RF TEST REPORT

Applicant	Espressif Systems (Shanghai) Co.,Ltd.
FCC ID	2AC7Z-ESPC3WROOMU
Product	Wi-Fi & Bluetooth Internet of Things Module
Brand	ESPRESSIF
Model	ESP32-C3-WROOM-02U
Report No.	R2109A0836-R1V1
Issue Date	April 27, 2023

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2022)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Prepared by: Xu Ying *Approved by: Xu Kai*

TA Technology (Shanghai) Co., Ltd.

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TABLE OF CONTENT

Version	Revision description	Issue Date
Rev.0	Initial issue of report.	April 18, 2023
Rev.1	Update FCC ID.	April 27, 2023
Note: This revised report (Report No.: R2109A0836-R1V1) supersedes and replaces the previously issued report (Report No.: R2109A0836-R1). Please discard or destroy the previously issued report and dispose of it accordingly.		

Summary of Measurement Results

Number	Test Case	Clause in FCC rules	Verdict
1	Maximum output power	15.247(b)(3)	PASS
2	99% Bandwidth and 6dB Bandwidth	15.247(a)(2) C63.10 6.7	PASS
3	Power spectral density	15.247(e)	PASS
4	Band Edge	15.247(d)	PASS
5	Spurious RF Conducted Emissions	15.247(d)	PASS
6	Unwanted Emissions	15.247(d),15.205,15.209	PASS
7	Conducted Emissions	15.207	PASS
Date of Testing: January 8, 2023 ~ February 17, 2023 Date of Sample Received: January 8, 2023			
Note: All indications of Pass/Fail in this report are opinions expressed by TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.			

1. Test Laboratory

1.1. Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA Technology (Shanghai) Co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein .Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Test Facility

FCC (Designation number: CN1179, Test Firm Registration Number: 446626)

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

A2LA (Certificate Number: 3857.01)

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform measurement.

1.3. Testing Location

Company:	TA Technology (Shanghai) Co., Ltd.
Address:	Building 3, No.145, Jintang Rd, Pudong Shanghai, P.R.China
City:	Shanghai
Post code:	201201
Country:	P. R. China
Contact:	Xu Kai
Telephone:	+86-021-50791141/2/3
Fax:	+86-021-50791141/2/3-8000
Website:	http://www.ta-shanghai.com
E-mail:	xukai@ta-shanghai.com

2. General Description of Equipment Under Test

2.1. Applicant and Manufacturer Information

Applicant	Espressif Systems (Shanghai) Co.,Ltd.
Applicant address	Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China
Manufacturer	Espressif Systems (Shanghai) Co.,Ltd.
Manufacturer address	Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China

2.2. General Information

EUT Description	
Model	ESP32-C3-WROOM-02U
Lab internal SN	R2109A0836/S01
Hardware Version	V1.3
Software Version	V1.1.3.0
Power Supply	External power supply
Antenna Type	Glue stick Antenna
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)
Antenna Gain	1.57 dBi
additional beamforming gain	NA
Operating Frequency Range(s)	802.11b/g/n(HT20): 2412 ~ 2462 MHz 802.11n(HT40): 2422 ~ 2452 MHz Bluetooth LE V5.0: 2402 ~2480 MHz
Modulation Type	802.11b: DSSS 802.11g/n(HT20/HT40): OFDM Bluetooth LE: GFSK
Max. Output Power	Wi-Fi 2.4G: 17.39 dBm Bluetooth LE: 8.16 dBm
Note: 1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.	

3. Applied Standards

According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

Test standards:

FCC CFR47 Part 15C (2022) Radio Frequency Devices

ANSI C63.10-2013

Reference standard:

KDB 558074 D01 15.247 Meas Guidance v05r02

4. Test Configuration

Test Mode

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application.

The radiated emission was measured in the following position: EUT stand-up position (Z axis), lie-down position (X, Y axis). The worst emission was found in lie-down position (X axis) and the loop antenna is vertical, the others are vertical and horizontal. and the worst case was recorded.

In order to find the worst case condition, Pre-tests are needed at the presence of different data rate. Preliminary tests have been done on all the configuration for confirming worst case. Data rate below means worst-case rate of each test item.

Worst-case data rates are shown as following table.

Test Mode	Data Rate
Bluetooth(Low Energy)	1Mbps; 2Mbps
802.11b	1 Mbps
802.11g	6 Mbps
802.11n HT20	MCS0
802.11n HT40	MCS0

5. Test Case Results

5.1. Maximum output power

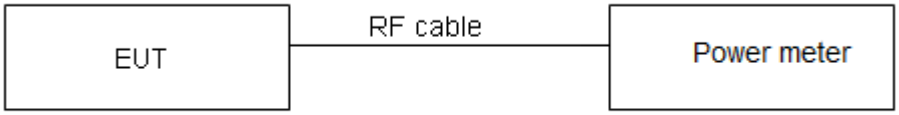
Ambient Condition

Temperature	Relative humidity
20°C ~ 25°C	45% ~ 50%

Methods of Measurement

During the process of the testing, The EUT was connected to Power meter with a known loss. The EUT is max power transmission with proper modulation.

Test Setup



Limits

Rule Part 15.247 (b) (3) specifies that " For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz: 1 Watt."

Average Output Power	≤ 1W (30dBm)

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 0.44 dB.

Test Results

Power Index					
Frequency (MHz)	802.11b	802.11g	802.11n HT20	Frequency (MHz)	802.11n HT40
2402					
2412	6	17	20	2422	24
2417	--	2	4	2427	16
2422	--	N/A	N/A	2432	16
2437	8	N/A	N/A	2437	8
2442	--	N/A	--	2442	16
2452	--	4	N/A	2447	28
2457	--	8	8	2452	32
2462	12	24	26	--	--

Power Index		
Frequency (MHz)	Bluetooth LE (1M)	Bluetooth LE (2M)
2402	11	11
2440	11	11
2480	11	11

Test Mode	Duty cycle	Duty cycle correction Factor(dB)
802.11b	1.00	0.00
802.11g	1.00	0.00
802.11n HT20	0.99	0.00
802.11n HT40	0.99	0.00
Bluetooth LE (1M)	0.839	0.761
Bluetooth LE (2M)	0.567	2.465
Note: when Duty cycle≥0.98, Duty cycle correction Factor not required.		

Test Mode	Carrier frequency (MHz)/ Channel	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412/CH 1	16.86	16.86	30	PASS
	2437/CH 6	16.23	16.23	30	PASS
	2462/CH 11	15.34	15.34	30	PASS
802.11g	2412/CH 1	13.49	13.49	30	PASS
	2417/CH 2	16.82	16.82	30	PASS
	2422/CH 3	17.16	17.16	30	PASS
	2437/CH 6	17.36	17.36	30	PASS
	2442/CH 7	17.39	17.39	30	PASS
	2452/CH 9	16.74	16.74	30	PASS
	2457/CH 10	16.02	16.02	30	PASS
	2462/CH 11	12.23	12.23	30	PASS
802.11n HT20	2412/CH 1	11.87	11.87	30	PASS
	2417/CH 2	15.61	15.61	30	PASS
	2422/CH 3	16.21	16.21	30	PASS
	2437/CH 6	16.41	16.41	30	PASS
	2452/CH 9	16.38	16.38	30	PASS
	2457/CH 10	15.14	15.14	30	PASS
	2462/CH 11	10.70	10.70	30	PASS
802.11n HT40	2422/CH 3	10.05	10.05	30	PASS
	2427/CH 4	11.46	11.46	30	PASS
	2432/CH 5	11.66	11.66	30	PASS
	2437/CH 6	13.56	13.56	30	PASS
	2442/CH 7	11.45	11.45	30	PASS
	2447/CH 8	8.91	8.91	30	PASS
	2452/CH 9	8.39	8.39	30	PASS
Bluetooth (Low Energy) (1M)	2402/CH0	6.87	7.63	30	PASS
	2440/CH19	7.22	7.98	30	PASS
	2480/CH39	6.54	7.30	30	PASS
Bluetooth (Low Energy) (2M)	2402/CH0	5.43	7.90	30	PASS
	2440/CH19	5.70	8.16	30	PASS
	2480/CH39	5.40	7.86	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

5.2. 99% Bandwidth and 6dB Bandwidth

Ambient Condition

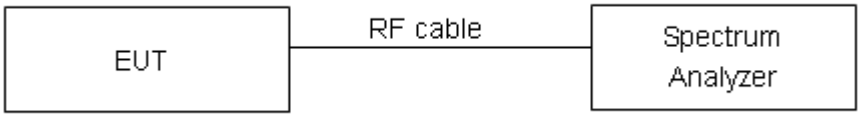
Temperature	Relative humidity
20°C ~ 25°C	45% ~ 50%

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable. RBW is set to 100 kHz; VBW is set to 300 kHz on spectrum analyzer.
Dector=Peak, Trace mode=max hold.

The EUT was connected to the spectrum analyzer through a known loss cable. The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value.

Test Setup



Limits

Rule Part 15.247 (a) (2) specifies that “Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.”

minimum 6 dB bandwidth	≥ 500 kHz

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 936 Hz.

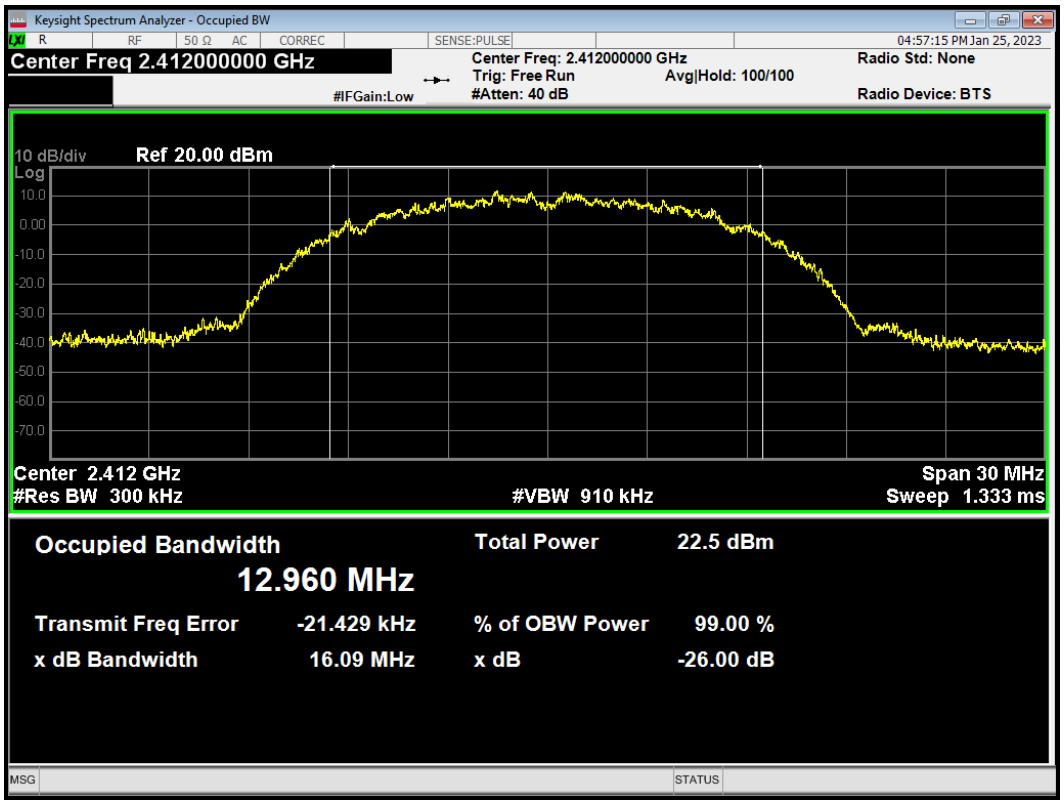
Test Results:

Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11b	2412	12.960	9.009	500	PASS
	2437	12.986	8.569	500	PASS
	2462	12.985	9.069	500	PASS
802.11g	2412	16.968	16.373	500	PASS
	2417	17.060	16.367	500	PASS
	2422	16.223	16.308	500	PASS
	2437	16.216	15.785	500	PASS
	2442	16.225	15.706	500	PASS
	2452	17.041	16.386	500	PASS
	2457	17.042	16.344	500	PASS
	2462	17.032	16.344	500	PASS
802.11n HT20	2412	18.092	17.627	500	PASS
	2417	18.138	17.802	500	PASS
	2422	18.136	17.615	500	PASS
	2437	18.149	17.630	500	PASS
	2452	18.121	17.602	500	PASS
	2457	18.126	17.616	500	PASS
	2462	18.114	17.624	500	PASS
802.11n HT40	2422	34.531	31.946	500	PASS
	2427	34.512	31.986	500	PASS
	2432	34.528	32.332	500	PASS
	2437	34.564	32.169	500	PASS
	2442	34.575	32.346	500	PASS
	2447	34.538	32.213	500	PASS
	2452	34.536	31.951	500	PASS
Bluetooth	2402	1.084	0.624	500	PASS

(Low Energy) (1M)	2440	1.083	0.642	500	PASS
	2480	1.082	0.618	500	PASS
Bluetooth (Low Energy) (2M)	2402	2.108	1.105	500	PASS
	2440	2.099	1.062	500	PASS
	2480	2.115	1.099	500	PASS

99%bandwidth

OBW 802.11b 2412MHz



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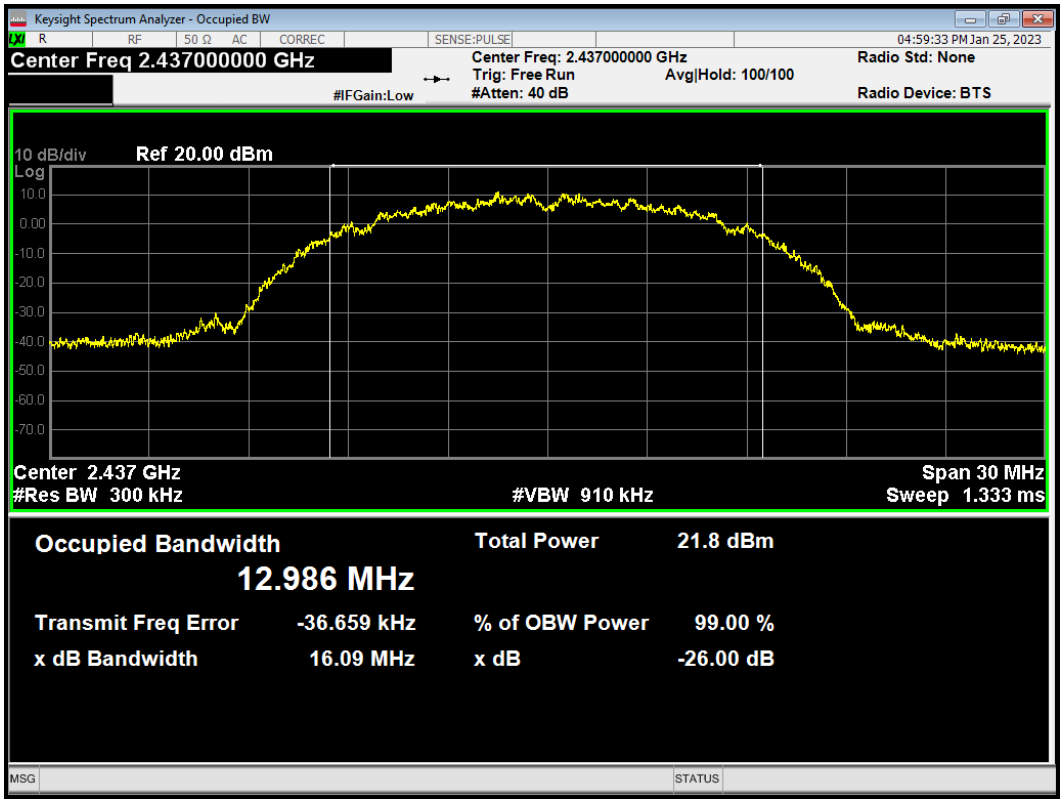

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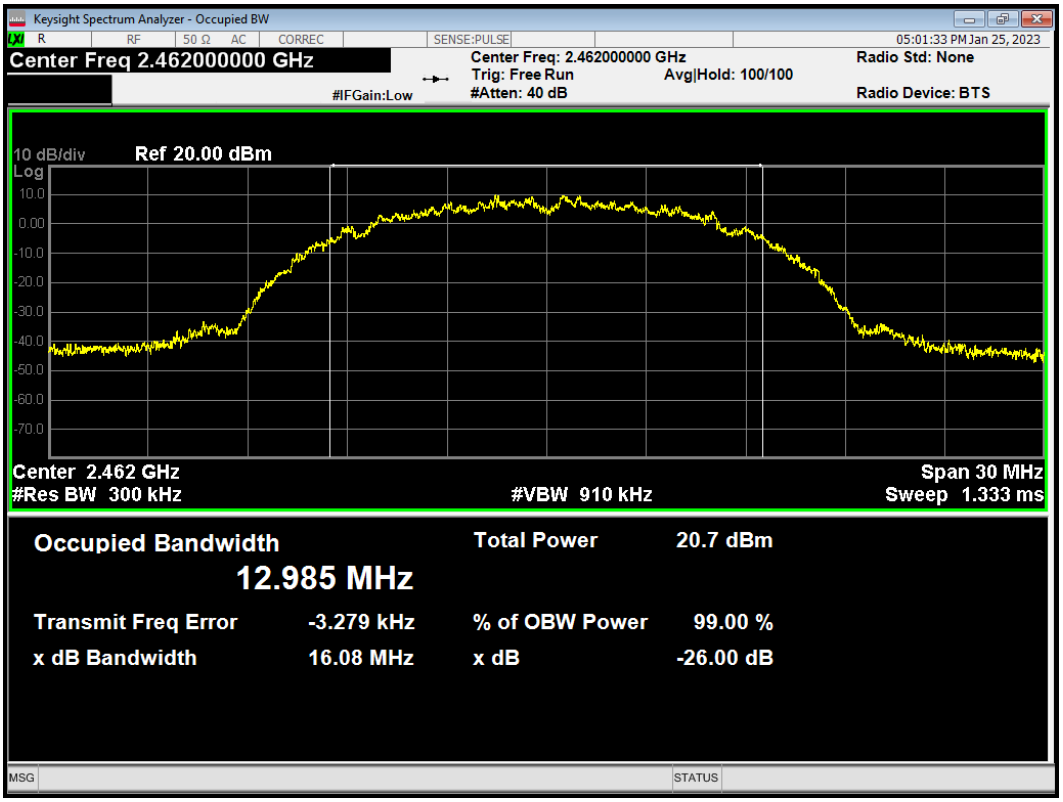
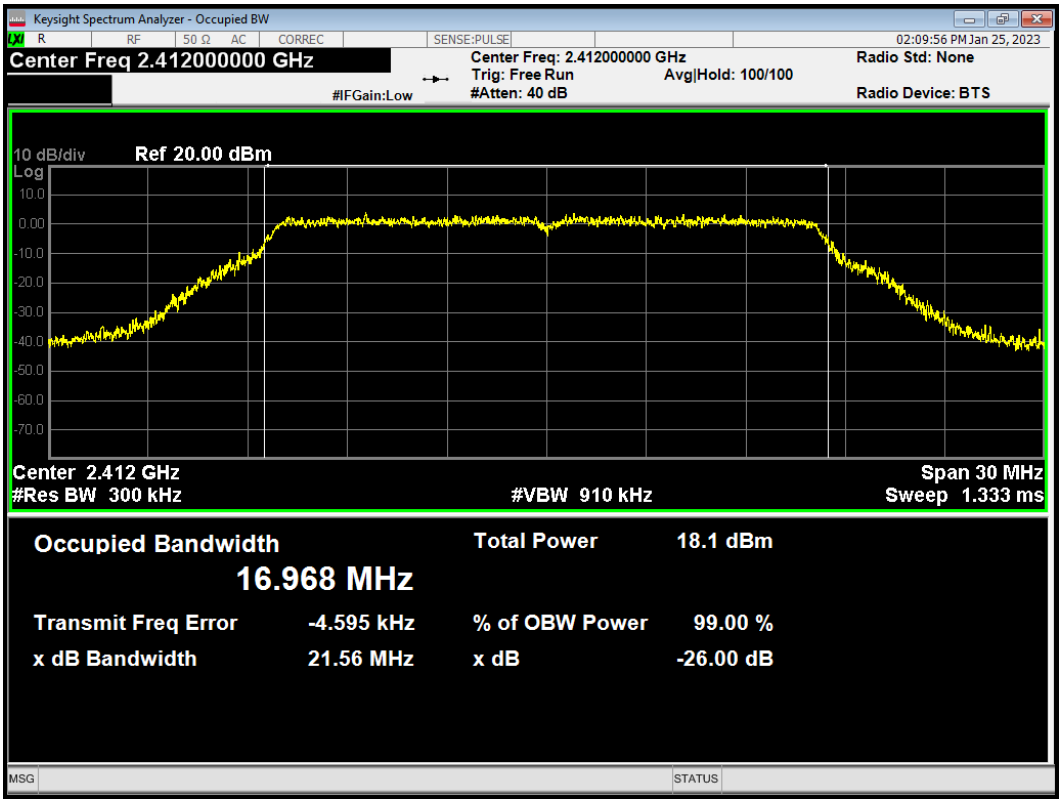


OBW 802.11g 2412MHz



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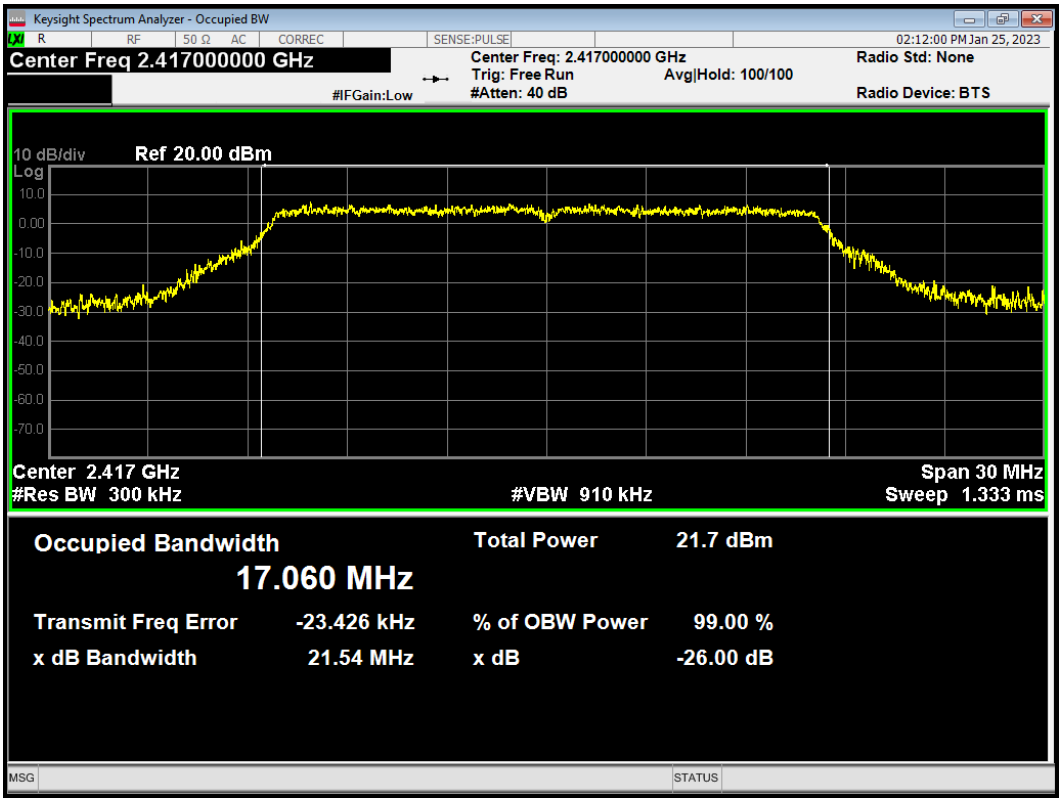

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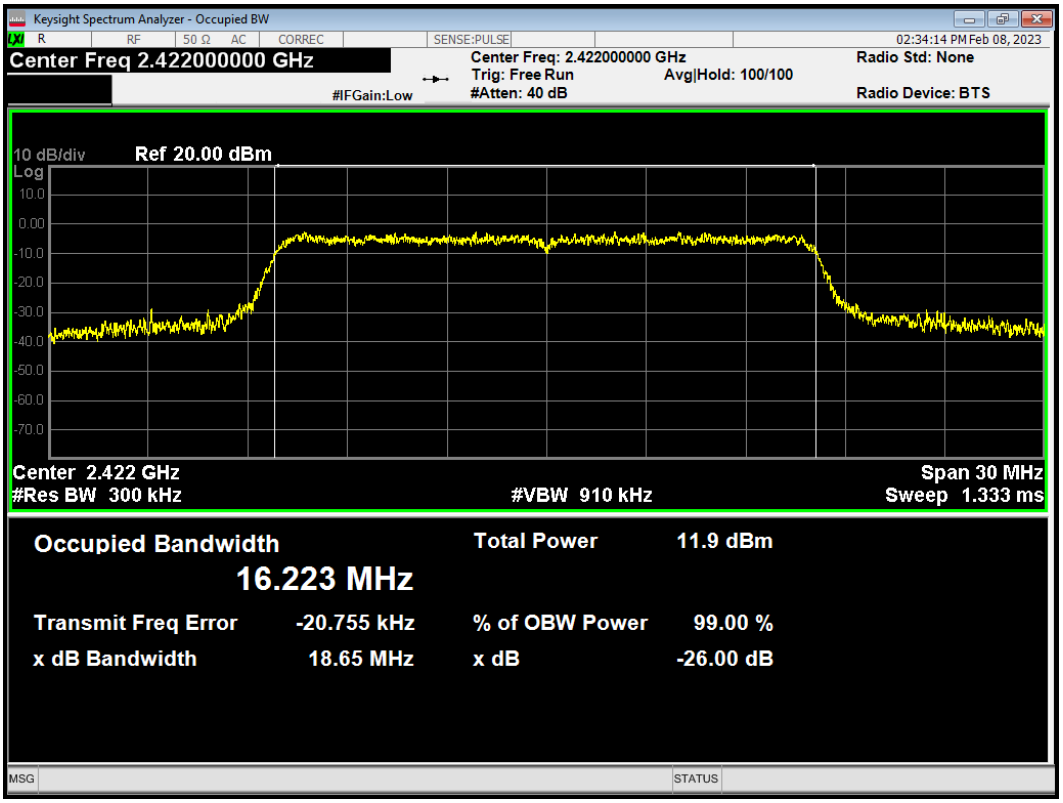

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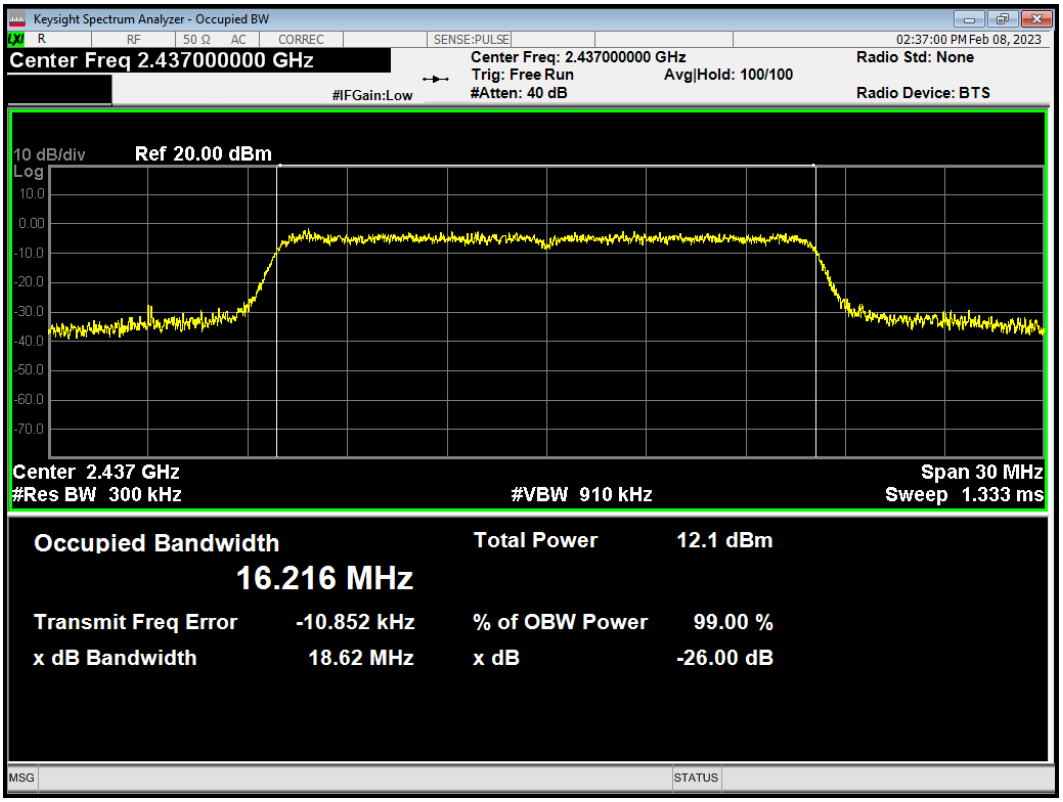
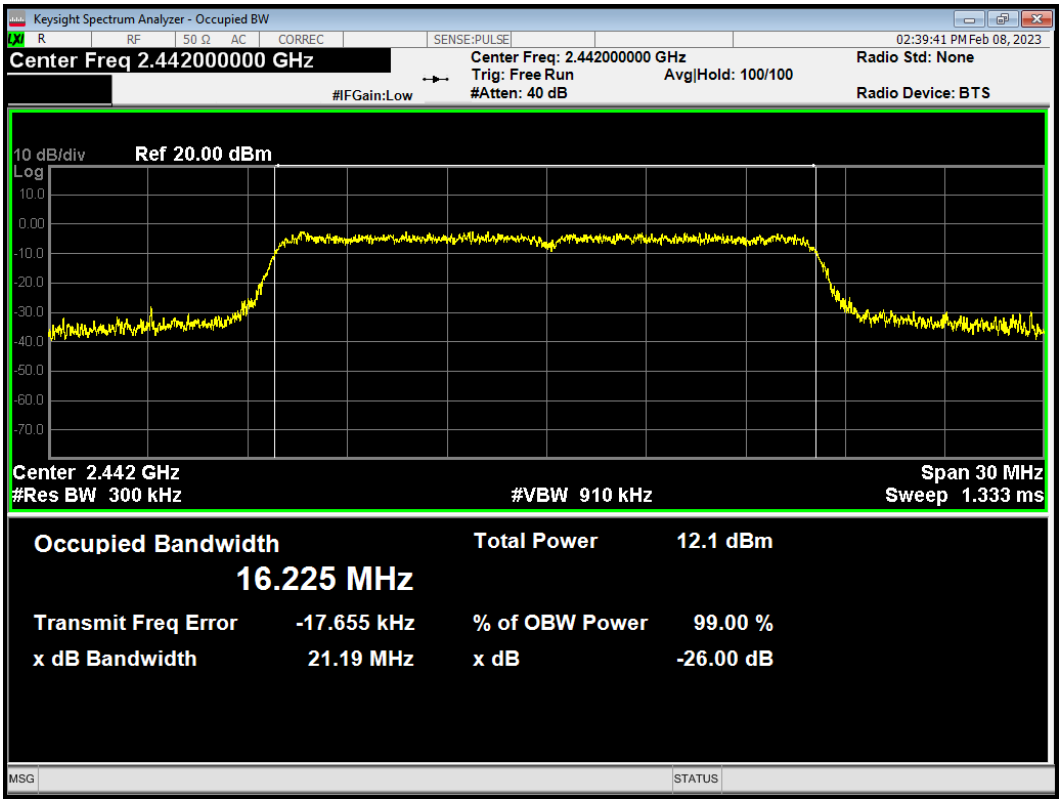


OBW 802.11g 2442MHz



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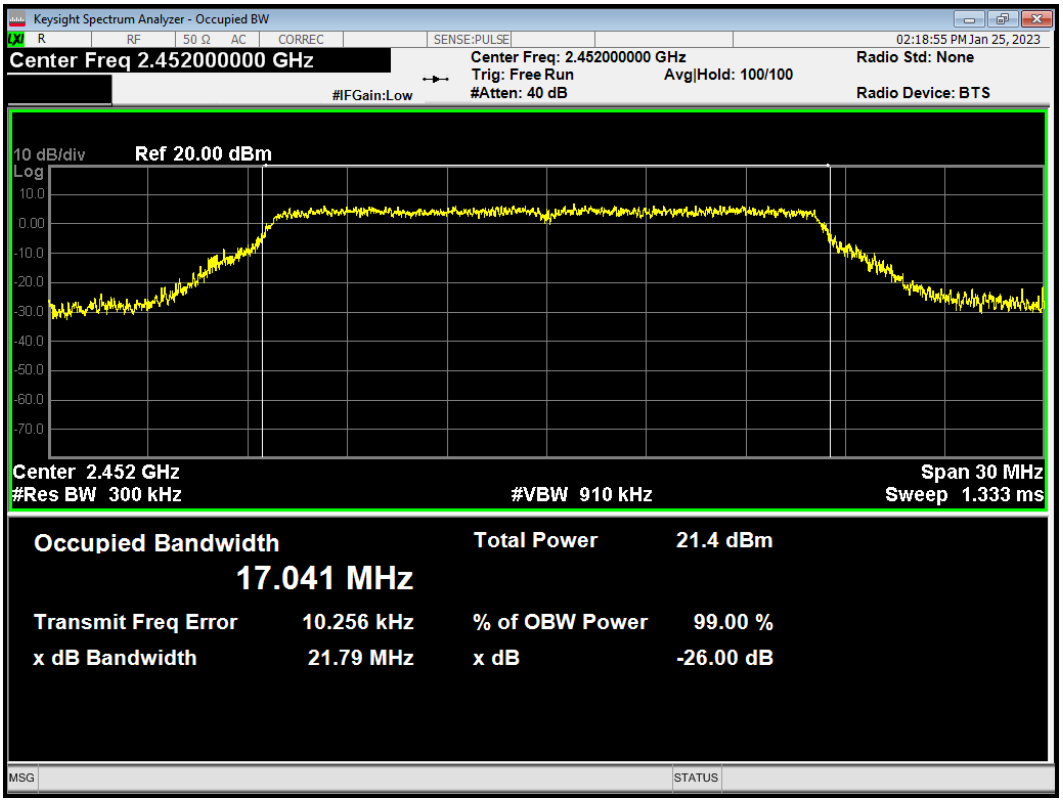

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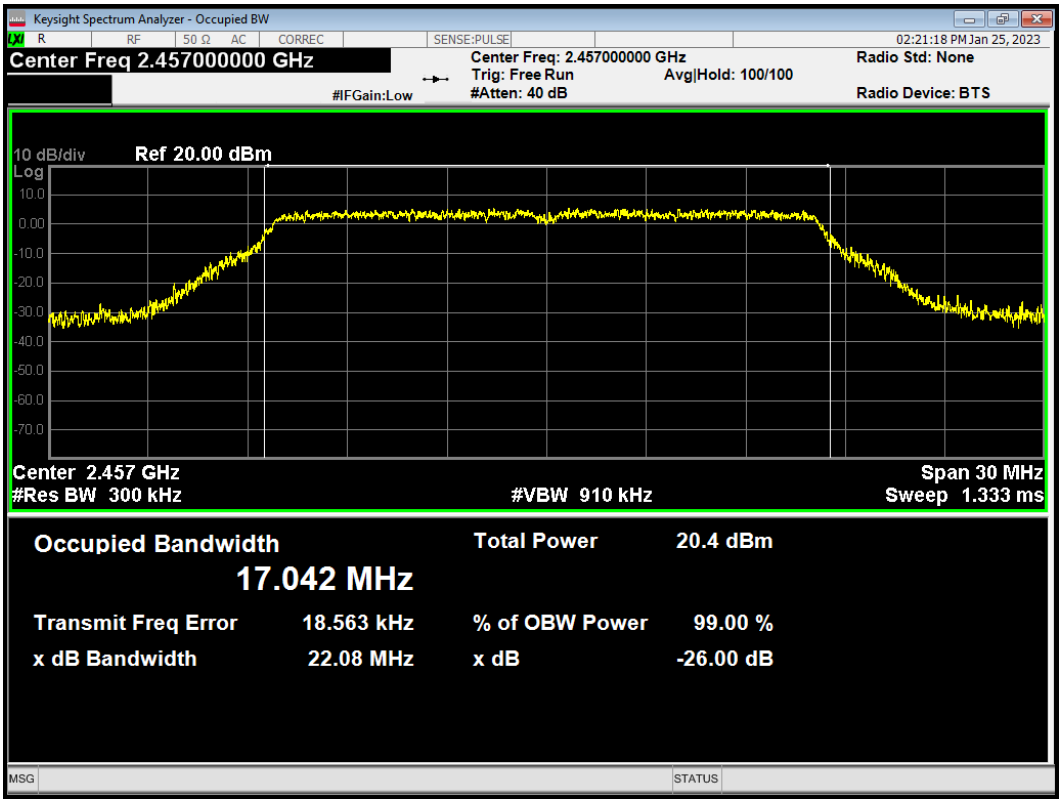
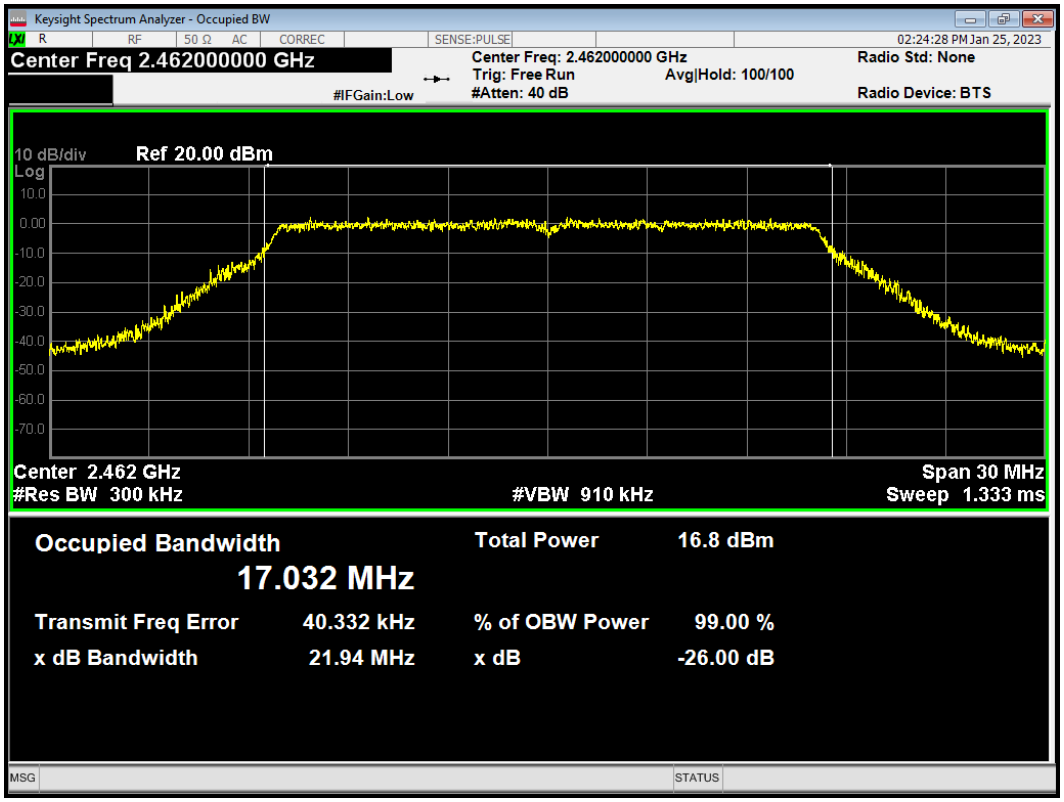
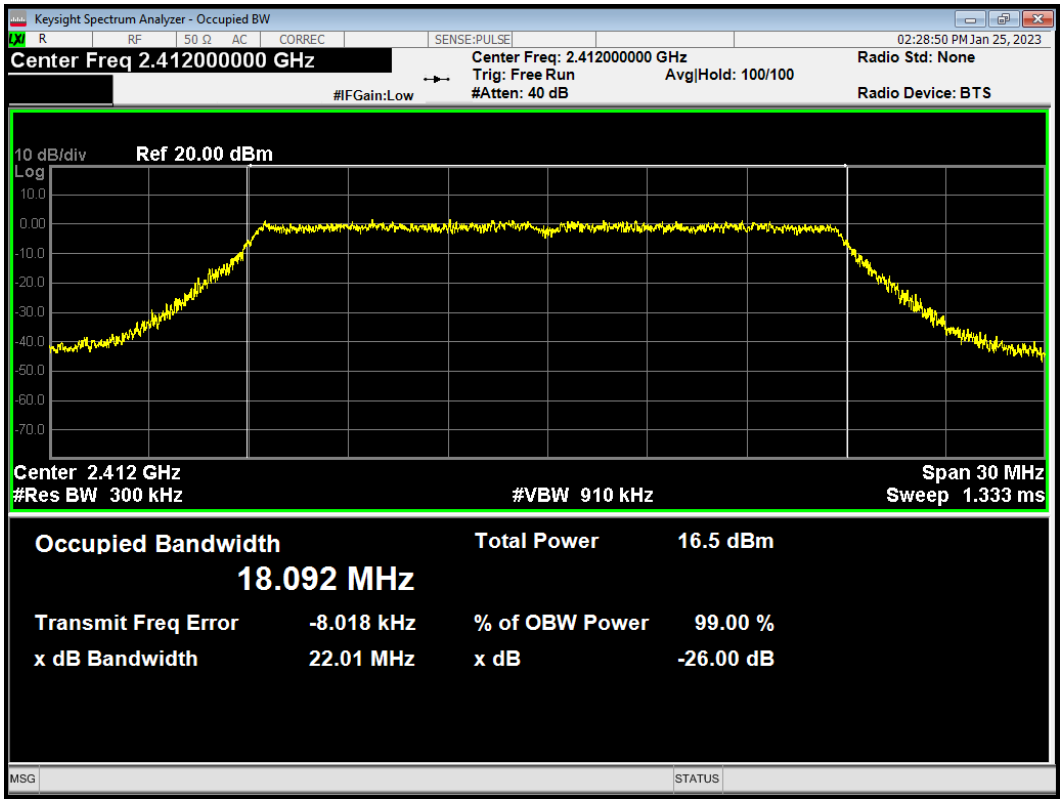


OBW 802.11g 2462MHz



OBW 802.11n(HT20) 2412MHz



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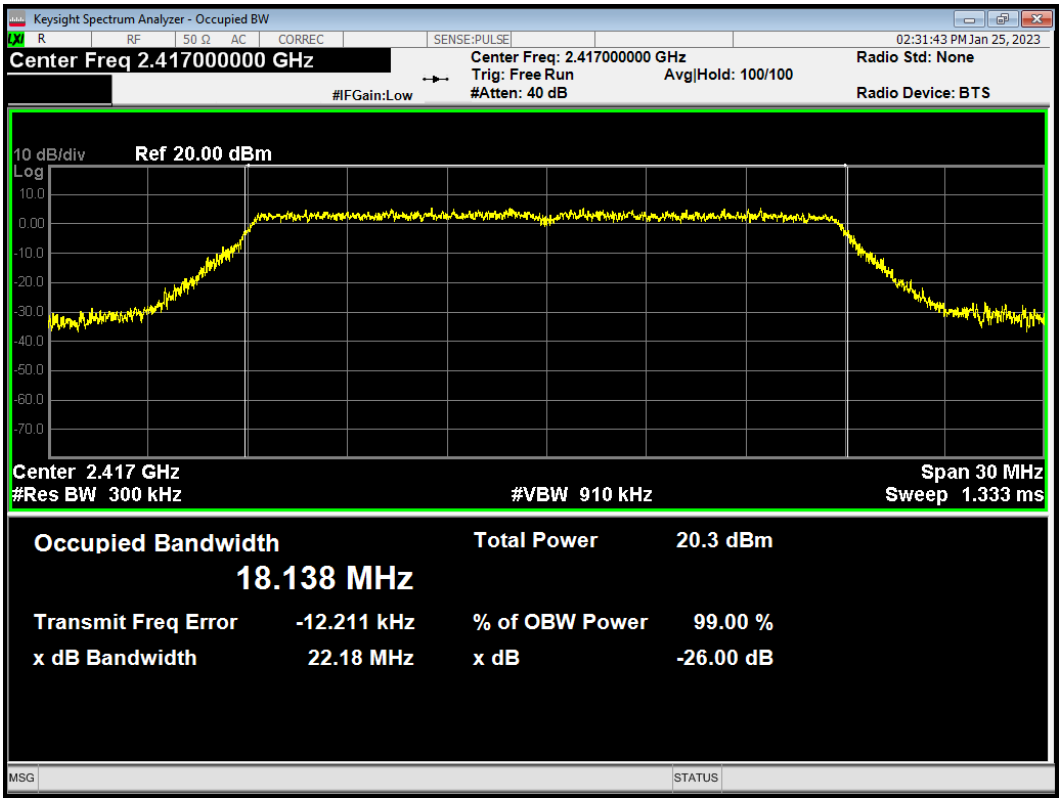

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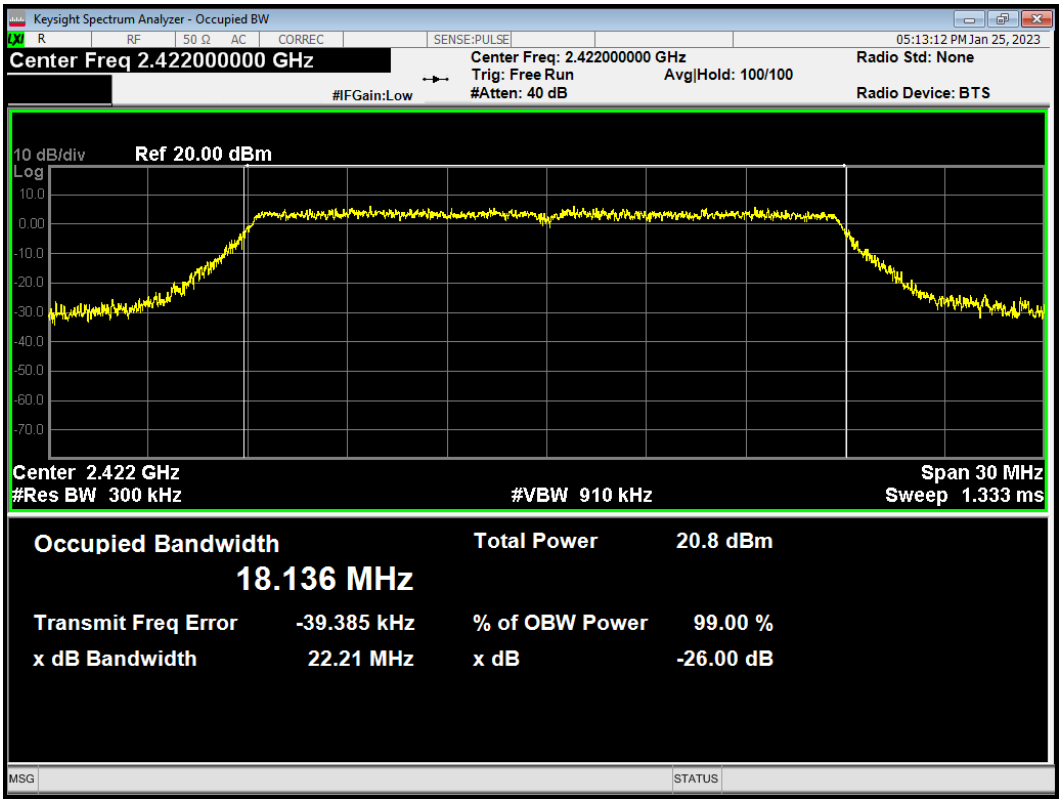

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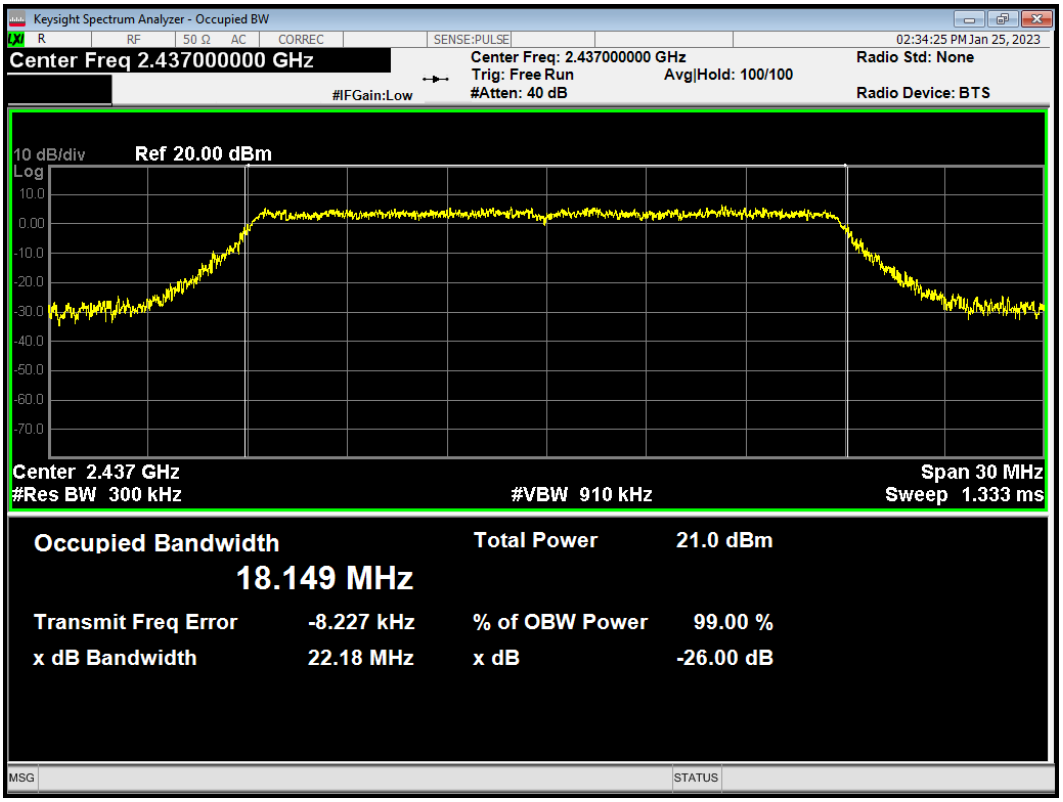

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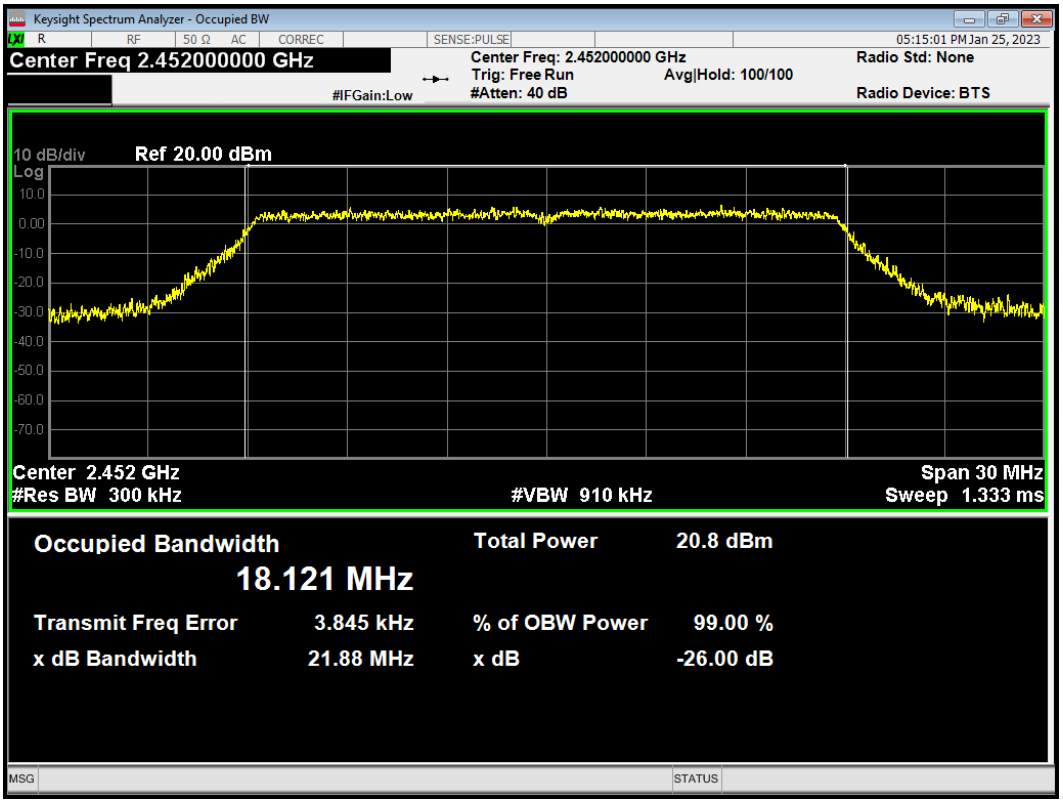
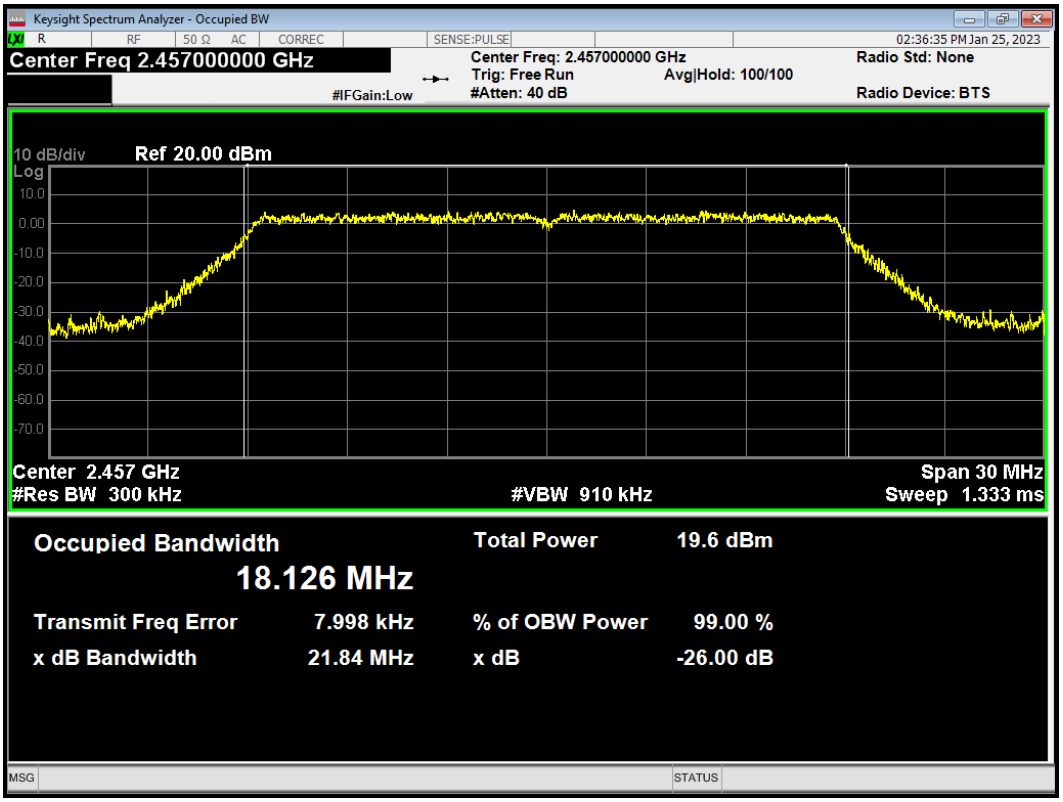
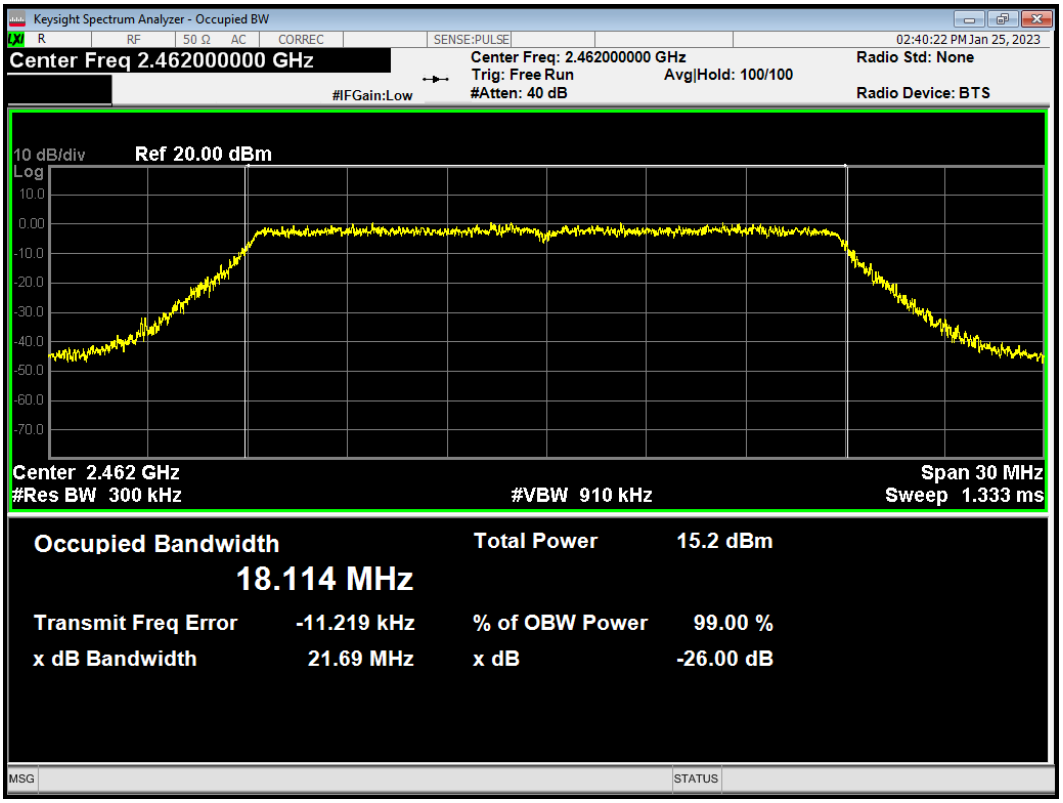


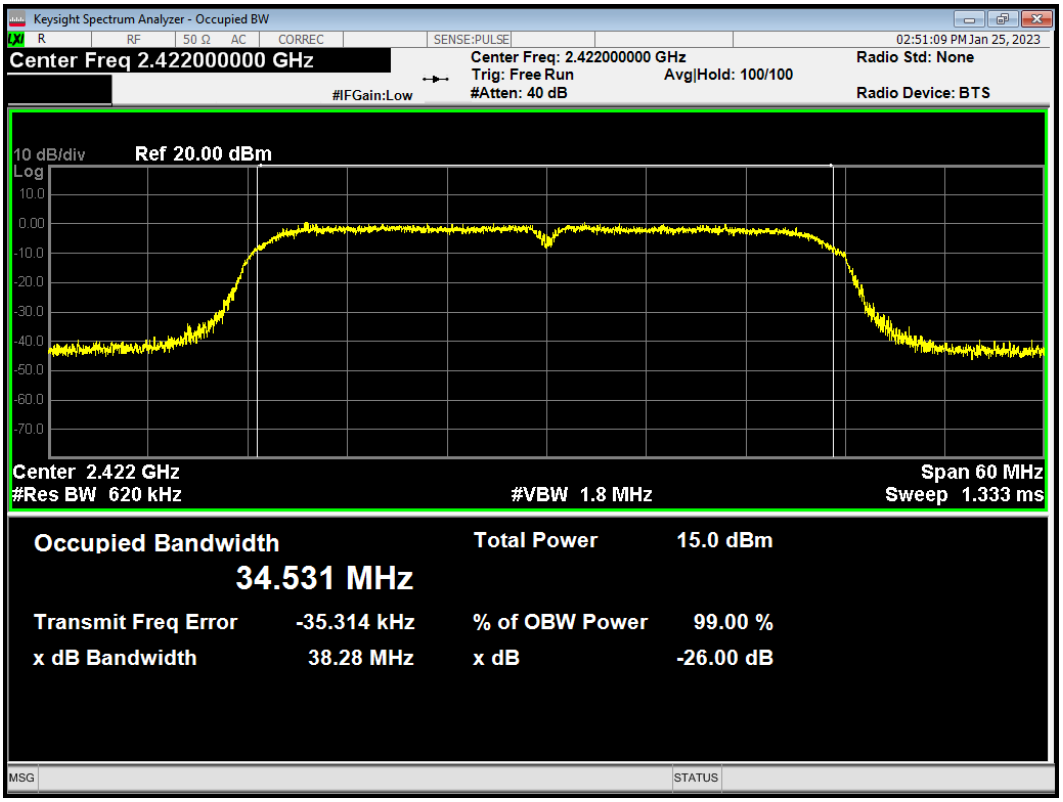
OBW 802.11n(HT20) 2457MHz



OBW 802.11n(HT20) 2462MHz



OBW 802.11n(HT40) 2422MHz



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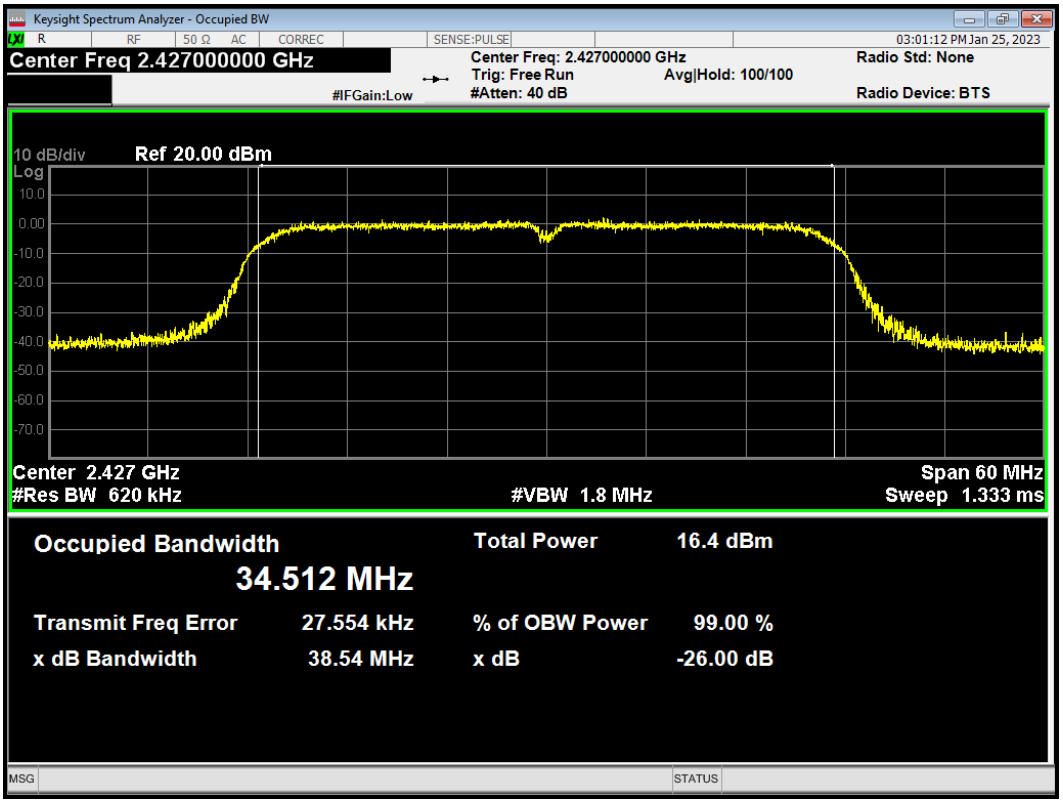

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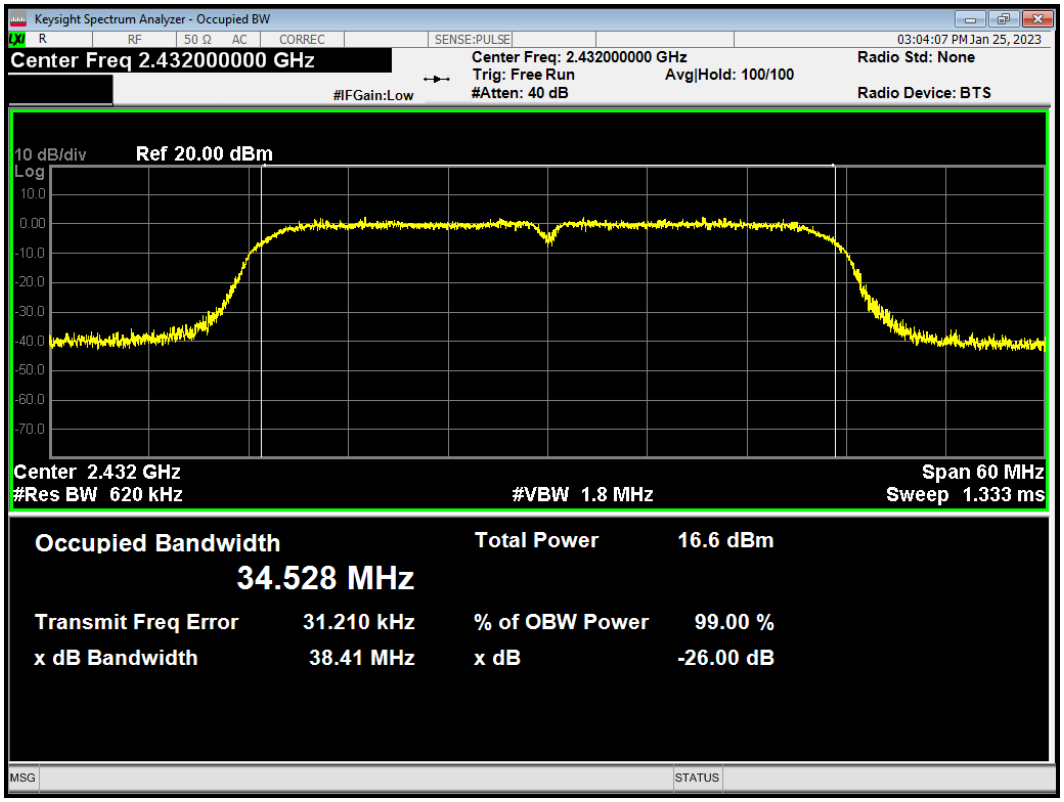

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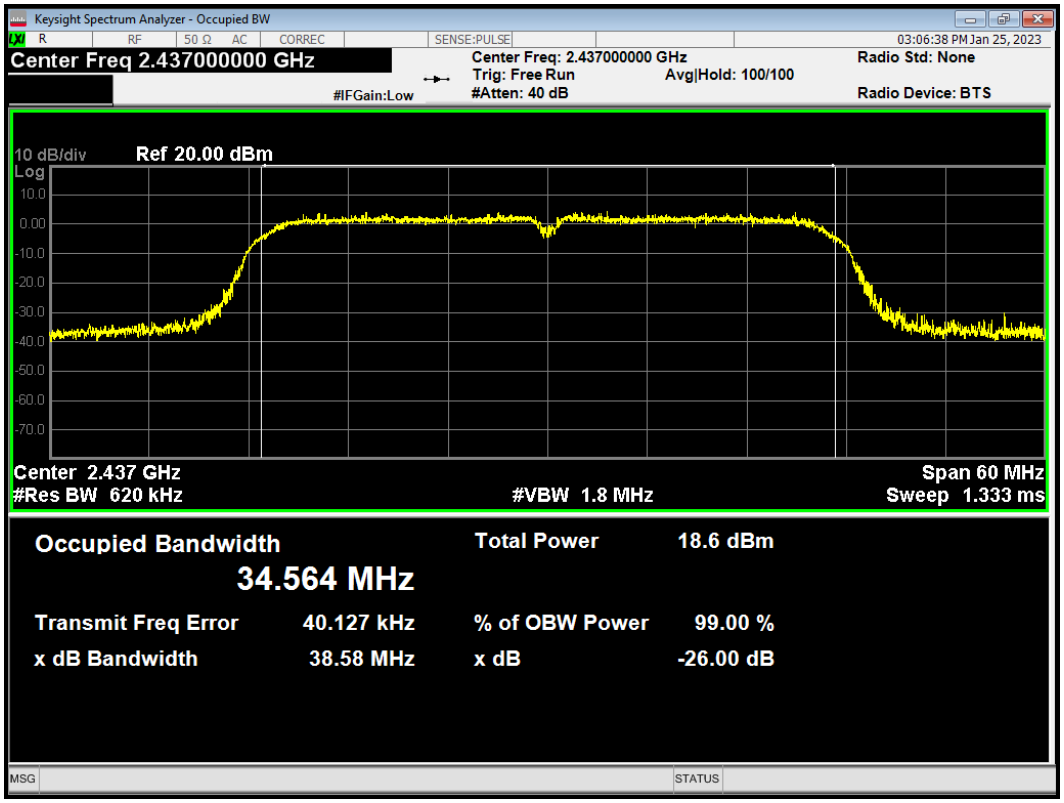

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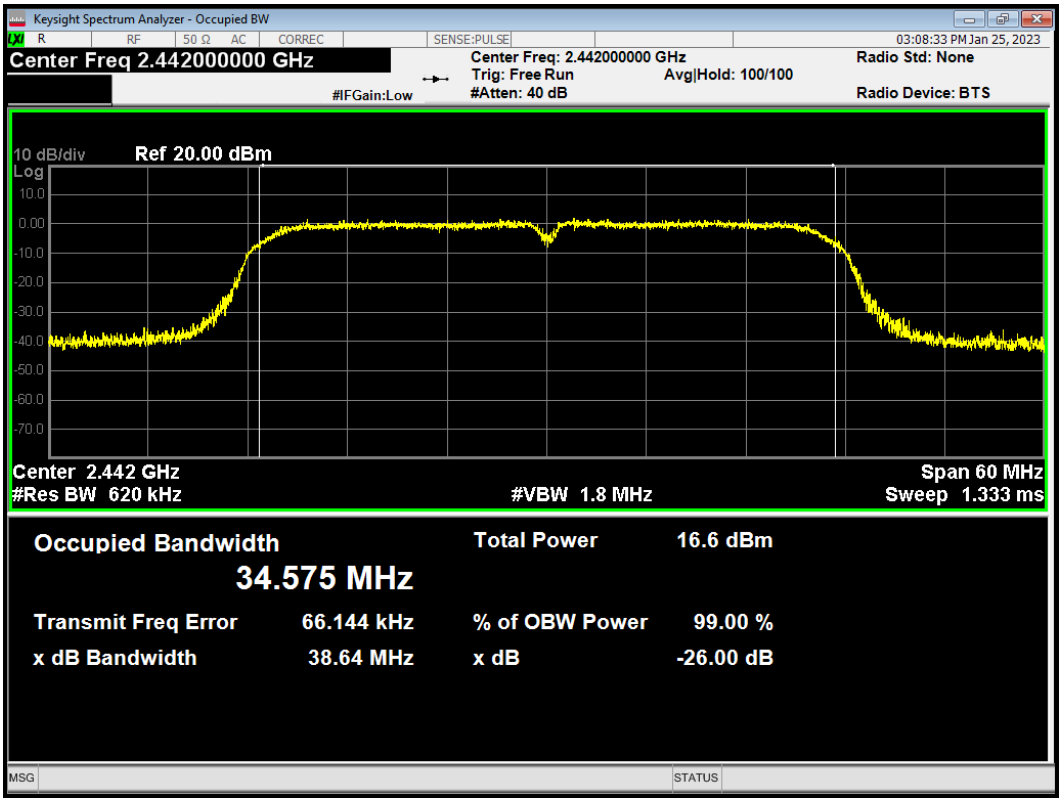
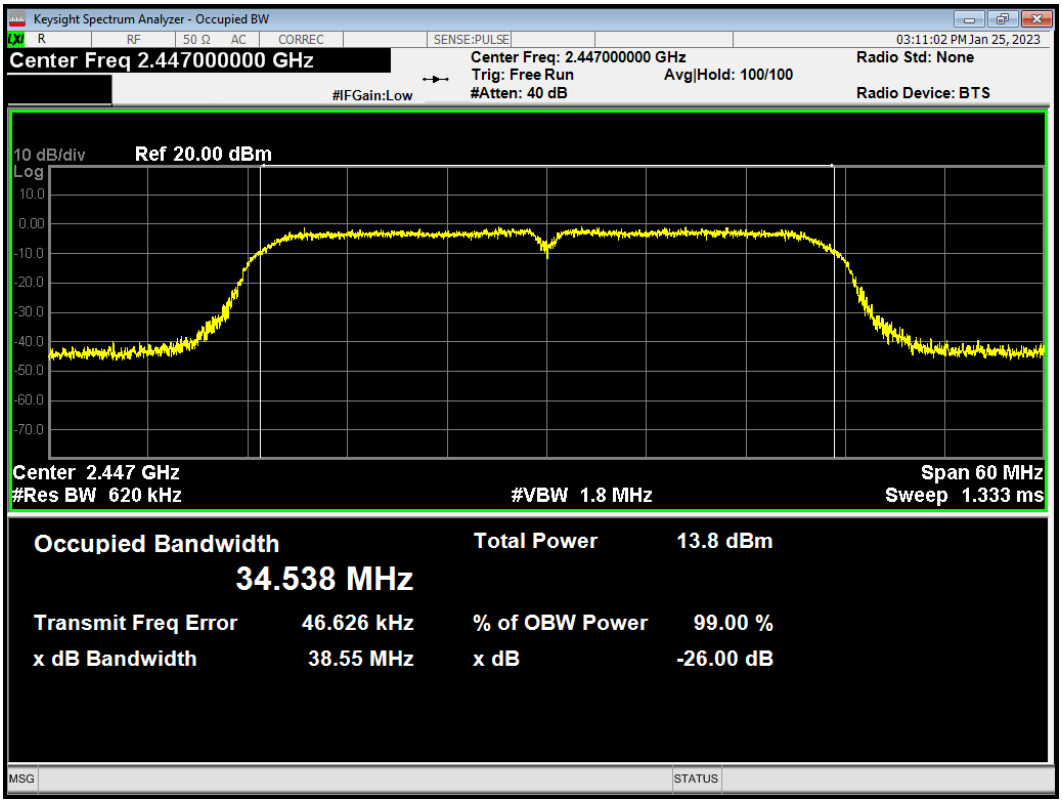
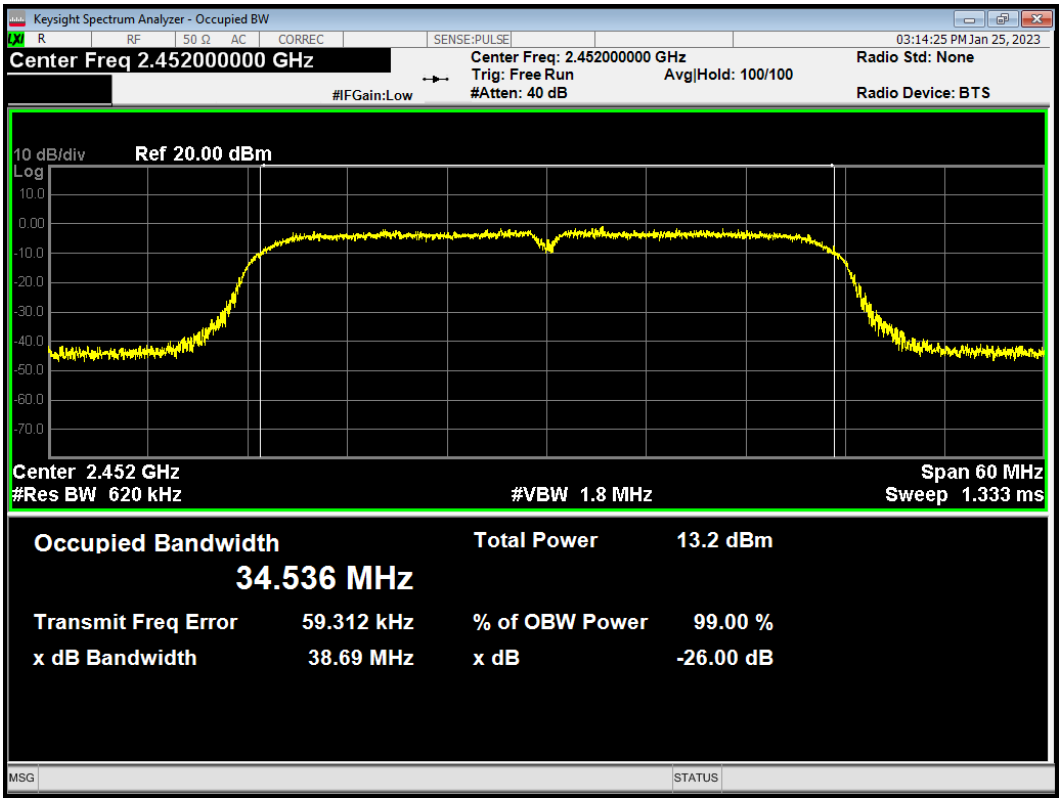


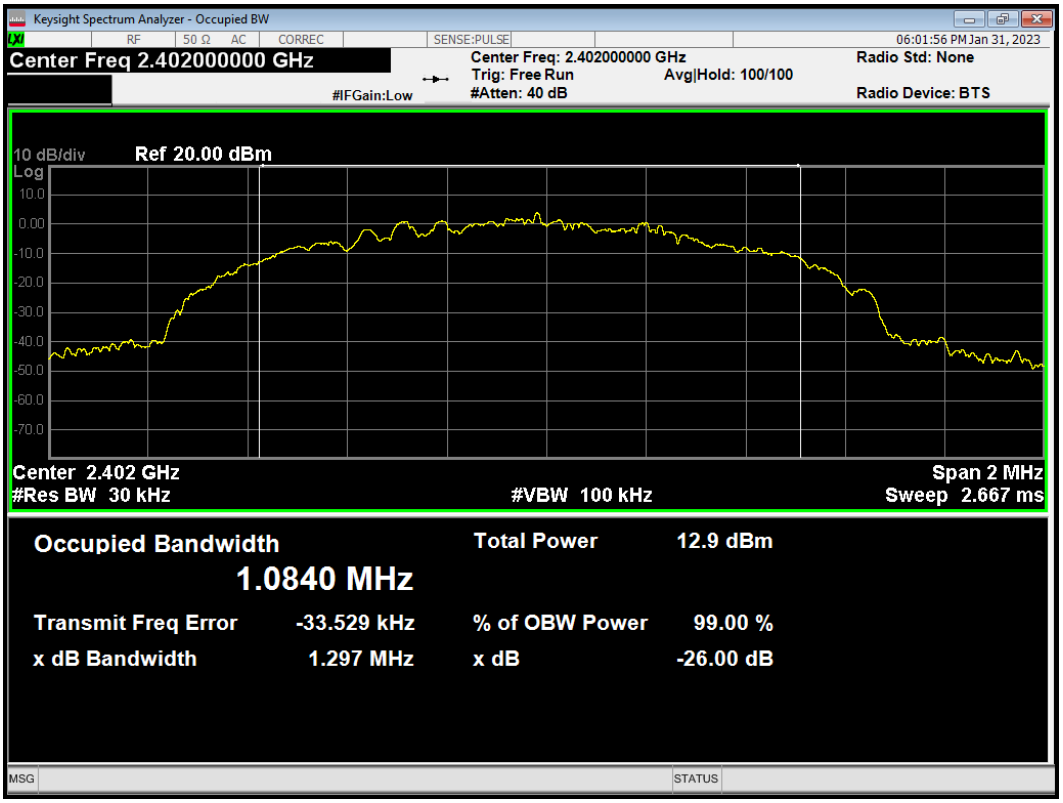
OBW 802.11n(HT40) 2447MHz



OBW 802.11n(HT40) 2452MHz



OBW BLE (1M) 2402MHz



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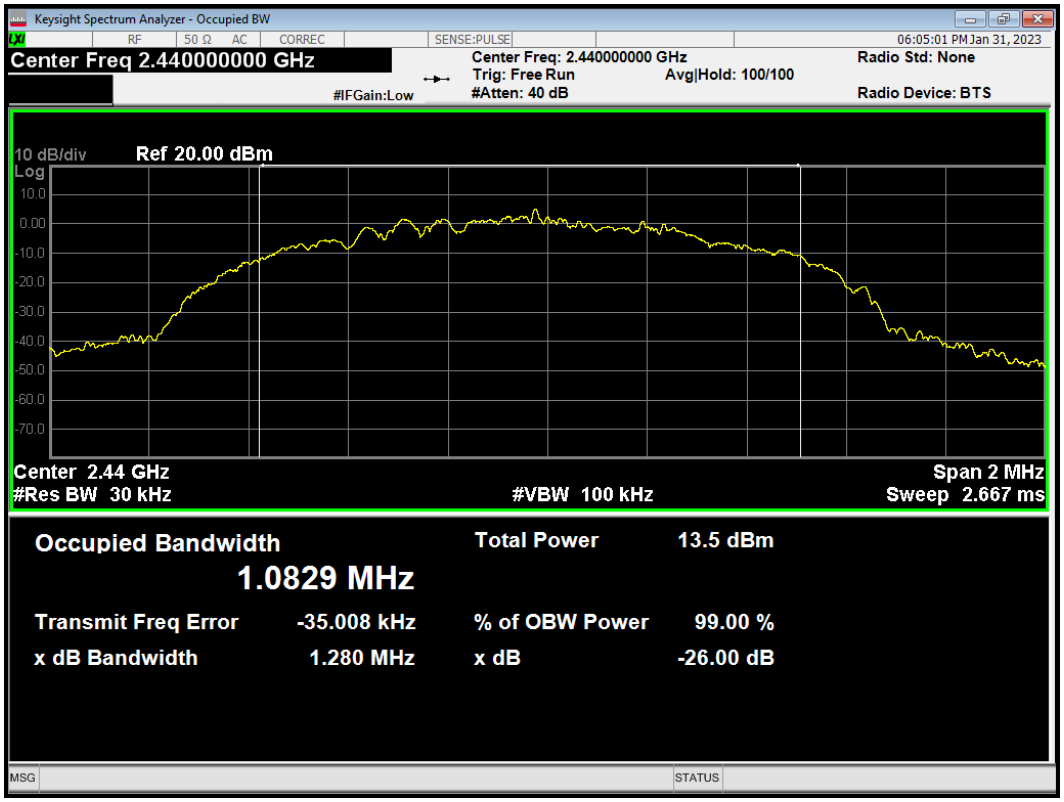
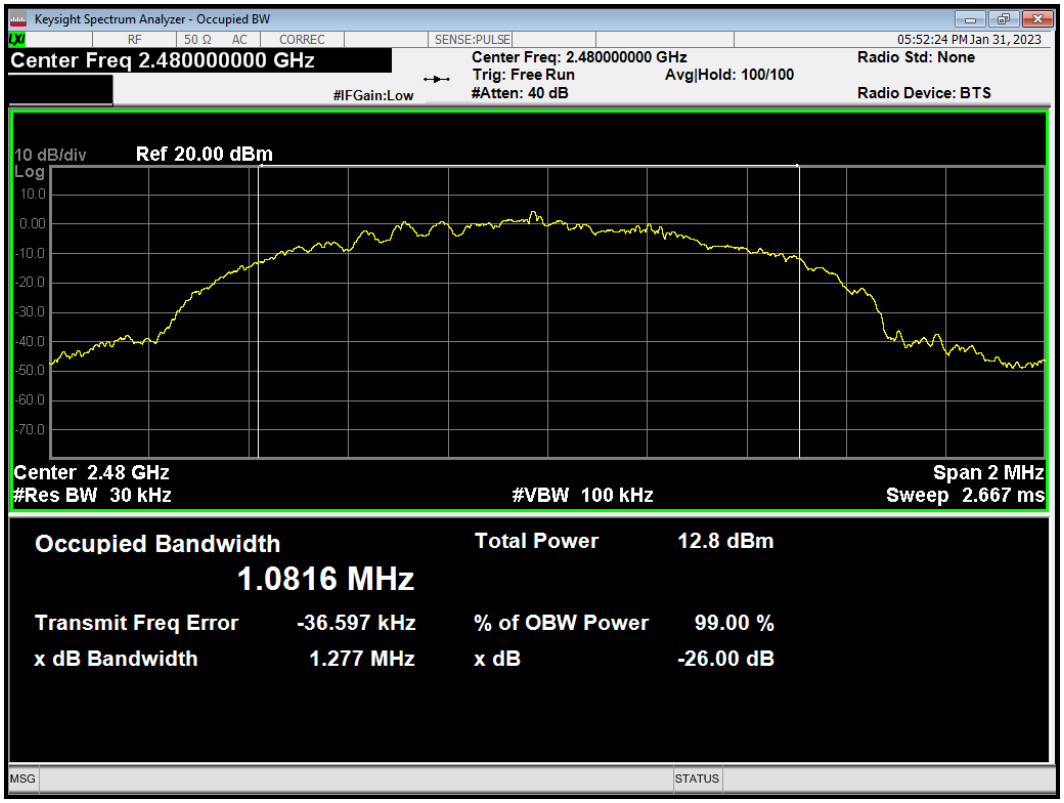
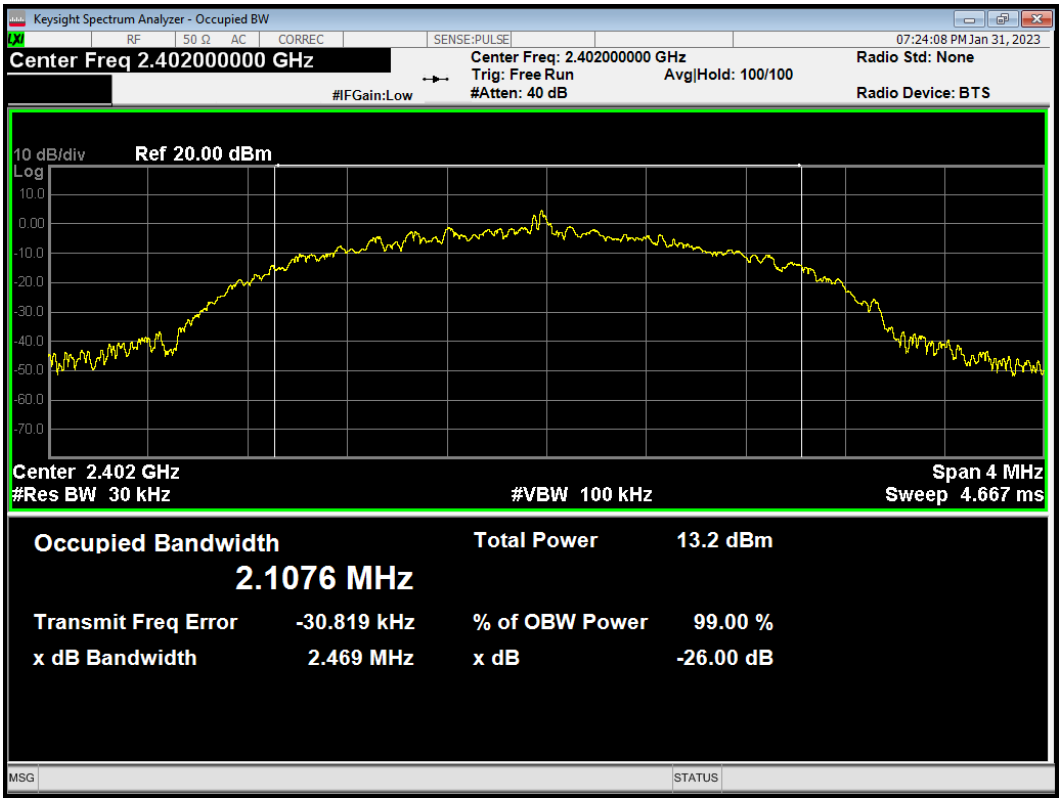


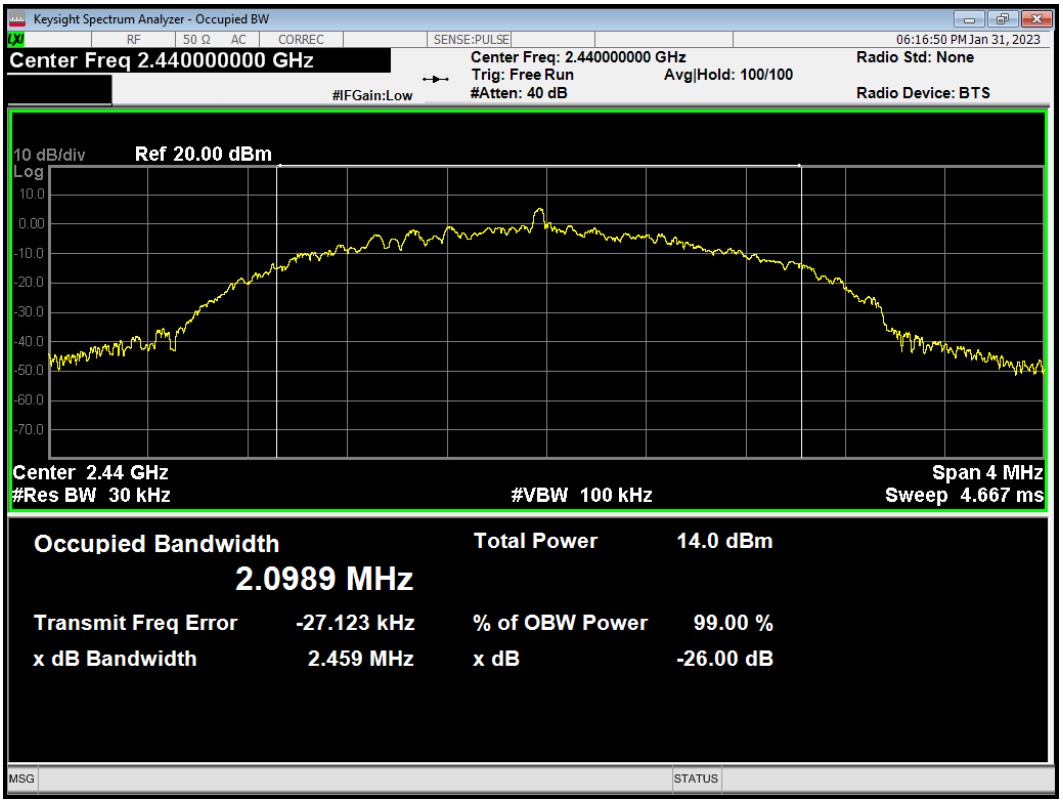
OBW BLE (1M) 2480MHz



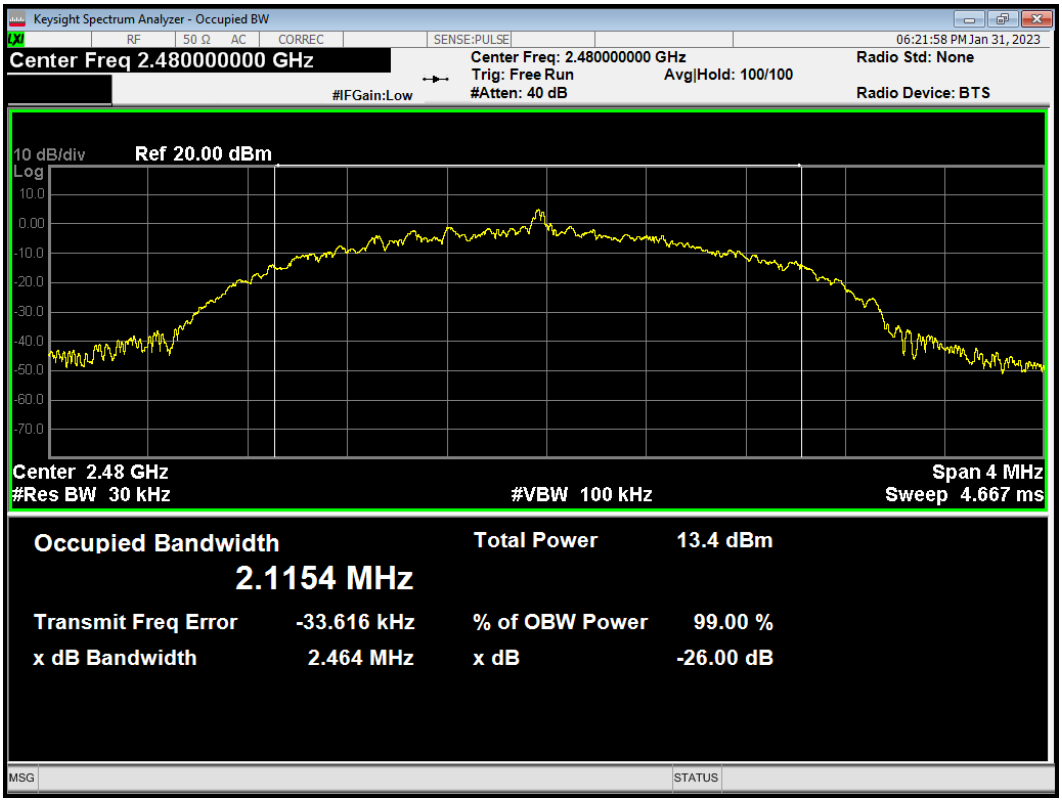
OBW BLE (2M) 2402MHz



OBW BLE (2M) 2440MHz

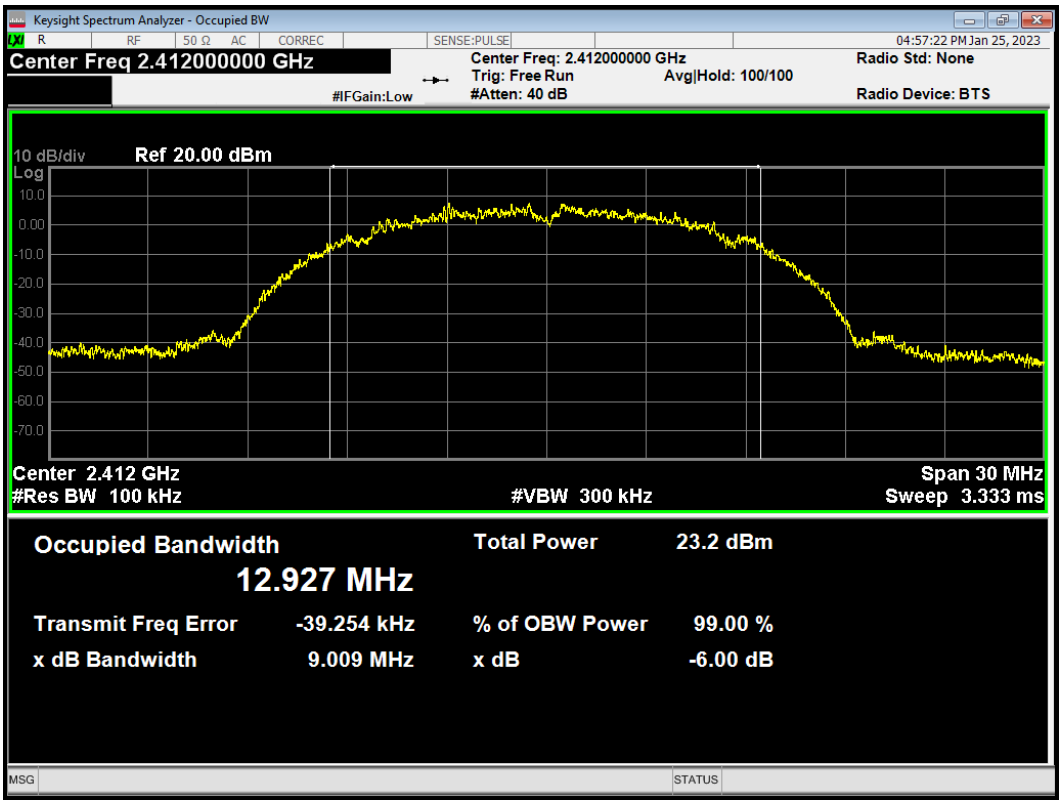


OBW BLE (2M) 2480MHz

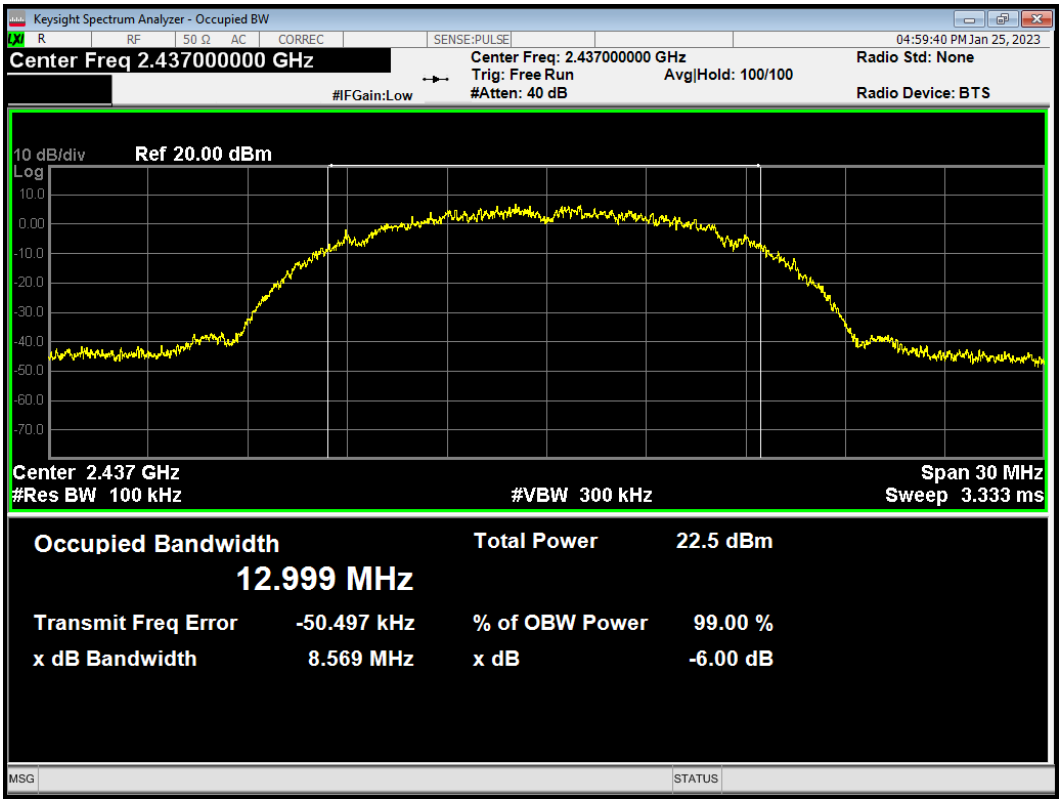


6 dB bandwidth

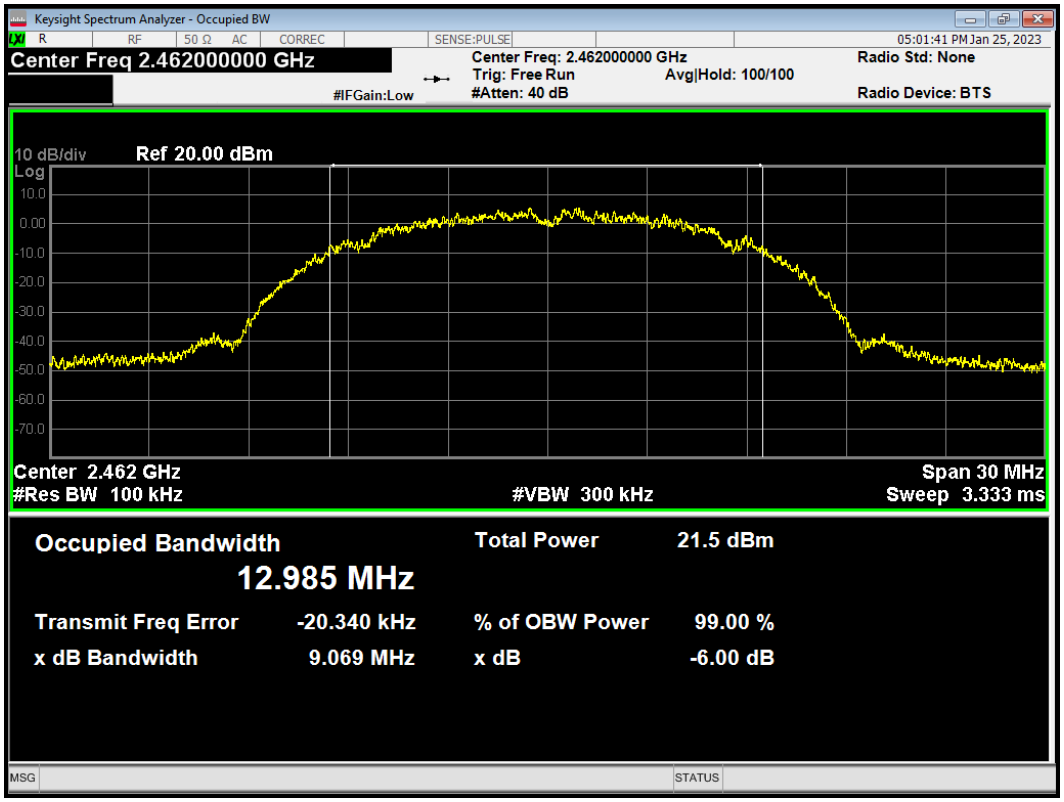
-6dB Bandwidth 802.11b 2412MHz



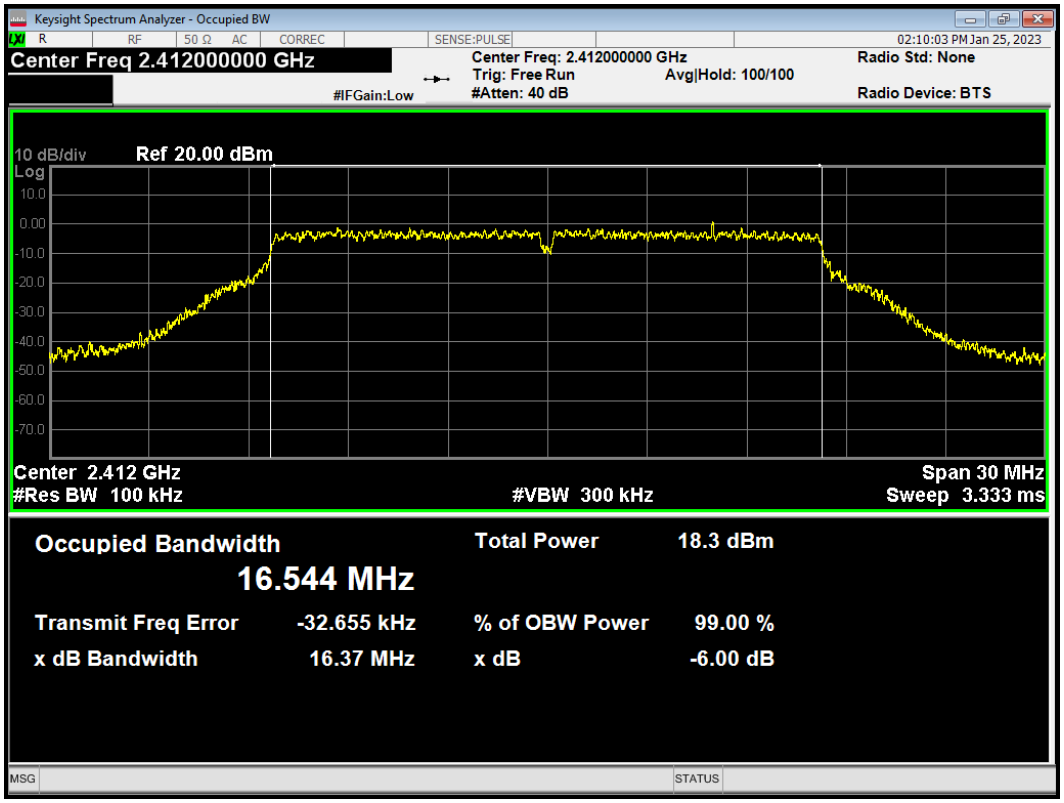
-6dB Bandwidth 802.11b 2437MHz



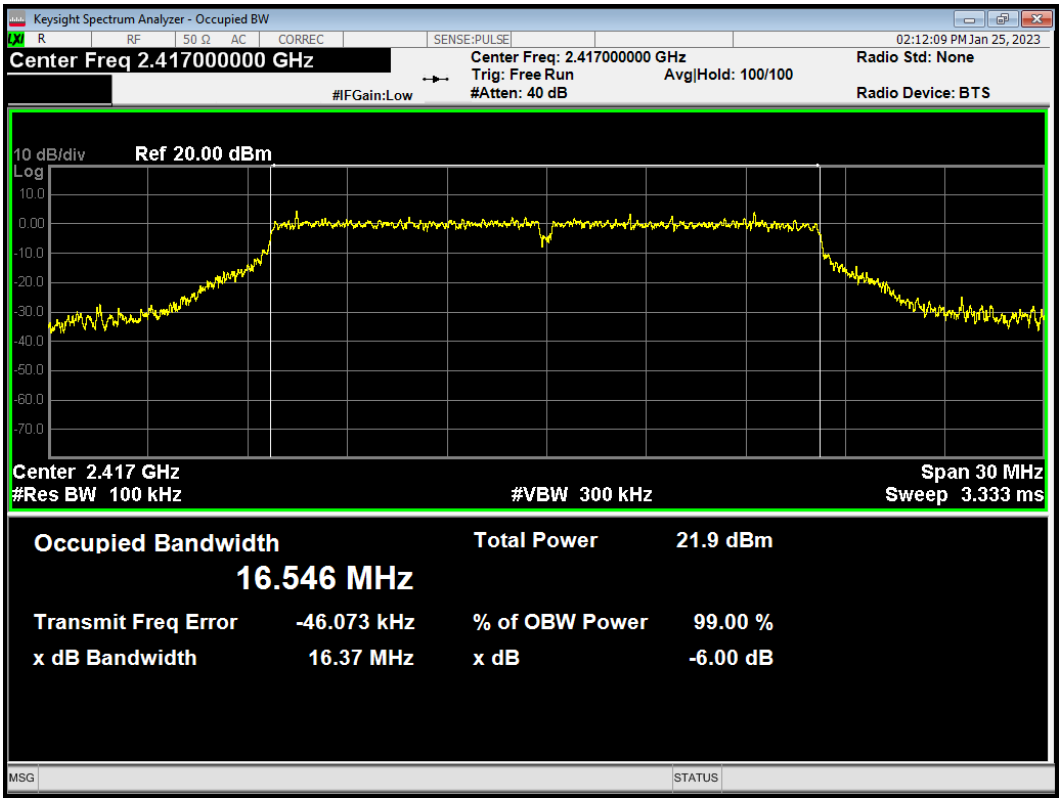
-6dB Bandwidth 802.11b 2462MHz



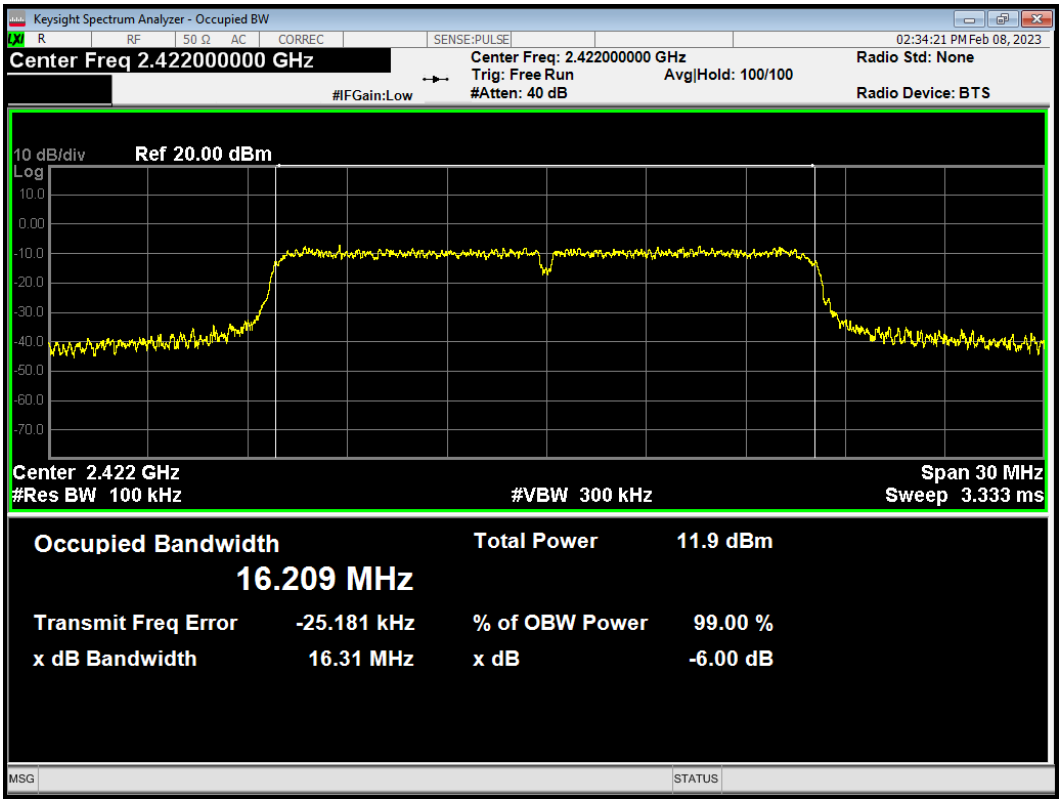
-6dB Bandwidth 802.11g 2412MHz



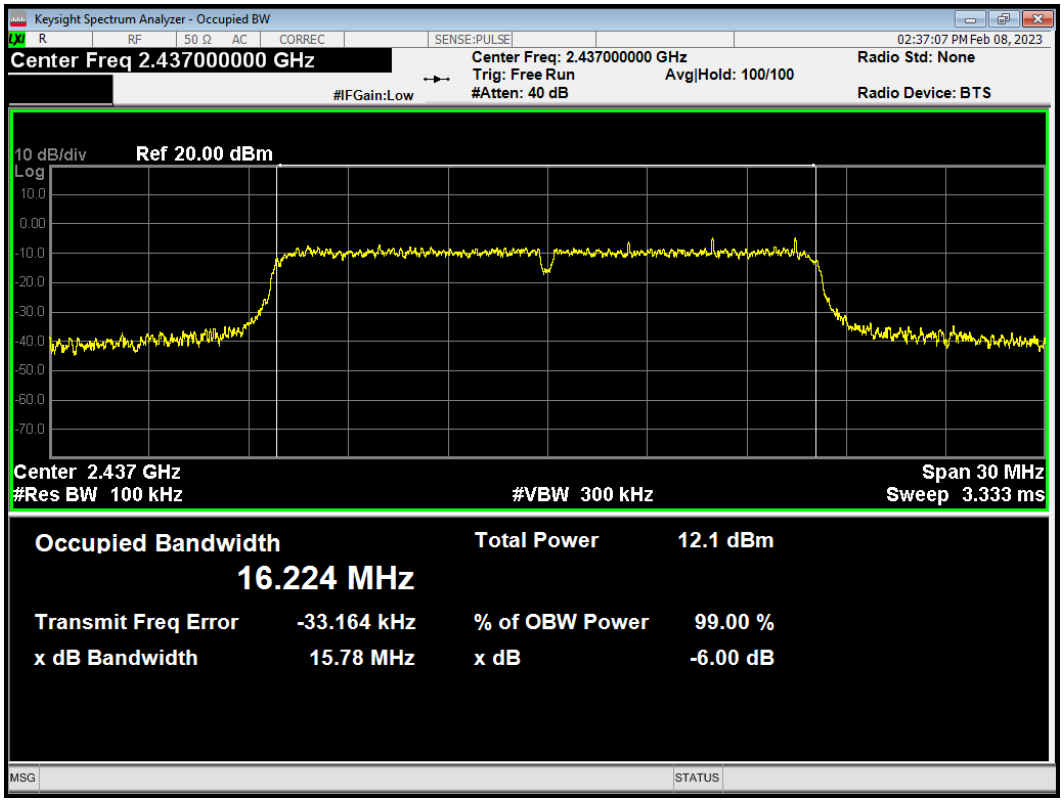
-6dB Bandwidth 802.11g 2417MHz



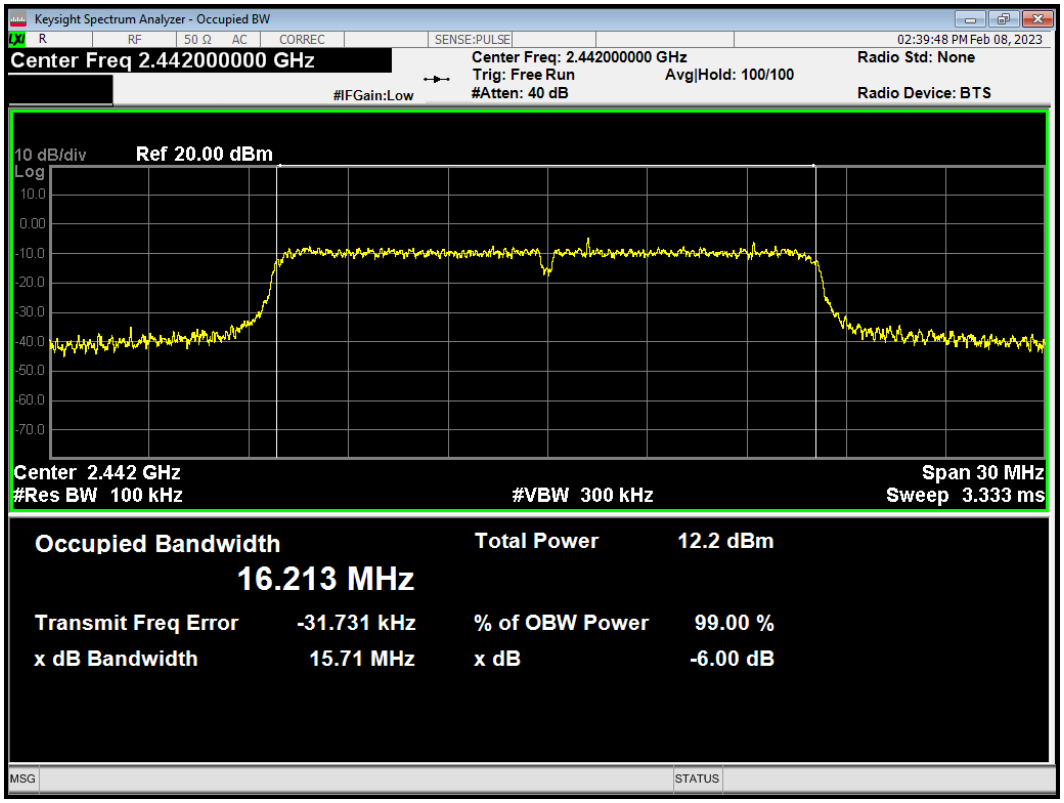
-6dB Bandwidth 802.11g 2422MHz



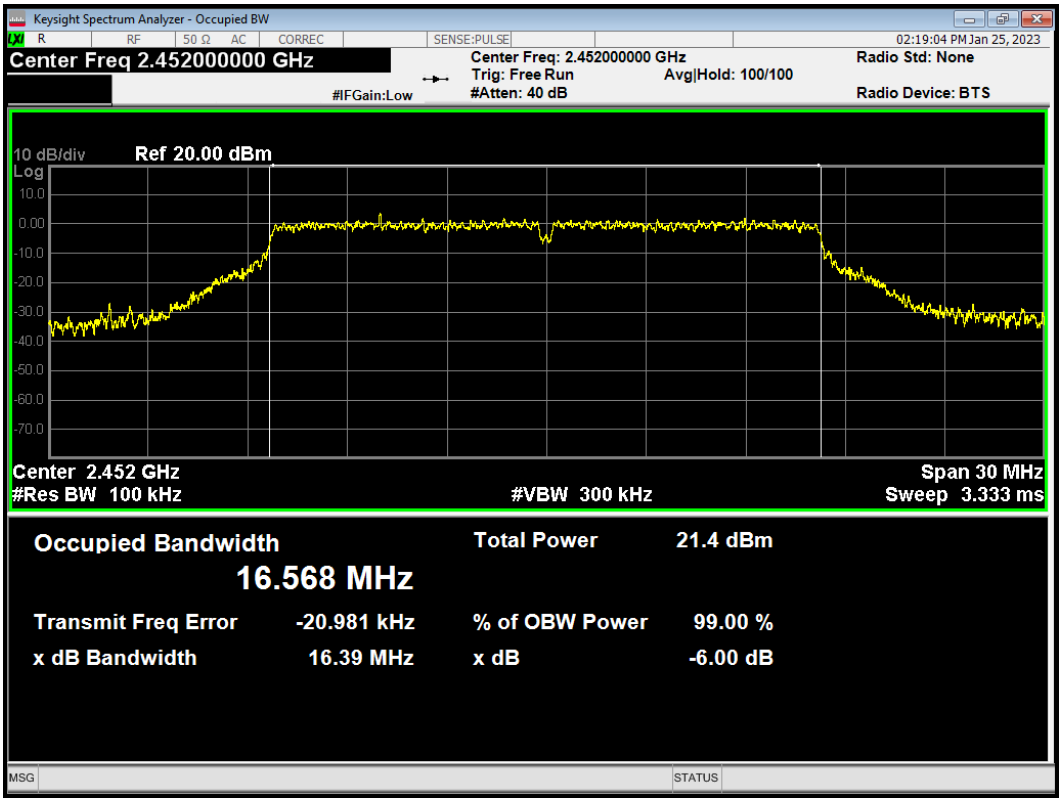
-6dB Bandwidth 802.11g 2437MHz



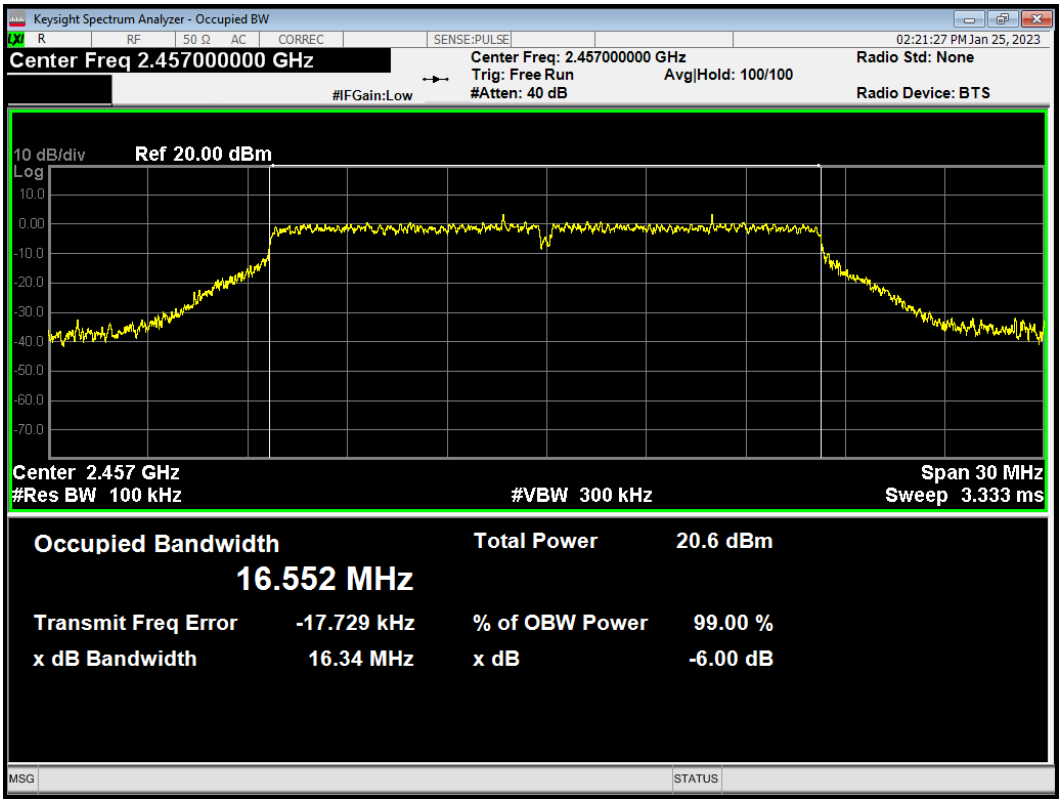
-6dB Bandwidth 802.11g 2442MHz



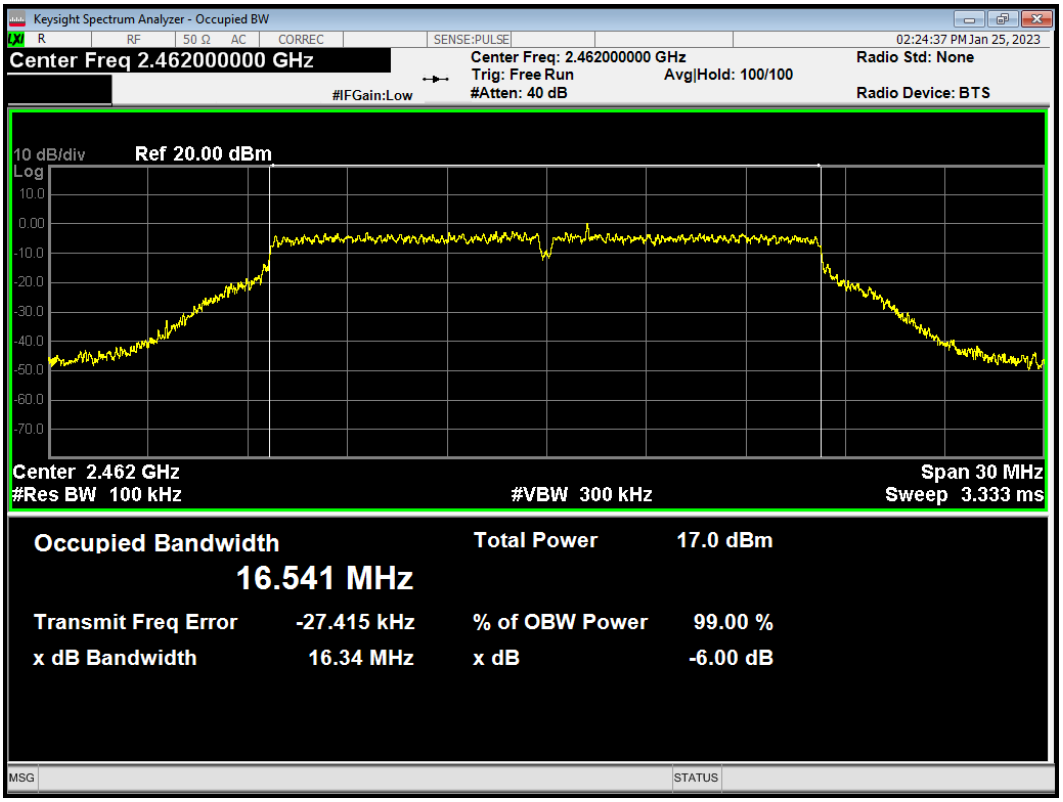
-6dB Bandwidth 802.11g 2452MHz



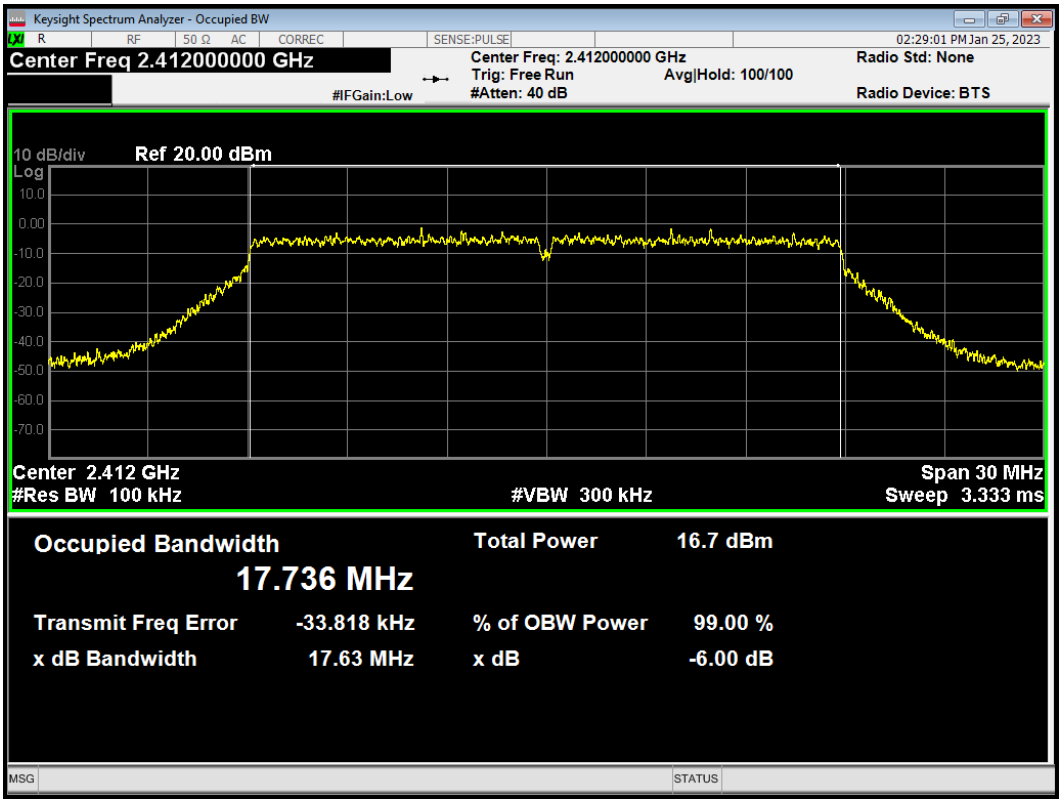
-6dB Bandwidth 802.11g 2457MHz



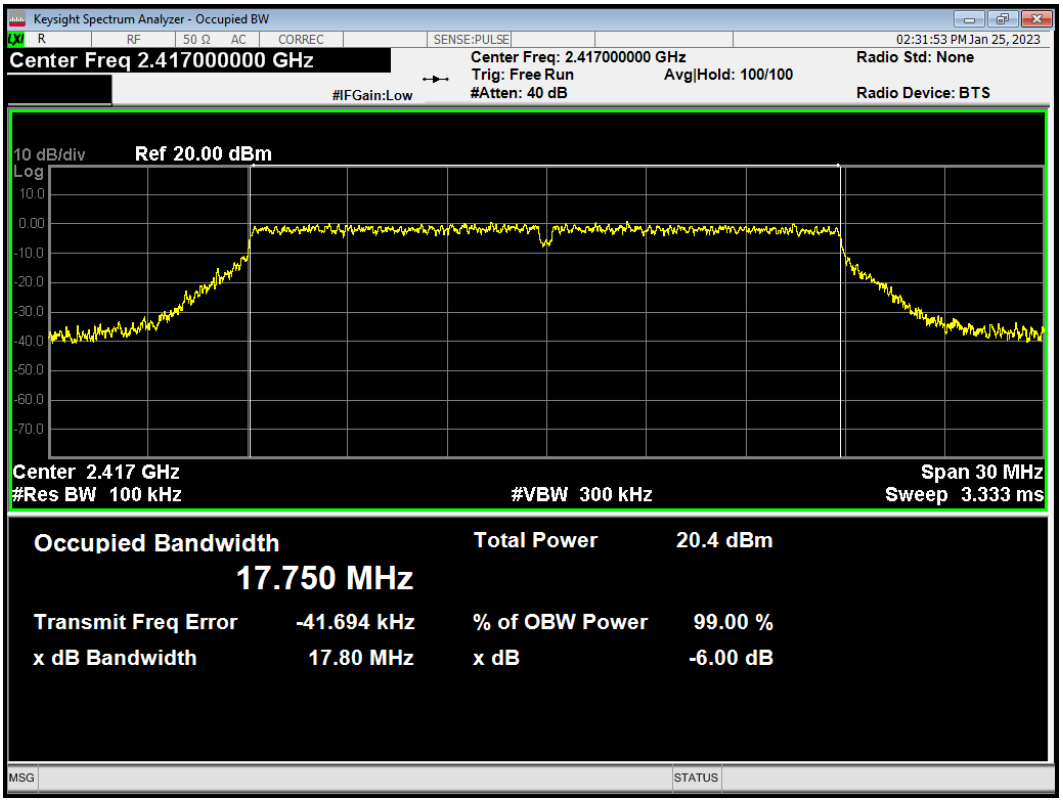
-6dB Bandwidth 802.11g 2462MHz



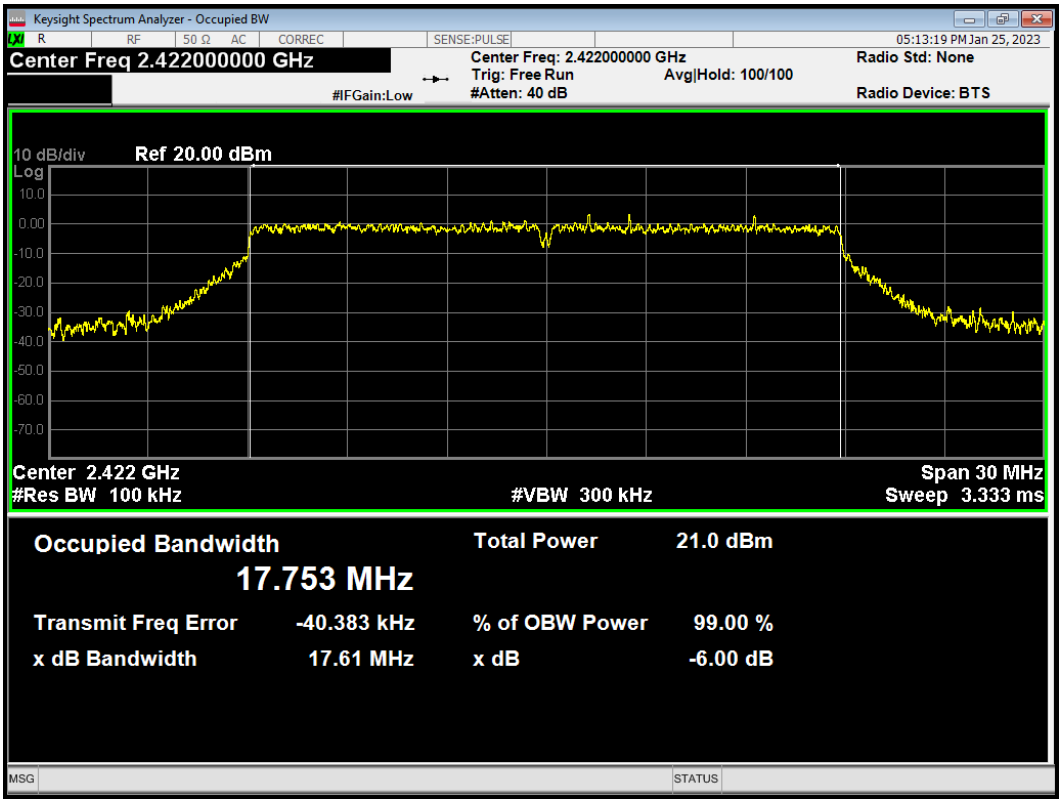
-6dB Bandwidth 802.11n(HT20) 2412MHz



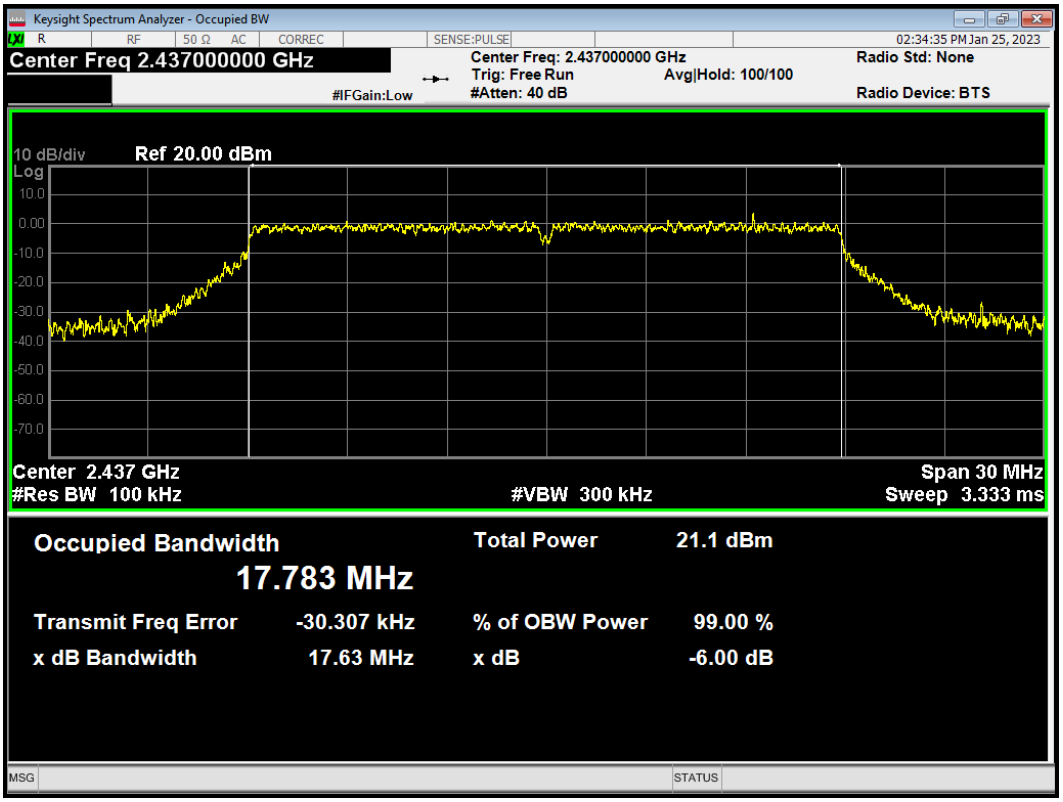
-6dB Bandwidth 802.11n(HT20) 2417MHz



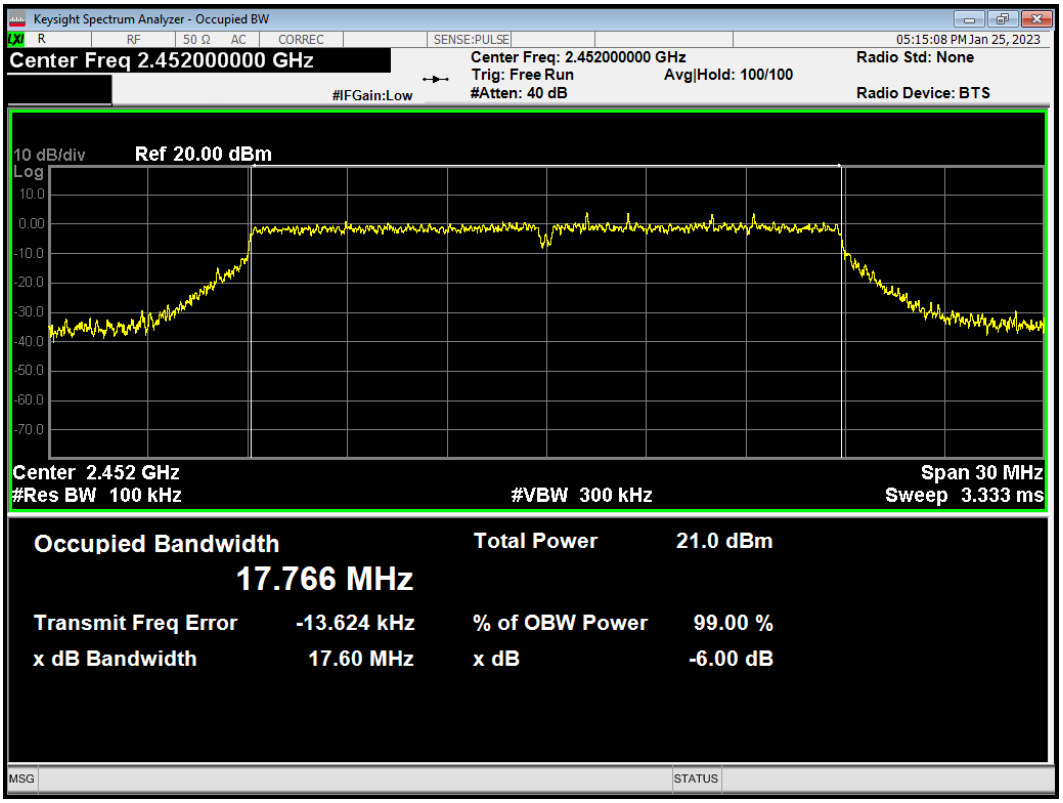
-6dB Bandwidth 802.11n(HT20) 2422MHz



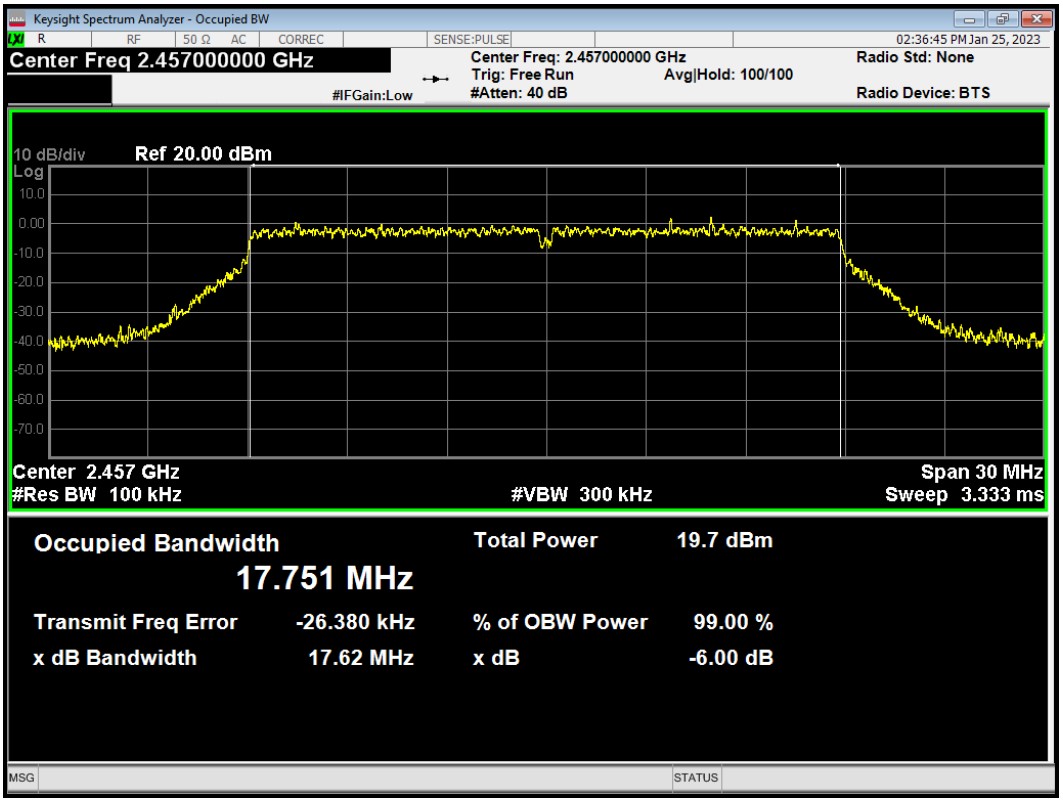
-6dB Bandwidth 802.11n(HT20) 2437MHz



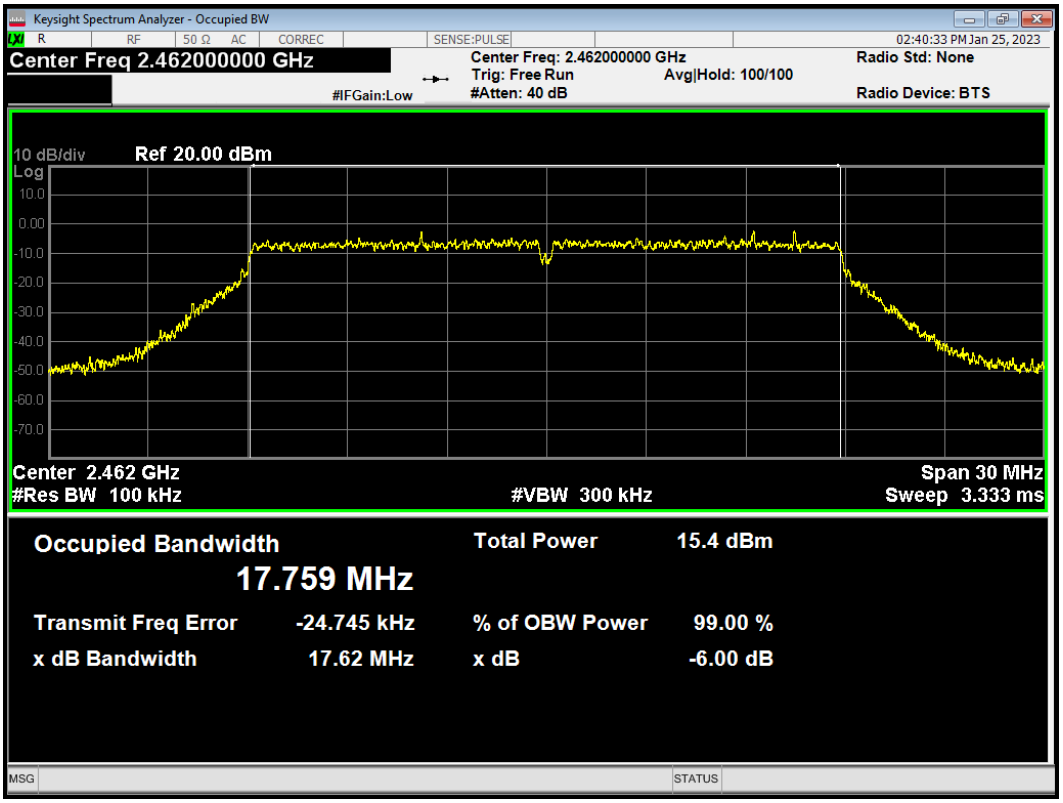
-6dB Bandwidth 802.11n(HT20) 2452MHz



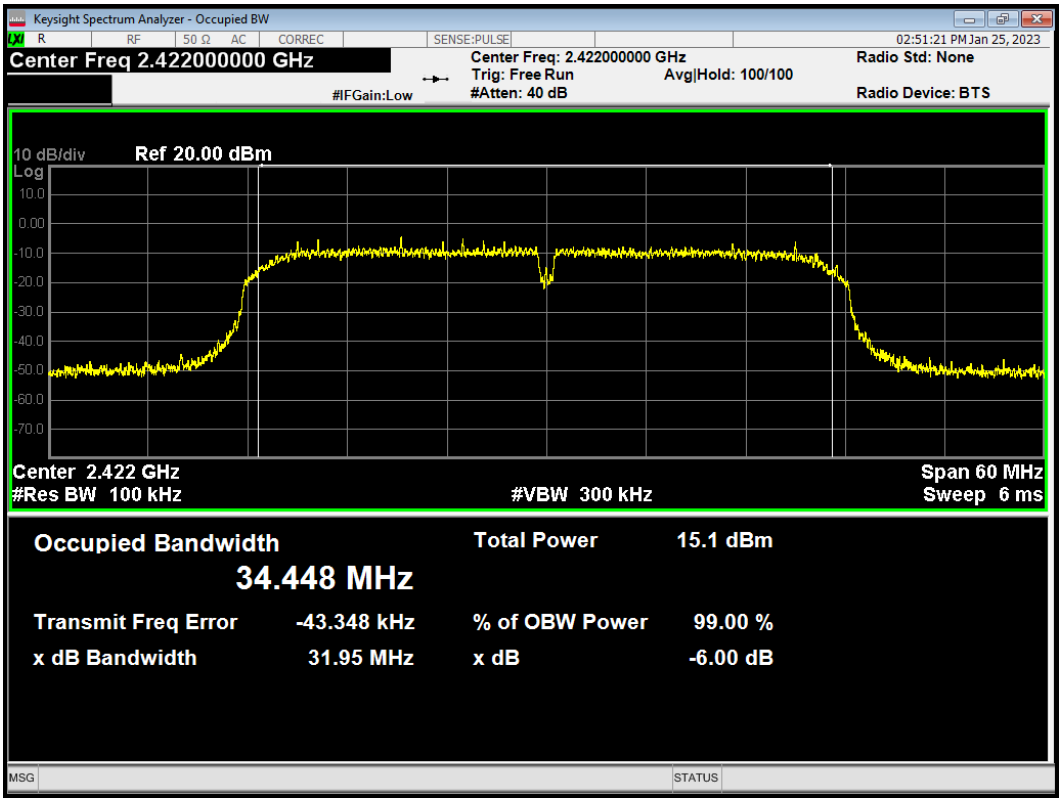
-6dB Bandwidth 802.11n(HT20) 2457MHz



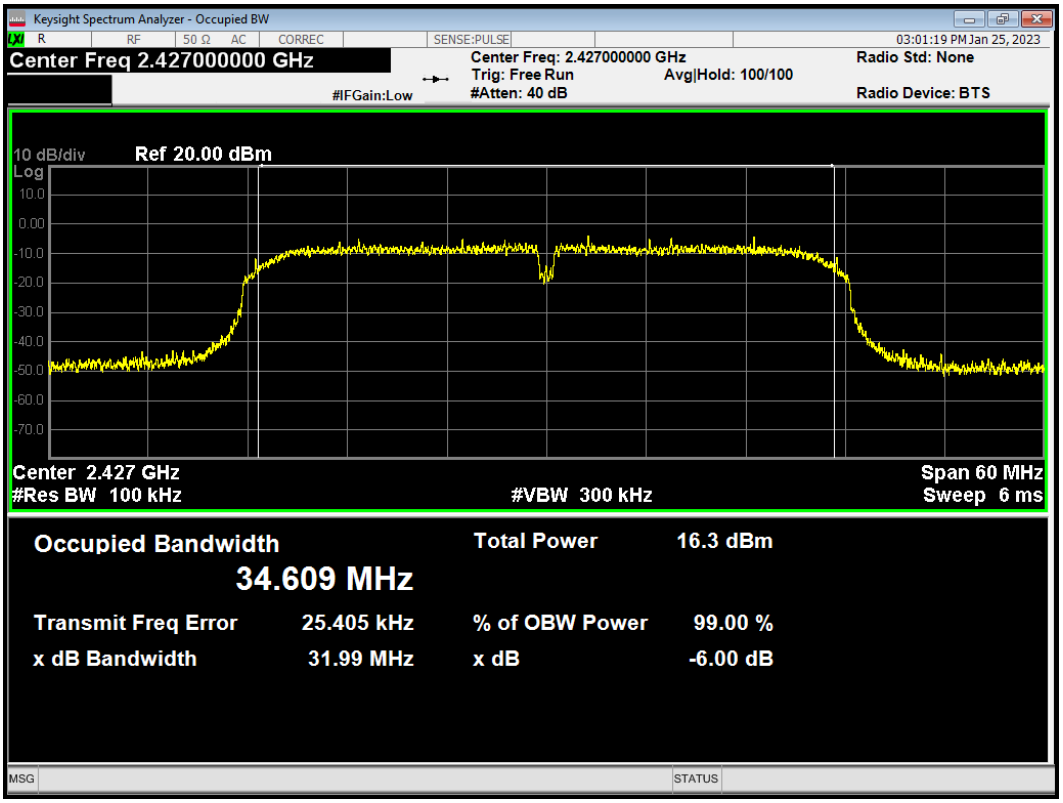
-6dB Bandwidth 802.11n(HT20) 2462MHz



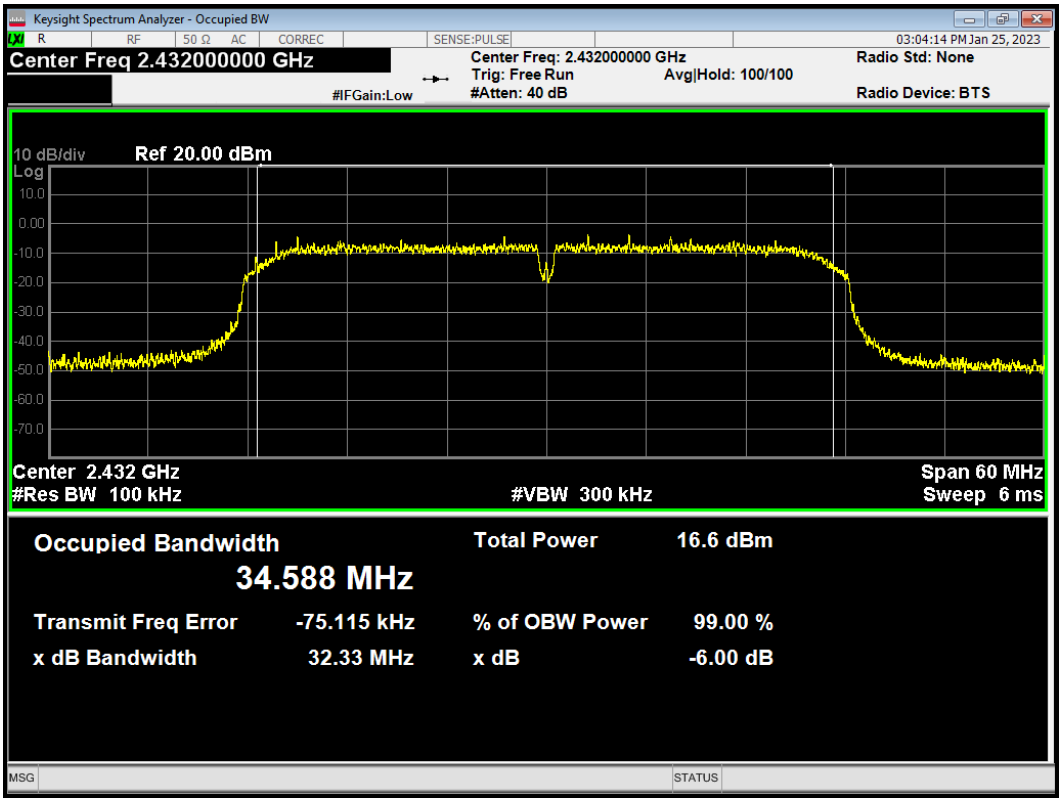
-6dB Bandwidth 802.11n(HT40) 2422MHz



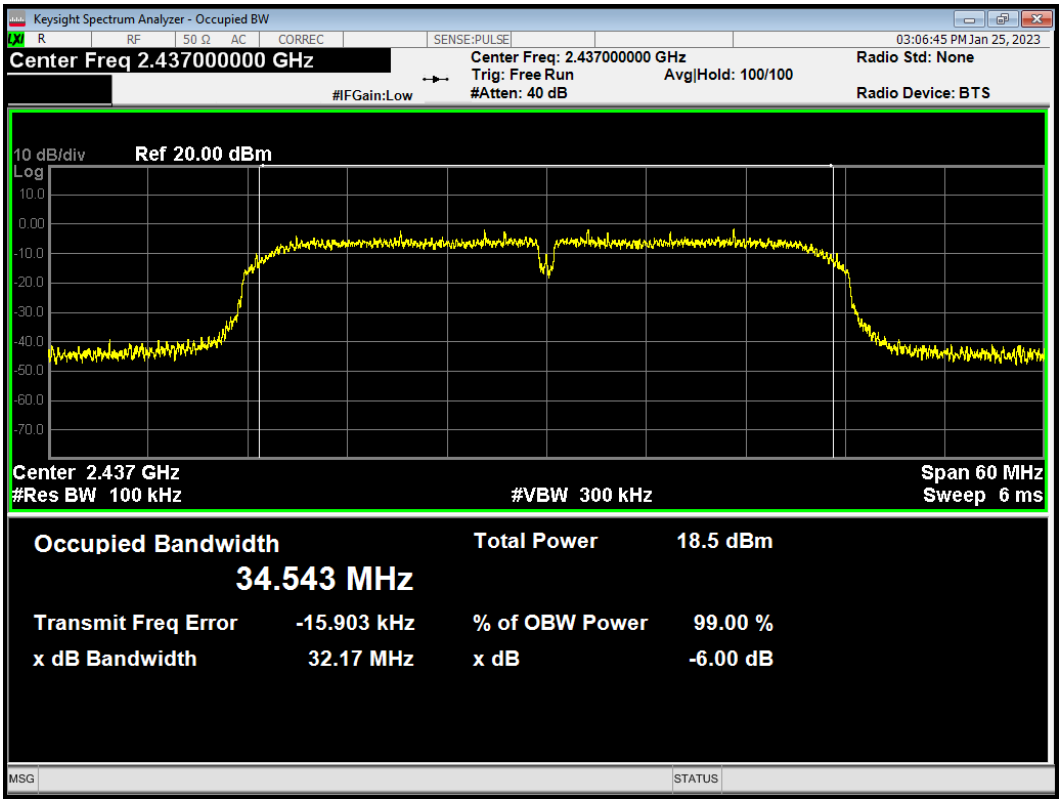
-6dB Bandwidth 802.11n(HT40) 2427MHz



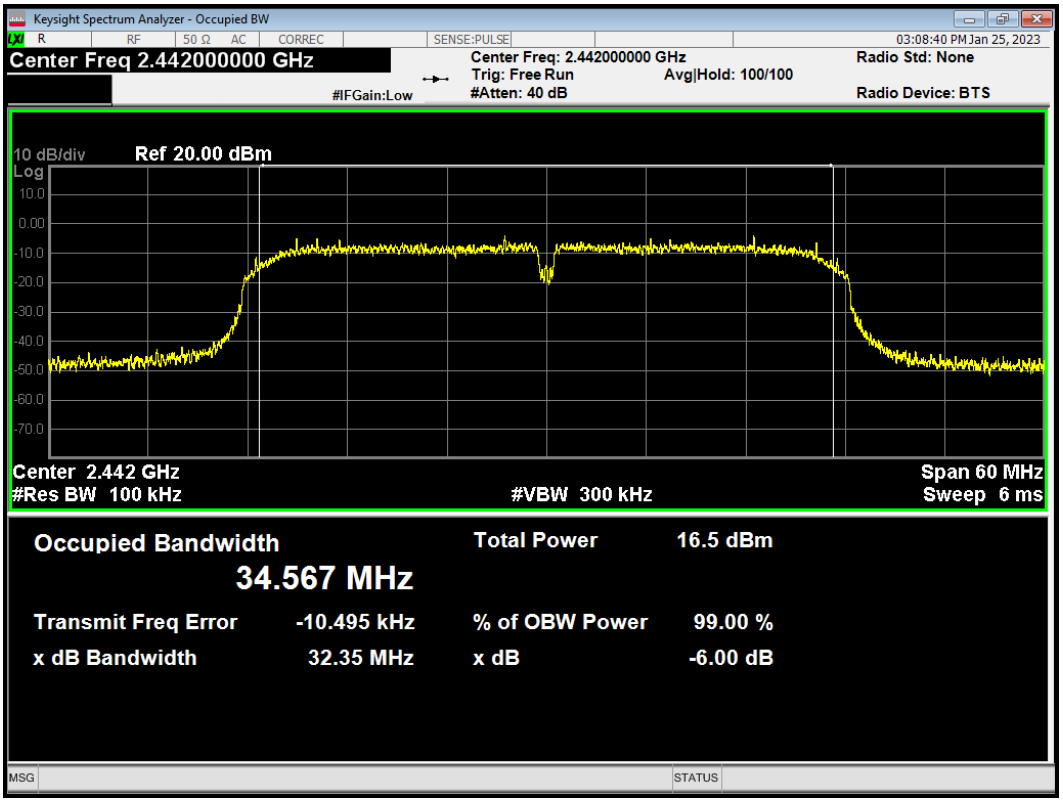
-6dB Bandwidth 802.11n(HT40) 2432MHz



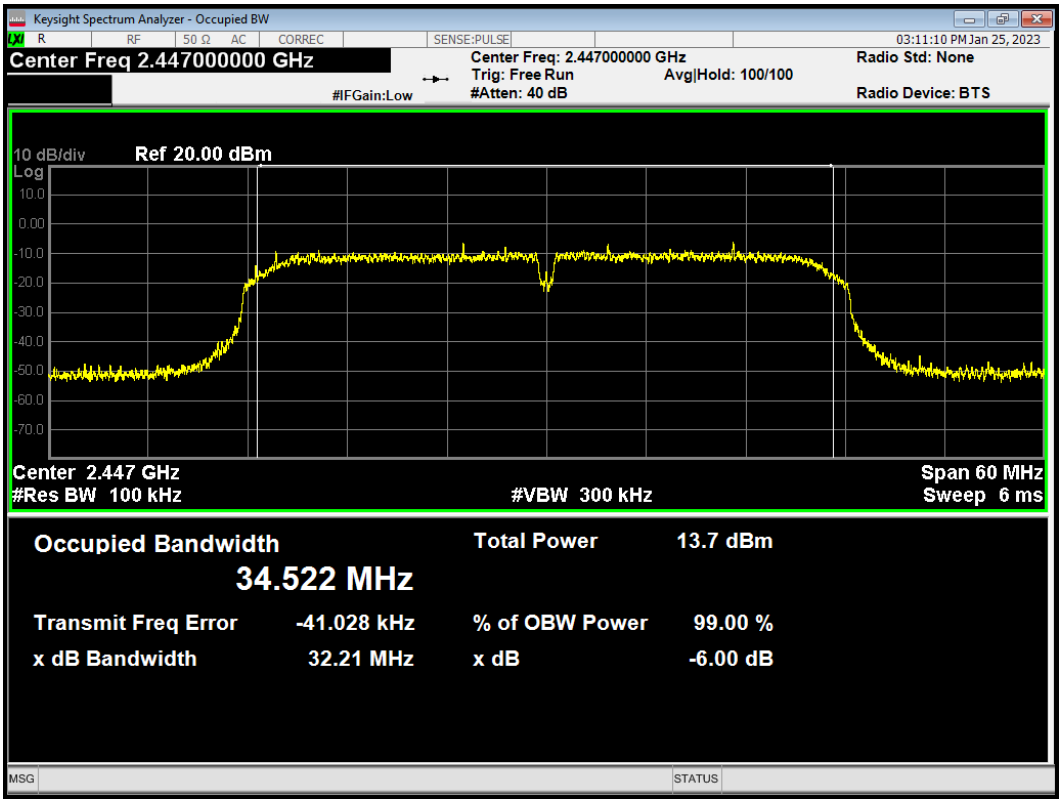
-6dB Bandwidth 802.11n(HT40) 2437MHz



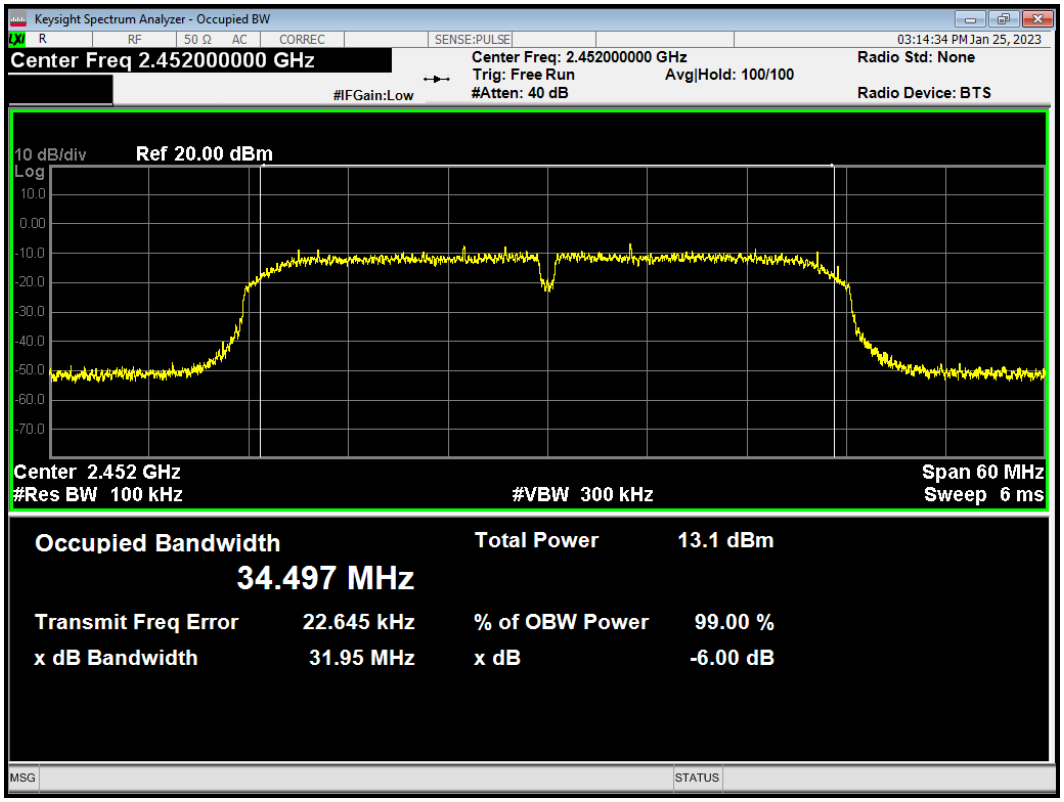
-6dB Bandwidth 802.11n(HT40) 2442MHz



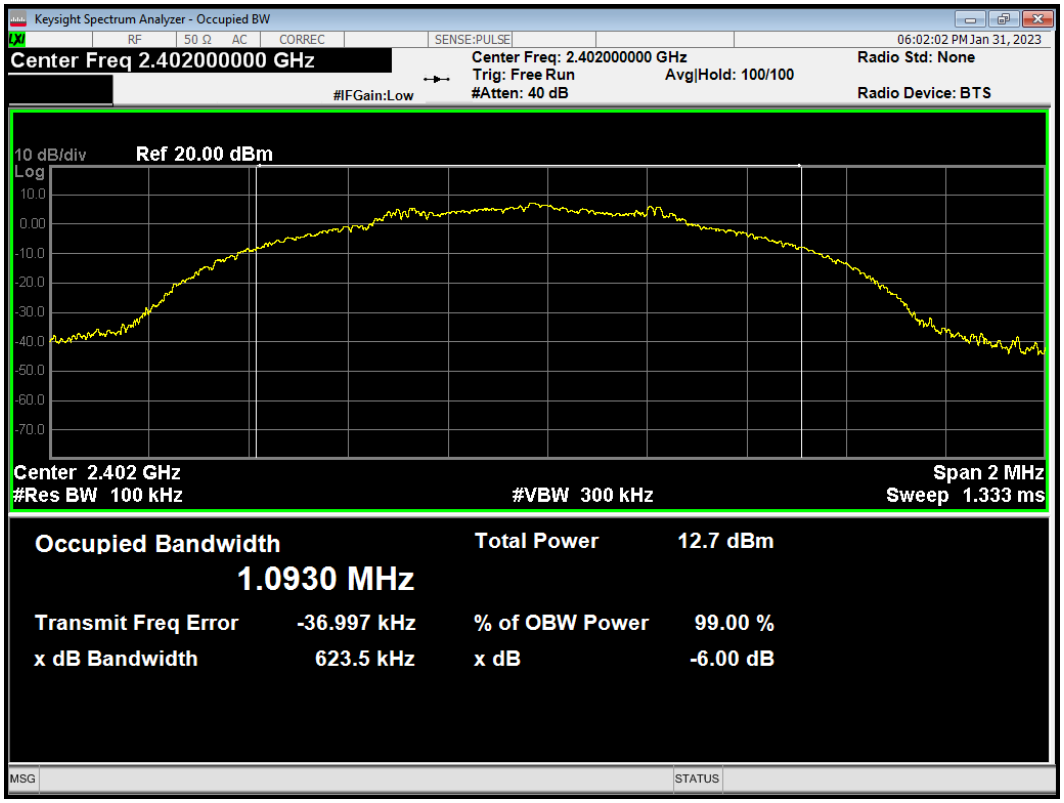
-6dB Bandwidth 802.11n(HT40) 2447MHz



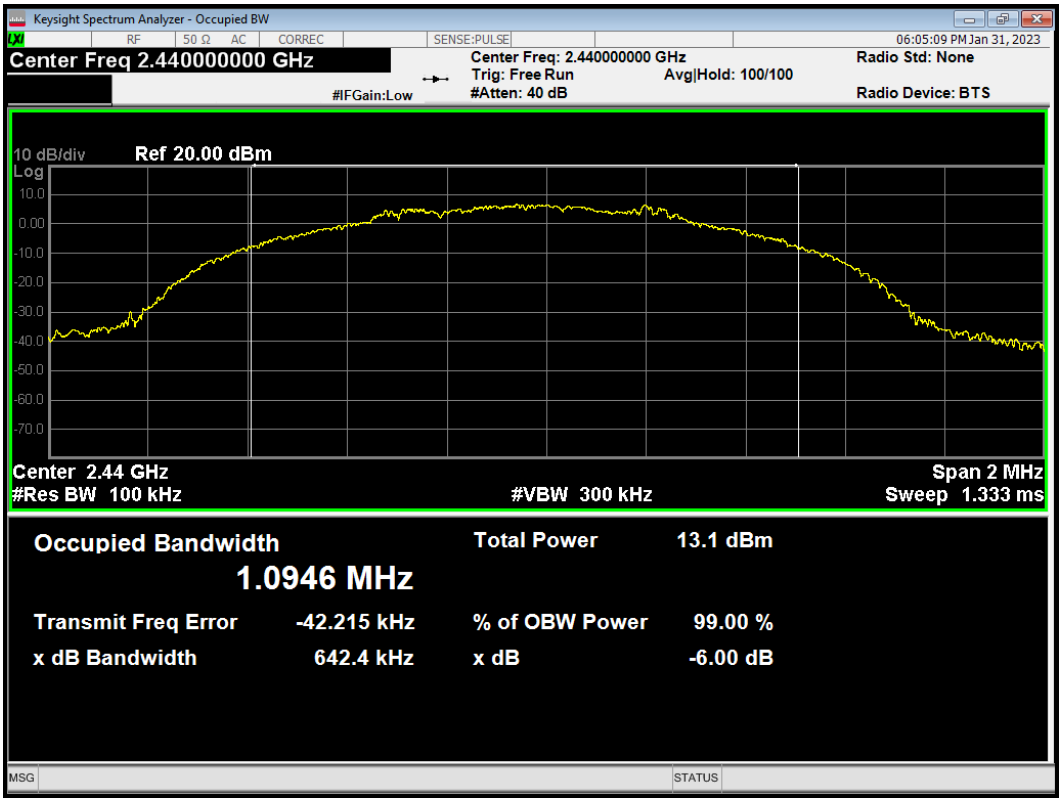
-6dB Bandwidth 802.11n(HT40) 2452MHz



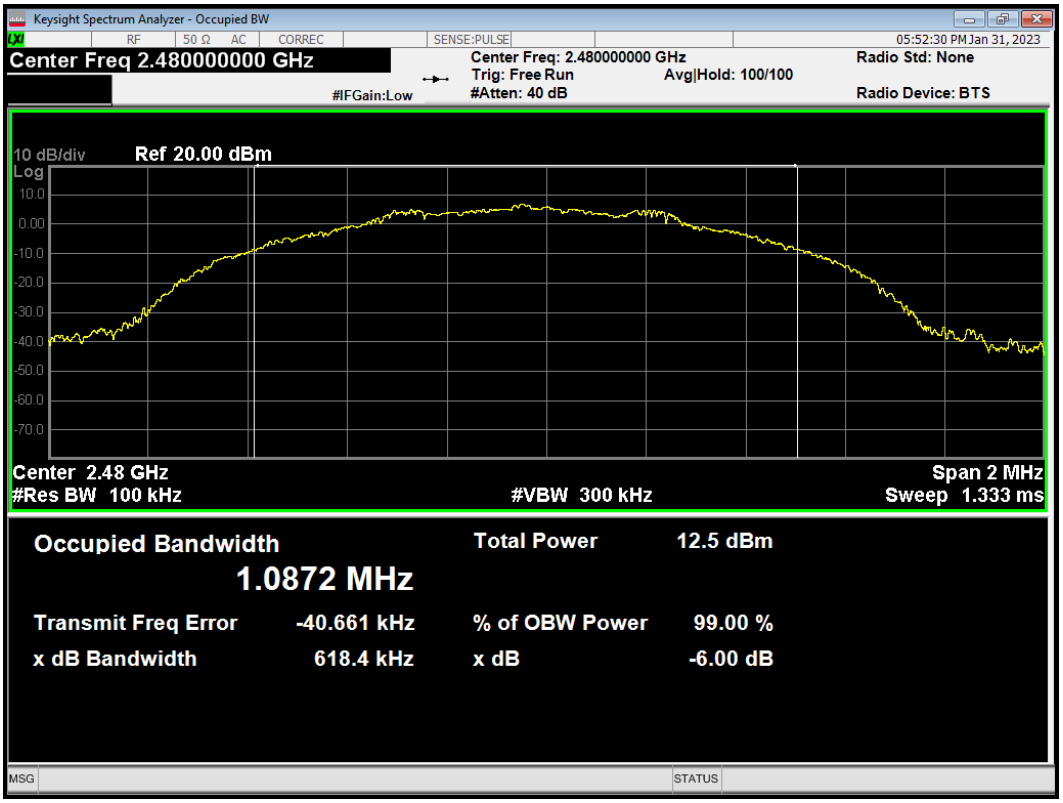
-6dB Bandwidth BLE (1M) 2402MHz



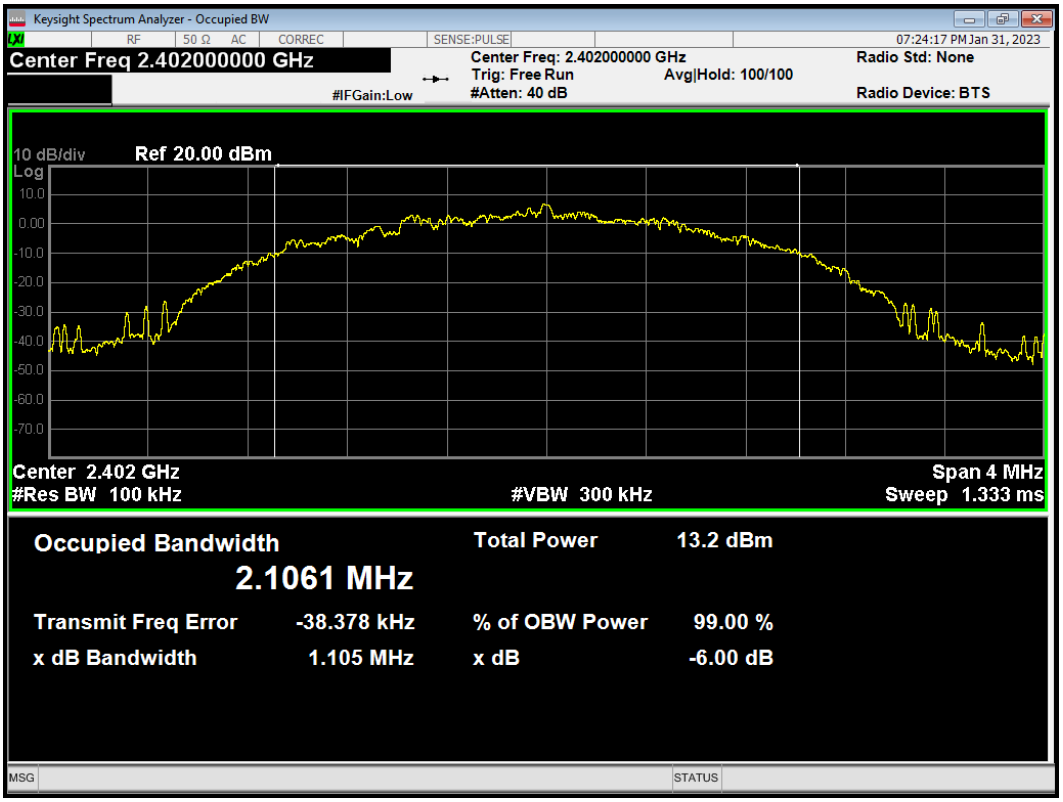
-6dB Bandwidth BLE (1M) 2440MHz



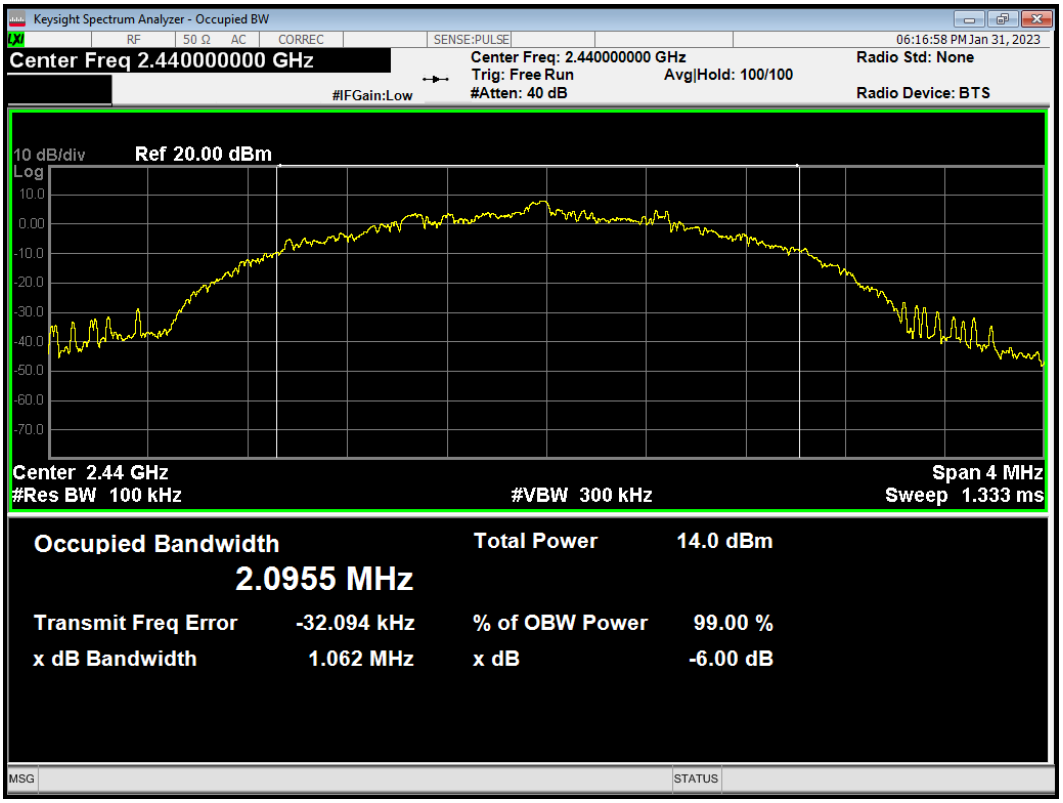
-6dB Bandwidth BLE (1M) 2480MHz



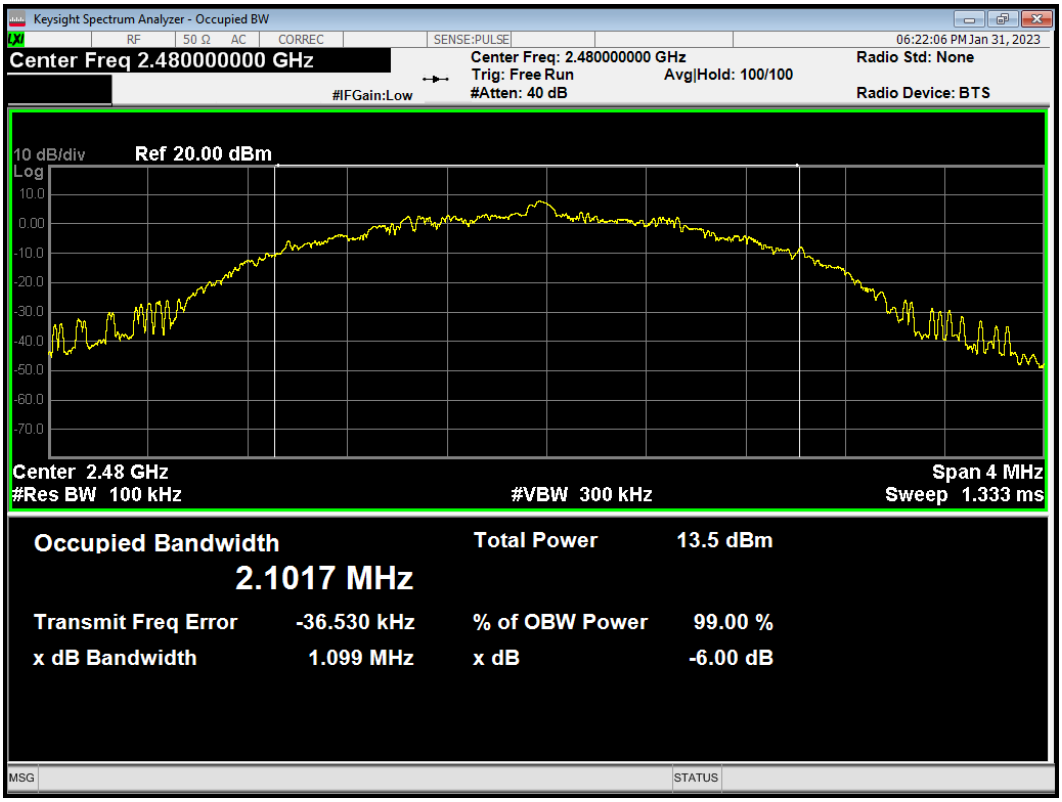
-6dB Bandwidth BLE (2M) 2402MHz



-6dB Bandwidth BLE (2M) 2440MHz



-6dB Bandwidth BLE (2M) 2480MHz



5.3. Band Edge

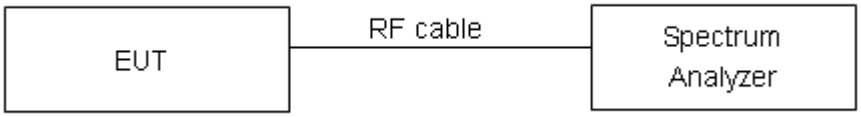
Ambient Condition

Temperature	Relative humidity
20°C ~ 25°C	45% ~ 50%

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable the band edge of the lowest and highest channels were measured. The peak detector is used and RBW is set to 100 kHz and VBW is set to 300 kHz on spectrum analyzer. Spectrum analyzer plots are included on the following pages.

Test Setup



Limits

Rule Part 15.247(d) specifies that “In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.” If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.”

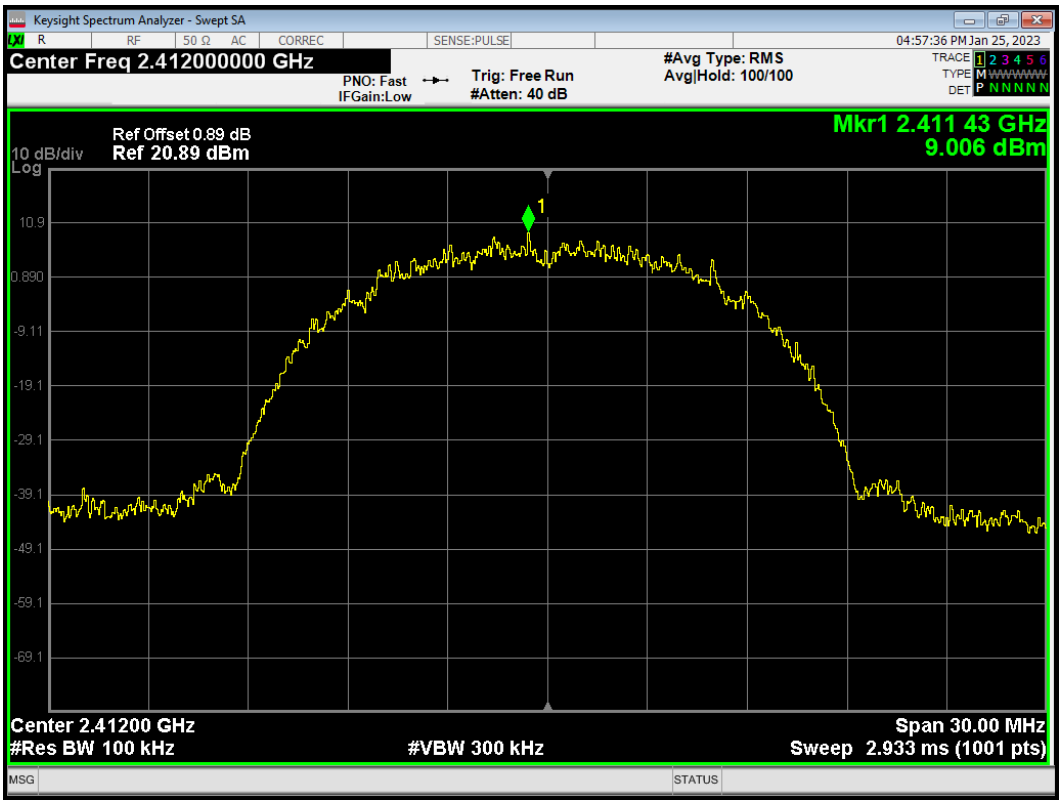
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 1.96.

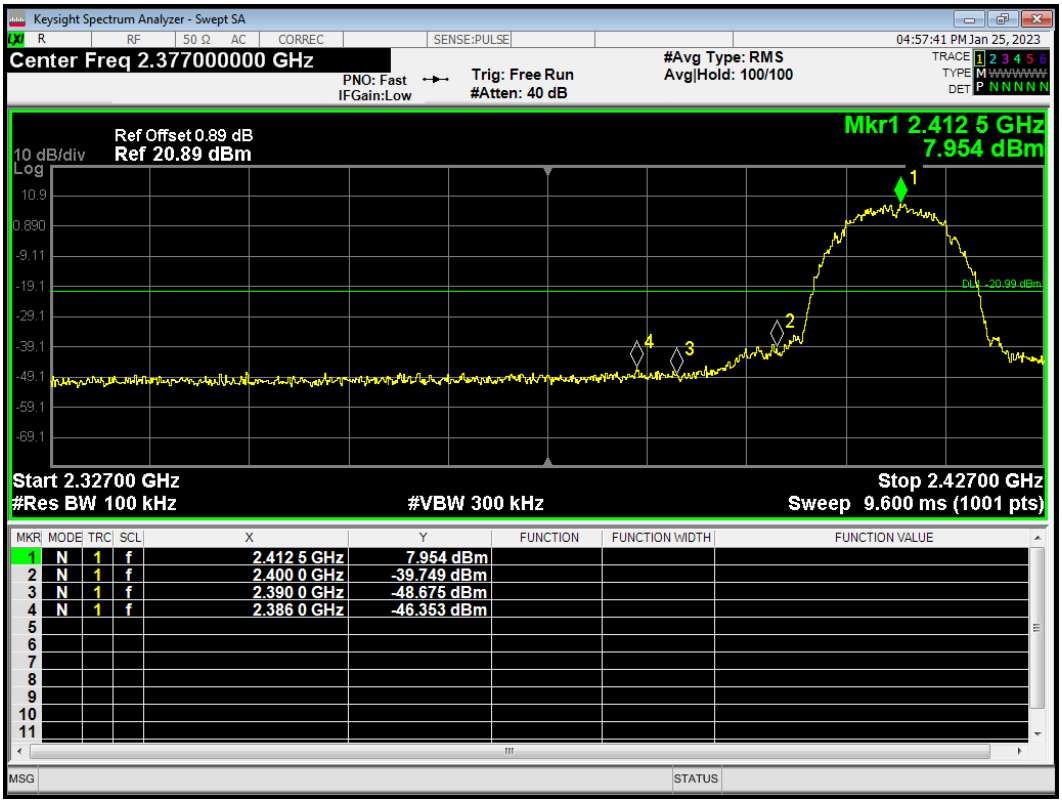
Frequency	Uncertainty
2GHz-3GHz	1.407 dB

Test Results: PASS

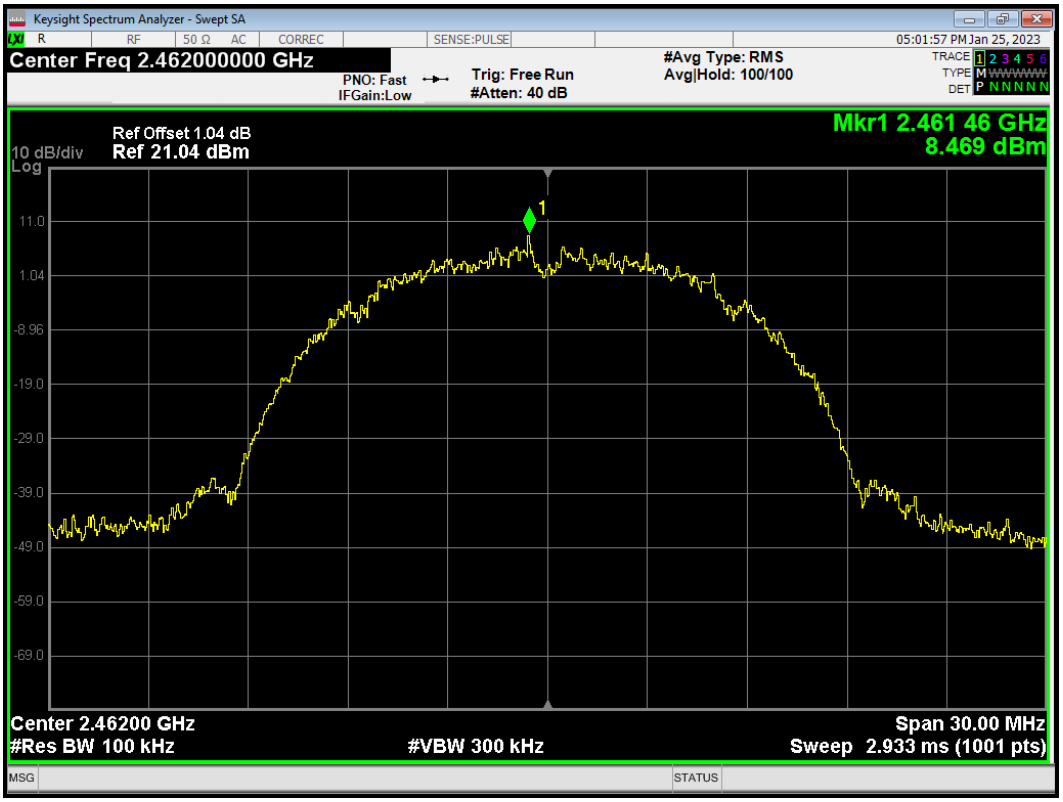
Band Edge 802.11b 2412MHz Ref



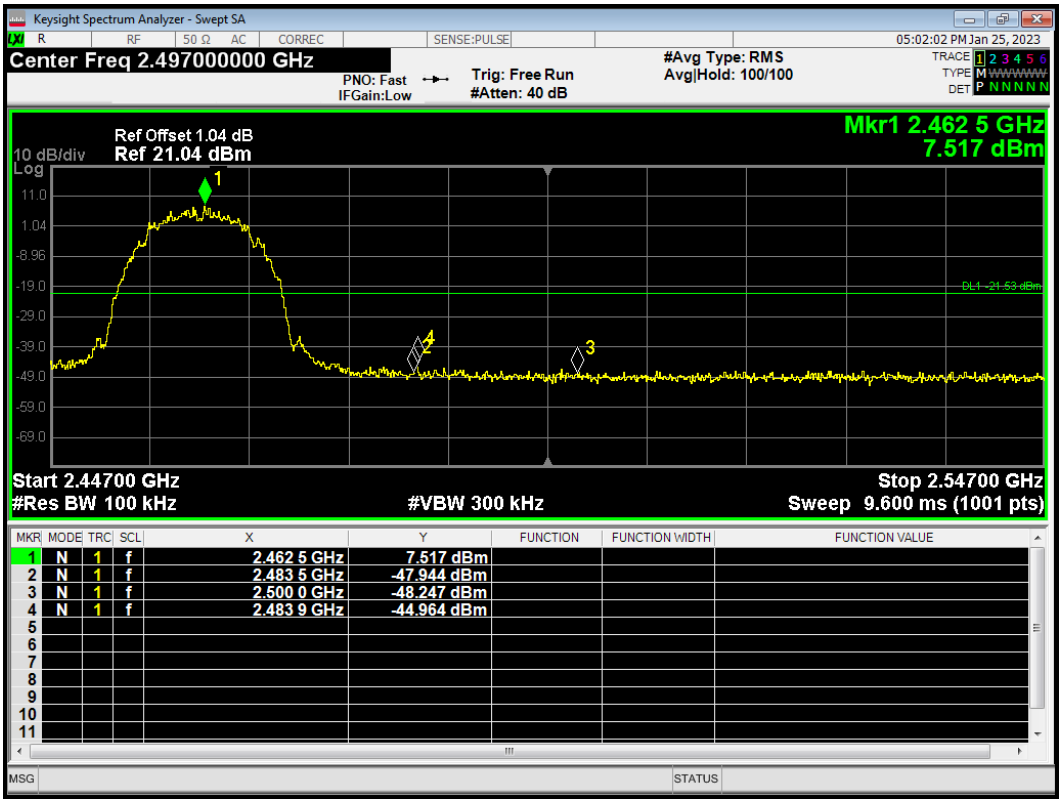
Band Edge 802.11b 2412MHz Emission



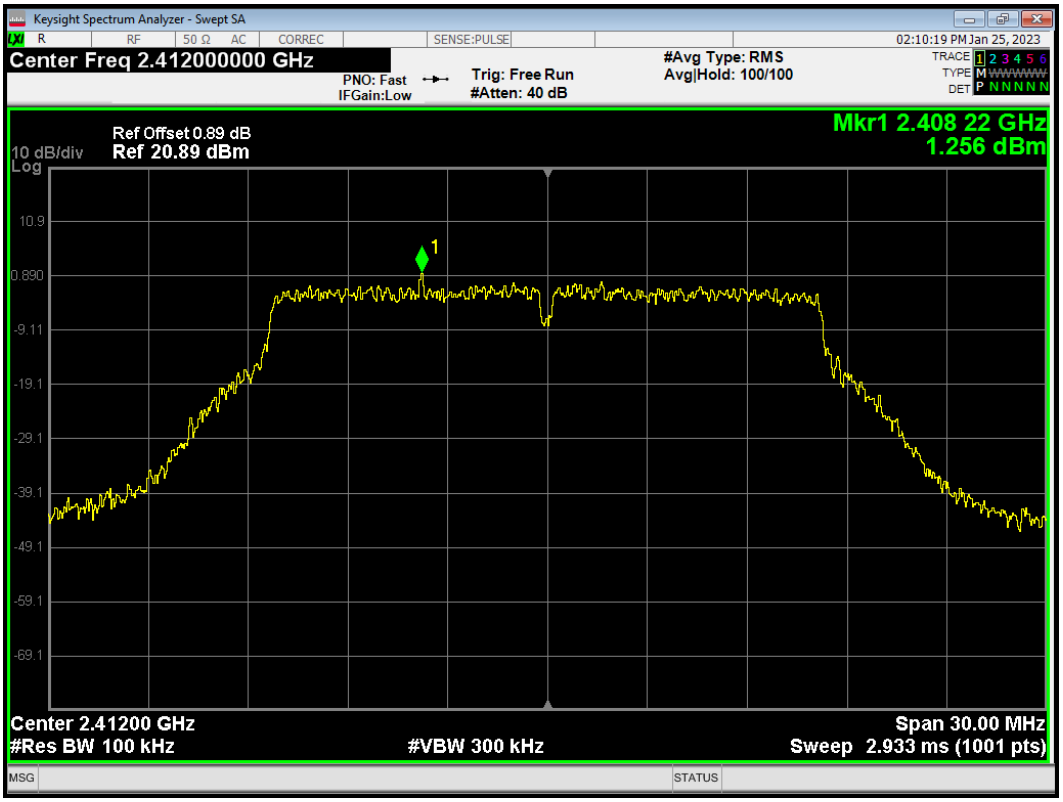
Band Edge 802.11b 2462MHz Ref



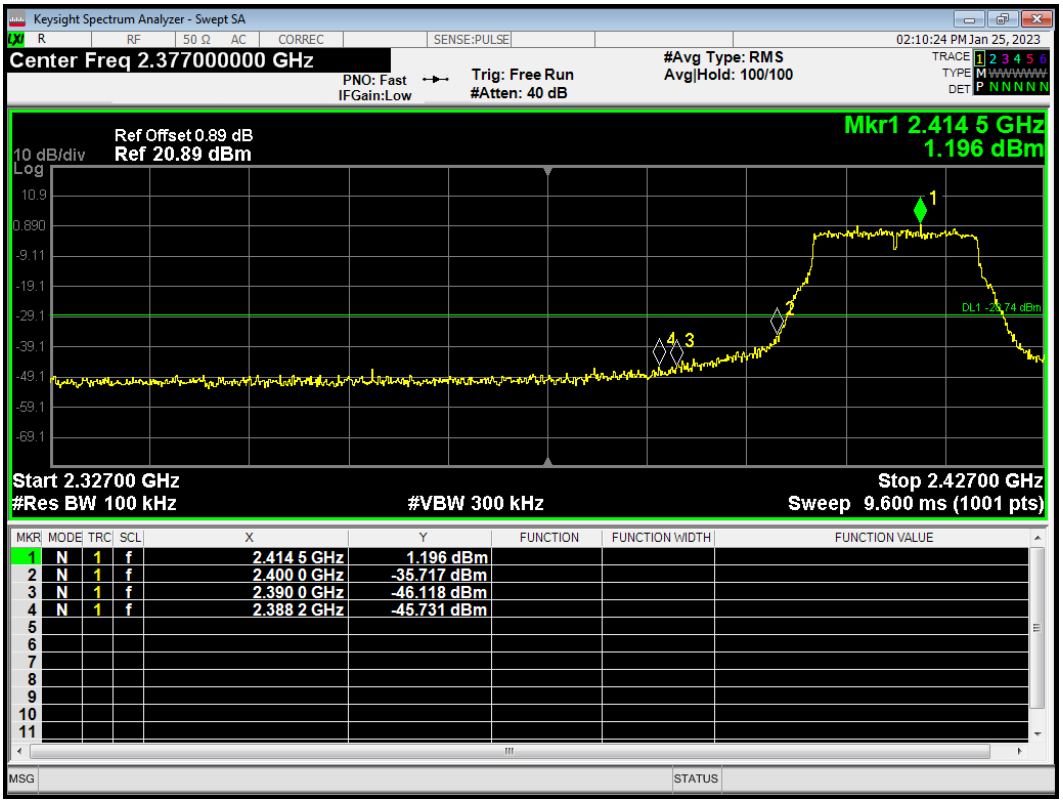
Band Edge 802.11b 2462MHz Emission



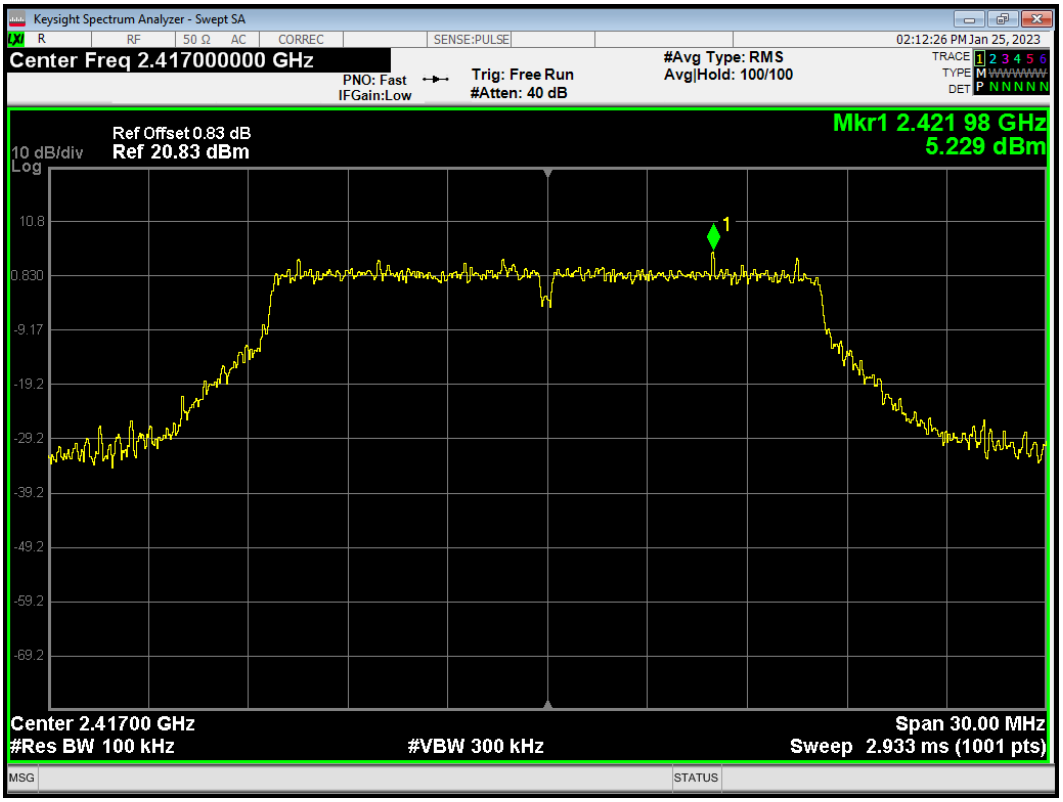
Band Edge 802.11g 2412MHz Ref



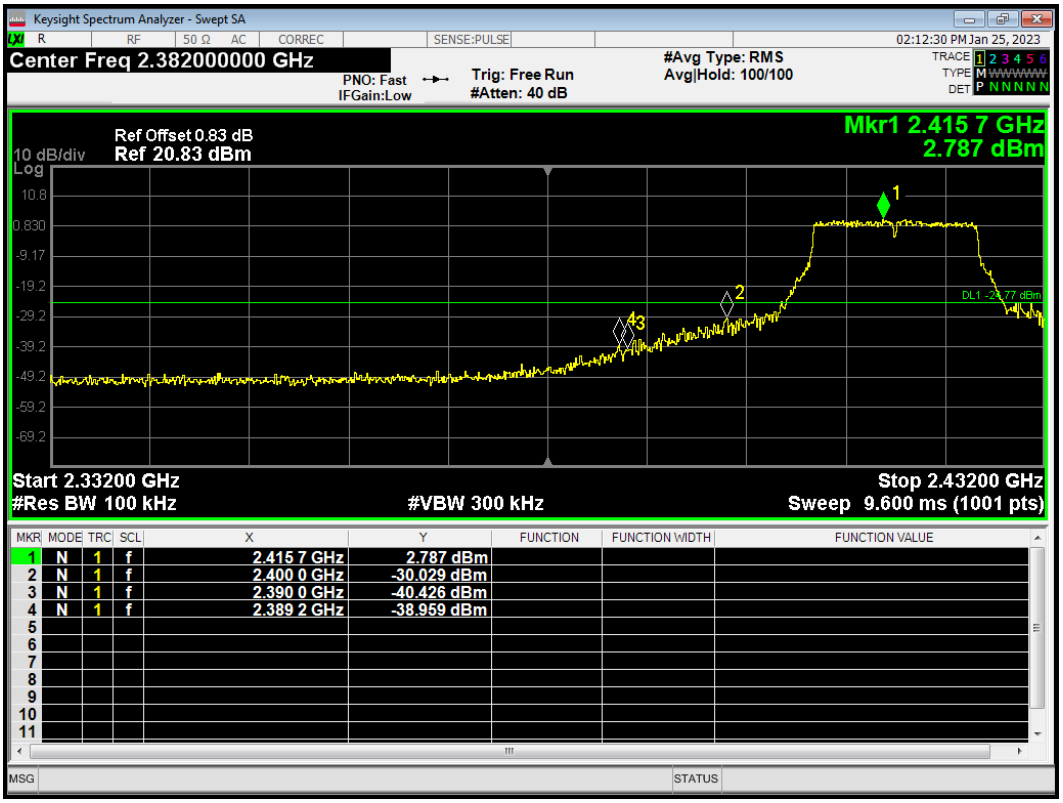
Band Edge 802.11g 2412MHz Emission



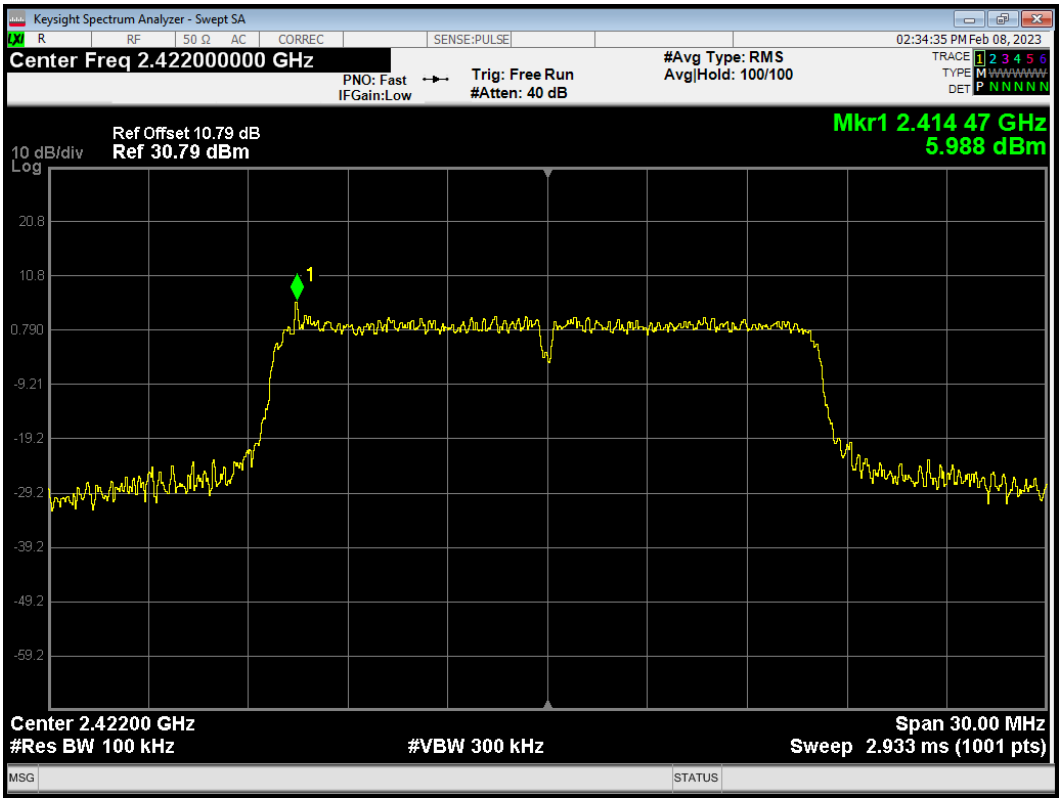
Band Edge 802.11g 2417MHz Ref



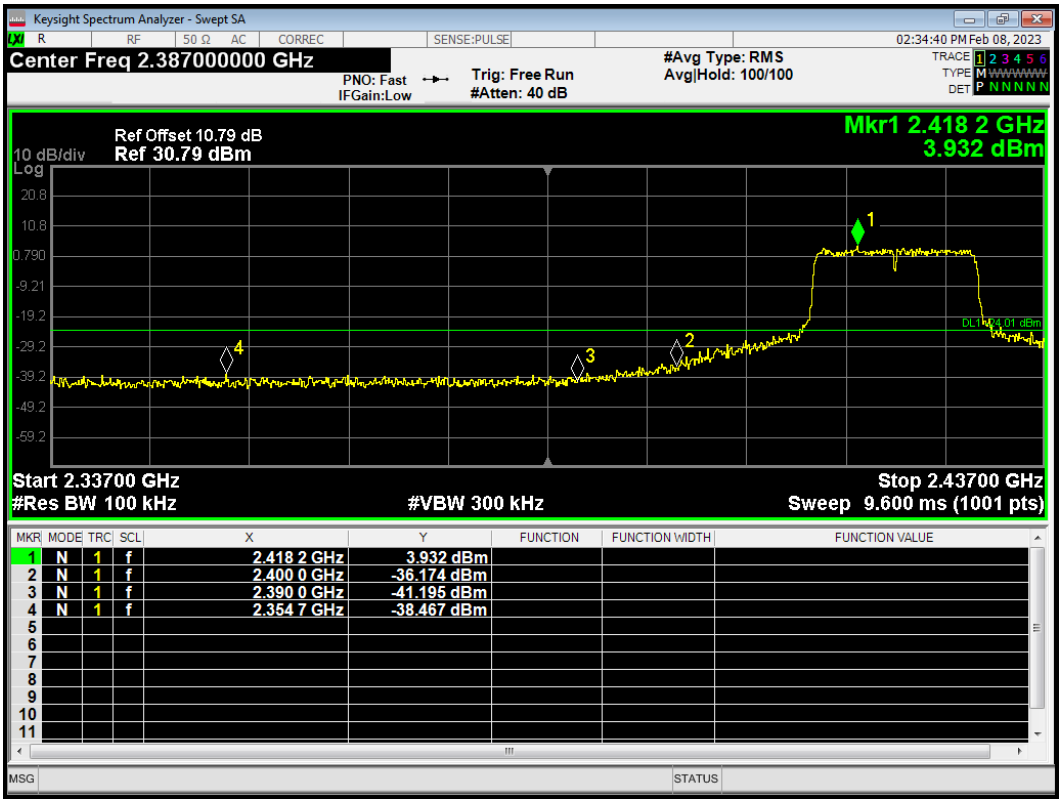
Band Edge 802.11g 2417MHz Emission



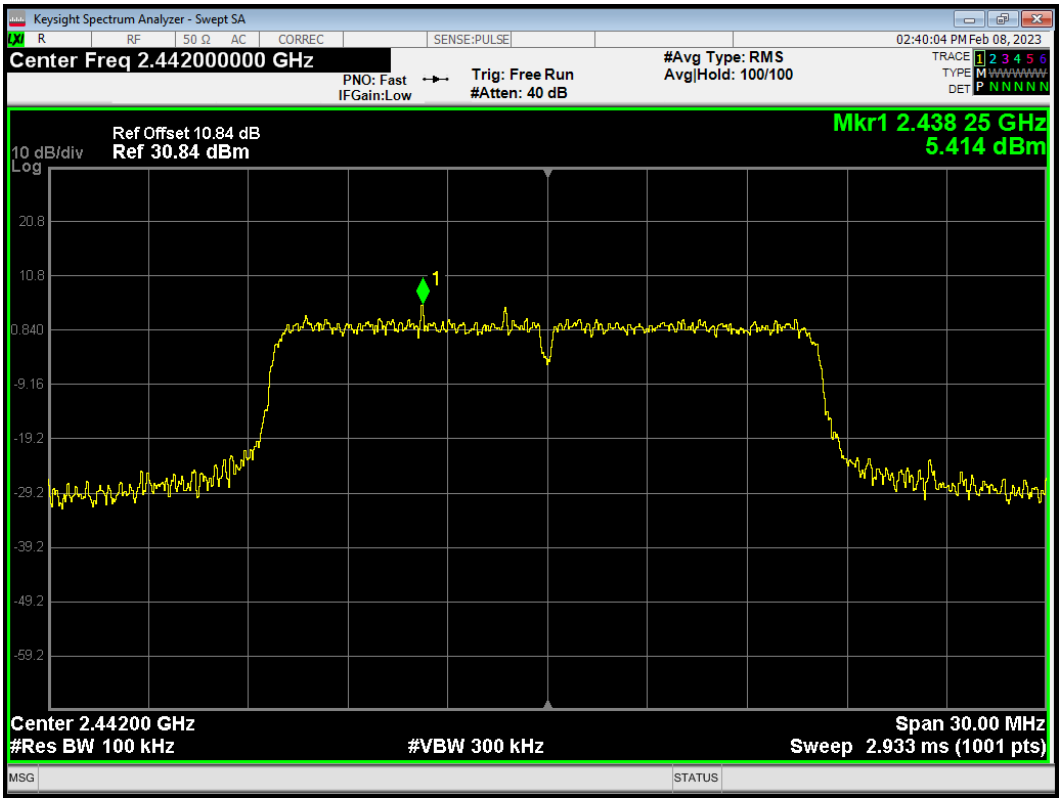
Band Edge 802.11g 2422MHz Ref



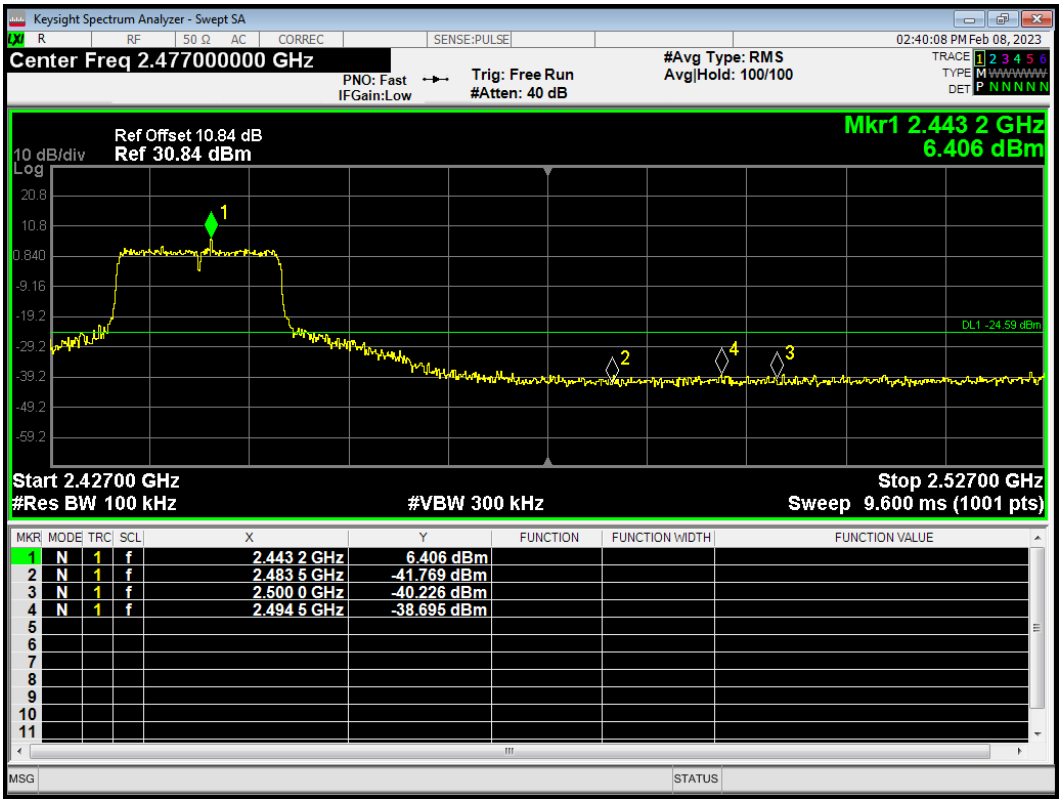
Band Edge 802.11g 2422MHz Emission



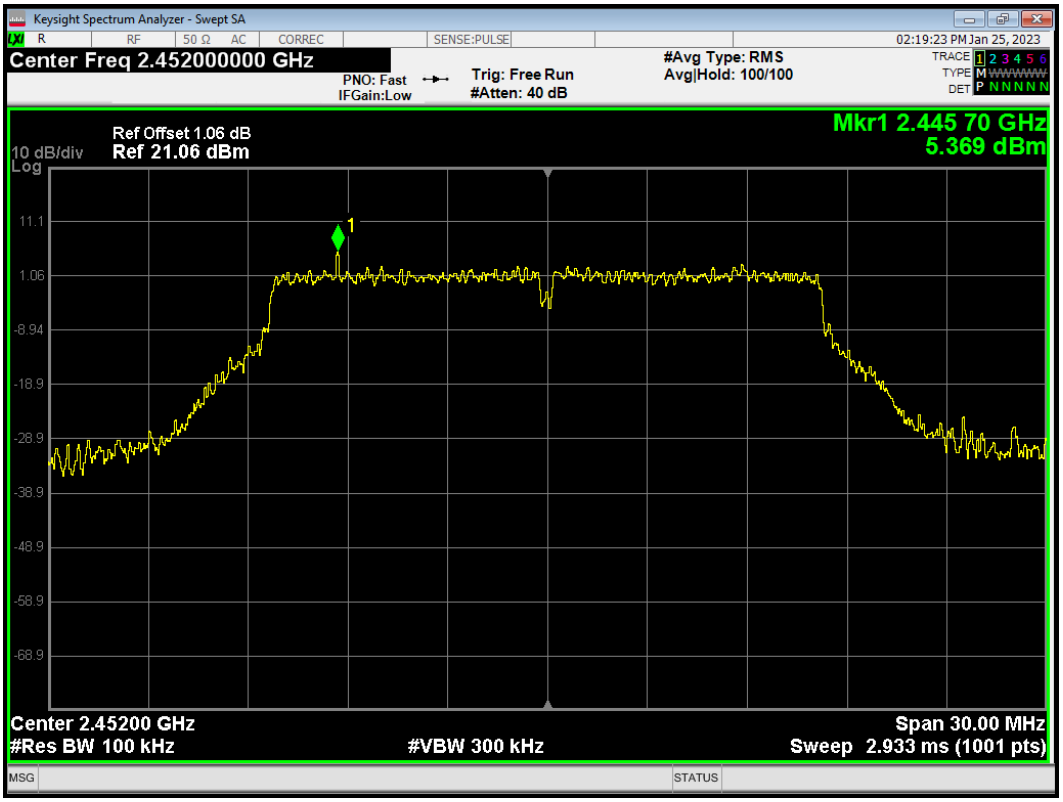
Band Edge 802.11g 2442MHz Ref



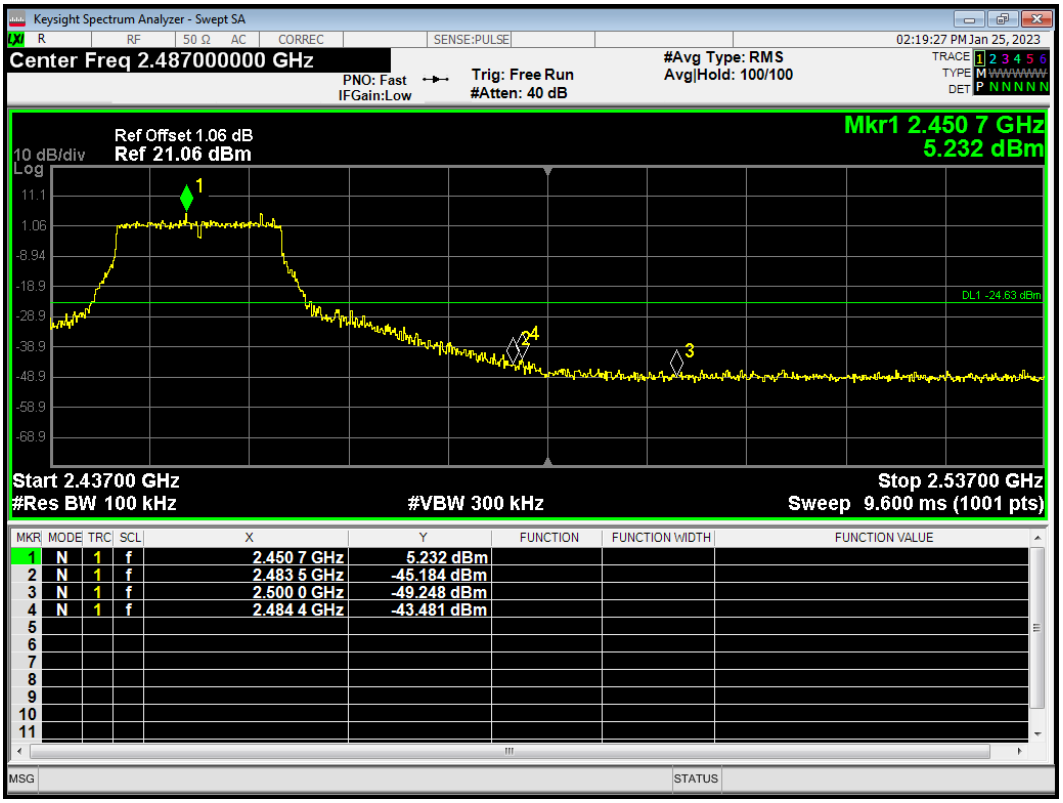
Band Edge 802.11g 2442MHz Emission



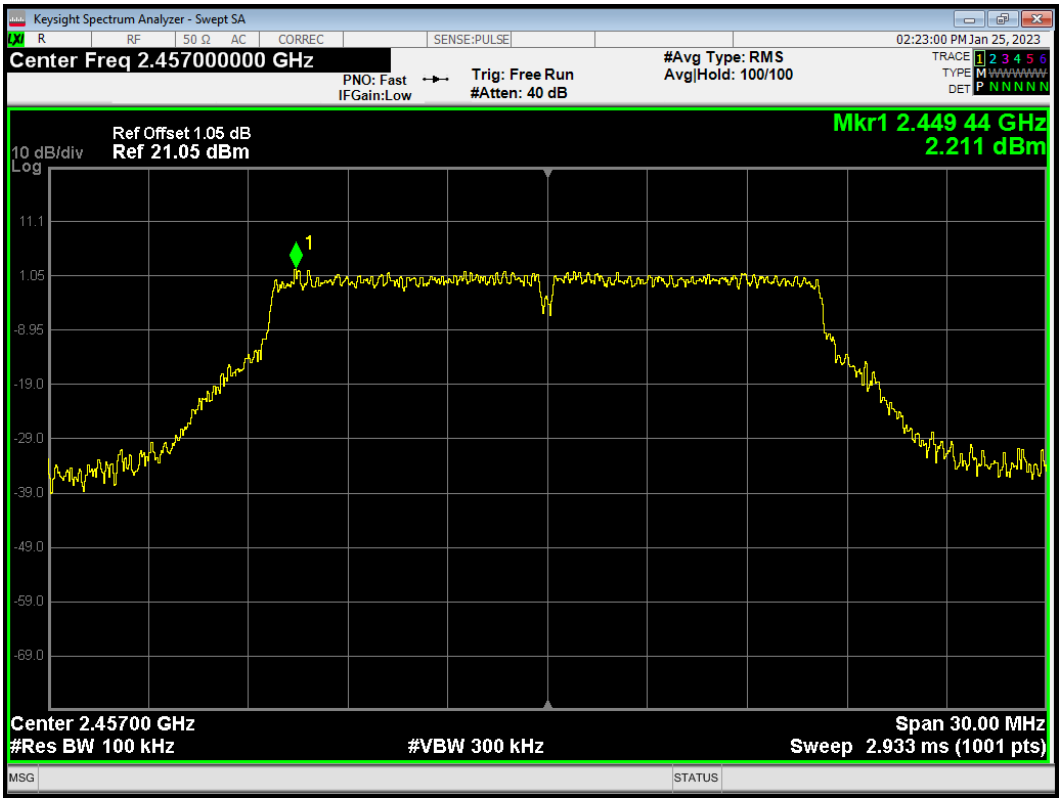
Band Edge 802.11g 2452MHz Ref



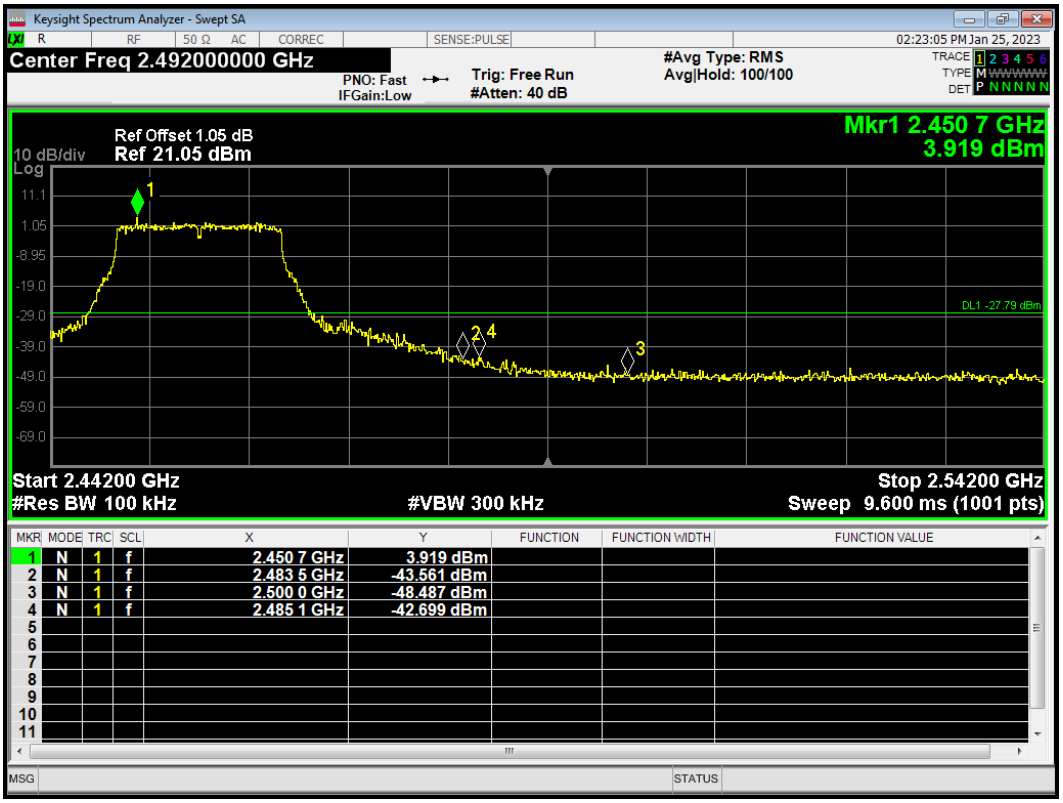
Band Edge 802.11g 2452MHz Emission



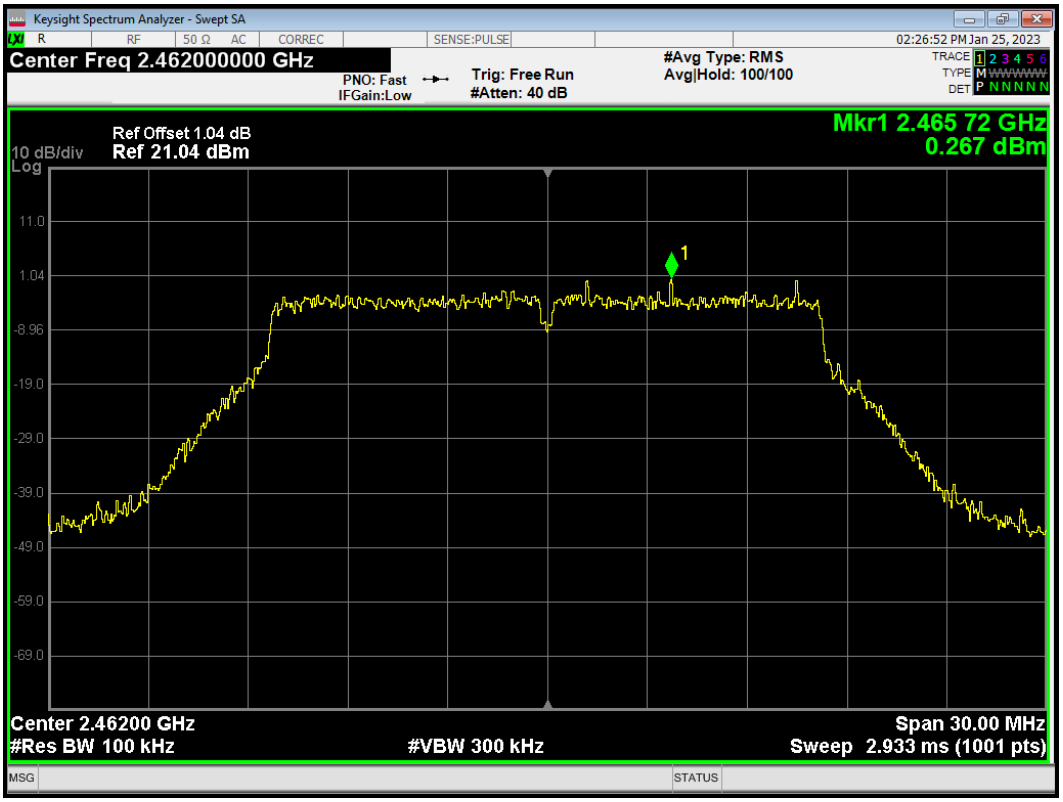
Band Edge 802.11g 2457MHz Ref



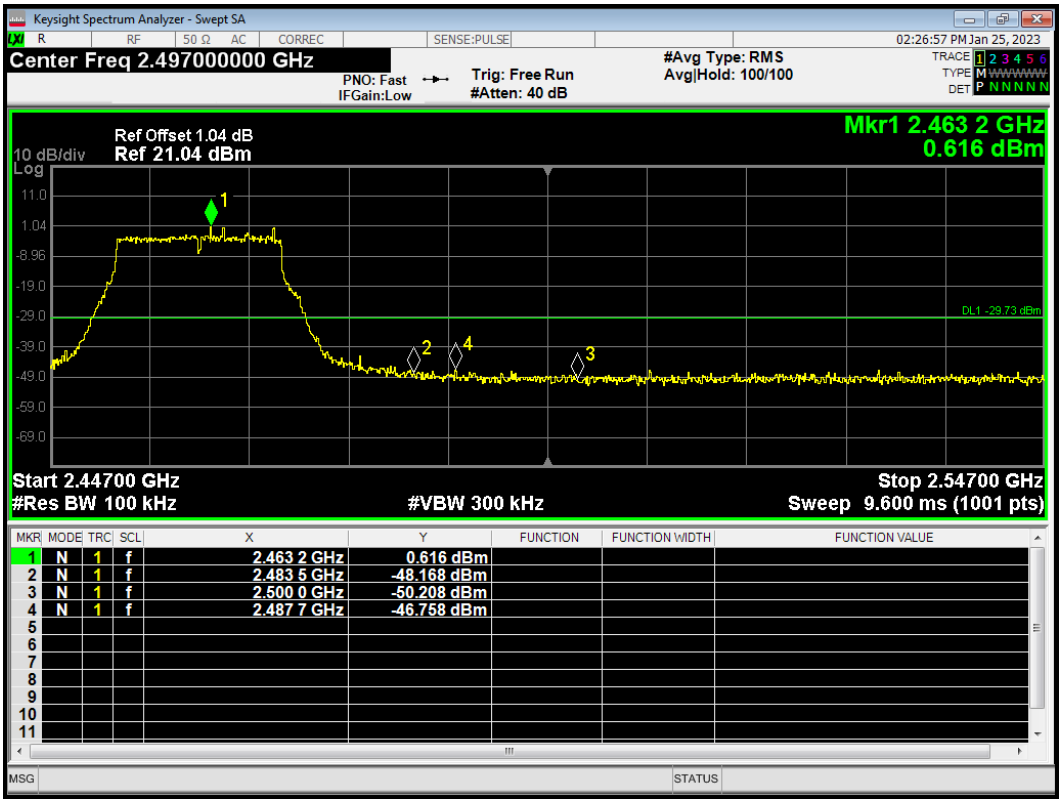
Band Edge 802.11g 2457MHz Emission



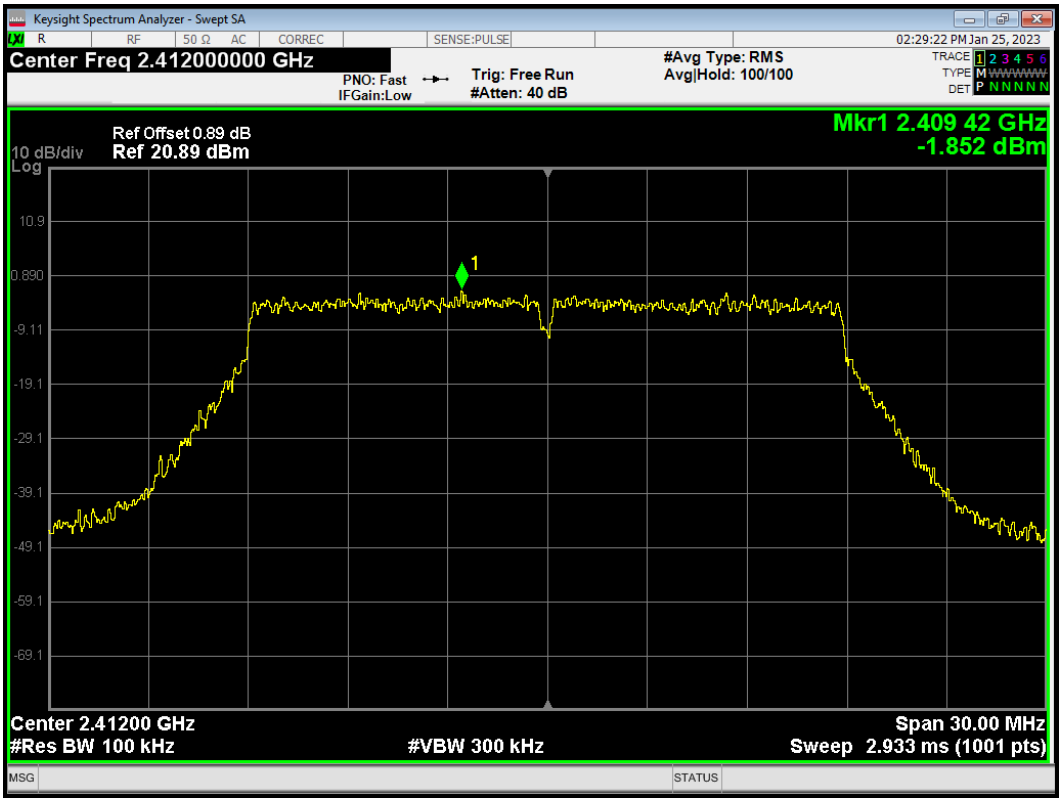
Band Edge 802.11g 2462MHz Ref



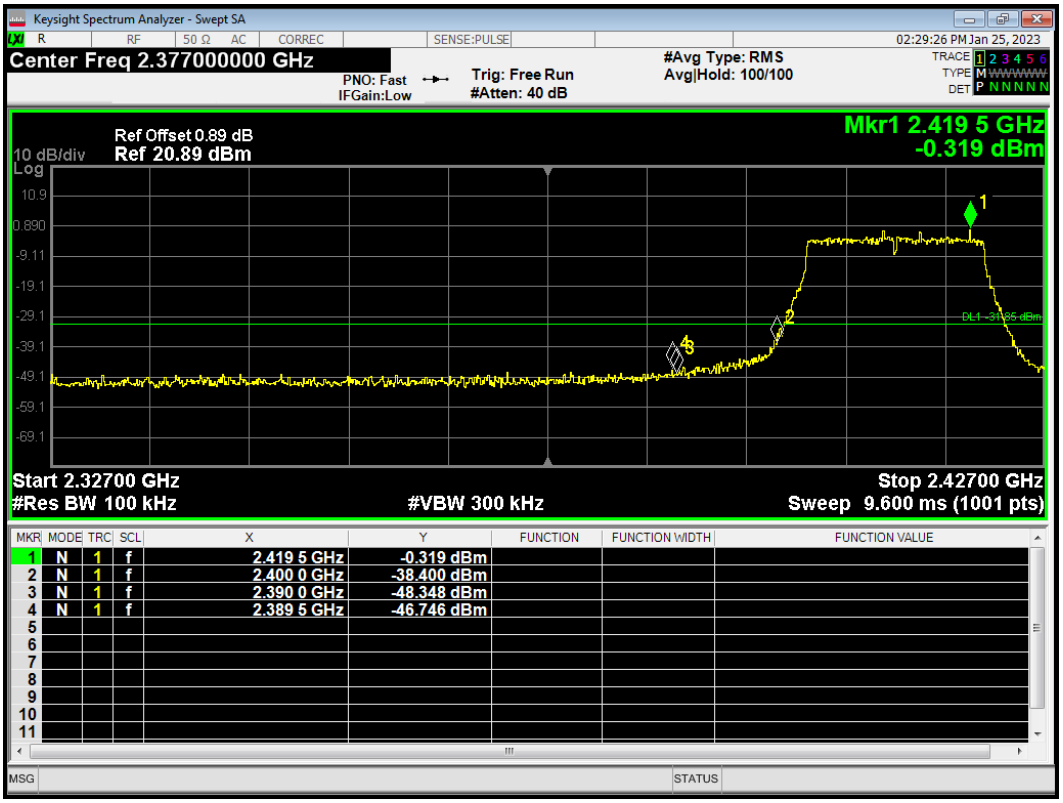
Band Edge 802.11g 2462MHz Emission



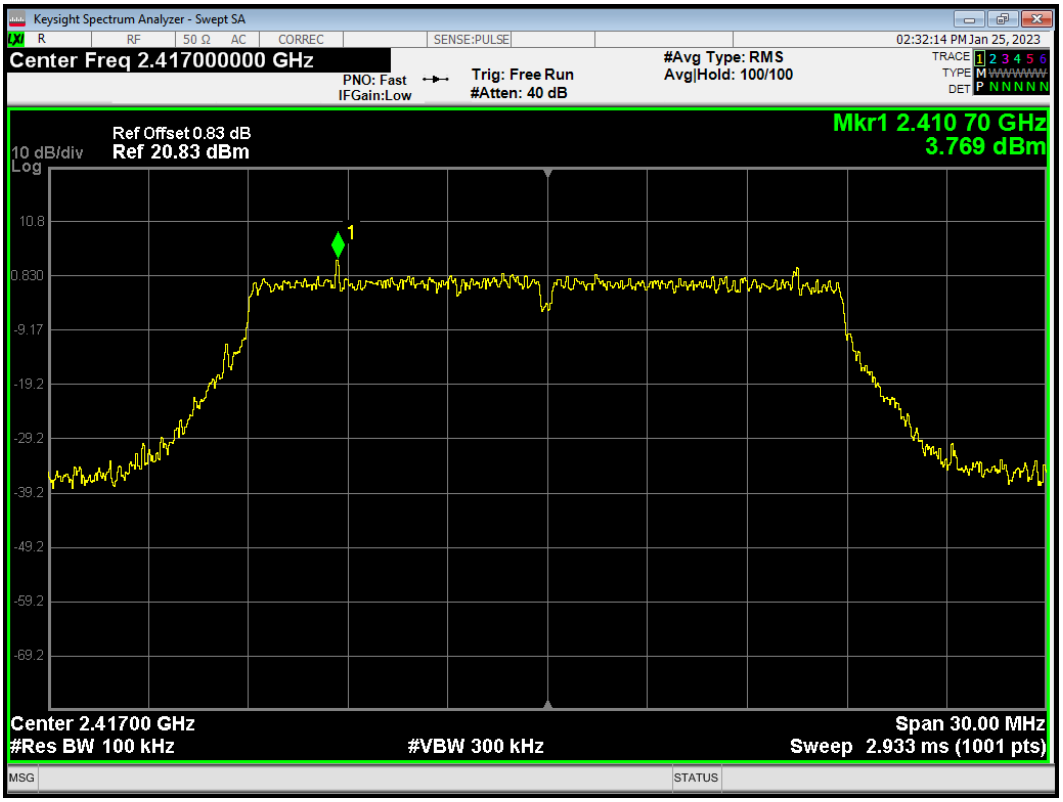
Band Edge 802.11n(HT20) 2412MHz Ref



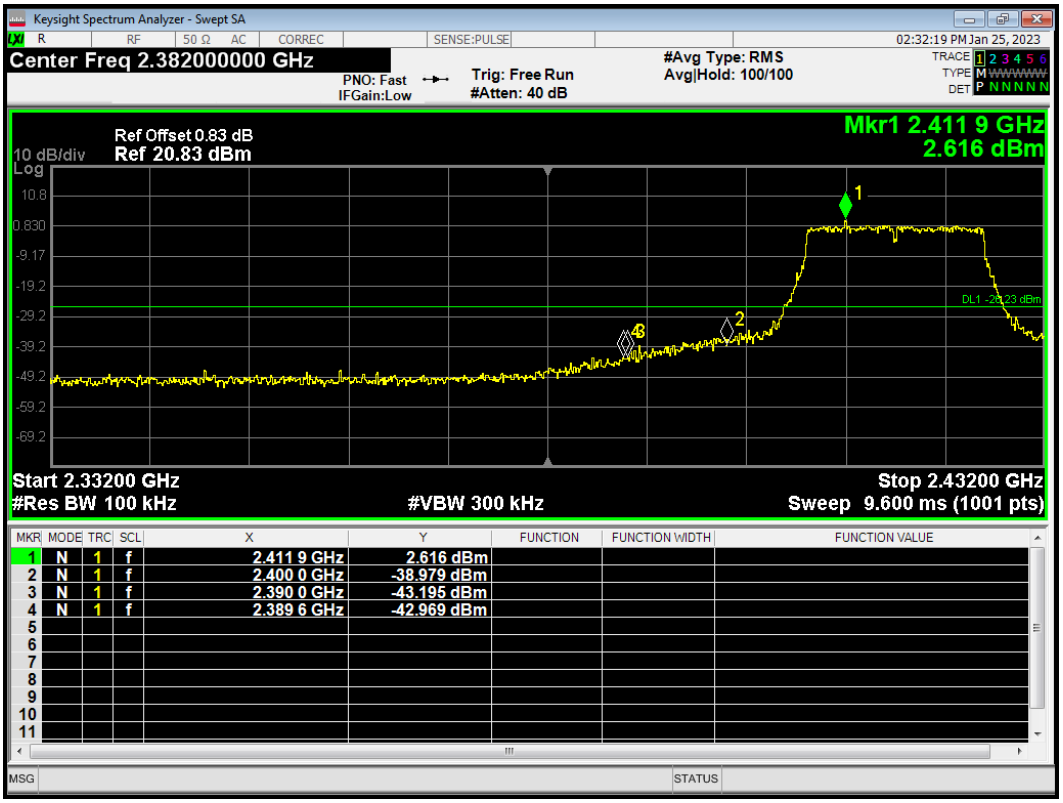
Band Edge 802.11n(HT20) 2412MHz Emission



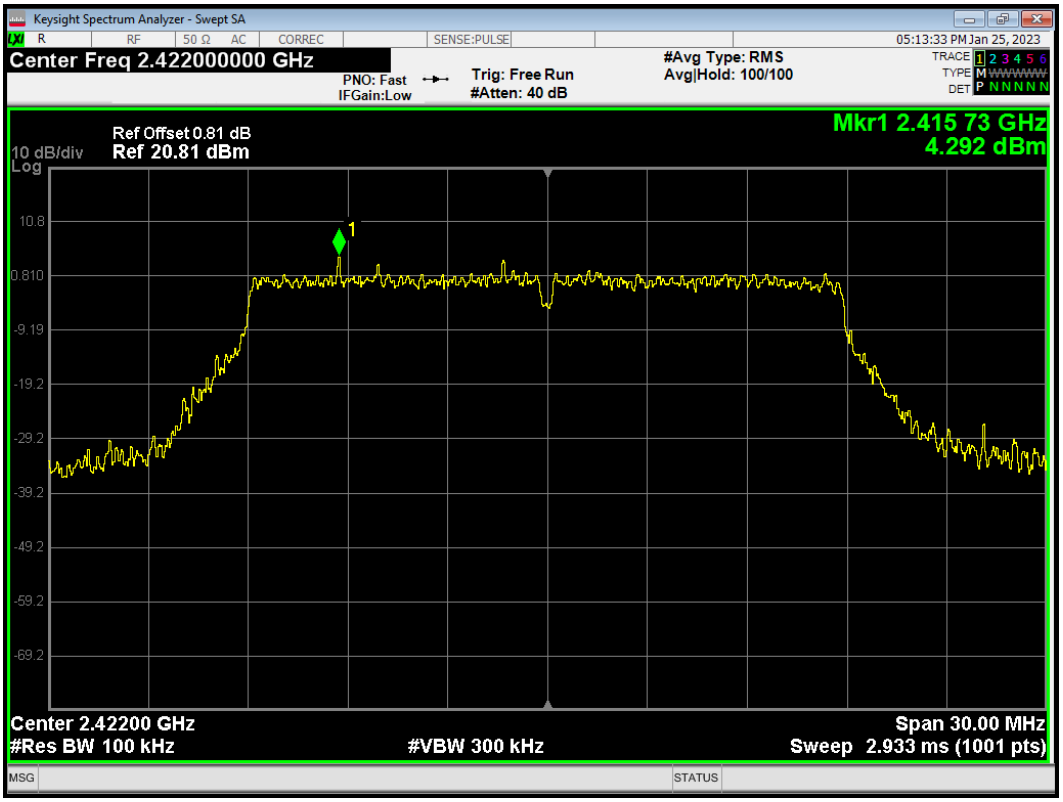
Band Edge 802.11n(HT20) 2417MHz Ref



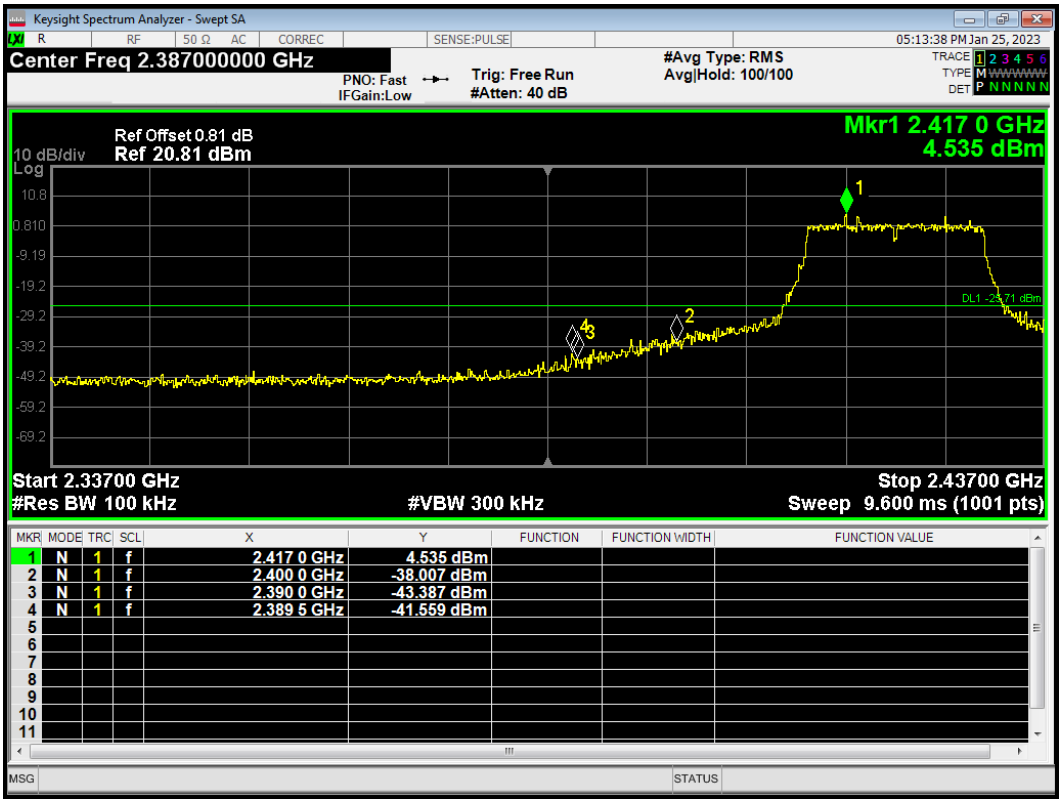
Band Edge 802.11n(HT20) 2417MHz Emission



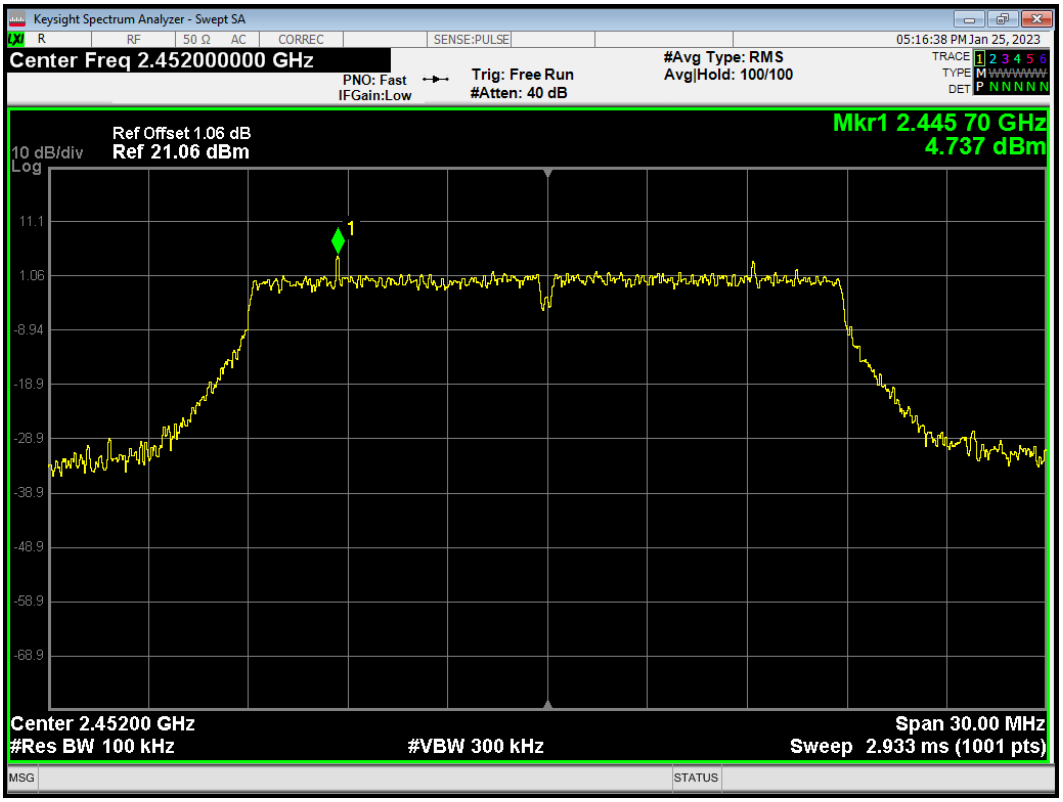
Band Edge 802.11n(HT20) 2422MHz Ref



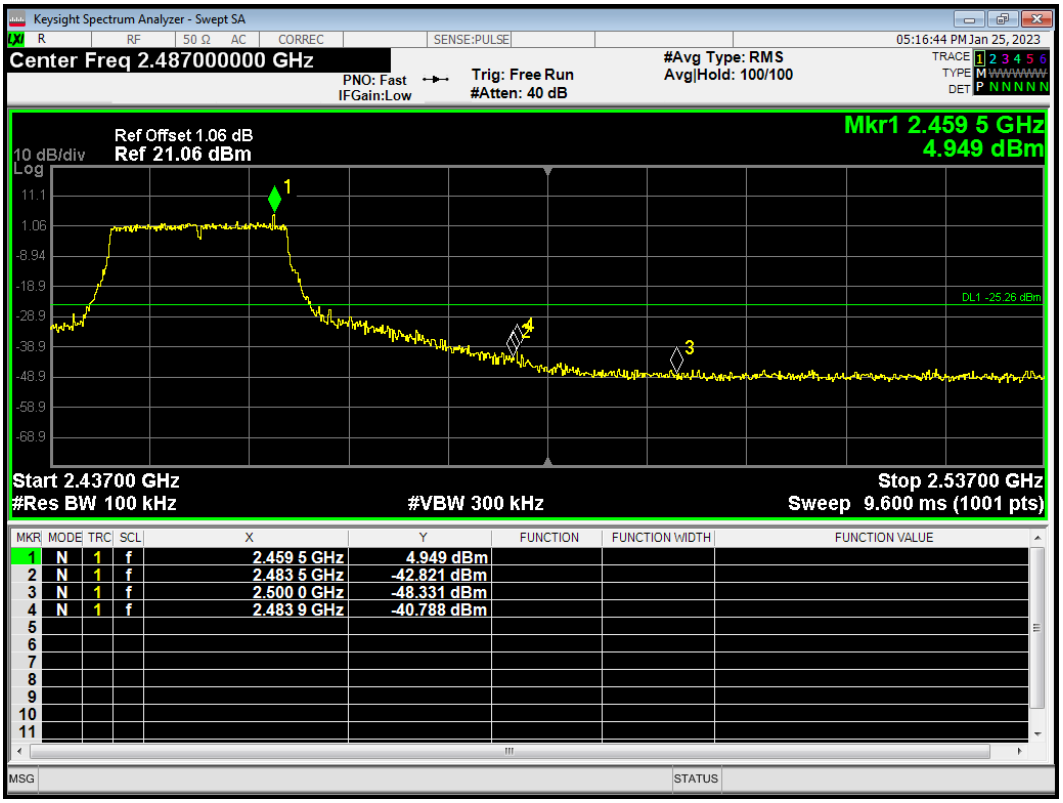
Band Edge 802.11n(HT20) 2422MHz Emission



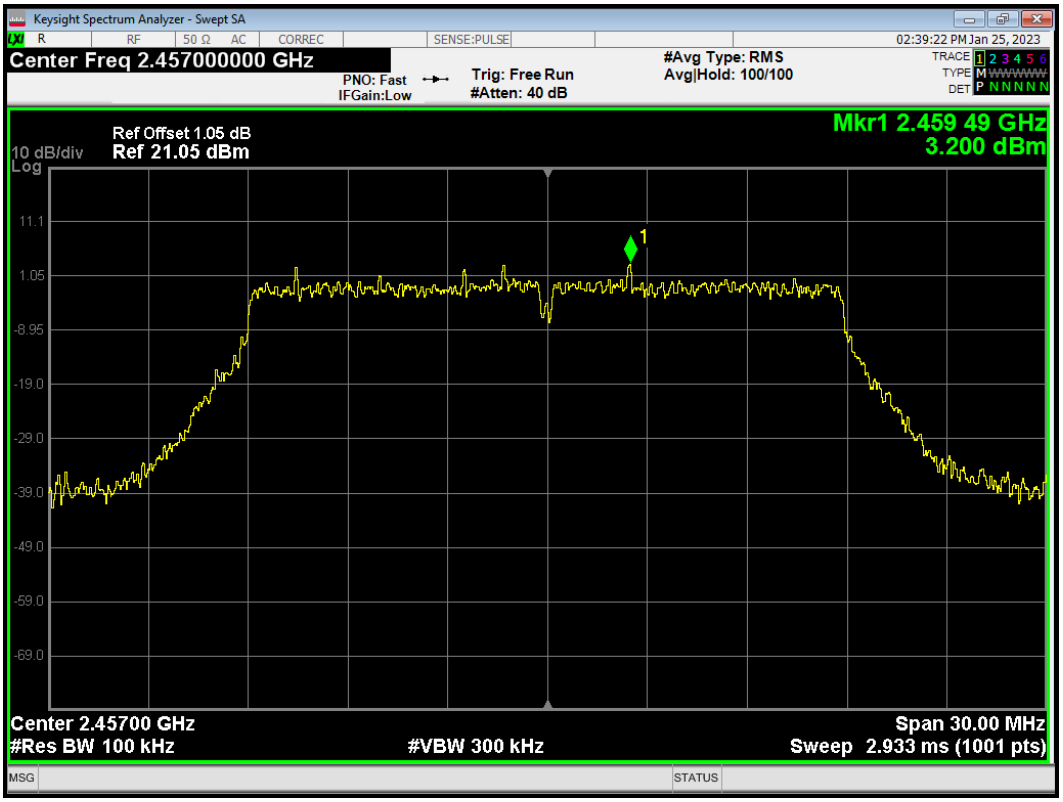
Band Edge 802.11n(HT20) 2452MHz Ref



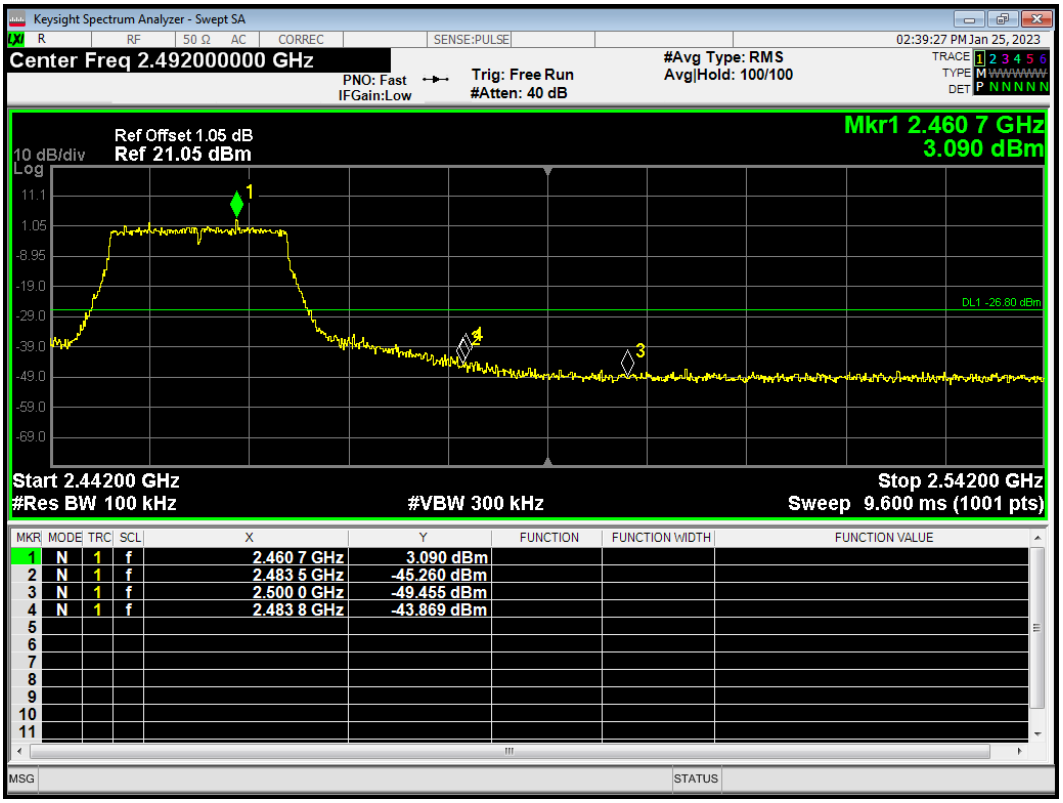
Band Edge 802.11n(HT20) 2452MHz Emission



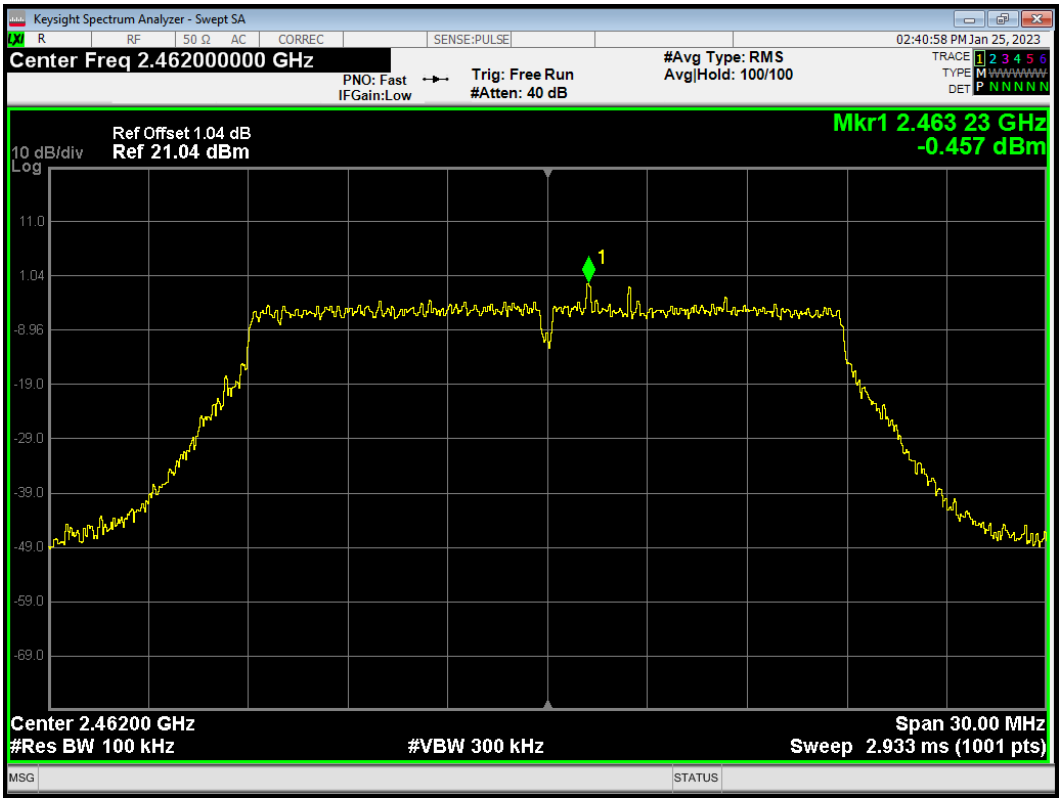
Band Edge 802.11n(HT20) 2457MHz Ref



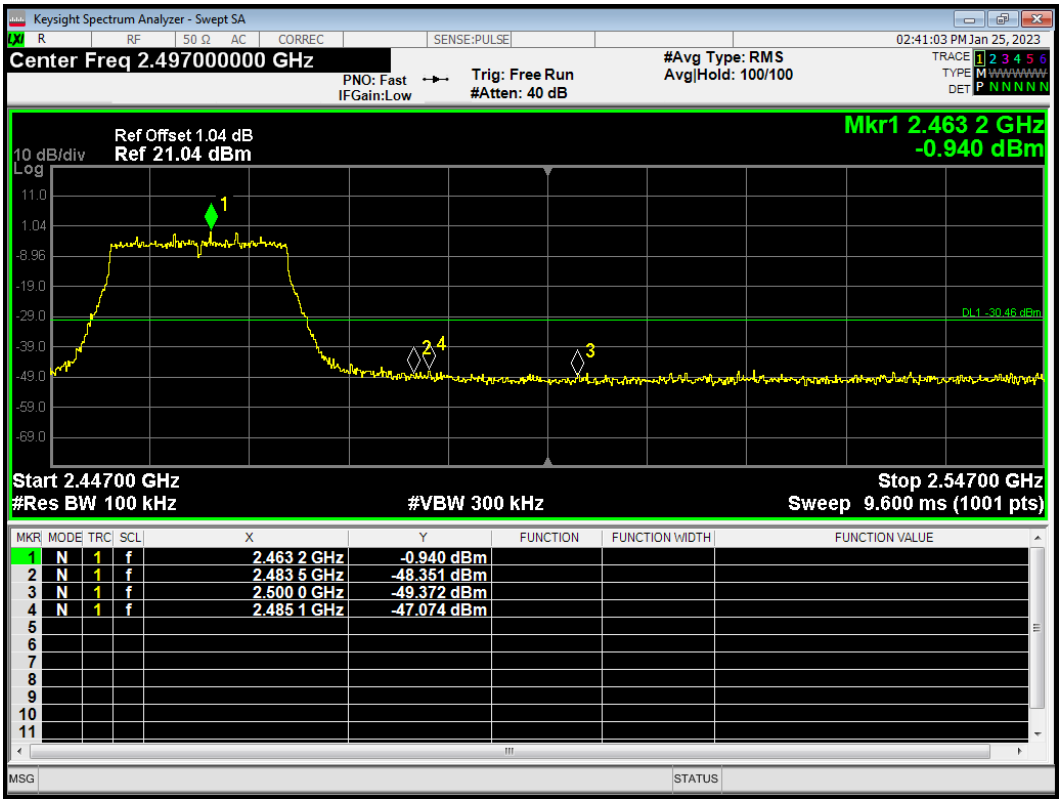
Band Edge 802.11n(HT20) 2457MHz Emission



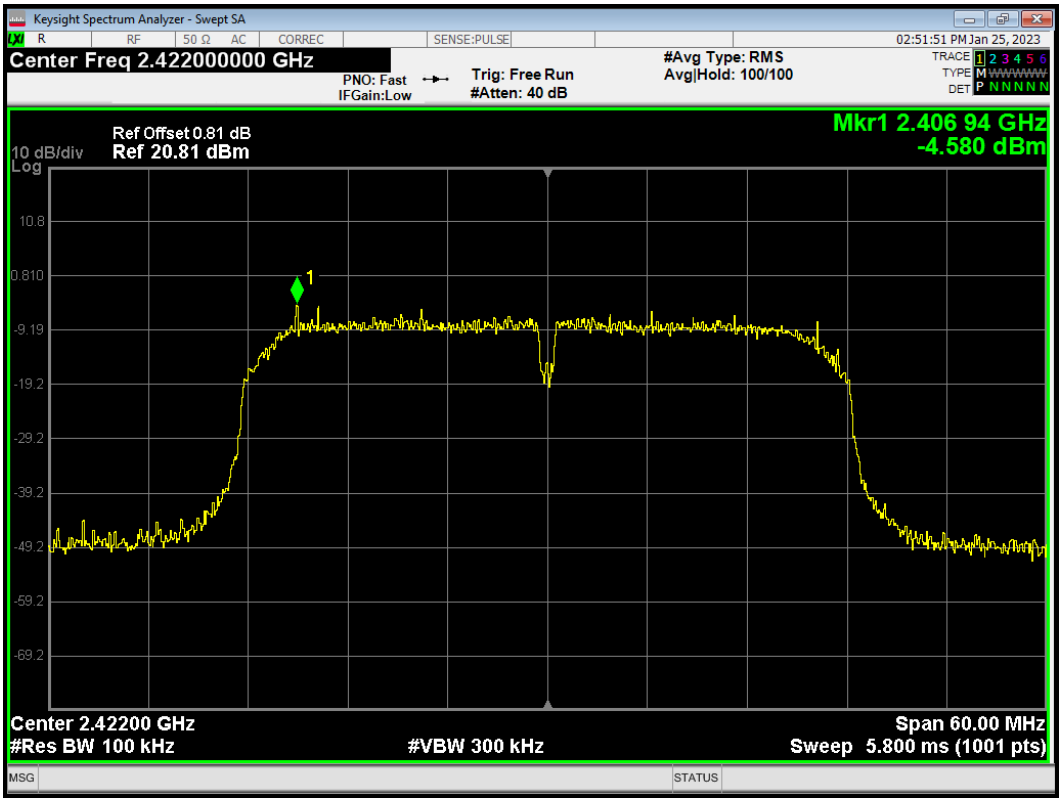
Band Edge 802.11n(HT20) 2462MHz Ref



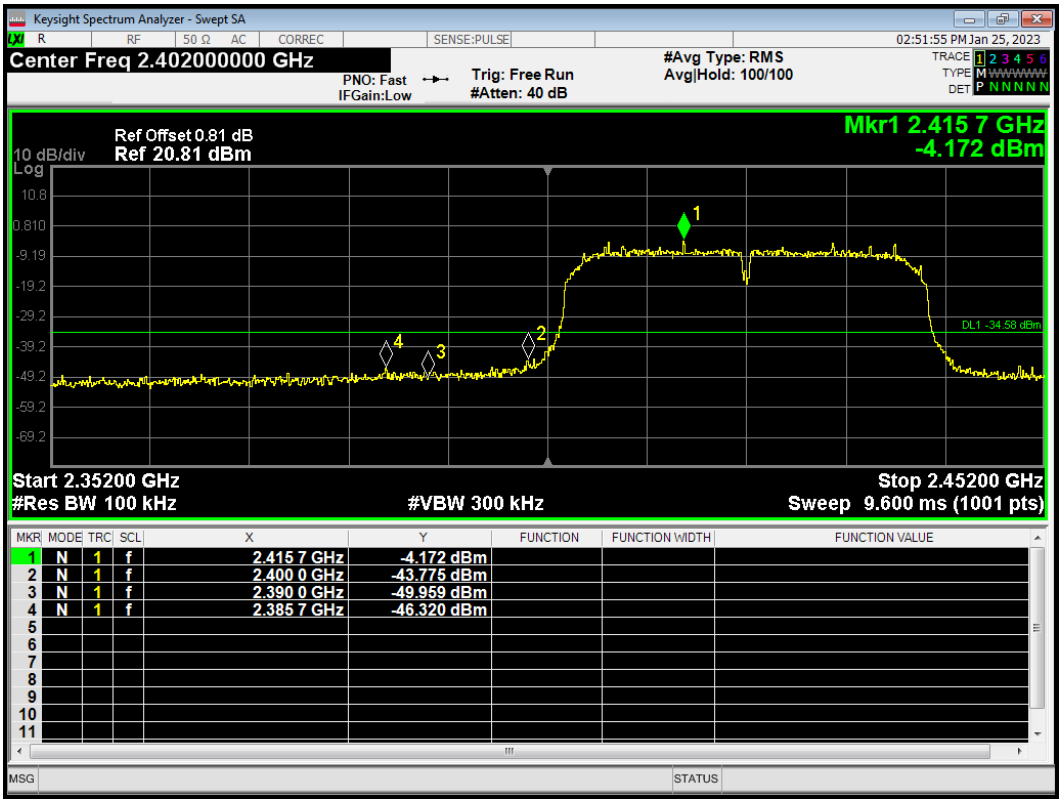
Band Edge 802.11n(HT20) 2462MHz Emission



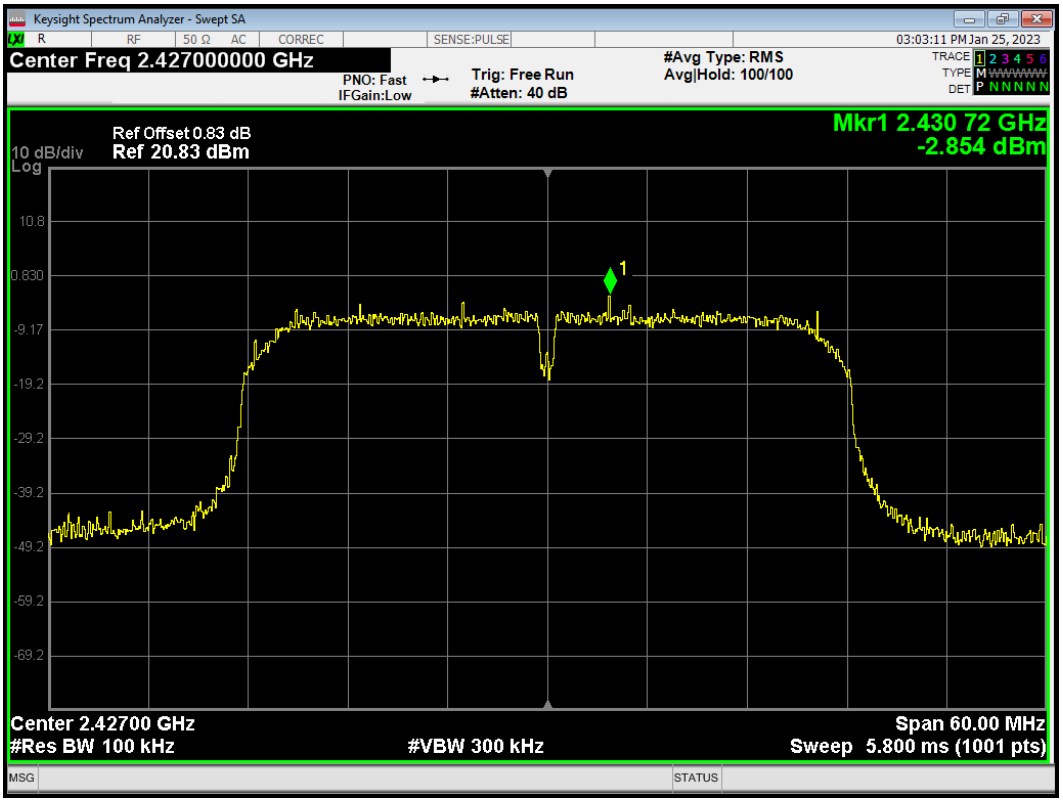
Band Edge 802.11n(HT40) 2422MHz Ref



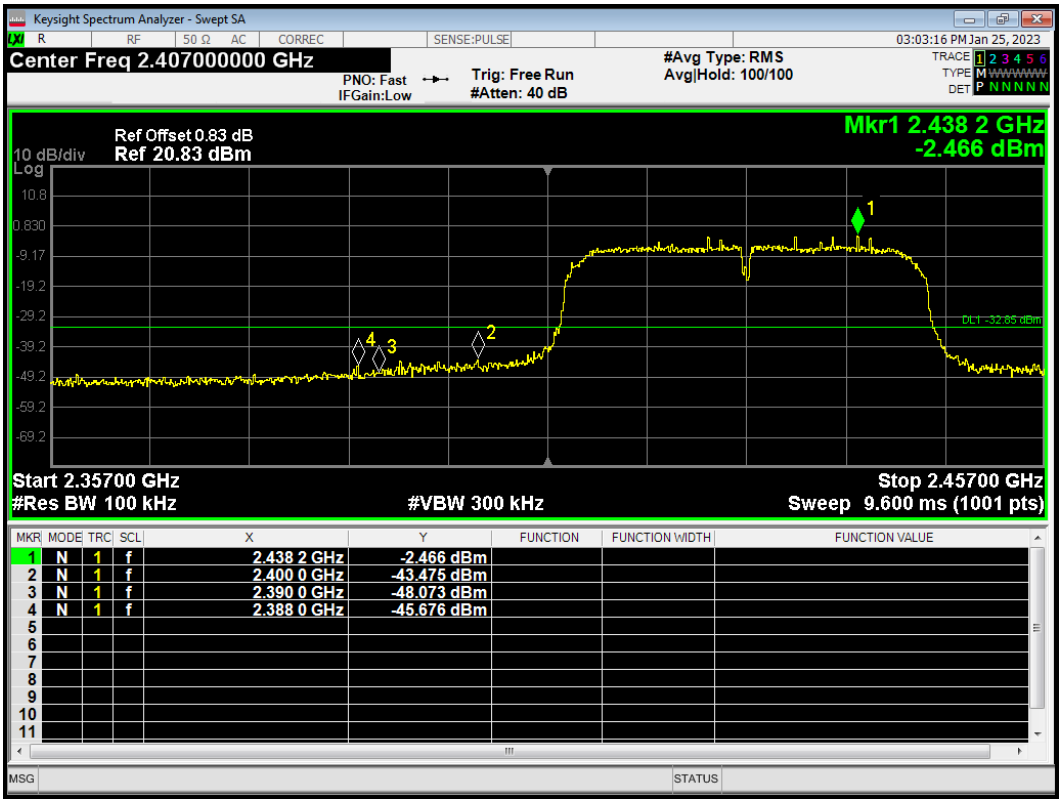
Band Edge 802.11n(HT40) 2422MHz Emission



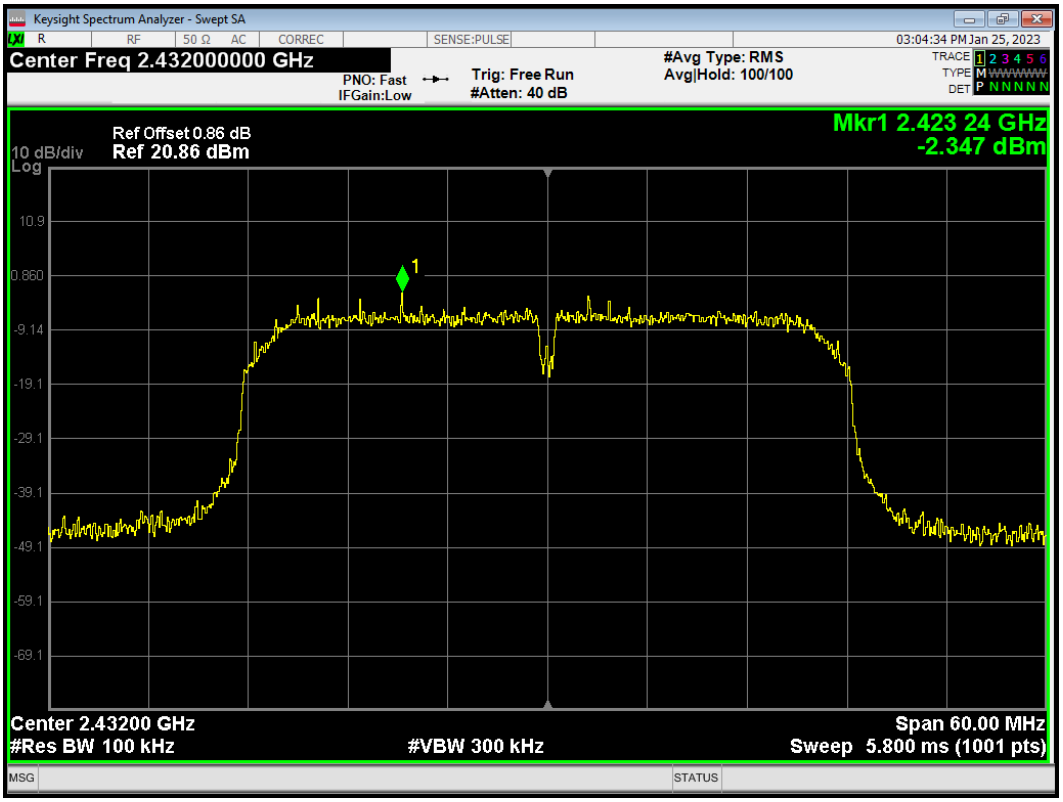
Band Edge 802.11n(HT40) 2427MHz Ref



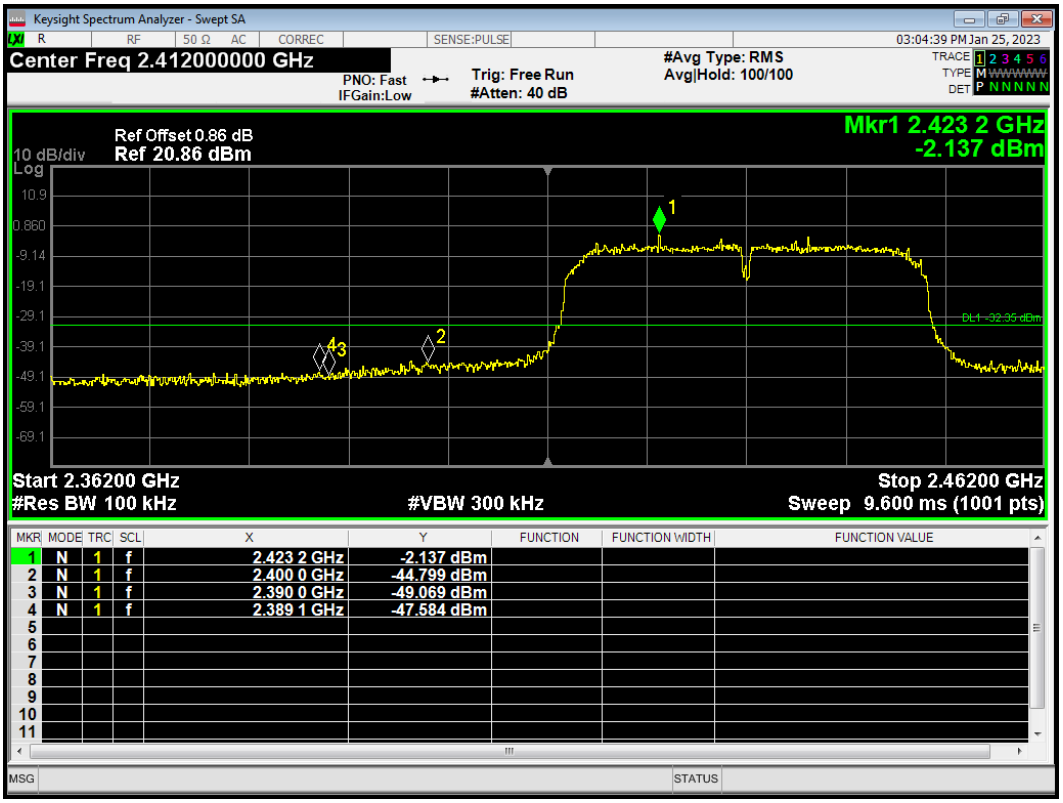
Band Edge 802.11n(HT40) 2427MHz Emission



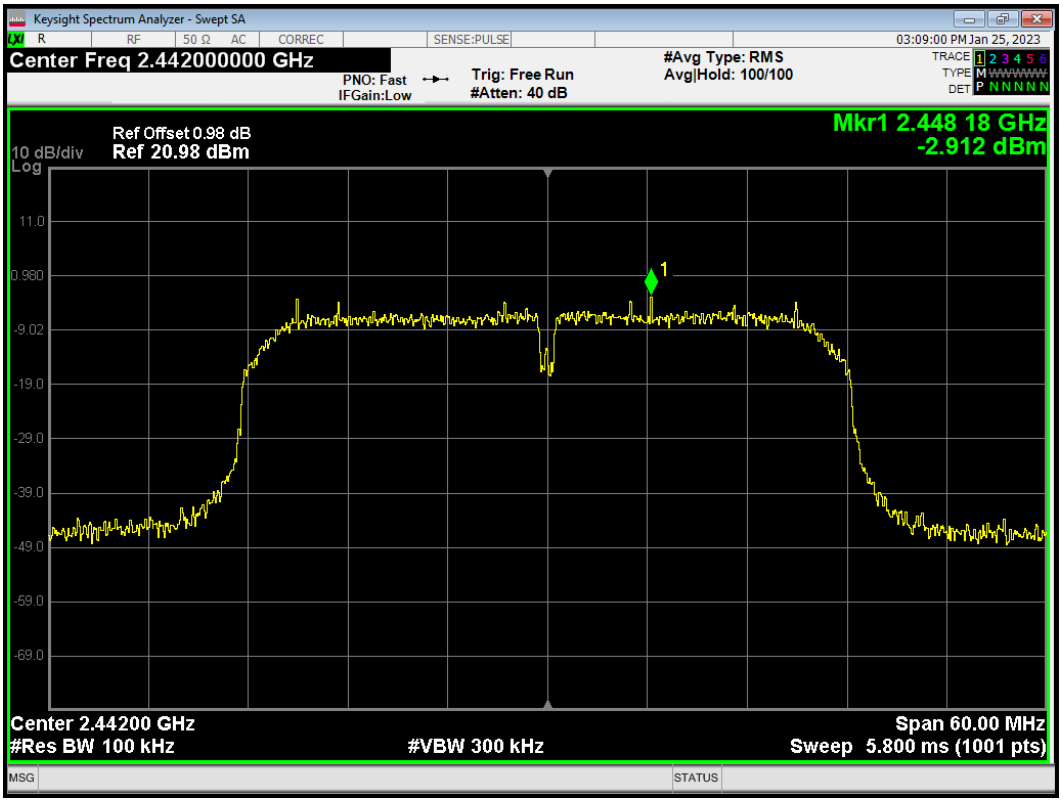
Band Edge 802.11n(HT40) 2432MHz Ref



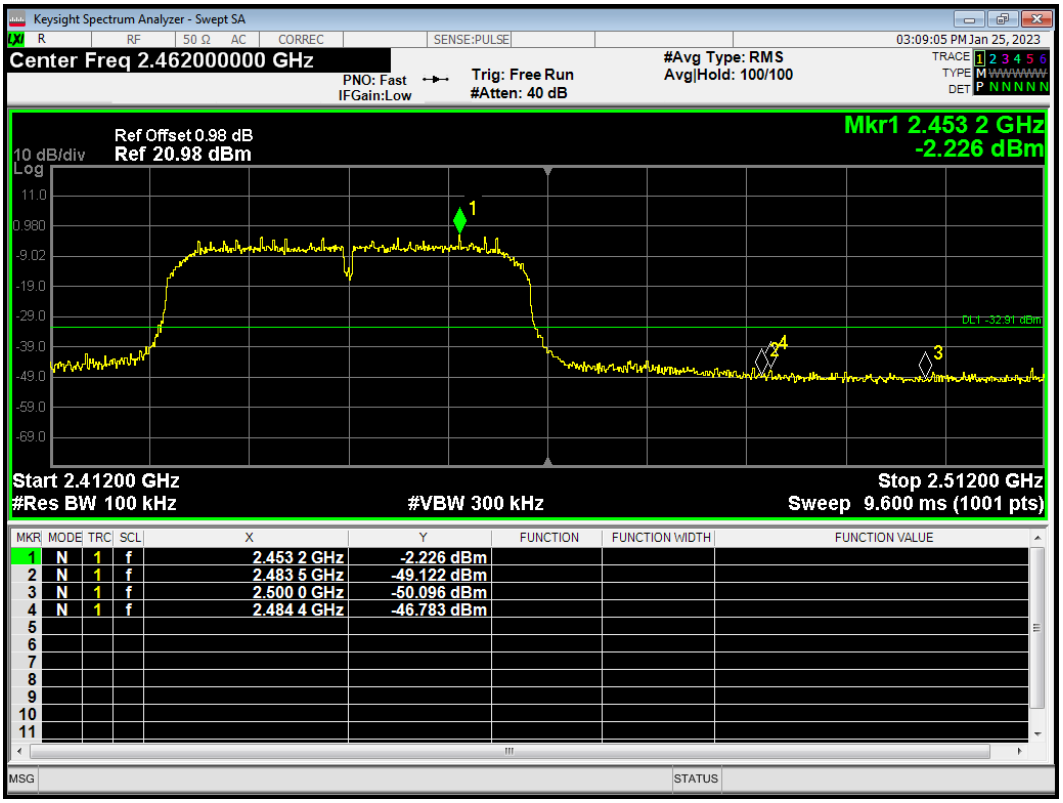
Band Edge 802.11n(HT40) 2432MHz Emission



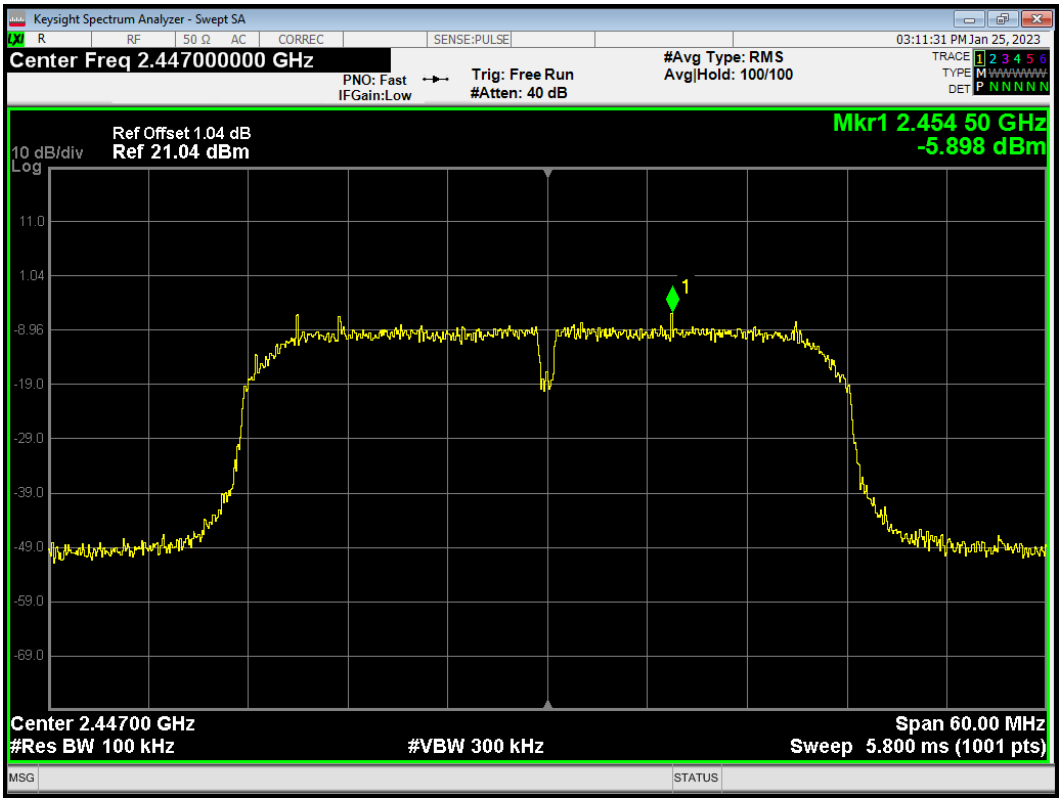
Band Edge 802.11n(HT40) 2442MHz Ref



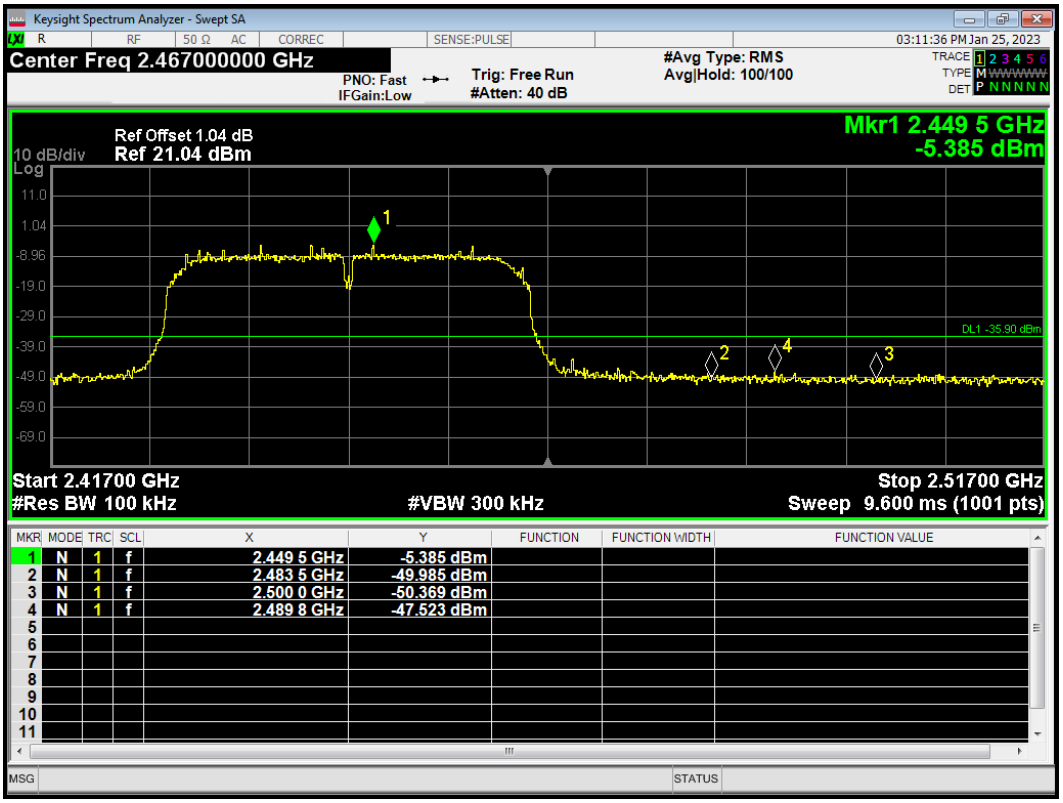
Band Edge 802.11n(HT40) 2442MHz Emission



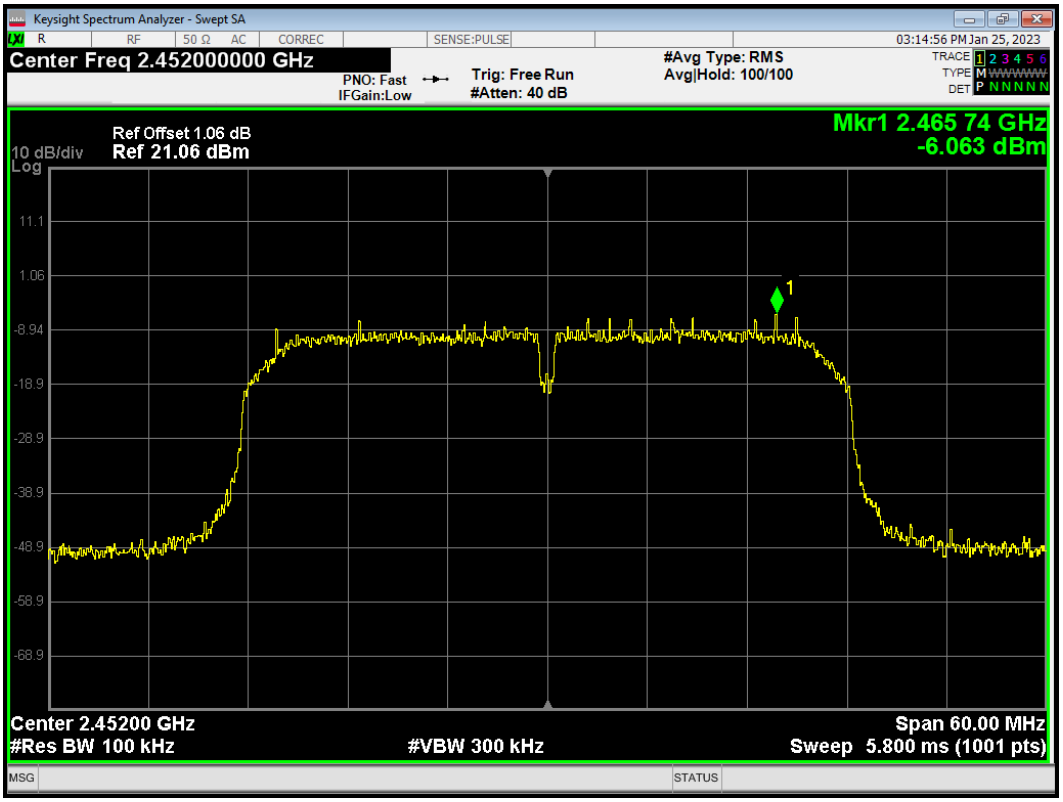
Band Edge 802.11n(HT40) 2447MHz Ref



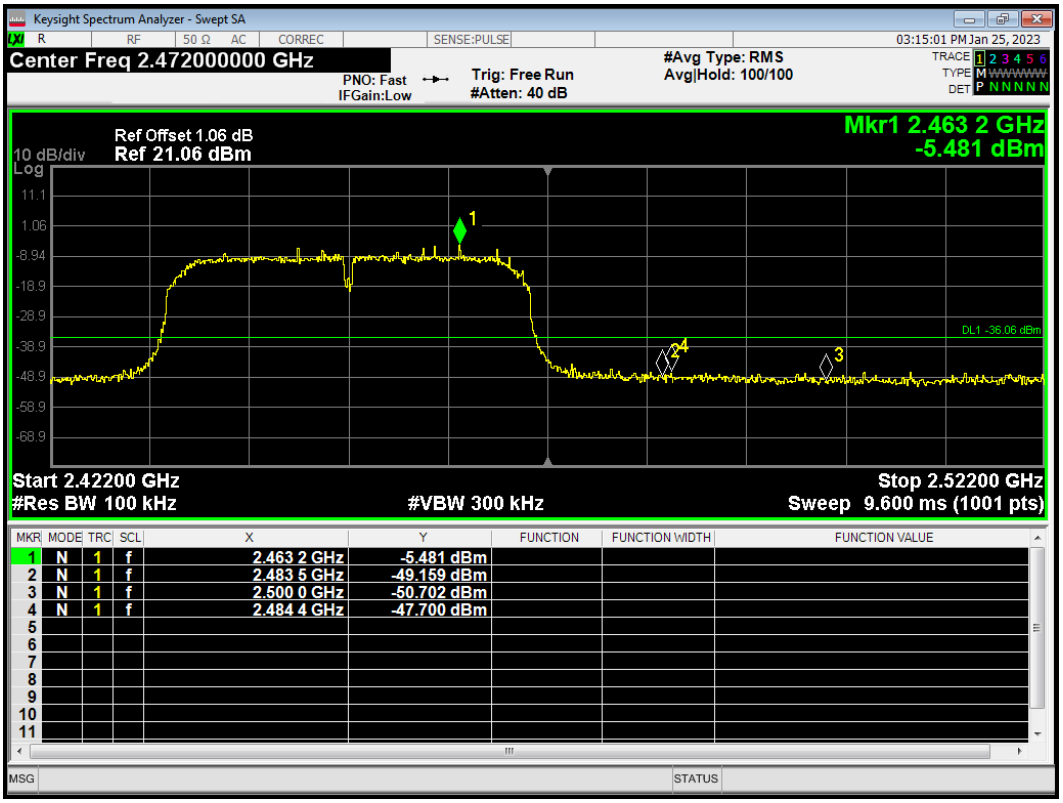
Band Edge 802.11n(HT40) 2447MHz Emission



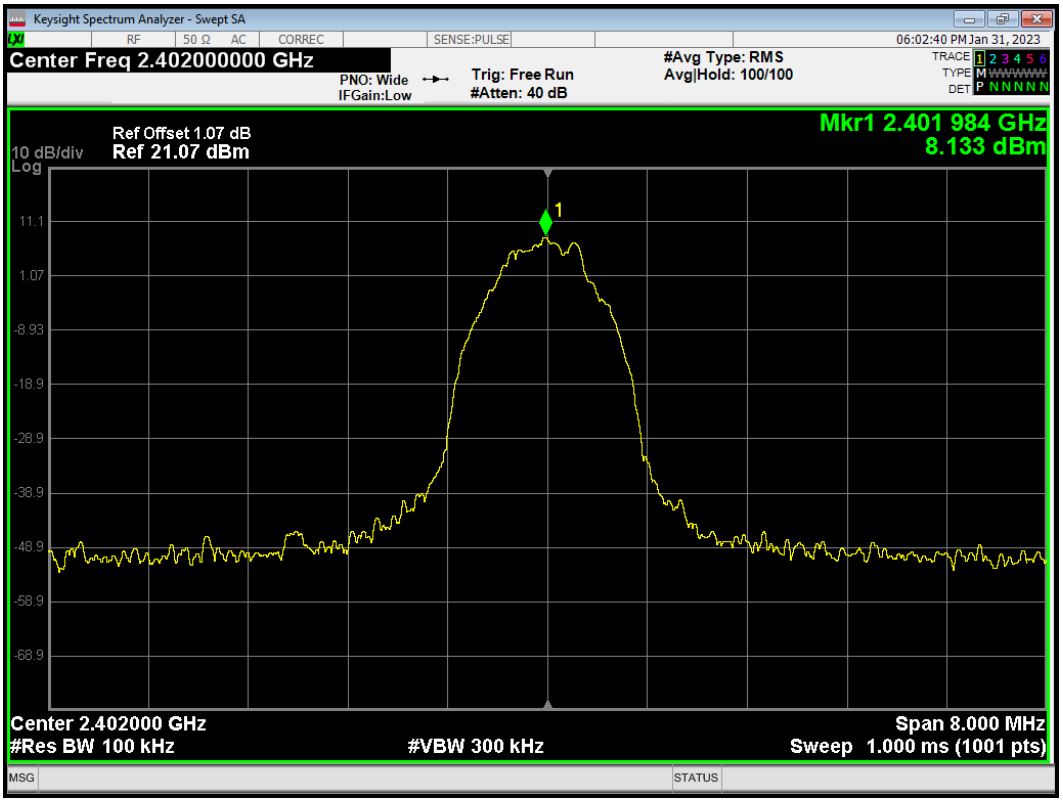
Band Edge 802.11n(HT40) 2452MHz Ref



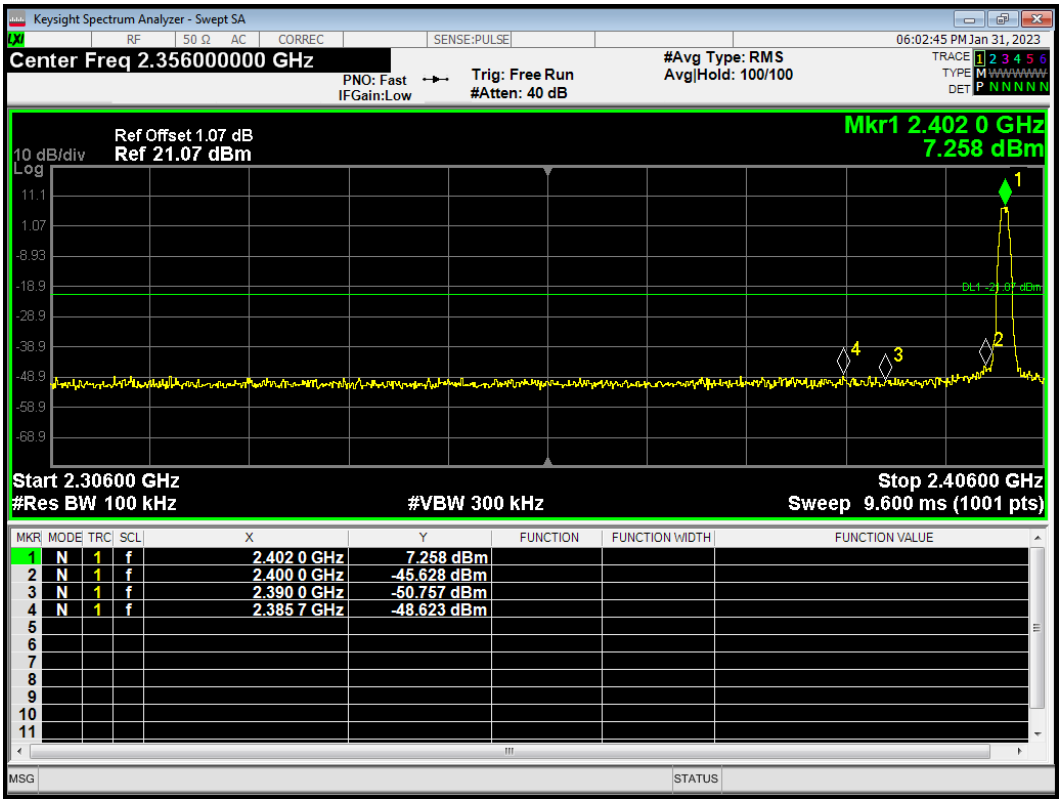
Band Edge 802.11n(HT40) 2452MHz Emission



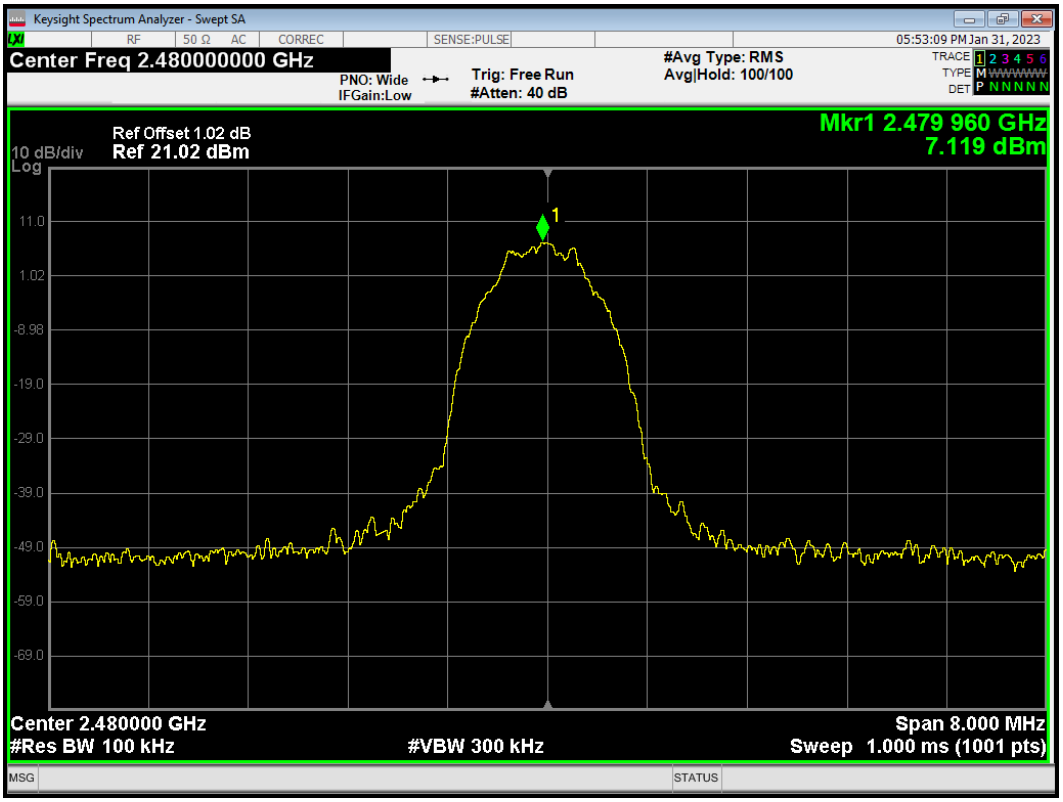
Band Edge BLE (1M) 2402MHz Ref



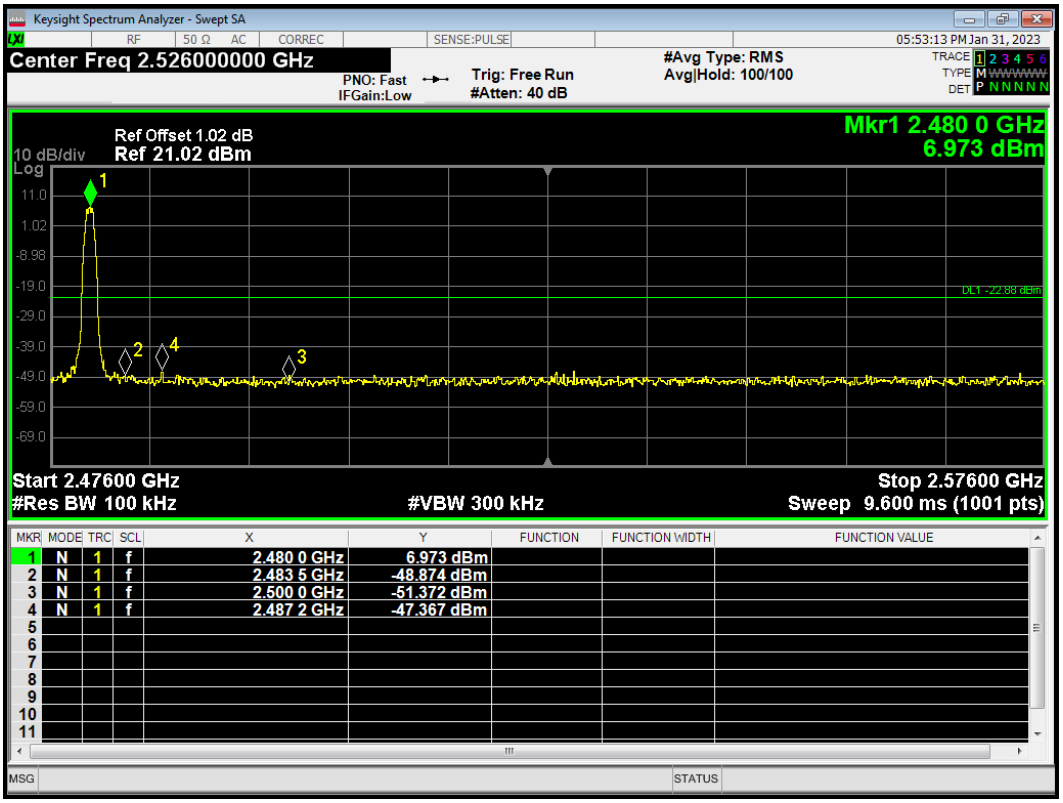
Band Edge BLE (1M) 2402MHz Emission



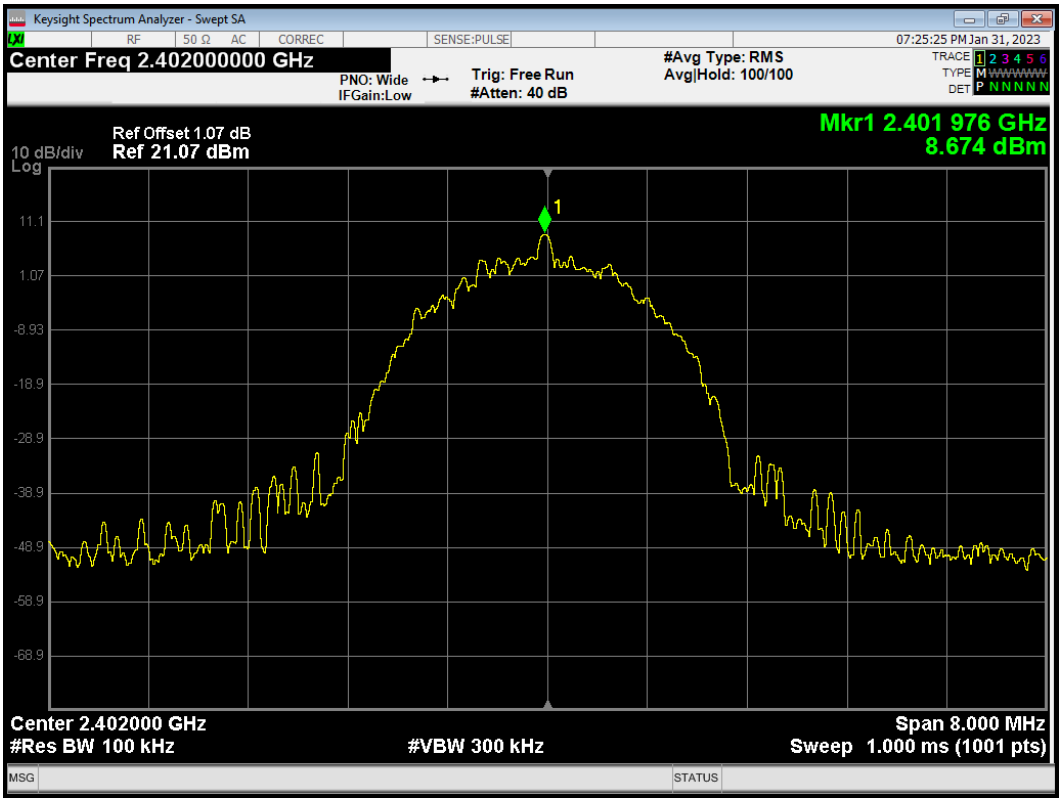
Band Edge BLE (1M) 2480MHz Ref



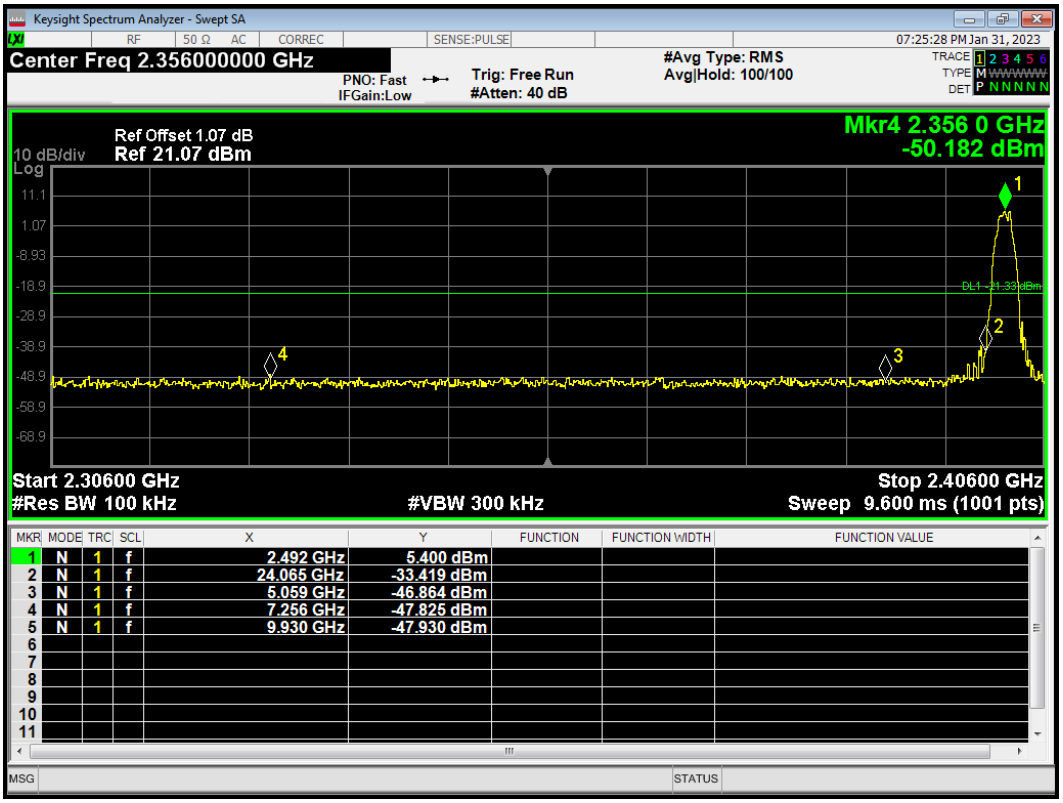
Band Edge BLE (1M) 2480MHz Emission



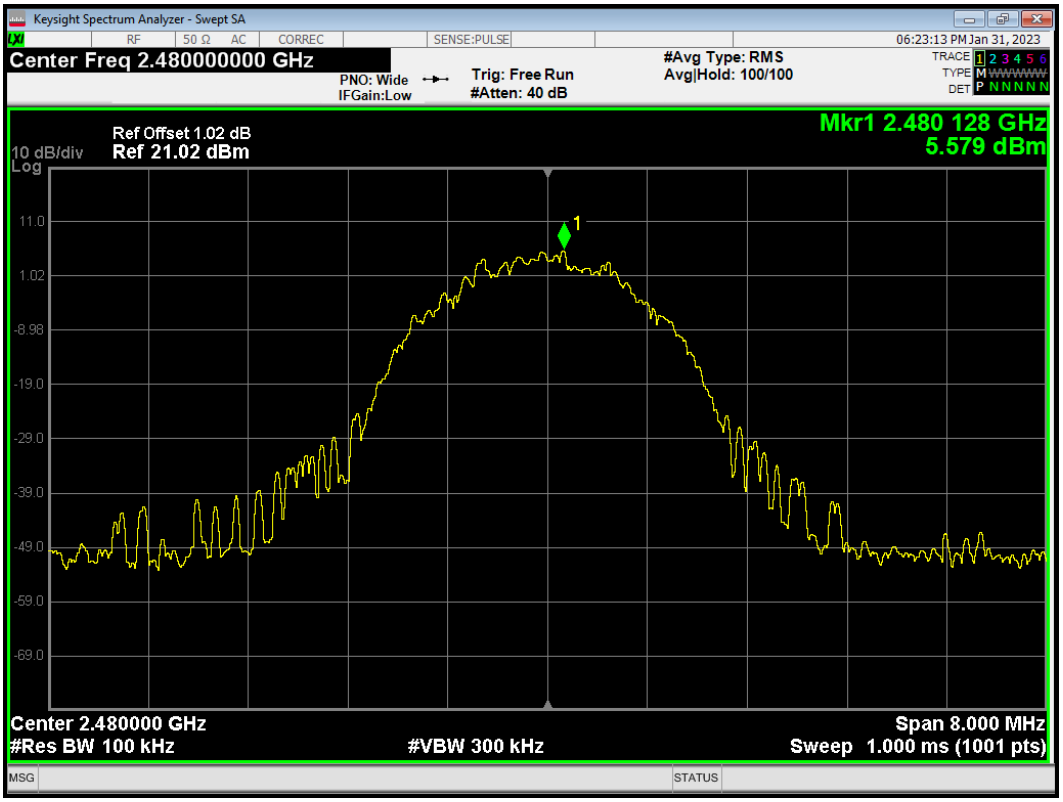
Band Edge BLE (2M) 2402MHz Ref



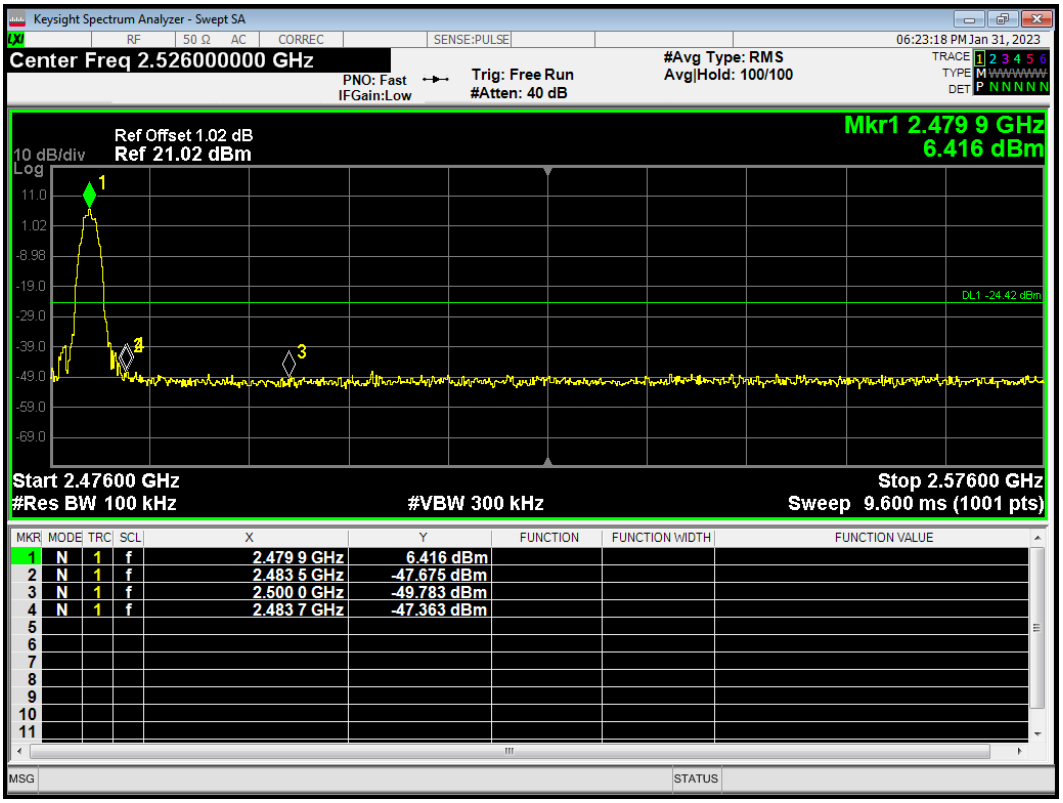
Band Edge BLE (2M) 2402MHz Emission



Band Edge BLE (2M) 2480MHz Ref



Band Edge BLE (2M) 2480MHz Emission



5.4. Power Spectral Density

Ambient Condition

Temperature	Relative humidity
20°C ~ 25°C	45% ~ 50%

Method of Measurement

During the process of the testing, The EUT was connected to Spectrum Analyzer with a known loss. The EUT is max power transmission with proper modulation.

Method AVGPSD-1 was used for this test.

a) Set instrument center frequency to DTS channel center frequency

b) Set span to at least 1.5 times the OBW

c) Set RBW to:3kHz≤RBW≤100kHz

d) Set VBW≥[3x RBW]

e) Detector=power averaging (rms) or sample detector (when rms not available)

f) Ensure that the number of measurement points in the sweep ≥ [2 X span/RBW]

g) Sweep time auto couple

h) Employ trace averaging (rms) mode over a minimum of 100 traces

i) Use the peak marker function to determine the maximum amplitude level.

j) If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)

Method AVGPSD-2 was used for this test.

a) Measure the duty cycle (D)of the transmitter output signal as described in 11.6

b) Set instrument center frequency to DTS channel center frequency

c) Set span to at least 1.5 times the OBW

d) Set RBW to:3kHz≤RBW≤100Kh

e) Set VBW≥[3x RBW]

f) Detector= power averaging (rms) or sample detector (when rms not available)

g) Ensure that the number of measurement points in the sweep ≥ [2 X span/RBW]

h) Sweep time =auto couple

i) Do not use sweep triggering; allow sweep to "free run”

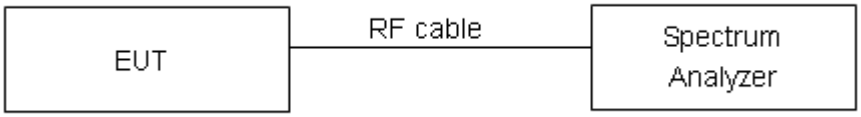
j) Employ trace averaging (rms) mode over a minimum of 100 traces

k) Use the peak marker function to determine the maximum amplitude level

l) Add [10 log(1/ D)], where D is the duty cycle measured in step a), to the measured PSD to compute the average PSD during the actual transmission time

m) If measured value exceeds requirement specified by regulatory agency then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)

Test setup



Limits

Rule Part 15.247(e) specifies that" For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. ''

Limits	≤ 8 dBm / 3kHz

Measurement Uncertainty

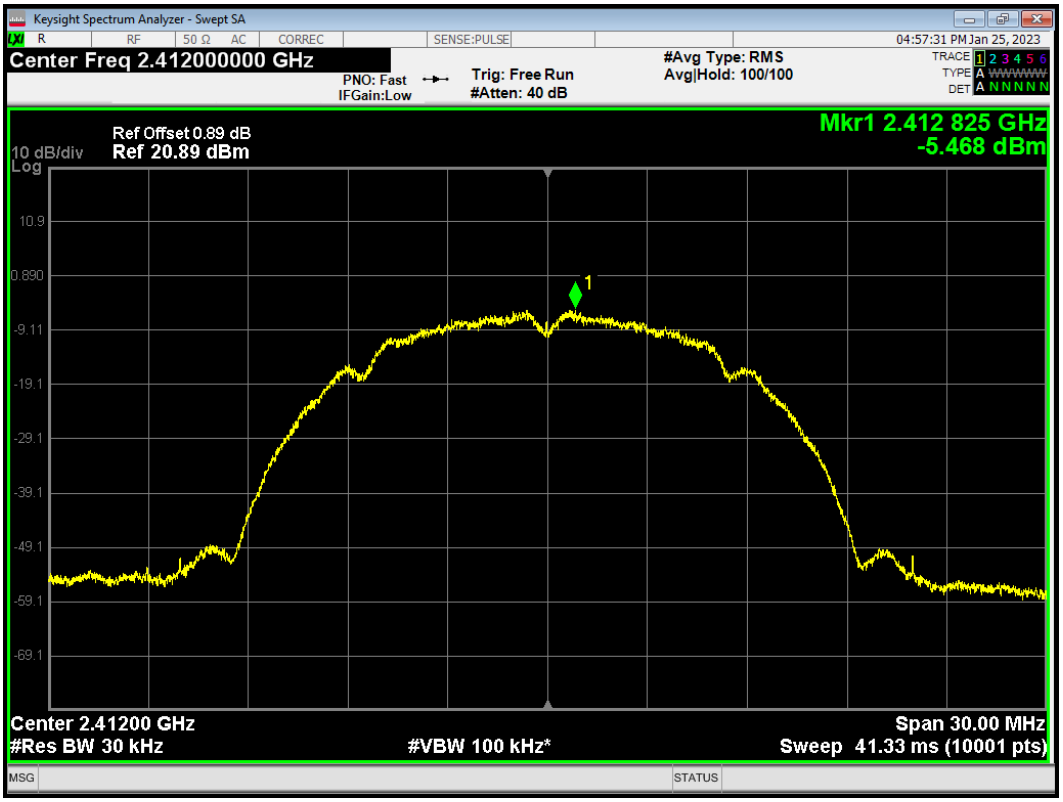
The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 0.75dB.

Test Results:

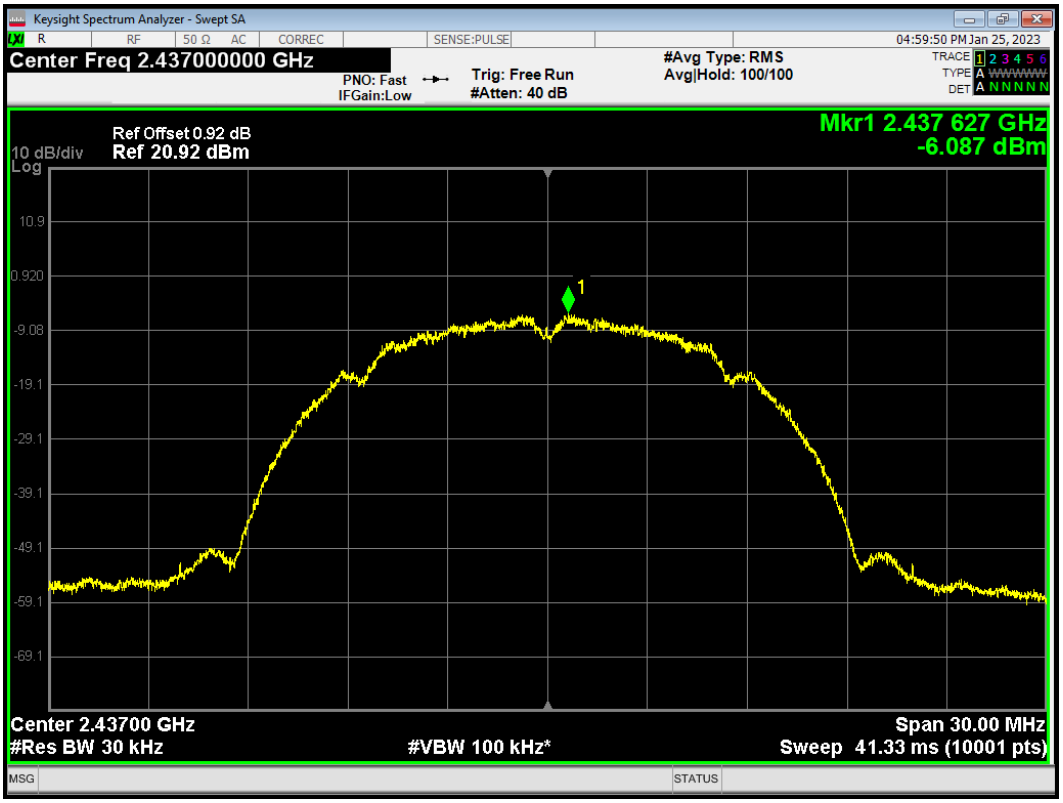
Test Mode	Carrier frequency (MHz)/ Channel	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	2412/CH 1	-5.47	-15.47	8	PASS
	2437/CH 6	-6.09	-16.09	8	PASS
	2462/CH 11	-7.03	-17.03	8	PASS
802.11g	2412/CH 1	-10.31	-20.31	8	PASS
	2417/CH 2	-7.07	-17.07	8	PASS
	2422/CH 3	-6.62	-16.62	8	PASS
	2437/CH 6	-6.87	-16.87	8	PASS
	2442/CH 7	-6.98	-16.98	8	PASS
	2452/CH 9	-7.82	-17.82	8	PASS
	2457/CH 10	-8.38	-18.38	8	PASS
	2462/CH 11	-11.91	-21.91	8	PASS
802.11n HT20	2412/CH 1	-12.37	-22.37	8	PASS
	2417/CH 2	-9.09	-19.09	8	PASS
	2422/CH 3	-8.33	-18.33	8	PASS
	2437/CH 6	-8.1	-18.10	8	PASS
	2452/CH 9	-8.47	-18.47	8	PASS
	2457/CH 10	-9.27	-19.27	8	PASS
	2462/CH 11	-13.76	-23.76	8	PASS
802.11n HT40	2422/CH 3	-16.58	-26.58	8	PASS
	2427/CH 4	-15.47	-25.47	8	PASS
	2432/CH 5	-15.04	-25.04	8	PASS
	2437/CH 6	-13.05	-23.05	8	PASS
	2442/CH 7	-14.57	-24.57	8	PASS
	2447/CH 8	-17.68	-27.68	8	PASS
	2452/CH 9	-18.52	-28.52	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3 / 30)					

Test Mode	Carrier frequency (MHz)/ Channel	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy) (1M)	2402/CH0	-13.22	-12.46	8	PASS
	2440/CH19	-12.68	-11.92	8	PASS
	2480/CH39	-13.76	-13.00	8	PASS
Bluetooth (Low Energy) (2M)	2402/CH0	-15.96	-13.50	8	PASS
	2440/CH19	-15.22	-12.76	8	PASS
	2480/CH39	-16.01	-13.55	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

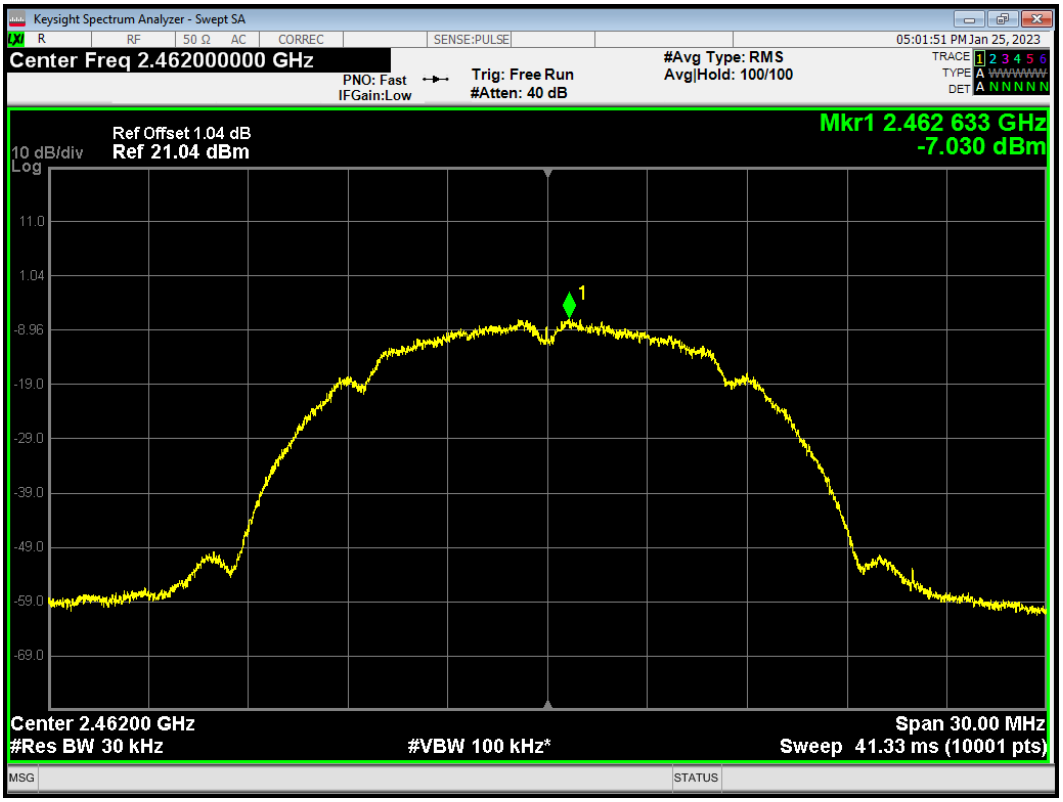
PSD 802.11b 2412MHz



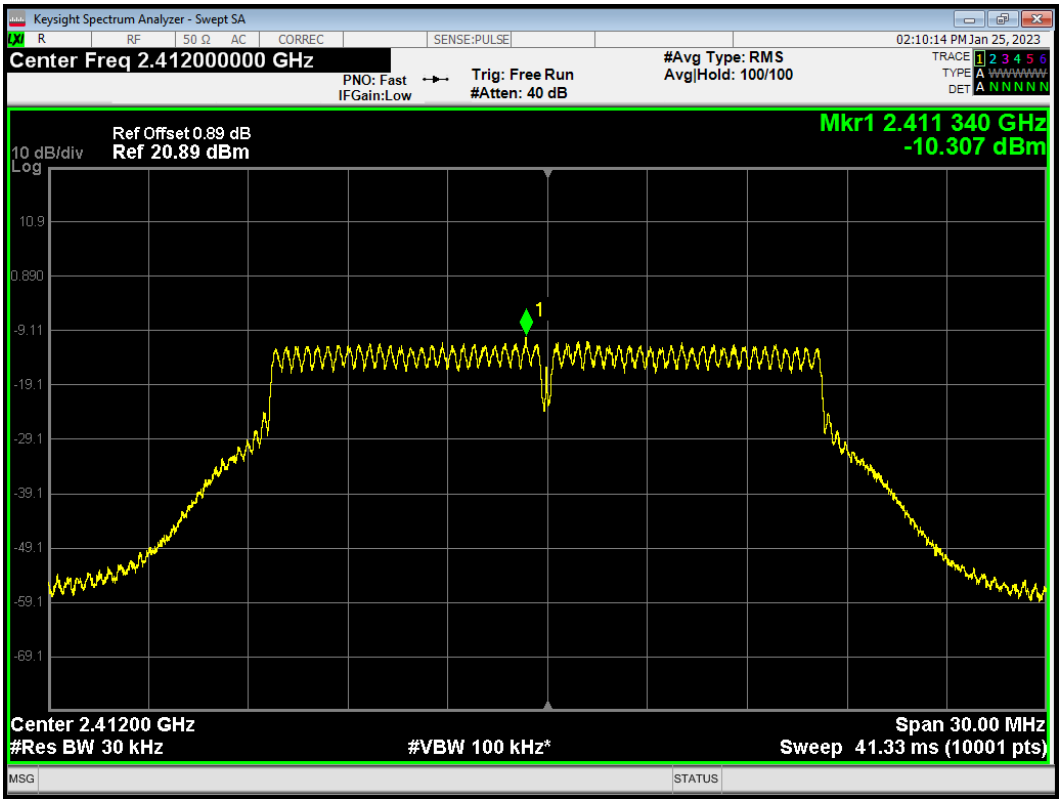
PSD 802.11b 2437MHz



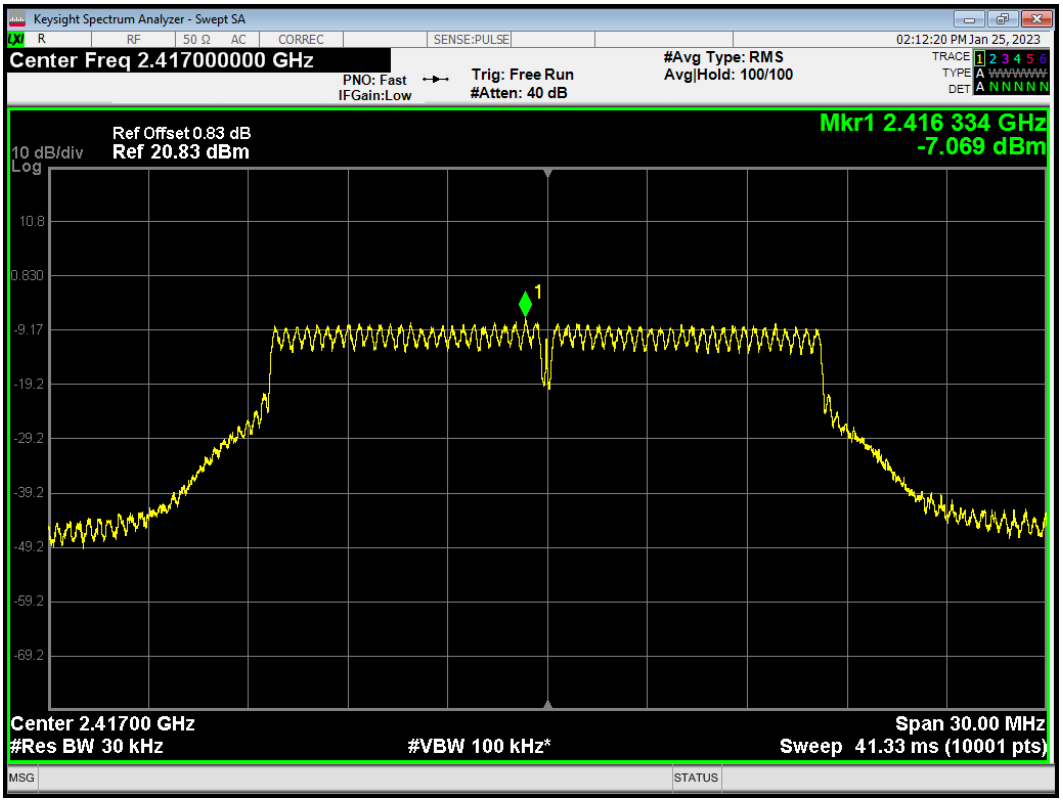
PSD 802.11b 2462MHz



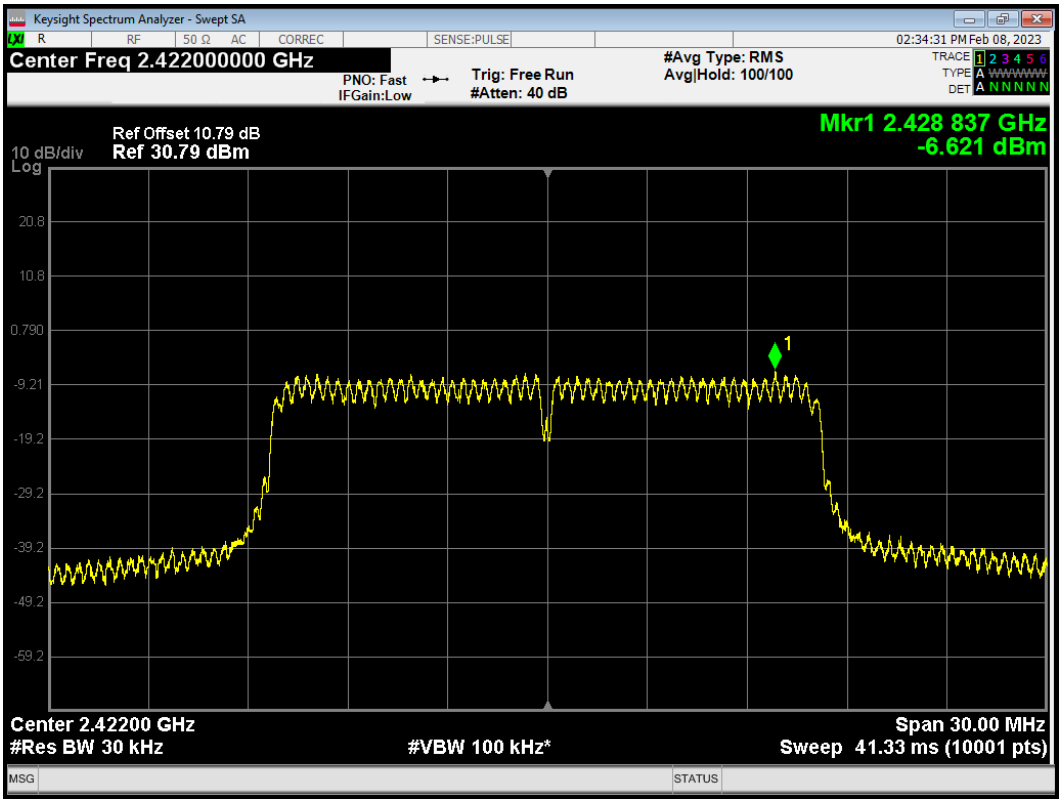
PSD 802.11g 2412MHz



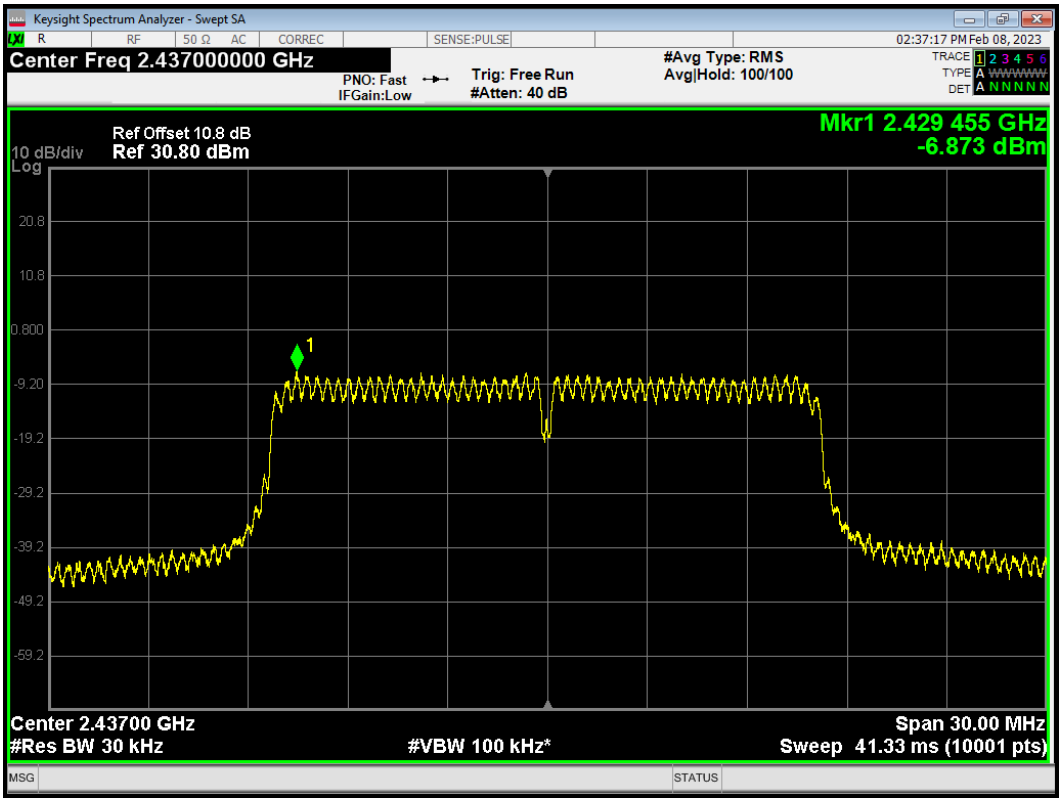
PSD 802.11g 2417MHz



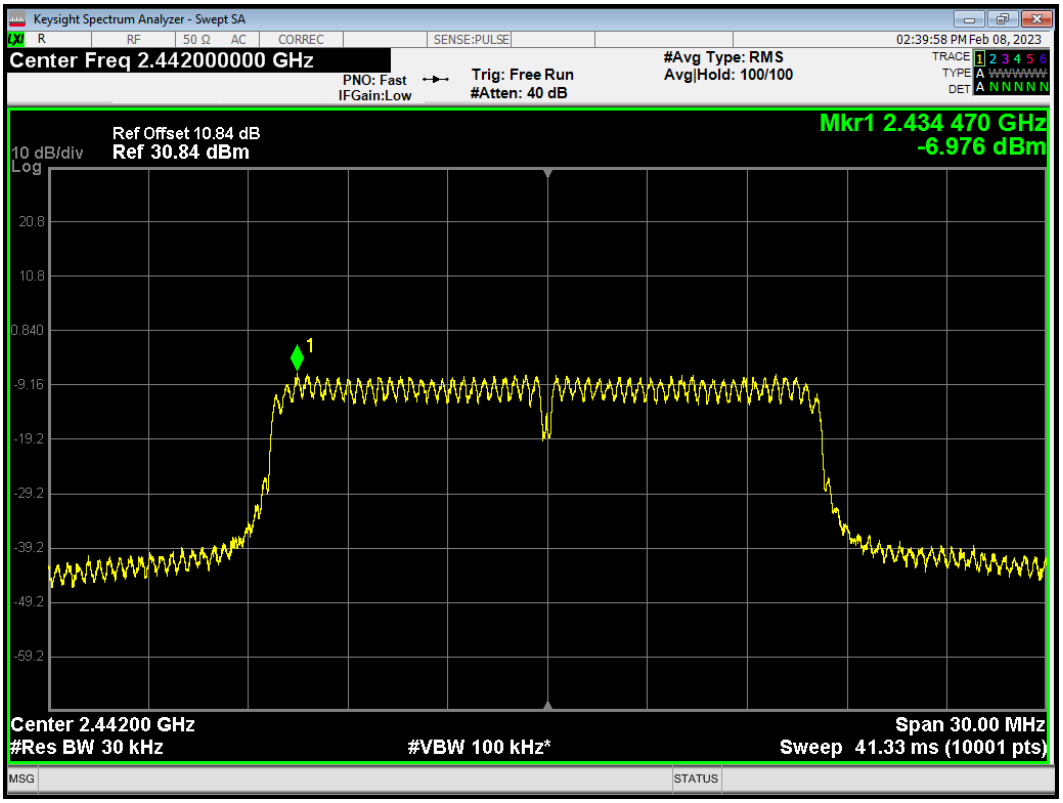
PSD 802.11g 2422MHz



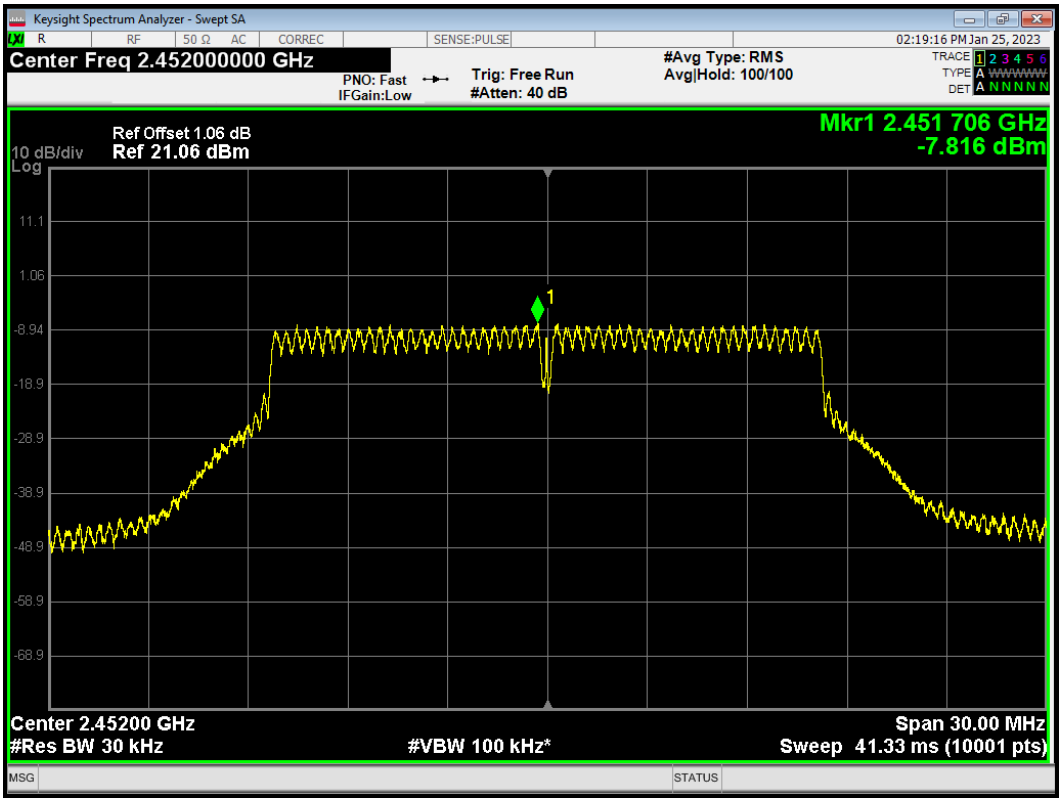
PSD 802.11g 2437MHz



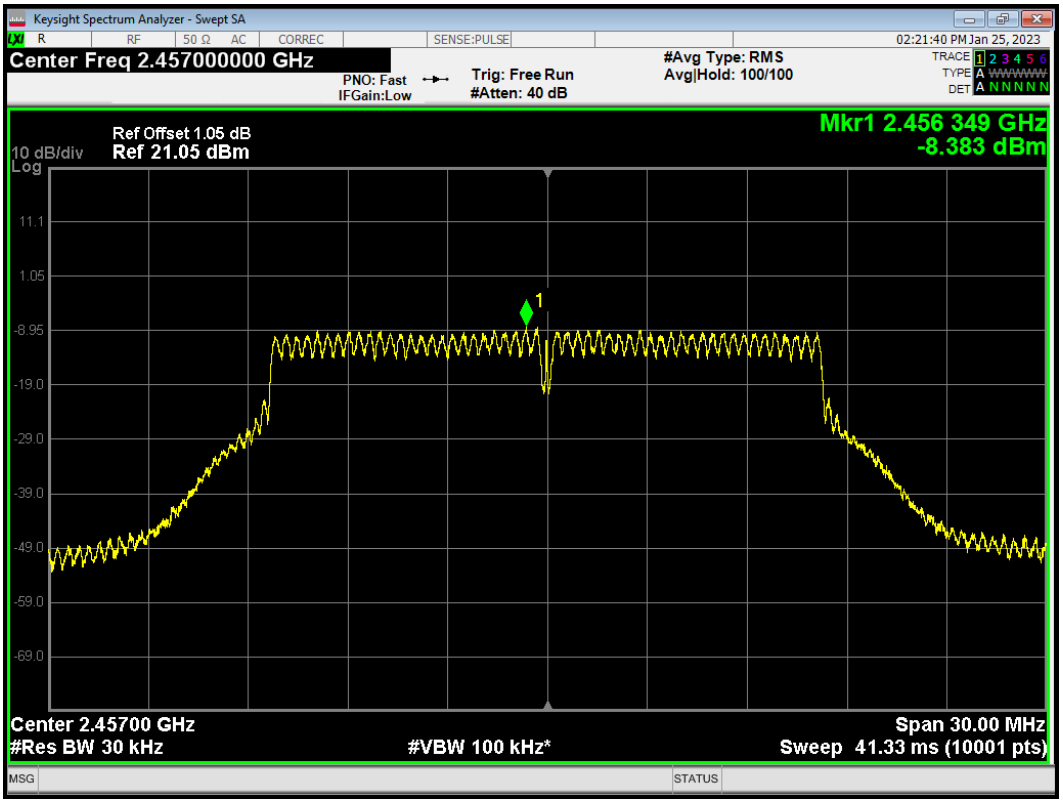
PSD 802.11g 2442MHz



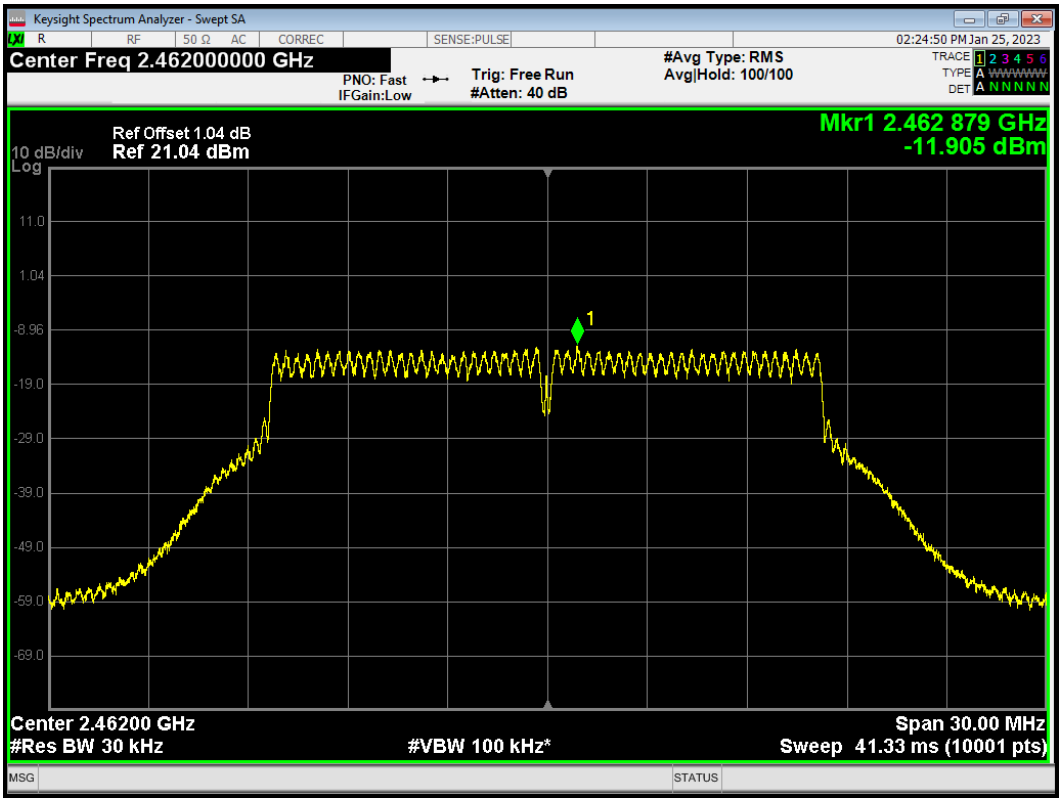
PSD 802.11g 2452MHz



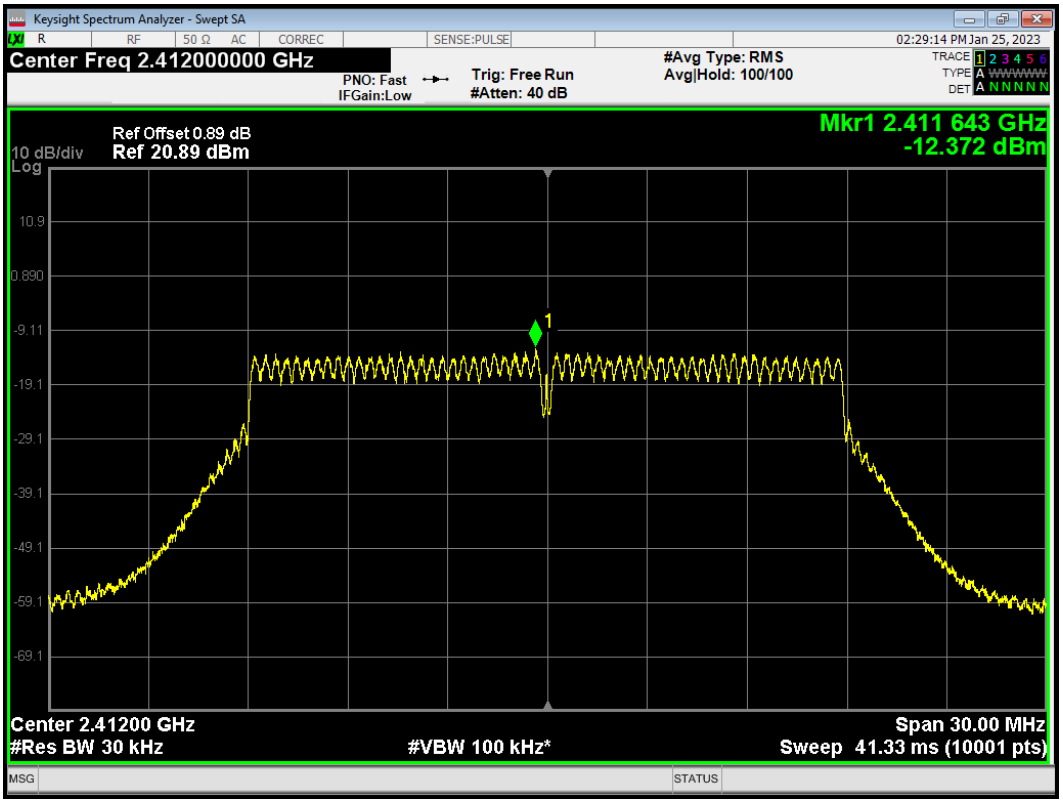
PSD 802.11g 2457MHz



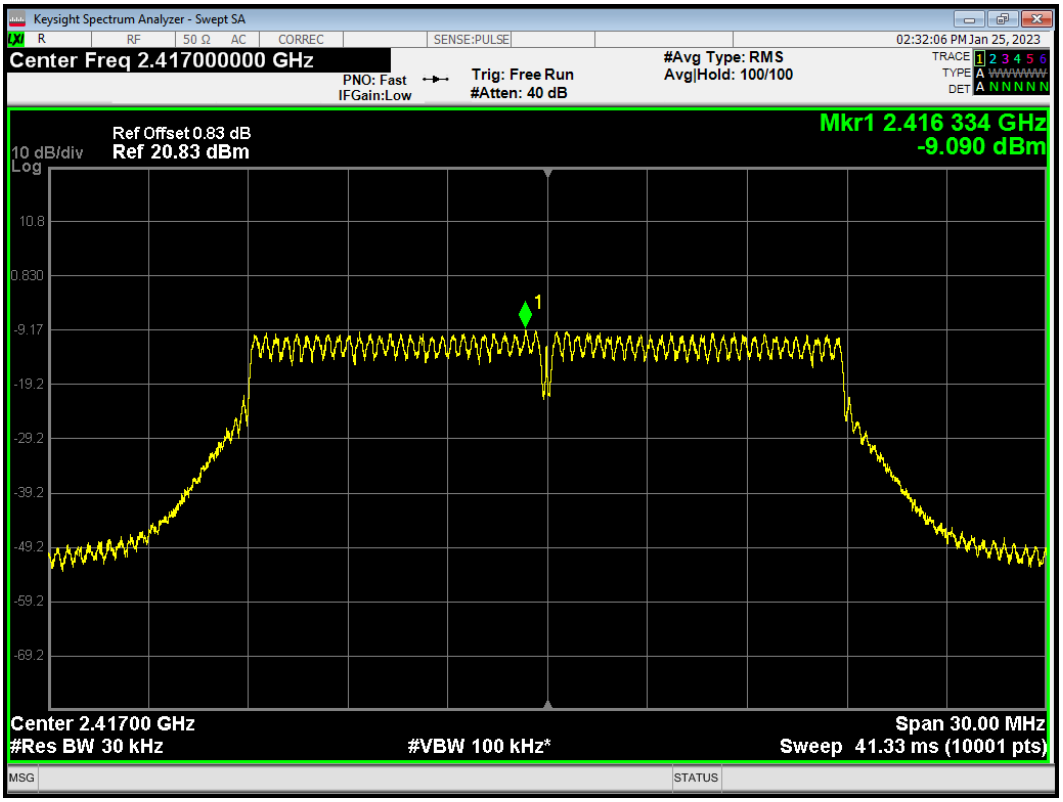
PSD 802.11g 2462MHz



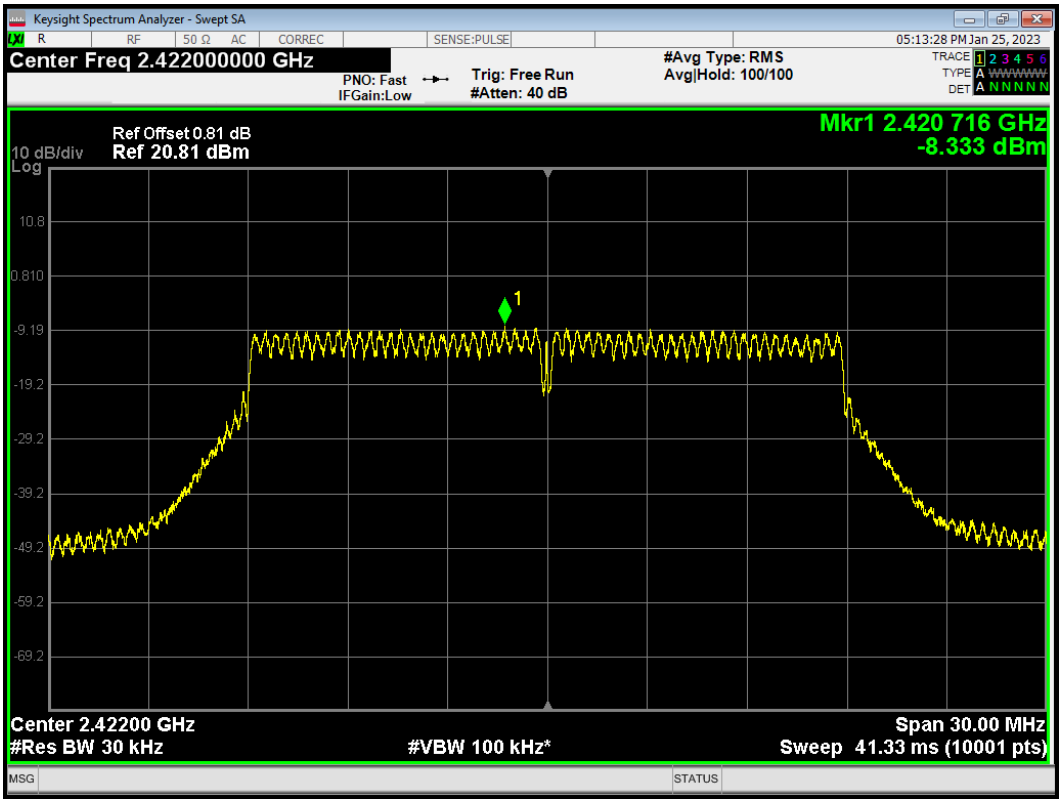
PSD 802.11n(HT20) 2412MHz



PSD 802.11n(HT20) 2417MHz



PSD 802.11n(HT20) 2422MHz



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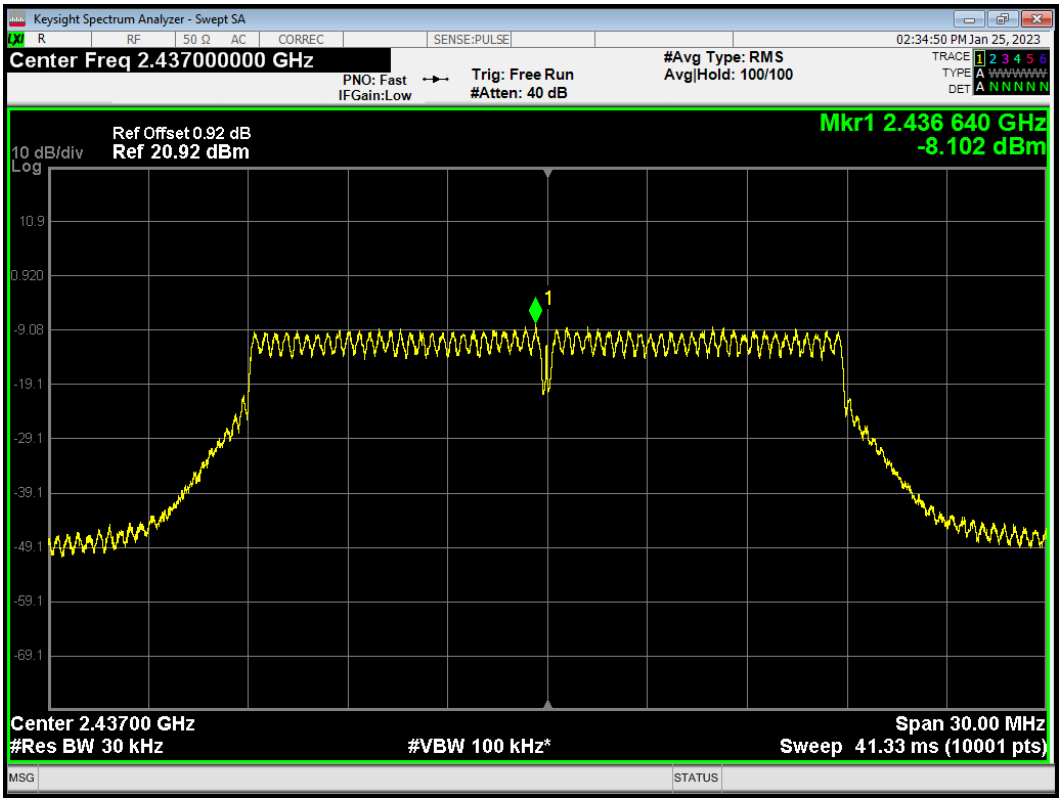

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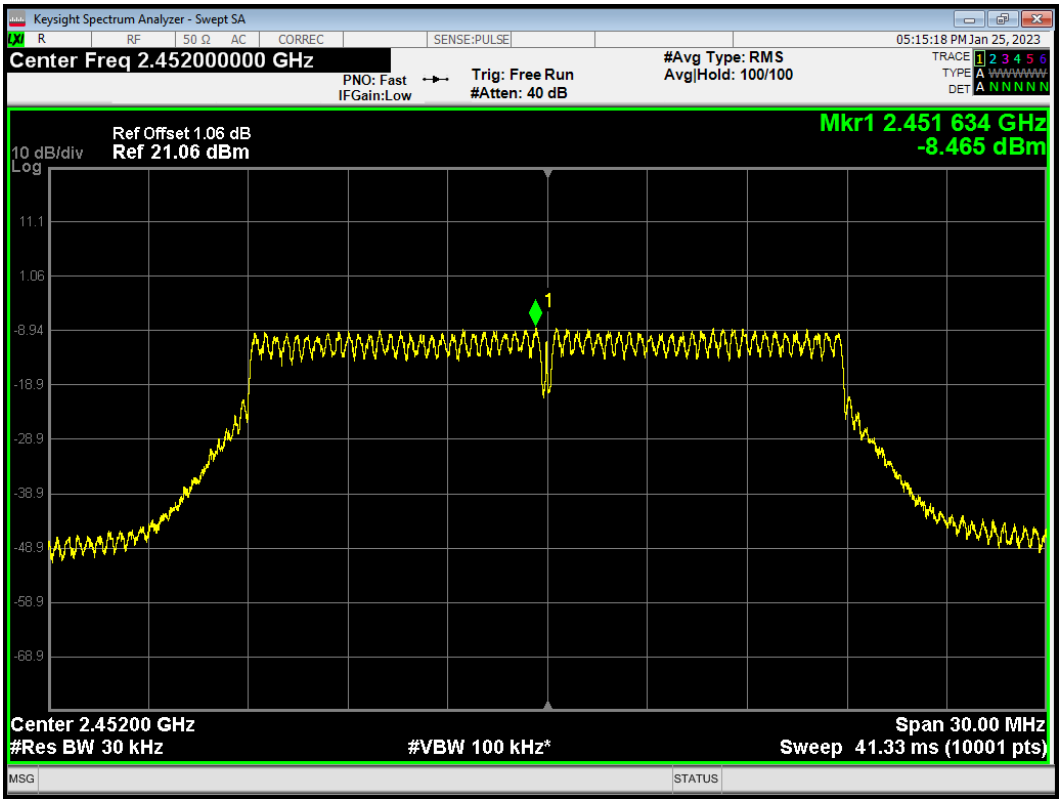

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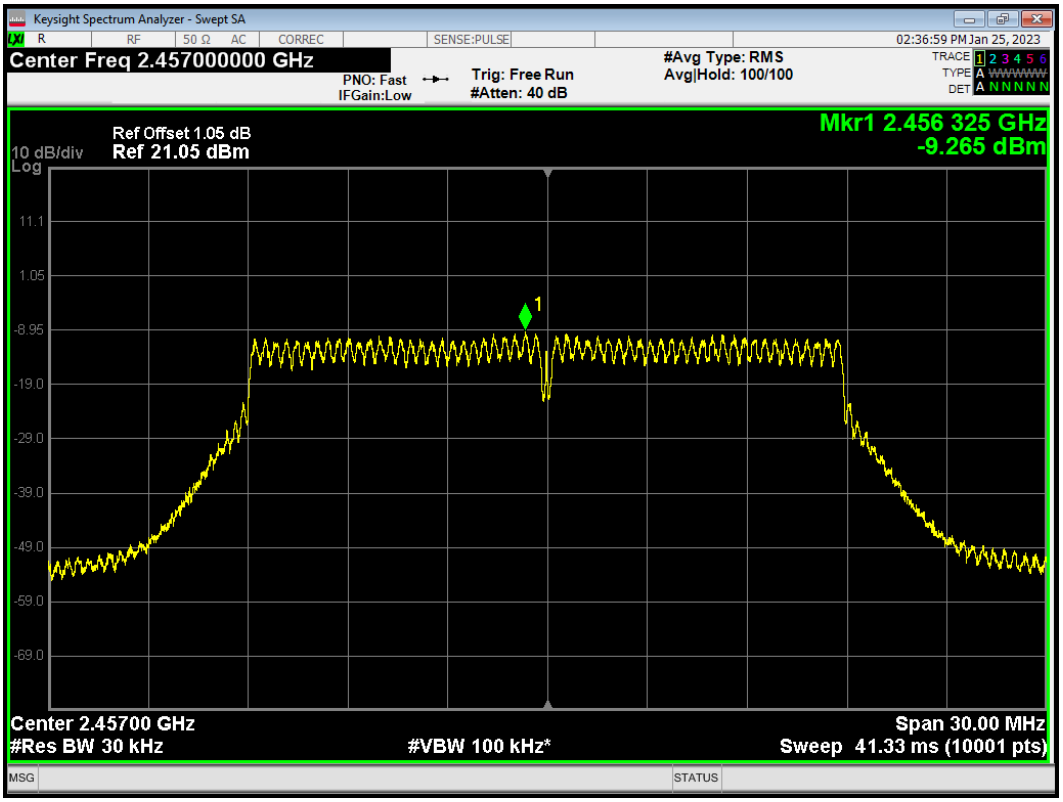

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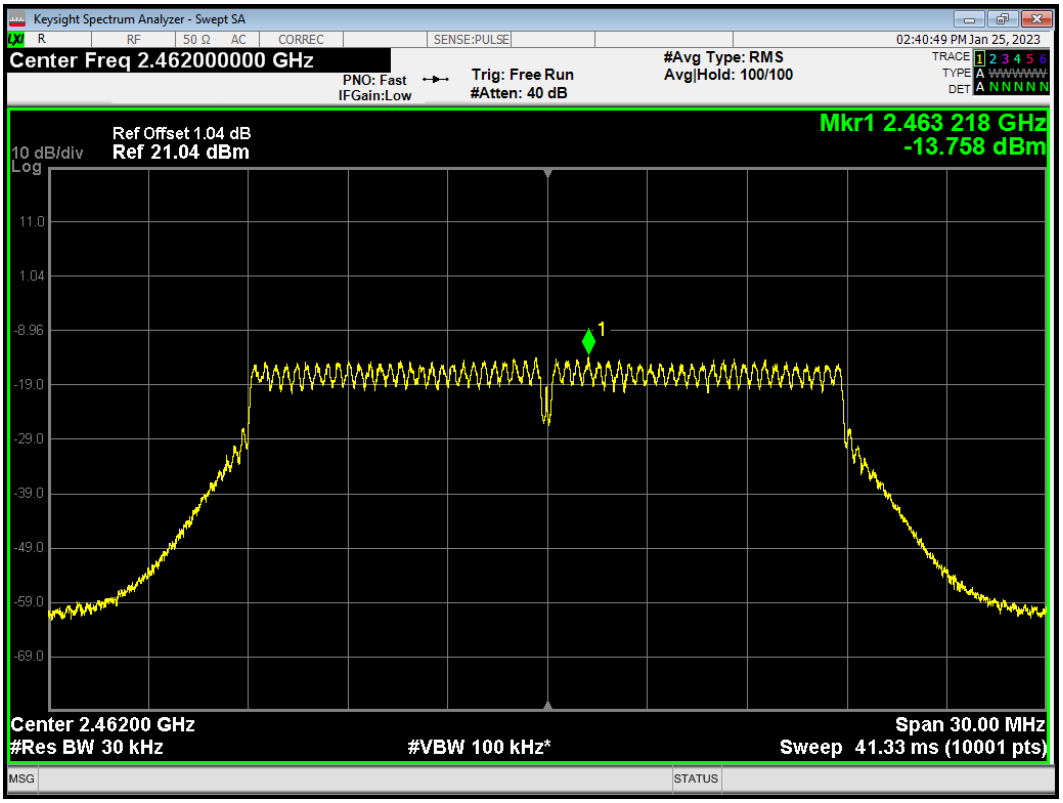
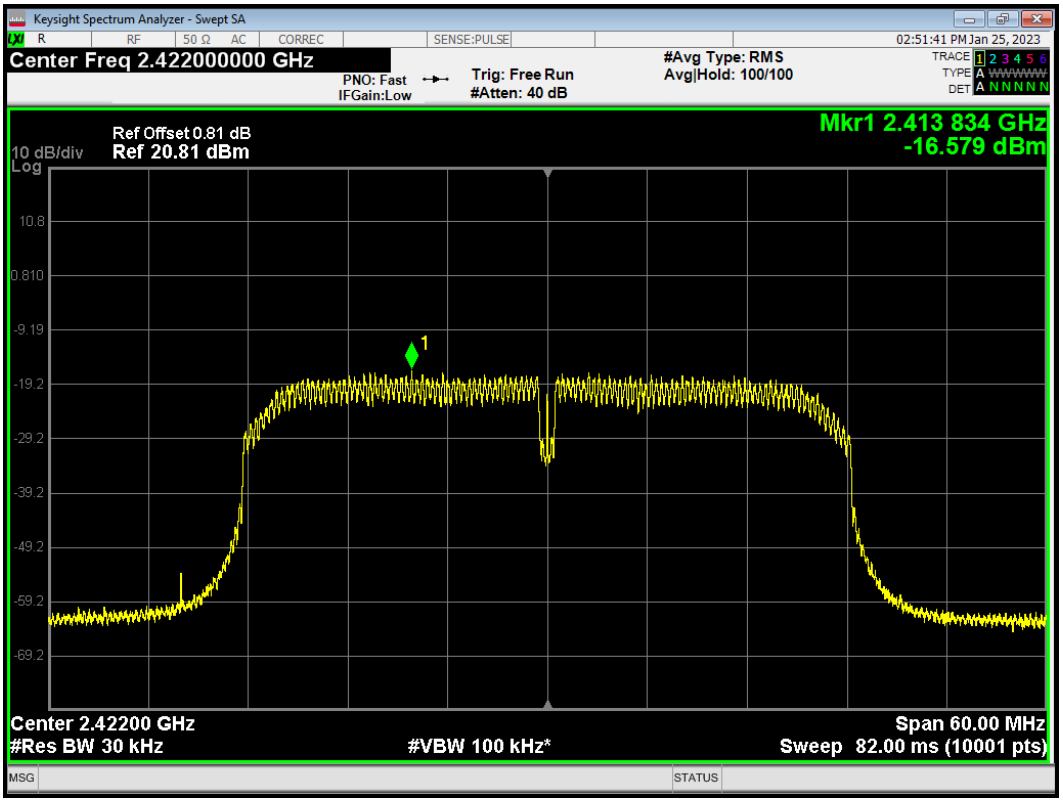


PSD 802.11n(HT40) 2422MHz



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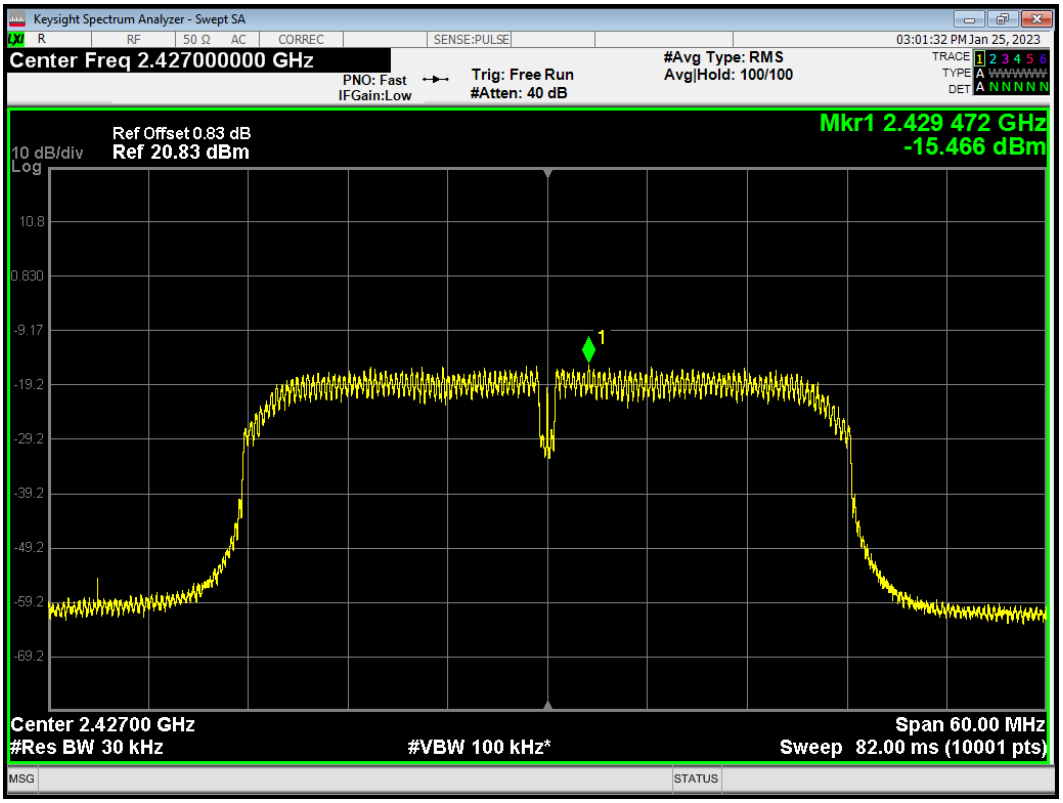

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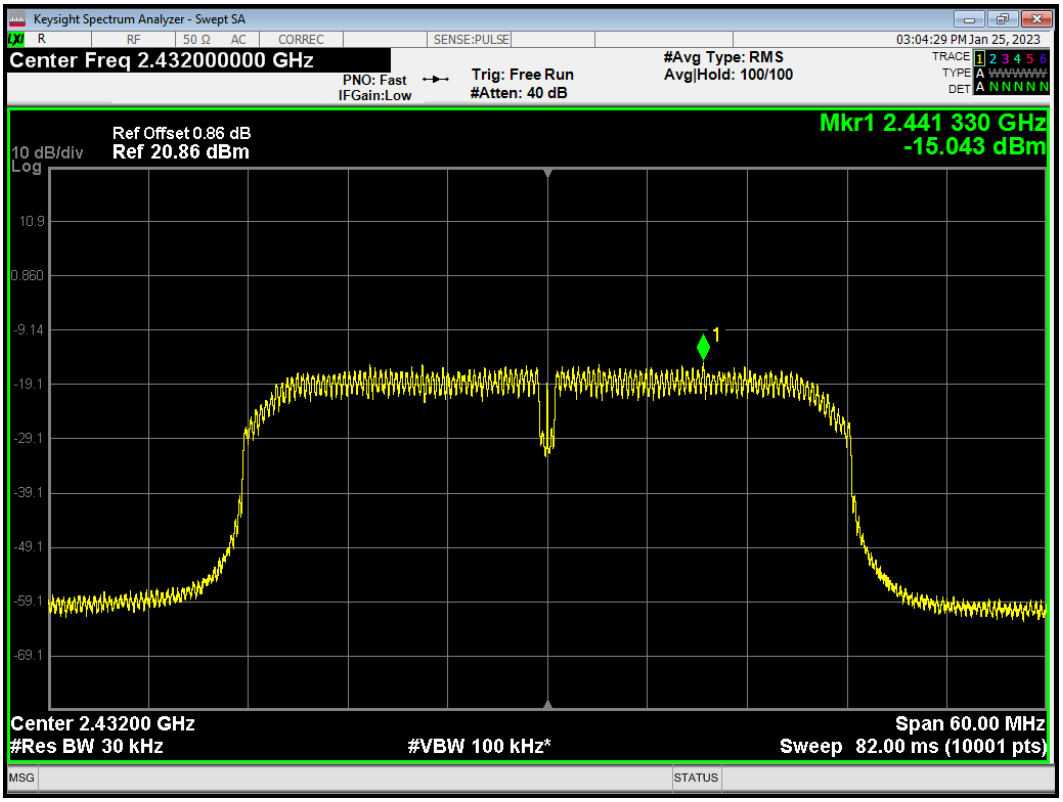
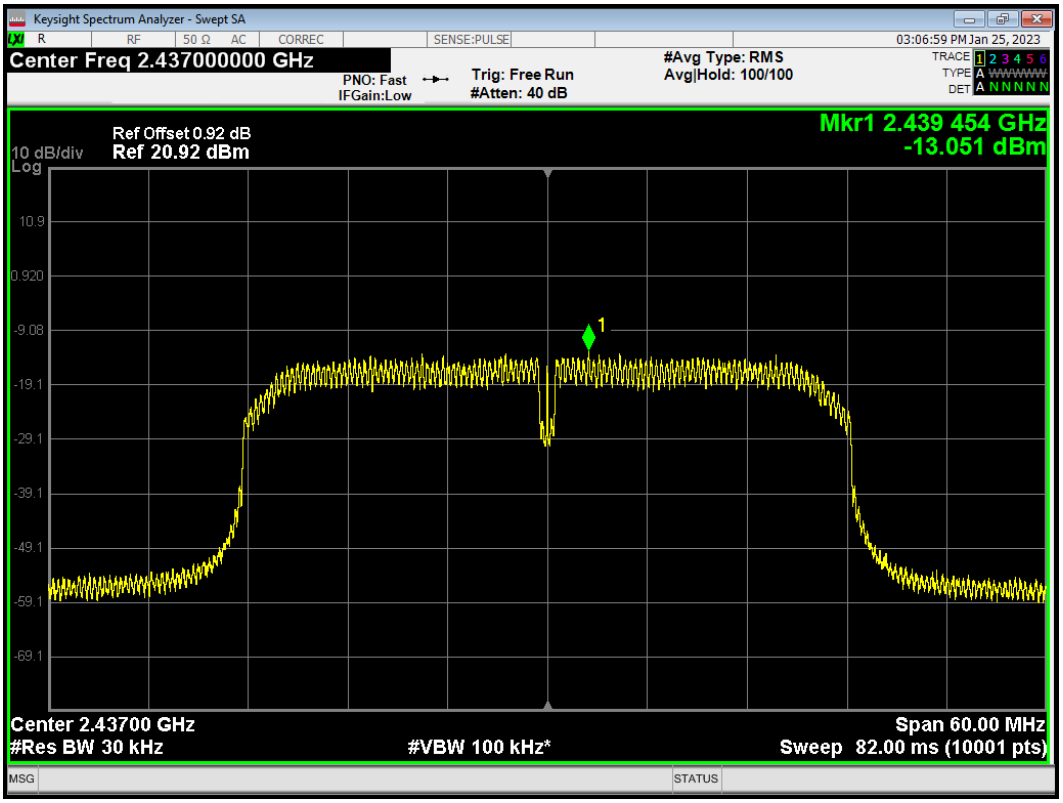
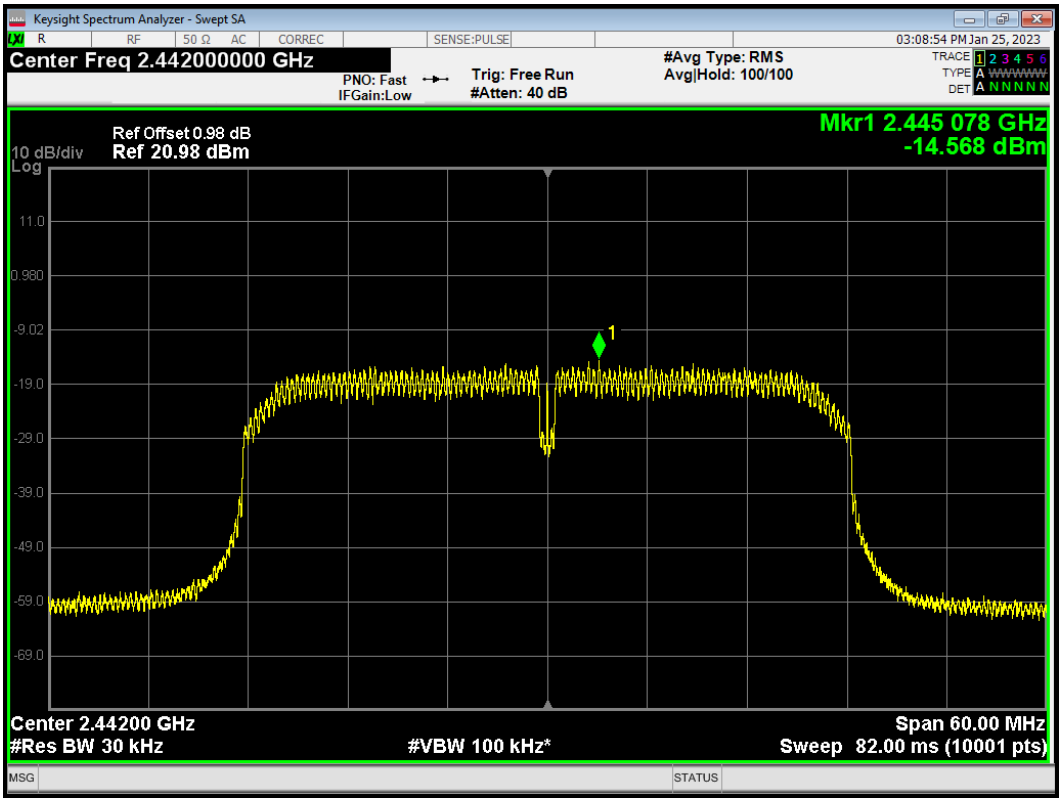


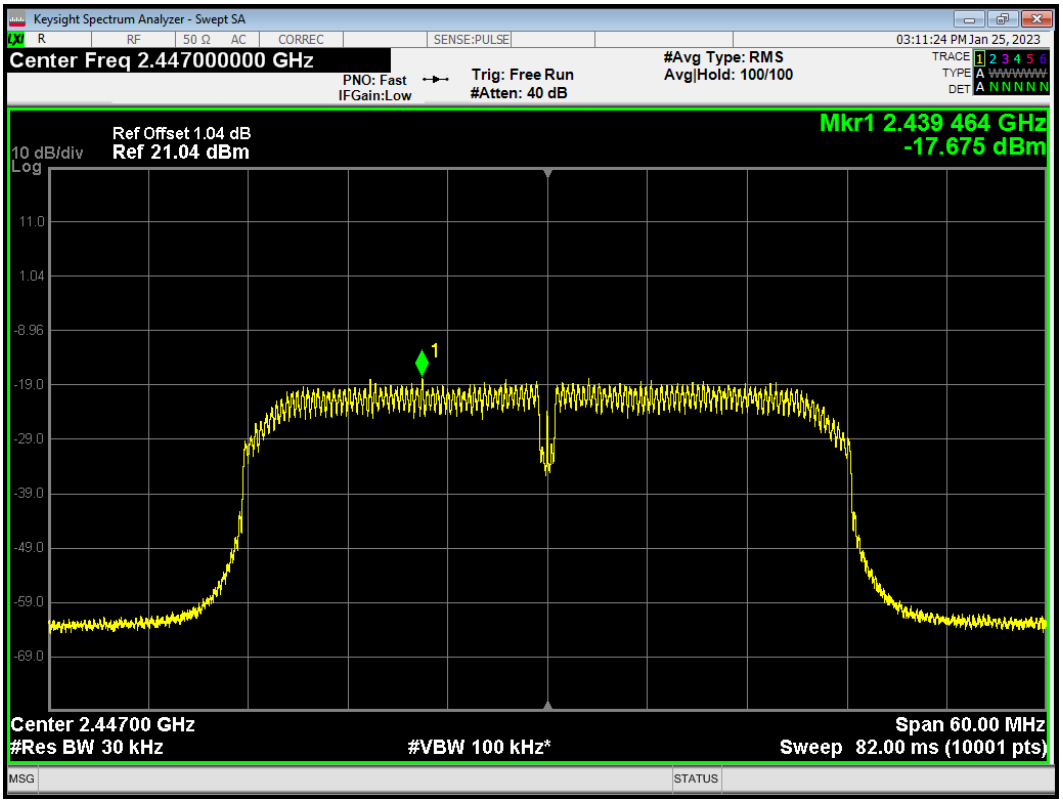
PSD 802.11n(HT40) 2437MHz



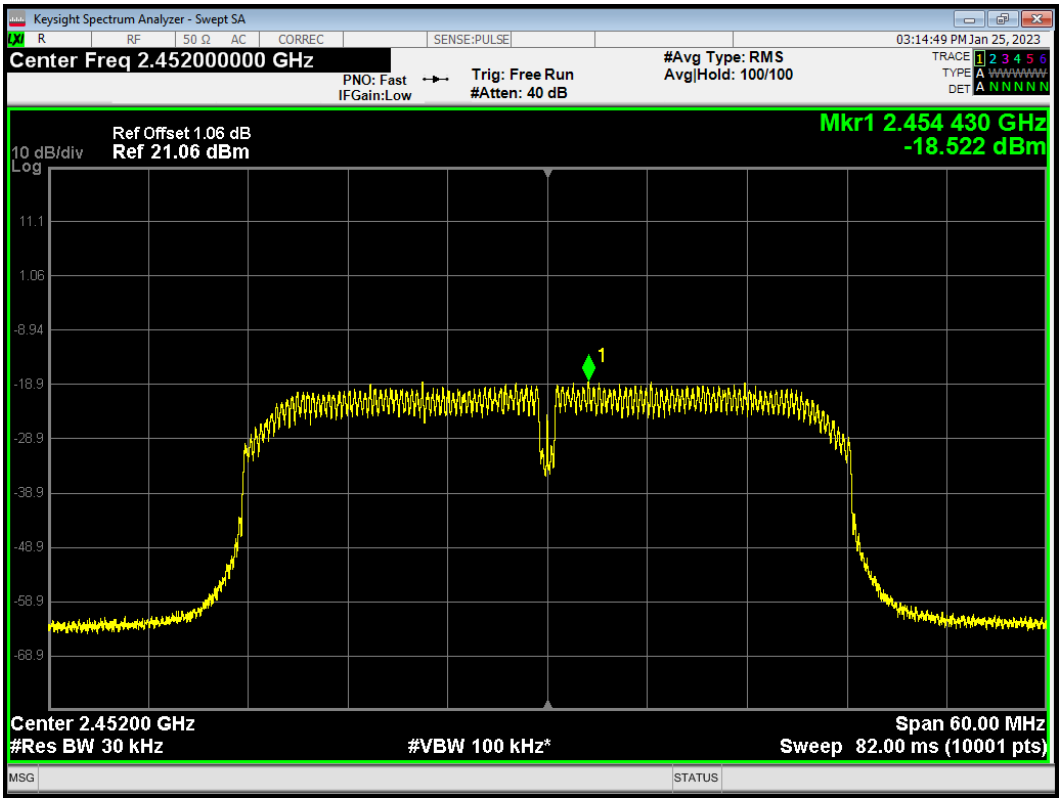
PSD 802.11n(HT40) 2442MHz



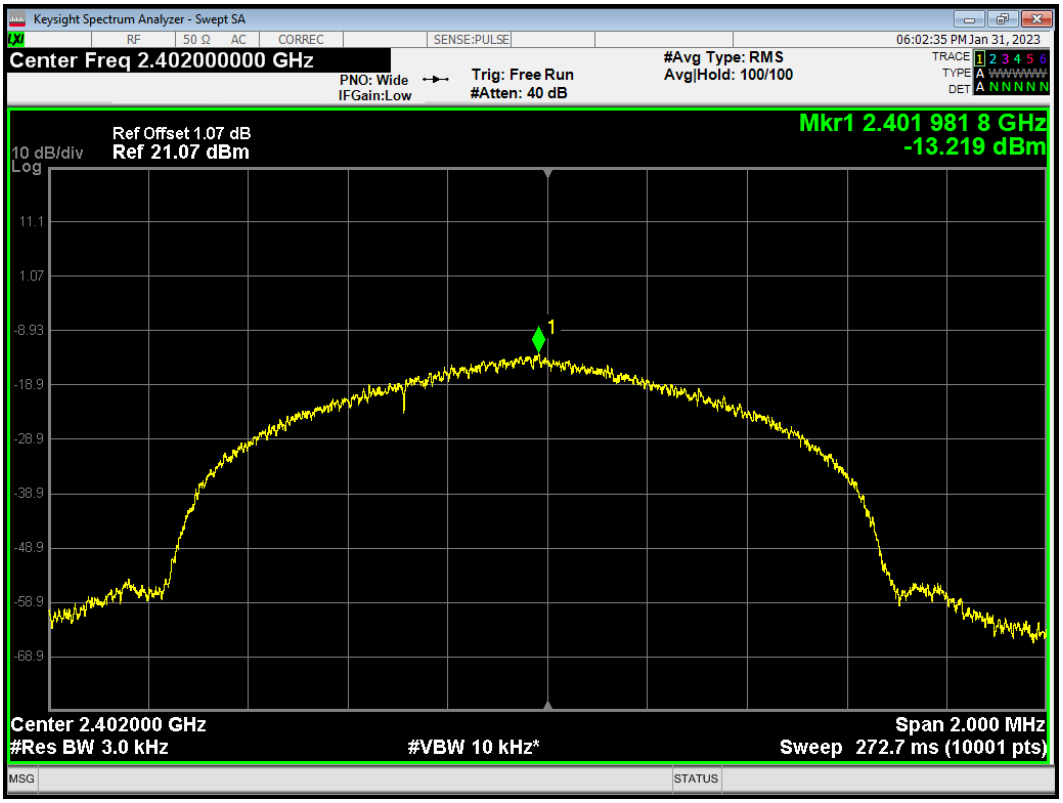
PSD 802.11n(HT40) 2447MHz



PSD 802.11n(HT40) 2452MHz



PSD BLE (1M) 2402MHz



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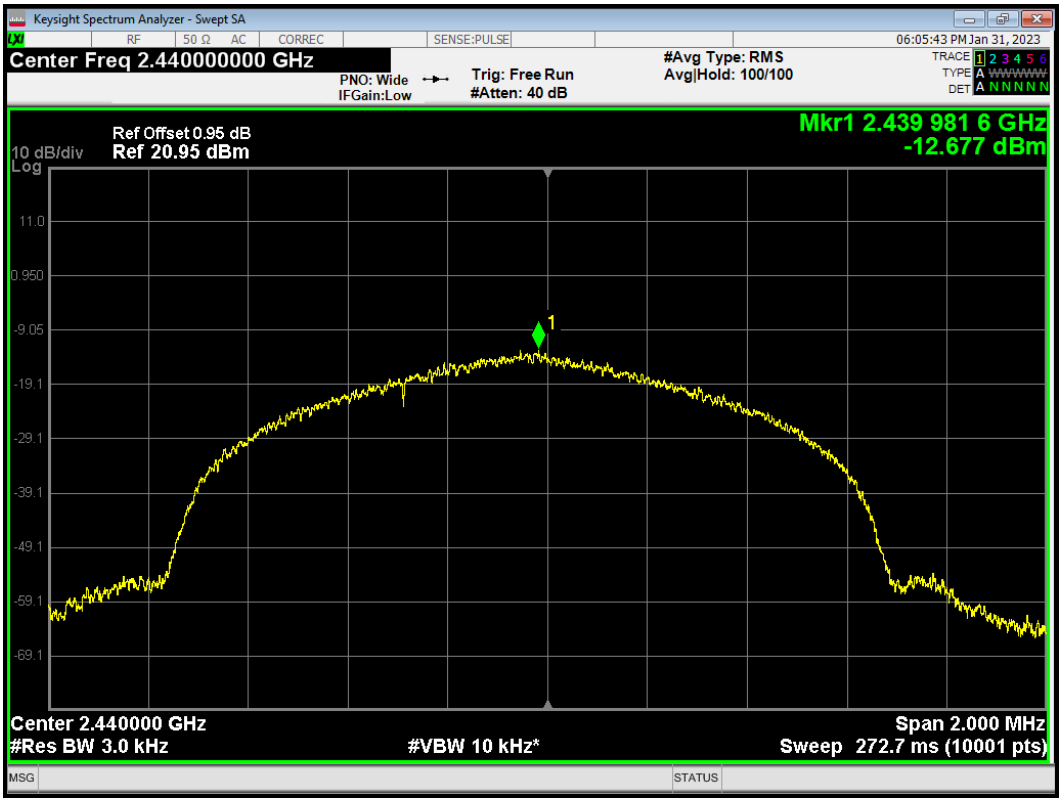

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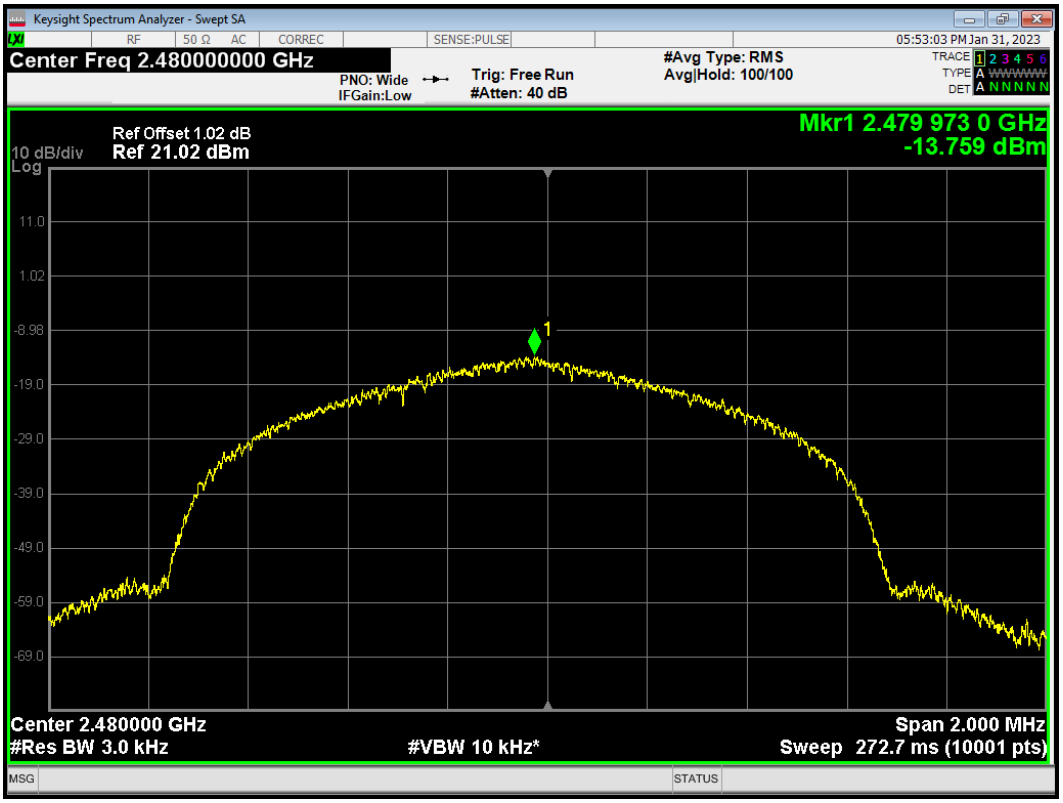
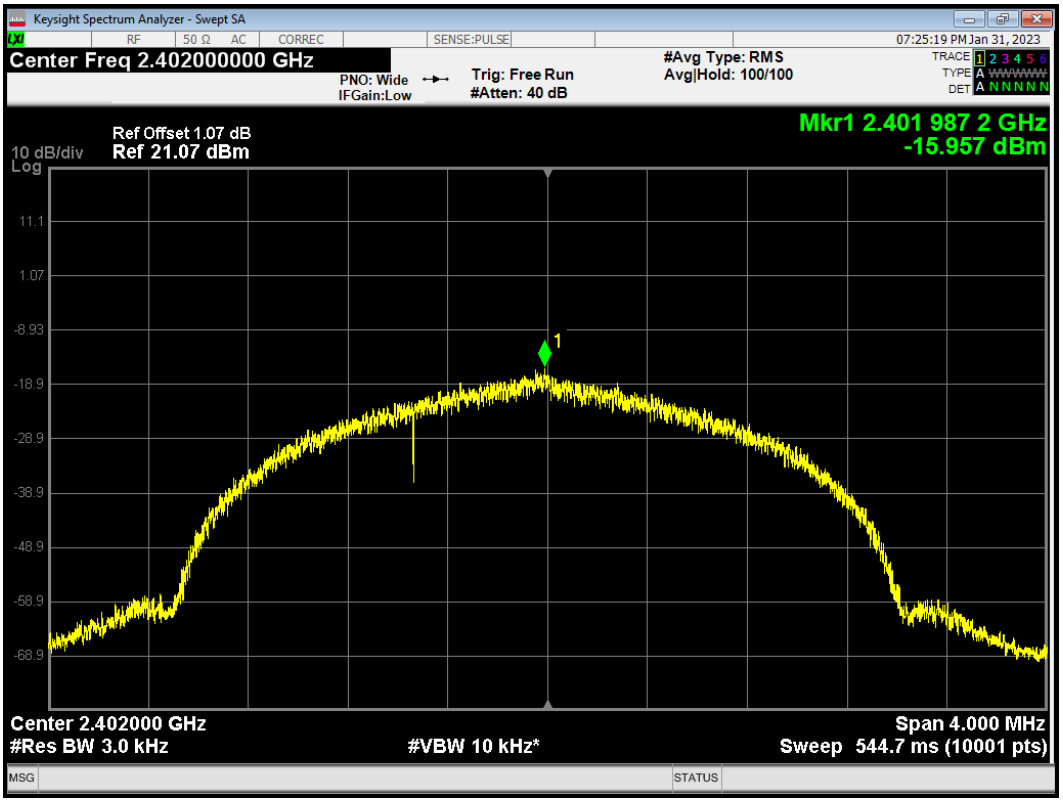
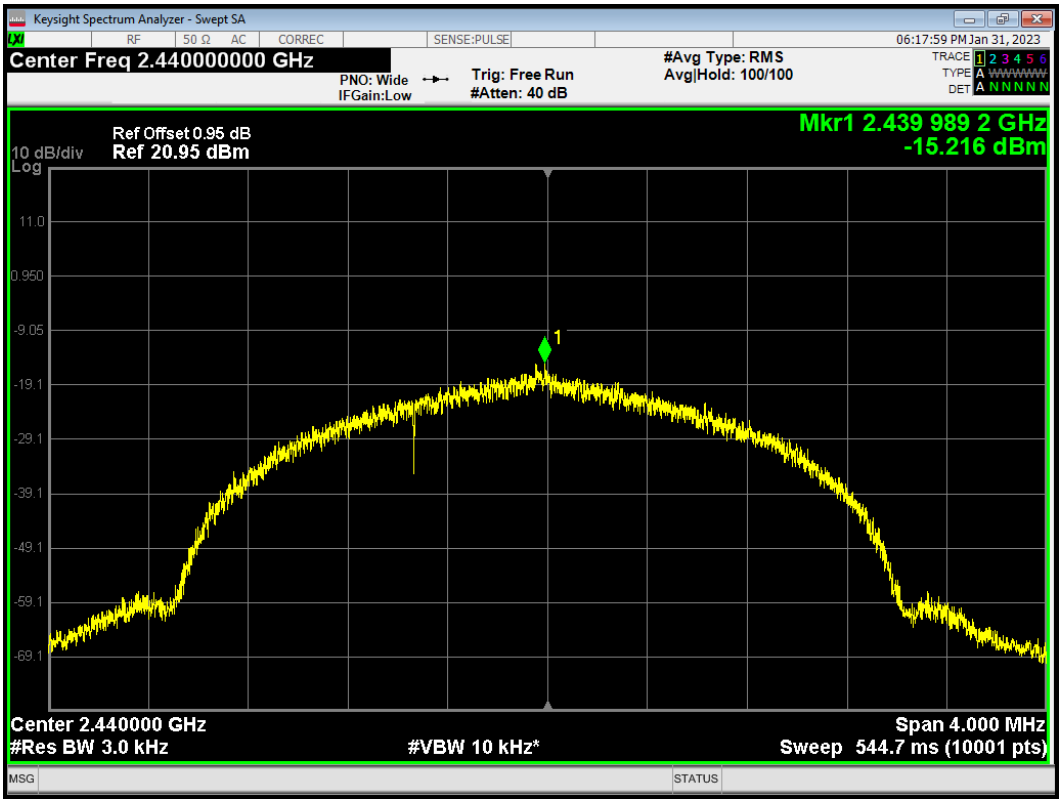


PSD BLE (2M) 2402MHz



PSD BLE (2M) 2440MHz



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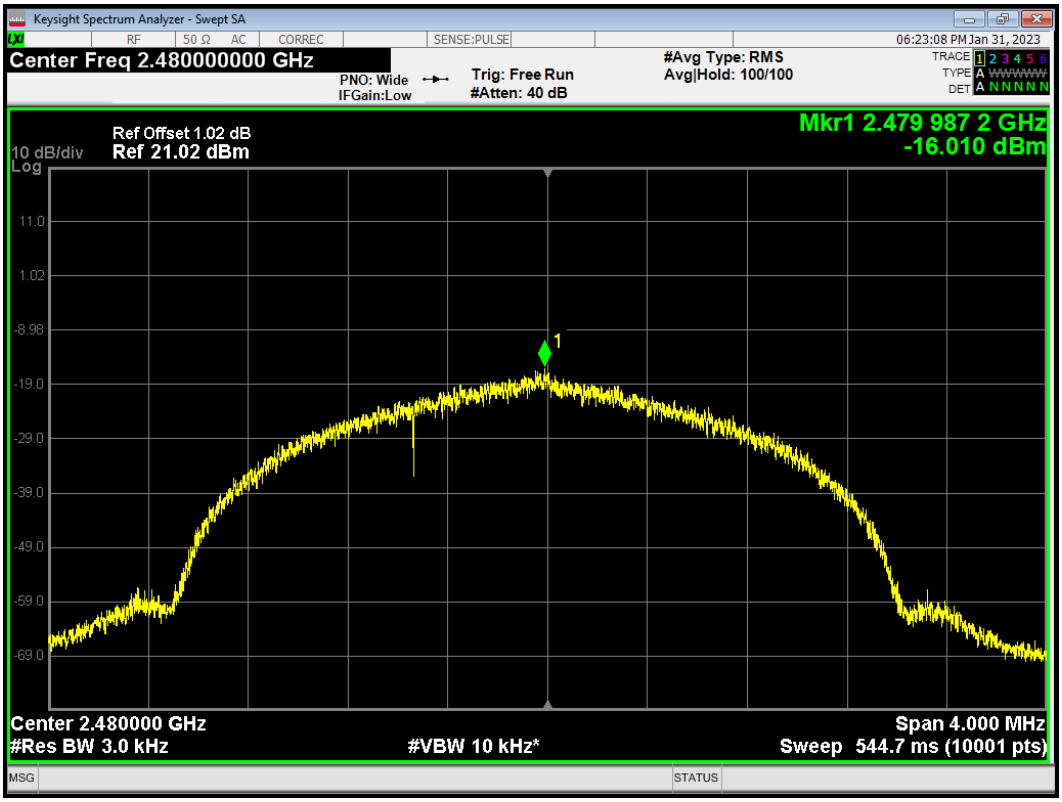


5.5. Spurious RF Conducted Emissions

Ambient Condition

Temperature	Relative humidity
20°C ~ 25°C	45% ~ 50%

Method of Measurement

The EUT was connected to the spectrum analyzer with a known loss. The spectrum analyzer scans from 30MHz to the 10th harmonic of the carrier. The peak detector is used. Set RBW to 100 kHz and VBW to 300 kHz, Sweep is set to ATUO.
The test is in transmitting mode.

Test Setup

Limits

Rule Part 15.247(d) pacifies that “In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. ”

Antenna 1

Test Mode	Carrier frequency (MHz)	Reference value (dBm)	Limit
802.11b	2412	8.380	-21.62
	2437	7.770	-22.23
	2462	7.230	-22.77
802.11g	2412	1.220	-28.78
	2417	4.330	-25.67
	2422	5.840	-19.78
	2437	4.890	-20.22
	2442	5.700	-19.83
	2452	4.930	-25.07
	2457	2.120	-27.88
	2462	0.360	-29.64

802.11n HT20	2412	-0.270	-30.27
	2417	3.440	-26.56
	2422	4.210	-25.79
	2437	4.740	-25.26
	2452	1.960	-28.04
	2457	2.670	-27.33
	2462	-1.020	-31.02
802.11n HT40	2422	-4.010	-34.01
	2427	-2.320	-32.32
	2432	-2.950	-32.95
	2437	-0.290	-30.29
	2442	-2.790	-32.79
	2447	-5.300	-35.30
	2452	-5.590	-35.59
Bluetooth (Low Energy) (1M)	2402	8.100	-21.90
	2440	8.050	-21.95
	2480	7.580	-22.42
Bluetooth (Low Energy) (2M)	2402	7.850	-22.15
	2440	8.930	-21.07
	2480	8.220	-21.78

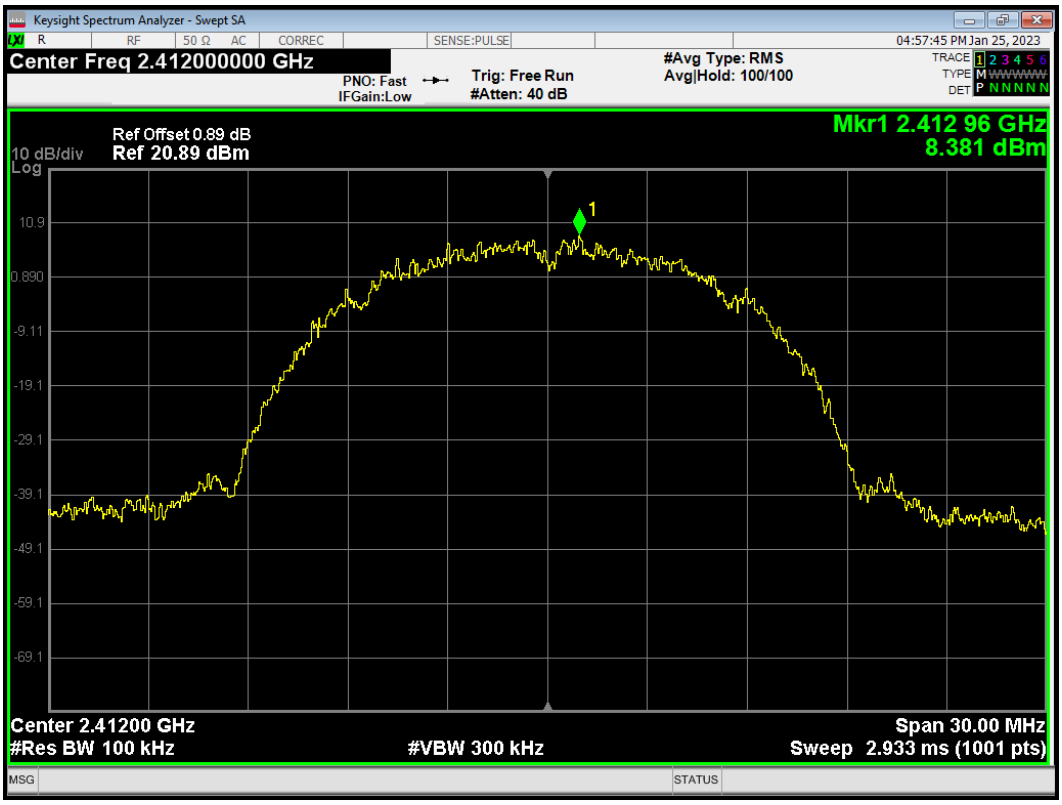
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 1.96.

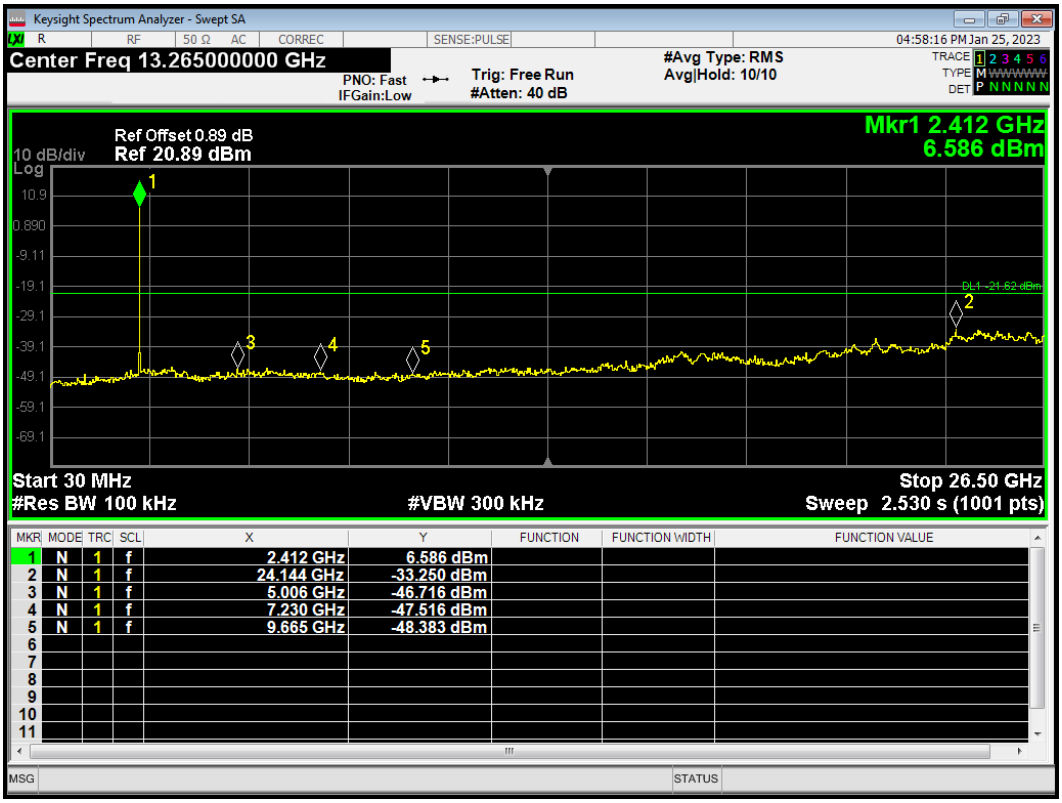
Frequency	Uncertainty
100kHz-2GHz	0.684 dB
2GHz-26GHz	1.407 dB

Test Results:

Tx. Spurious 802.11b 2412MHz Ref



Tx. Spurious 802.11b 2412MHz Emission



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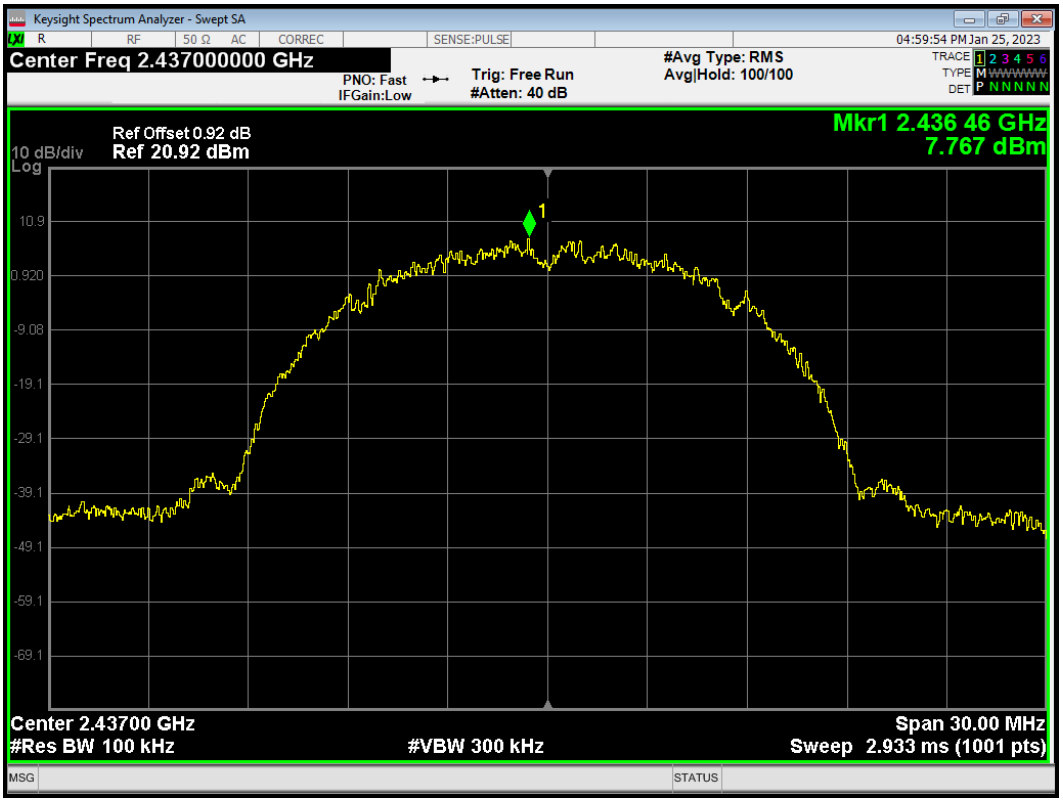

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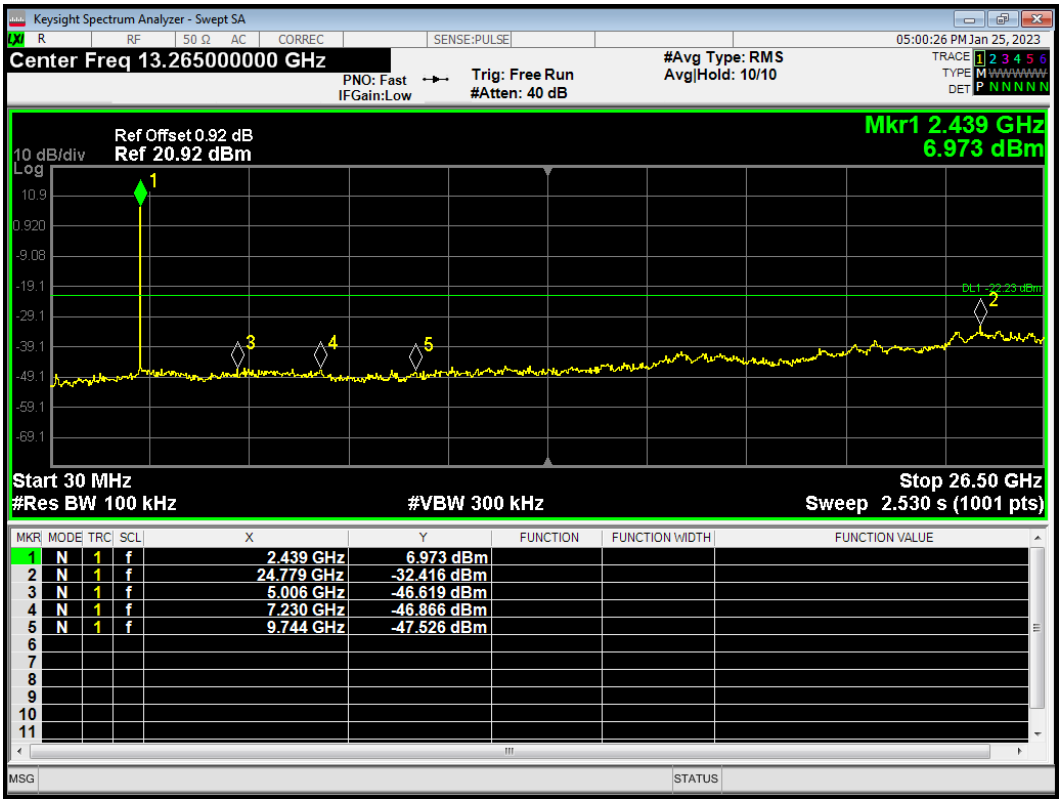

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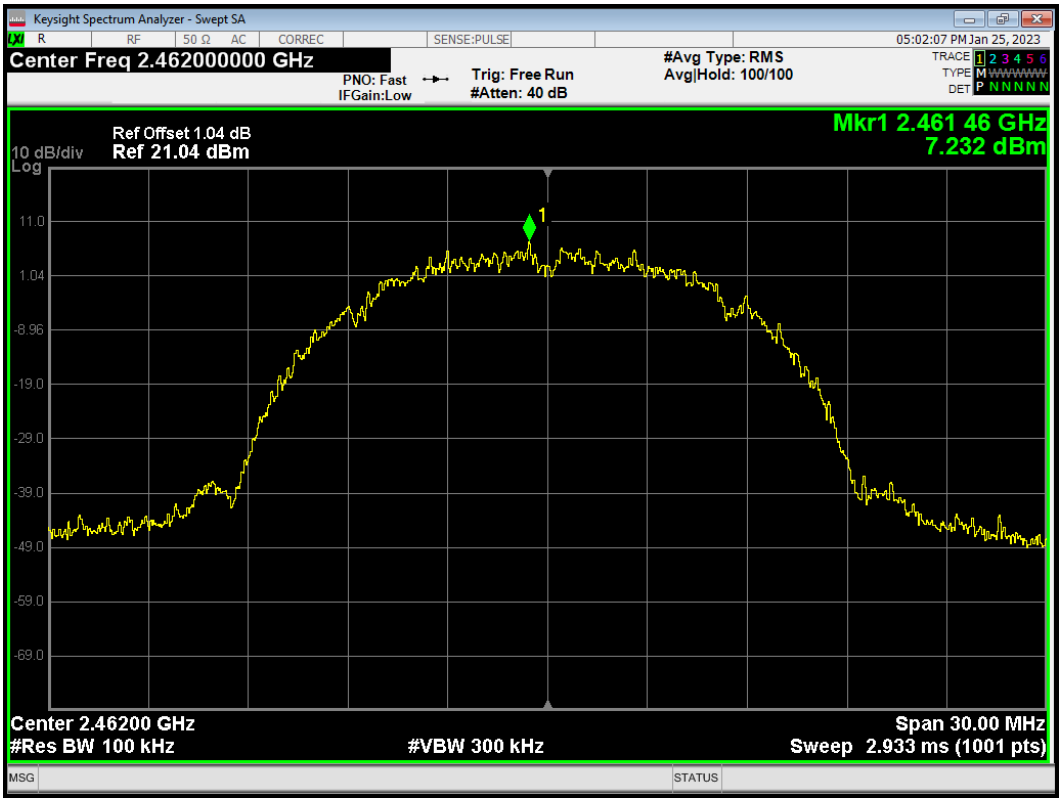

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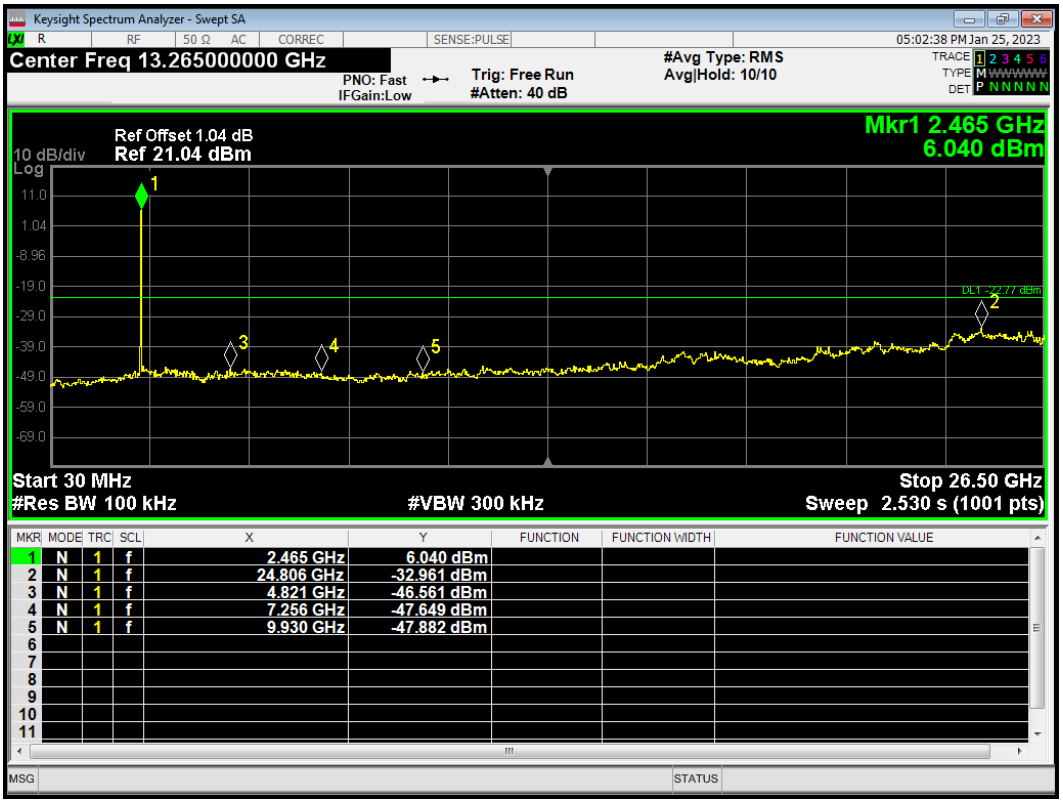
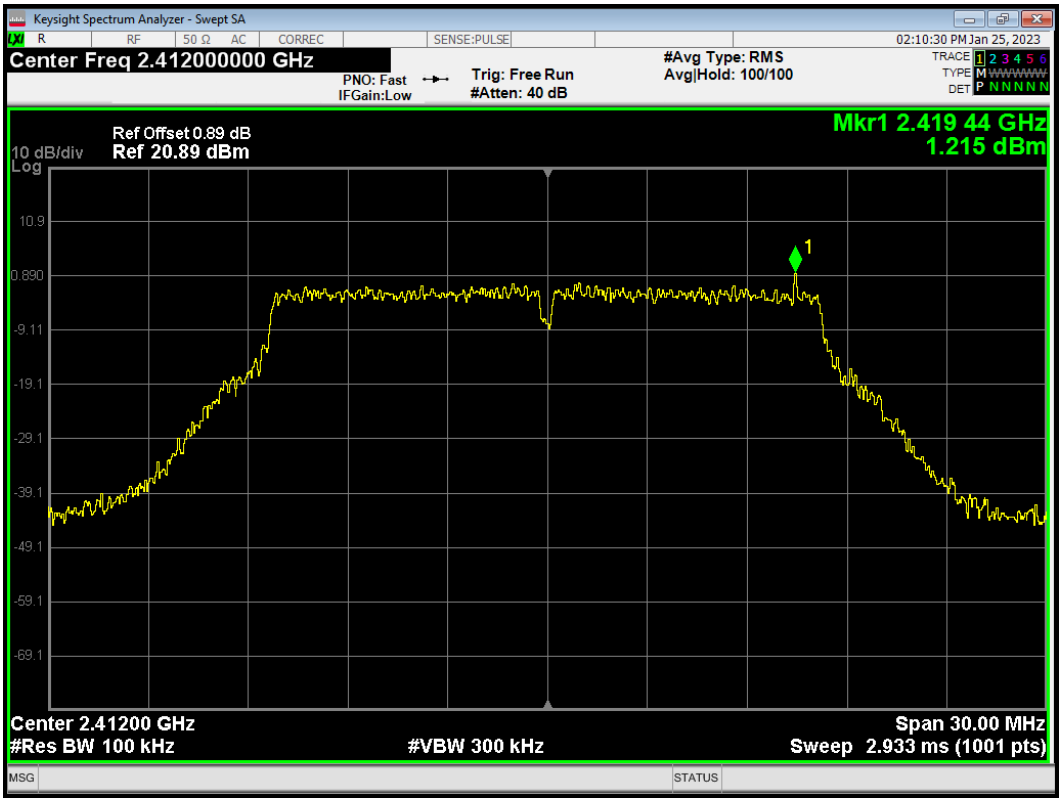
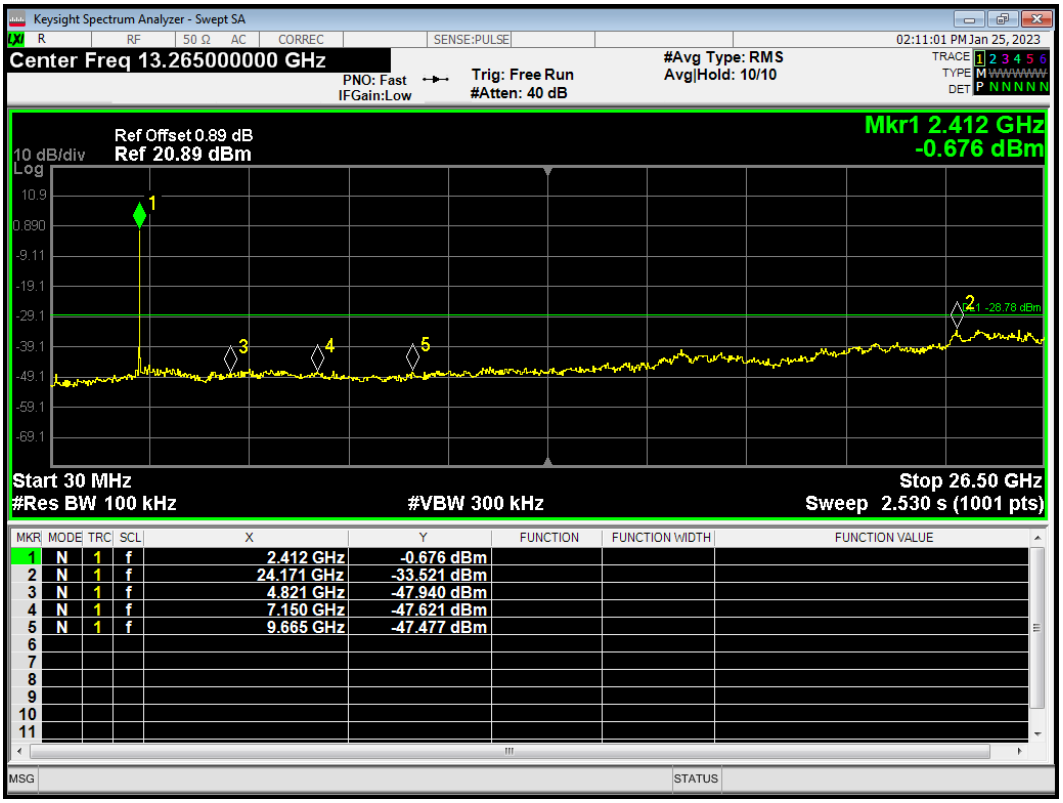


Tx. Spurious 802.11g 2412MHz Ref

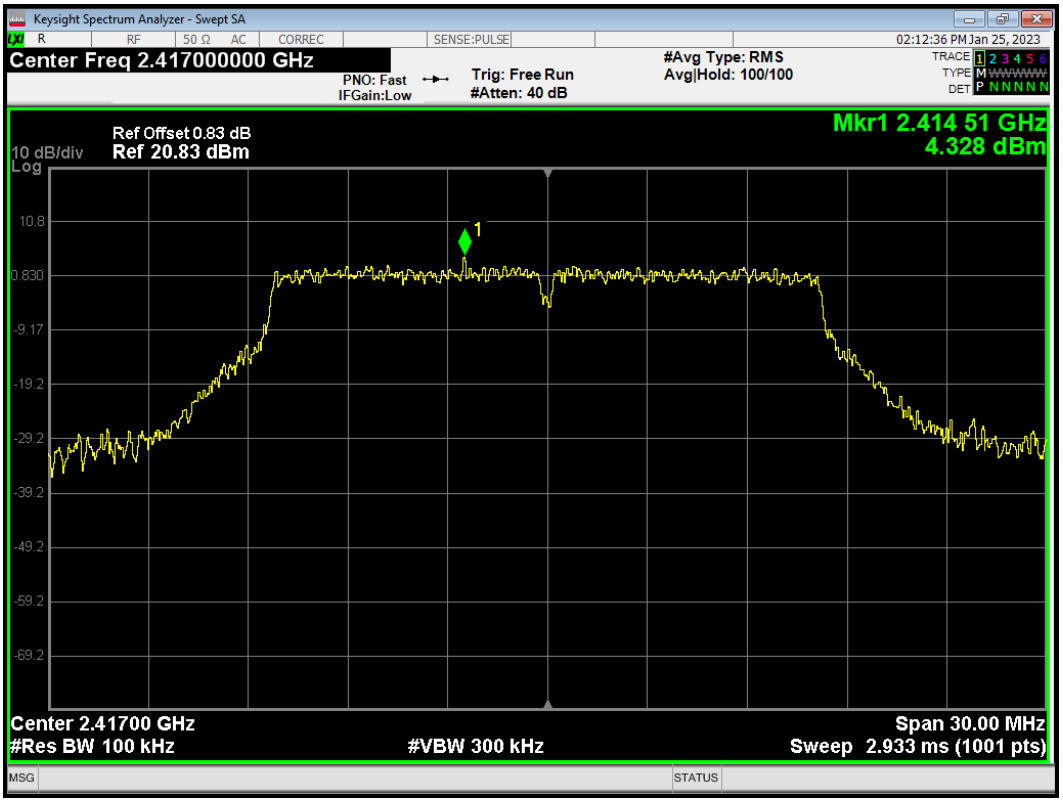


Tx. Spurious 802.11g 2412MHz Emission

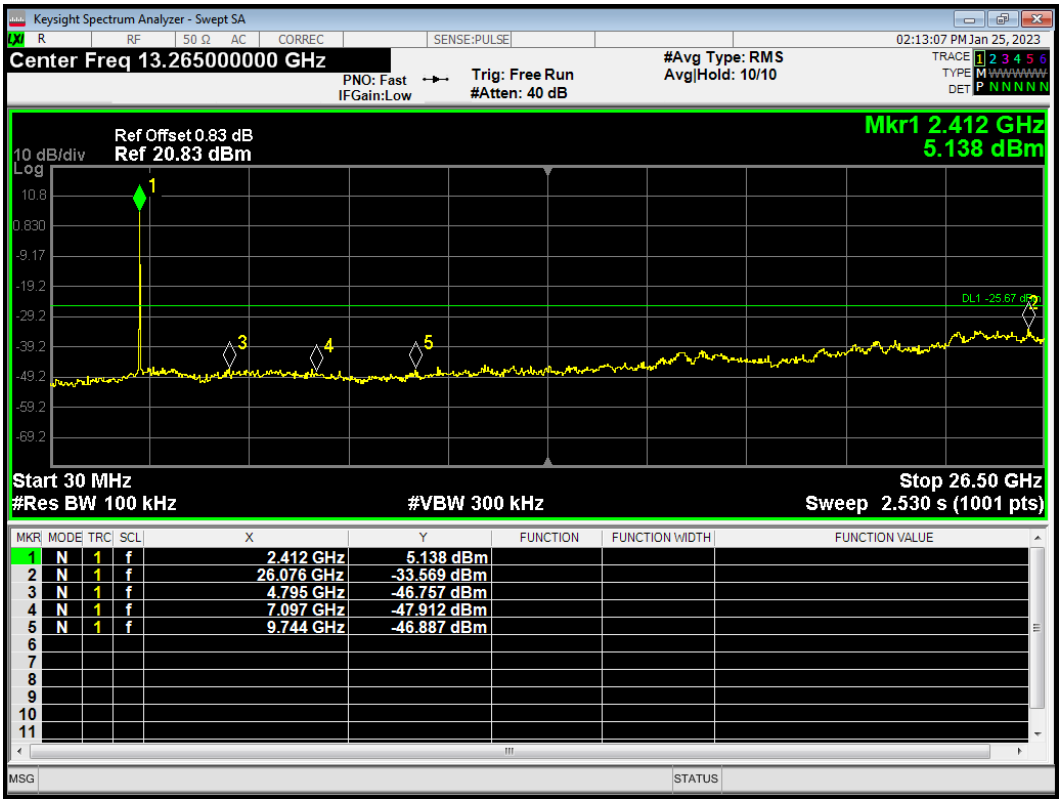


MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.412 GHz	-0.676 dBm			
2	N	1	f	24.171 GHz	-33.521 dBm			
3	N	1	f	4.821 GHz	-47.940 dBm			
4	N	1	f	7.150 GHz	-47.621 dBm			
5	N	1	f	9.665 GHz	-47.477 dBm			
6								
7								
8								
9								
10								
11								

Tx. Spurious 802.11g 2417MHz Ref

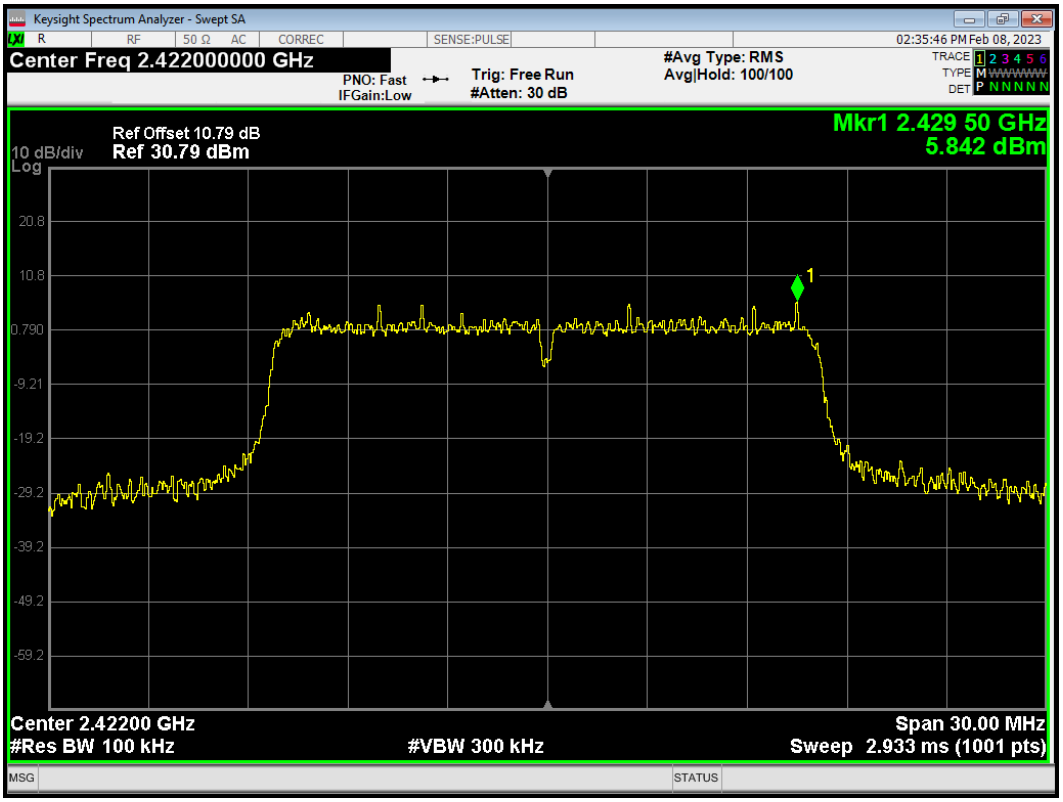


Tx. Spurious 802.11g 2417MHz Emission



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.412 GHz	5.138 dBm			
2	N	1	f	26.076 GHz	-33.569 dBm			
3	N	1	f	4.795 GHz	-46.757 dBm			
4	N	1	f	7.097 GHz	-47.912 dBm			
5	N	1	f	9.744 GHz	-46.887 dBm			

Tx. Spurious 802.11g 2422MHz Ref



Tx. Spurious 802.11g 2422MHz Emission