FCC and ISED Test Report

Apple Inc
Model: A3389

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

TUV SUD Limited Digitally signed by TUV SUD Limited Date: 2024.11.28 09:52:31 Z

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

FCC ID: BCGA3389 IC: 579C-A3389

COMMERCIAL-IN-CONFIDENCE

Document 75961400-88 Issue 01

SIGNATURE			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Steve Marshall	Senior Engineer	Authorised Signatory	28 November 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	27 November 2024	

FCC Accreditation
553713/UK2026 Concorde Park, Fareham Test Laboratory

ISED Accreditation
28798/UK0003 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: 2023, ISED RSS-247: Issue 3 (2023-08) and ISED RSS-GEN: Issue 5 (2018-04) + A2 (2021-02) for the tests detailed in section 1.3.

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Contents

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	28-November-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: 2023 ISED RSS-247: Issue 3 (2023-08) ISED RSS-GEN: Issue 5 (2018-04) + A2 (2021-02)
Start of Test	06-October-2024
Finish of Test	01-November-2024
Name of Engineer(s)	Akhil Rajendran Bhaskaran Nair, Ioan-Alexandru Bogatu, Thomas Randall, David Hill, Ian Hart and Manohar Thota
Related Document(s)	ANSI C63.4 (2014) ANSI C63.10 (2020) 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, ISED RSS-247 and ISED RSS-GEN is shown below.

Section	Specification Clause			Test Description	Result	Comments/Base Standard
	FCC Part 15C	RSS-247	RSS-GEN			
Configuration and Mode: 2.4 GHz Bluetooth BDR/EDR						
-	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) KDB 662911 D01 v02r01
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 C63.4 (2014) ANSI C63.10 (2020)

Table 2

1.4 Product Information

1.4.1 Technical Description

The equipment under test (EUT) was a desktop computer.

1.4.2 Test Modes

The EUT's 2.4 GHz Bluetooth radio supports SISO (Single Input/Single Output) operation on three different cores (Core 0, Core 1, and Core 2). It also supports MIMO (Multiple Input/Multiple Output) beamforming operation on Core 0 + Core 1. The EUT supports Basic Rate and Enhanced Data Rate modes for FHSS operation.

Core 0 + Core 1 also operate at two power settings: low power "iPA" and high power "ePA", with dedicated Core 2 only supporting the lower power mode. The EUT uses different output powers per core dependent on how many cores are used.

After preliminary investigations, conducted tests on the EUT and Radiated Band Edge were performed in the following modes:

SISO modes:

- DH5 - iPA - Core 1
- 2-DH5 - iPA - Core 1
- 3-DH5 - iPA - Core 1
- DH5 - iPA - Core 2
- 2-DH5 - iPA - Core 2
- 3-DH5 - iPA - Core 2
- 2-DH5 - ePA - Core 1
- 3-DH5 - ePA - Core 1

MIMO modes:

- DH5 - iPA - Core 0 + Core 1
- 2-DH5 - iPA - Core 0 + Core 1
- 3-DH5 - iPA - Core 0 + Core 1
- 2-DH5 - ePA - Core 0 + Core 1
- 3-DH5 - ePA - Core 0 + Core 1

Spurious Radiated Emissions tests were limited to the modes shown below, with the device configured to operate at maximum output power. As this was deemed to be worst case.

SISO mode:

- DH5 - iPA - Core 2

MIMO modes:

- DH5 - iPA - Core 0 + Core 1
- 2-DH5 - ePA - Core 0 + Core 1

1.4.3 Test Setup

For conducted tests the EUT antennas were disconnected and replaced with U. FL to SMA test cables to enable conducted testing on each core. The loss of these test cables were known and compensated for in any conducted measurements.

For all tests the EUT was put into a continuous transmit/receive test mode with the chipset manufacturer's test commands. These ran the specified modulation types on either a fixed single channel or in Hopping mode, to ensure the measured signals were representative.

All testing was performed with the EUT powered via a 120 V AC, 60 Hz source.

1.4.4 Antenna Gain Table

Antenna Port	Frequency Range (MHz)	Peak Gain (dBi)	Conducted Cable Loss (dB)
Core 0	2400 to 2480	0.07	0.71
Core 1	2400 to 2480	1.55	0.71
Dedicated Core 2	2400 to 2480	1.07	0.71

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: A3389			
Serial Number	Hardware Version	Software Version	Firmware
LVV0X46J3D	REV1.0	24A62401t	22.1.65.459
QQHY5J5267	REV1.0	24A62401t	22.1.65.459
J7CW3WPWFV	REV1.0	24A62401j	22.1.65.459
MGC29YC7F7	REV1.0	24A62401t	22.1.65.459

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: A3389, Serial Number: LVV0X46J3D			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A3389, Serial Number: QQHY5J5267			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A3389, Serial Number: J7CW3WPWFV			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: A3389, Serial Number: MGC29YC7F7			
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 BDR/EDR		
Restricted Band Edges	Akhil Rajendran Bhaskaran Nair, Ioan-Alexandru Bogatu and Thomas Randall	UKAS
Frequency Hopping Systems - Average Time of Occupancy	David Hill	UKAS
Frequency Hopping Systems - Channel Separation	David Hill	UKAS
Frequency Hopping Systems - Number of Hopping Channels	David Hill	UKAS
Frequency Hopping Systems - 99% & 20 dB Bandwidth	David Hill	UKAS
Maximum Conducted Output Power	David Hill	UKAS
Authorised Band Edges	Akhil Rajendran Bhaskaran Nair, Ioan-Alexandru Bogatu and Thomas Randall	UKAS
Spurious Radiated Emissions	Akhil Rajendran Bhaskaran Nair, Ian Hart and Manohar Thota	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

A3389, S/N: LVV0X46J3D - Modification State 0

2.1.3 Date of Test

10-October-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 dBµV/m to µV/m:
10^(Field Strength in dBµV/m/20).

2.1.5 Environmental Conditions

Ambient Temperature	22.3 - 23.7 °C
Relative Humidity	42.3 - 53.9 %

2.1.6 Test Results

2.4 GHz Bluetooth BDR/EDR

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	55.62	40.80
Static	2-DH5	2402	2390	56.44	40.81
Static	3-DH5	2402	2390	55.38	40.81
Static	DH5	2480	2483.5	54.86	41.52
Static	2-DH5	2480	2483.5	54.40	41.49
Static	3-DH5	2480	2483.5	54.34	41.43

Table 7 - SISO Restricted Band Edge Results

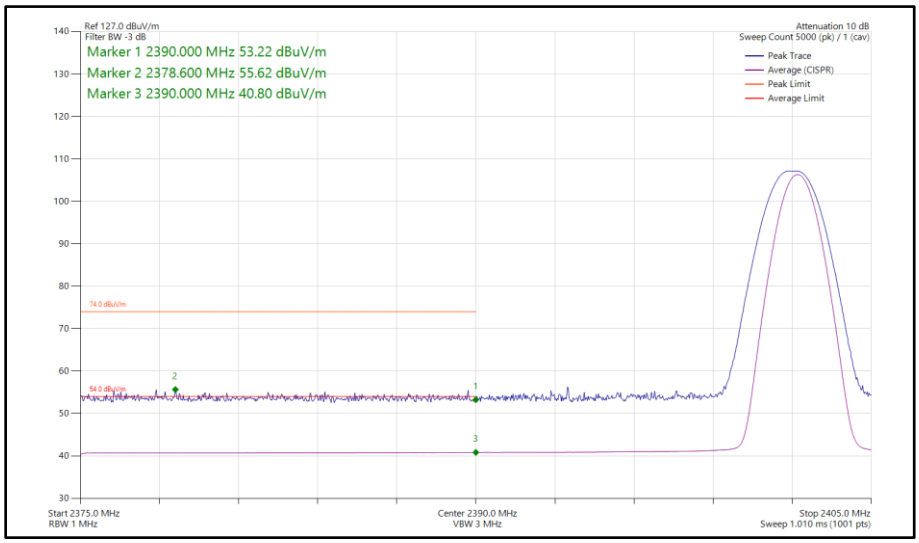

Figure 1 - Bluetooth DH5, SISO, Core 0 - 2402 MHz Band Edge Frequency 2390 MHz

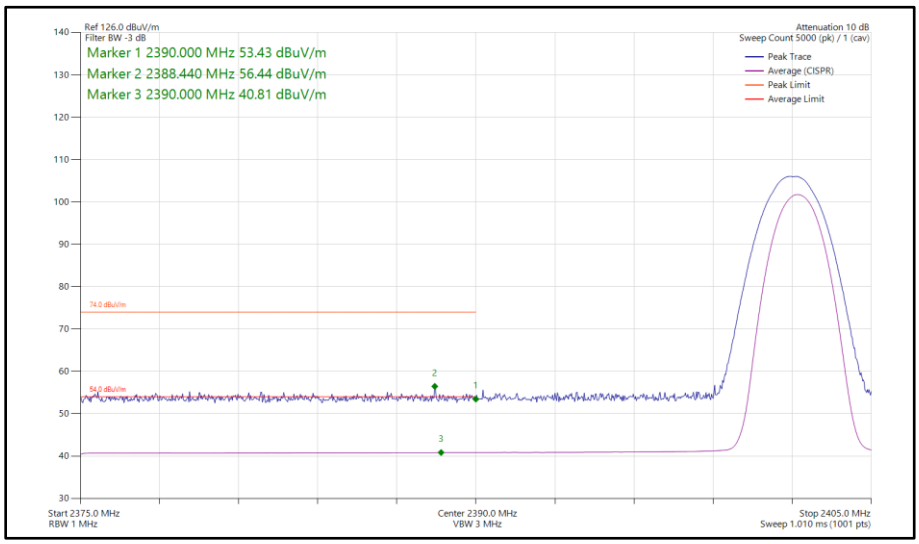

Figure 2 - Bluetooth 2-DH5, SISO, Core 0 - 2402 MHz Band Edge Frequency 2390 MHz

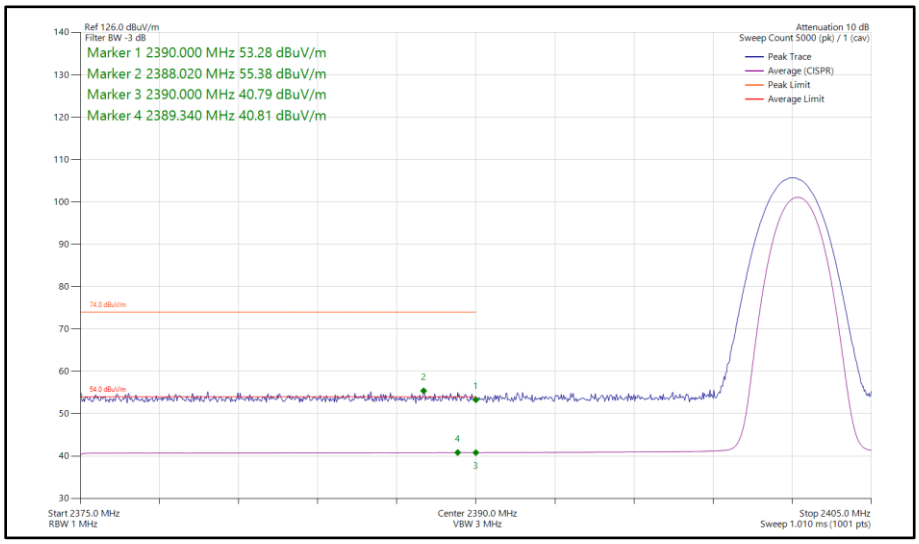

Figure 3 - Bluetooth 3-DH5, SISO, Core 0 - 2402 MHz Band Edge Frequency 2390 MHz

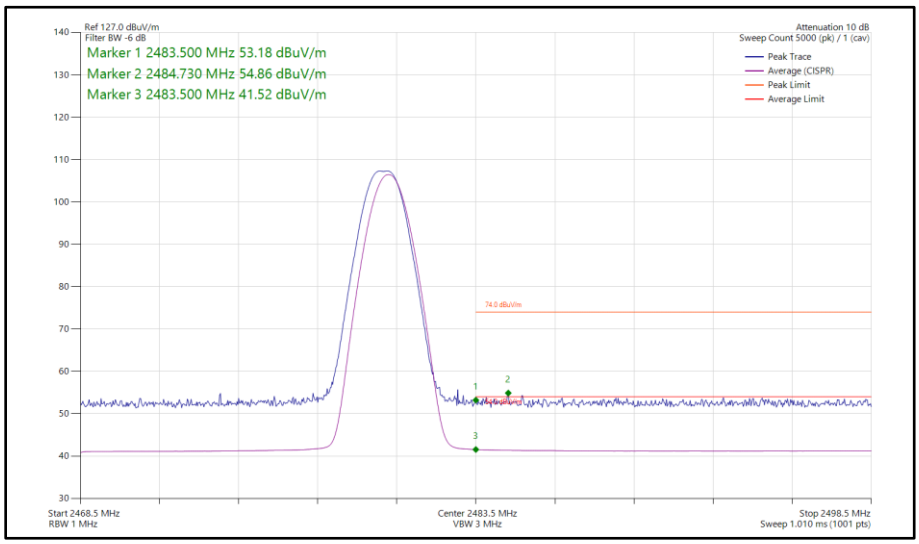

Figure 4 - Bluetooth DH5, SISO, Core 0 - 2480 MHz Band Edge Frequency 2483.5 MHz

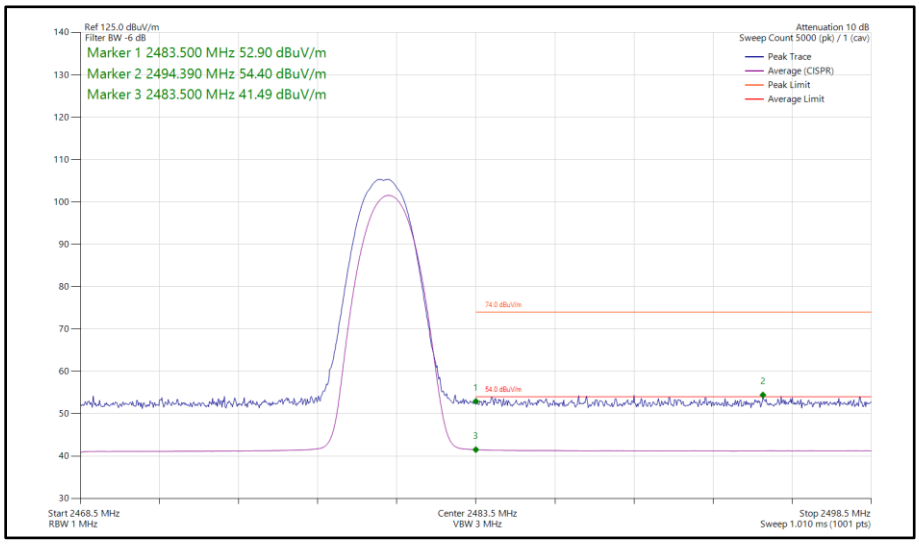

Figure 5 - Bluetooth 2-DH5, SISO, Core 0 - 2480 MHz Band Edge Frequency 2483.5 MHz

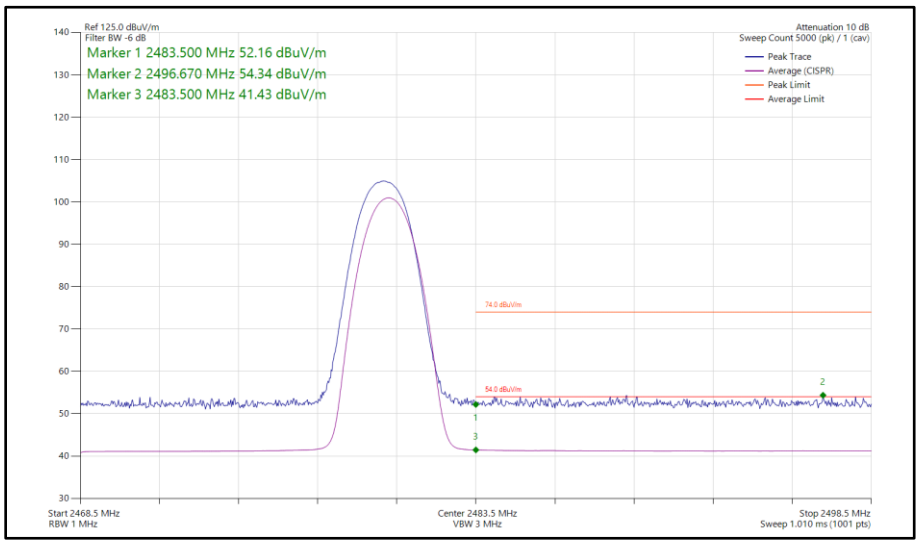

Figure 6 - Bluetooth 3-DH5, SISO, Core 0 - 2480 MHz Band Edge Frequency 2483.5 MHz

iPA - Core 1 (SISO)

Mode	Packet Type	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
Static	DH5	2402	2390	56.00	40.79
Static	2-DH5	2402	2390	55.22	40.82
Static	3-DH5	2402	2390	55.15	40.82
Static	DH5	2480	2483.5	54.47	41.42
Static	2-DH5	2480	2483.5	54.89	41.45
Static	3-DH5	2480	2483.5	55.25	41.45

Table 8 - SISO Restricted Band Edge Results

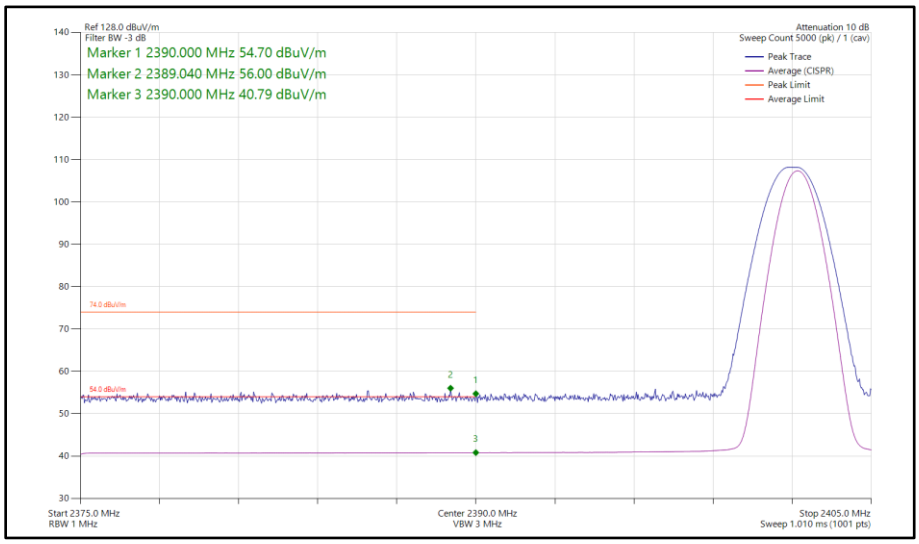

Figure 7 - Bluetooth DH5, SISO, Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

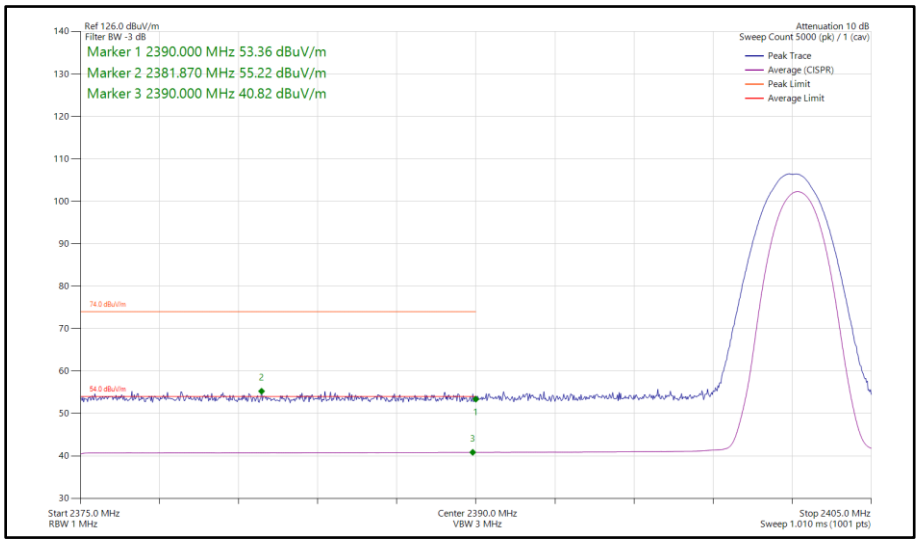

Figure 8 - Bluetooth 2-DH5, SISO, Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

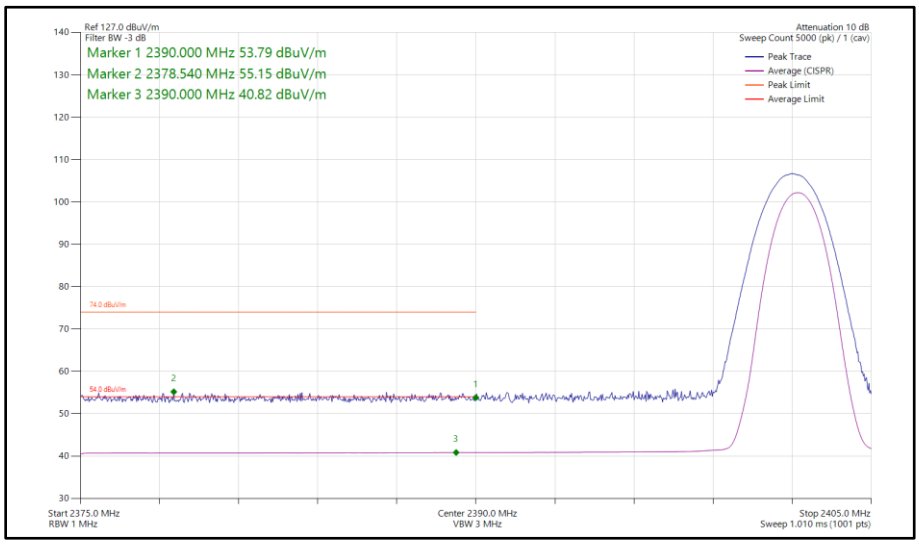

Figure 9 - Bluetooth 3-DH5, SISO, Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

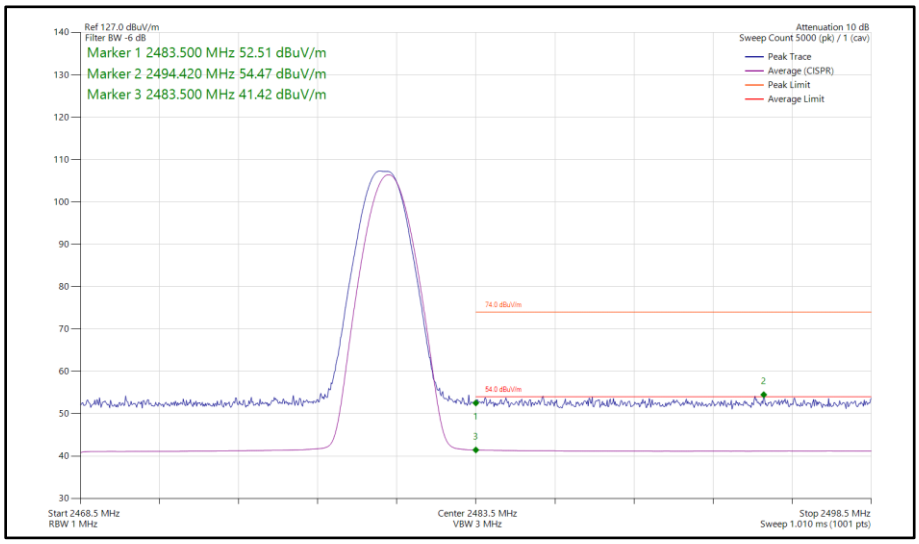

Figure 10 - Bluetooth DH5, SISO, Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

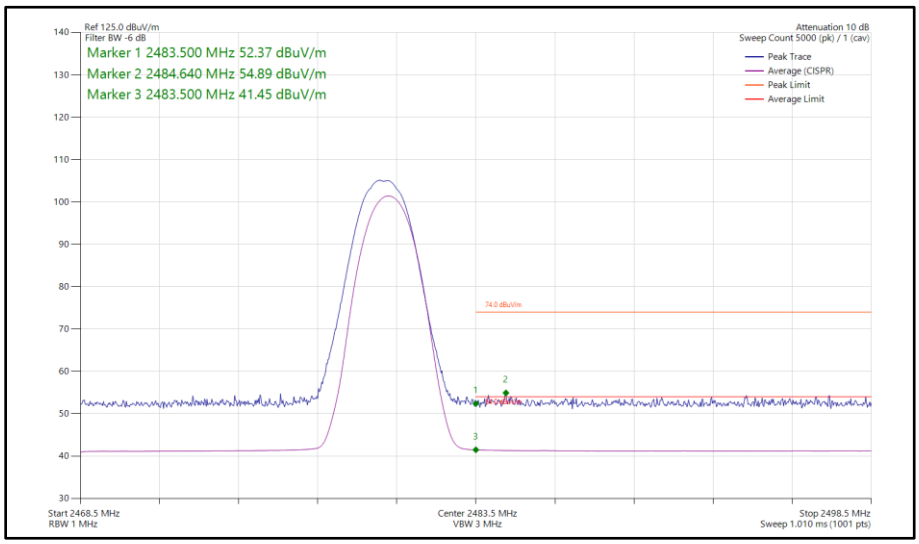

Figure 11 - Bluetooth 2-DH5, SISO, Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

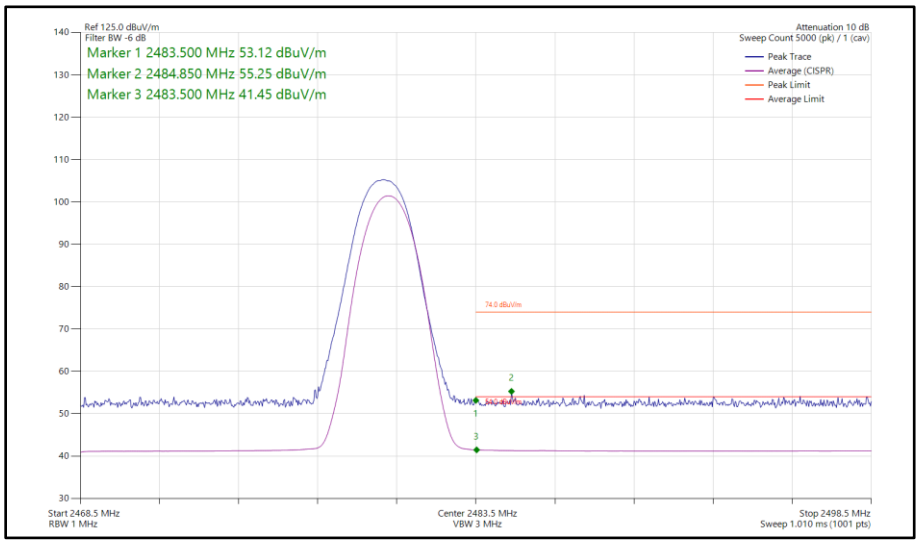

Figure 12 - Bluetooth 3-DH5, SISO, Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

iPA - Core 2 (SISO)

Mode	Packet Type	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
Static	DH5	2402	2390	55.84	40.83
Static	2-DH5	2402	2390	55.51	40.85
Static	3-DH5	2402	2390	55.38	40.85
Static	DH5	2480	2483.5	54.95	41.63
Static	2-DH5	2480	2483.5	54.27	41.71
Static	3-DH5	2480	2483.5	54.35	41.76

Table 9 - SISO Restricted Band Edge Results

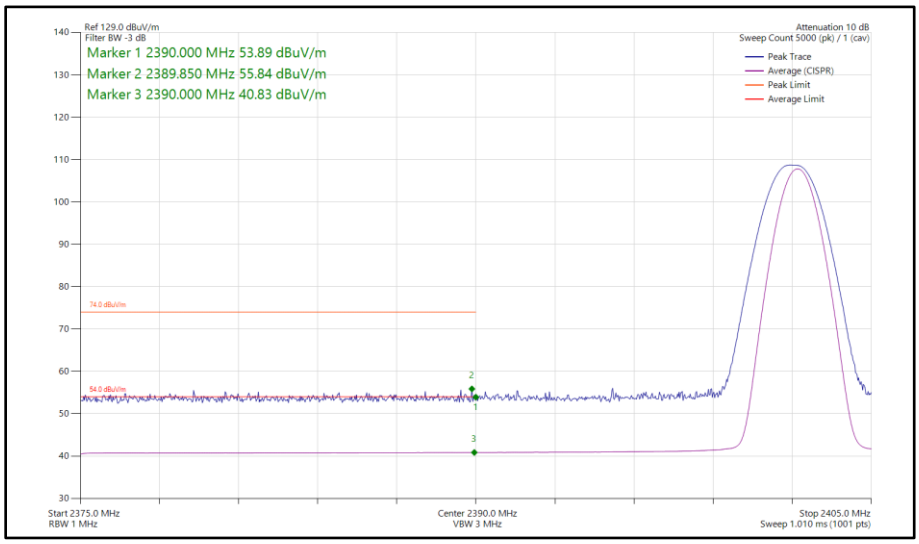

Figure 13 - Bluetooth DH5, SISO, Core 2 - 2402 MHz Band Edge Frequency 2390 MHz

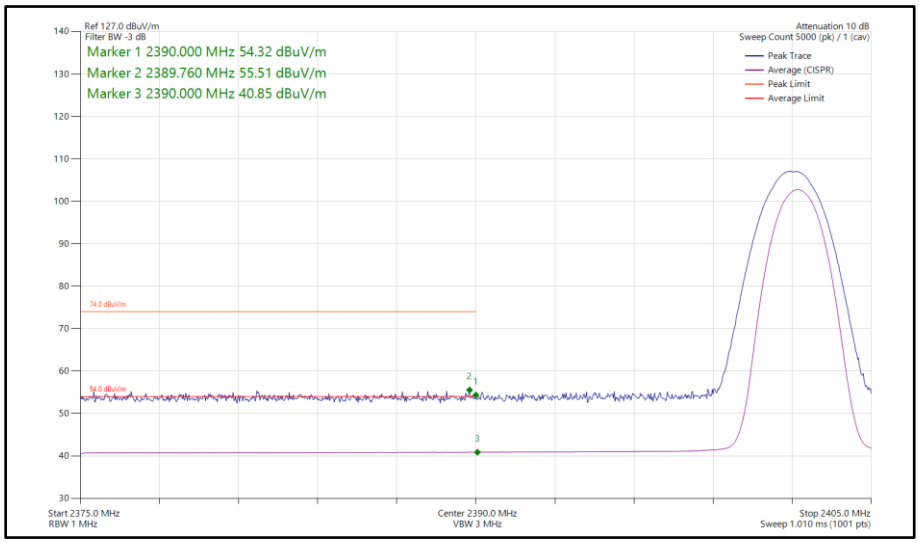

Figure 14 - Bluetooth 2-DH5, SISO, Core 2 - 2402 MHz Band Edge Frequency 2390 MHz

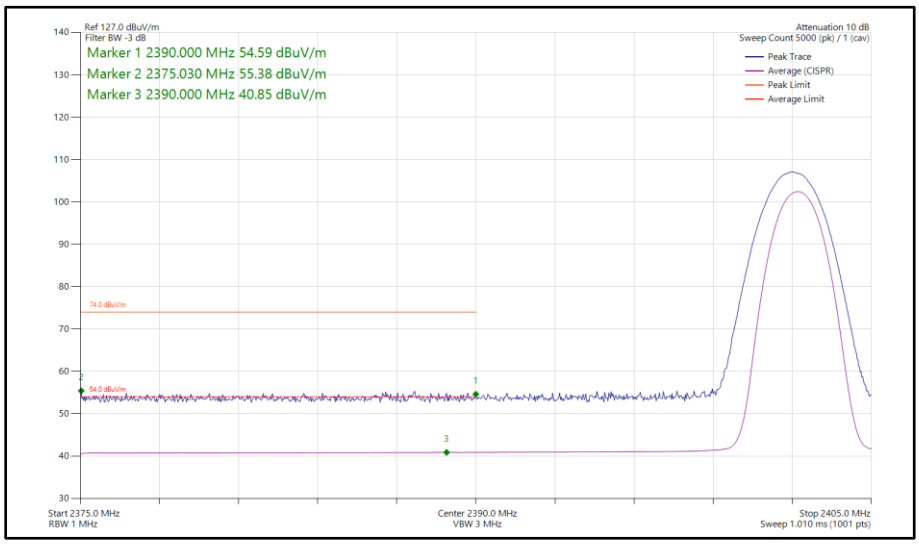

Figure 15 - Bluetooth 3-DH5, SISO, Core 2 - 2402 MHz Band Edge Frequency 2390 MHz

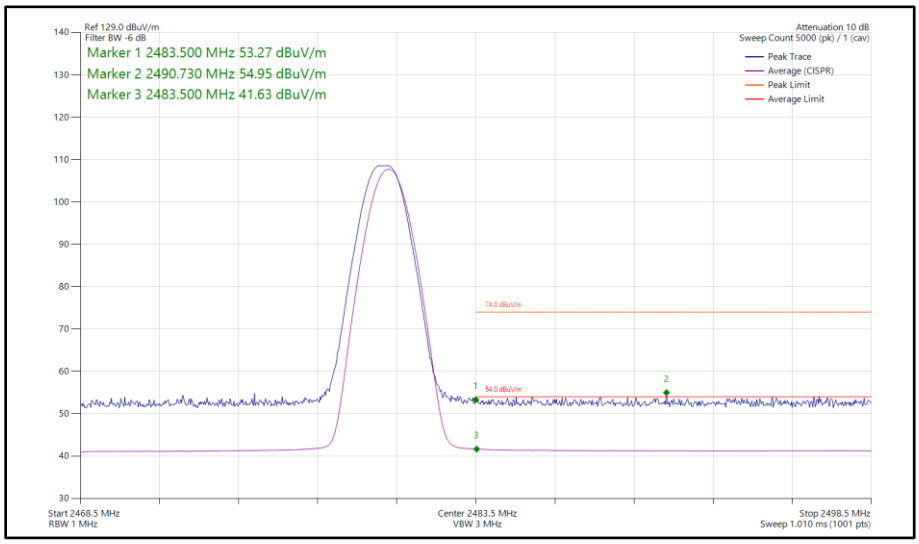

Figure 16 - Bluetooth DH5, SISO, Core 2 - 2480 MHz Band Edge Frequency 2483.5 MHz

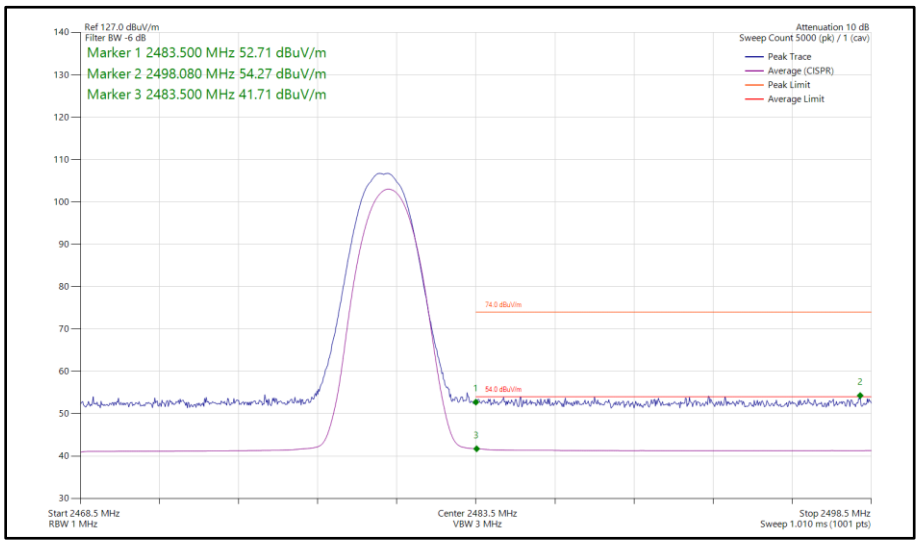

Figure 17 - Bluetooth 2-DH5, SISO, Core 2 - 2480 MHz Band Edge Frequency 2483.5 MHz

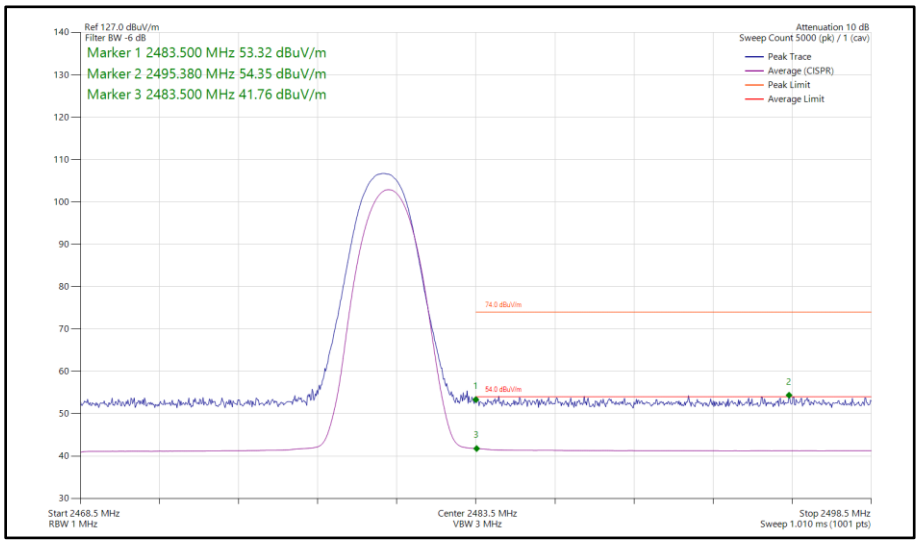

Figure 18 - Bluetooth 3-DH5, SISO, Core 2 - 2480 MHz Band Edge Frequency 2483.5 MHz

iPA - Core 0 - Core 1 (MIMO)

Mode	Packet Type	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
Static	DH5	2402	2390	55.13	40.80
Static	2-DH5	2402	2390	55.25	40.80
Static	3-DH5	2402	2390	55.54	40.81
Static	DH5	2480	2483.5	54.63	41.50
Static	2-DH5	2480	2483.5	54.44	41.46
Static	3-DH5	2480	2483.5	55.08	41.51

Table 10 - MIMO Restricted Band Edge Results

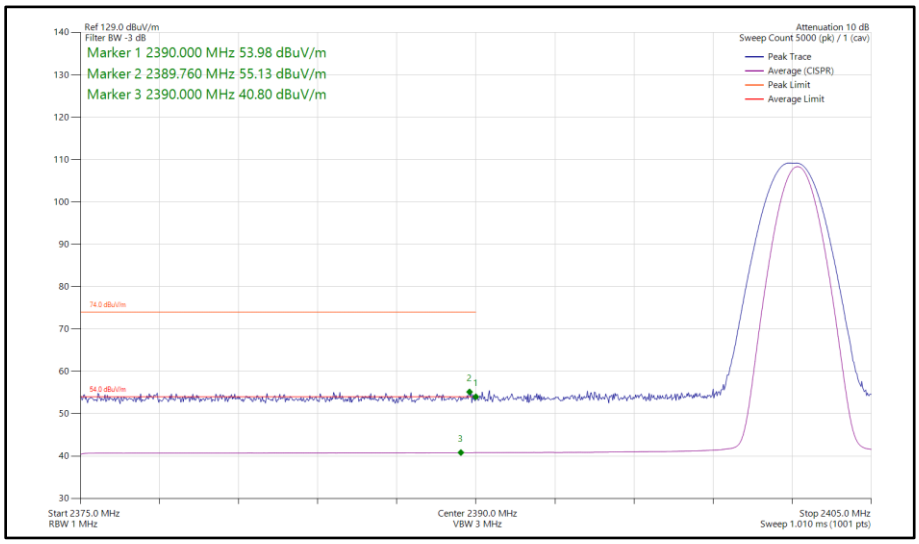

Figure 19 - Bluetooth DH5, MIMO, Core 0 - Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

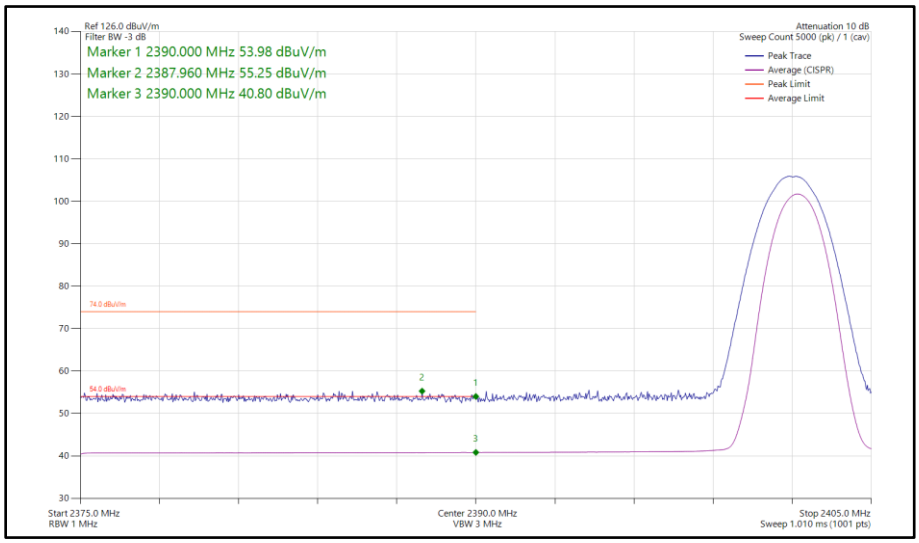

Figure 20 - Bluetooth 2-DH5, MIMO, Core 0 - Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

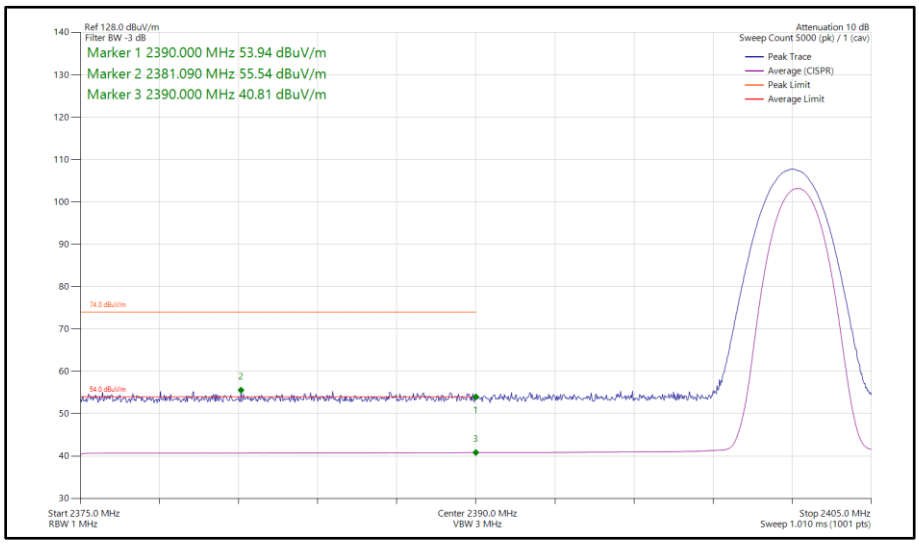

Figure 21 - Bluetooth 3-DH5, MIMO, Core 0 - Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

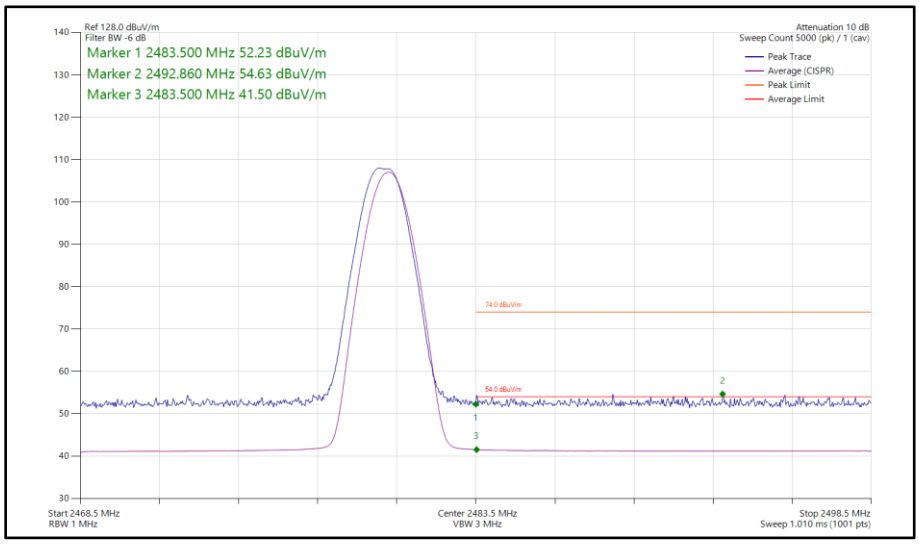

Figure 22 - Bluetooth DH5, MIMO, Core 0 - Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

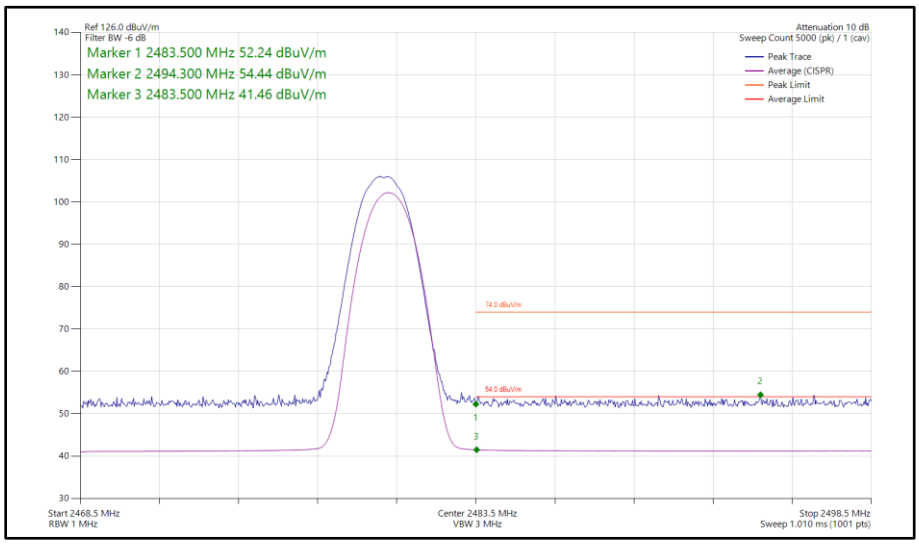

Figure 23 - Bluetooth 2-DH5, MIMO, Core 0 - Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

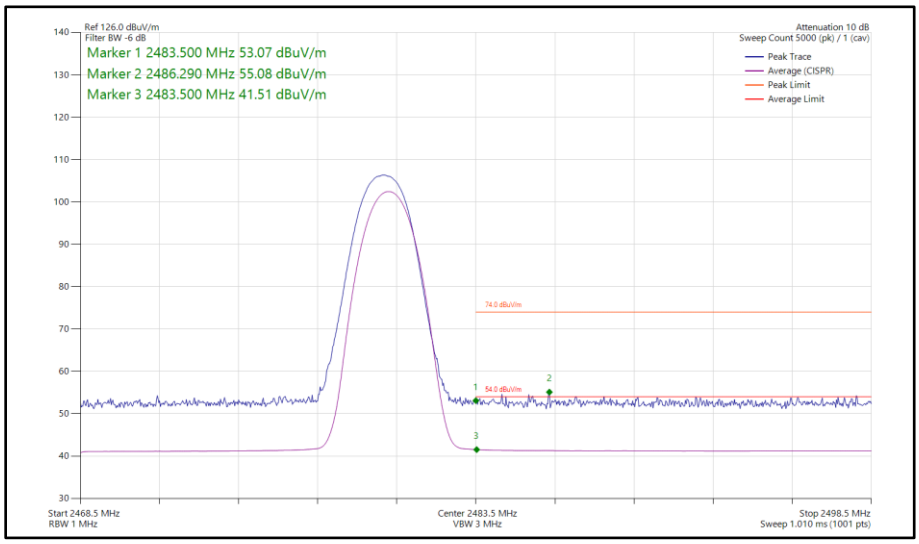

Figure 24 - Bluetooth 3-DH5, MIMO, Core 0 - Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

ePA - Core 0 (SISO)

Mode	Packet Type	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
Static	2-DH5	2402	2390	55.78	41.39
Static	3-DH5	2402	2390	56.83	41.48
Static	2-DH5	2480	2483.5	55.87	43.66
Static	3-DH5	2480	2483.5	56.97	44.70

Table 11 - SISO Restricted Band Edge Results

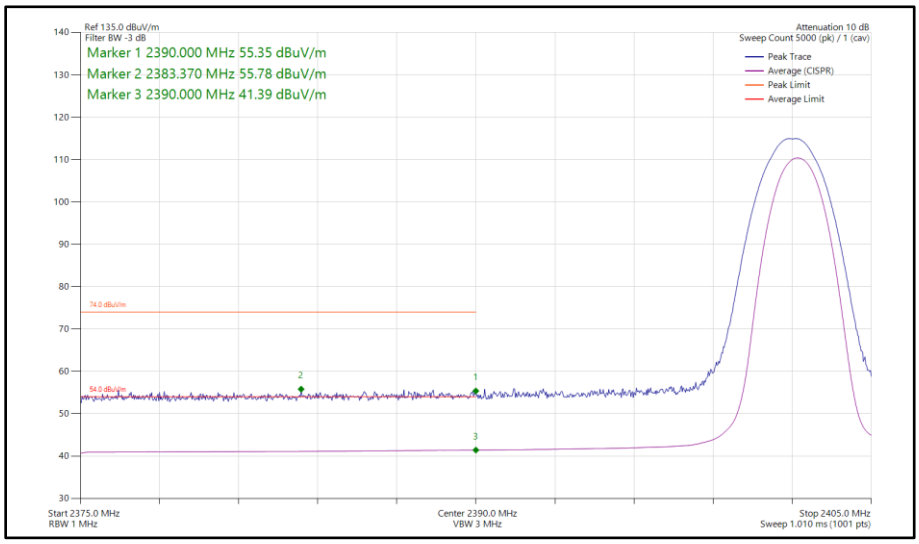

Figure 25 - Bluetooth 2-DH5, SISO, Core 0 - 2402 MHz Band Edge Frequency 2390 MHz

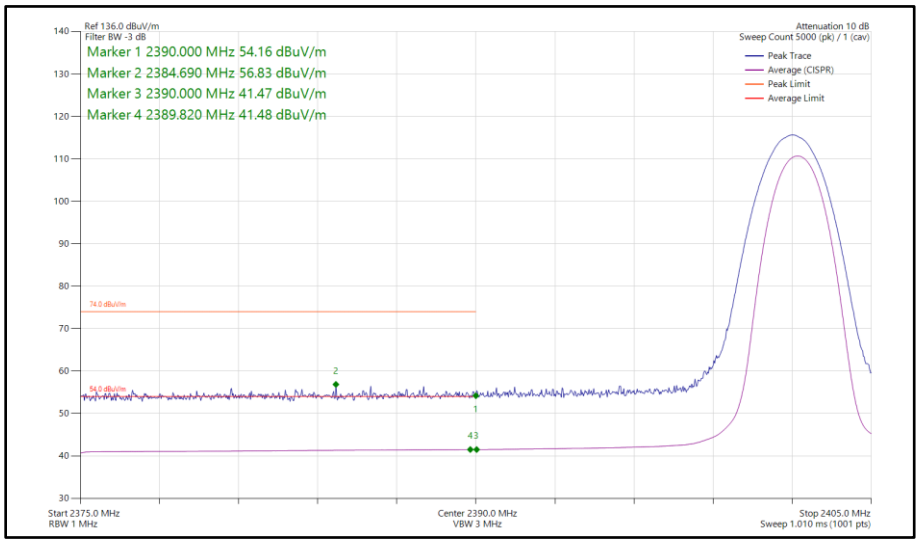

Figure 26 - Bluetooth 3-DH5, SISO, Core 0 - 2402 MHz Band Edge Frequency 2390 MHz

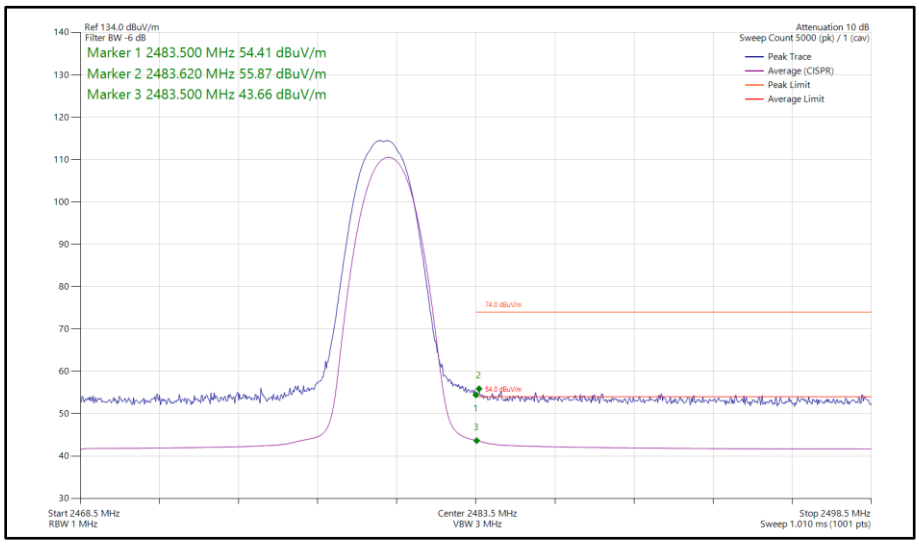

Figure 27 - Bluetooth 2-DH5, SISO, Core 0 - 2480 MHz Band Edge Frequency 2483.5 MHz

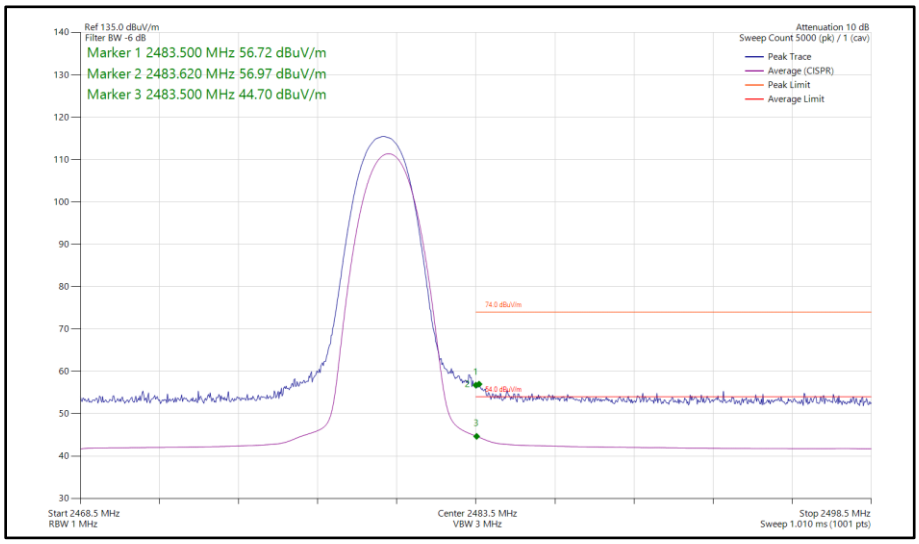

Figure 28 - Bluetooth 3-DH5, SISO, Core 0 - 2480 MHz Band Edge Frequency 2483.5 MHz

ePA - Core 1 (SISO)

Mode	Packet Type	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
Static	2-DH5	2402	2390	56.20	41.48
Static	3-DH5	2402	2390	56.54	41.64
Static	2-DH5	2480	2483.5	55.94	43.36
Static	3-DH5	2480	2483.5	55.45	43.74

Table 12 - SISO Restricted Band Edge Results

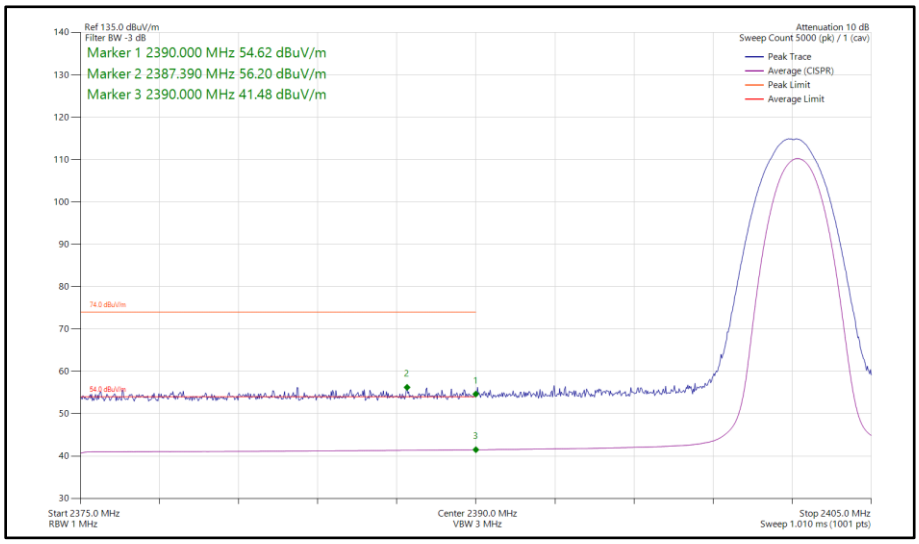

Figure 29 - Bluetooth 2-DH5, SISO, Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

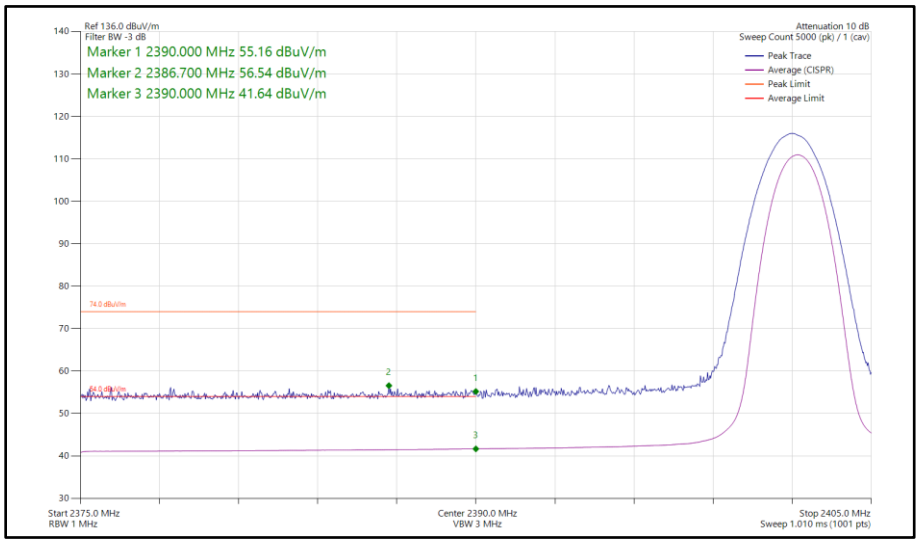

Figure 30 - Bluetooth 3-DH5, SISO, Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

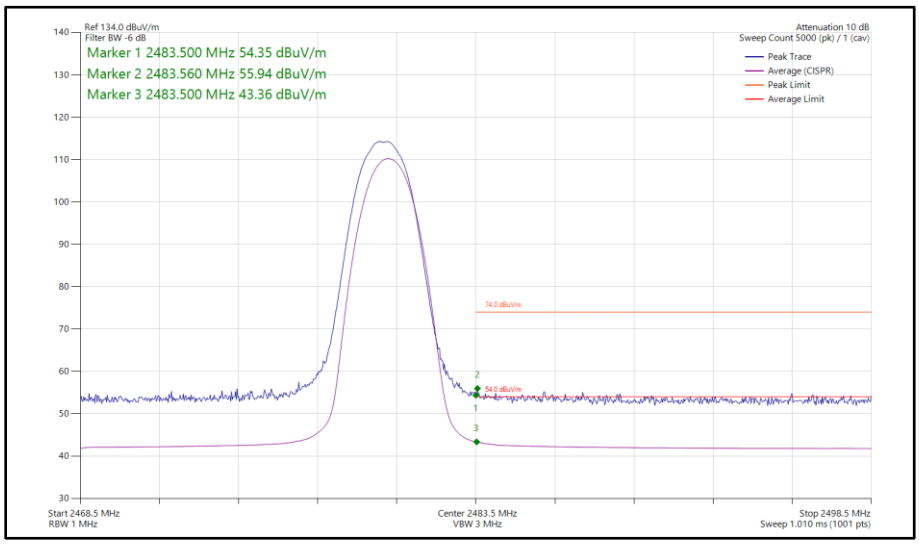

Figure 31 - Bluetooth 2-DH5, SISO, Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

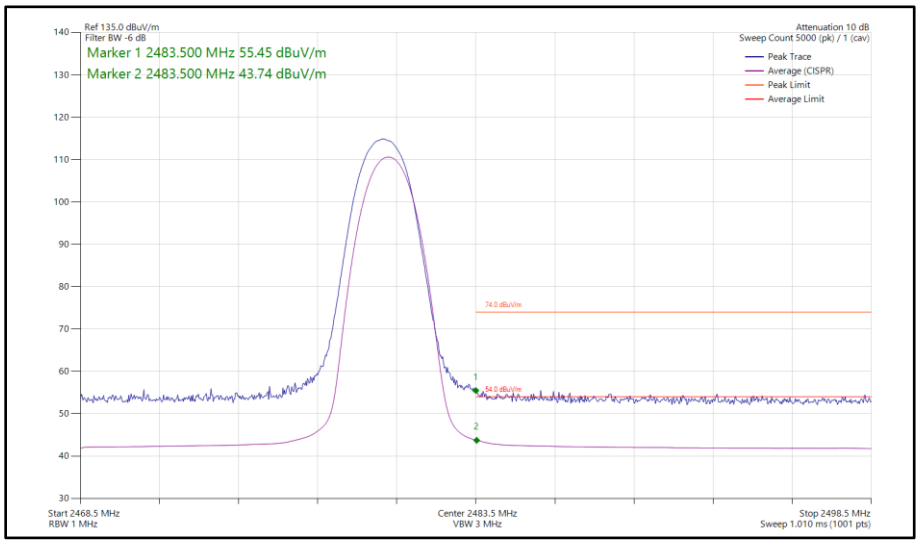

Figure 32 - Bluetooth 3-DH5, SISO, Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

ePA - Core 0 - Core 1 (MIMO)

Mode	Packet Type	TX Frequency (MHz)	Band Edge Frequency (MHz)	Peak Level (dBµV/m)	Average Level (dBµV/m)
Static	2-DH5	2402	2390	56.09	41.35
Static	3-DH5	2402	2390	56.13	41.36
Static	2-DH5	2480	2483.5	54.95	42.91
Static	3-DH5	2480	2483.5	55.53	43.86

Table 13 - MIMO Restricted Band Edge Results

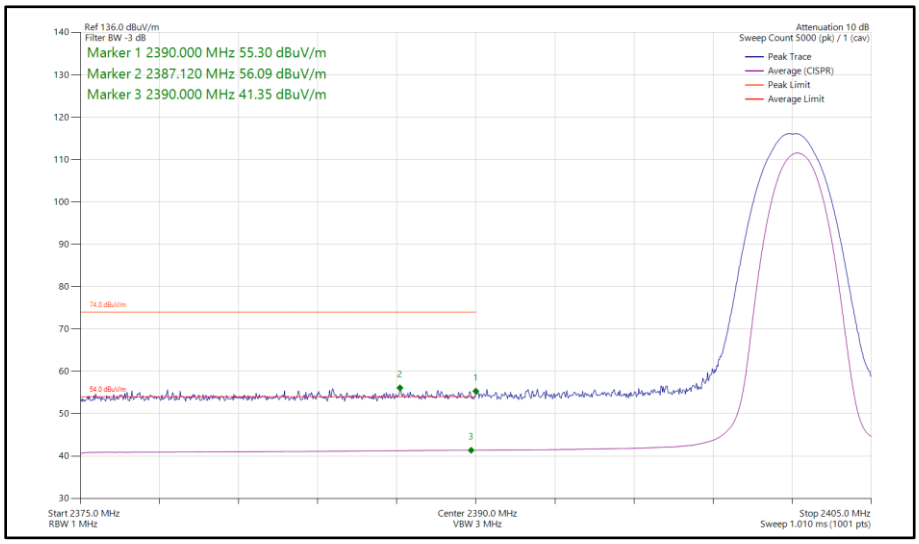

Figure 33 - Bluetooth 2-DH5, MIMO, Core 0 - Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

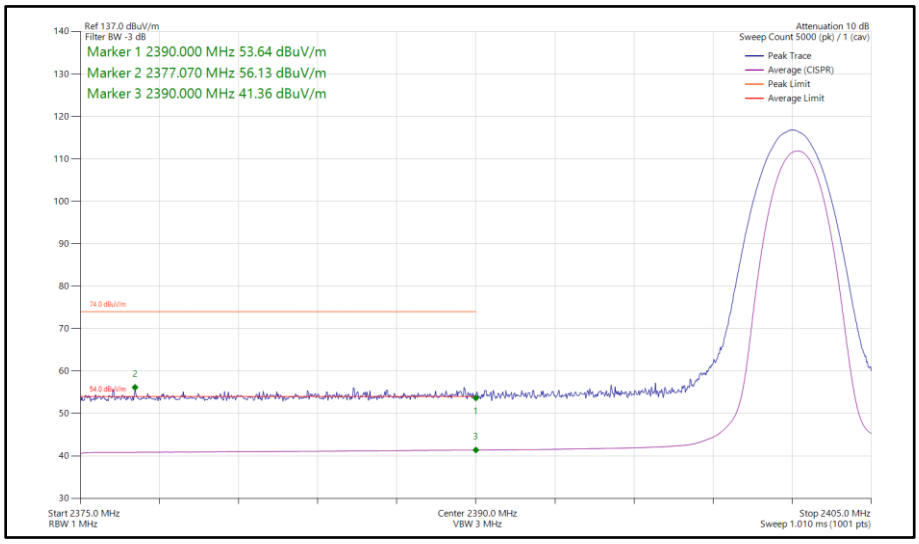

Figure 34 - Bluetooth 3-DH5, MIMO, Core 0 - Core 1 - 2402 MHz Band Edge Frequency 2390 MHz

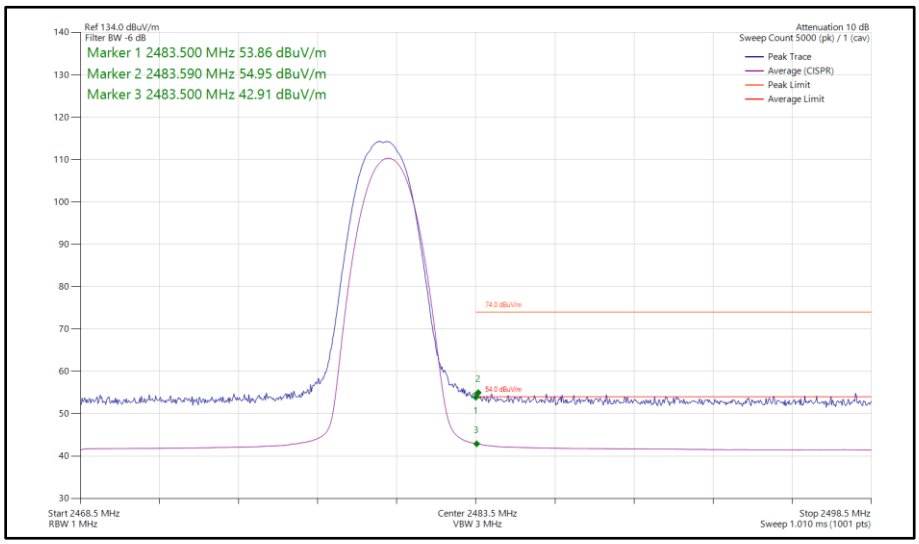

Figure 35 - Bluetooth 2-DH5, MIMO, Core 0 - Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

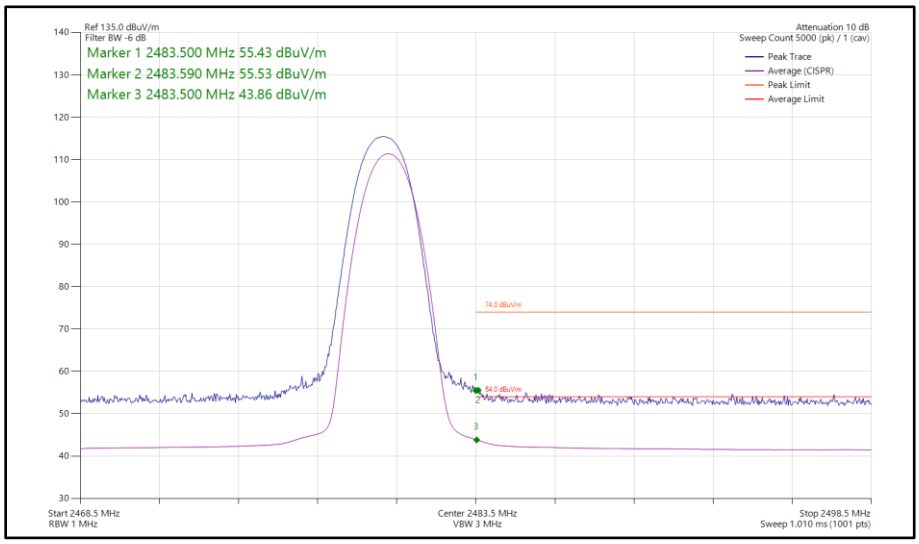

Figure 36 - Bluetooth 3-DH5, MIMO, Core 0 - Core 1 - 2480 MHz Band Edge Frequency 2483.5 MHz

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 14

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 15

*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 14.

Instrument	Manufacturer	Type No.	TE No.	Calibration Period (months)	Calibration Expiry Date
Emissions Software	TUV SUD	EmX V3.4.2	5125	-	Software
Test Receiver	Rohde & Schwarz	ESW44	5914	12	24-May-2025
1500W (300V 12A) AC Power Supply	iTech	IT7324	5956	-	O/P Mon
5m Semi-Anechoic Chamber (Dual-Axis)	Albatross Projects	RF Chamber 14	5958	36	26-Apr-2025
Compact Antenna Mast	Maturo Gmbh	CAM4.0-P	5959	-	TU
Mast & Turntable Controller	Maturo Gmbh	FCU3.0	5960	-	TU
Tilt Antenna Mast	Maturo Gmbh	BAM4.5-P	5961	-	TU
Turntable	Maturo Gmbh	TT1.5SI	5962	-	TU
Cable (SMA to SMA 1m)	Junkosha	MWX221-01000AMSAMS/A	6007	12	20-May-2025
Horn Antenna (1-10 GHz)	Schwarzbeck	BBHA9120B	6141	12	05-May-2025
Digital Multimeter	Fluke	115	6145	12	06-Jun-2025
Humidity & Temperature meter	R.S Components	1364	6149	12	12-Aug-2025
SAC Switch Unit	TUV SUD	TUV_SSU_001	6190	12	22-Dec-2024
1m Cable	Junkosha	MWX241-01000AMSAMS/B	6741	12	01-Feb-2025
8M SMA Cable	Junkosha	MWX221-08000AMSAMS/B	6834	12	14-Aug-2025

Table 16

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

A3389, S/N: MGC29YC7F7 - Modification State 0

2.2.3 Date of Test

30-October-2024 to 31-October-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	20.7 - 21.0 °C
Relative Humidity	52.4 - 57.0 %

2.2.6 Test Results

2.4 GHz Bluetooth BDR/EDR

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247 (a)(1)(iii) 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):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.889	99	286.0	400.0

Table 17 - Time of Occupancy Results

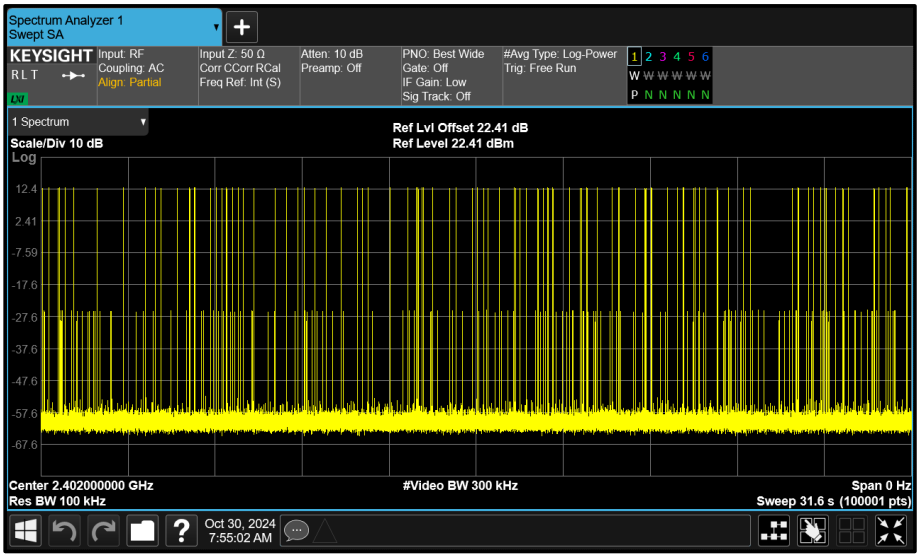

Figure 37 - GFSK - 2402 MHz Accumulated Transmit Time

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

DUT Configuration			
Mode:	iPA π/4 DQPSK (2-DH5)	Duty Cycle (%):	76.8
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.892	105	303.7	400.0

Table 18 - Time of Occupancy Results

Figure 38 - π/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) 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 (%):	77.2
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.895	117	338.7	400.0

Table 19 - Time of Occupancy Results

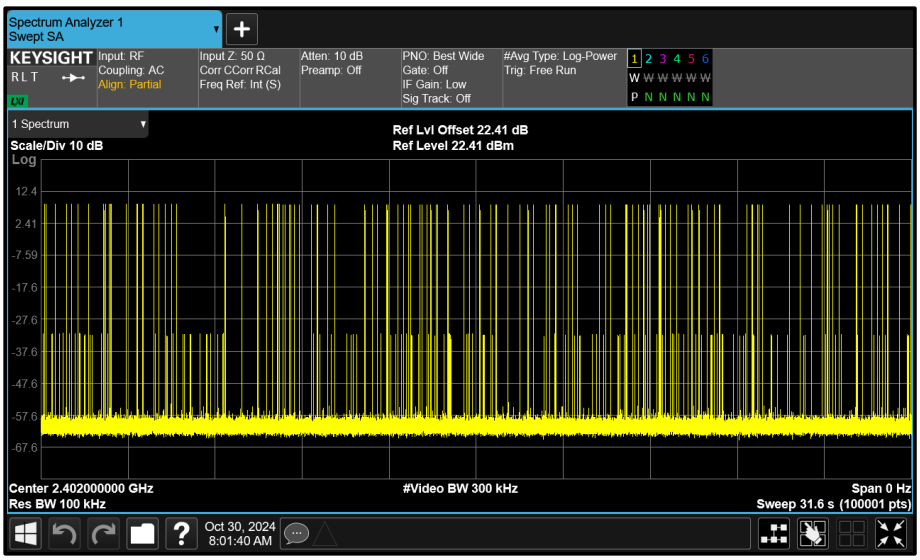

Figure 39 - 8-DPSK - 2402 MHz Accumulated Transmit Time

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247 (a)(1)(iii) 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 (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.889	112	323.6	400.0

Table 20 - Time of Occupancy Results

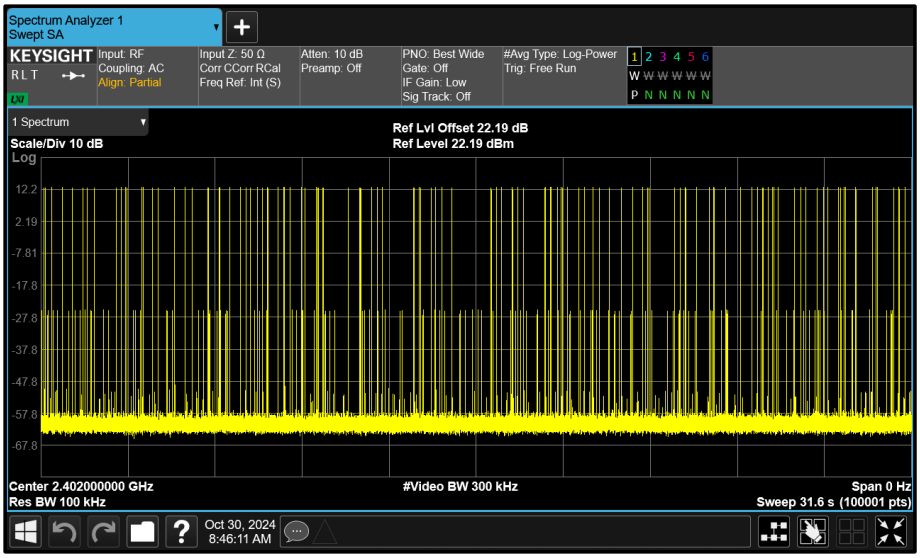

Figure 40 - GFSK - 2402 MHz Accumulated Transmit Time

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

DUT Configuration			
Mode:	iPA π/4 DQPSK (2-DH5)	Duty Cycle (%):	76.8
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	C (Core 2)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.892	102	295.0	400.0

Table 21 - Time of Occupancy Results

Figure 41 - π/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) 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 (%):	77.2
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	C (Core 2)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.894	95	275.0	400.0

Table 22 - Time of Occupancy Results

Figure 42 - 8-DPSK - 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) RSS-247 5.1 d)	Test Method(s):	C63.10 7.8.4
Additional Reference(s):	-		

DUT Configuration			
Mode:	ePA π/4 DQPSK (2-DH5)	Duty Cycle (%):	76.8
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.894	112	324.1	400.0

Table 23 - Time of Occupancy Results

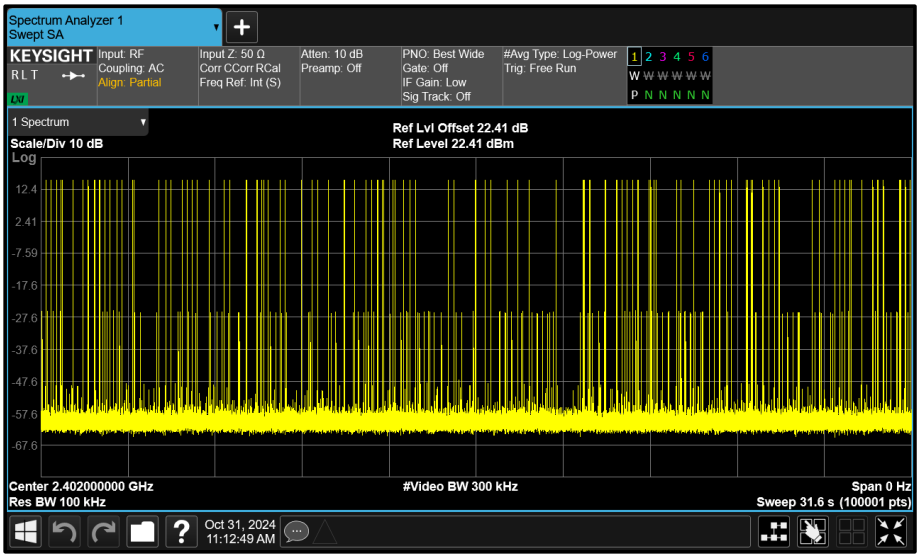

Figure 43 - π/4 DQPSK - 2402 MHz Accumulated Transmit Time

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

DUT Configuration			
Mode:	ePA 8-DPSK (3-DH5)	Duty Cycle (%):	77.2
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.896	115	333.0	400.0

Table 24 - Time of Occupancy Results

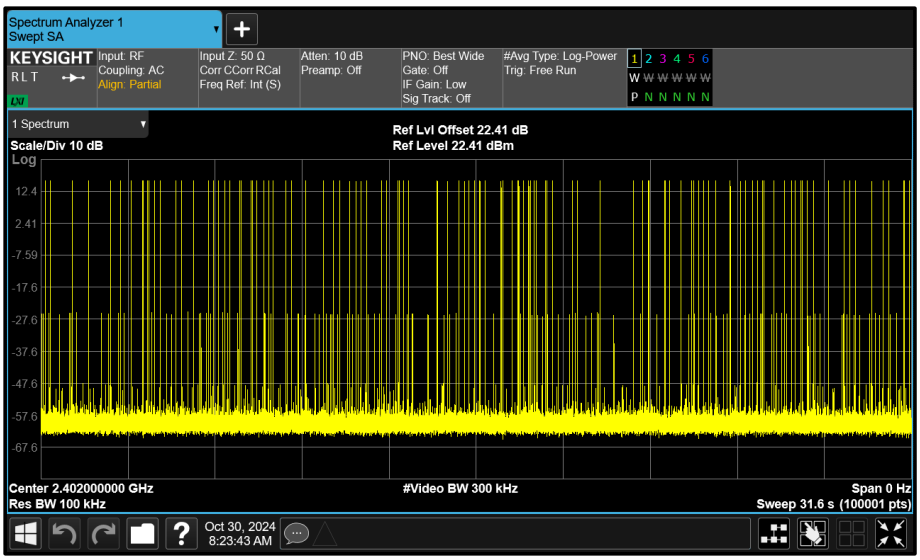

Figure 44 - 8-DPSK - 2402 MHz Accumulated Transmit Time

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247 (a)(1)(iii) 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 (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.889	98	283.1	400.0

Table 25 - Time of Occupancy Results

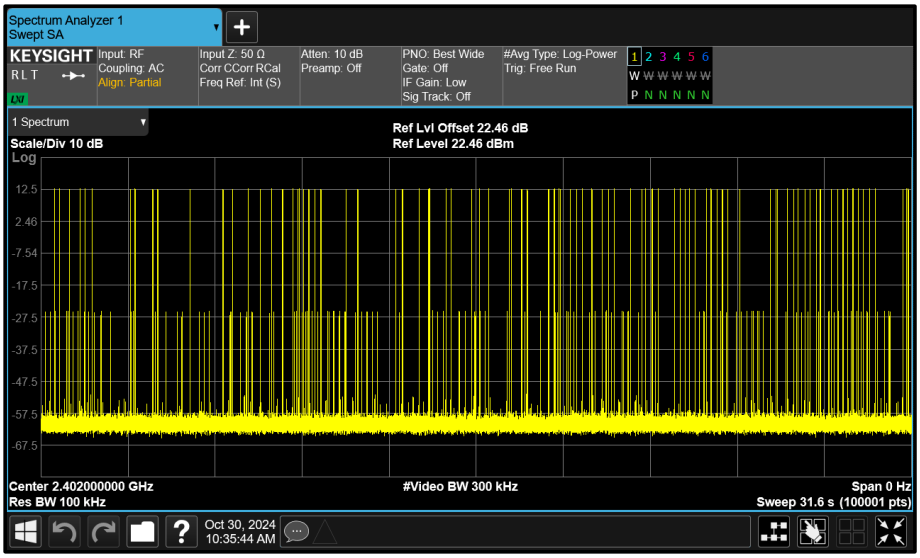

Figure 45 - GFSK - 2402 MHz Accumulated Transmit Time

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

DUT Configuration			
Mode:	iPA π/4 DQPSK (2-DH5)	Duty Cycle (%):	77.1
Antenna Configuration:	Beamforming	DCCF (dB):	-
Active Port(s):	A+B (Core 0 + Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.892	104	300.8	400.0

Table 26 - Time of Occupancy Results

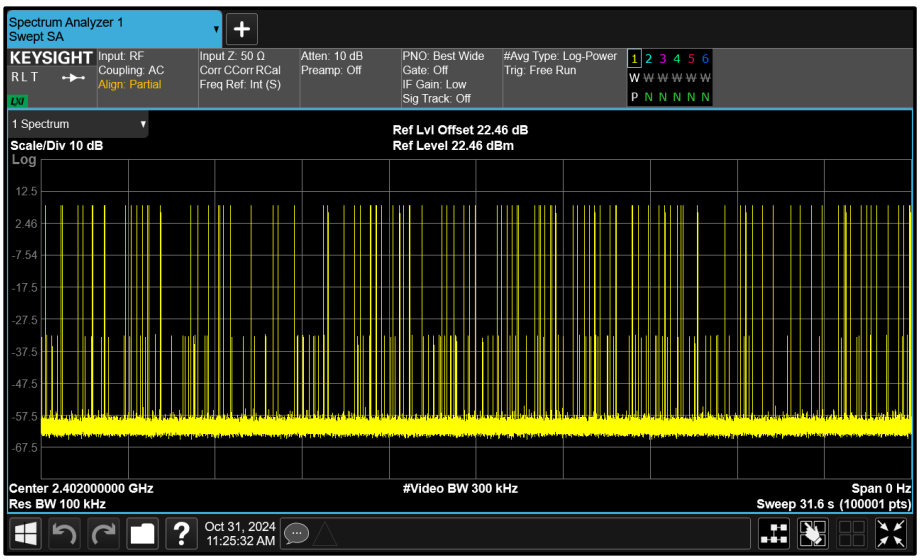

Figure 46 - π/4 DQPSK - 2402 MHz Accumulated Transmit Time

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247 (a)(1)(iii) 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 (%):	76.9
Antenna Configuration:	Beamforming	DCCF (dB):	-
Active Port(s):	A+B (Core 0 + Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.894	109	315.5	400.0

Table 27 - Time of Occupancy Results

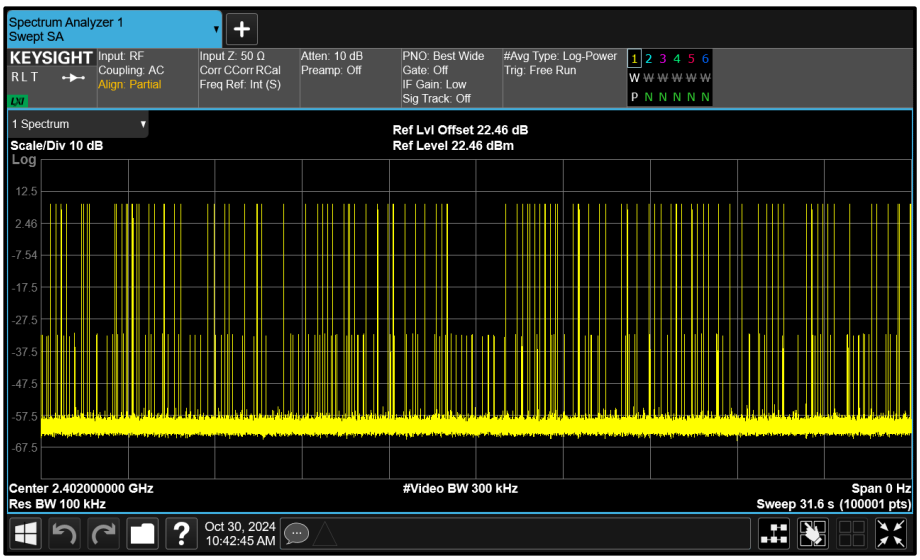

Figure 47 - 8-DPSK - 2402 MHz Accumulated Transmit Time

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

DUT Configuration			
Mode:	ePA π/4 DQPSK (2-DH5)	Duty Cycle (%):	77.1
Antenna Configuration:	Beamforming	DCCF (dB):	-
Active Port(s):	A+B (Core 0 + Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.893	114	329.7	400.0

Table 28 - Time of Occupancy Results

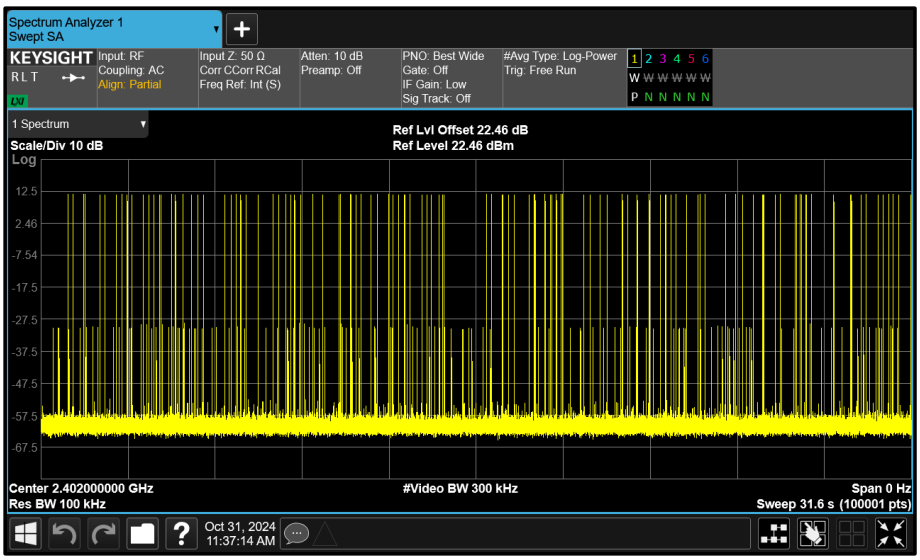

Figure 48 - π/4 DQPSK - 2402 MHz Accumulated Transmit Time

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

DUT Configuration			
Mode:	ePA 8-DPSK (3-DH5)	Duty Cycle (%):	76.9
Antenna Configuration:	Beamforming	DCCF (dB):	-
Active Port(s):	A+B (Core 0 + Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Time of Occupancy			Limit (ms)
	Dwell Time (ms)	Number of Transmissions	Time of Occupancy (ms)	
2402	2.895	102	295.3	400.0

Table 29 - Time of Occupancy Results

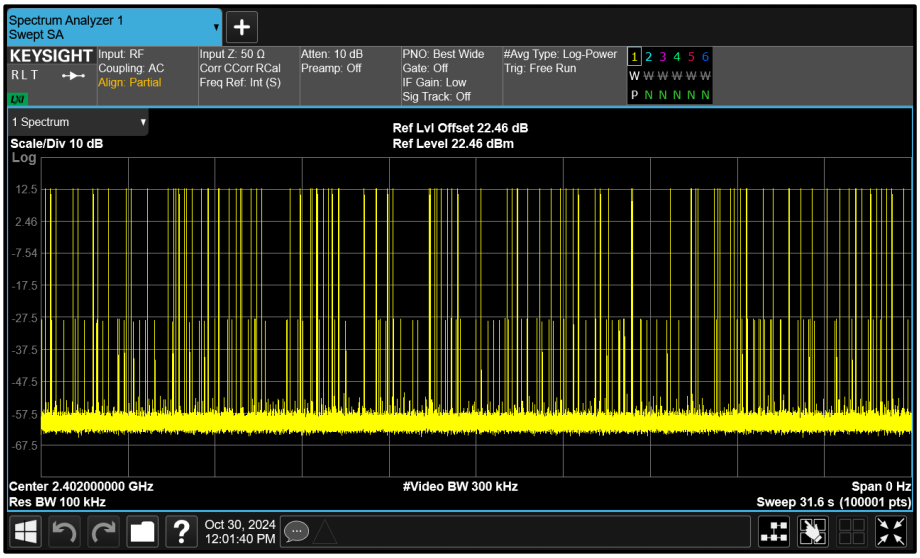

Figure 49 - 8-DPSK - 2402 MHz Accumulated Transmit Time

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
1500VA AC Power Supply	iTech	IT7324	5907	-	O/P Mon
MXA Signal Analyser	Keysight Technologies	N9020B	5919	24	18-Mar-2026
Digital Multimeter	Fluke	115	6145	12	06-Jun-2025
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	6519	12	08-Feb-2025
SCU Cable Assembly	TUV SUD	SPECTRUM_SCU_CA	6520	12	09-Feb-2025
SCU Cable Assembly	TUV SUD	SPECTRUM_SCU_CA	6521	12	09-Feb-2025
SCU Cable Assembly	TUV SUD	SPECTRUM_SCU_CA	6522	12	09-Feb-2025

Table 30

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

A3389, S/N: MGC29YC7F7 - Modification State 0

2.3.3 Date of Test

30-October-2024 to 31-October-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	20.7 - 21.0 °C
Relative Humidity	52.4 - 57.0 %

2.3.6 Test Results

2.4 GHz Bluetooth BDR/EDR

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) 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):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)	Carrier Frequency Separation (MHz)			Limit (kHz)
		F1C	F2C	FHS	
2441	0.932	2441.019	2442.020	1.001	≥621.6

Table 31 - Carrier Frequency Separation Results

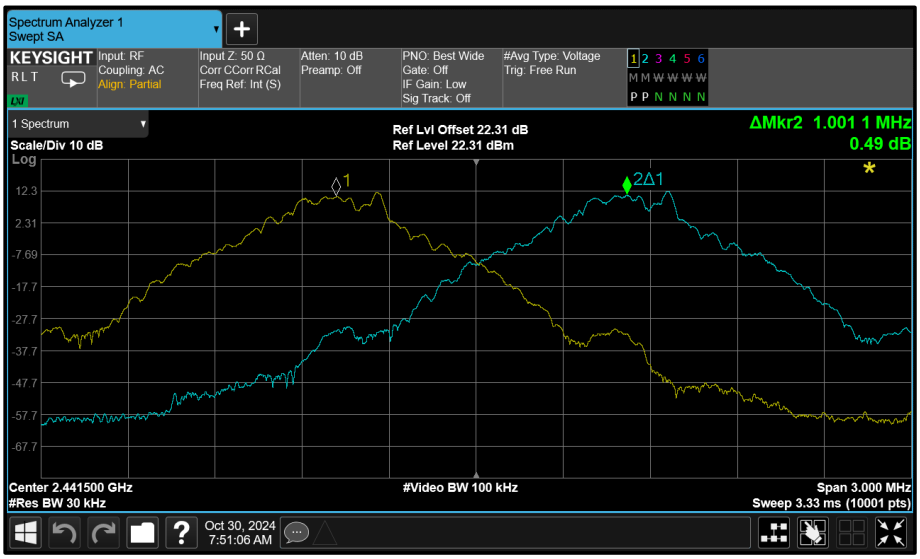

Figure 50 - GFSK - 2441 MHz (CH39)

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

DUT Configuration			
Mode:	iPA π/4 DQPSK (2-DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)	Carrier Frequency Separation (MHz)			Limit (kHz)
		F1C	F2C	FHS	
2441	1.349	2441.002	2442.003	1.001	≥899.2

Table 32 - Carrier Frequency Separation Results

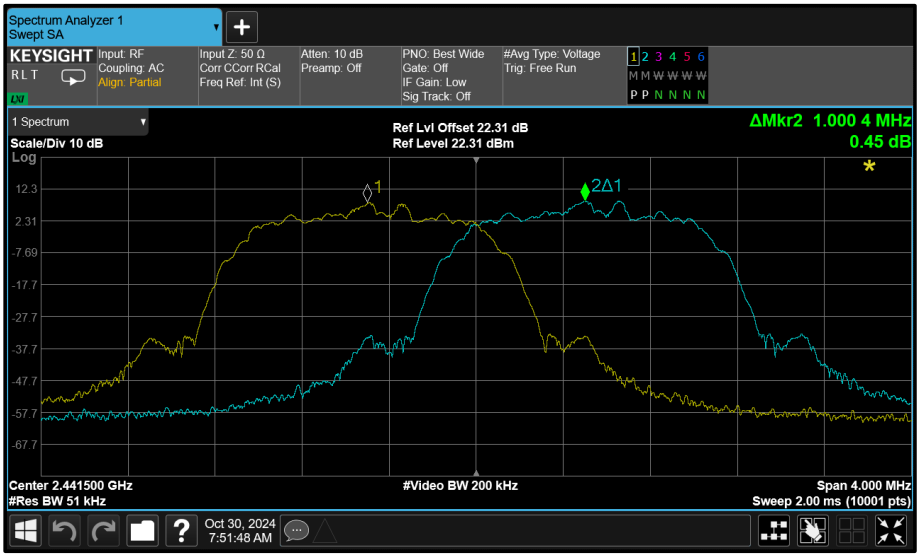

Figure 51 - π/4 DQPSK - 2441 MHz (CH39)

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) 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):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)	Carrier Frequency Separation (MHz)			Limit (kHz)
		F1C	F2C	FHS	
2441	1.323	2441.010	2442.010	1.000	≥881.9

Table 33 - Carrier Frequency Separation Results

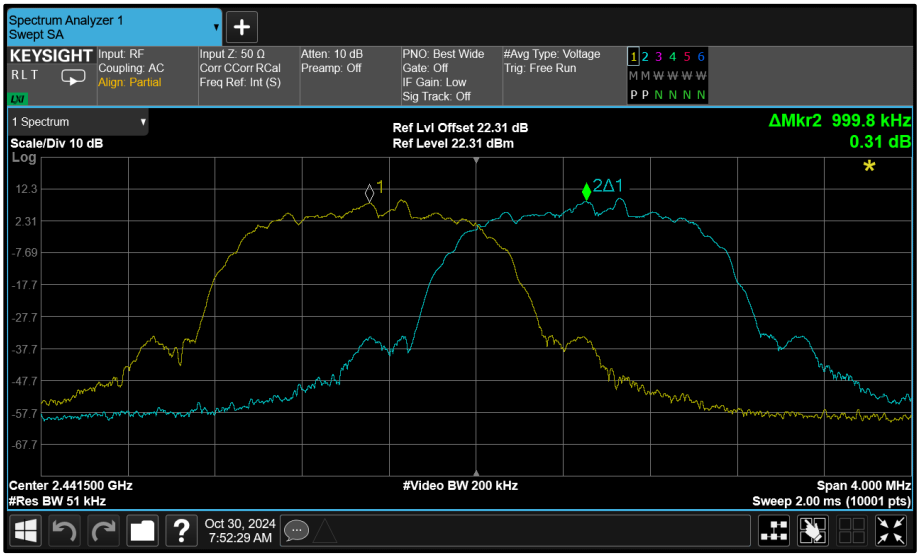

Figure 52 - 8-DPSK - 2441 MHz (CH39)

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) 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	0.974	2441.009	2442.019	1.010	≥649.0

Table 34 - Carrier Frequency Separation Results

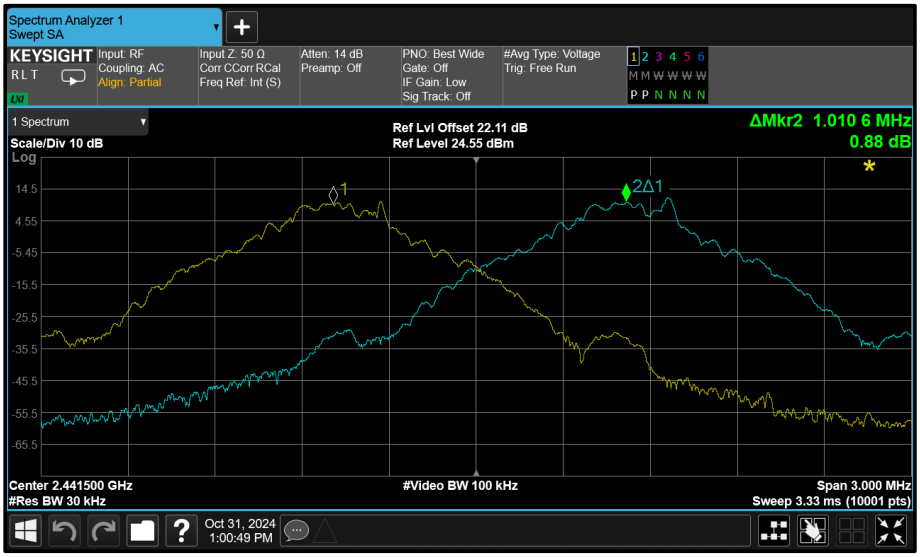

Figure 53 - GFSK - 2441 MHz (CH39)

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

DUT Configuration			
Mode:	iPA π/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	1.345	2441.004	2442.003	0.999	≥896.5

Table 35 - Carrier Frequency Separation Results

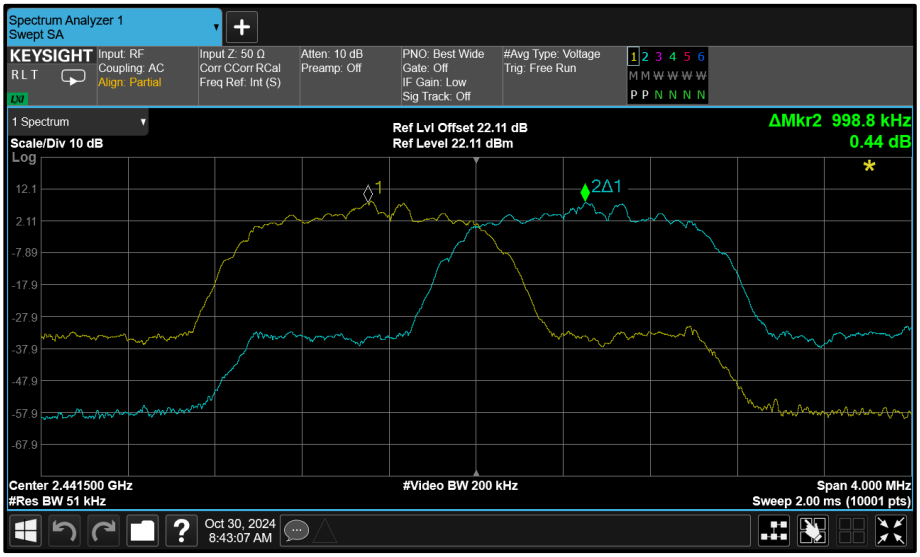

Figure 54 - π/4 DQPSK - 2441 MHz (CH39)

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) 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	1.322	2441.011	2442.011	1.000	≥881.6

Table 36 - Carrier Frequency Separation Results

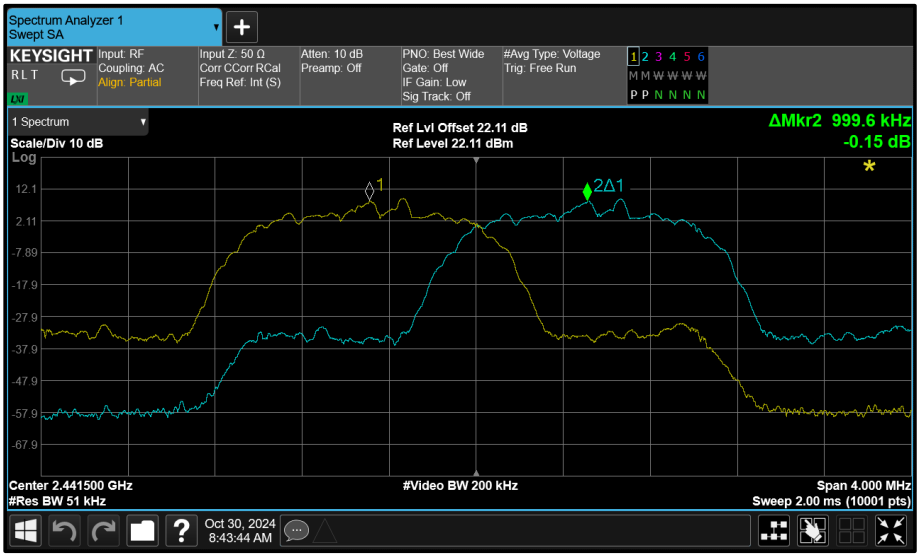

Figure 55 - 8-DPSK - 2441 MHz (CH39)

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

DUT Configuration			
Mode:	ePA π/4 DQPSK (2-DH5)	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)	Carrier Frequency Separation (MHz)			Limit (kHz)
		F1C	F2C	FHS	
2441	1.355	2441.001	2442.000	0.999	≥903.5

Table 37 - Carrier Frequency Separation Results

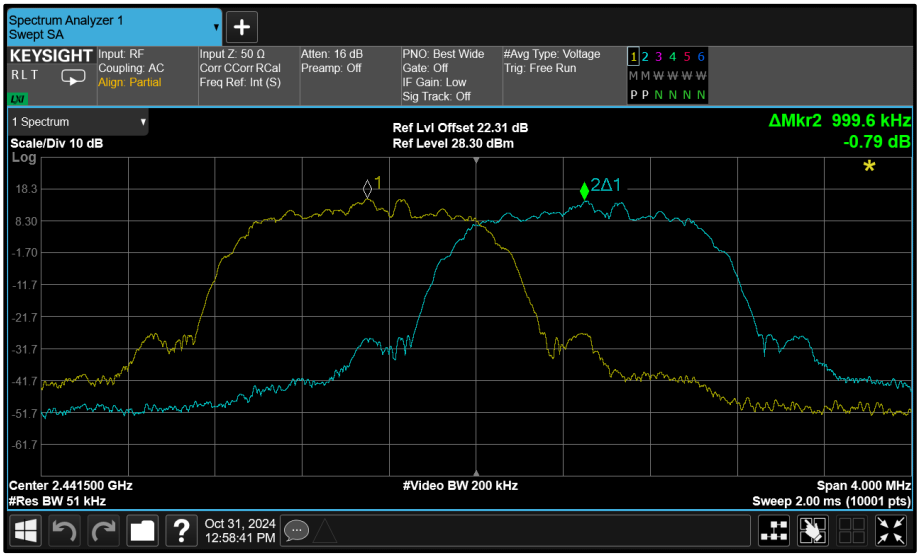

Figure 56 - π/4 DQPSK - 2441 MHz (CH39)

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) 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):	B (Core 1)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	20 dB Bandwidth (MHz)	Carrier Frequency Separation (MHz)			Limit (kHz)
		F1C	F2C	FHS	
2441	1.321	2441.008	2442.008	1.000	≥880.5

Table 38 - Carrier Frequency Separation Results

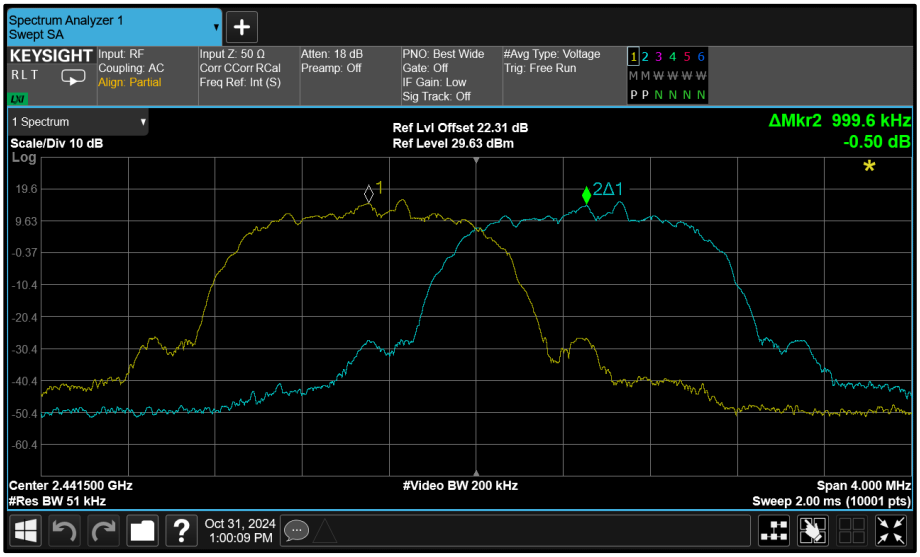

Figure 57 - 8-DPSK - 2441 MHz (CH39)

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) 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	0.929	2441.021	2442.009	0.988	≥619.0

Table 39 - Carrier Frequency Separation Results

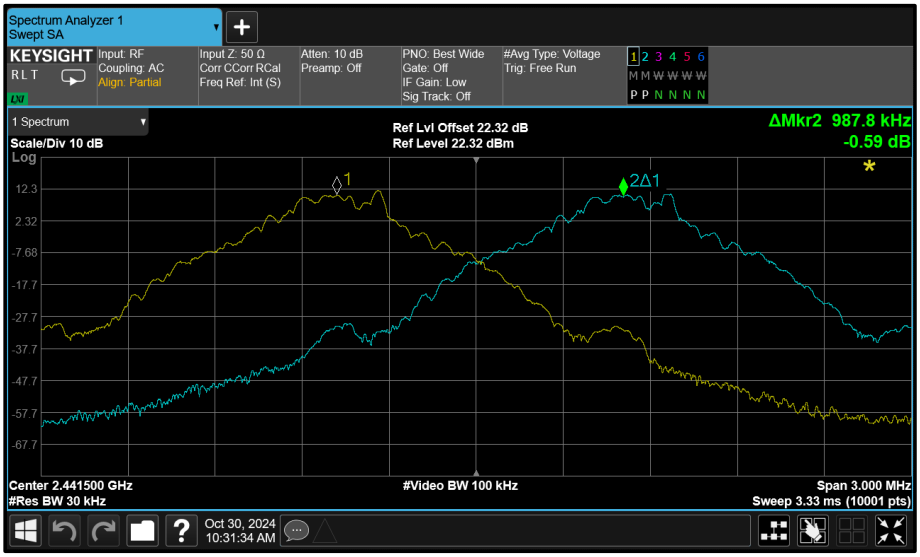

Figure 58 - GFSK - 2441 MHz (CH39)

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

DUT Configuration			
Mode:	iPA π/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	1.352	2441.003	2442.002	0.999	≥901.1

Table 40 - Carrier Frequency Separation Results

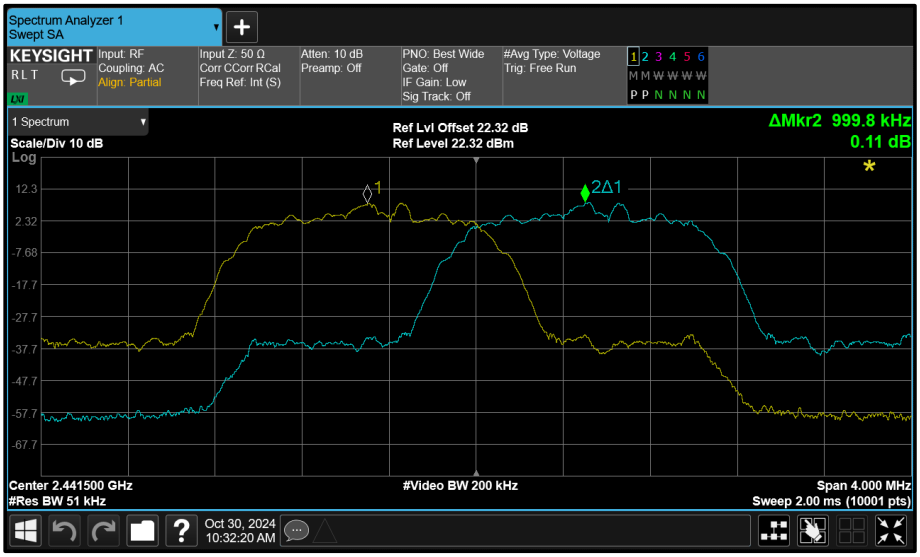

Figure 59 - π/4 DQPSK - 2441 MHz (CH39)

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz
Limit Clause(s):	FCC 15.247(a)(1) 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	1.322	2441.011	2442.011	1.000	≥881.1

Table 41 - Carrier Frequency Separation Results

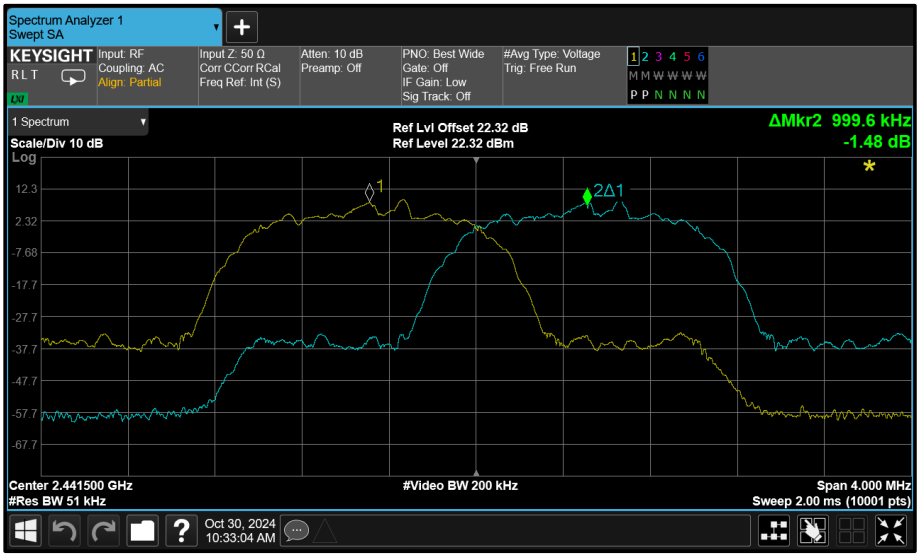

Figure 60 - 8-DPSK - 2441 MHz (CH39)

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

DUT Configuration			
Mode:	ePA π/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	1.352	2441.001	2442.001	1.000	≥901.1

Table 42 - Carrier Frequency Separation Results

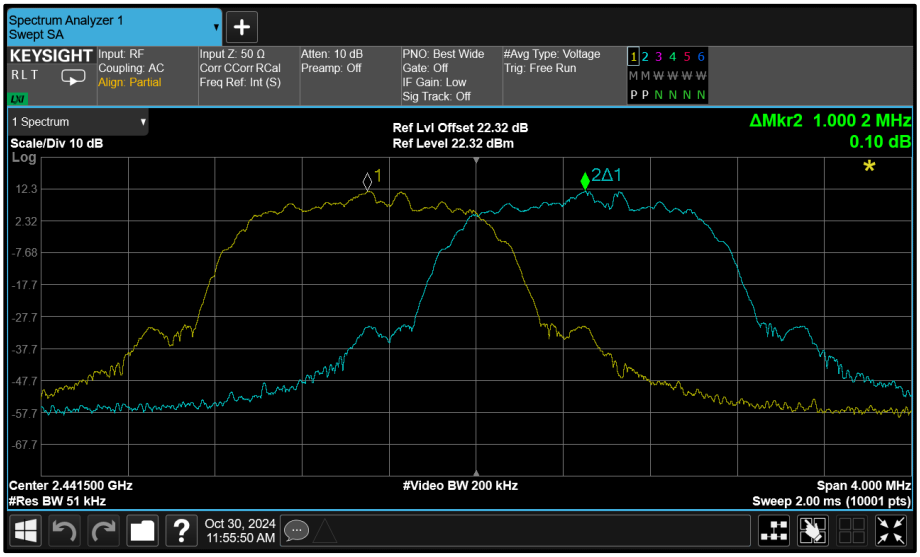

Figure 61 - π/4 DQPSK - 2441 MHz (CH39)