TEST REPORT

Report Number: R15374786-E2

Applicant	:	Microsoft Corporation 1 Microsoft Way Redmond, WA 98052-8300, USA
Model	:	HWB-Q93
FCC ID	:	C3K00002101
IC	:	3048A-00002101
EUT Description	:	Wireless Module
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C: 2024 ISED RSS-247 ISSUE 3: 2023 ISED RSS-GEN ISSUE 5 + A1 + A2: 2021

Date Of Issue:
2025-01-10

Prepared by:
UL LLC
12 Laboratory Dr.
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CERT #0751.06

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2024-12-03	Initial Issue	Charles Moody
V2	2024-12-31	Included Correlated and Uncorrelated Gain Calculation to Section 6.3.	Charles Moody
V3	2025-01-10	Revised Antenna Gain Statement in Section 6.3 and Added Note Regarding Calibration Dates in Section 8	Charles Moody

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Microsoft Corporation
1 Microsoft Way
Redmond, WA 98052-8300, USA

EUT DESCRIPTION: Wireless Module

MODEL: HWB-Q93

SERIAL NUMBER: 6-19, 6-25, 6-28

SAMPLE RECEIPT DATE: 2024-06-20 TO 2024-10-10

DATE TESTED: 2024-10-07 TO 2024-11-22

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C: 2024	Refer to Section 2
ISED RSS-247 Issue 3: 2023	Refer to Section 2
ISED RSS-GEN Issue 5 + A1 + A2: 2021	Refer to Section 2

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document.

Approved & Released For
UL LLC By:

Brian Kiewra
Project Engineer
Consumer, Medical and IT Segment
UL LLC

Prepared By:

Charles Moody
Senior Project Engineer
Consumer, Medical and IT Segment
UL LLC

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2. TEST RESULTS SUMMARY

This report contains data provided by the customer which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.
Below is a list of the data provided by the customer:

1. Antenna gain and type (see section 6.3)

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	ANSI C63.10 Section 11.6.
-	RSS-GEN 6.7	99% OBW	Reporting purposes only	ANSI C63.10 Section 6.9.3.
15.247 (a) (2)	RSS-247 5.2 (a)	6dB BW	Compliant	None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power		
See Comment		Average power	Reporting purposes only	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (e)	RSS-247 5.2 (b)	PSD	Compliant	None.
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions		
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions		
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Not Performed	See Note 1

NOTE 1: AC Mains emissions testing was not performed since the EUT is a radio module that is powered through a DC internal power supply.

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC 47 CFR Part 2, FCC 47 CFR Part 15, ANSI C63.10-2020, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, RSS-GEN Issue 5 + A1 + A2, and RSS-247 Issue 3

4. FACILITIES AND ACCREDITATION

UL LLC is accredited A2LA, certification # 0751.06, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
☐	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
☒	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A		27265	

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5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	6.01 dB
Conducted Emissions (0.150-30MHz) - LISN	3.40 dB
Temperature	0.57°C
Humidity	3.39%
DC Supply voltages	1.70%
Time	3.39%

Uncertainty figures are valid to a confidence level of 95%.

5.4. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:
Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

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6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a wireless module. This report covers the emissions testing of the BLE radio.

6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2402 - 2480	BLE - C0	20.19	104.47
2402 - 2480	BLE - C1	20.26	106.17
2402 - 2480	BLE - 2Tx	18.00	63.10

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer' are as follows:

Low Gain Antenna:

Chain	Frequency (MHz)	Gain (dBi)	Type
0	2400-2483.5	3.6	PIFA
1	2400-2483.5	3.6	
(Uncorrelated)	2400-2483.5	3.6	
(Correlated)	2400-2483.5	6.61	

Mid Gain Antenna:

Chain	Frequency (MHz)	Gain (dBi)	Type
0	2400-2483.5	4.4	PIFA
1	2400-2483.5	4.4	
(Uncorrelated)	2400-2483.5	4.4	
(Correlated)	2400-2483.5	7.41	

High Gain Antenna:

Chain	Frequency (MHz)	Gain (dBi)	Type
0	2400-2483.5	6.1	PIFA
1	2400-2483.5	6.1	
(Uncorrelated)	2400-2483.5	6.1	
(Correlated)	2400-2483.5	9.11	

NOTE: High gain was used in all of the testing as a worst-case since the power for all antenna gains was the same.

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Antenna gains for MIMO operations are calculated using the formulae from KDB 662911 D01 Multiple Transmitter Output v02r01 section F. As the two antennas have the same gain equations 2)a)(i) and 2)a)(ii) for correlated and uncorrelated transmissions respectively are used.

Correlated directional gain = G_{ANT} + 10 log(N_{ANT}) dBi, where N_{ANT} = 2 for a 2x2 MIMO device

Uncorrelated directional gain = G_{ANT}

6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 10.0.22621.1.

The test utility software used during testing was Qualcomm Radio Control Toolkit Version 4.0.118.1.

6.5. WORST-CASE CONFIGURATION AND MODE

All conducted emissions testing was performed as SISO to cover MIMO as a worst case, power-per-chain, mode. Output power was measured on SISO C0, SISO C1, and MIMO.

Radiated emissions below 1GHz and above 18GHz were performed with the EUT set to transmit at the channel with the highest power spectral density for SISO C0 and SISO C1, and highest average power for MIMO, as a worst-case mode.

Band edge was performed with the EUT set to transmit at the highest power on low and high channels. Testing was performed using a conducted restricted band edge setup. First, a traditional restricted band edge scan (C63.10 Section 11.12.2.5.2.1) was ran on chain 0 and chain 1, each operating in SISO mode as a worst-case scenario unless otherwise noted within the report. The data was then summed together accounting for the high gain antenna gain (worst-case), and duty cycle correction factor. On modes were the average summed data appeared to exceed the limit, a supplemental integration measurement (C63.10 Section 11.12.3.2.3) was performed on each chain at the band edge. Again, duty cycle correction and antenna gain were accounted for in the summing of the integration data. An example traditional band edge scan and integration plot has been included for each mode for reference. The summed tabular and plot data has been included for each scan.

For all bandedge testing, unless otherwise noted, the device was set to transmit at SISO power as a worst-case scenario. SISO C0 and SISO C1 was then summed to give a worst-case MIMO transmission.

All radiated emissions testing was performed using the high gain antenna boards in order to yield worst-case over the air results due to the power across all gains being the same.

Radiated spurious emissions between 1GHz and 18GHz were performed with the EUT set to transmit on low, mid, and high channels at the worst-case average power and PSD mode for SISO C0 and SISO C1, and at the worst-case average power mode for MIMO. These modes were found to be 1Mbps and 125kbps for SISO C0, 2Mbps and 500kbps for SISO C1, and 2Mbps for MIMO.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that Z orientation was worst-case orientation for SISO C0, SISO C1, and MIMO; therefore, all final radiated testing was performed with the antennas in Z orientation.

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6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
NUC	Intel	NuC	BTAN3160022Z/ BTAN322009FE/ BTAN331003QS/ BTAN331002VK	N/A
Intel NUC Charger	Chicony Power Technology	A17-120P2A	0432-05LT1002333012523	N/A

I/O CABLES

I/O Cable List						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	Ribbon	1	Ribbon	Unshielded	3>	Connects EUT to NUC
2	DC Mains	1	Barrel	Unshielded	3>	Connects NUC to DC Adaptor

TEST SETUP

Test software exercised the radio card.

SETUP DIAGRAMS

Please refer to R15374786-EP1 for setup diagrams

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7. MEASUREMENT METHOD

On Time and Duty Cycle: ANSI C63.10, Section 11.6: Zero-Span Spectrum Analyzer Method.

6 dB BW: ANSI C63.10 Subclause -11.8.1

Occupied BW (99%): ANSI C63.10-2020 Section 6.9.3

Output Power: ANSI C63.10 Subclause -11.9.2.3.1 Method PKPM1 Peak-reading power meter
ANSI C63.10 Subclause -11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading power meter)

PSD: ANSI C63.10 Subclause -11.10.2 Method PKPSD (peak PSD)

Emissions non-restricted frequency bands: ANSI C63.10 Subclause -11.11 and 6.10.4

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1 and 6.10.5

Radiated Spurious Emissions: ANSI C63.10-2020 Section 6.3 to 6.6

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8. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville – Chamber 4)

Equip. ID	Description	Manufacturer/Brand	Model Number	Last Cal.	Next Cal.
	1-18 GHz				
89509	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2023-05-23	2025-05-23
	Gain-Loss Chains				
207640	Gain-loss string: 1-18GHz	Various	Various	2024-05-22	2025-05-22
	Receiver & Software				
197955	Spectrum Analyzer	Rohde & Schwarz	ESW44	2024-04-16	2025-04-16
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Additional Equipment used				
241204	Environmental Meter	Fisher Scientific	15-077-963	2023-09-05	2025-09-05
**170112	10dB, DC-18GHz, 5W	Mini-Circuits	BW-N10W5	2023-11-09	2024-11-09

**NOTE: Testing on this equipment was performed within the active calibration date.

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Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville – Chamber 1)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	0.009-30MHz				
135144	Active Loop Antenna	ETS-Lindgren	6502	2024-10-02	2025-10-02
	30-1000 MHz				
90629	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2024-01-30	2026-01-30
	1-18 GHz				
135143	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2024-02-07	2026-02-07
	18-40 GHz				
204704	Horn Antenna, 18-26.5GHz	Com-Power	AH-826	2023-07-20	2025-07-20
	Gain-Loss Chains				
91974	Gain-loss string: 0.009-30MHz	Various	Various	2024-05-08	2025-05-08
91976	Gain-loss string: 25-1000MHz	Various	Various	2024-05-08	2025-05-08
91979	Gain-loss string: 1-18GHz	Various	Various	2024-05-08	2025-05-08
135999	Gain-loss string: 18-40GHz	Various	Various	2024-05-08	2025-05-08
	Receiver & Software				
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2024-03-05	2025-03-05
81018	Spectrum Analyzer	Agilent	E4446A	2024-07-31	2025-07-31
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Additional Equipment used				
241205	Environmental Meter	Fisher Scientific	15-077-963	2023-09-05	2025-09-05
**170112	10dB Pad, DC-18GHz, 5W	Mini-Circuits	BW-N10W5+	2023-11-09	2024-11-09

**NOTE: Testing on this equipment was performed within the active calibration date.

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Test Equipment Used - Wireless Conducted Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	Common Equipment				
	Conducted Room 1				
90416	Spectrum Analyzer	Keysight Technologies	N9030A	2024-09-23	2025-09-23
**206459	Spectrum Analyzer	Rohde & Schwarz	FSW	2023-11-15	2024-11-15
179892	Environmental Meter	Fisher Scientific	15-077-963	2024-08-12	2025-08-12
SOFTEMI	Antenna Port Software	UL	Version 2024.2.23	NA	NA
Power Software	Boonton Power Analyzer	Boonton	Version 3.0.13.0	NA	NA
	Conducted Room 2				
90410	Spectrum Analyzer	Keysight Technologies	N9030A	2024-06-14	2025-06-14
248881	Environmental Meter	Control Company	06-662-4	2024-04-10	2026-04-10
SOFTEMI	Antenna Port Software	UL	Version 2024.2.23	NA	NA
Power Software	Boonton Power Analyzer	Boonton	Version 3.0.13.0	NA	NA
	Additional Equipment used				
245262	Conducted Switch Box	UL	CSB	2024-02-20	2025-02-20

**NOTE: Testing on this equipment was performed within the active calibration date.

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9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

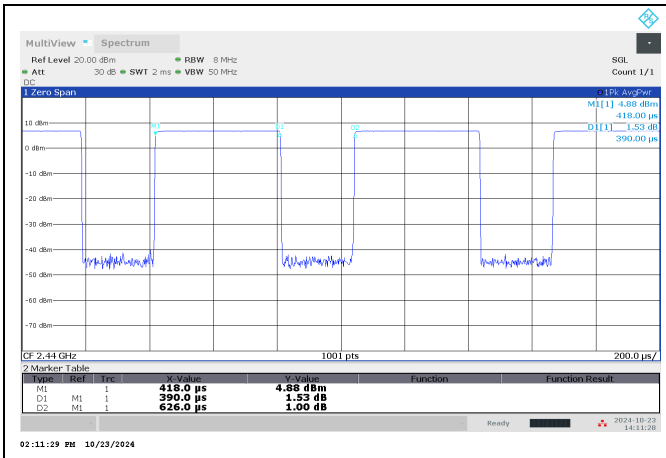
PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

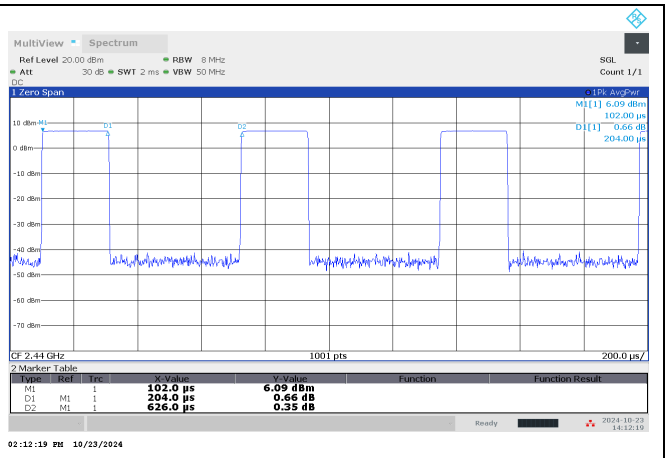
ON TIME AND DUTY CYCLE RESULTS

Mode	On Time (ms)	Period (ms)	Duty Cycle (linear)	Duty Cycle (%)	RMS Duty Cycle Correction Factor (dB)	Volt. AV Duty Cycle Correction Factor (dB)
BLE - 1Mbps	0.390	0.626	0.6230	62.30%	2.06	4.11
BLE - 2Mbps	0.204	0.626	0.3259	32.59%	4.87	9.74
BLE - 125kbps	3.105	3.750	0.8280	82.80%	0.82	1.64
BLE - 500kbps	1.066	1.875	0.5683	56.83%	2.45	4.91

Tester ID:
107116/85502



DUTY CYCLE BLE 1Mbps



DUTY CYCLE BLE 2Mbps

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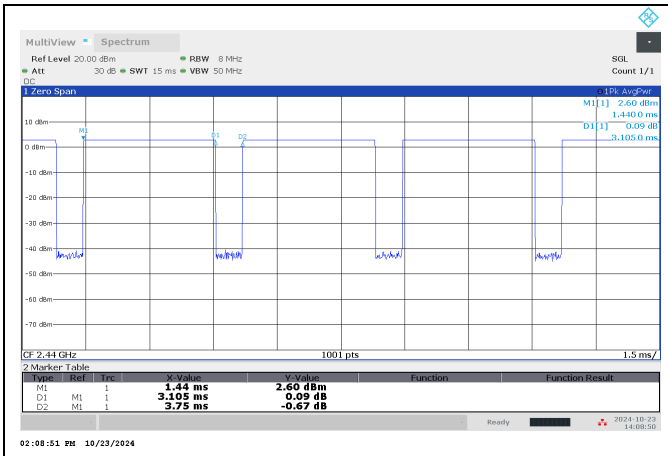
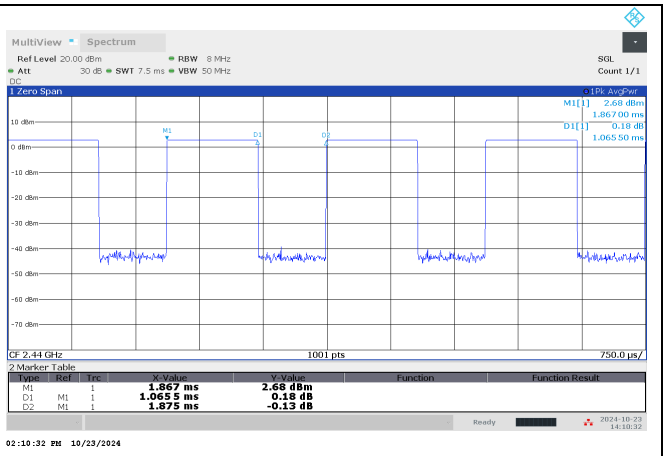


DUTY CYCLE BLE 125kbps



DUTY CYCLE BLE 500kbps

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9.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

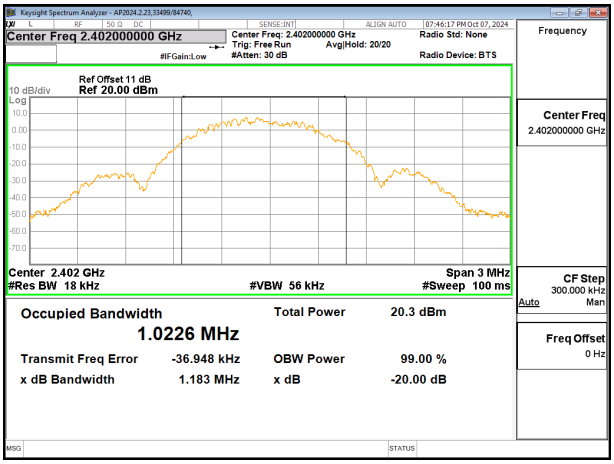
RESULTS

NOTE: Peak detection and max-hold trace was used for all 99% OBW measurements.

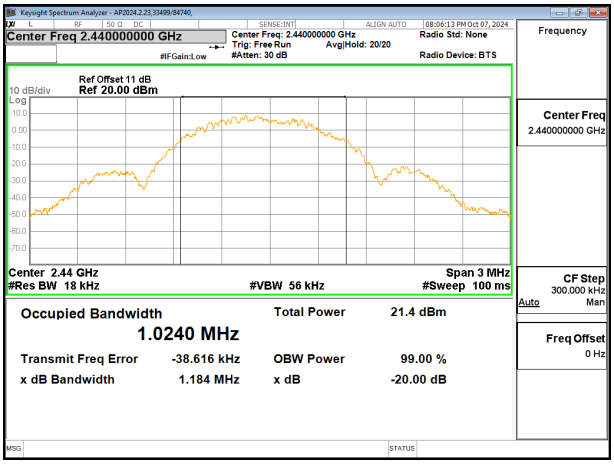
9.2.1. BLE (1Mbps)

Chain 0

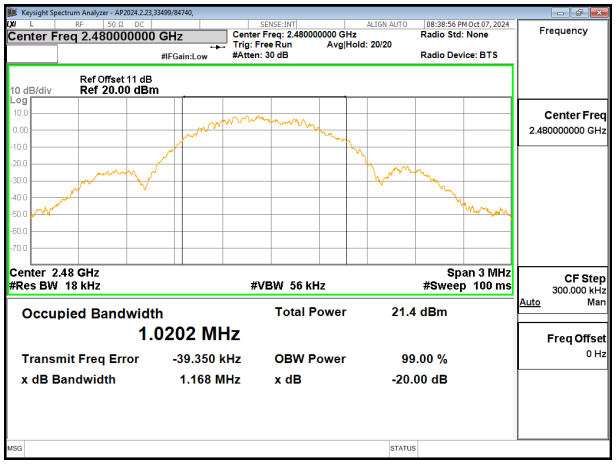
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0226
Middle	2440	1.0240
High	2480	1.0202



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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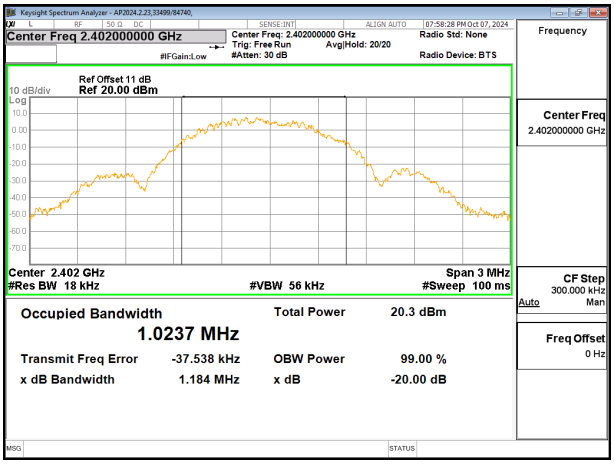
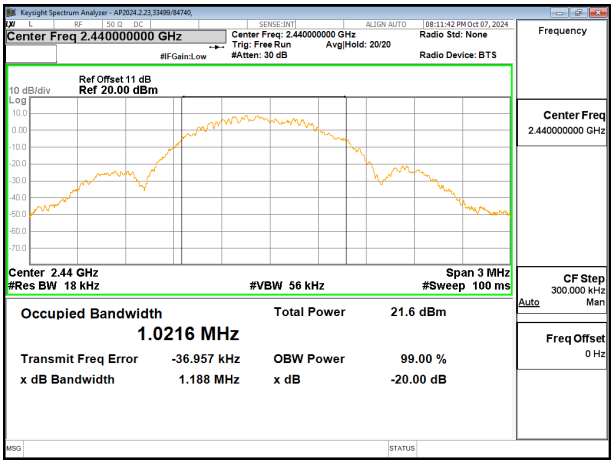
Chain 1

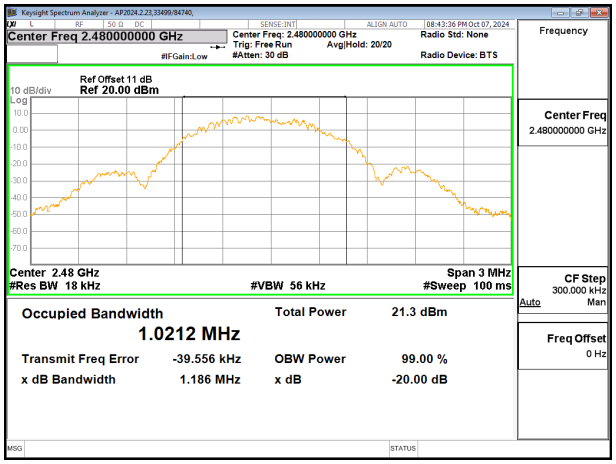
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0237
Middle	2440	1.0216
High	2480	1.0212



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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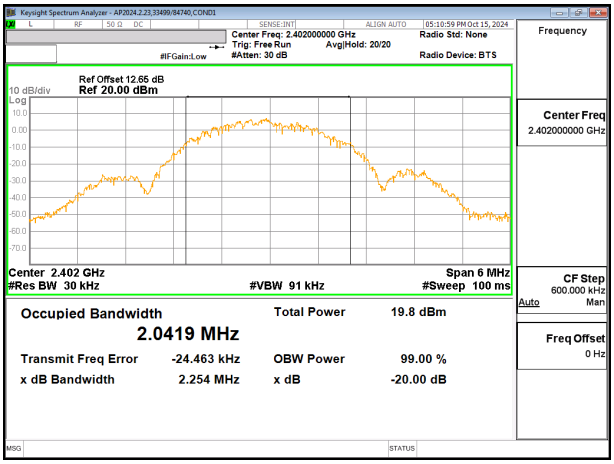
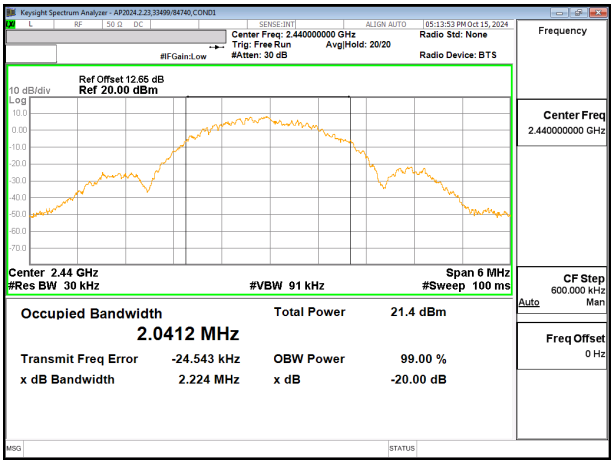
9.2.2. BLE (2Mbps)

Chain 0

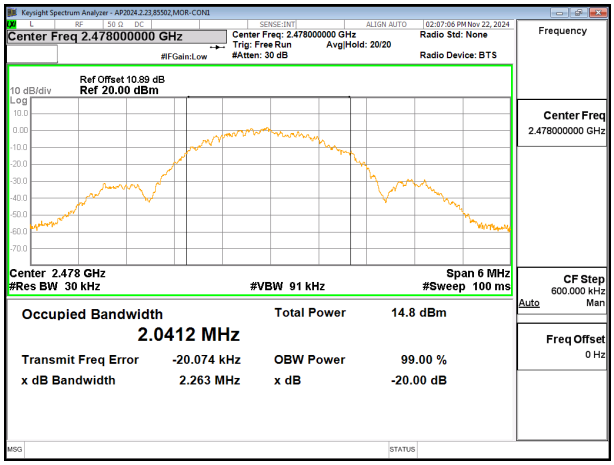
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0419
Middle	2440	2.0412
High	2478	2.0412



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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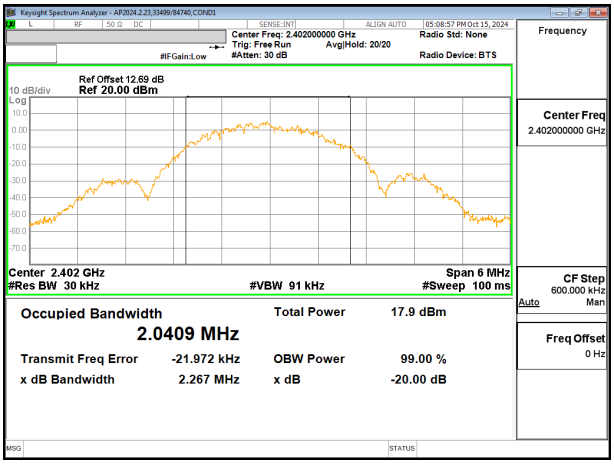
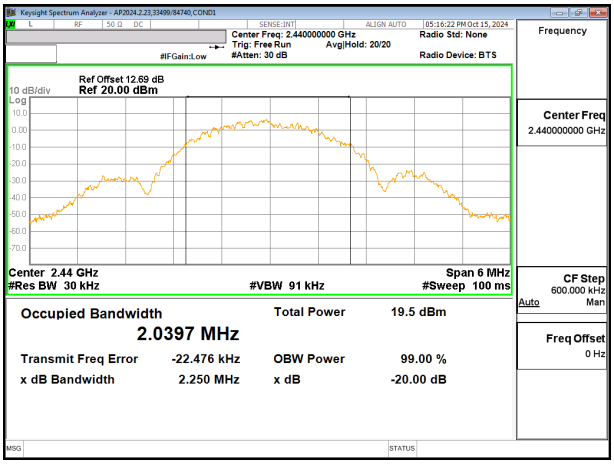
Chain 1

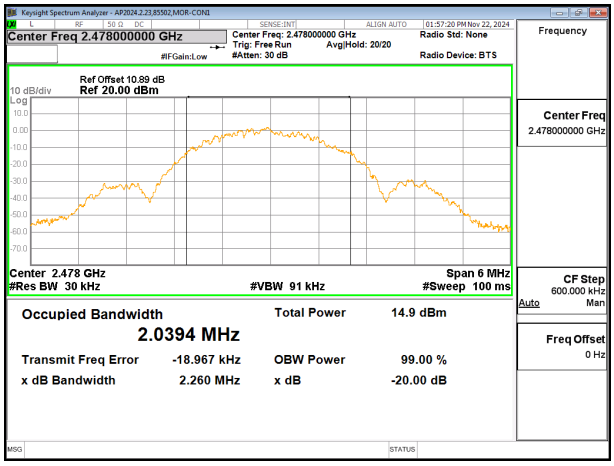
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	2.0409
Middle	2440	2.0397
High	2478	2.0394



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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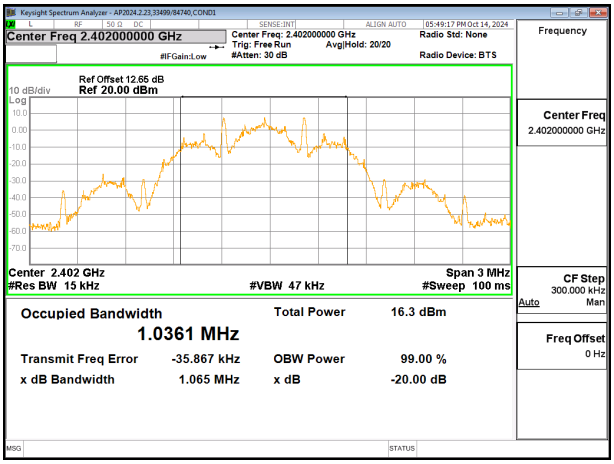
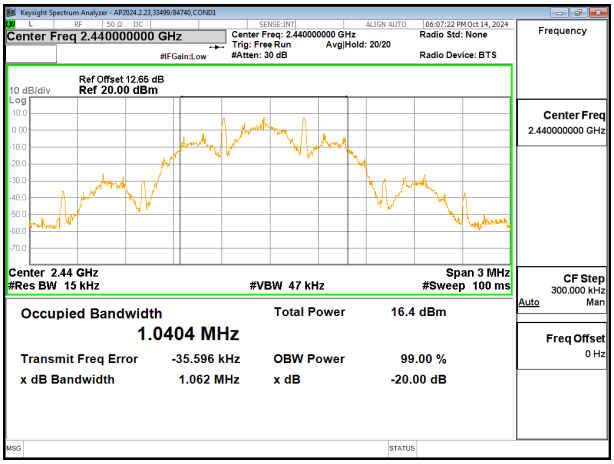
9.2.3. BLE (125Kbps)

Chain 0

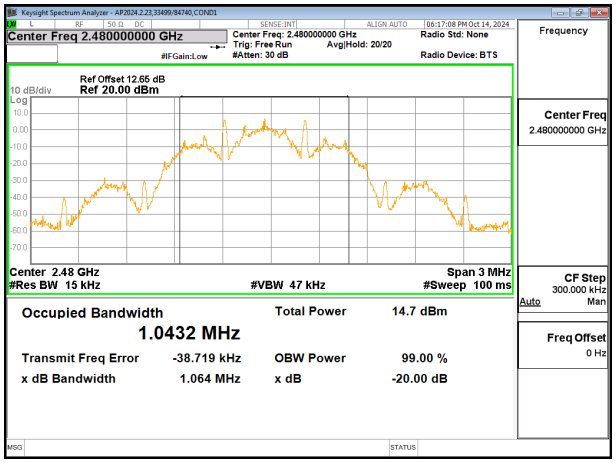
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0361
Middle	2440	1.0404
High	2480	1.0432



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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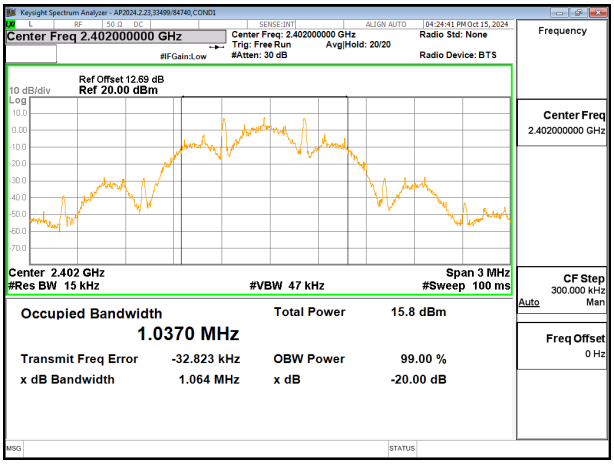
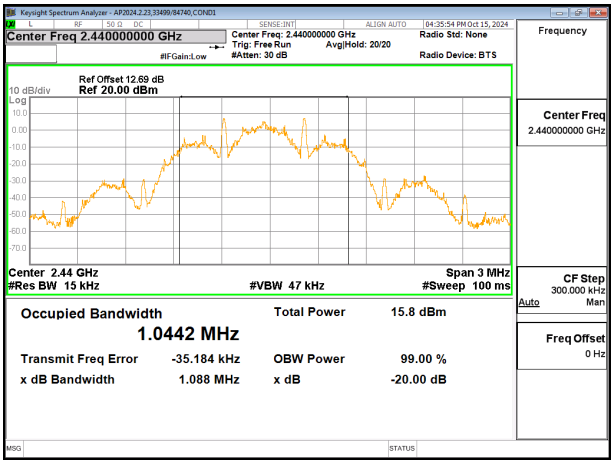
Chain 1

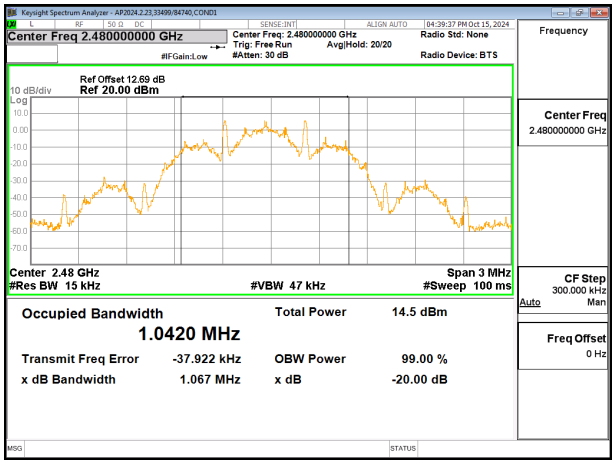
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0370
Middle	2440	1.0442
High	2480	1.0420



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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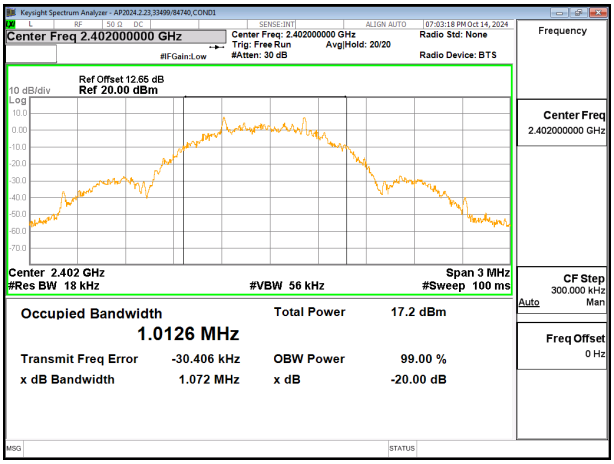
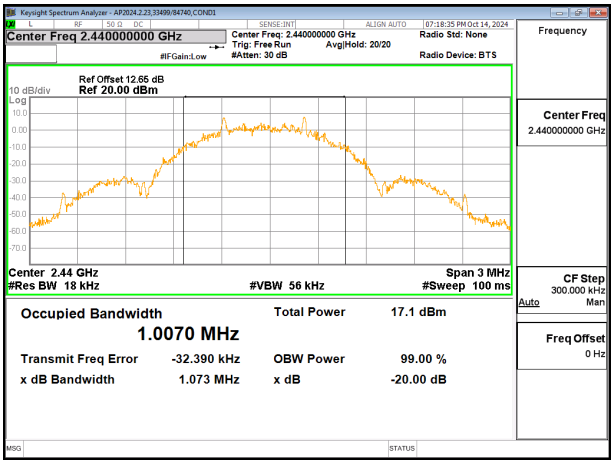
9.2.4. BLE (500Kbps)

Chain 0

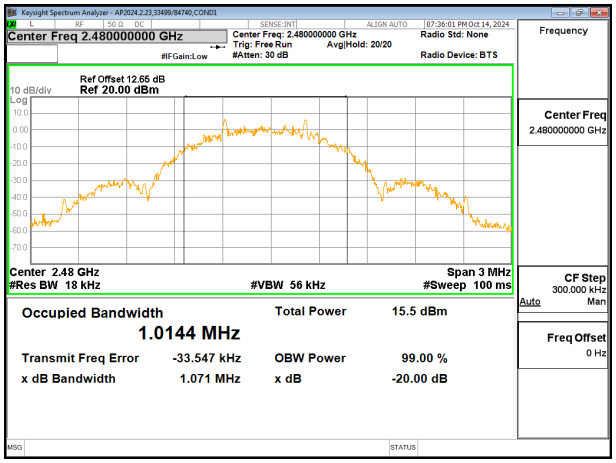
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0126
Middle	2440	1.0070
High	2480	1.0144



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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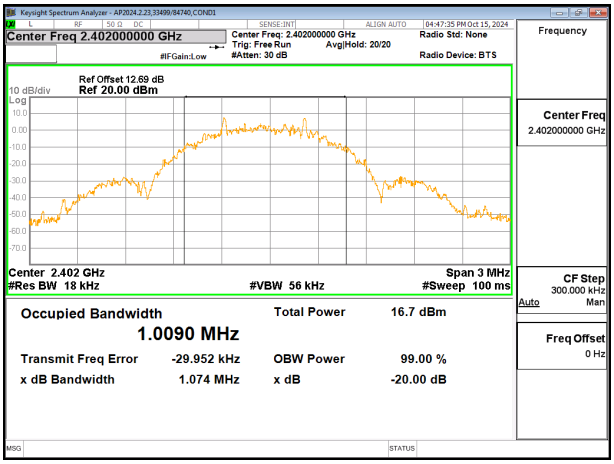
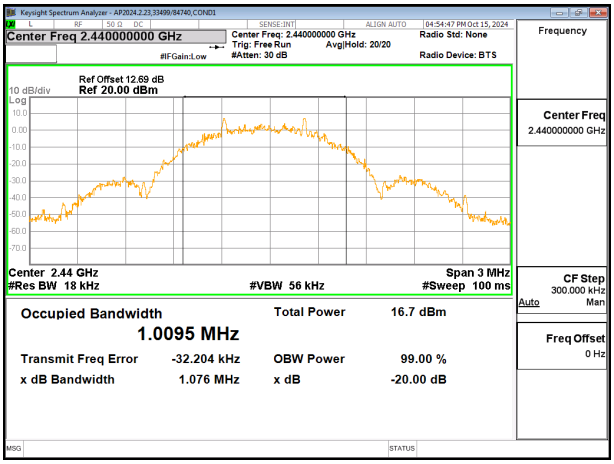
Chain 1

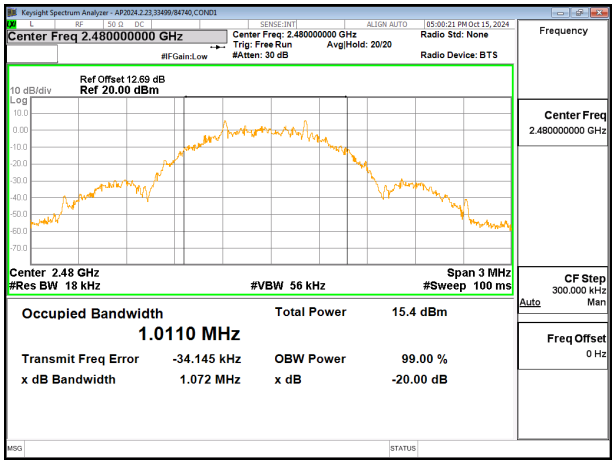
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0090
Middle	2440	1.0095
High	2480	1.0110



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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9.3. 6 dB BANDWIDTH

LIMITS

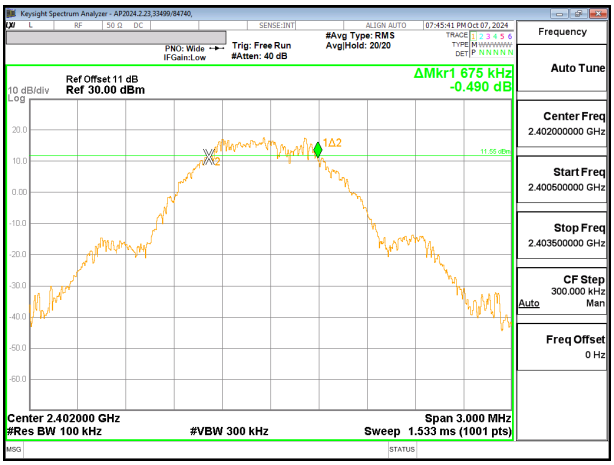
FCC §15.247 (a) (2)
RSS-247 5.2 (a)
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

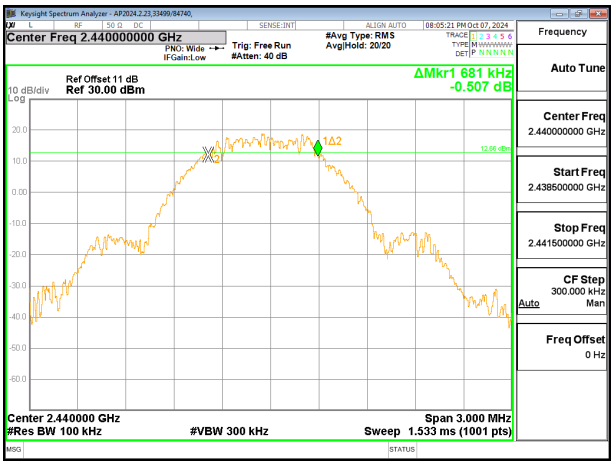
9.3.1. BLE (1Mbps)

Chain 0

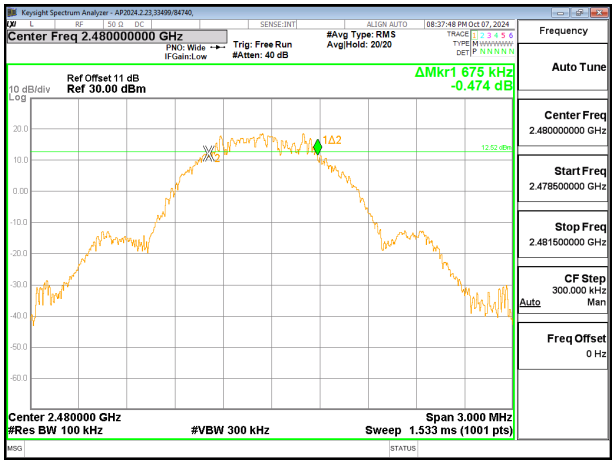
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.675	0.5
Middle	2440	0.681	0.5
High	2480	0.675	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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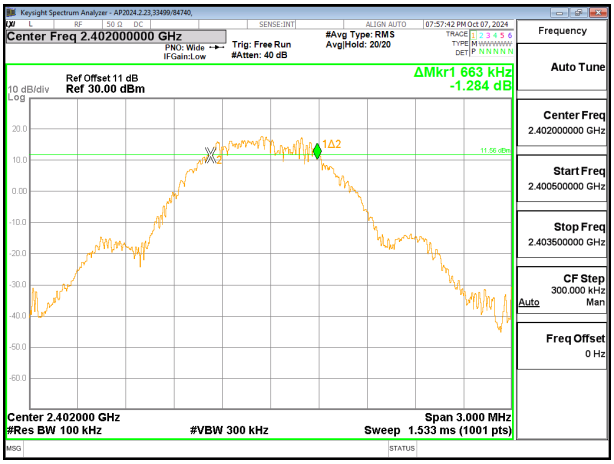
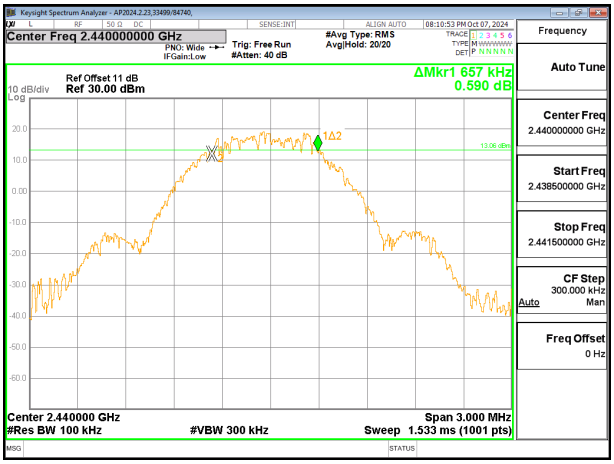
Chain 1

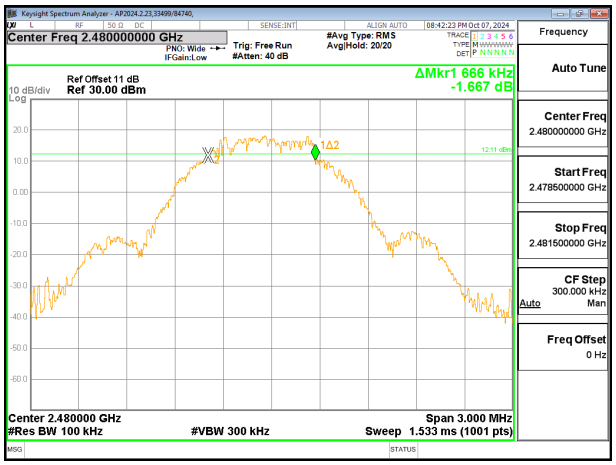
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.663	0.5
Middle	2440	0.657	0.5
High	2480	0.666	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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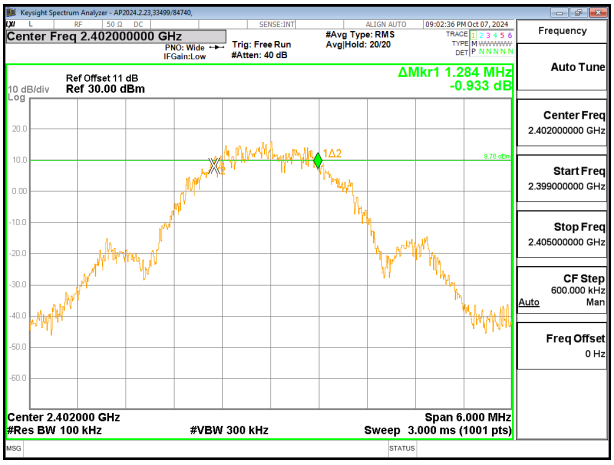
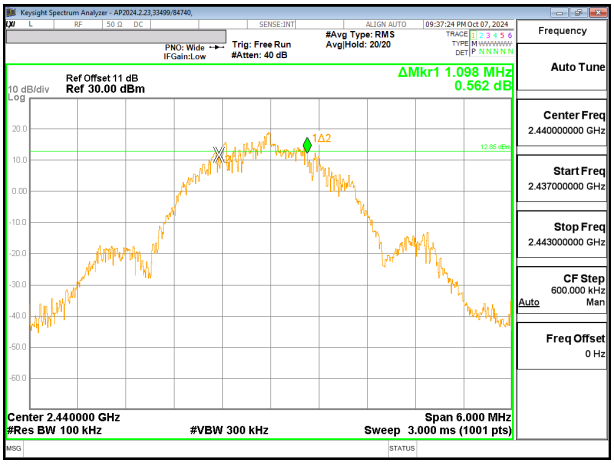
9.3.2. BLE (2Mbps)

Chain 0

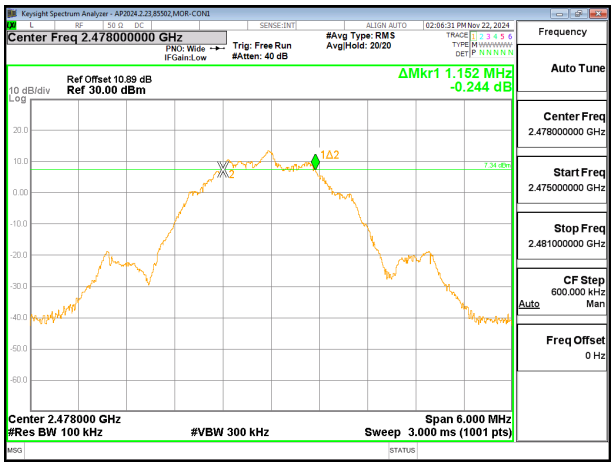
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.284	0.5
Middle	2440	1.098	0.5
High	2478	1.152	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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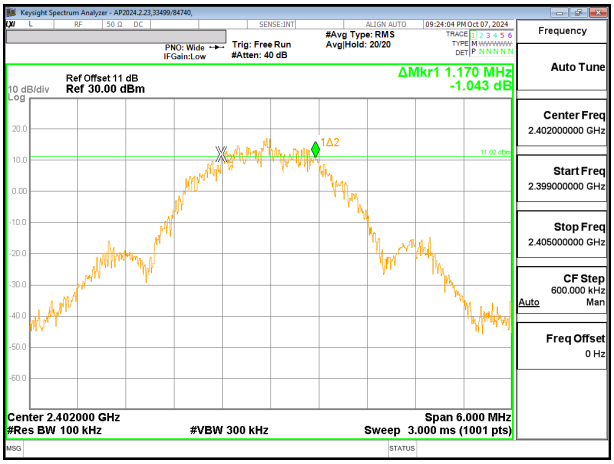
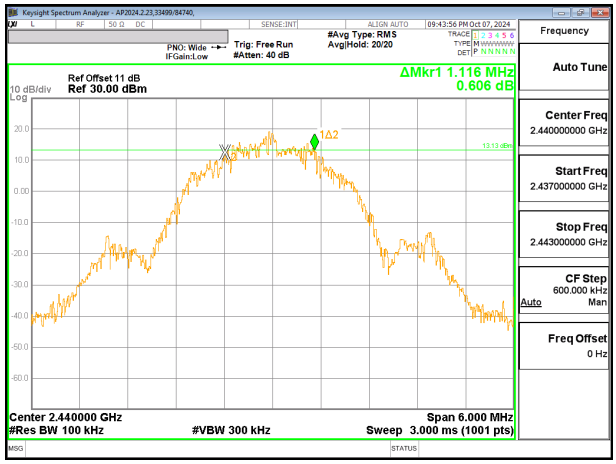
Chain 1

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	1.170	0.5
Middle	2440	1.116	0.5
High	2478	1.242	0.5



LOW CHANNEL



MID CHANNEL

HIGH CHANNEL

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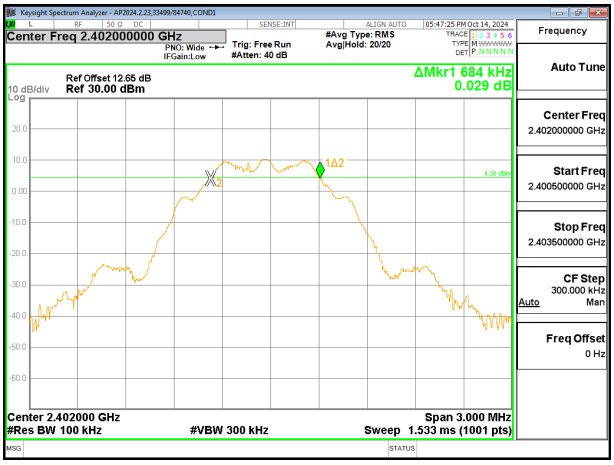
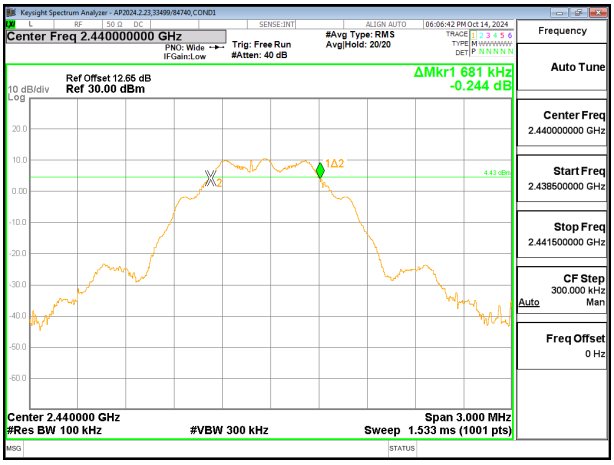
9.3.3. BLE (125Kbps)

Chain 0

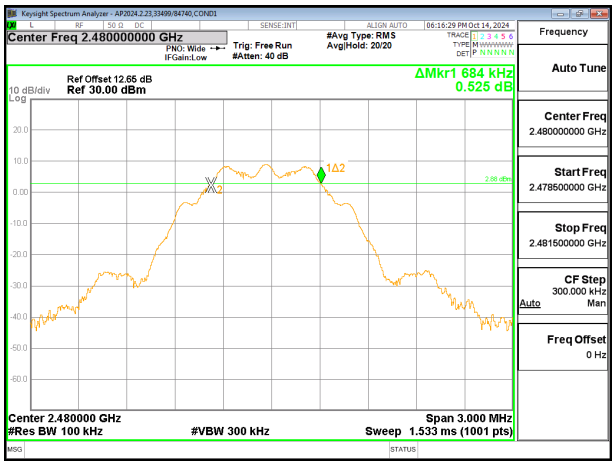
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.684	0.5
Middle	2440	0.681	0.5
High	2480	0.684	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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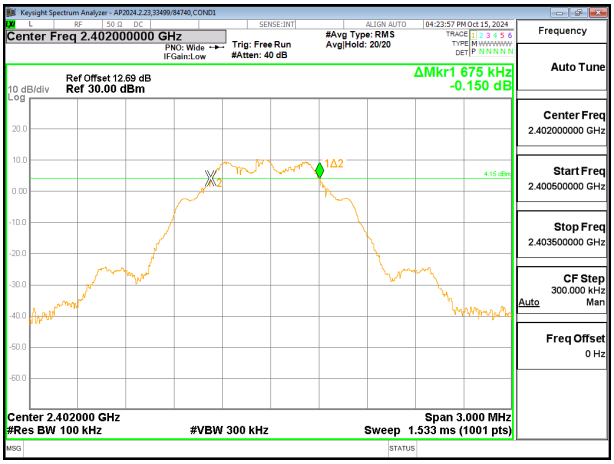
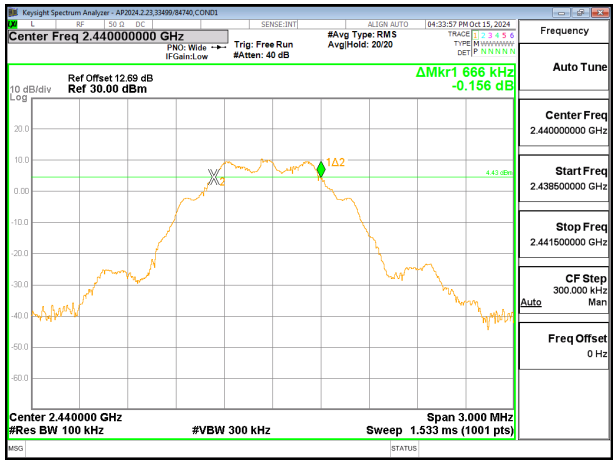
Chain 1

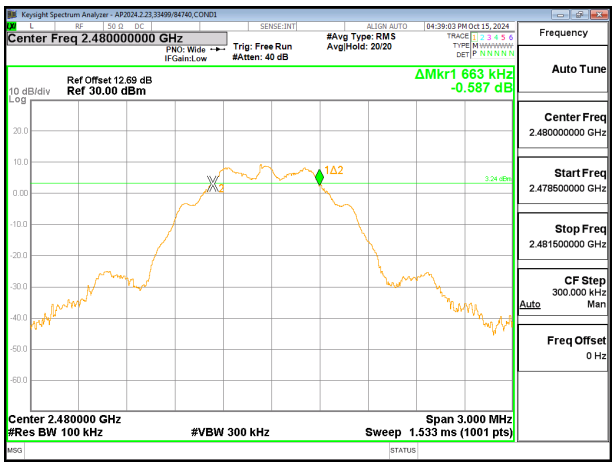
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.675	0.5
Middle	2440	0.666	0.5
High	2480	0.663	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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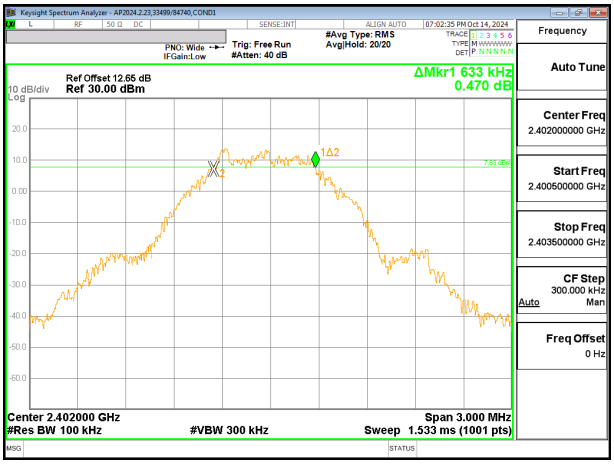
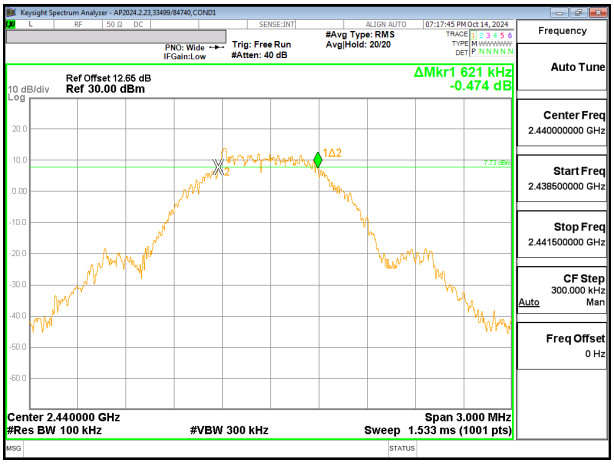
9.3.4. BLE (500Kbps)

Chain 0

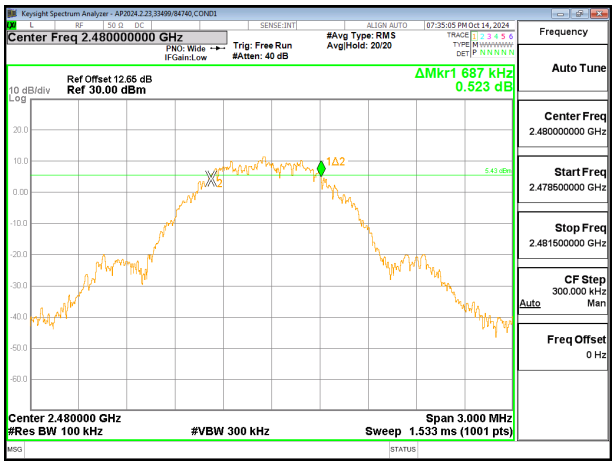
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.633	0.5
Middle	2440	0.621	0.5
High	2480	0.687	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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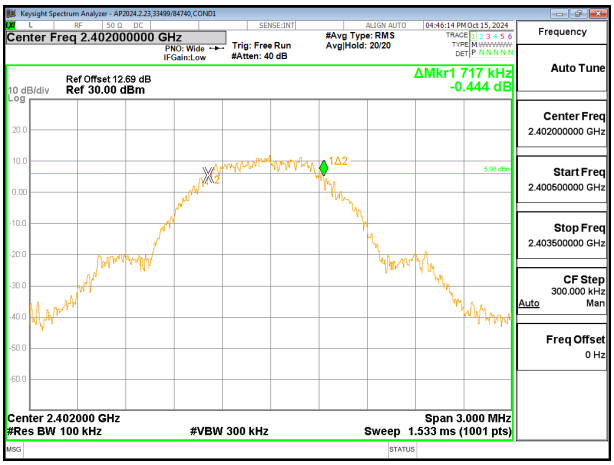
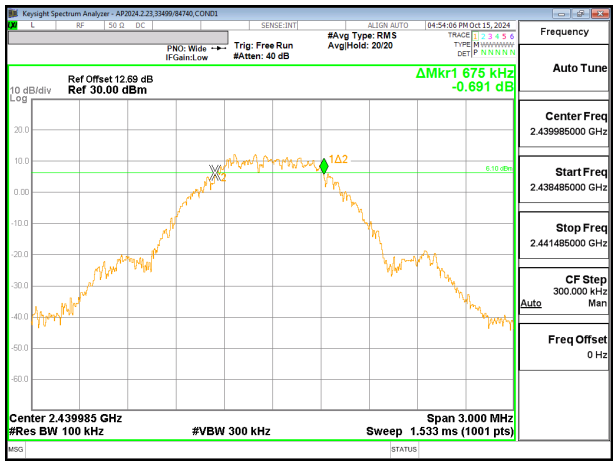
Chain 1

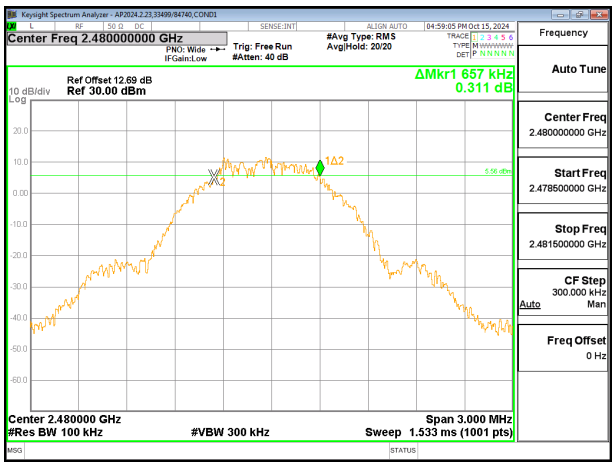
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.717	0.5
Middle	2440	0.675	0.5
High	2480	0.657	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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9.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)
RSS-247 5.4 (d)

The maximum SISO and uncorrelated antenna gain is 6.1 dBi, greater than the 6 dBi requirement. Therefore the 30 dBm limit is reduced by 0.1 dBm to 29.9 dBm.

TEST PROCEDURE
The transmitter output is connected to a wideband RF power meter.

The cable assembly insertion loss of 11.04 dB for C0 (including 9.72 dB pad and 1.32 dB EUT cable) and 11 dB for C1 (9.68 dB pad and 1.32 dB EUT) was entered as an offset in the power meter.

RESULTS

UL LLC
12 Laboratory Drive, Research Triangle Park, NC 27709; USA TEL:(919) 549-1400

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9.4.1. BLE (1Mbps)

Chain 0

Tested By:	33499/84740
Date:	2024-10-07

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	19.43	29.9	-10.470
Middle	2440	19.88	29.9	-10.020
High	2480	19.75	29.9	-10.150

Chain 1

Tested By:	33499/84740
Date:	2024-10-07

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	17.730	29.9	-12.170
Middle	2440	18.880	29.9	-11.020
High	2480	19.240	29.9	-10.660

2Tx MIMO

Tested By:	33499/84740
Date:	2024-10-07

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	PK MIMO power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	14.46	14.89	17.69	29.9	-12.21
Middle	2440	14.46	14.86	17.67	29.9	-12.23
High	2480	12.96	13.70	16.36	29.9	-13.54

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9.4.2. BLE (2Mbps)

Chain 0

Tested By:	33499/84740, 85502
Date:	2024-10-07, 2024-11-22

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.810	29.9	-11.090
Middle	2440	20.190	29.9	-9.710
High	2478	19.530	29.9	-10.370

Chain 1

Tested By:	33499/84740, 85502
Date:	2024-10-07, 2024-11-22

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	19.320	29.9	-10.580
Middle	2440	20.260	29.9	-9.640
High	2478	19.930	29.9	-9.970

2Tx MIMO

Tested By:	33499/84740, 85502
Date:	2024-10-07, 2024-11-22

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	PK MIMO power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	14.18	14.59	17.40	29.9	-12.50
Middle	2440	14.93	15.04	18.00	29.9	-11.90
High	2478	14.11	13.82	16.98	29.9	-12.92

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9.4.3. BLE (125Kbps)

Chain 0

Tested By:	107116/85502
Date:	2024-10-14

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	14.520	29.9	-15.380
Middle	2440	14.630	29.9	-15.270
High	2480	13.200	29.9	-16.700

Chain 1

Tested By:	107116/85502
Date:	2024-10-14

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	14.290	29.9	-15.610
Middle	2440	14.430	29.9	-15.470
High	2480	13.060	29.9	-16.840

2Tx MIMO

Tested By:	107116/85502
Date:	2024-10-14

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	PK MIMO power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	10.76	10.21	13.50	29.9	-16.40
Middle	2440	11.11	10.46	13.80	29.9	-16.10
High	2480	9.96	9.58	12.78	29.9	-17.12

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9.4.4. BLE (500Kbps)

Chain 0

Tested By:	107116/85502
Date:	2024-10-14

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	14.470	29.9	-15.430
Middle	2440	14.760	29.9	-15.140
High	2480	13.330	29.9	-16.570

Chain 1

Tested By:	107116/85502
Date:	2024-10-14

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	14.390	29.9	-15.510
Middle	2440	14.460	29.9	-15.440
High	2480	13.120	29.9	-16.780

2Tx MIMO

Tested By:	107116/85502
Date:	2024-10-14

Channel	Frequency (MHz)	Chain 0 PK Power (dBm)	Chain 1 PK Power (dBm)	PK MIMO power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	9.66	10.24	12.97	29.9	-16.93
Middle	2440	11.20	10.44	13.85	29.9	-16.05
High	2480	10.06	9.64	12.87	29.9	-17.03

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9.5. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a wideband gated RF power meter.

The cable assembly insertion loss of 11.04 dB for C0 (including 9.72 dB pad and 1.32 dB EUT cable) and 11 dB for C1 (9.68 dB pad and 1.32 dB EUT) was entered as an offset in the power meter.

RESULTS

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9.5.1. BLE (1Mbps)

Chain 0

Tested By:	33499/84740
Date:	2024-10-07

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	19.11
Middle	2440	19.46
High	2480	19.36

Chain 1

Tested By:	33499/84740
Date:	2024-10-07

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	17.41
Middle	2440	18.59
High	2480	18.89

2Tx MIMO

Tested By:	33499/84740
Date:	2024-10-07

Channel	Frequency (MHz)	Chain 0 AV Power (dBm)	Chain 1 AV Power (dBm)	AV MIMO power (dBm)
Low	2402	14.12	14.56	17.36
Middle	2440	14.13	14.58	17.37
High	2480	12.52	13.33	15.95

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9.5.2. BLE (2Mbps)

Chain 0

Tested By:	33499/84740, 85502
Date:	2024-10-07, 2024-11-22

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	18.12
Middle	2440	19.45
High	2478	19.1

Chain 1

Tested By:	33499/84740, 85502
Date:	2024-10-07, 2024-11-22

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	18.71
Middle	2440	19.41
High	2478	19.46

2Tx MIMO

Tested By:	33499/84740, 85502
Date:	2024-10-07, 2024-11-22

Channel	Frequency (MHz)	Chain 0 AV Power (dBm)	Chain 1 AV Power (dBm)	AV MIMO power (dBm)
Low	2402	14.20	14.60	17.41
Middle	2440	14.56	14.71	17.65
High	2478	13.78	13.54	16.67

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9.5.3. BLE (125Kbps)

Chain 0

Tested By:	33499/84740
Date:	2024-10-14

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	14.24
Middle	2440	14.35
High	2480	12.9

Chain 1

Tested By:	33499/84740
Date:	2024-10-14

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	14.00
Middle	2440	14.13
High	2480	12.73

2Tx MIMO

Tested By:	33499/84740
Date:	2024-10-14

Channel	Frequency (MHz)	Chain 0 AV Power (dBm)	Chain 1 AV Power (dBm)	AV MIMO power (dBm)
Low	2402	10.46	9.86	13.18
Middle	2440	10.78	10.11	13.47
High	2480	9.60	9.23	12.43

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9.5.4. BLE (500Kbps)

Chain 0

Tested By:	33499/84740
Date:	2024-10-14

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	14.37
Middle	2440	14.47
High	2480	13.02

Chain 1

Tested By:	33499/84740
Date:	2024-10-14

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	14.09
Middle	2440	14.18
High	2480	12.79

2Tx MIMO

Tested By:	33499/84740
Date:	2024-10-14

Channel	Frequency (MHz)	Chain 0 AV Power (dBm)	Chain 1 AV Power (dBm)	AV MIMO power (dBm)
Low	2402	9.38	9.92	12.67
Middle	2440	10.89	10.14	13.54
High	2480	9.72	9.28	12.52

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9.6. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)
RSS-247 (5.2) (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

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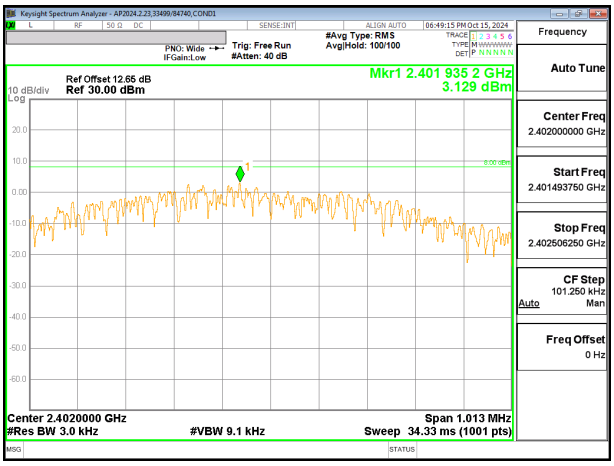
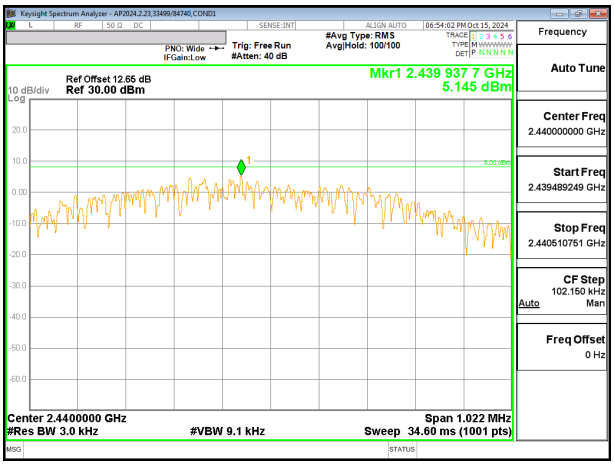
9.6.1. BLE (1Mbps)

Chain 0

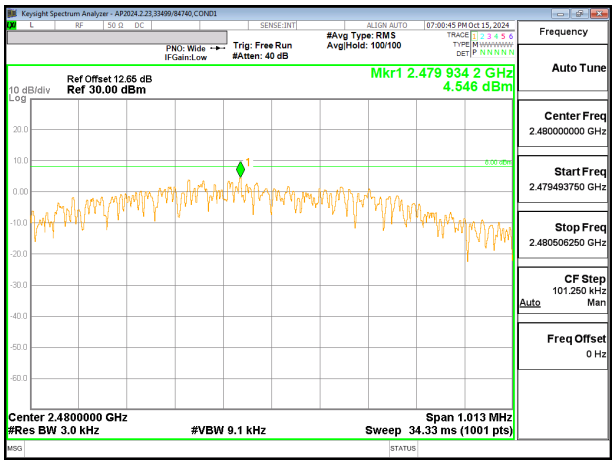
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	3.129	7.9	-4.77
Middle	2440	5.145	7.9	-2.76
High	2480	4.546	7.9	-3.35



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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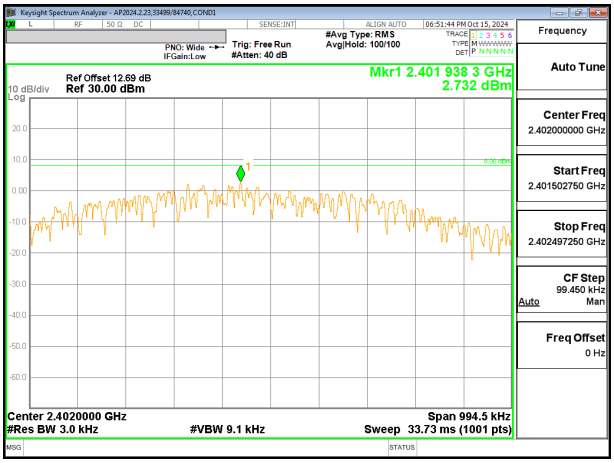
Chain 1

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	2.732	7.9	-5.17
Middle	2440	3.680	7.9	-4.22
High	2480	3.164	7.9	-4.74



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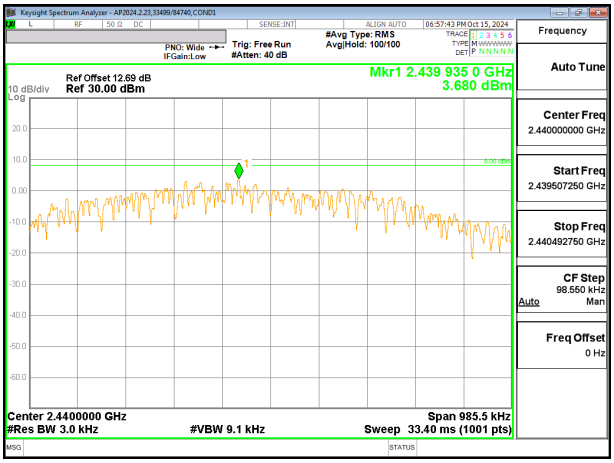

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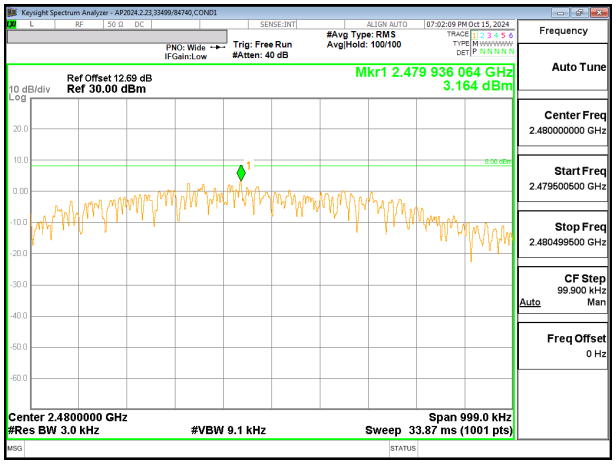

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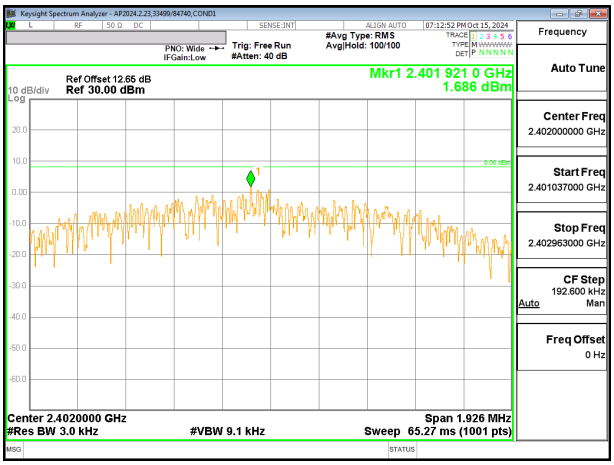
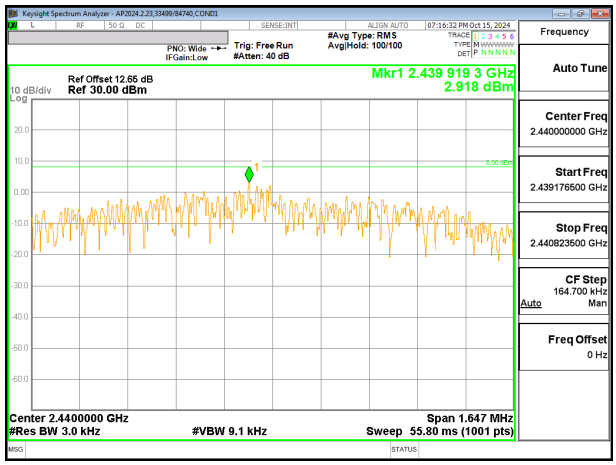
9.6.2. BLE (2Mbps)

Chain 0

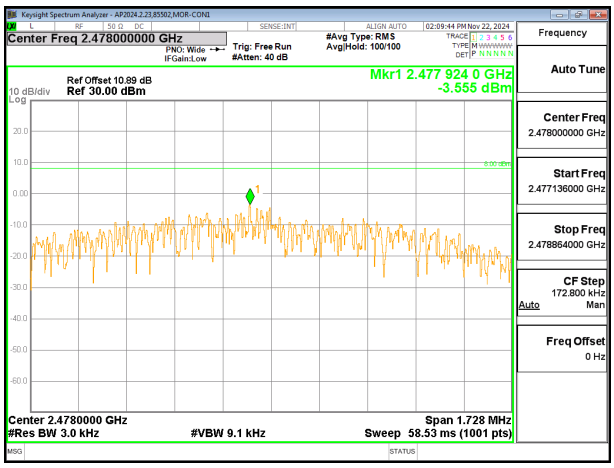
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	1.686	7.9	-6.21
Middle	2440	2.918	7.9	-4.98
High	2478	-3.555	7.9	-11.46



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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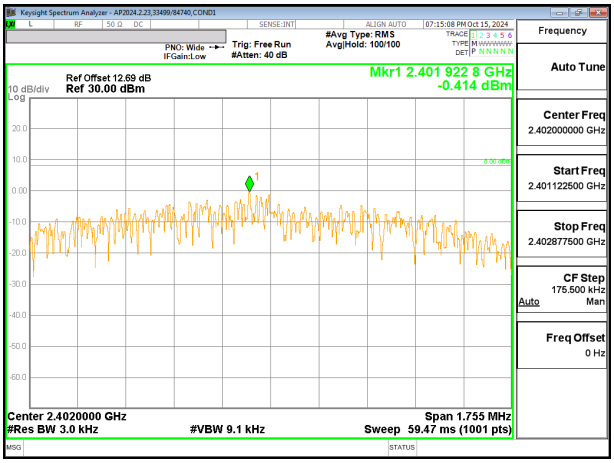
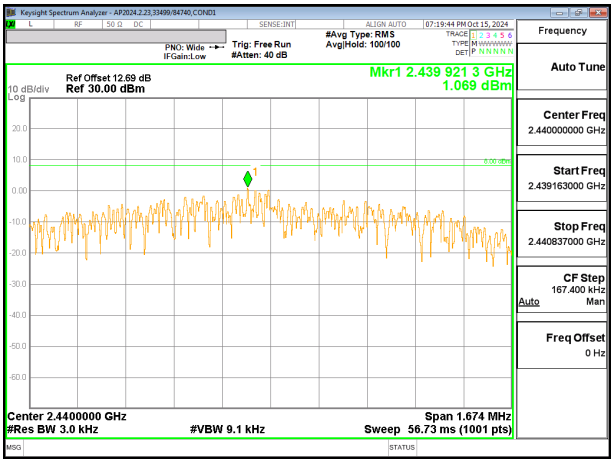
Chain 1

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	-0.414	7.9	-8.31
Middle	2440	1.069	7.9	-6.83
High	2478	-3.580	7.9	-11.48



LOW CHANNEL



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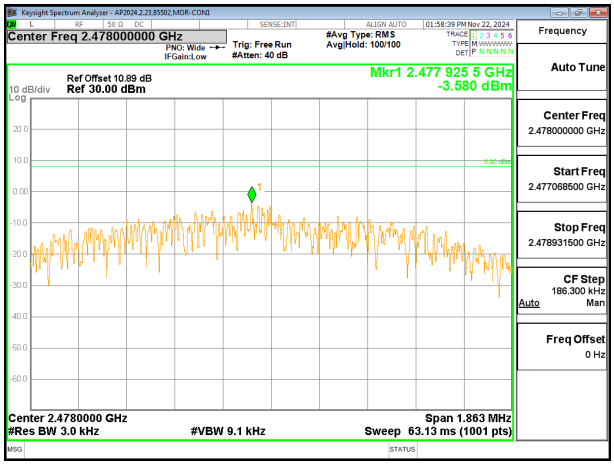

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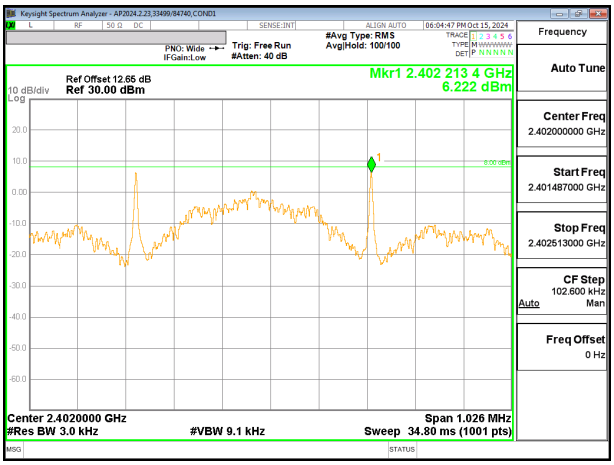
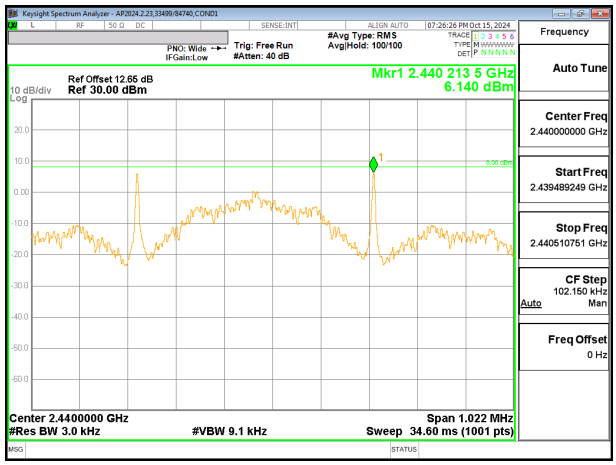
9.6.3. BLE (125Kbps)

Chain 0

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	6.222	7.9	-1.68
Middle	2440	6.140	7.9	-1.76
High	2480	4.784	7.9	-3.12



LOW CHANNEL



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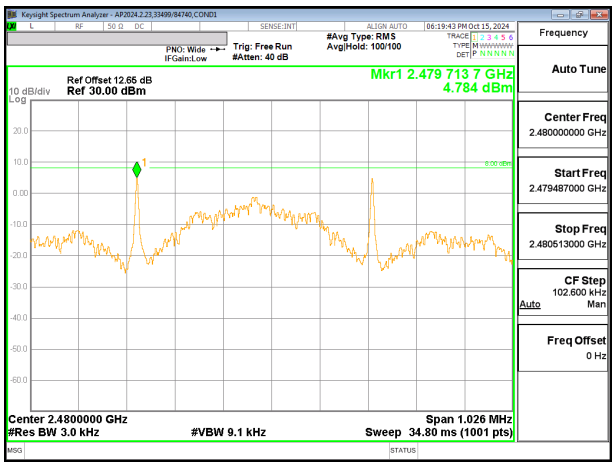

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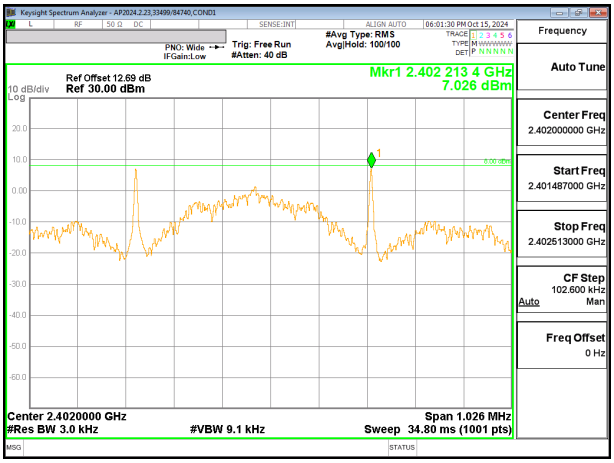
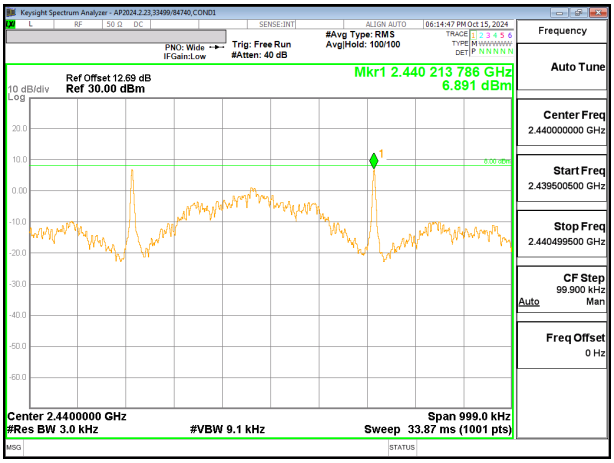
Chain 1

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	7.026	7.9	-0.87
Middle	2440	6.891	7.9	-1.01
High	2480	4.343	7.9	-3.56



LOW CHANNEL



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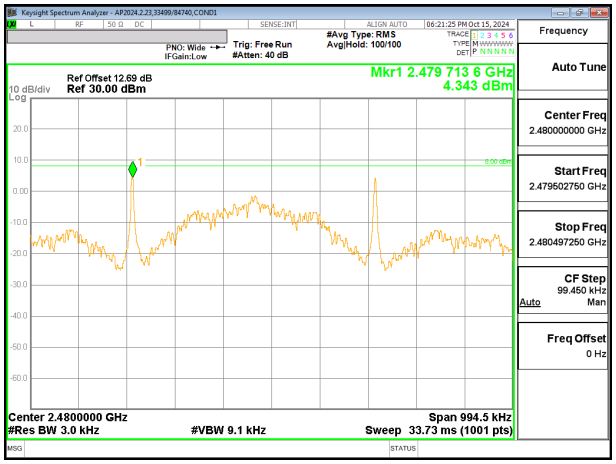

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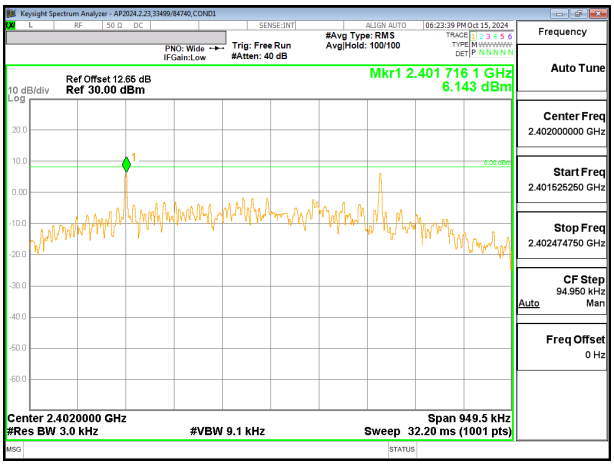
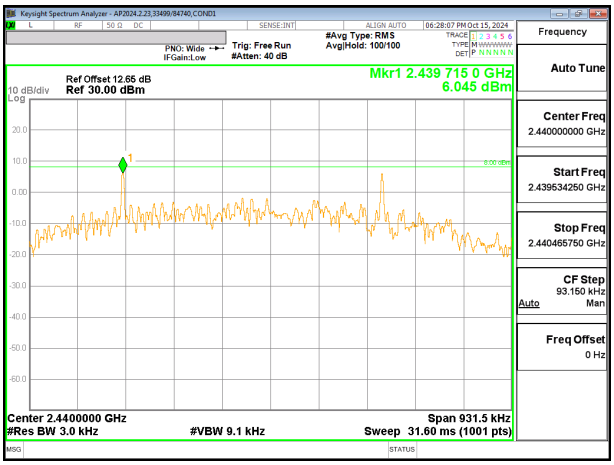
9.6.4. BLE (500Kbps)

Chain 0

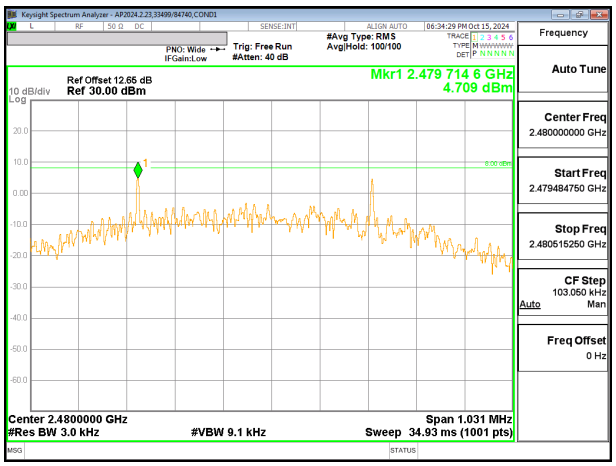
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	6.143	7.9	-1.76
Middle	2440	6.045	7.9	-1.86
High	2480	4.709	7.9	-3.19



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

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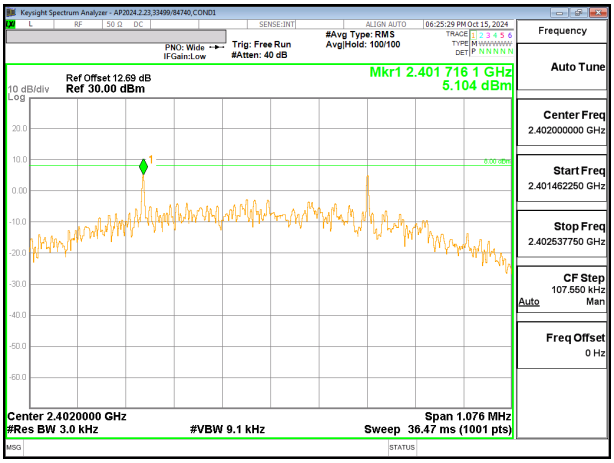
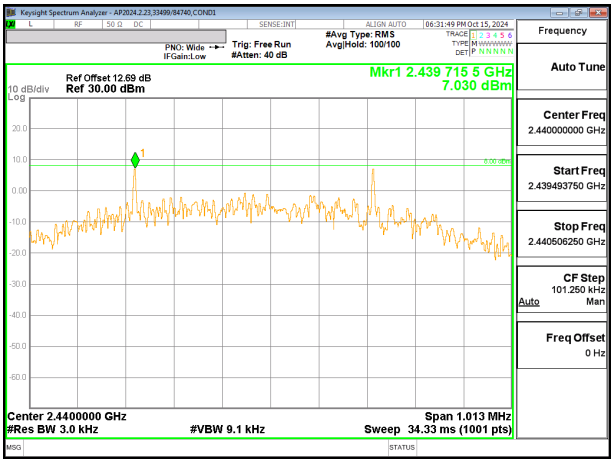
Chain 1

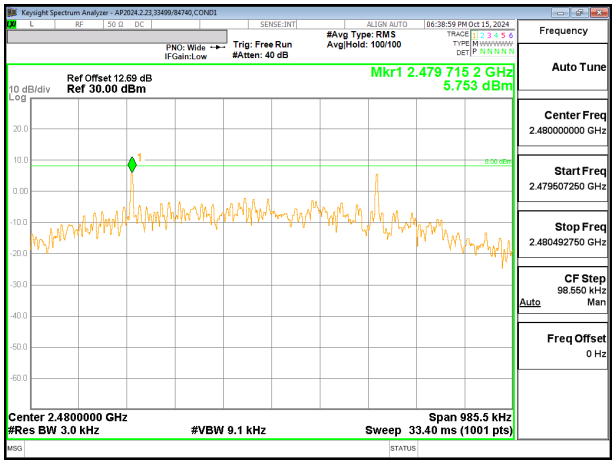
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	5.104	7.9	-2.80
Middle	2440	7.030	7.9	-0.87
High	2480	5.753	7.9	-2.15



LOW CHANNEL



MID CHANNEL



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9.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)
RSS-247 5.5

Output power was measured based on the use of a peak measurement, therefore the required attenuation is -20 dBc.

RESULTS

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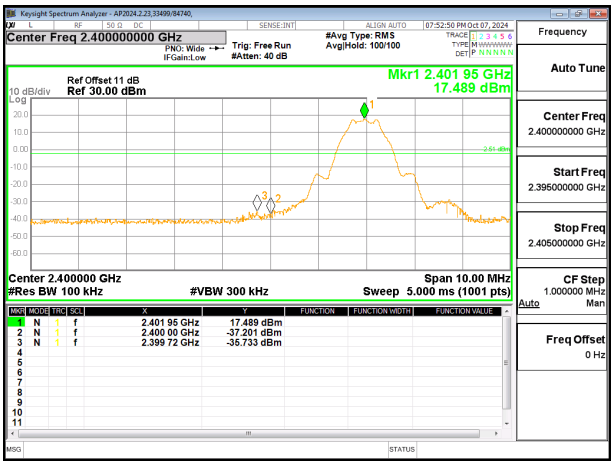
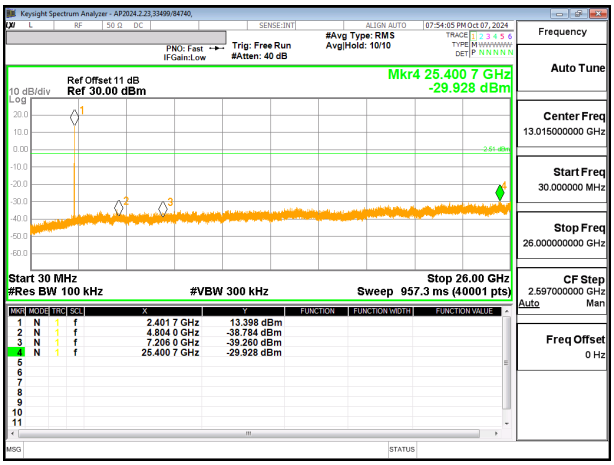
9.7.1. BLE (1Mbps)

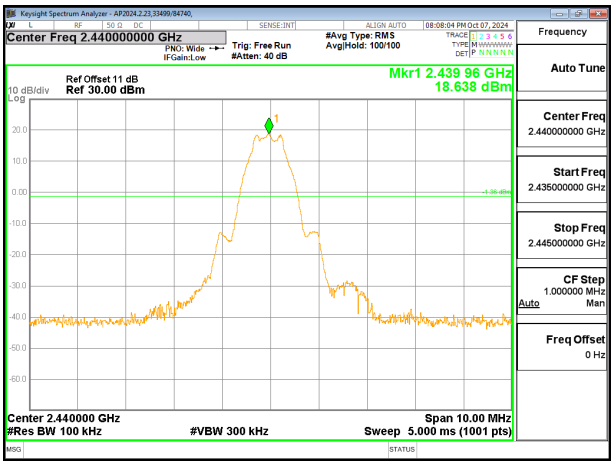
Chain 0



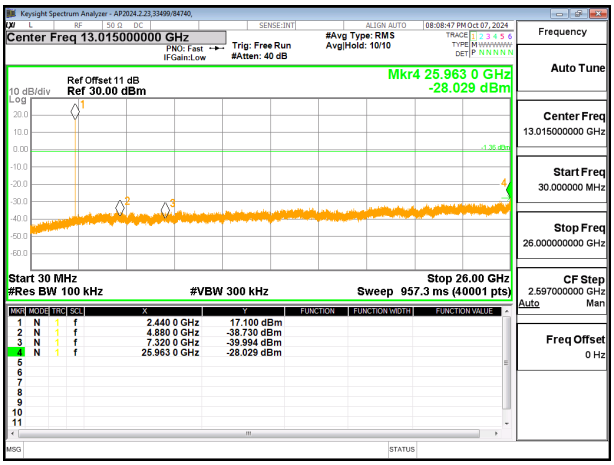
LOW CHANNEL BANDEDGE



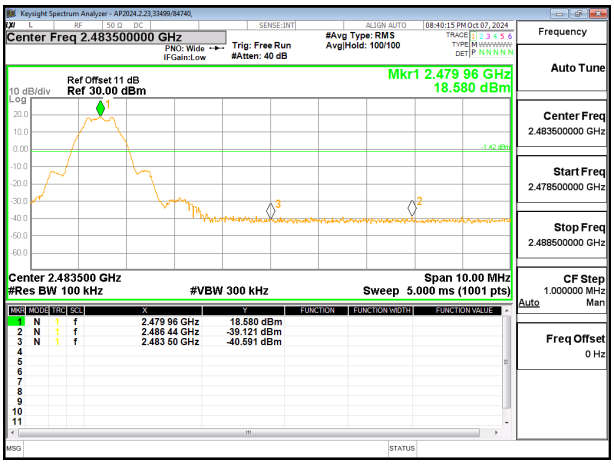
OUT-OF-BAND LOW CHANNEL



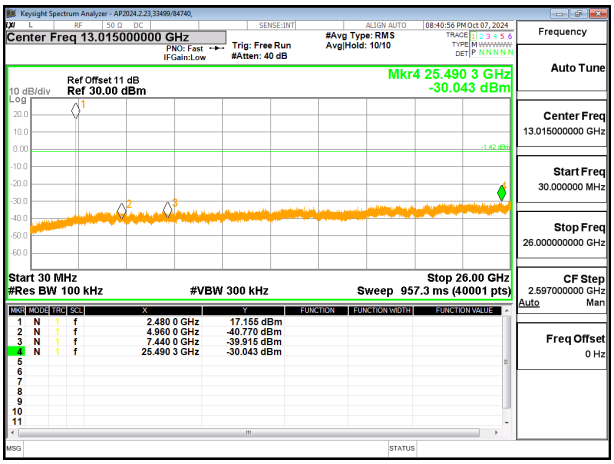
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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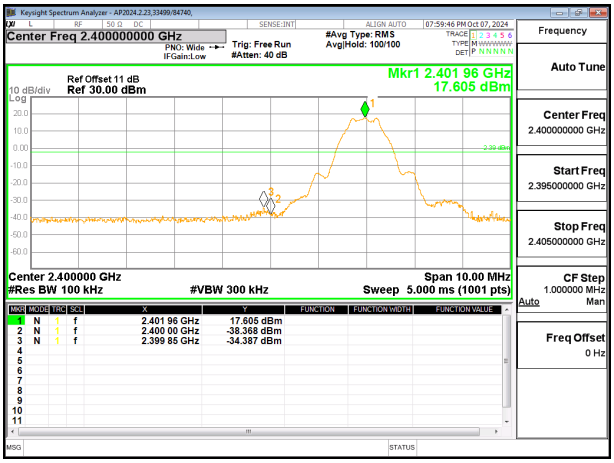
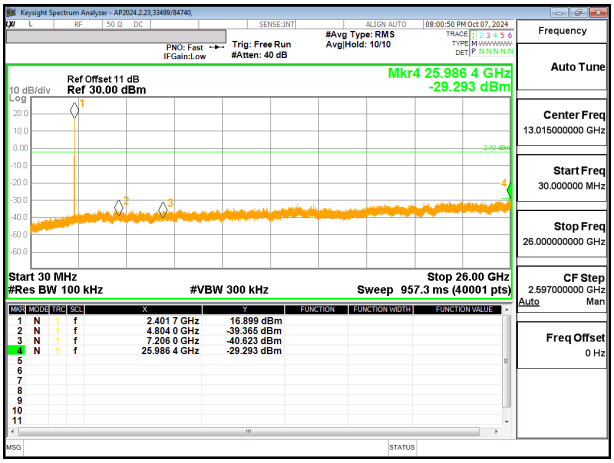
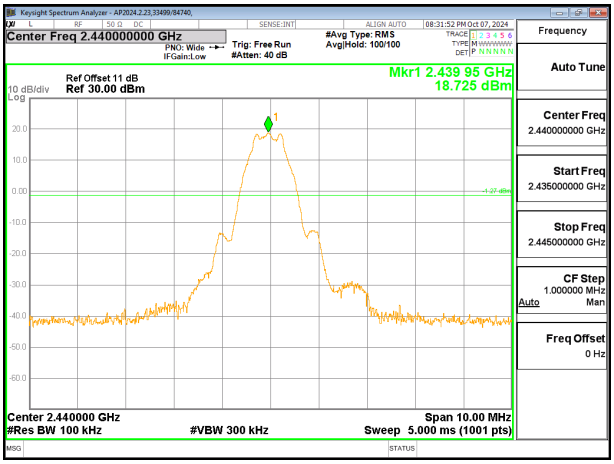
Chain 1



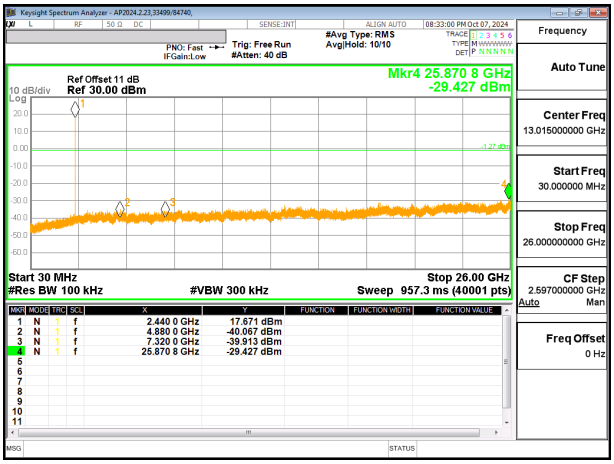
LOW CHANNEL BANDEDGE



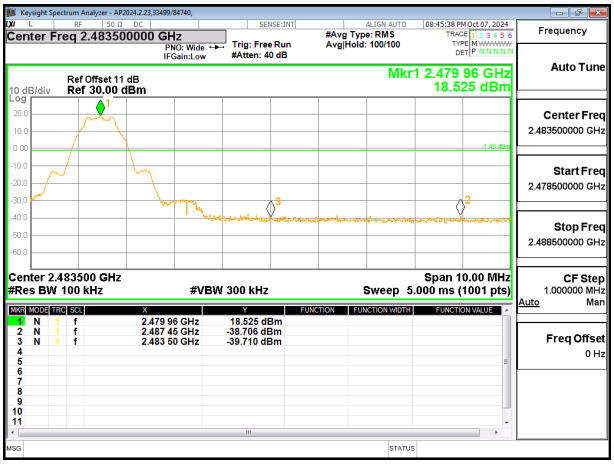
OUT-OF-BAND LOW CHANNEL



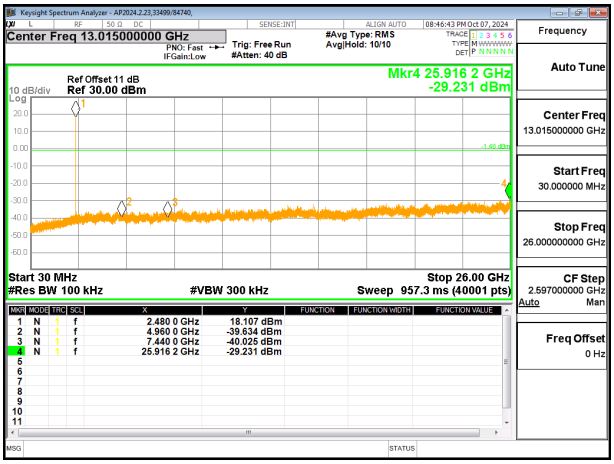
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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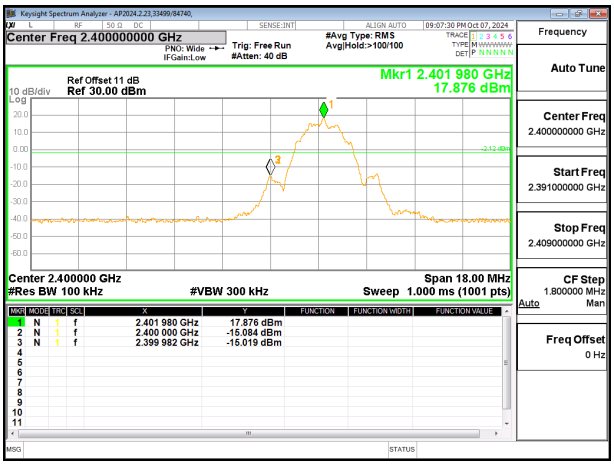
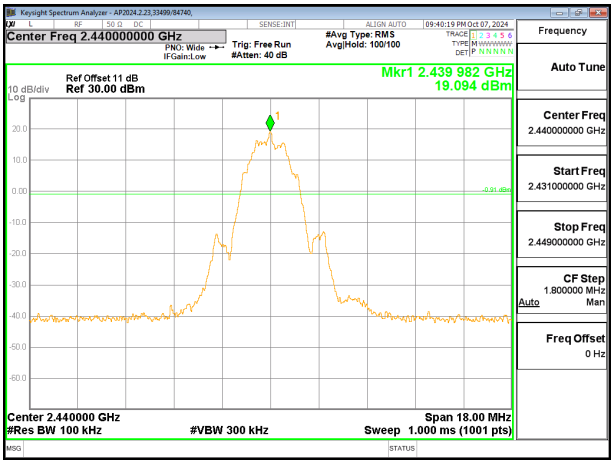
9.7.2. BLE (2Mbps)

Chain 0

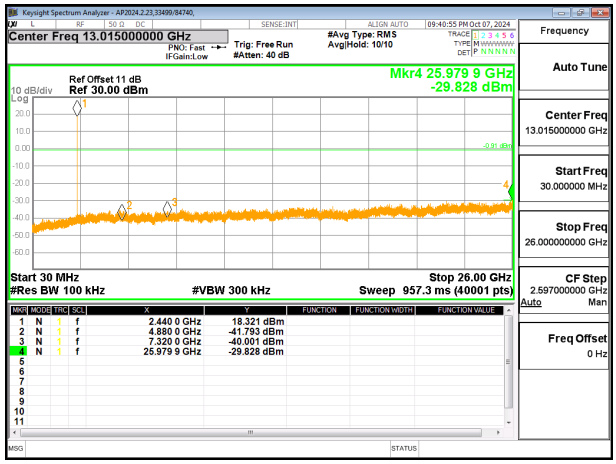


LOW CHANNEL BANDEDGE

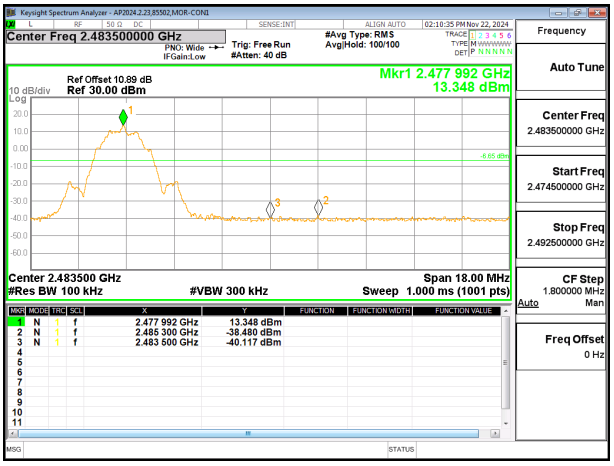
OUT-OF-BAND LOW CHANNEL



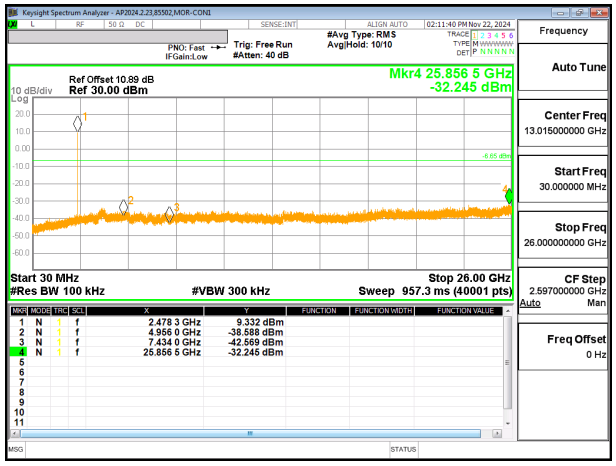
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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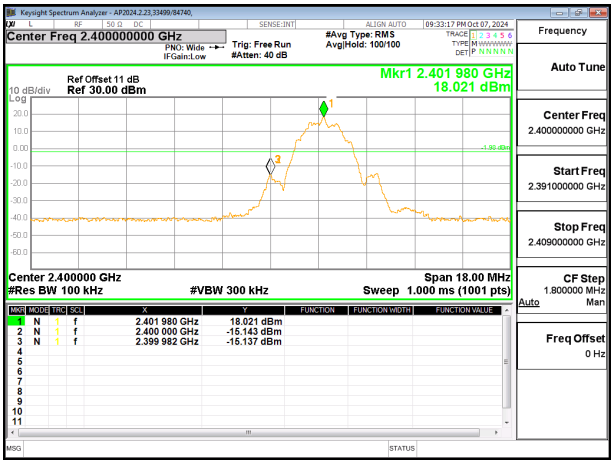
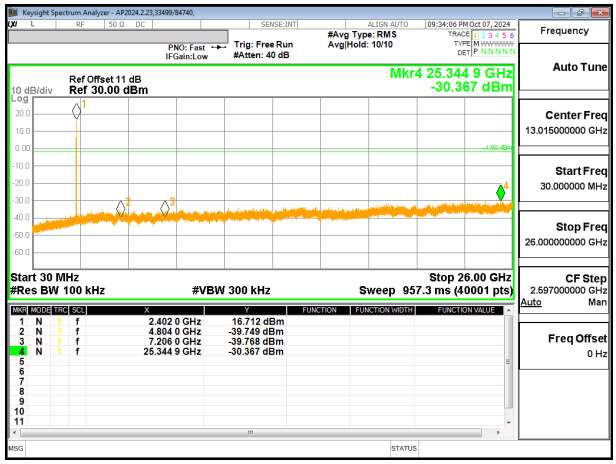
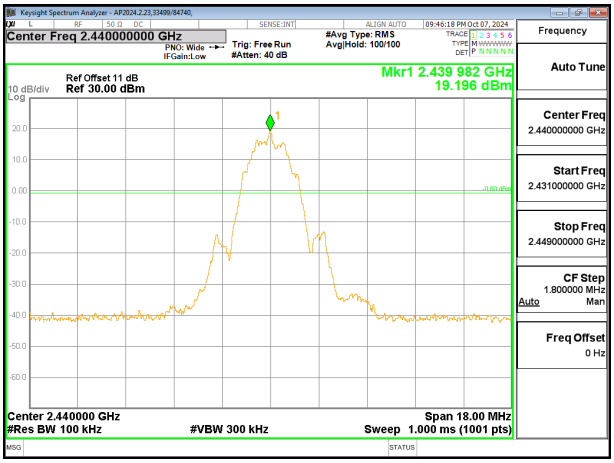
Chain 1



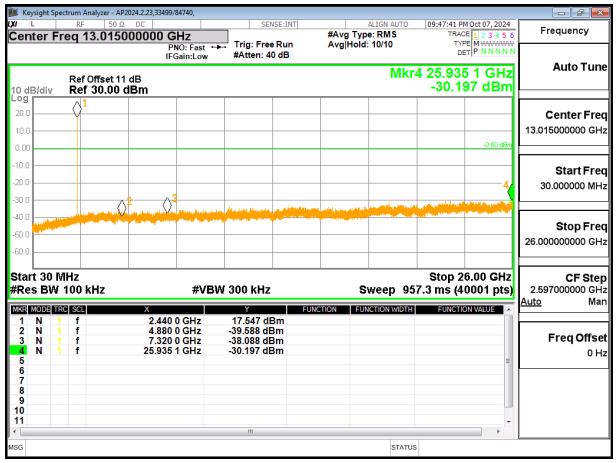
LOW CHANNEL BANDEDGE



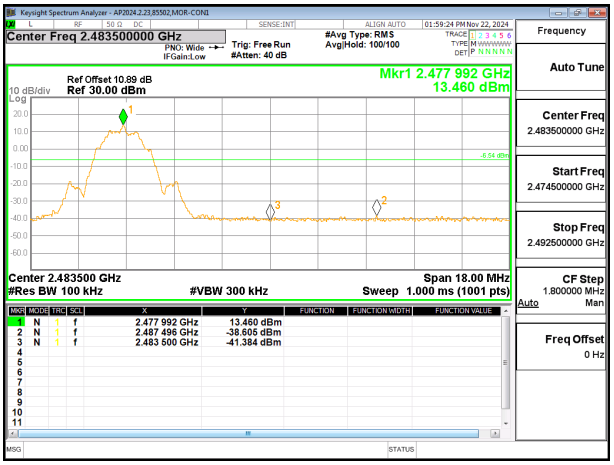
OUT-OF-BAND LOW CHANNEL



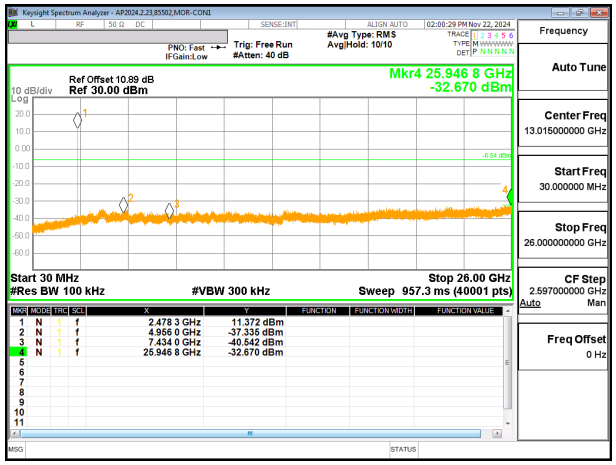
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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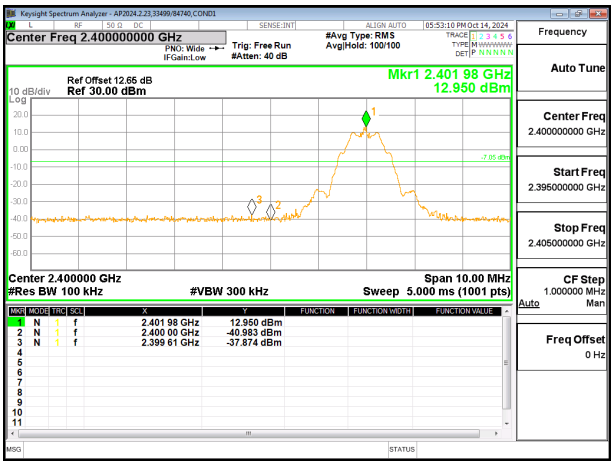
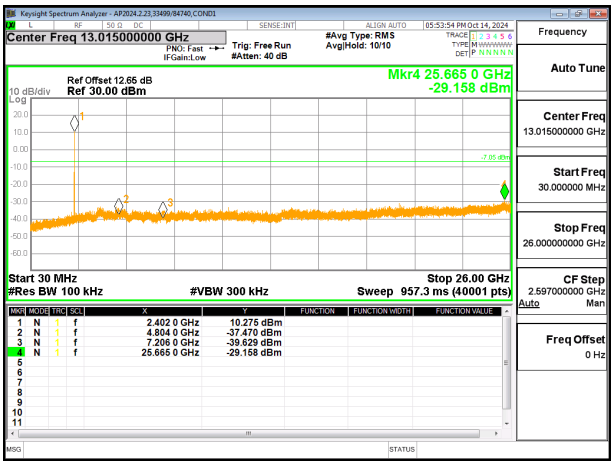
9.7.3. BLE (125Kbps)

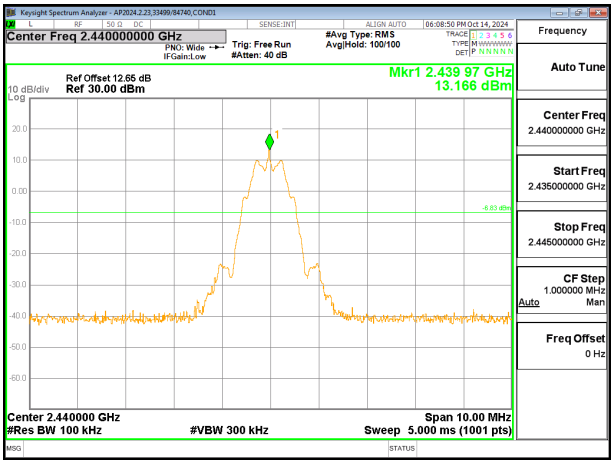
Chain 0



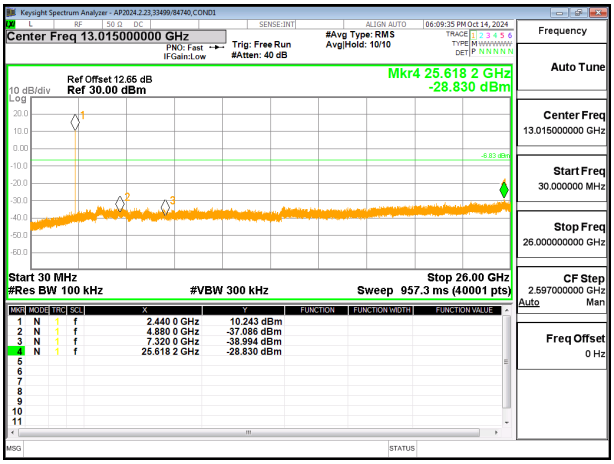
LOW CHANNEL BANDEDGE



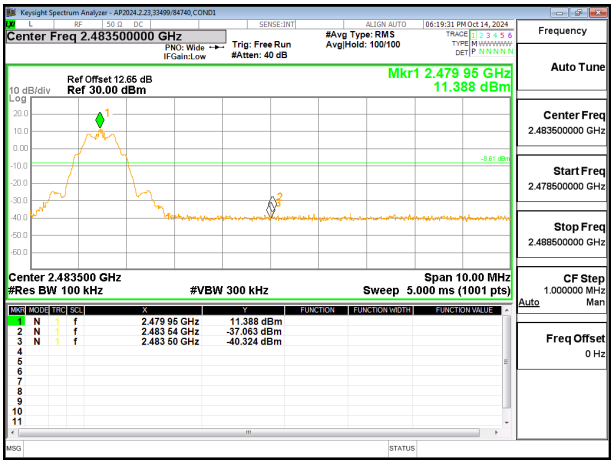
OUT-OF-BAND LOW CHANNEL



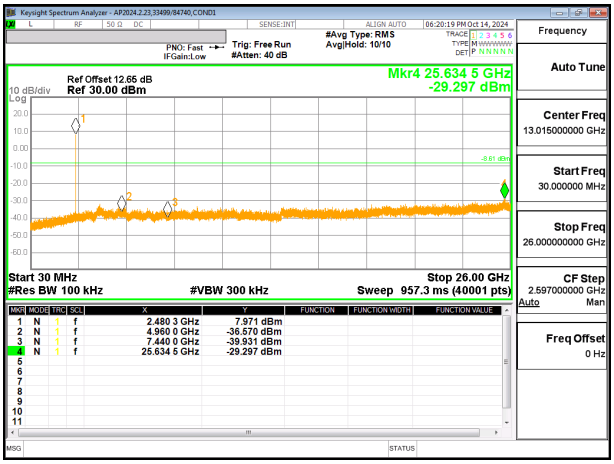
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

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