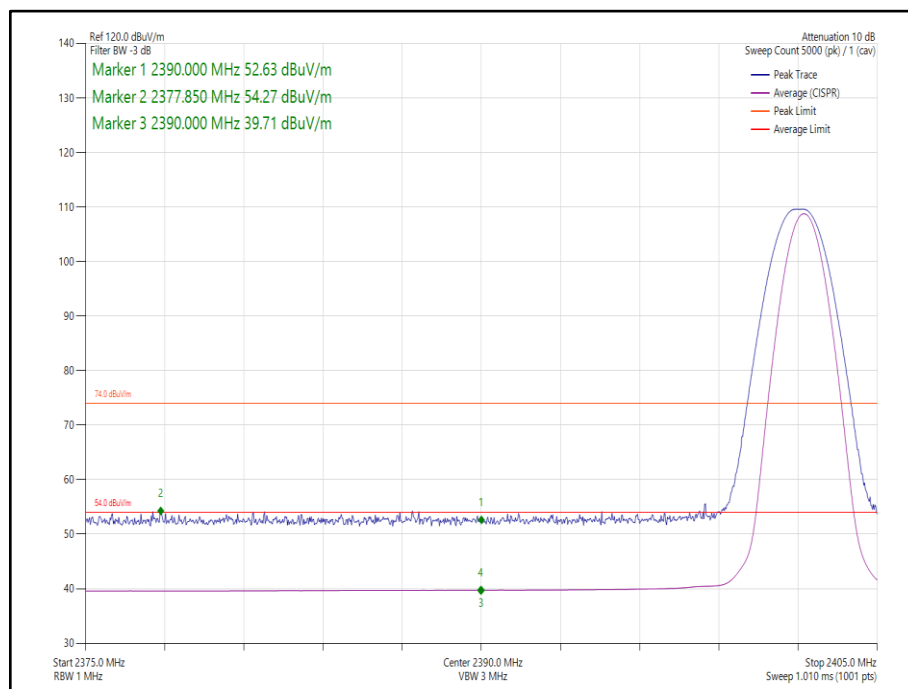
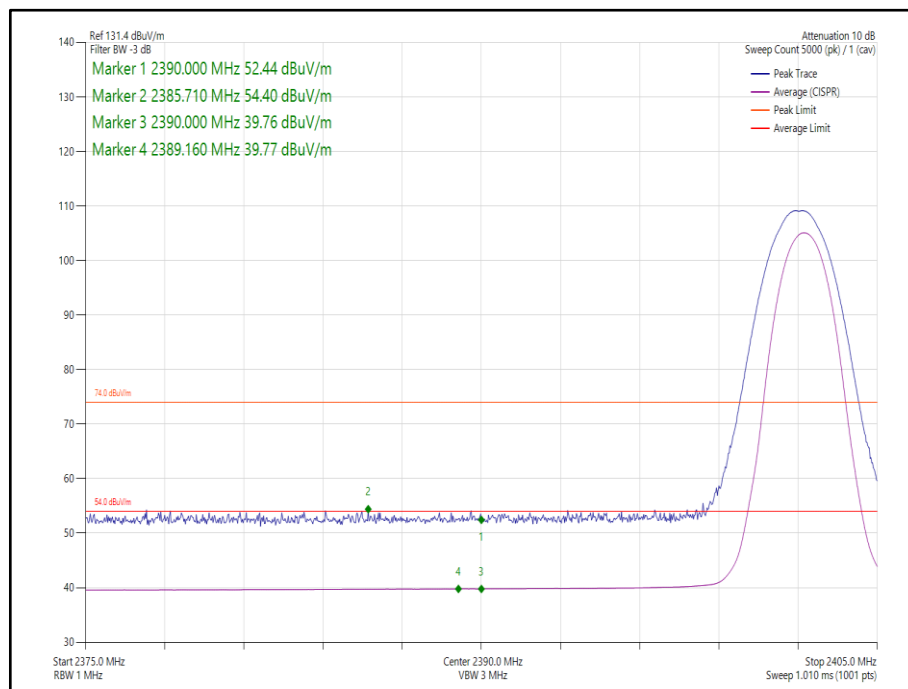
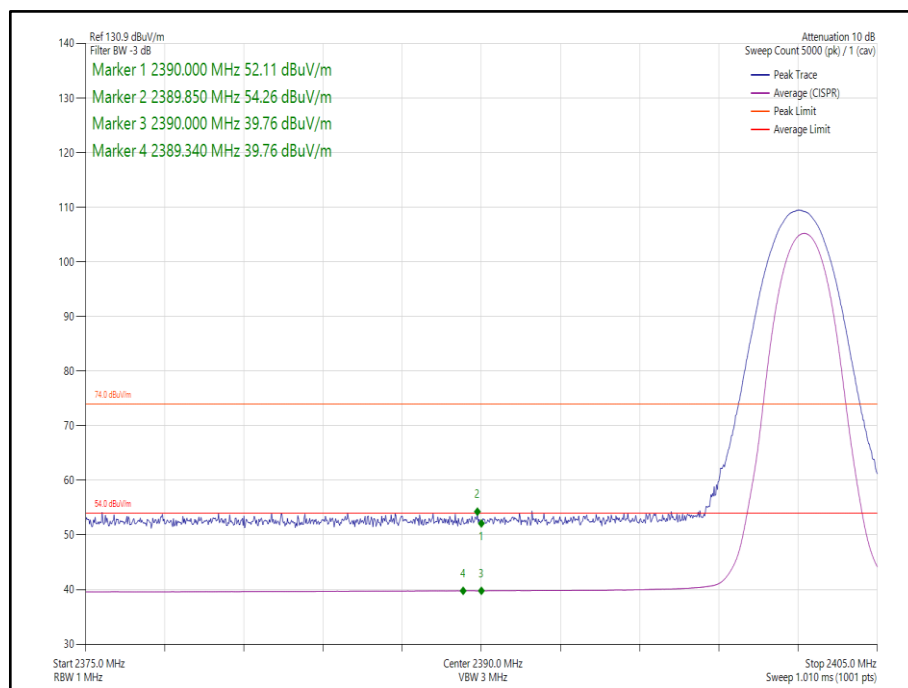


Figure 1 Core 0- Static - GFSK/DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz



**Figure 2 Core 0- Static -  $\pi/4$  DQPSK/2DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz**



**Figure 3 Core 0- Static - 8-DPSK/3DH5 - 2402 MHz Band Edge Frequency 2390.0 MHz**

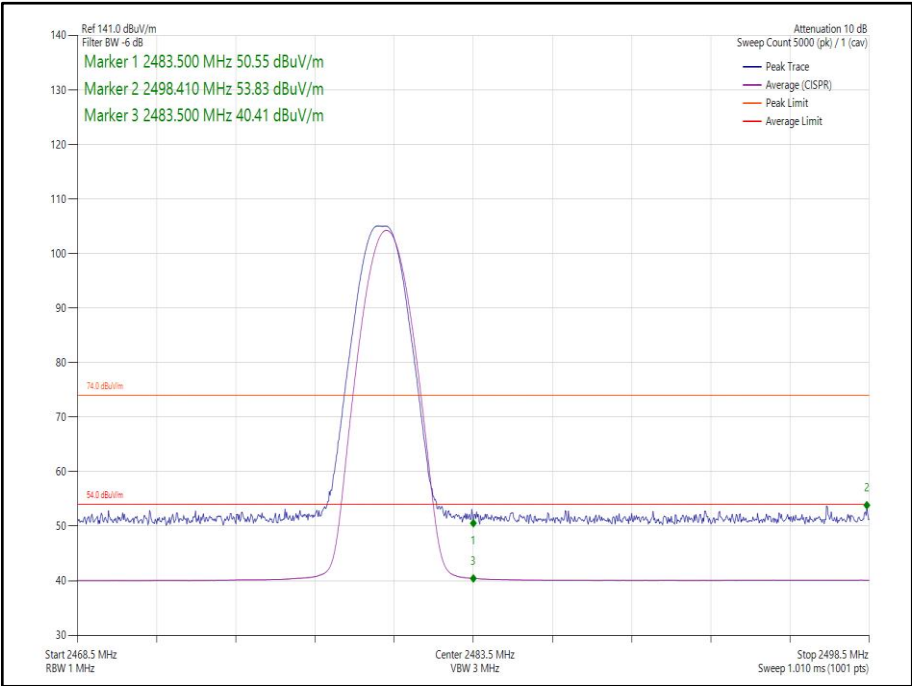


Figure 4 Core 0- Static - GFSK/DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

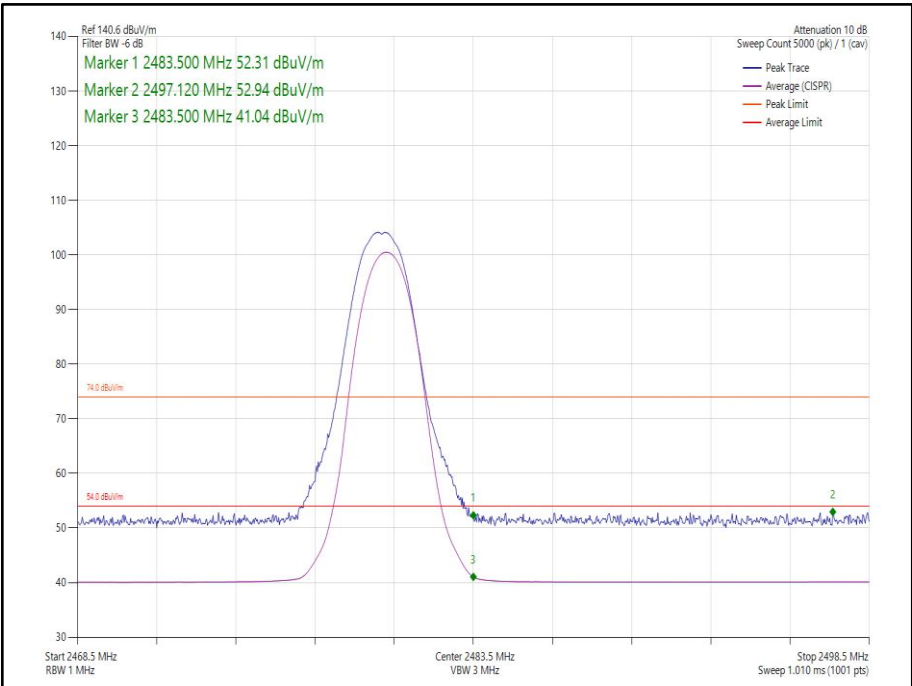


Figure 5 Core 0- Static -  $\pi/4$  DQPSK/2DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

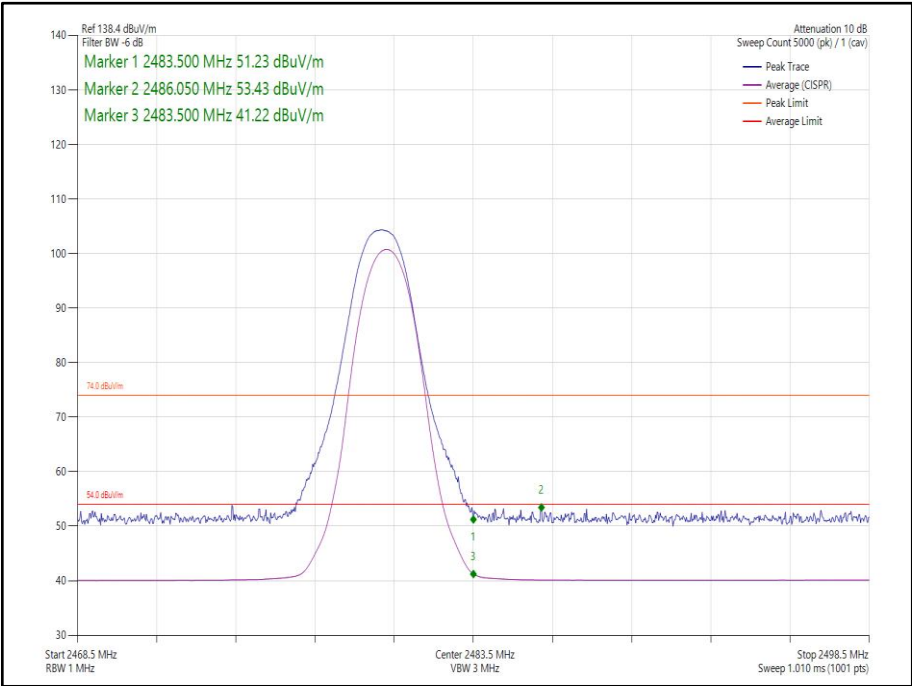


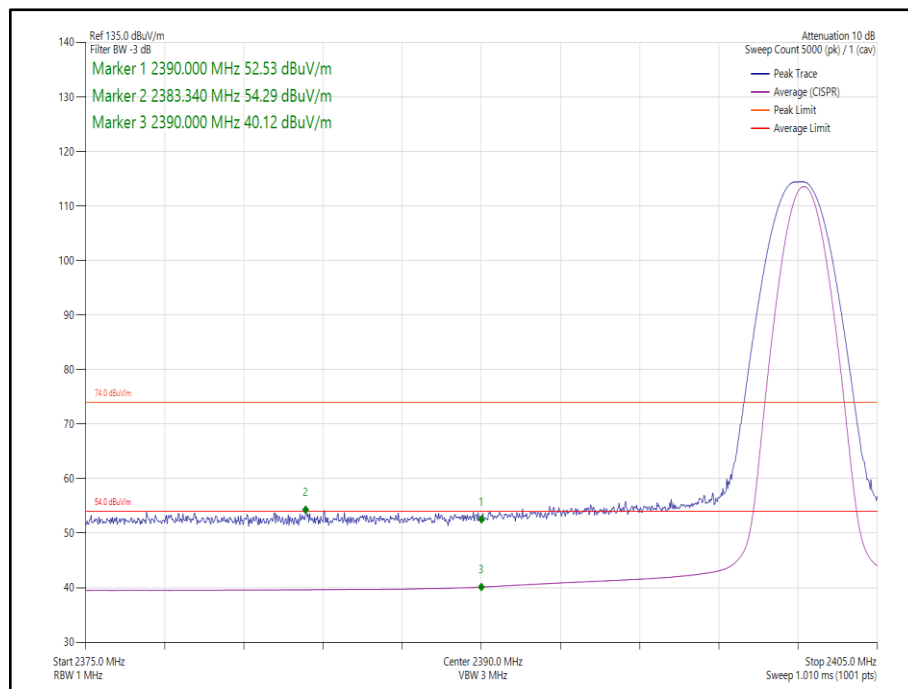
Figure 6 Core 0- Static - 8-DPSK/3DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

## 2.4 GHz Bluetooth (FHSS)

### ePA

| Mode   | Modulation    | Core | Packet Type | Tx Frequency (MHz) | Band Edge Frequency (MHz) | Peak Level (dBμV/m) | Average Level (dBμV/m) |
|--------|---------------|------|-------------|--------------------|---------------------------|---------------------|------------------------|
| Static | GFSK          | 0    | DH5         | 2402               | 2390.0                    | 54.29               | 40.12                  |
| Static | $\pi/4$ DQPSK | 0    | 2DH5        | 2402               | 2390.0                    | 54.58               | 40.07                  |
| Static | 8-DPSK        | 0    | 3DH5        | 2402               | 2390.0                    | 54.29               | 40.14                  |
| Static | GFSK          | 0    | DH5         | 2480               | 2483.5                    | 53.81               | 41.37                  |
| Static | $\pi/4$ DQPSK | 0    | 2DH5        | 2480               | 2483.5                    | 53.76               | 41.29                  |
| Static | 8-DPSK        | 0    | 3DH5        | 2480               | 2483.5                    | 54.14               | 41.77                  |

**Table 7 - Restricted Band Edge Results**



**Figure 7 Core 0- Static - GFSK/DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz**

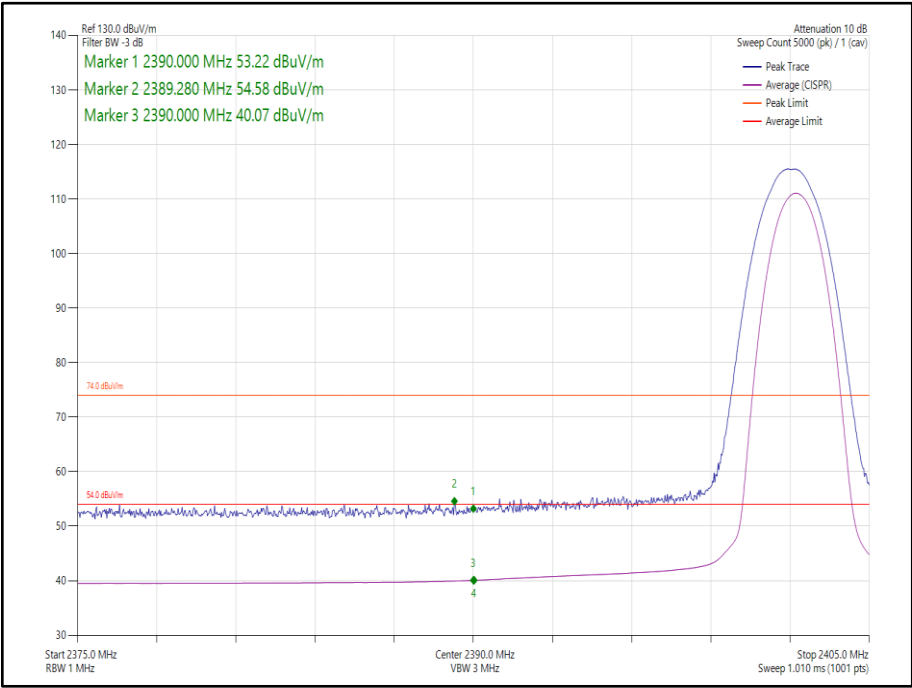


Figure 8 - Static Core 0-  $\pi/4$  DQPSK/2DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz

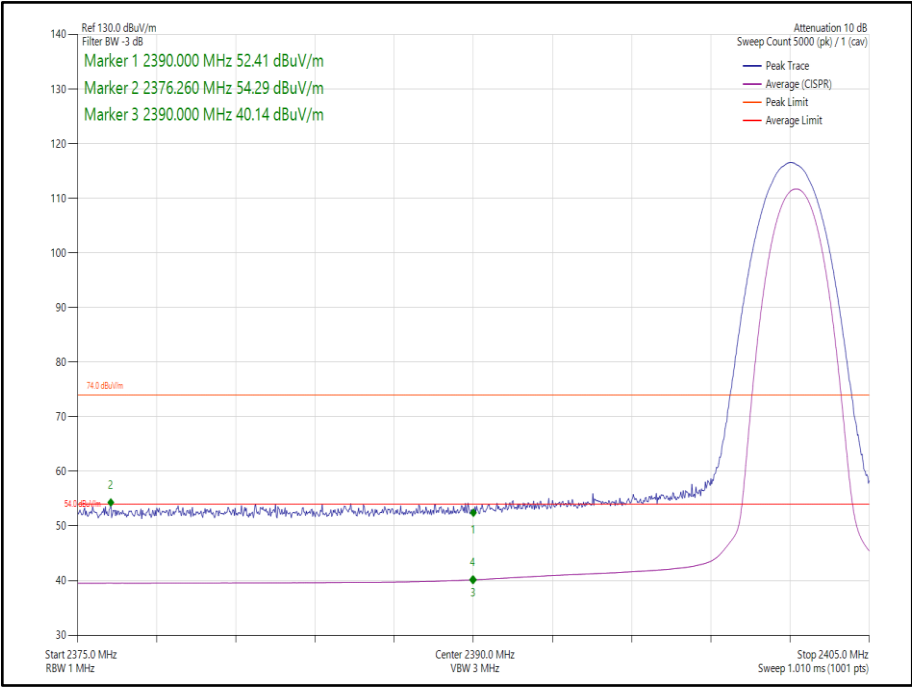


Figure 9 Core 0- Static - 8-DPSK/3DH5 - 2402 MHz Band Edge Frequency 2390.0 MHz

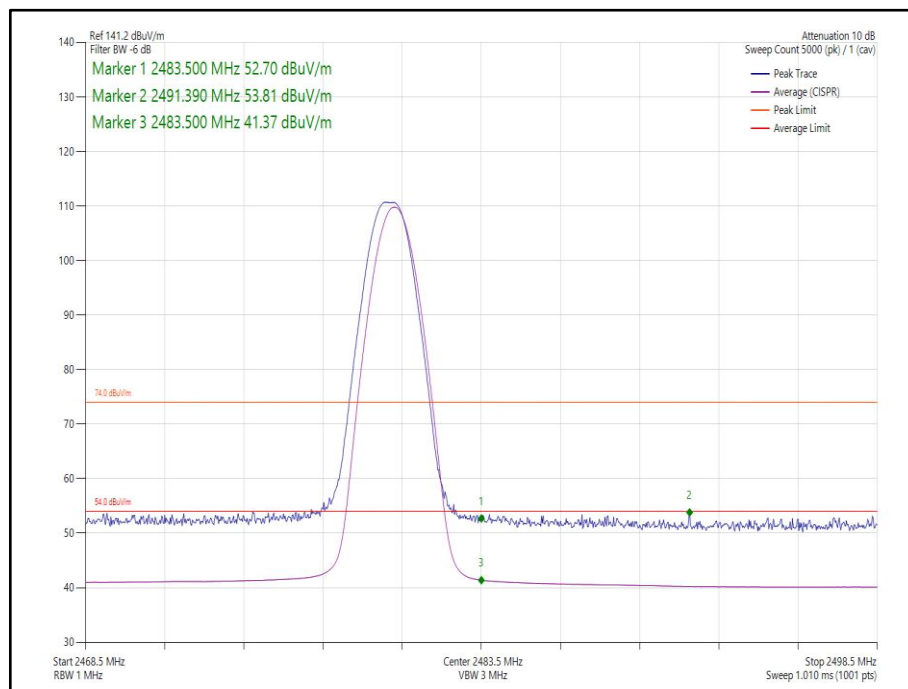


Figure 10 Core 0- Static - GFSK/DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

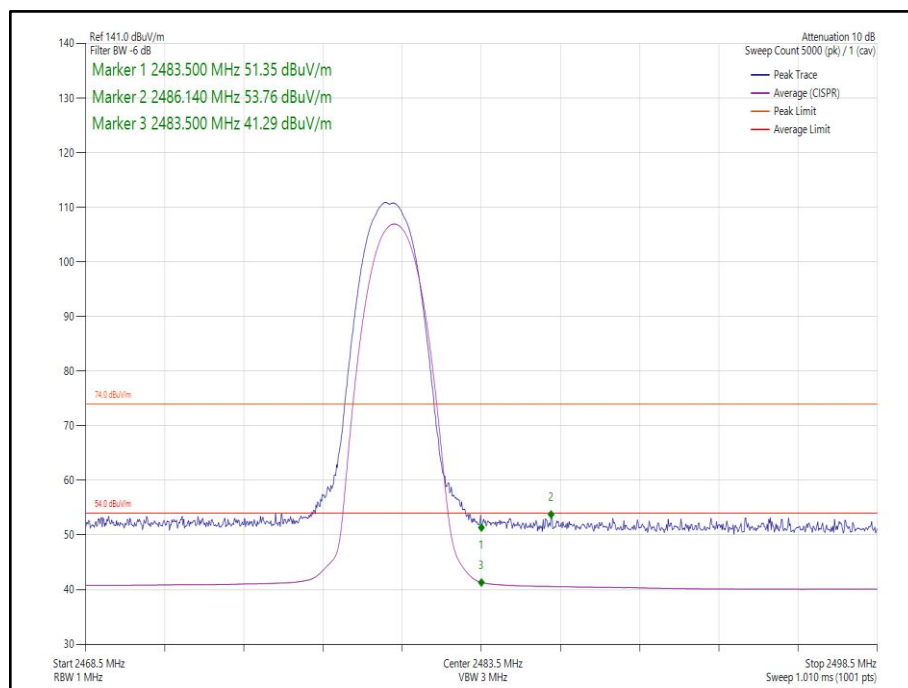


Figure 11 Core 0- Static -  $\pi/4$  DQPSK/2DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

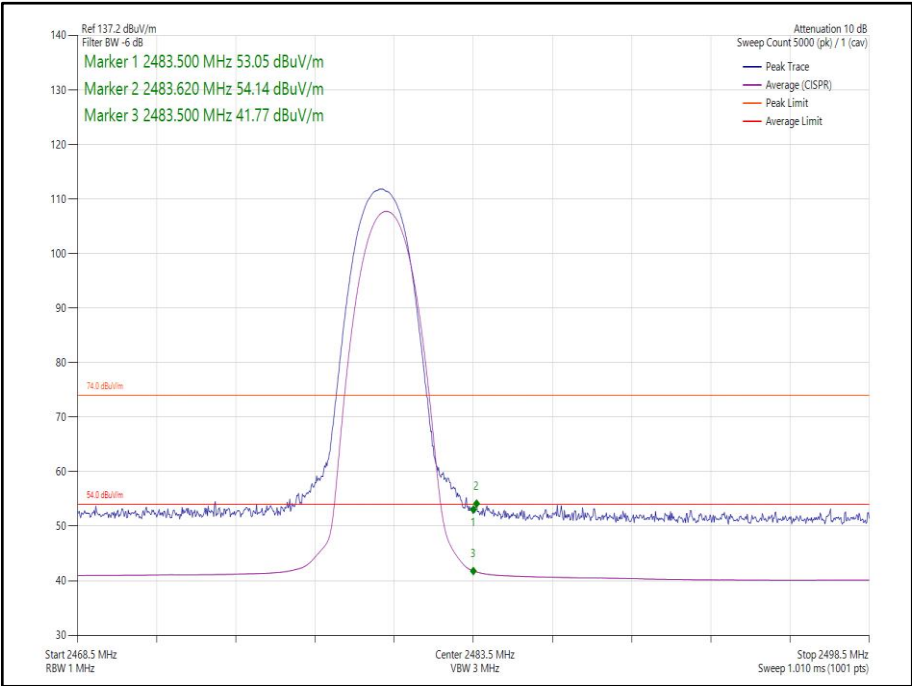


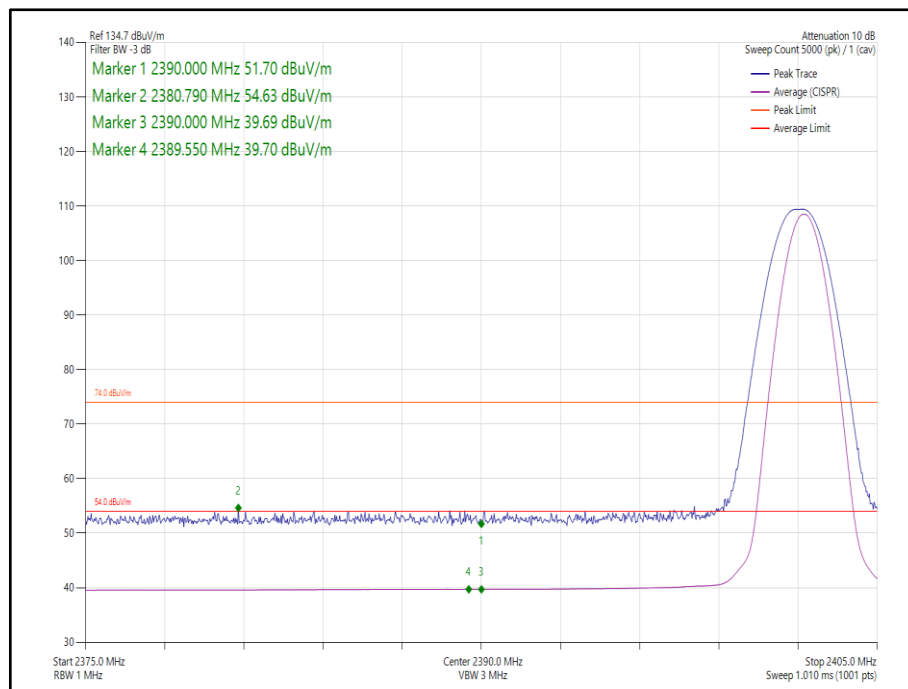
Figure 12 Core 0- Static - 8-DPSK/3DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

## 2.4 GHz Bluetooth (FHSS)

### iPA

| Mode   | Modulation    | Core | Packet Type | Tx Frequency (MHz) | Band Edge Frequency (MHz) | Peak Level (dBμV/m) | Average Level (dBμV/m) |
|--------|---------------|------|-------------|--------------------|---------------------------|---------------------|------------------------|
| Static | GFSK          | 2    | DH5         | 2402               | 2390.0                    | 54.63               | 39.70                  |
| Static | $\pi/4$ DQPSK | 2    | 2DH5        | 2402               | 2390.0                    | 54.20               | 39.73                  |
| Static | 8-DPSK        | 2    | 3DH5        | 2402               | 2390.0                    | 54.47               | 39.73                  |
| Static | GFSK          | 2    | DH5         | 2480               | 2483.5                    | 53.28               | 40.59                  |
| Static | $\pi/4$ DQPSK | 2    | 2DH5        | 2480               | 2483.5                    | 53.20               | 40.42                  |
| Static | 8-DPSK        | 2    | 3DH5        | 2480               | 2483.5                    | 52.84               | 40.44                  |

**Table 8 - Restricted Band Edge Results**



**Figure 13 Core 2- Static - GFSK/DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz**

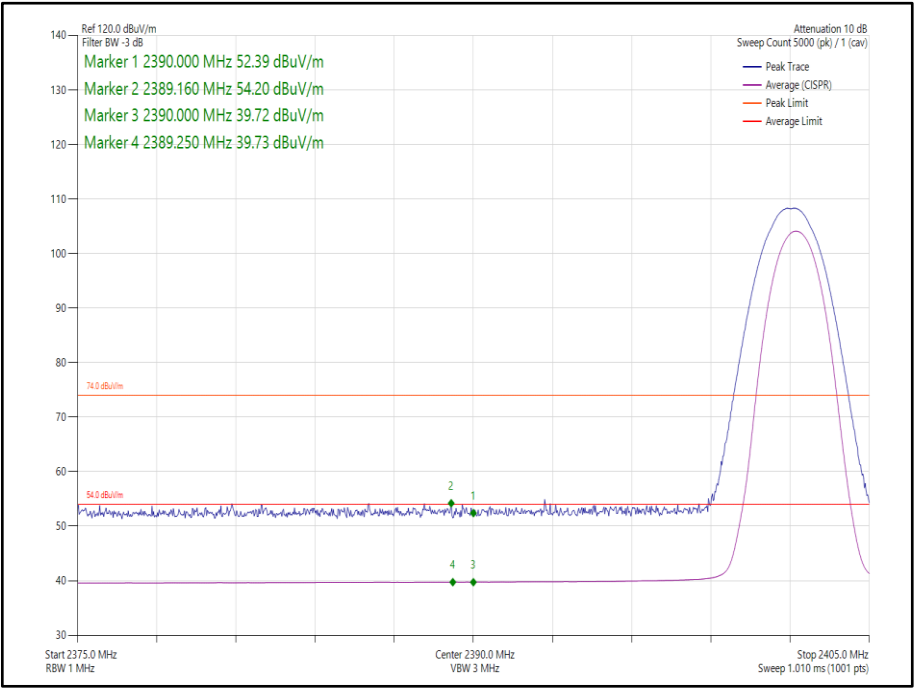


Figure 14 Core 2- Static -  $\pi/4$  DQPSK/2DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz

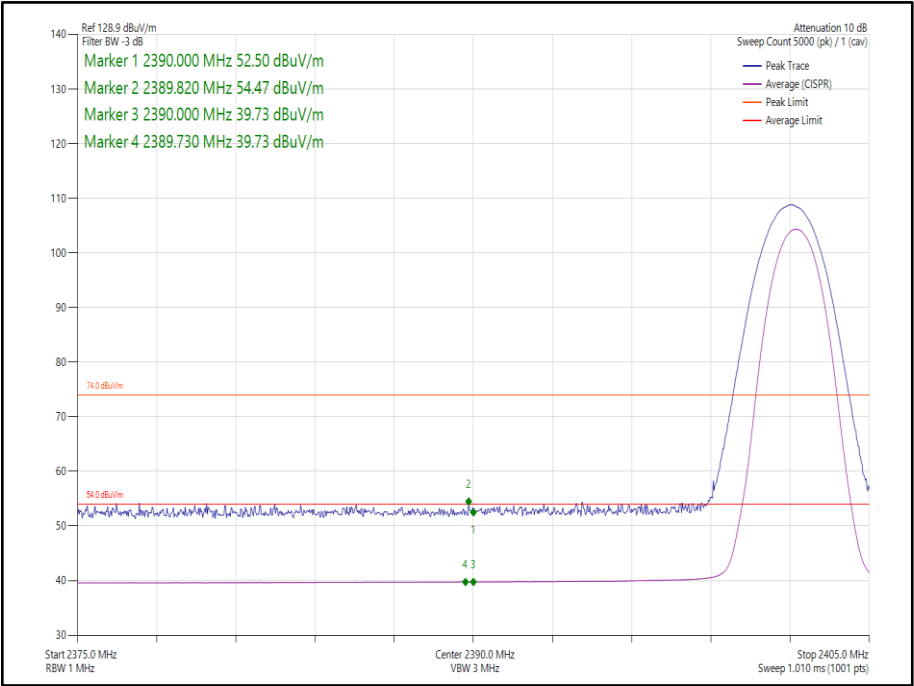


Figure 15 Core 2- Static - 8-DPSK/3DH5 - 2402 MHz Band Edge Frequency 2390.0 MHz

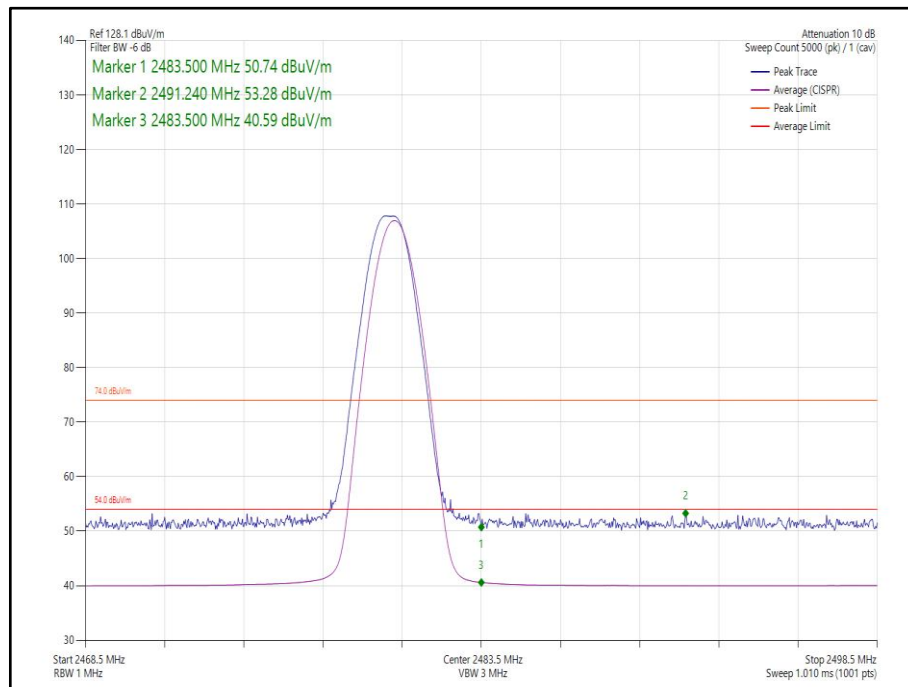


Figure 16 Core 2- Static - GFSK/DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

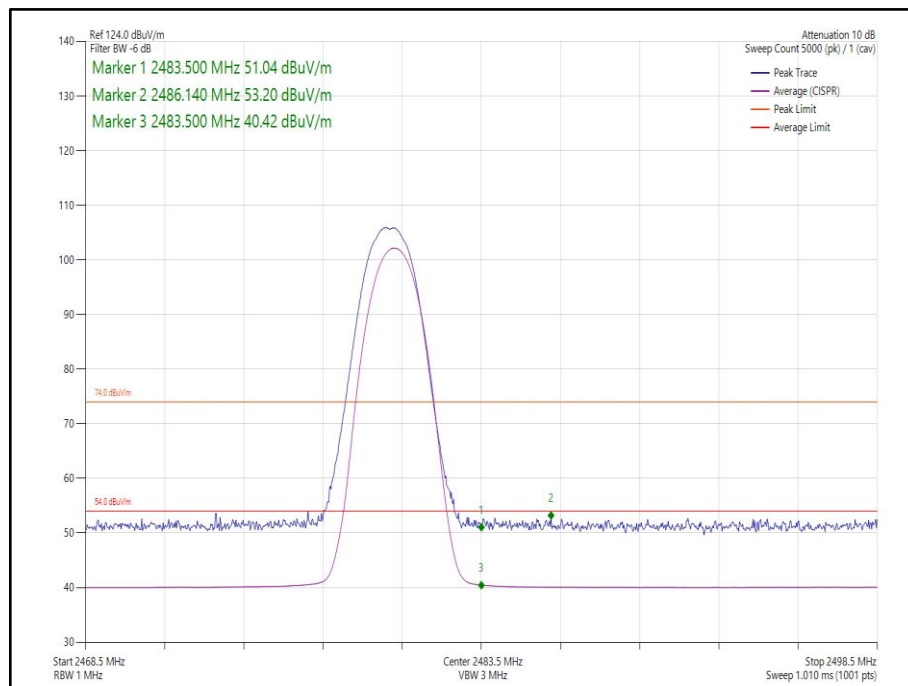


Figure 17 Core 2- Static -  $\pi/4$  DQPSK/2DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

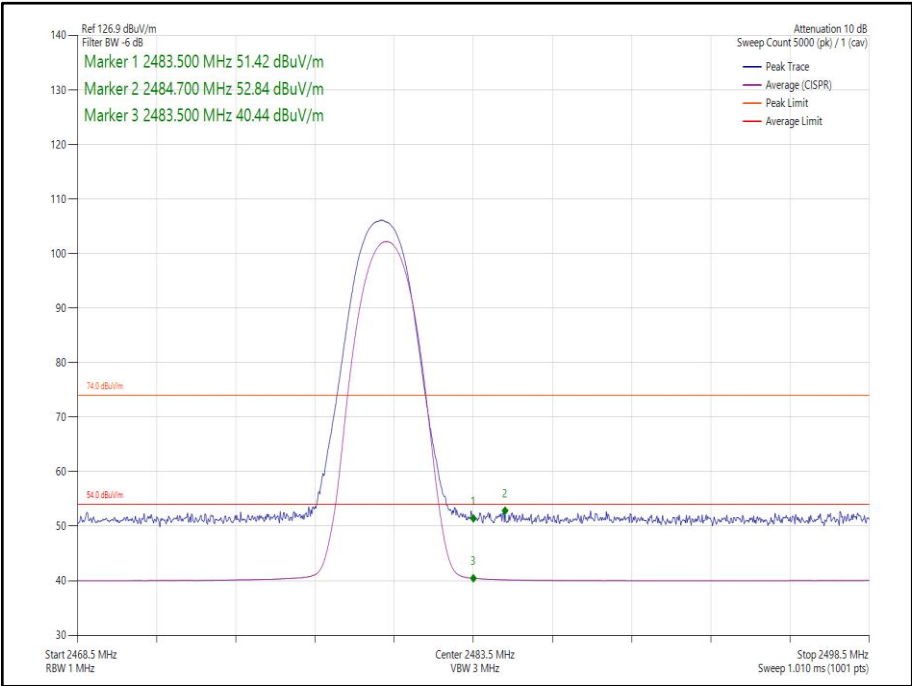


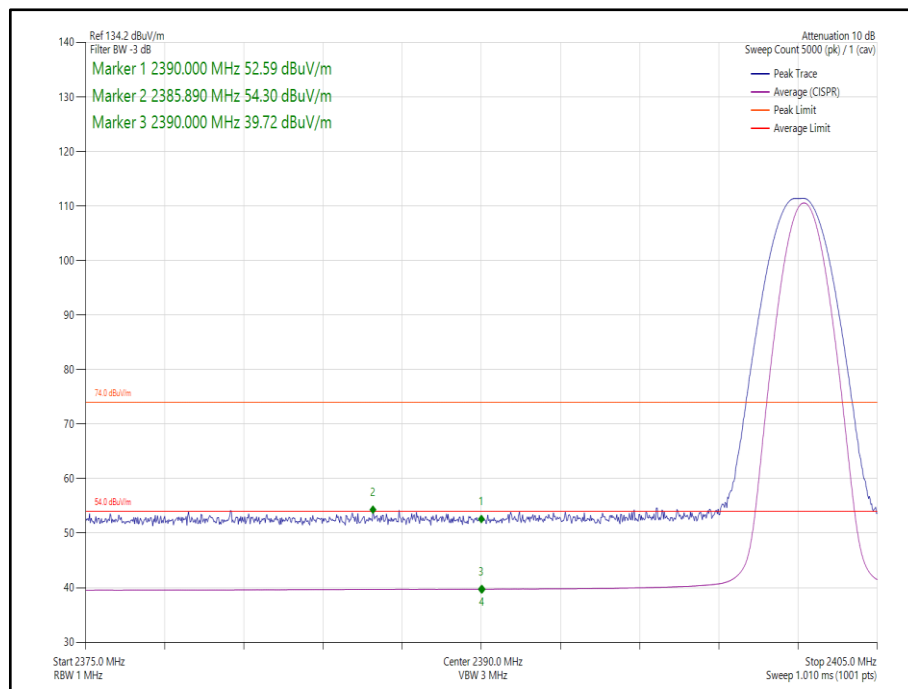
Figure 18 Core 2- Static - 8-DPSK/3DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

## 2.4 GHz Bluetooth (FHSS)

### iPA

| Mode   | Modulation    | Core | Packet Type | Tx Frequency (MHz) | Band Edge Frequency (MHz) | Peak Level (dBμV/m) | Average Level (dBμV/m) |
|--------|---------------|------|-------------|--------------------|---------------------------|---------------------|------------------------|
| Static | GFSK          | 0-1  | DH5         | 2402               | 2390.0                    | 54.30               | 39.72                  |
| Static | $\pi/4$ DQPSK | 0-1  | 2DH5        | 2402               | 2390.0                    | 54.42               | 39.76                  |
| Static | 8-DPSK        | 0-1  | 3DH5        | 2402               | 2390.0                    | 54.70               | 39.77                  |
| Static | GFSK          | 0-1  | DH5         | 2480               | 2483.5                    | 53.15               | 40.49                  |
| Static | $\pi/4$ DQPSK | 0-1  | 2DH5        | 2480               | 2483.5                    | 53.17               | 40.56                  |
| Static | 8-DPSK        | 0-1  | 3DH5        | 2480               | 2483.5                    | 52.97               | 40.56                  |

**Table 9 - Restricted Band Edge Results**



**Figure 19 Core 0-1- Static - GFSK/DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz**

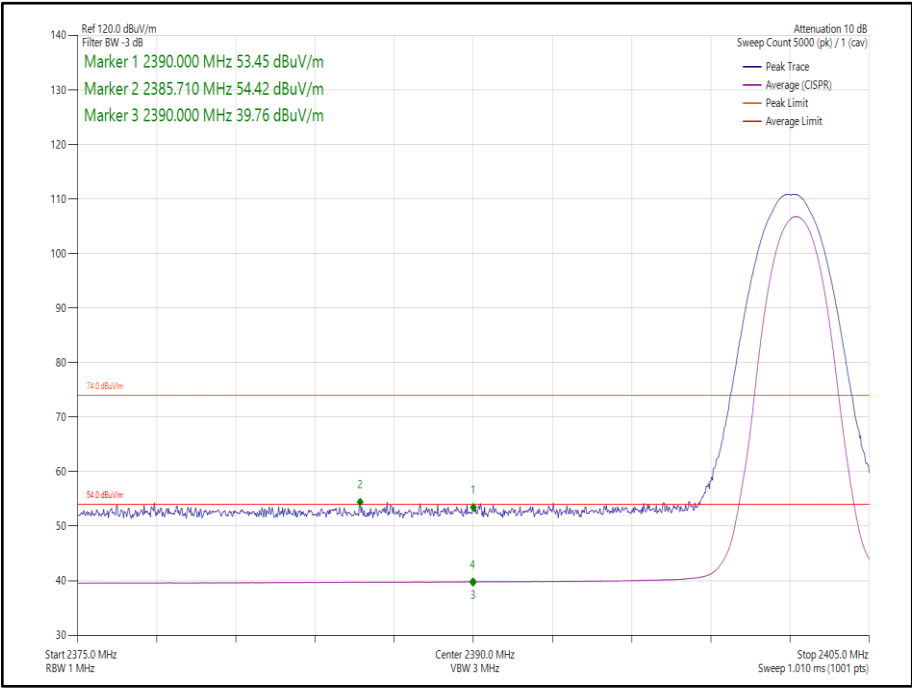


Figure 20 - Static Core 0-1-  $\pi/4$  DQPSK/2DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz

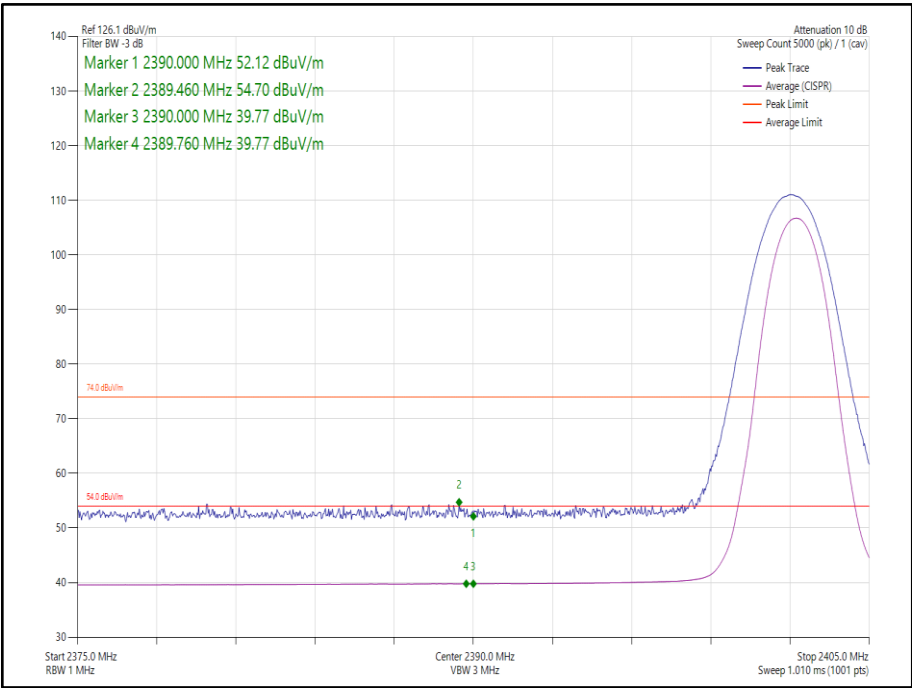


Figure 21 - Static Core 0-1- 8-DPSK/3DH5 - 2402 MHz Band Edge Frequency 2390.0 MHz

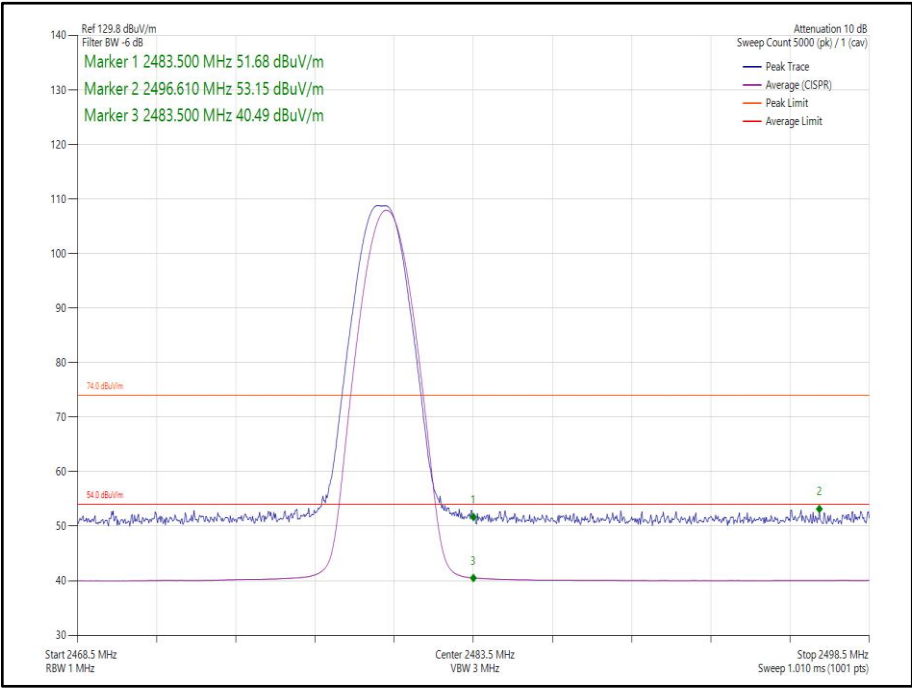


Figure 22 - Static Core 0-1- GFSK/DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

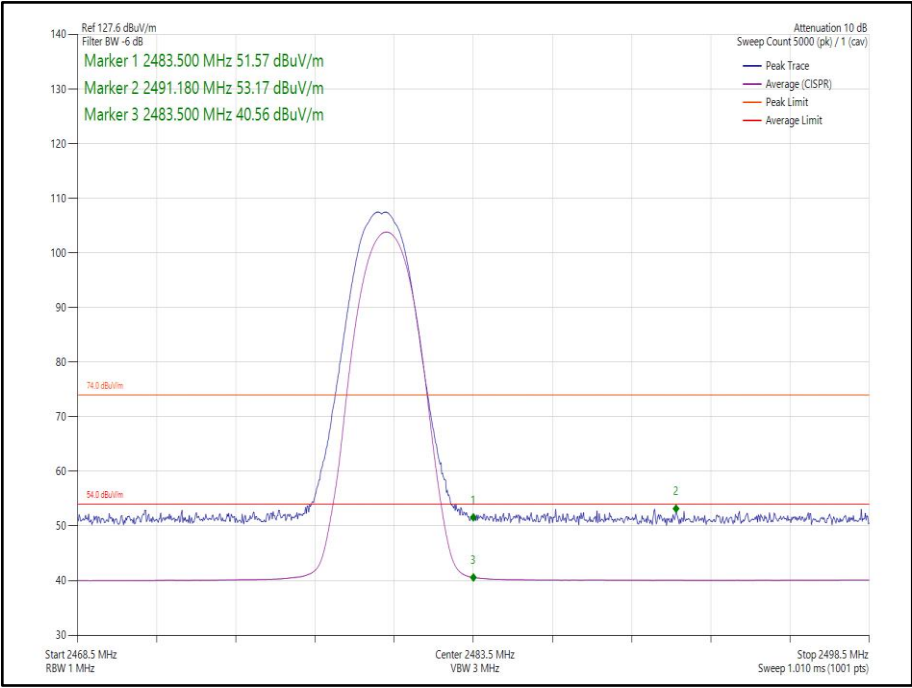


Figure 23 - Static Core 0-1-  $\pi/4$  DQPSK/2DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

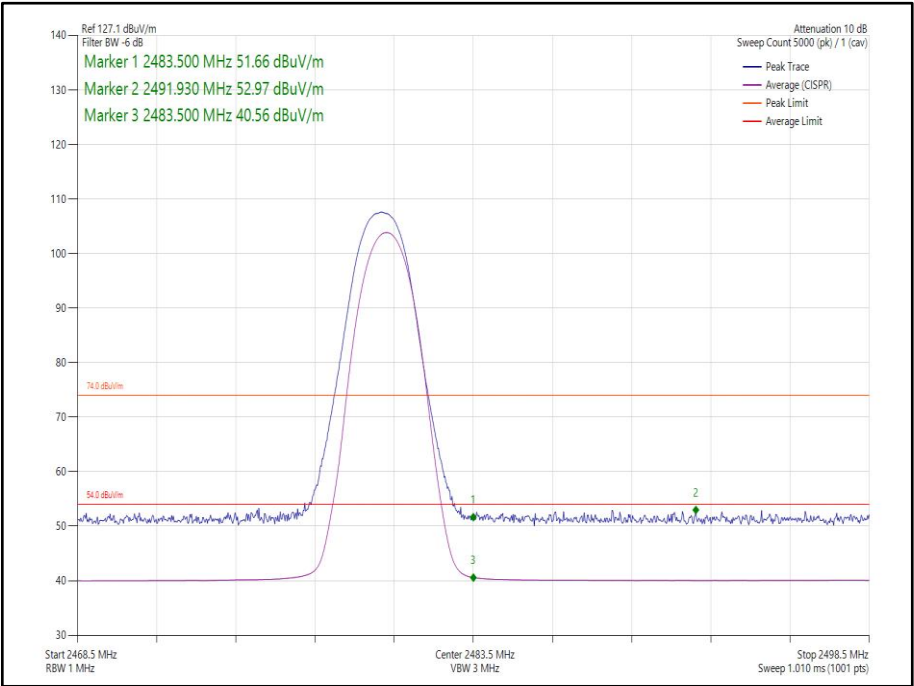


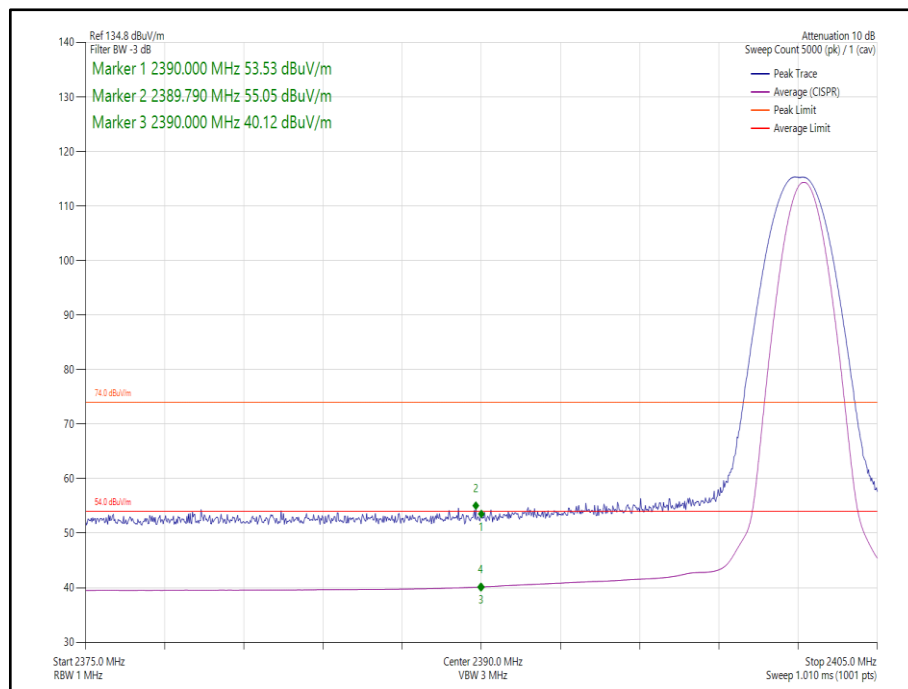
Figure 24 Core 0-1- Static - 8-DPSK/3DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

## 2.4 GHz Bluetooth (FHSS)

### ePA

| Mode   | Modulation    | Core | Packet Type | Tx Frequency (MHz) | Band Edge Frequency (MHz) | Peak Level (dBμV/m) | Average Level (dBμV/m) |
|--------|---------------|------|-------------|--------------------|---------------------------|---------------------|------------------------|
| Static | GFSK          | 0-1  | DH5         | 2402               | 2390.0                    | 55.05               | 40.12                  |
| Static | $\pi/4$ DQPSK | 0-1  | 2DH5        | 2402               | 2390.0                    | 54.27               | 40.10                  |
| Static | 8-DPSK        | 0-1  | 3DH5        | 2402               | 2390.0                    | 54.70               | 40.18                  |
| Static | GFSK          | 0-1  | DH5         | 2480               | 2483.5                    | 54.78               | 41.64                  |
| Static | $\pi/4$ DQPSK | 0-1  | 2DH5        | 2480               | 2483.5                    | 54.60               | 42.18                  |
| Static | 8-DPSK        | 0-1  | 3DH5        | 2480               | 2483.5                    | 54.78               | 42.45                  |

**Table 10 - Restricted Band Edge Results**



**Figure 25 Core 0-1- Static - GFSK/DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz**

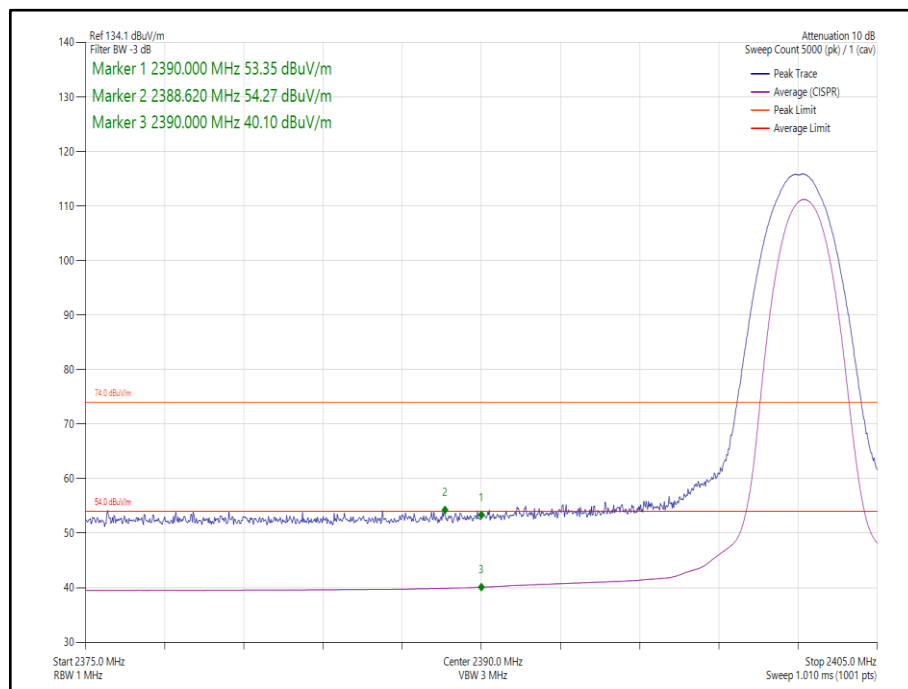


Figure 26 - Static Core 0-1-  $\pi/4$  DQPSK/2DH5 - 2402 MHz - Band Edge Frequency 2390.0 MHz

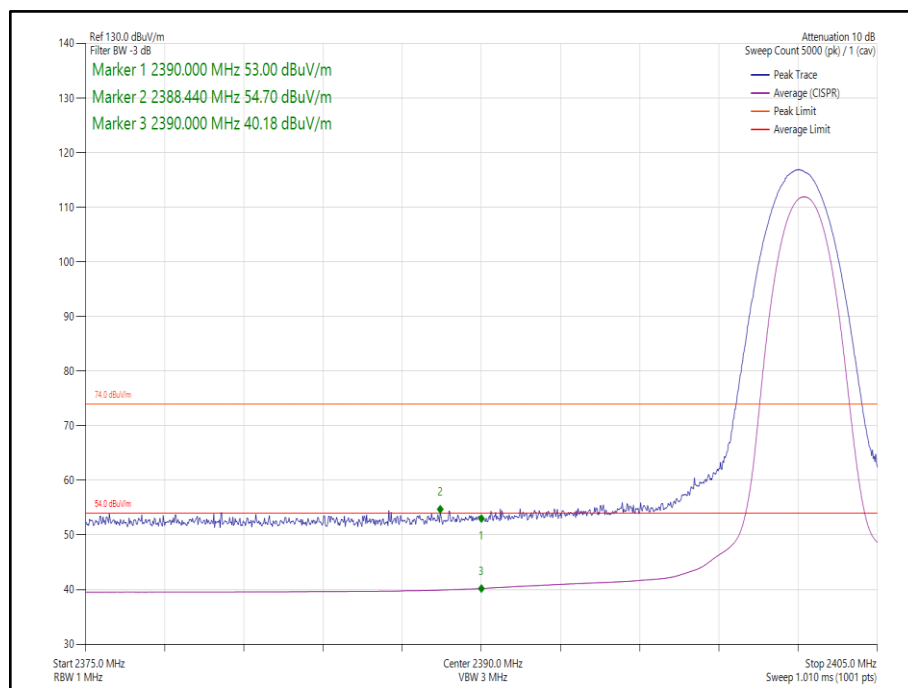


Figure 27 - Static Core 0-1- 8-DPSK/3DH5 - 2402 MHz Band Edge Frequency 2390.0 MHz

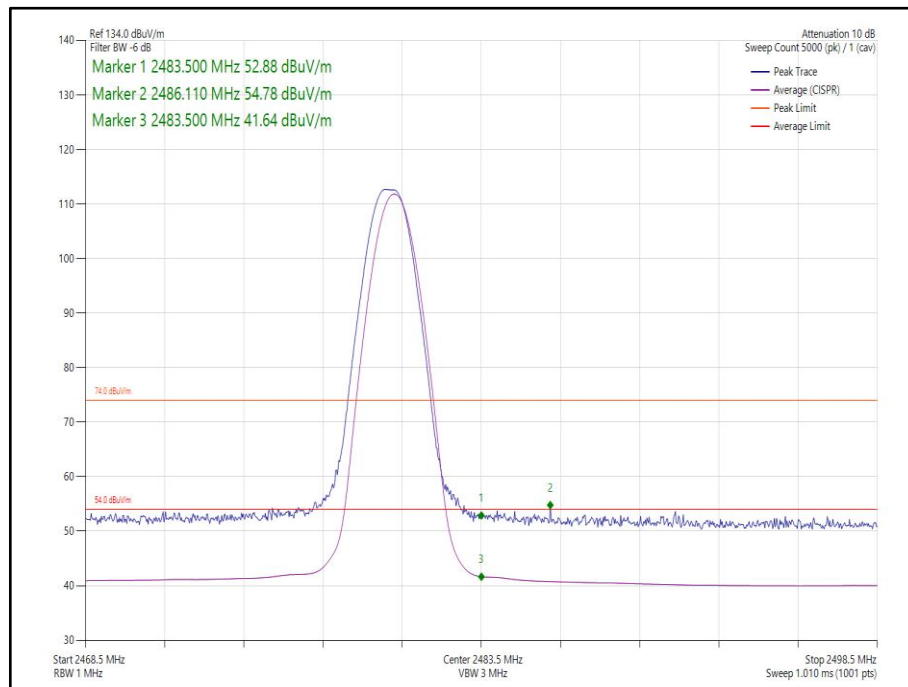


Figure 28 - Static Core 0-1- GFSK/DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

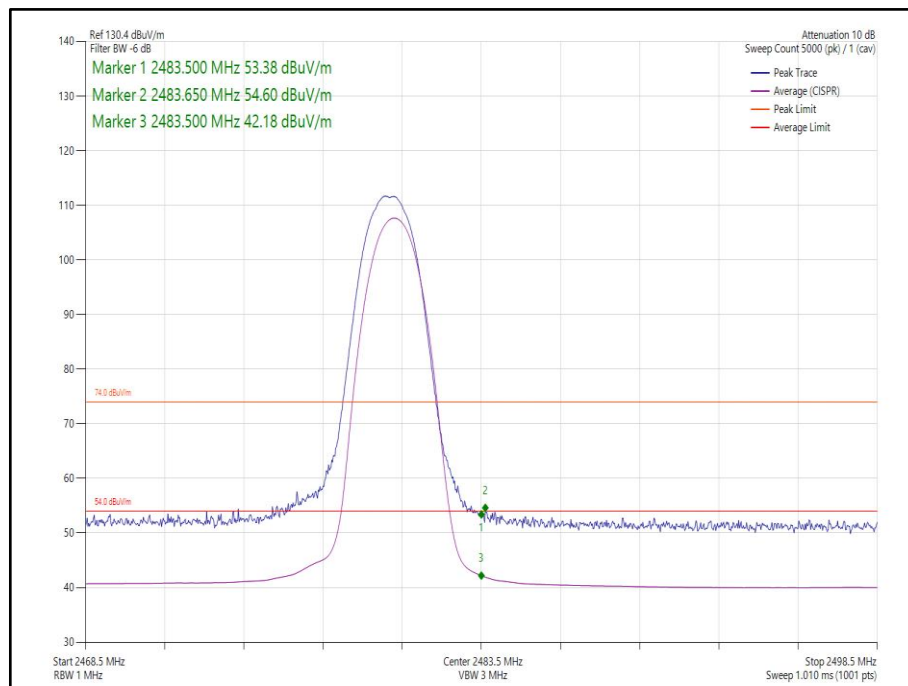


Figure 29 - Static Core 0-1-  $\pi/4$  DQPSK/2DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

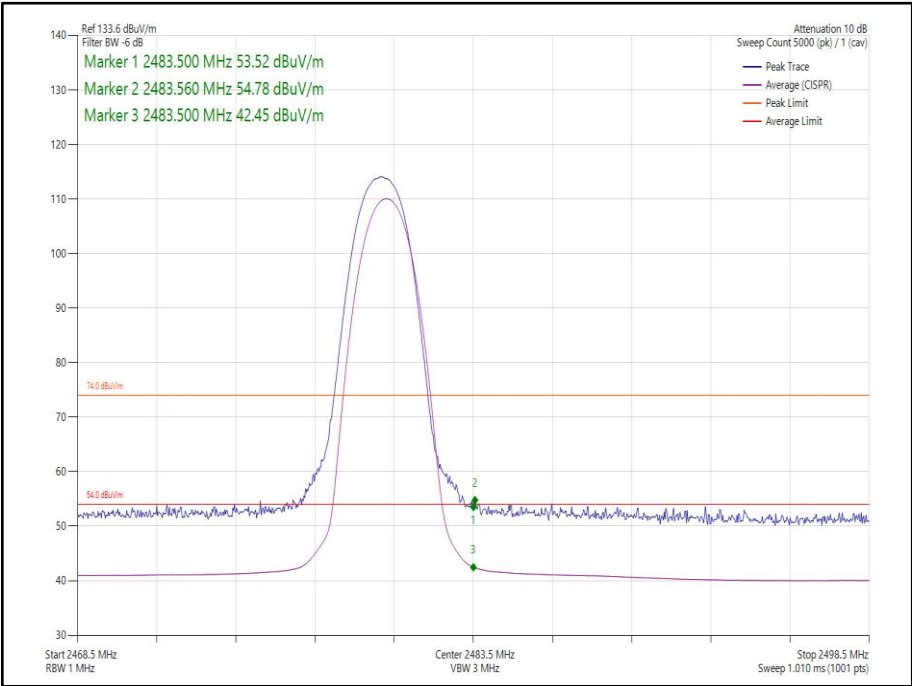


Figure 30 - Static Core 0-1- 8-DPSK/3DH5 - 2480 MHz - Band Edge Frequency 2483.5 MHz

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 11

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 12

\*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 11.

| Instrument                    | Manufacturer    | Type No              | TE No | Calibration Period (months) | Calibration Expires |
|-------------------------------|-----------------|----------------------|-------|-----------------------------|---------------------|
| Multimeter                    | Iso-tech        | IDM101               | 2421  | 12                          | 28-Oct-2021         |
| EMI Test Receiver             | Rohde & Schwarz | ESW44                | 5084  | 12                          | 08-Mar-2022         |
| Emissions Software            | TUV SUD         | EmX V2.1.11          | 5125  | -                           | Software            |
| Screened Room (11)            | Rainford        | Rainford             | 5136  | 36                          | 01-Nov-2021         |
| Mast                          | Maturo          | TAM 4.0-P            | 5158  | -                           | TU                  |
| Mast and Turntable Controller | Maturo          | Maturo NCD           | 5159  | -                           | TU                  |
| Turntable                     | Maturo          | TT 15WF              | 5160  | -                           | TU                  |
| Horn Antenna (1-10GHz)        | Schwarzbeck     | BBHA 9120 B          | 5215  | 12                          | 01-Apr-2022         |
| 2m SMA Cable                  | Junkosha        | MWX221-02000AMSAMS/A | 5518  | 12                          | 09-Apr-2022         |
| 8m N Type Cable               | Junkosha        | MWX221-08000NMSNMS/B | 5522  | 12                          | 24-Mar-2022         |
| Thermo-Hygro-Barometer        | PCE Instruments | PCE-THB 40           | 5604  | 12                          | 22-Sep-2022         |

**Table 13**

TU - Traceability Unscheduled



## **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**

A2615, S/N: H617C20363 - Modification State 0

### **2.2.3 Date of Test**

15-December-2021 to 16-December-2021

### **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 | 22.6 - 23.5 °C |
| Relative Humidity   | 31.7 - 44.3 %  |



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

| Test Frequency (MHz) | Time of Occupancy |                         |                        | Limit (ms) |
|----------------------|-------------------|-------------------------|------------------------|------------|
|                      | Dwell Time (ms)   | Number of Transmissions | Time of Occupancy (ms) |            |
| 2402                 | 2.888             | 101                     | 291.7                  | 400.0      |

Table 14 - Time of Occupancy Results

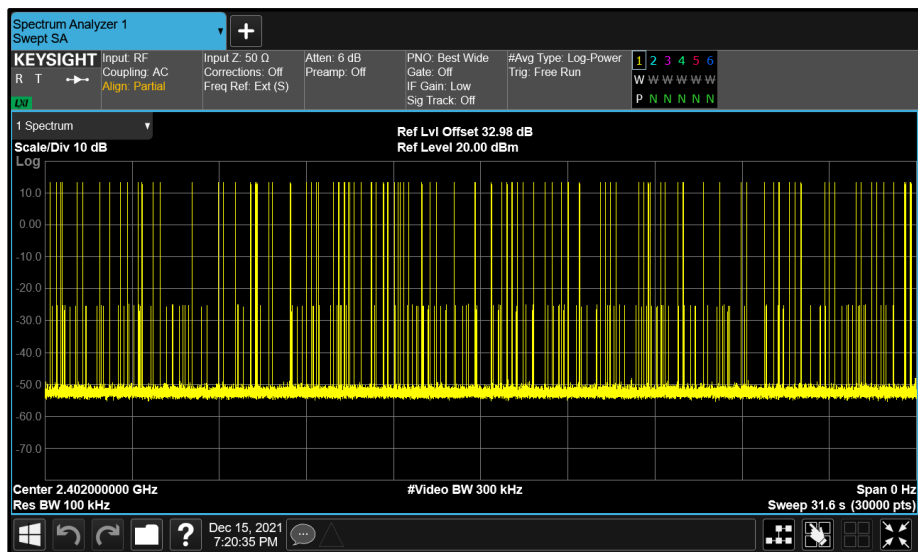


Figure 31 - GFSK - 2402 MHz Accumulated Transmit Time



| 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:                  | ePA GFSK (DH5)        | Duty Cycle (%):          | 76.7 |
| Antenna Configuration: | Beamforming           | DCCF (dB):               | -    |
| Active Port(s):        | A+B (Core 0 + Core 1) | 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              | 107                     | 309.0                     | 400.0         |

**Table 15 - Time of Occupancy Results**



**Figure 32 - GFSK - 2402 MHz Accumulated Transmit Time**

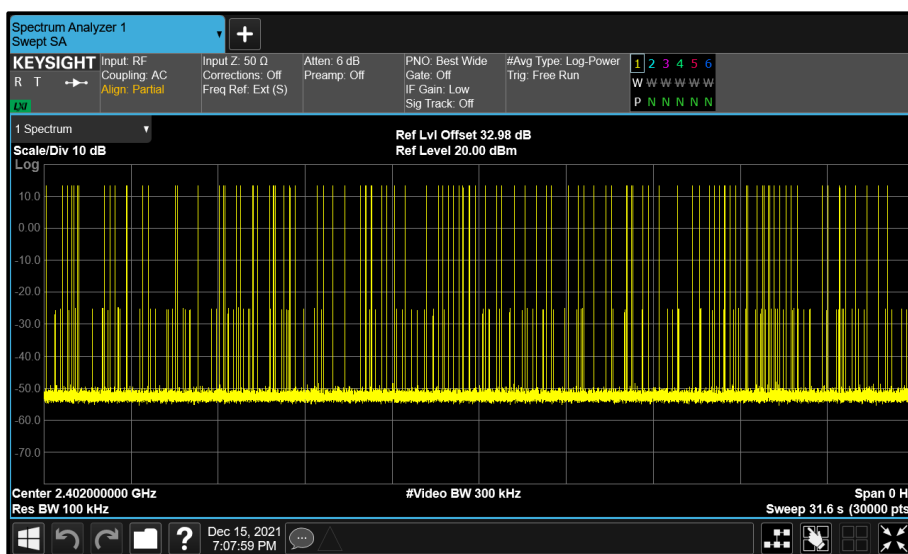


| Test Configuration       |                                          |                 |              |
|--------------------------|------------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                          | Band:           | 2.4 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 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              | 108                     | 311.9                     | 400.0         |

**Table 16 - Time of Occupancy Results**



**Figure 33 - GFSK - 2402 MHz Accumulated Transmit Time**

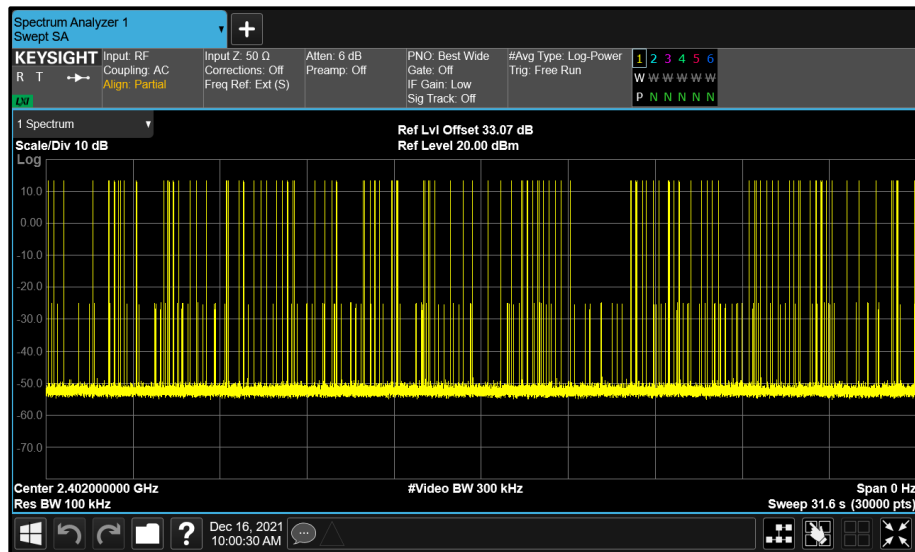


| Test Configuration       |                                          |                 |              |
|--------------------------|------------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                          | Band:           | 2.4 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 GFSK (DH5) | Duty Cycle (%):          | 76.7 |
| Antenna Configuration: | SISO           | DCCF (dB):               | -    |
| Active Port(s):        | C (Core 2)     | 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              | 112                     | 323.5                     | 400.0         |

**Table 17 - Time of Occupancy Results**



**Figure 34 - GFSK - 2402 MHz Accumulated Transmit Time**

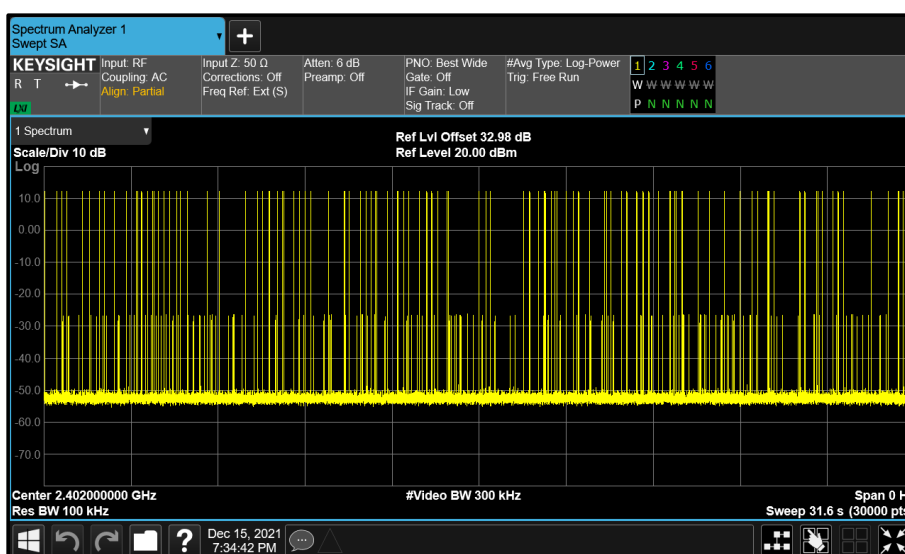


| Test Configuration       |                                          |                 |              |
|--------------------------|------------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                          | Band:           | 2.4 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 GFSK (DH5)        | Duty Cycle (%):          | 76.7 |
| Antenna Configuration: | Beamforming           | DCCF (dB):               | -    |
| Active Port(s):        | A+B (Core 0 + Core 1) | 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              | 106                     | 306.1                     | 400.0         |

**Table 18 - Time of Occupancy Results**



**Figure 35 - GFSK - 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 1.

| Instrument                   | Manufacturer          | Type No                   | TE No | Calibration Period (months) | Calibration Expires |
|------------------------------|-----------------------|---------------------------|-------|-----------------------------|---------------------|
| Multimeter                   | Fluke                 | 79 Series II              | 3057  | 12                          | 23-Aug-2022         |
| Hygrometer                   | Rotronic              | I-1000                    | 3220  | 12                          | 05-Nov-2022         |
| Frequency Standard           | Spectracom            | SecureSync 1200-0408-0601 | 4393  | 6                           | 03-Jan-2022         |
| AC Programmable Power Supply | iTech                 | IT7324                    | 5226  | -                           | O/P Mon             |
| MXA Signal Analyser          | Keysight Technologies | N9020B                    | 5528  | 24                          | 04-Mar-2022         |
| Signal Commissioning Unit    | TUV SUD               | SCU002                    | 5759  | 12                          | 30-Jun-2022         |

**Table 19**

O/P Mon – Output Monitored using calibrated equipment



## **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**

A2615, S/N: H617C20363 - Modification State 0

### **2.3.3 Date of Test**

15-December-2021

### **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 | 22.6 - 23.5 °C |
| Relative Humidity   | 31.7 - 44.3 %  |

## 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:                  | ePA 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) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 0.959                 | 2441.024                           | 2442.024 | 1.000 | ≥639.2      |

Table 20 - Carrier Frequency Separation Results



Figure 36 - 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:                  | ePA $\pi/4$ DQPSK (2-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) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz)  |
|----------------------|-----------------------|------------------------------------|----------|-------|--------------|
|                      |                       | F1C                                | F2C      | FHS   |              |
| 2441                 | 1.387                 | 2441.009                           | 2442.010 | 1.001 | $\geq 924.5$ |

Table 21 - Carrier Frequency Separation Results



Figure 37 -  $\pi/4$  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:                  | ePA 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) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 1.368                 | 2441.005                           | 2442.004 | 0.999 | ≥912.3      |

Table 22 - Carrier Frequency Separation Results

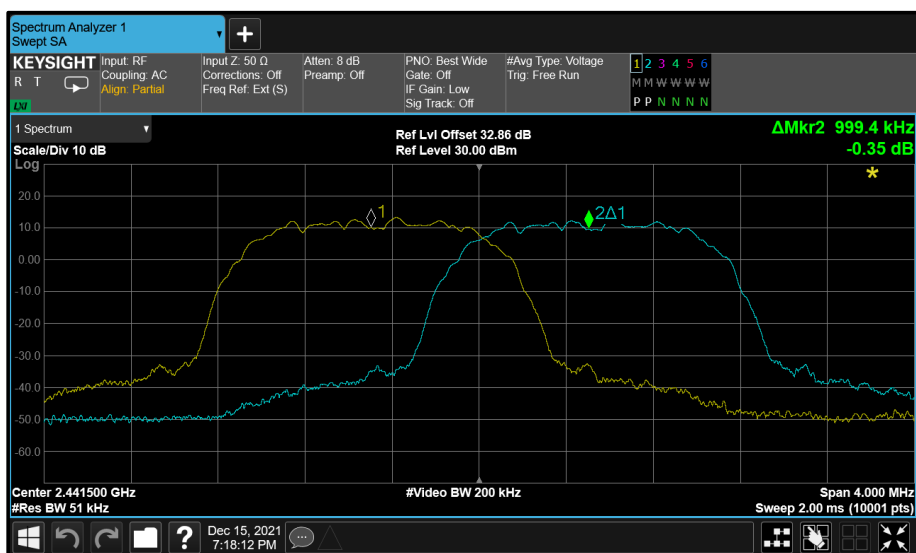


Figure 38 - 8-DPSK - 2441 MHz (CH39)



| 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:                  | ePA GFSK (DH5)        | Duty Cycle (%):          | - |
| Antenna Configuration: | Beamforming           | DCCF (dB):               | - |
| Active Port(s):        | A+B (Core 0 + Core 1) | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 0.956                 | 2441.023                           | 2442.023 | 1.000 | ≥637.4      |

Table 23 - Carrier Frequency Separation Results

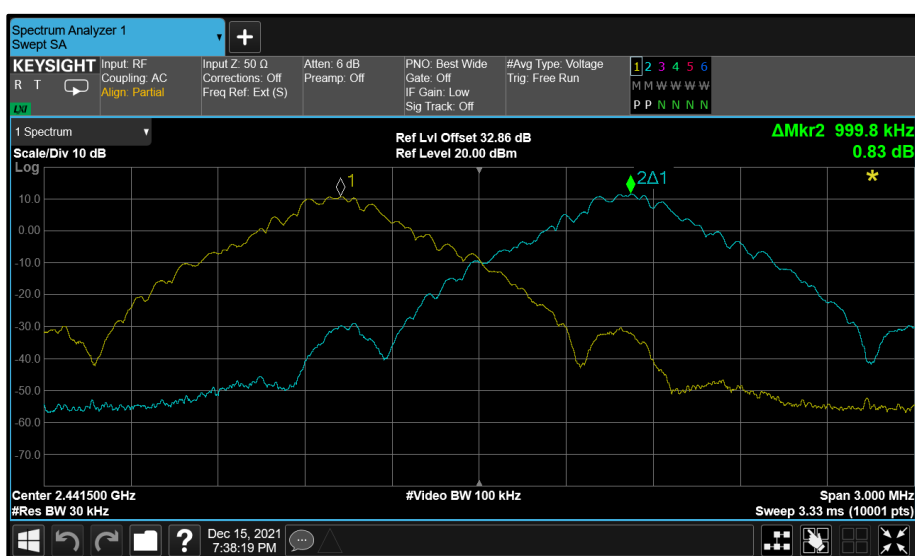


Figure 39 - GFSK - 2441 MHz (CH39)



| 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:                  | ePA $\pi/4$ DQPSK (2-DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | Beamforming               | DCCF (dB):               | - |
| Active Port(s):        | A+B (Core 0 + Core 1)     | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz)  |
|----------------------|-----------------------|------------------------------------|----------|-------|--------------|
|                      |                       | F1C                                | F2C      | FHS   |              |
| 2441                 | 1.387                 | 2441.008                           | 2442.007 | 0.999 | $\geq 924.8$ |

Table 24 - Carrier Frequency Separation Results



Figure 40 -  $\pi/4$  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:                  | ePA 8-DPSK (3-DH5)    | Duty Cycle (%):          | - |
| Antenna Configuration: | Beamforming           | DCCF (dB):               | - |
| Active Port(s):        | A+B (Core 0 + Core 1) | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 1.371                 | 2441.002                           | 2442.003 | 1.001 | ≥913.9      |

Table 25 - Carrier Frequency Separation Results



Figure 41 - 8-DPSK - 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 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) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 0.958                 | 2441.024                           | 2442.024 | 1.000 | ≥638.4      |

Table 26 - Carrier Frequency Separation Results

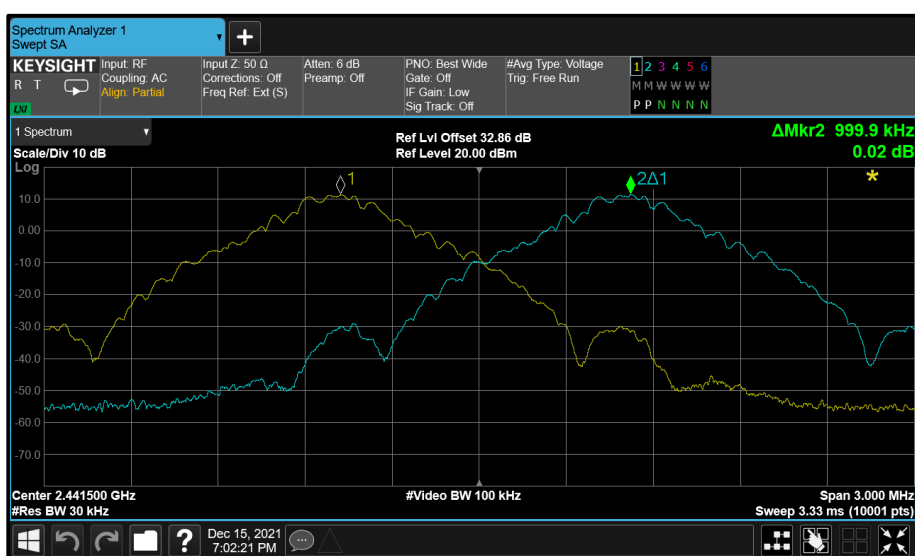


Figure 42 - GFSK - 2441 MHz (CH39)



| 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 (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz)  |
|----------------------|-----------------------|------------------------------------|----------|-------|--------------|
|                      |                       | F1C                                | F2C      | FHS   |              |
| 2441                 | 1.391                 | 2441.011                           | 2442.010 | 0.999 | $\geq 927.5$ |

Table 27 - Carrier Frequency Separation Results



Figure 43 -  $\pi/4$  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 (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 1.374                 | 2441.002                           | 2442.002 | 1.000 | ≥916.3      |

Table 28 - Carrier Frequency Separation Results



Figure 44 - 8-DPSK - 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 GFSK (DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | SISO           | DCCF (dB):               | - |
| Active Port(s):        | C (Core 2)     | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 0.957                 | 2441.024                           | 2442.023 | 0.999 | ≥638.2      |

Table 29 - Carrier Frequency Separation Results



Figure 45 - 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):        | C (Core 2)                | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz)  |
|----------------------|-----------------------|------------------------------------|----------|-------|--------------|
|                      |                       | F1C                                | F2C      | FHS   |              |
| 2441                 | 1.393                 | 2441.011                           | 2442.011 | 1.000 | $\geq 928.5$ |

Table 30 - Carrier Frequency Separation Results

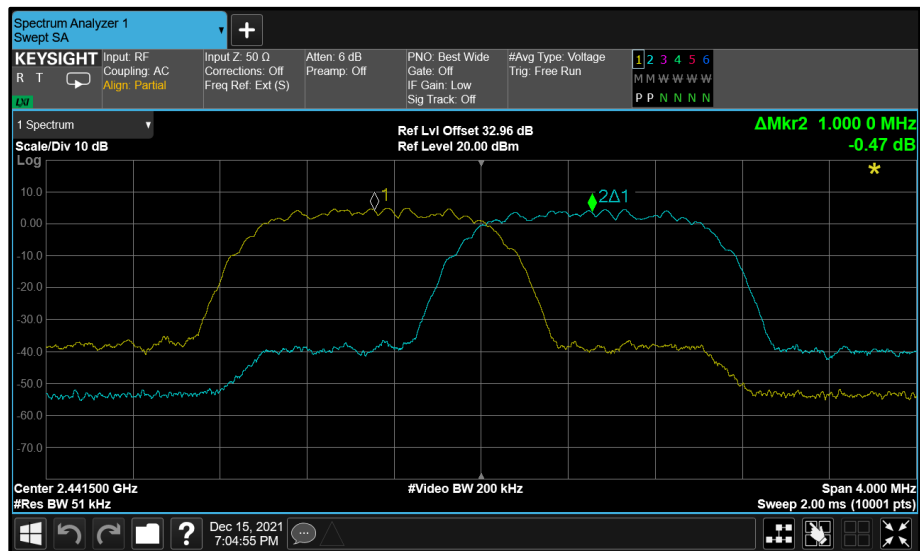


Figure 46 -  $\pi/4$  DQPSK - 2441 MHz (CH39)



| 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):        | C (Core 2)         | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 1.376                 | 2441.002                           | 2442.002 | 1.000 | ≥917.3      |

Table 31 - Carrier Frequency Separation Results

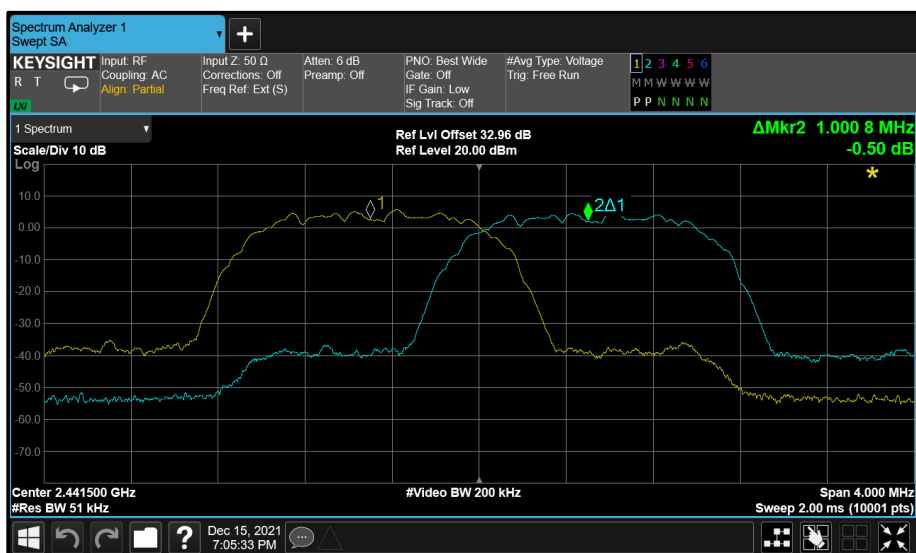


Figure 47 - 8-DPSK - 2441 MHz (CH39)



| 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 GFSK (DH5)        | Duty Cycle (%):          | - |
| Antenna Configuration: | Beamforming           | DCCF (dB):               | - |
| Active Port(s):        | A+B (Core 0 + Core 1) | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 0.958                 | 2441.024                           | 2442.024 | 1.000 | ≥638.4      |

Table 32 - Carrier Frequency Separation Results



Figure 48 - 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: | Beamforming               | DCCF (dB):               | - |
| Active Port(s):        | A+B (Core 0 + Core 1)     | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz)  |
|----------------------|-----------------------|------------------------------------|----------|-------|--------------|
|                      |                       | F1C                                | F2C      | FHS   |              |
| 2441                 | 1.388                 | 2441.011                           | 2442.010 | 0.999 | $\geq 925.6$ |

Table 33 - Carrier Frequency Separation Results



Figure 49 -  $\pi/4$  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: | Beamforming           | DCCF (dB):               | - |
| Active Port(s):        | A+B (Core 0 + Core 1) | Peak Antenna Gain (dBi): | - |

| Test Frequency (MHz) | 20 dB Bandwidth (MHz) | Carrier Frequency Separation (MHz) |          |       | Limit (kHz) |
|----------------------|-----------------------|------------------------------------|----------|-------|-------------|
|                      |                       | F1C                                | F2C      | FHS   |             |
| 2441                 | 1.376                 | 2441.002                           | 2442.003 | 1.001 | ≥917.3      |

Table 34 - Carrier Frequency Separation Results

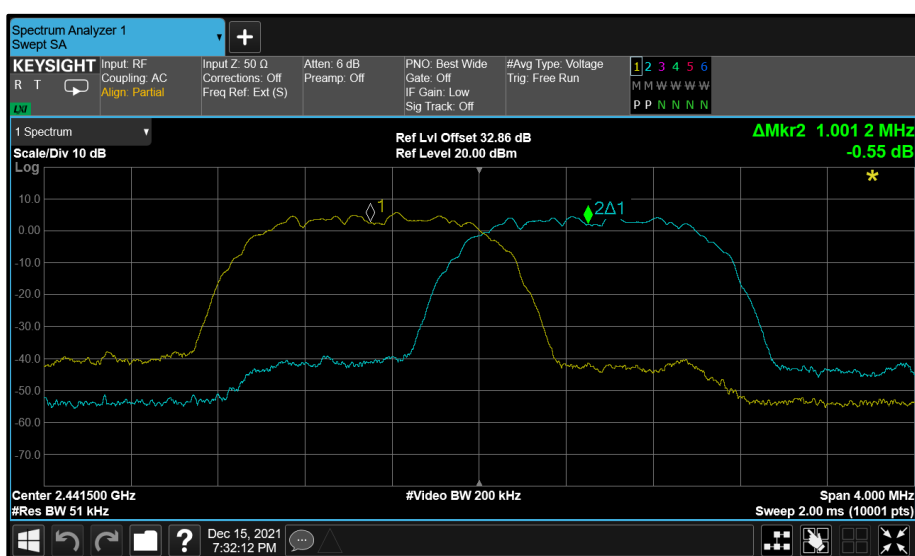


Figure 50 - 8-DPSK - 2441 MHz (CH39)



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 1.

| Instrument                   | Manufacturer          | Type No                   | TE No | Calibration Period (months) | Calibration Expires |
|------------------------------|-----------------------|---------------------------|-------|-----------------------------|---------------------|
| Multimeter                   | Fluke                 | 79 Series II              | 3057  | 12                          | 23-Aug-2022         |
| Hygrometer                   | Rotronic              | I-1000                    | 3220  | 12                          | 05-Nov-2022         |
| Frequency Standard           | Spectracom            | SecureSync 1200-0408-0601 | 4393  | 6                           | 03-Jan-2022         |
| AC Programmable Power Supply | iTech                 | IT7324                    | 5226  | -                           | O/P Mon             |
| MXA Signal Analyser          | Keysight Technologies | N9020B                    | 5528  | 24                          | 04-Mar-2022         |
| Signal Commissioning Unit    | TUV SUD               | SCU002                    | 5759  | 12                          | 30-Jun-2022         |

**Table 35**

O/P Mon – Output Monitored using calibrated equipment



## **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**

A2615, S/N: H617C20363 - Modification State 0

### **2.4.3 Date of Test**

15-December-2021 to 16-December-2021

### **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 | 22.6 - 23.5 °C |
| Relative Humidity   | 31.7 - 44.3 %  |



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:                  | ePA 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 36 - Number of Hopping Frequencies Results

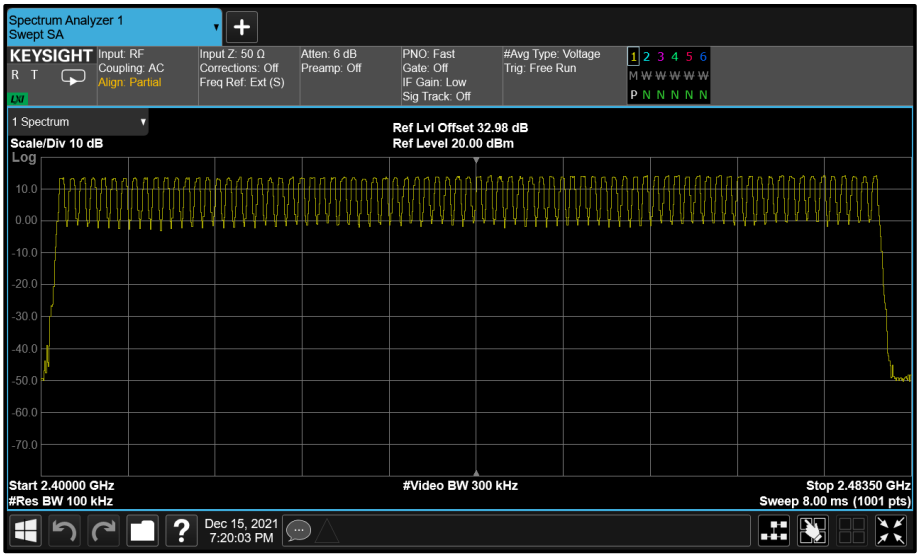


Figure 51 - GFSK (DH5) - Number of Hopping Channels

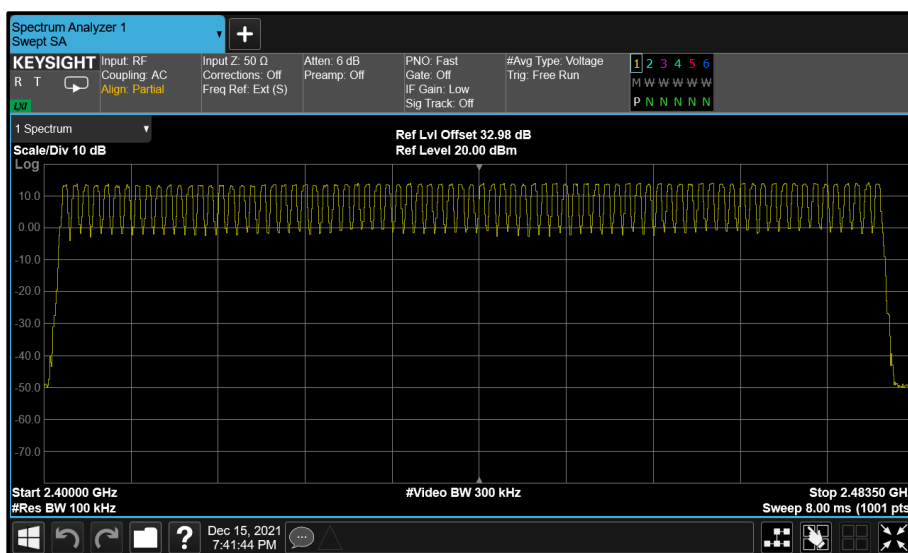


| Test Configuration       |                                         |                 |              |
|--------------------------|-----------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                         | Band:           | 2.4 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:                  | ePA GFSK (DH5)        | Duty Cycle (%):          | - |
| Antenna Configuration: | Beamforming           | DCCF (dB):               | - |
| Active Port(s):        | A+B (Core 0 + Core 1) | Peak Antenna Gain (dBi): | - |

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

**Table 37 - Number of Hopping Frequencies Results**



**Figure 52 - GFSK (DH5) - Number of Hopping Channels**

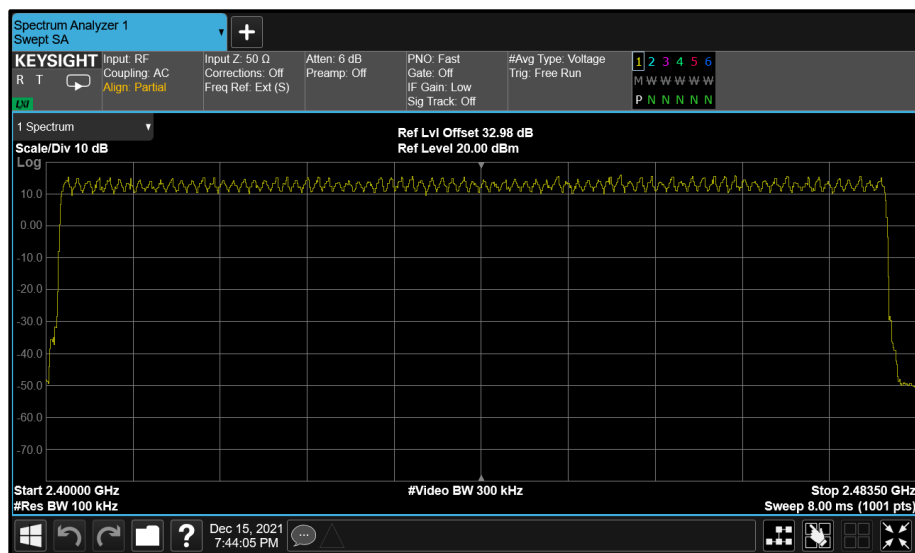


| Test Configuration       |                                         |                 |              |
|--------------------------|-----------------------------------------|-----------------|--------------|
| Frequency Range:         | 2400-2483.5 MHz                         | Band:           | 2.4 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:                  | ePA $\pi/4$ DQPSK (2-DH5) | Duty Cycle (%):          | - |
| Antenna Configuration: | Beamforming               | DCCF (dB):               | - |
| Active Port(s):        | A+B (Core 0 + Core 1)     | Peak Antenna Gain (dBi): | - |

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

**Table 38 - Number of Hopping Frequencies Results**



**Figure 53 -  $\pi/4$  DQPSK (2-DH5) - Number of Hopping Channels**