

RF TEST REPORT

Applicant Roobuck Pty Ltd

FCC ID 2BDKT4EWB

Product WiFi/BLE Cordless Cap lamp;
Intrinsically Safe WiFi/BLE Cordless Cap lamp

Brand Roobuck

Model RN4E-WB; KC4E-WB-Ex; KH4E-WB-Ex

Report No. R2309A1021-R1

Issue Date January 9, 2024

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.

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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 6.9	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	NA
Date of Testing: October 11, 2023 ~ November 28, 2023			
Date of Sample Received: September 22, 2023			
Note: NA = Not Applicable. 1. 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
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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	Roobuck Pty Ltd
Applicant address	6/20 West Street, Brookvale, NSW, Australia, 2100
Manufacturer	Roobuck Pty Ltd
Manufacturer address	6/20 West Street, Brookvale, NSW, Australia, 2100

2.2. General Information

EUT Description	
Model	RN4E-WB; KC4E-WB-Ex; KH4E-WB-Ex
Lab internal SN	R2309A1021/S01
Hardware Version	V1.1
Software Version	V1.1
Power Supply	Battery / AC adapter
Antenna Type	PCB Antenna
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)
Antenna Gain	2.0 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 V4.2: 2402 ~ 2480 MHz
Modulation Type	802.11b: DSSS 802.11g/n: OFDM Bluetooth LE: GFSK
Max. Output Power	Wi-Fi 2.4G: 12.98 dBm Bluetooth LE: 4.66 dBm
EUT Accessory	
Battery	Manufacturer: Panasonic Model: NCR18500A
Auxiliary test equipment	
Adapter 1	Manufacturer: Kinyun Sci. & Tech. Development Co., Ltd. Model: MCE
Adapter 2	Manufacturer: Kinyun Sci. & Tech. Development Co., Ltd. Model: MCE-US
PC	Manufacturer: DELL Model: Latitude 3301
Note:	
1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.	
2. The customer claims that RN4E-WB, KC4E-WB-Ex and KH4E-WB-Ex are only different in model, and the others are the same. This report only records RN4E-WB test data.	

Product	WiFi/BLE Cordless Cap lamp	Intrinsically Safe WiFi/BLE Cordless Cap lamp	Intrinsically Safe WiFi/BLE Cordless Cap lamp
Model	RN4E-WB	KC4E-WB-Ex	KH4E-WB-Ex
Note: These differences are only because they are for different markets.			

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
802.11b	1 Mbps
802.11g	6 Mbps
802.11n HT20	MCS0
802.11n HT40	MCS0
Bluetooth(Low Energy)	1Mbps

5. Test Case Results

5.1. Maximum output power

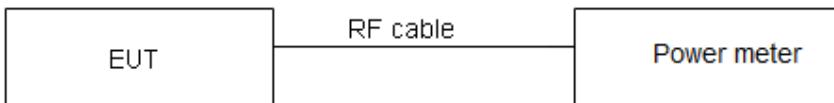
Ambient Condition

Temperature	Relative humidity
15°C ~ 35°C	20% ~ 80%

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	$\leq 1\text{W}$ (30dBm)
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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					
Channel	802.11b	802.11g	802.11n HT20	Channel	802.11n HT40
CH1	4	0	0	CH3	0
CH6	4	0	0	CH6	0
CH11	4	0	0	CH9	0

Power Index	
Channel	Bluetooth (Low Energy)
CH0	8
CH19	8
CH39	8

Test Mode	Duty cycle	Duty cycle correction Factor (dB)
802.11b	1.000	0.000
802.11g	1.000	0.000
802.11n HT20	1.000	0.000
802.11n HT40	1.000	0.000
Bluetooth LE	0.837	0.770

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	12.77	12.77	30	PASS
	2437/CH 6	12.81	12.81	30	PASS
	2462/CH11	12.98	12.98	30	PASS
802.11g	2412/CH 1	12.18	12.18	30	PASS
	2437/CH 6	12.19	12.19	30	PASS
	2462/CH11	12.65	12.65	30	PASS
802.11n HT20	2412/CH 1	12.27	12.27	30	PASS
	2437/CH 6	11.99	11.99	30	PASS
	2462/CH11	12.45	12.45	30	PASS
802.11n HT40	2422/CH3	11.64	11.64	30	PASS
	2437/CH6	11.84	11.84	30	PASS
	2452/CH9	11.95	11.95	30	PASS
Bluetooth (Low Energy)	2402/CH0	2.45	3.22	30	PASS
	2440/CH19	3.15	3.92	30	PASS
	2480/CH39	3.89	4.66	30	PASS

Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor

5.2. 99% Bandwidth and 6dB Bandwidth

Ambient Condition

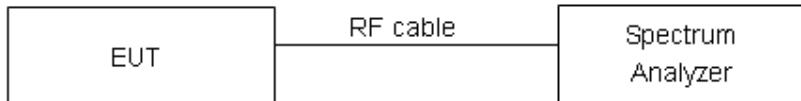
Temperature	Relative humidity
15°C ~ 35°C	20% ~ 80%

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
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Measurement Uncertainty

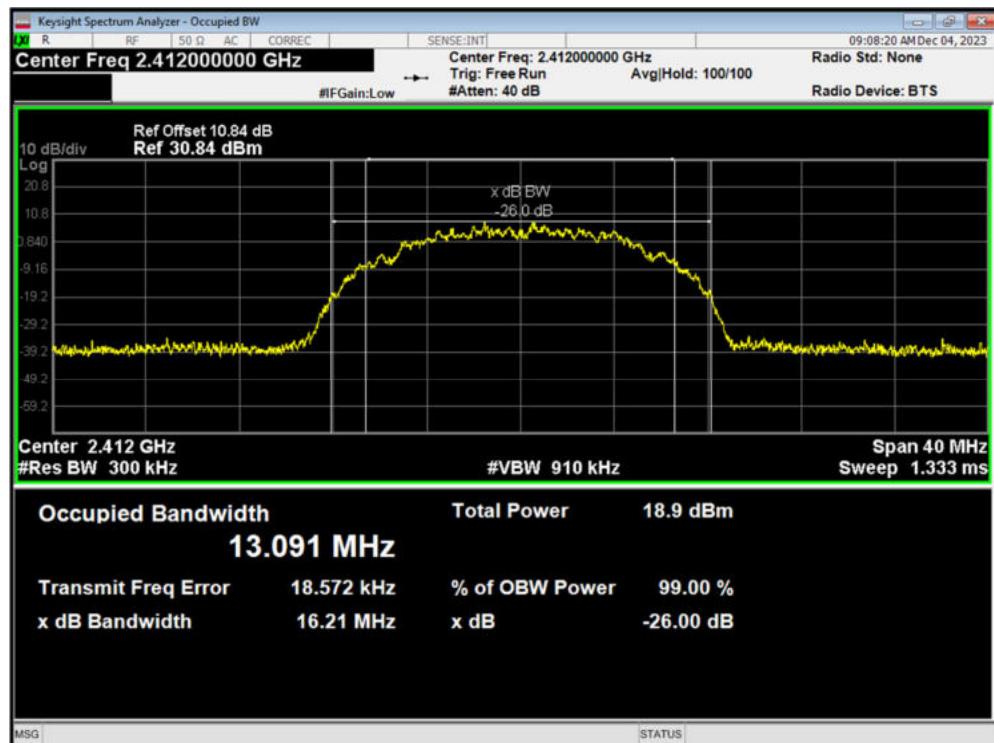
The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U = 936$ Hz.

Test Results:

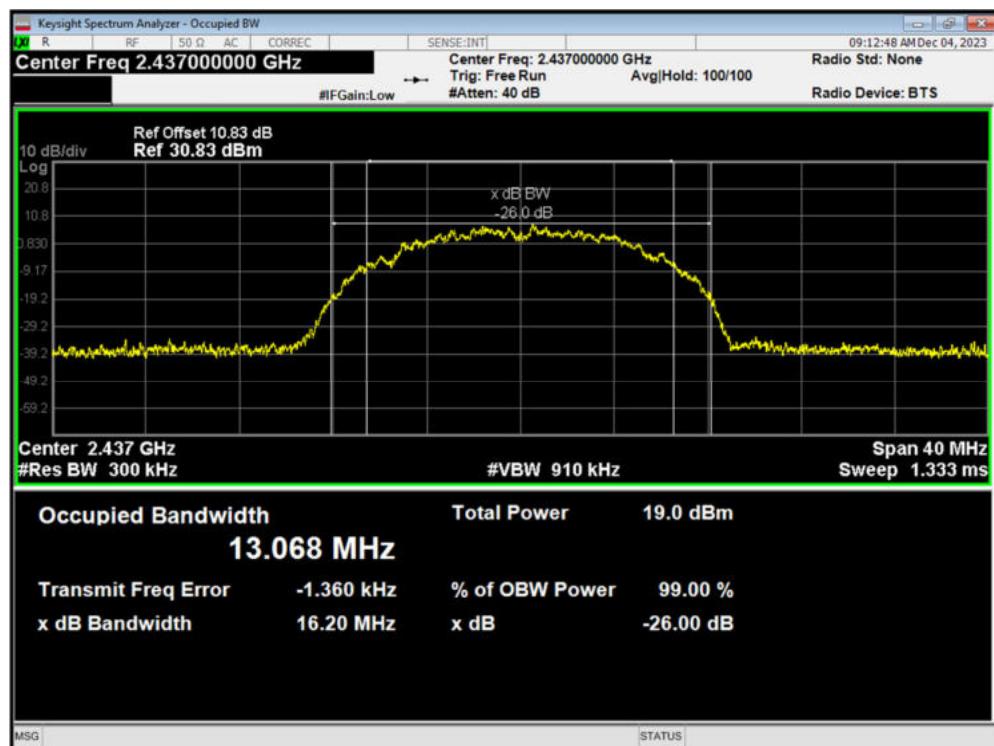
Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11b	2412	13.091	9.086	500	PASS
	2437	13.068	9.342	500	PASS
	2462	13.160	10.009	500	PASS
802.11g	2412	16.568	16.413	500	PASS
	2437	16.577	16.412	500	PASS
	2462	16.578	16.430	500	PASS
802.11n HT20	2412	17.409	17.353	500	PASS
	2437	17.411	17.311	500	PASS
	2462	17.426	17.333	500	PASS
802.11n HT40	2422	34.762	33.171	500	PASS
	2437	34.843	33.701	500	PASS
	2452	34.817	33.692	500	PASS
Bluetooth (Low Energy)	2402	1.017	0.638	500	PASS
	2440	1.013	0.655	500	PASS
	2480	1.018	0.642	500	PASS

99%bandwidth

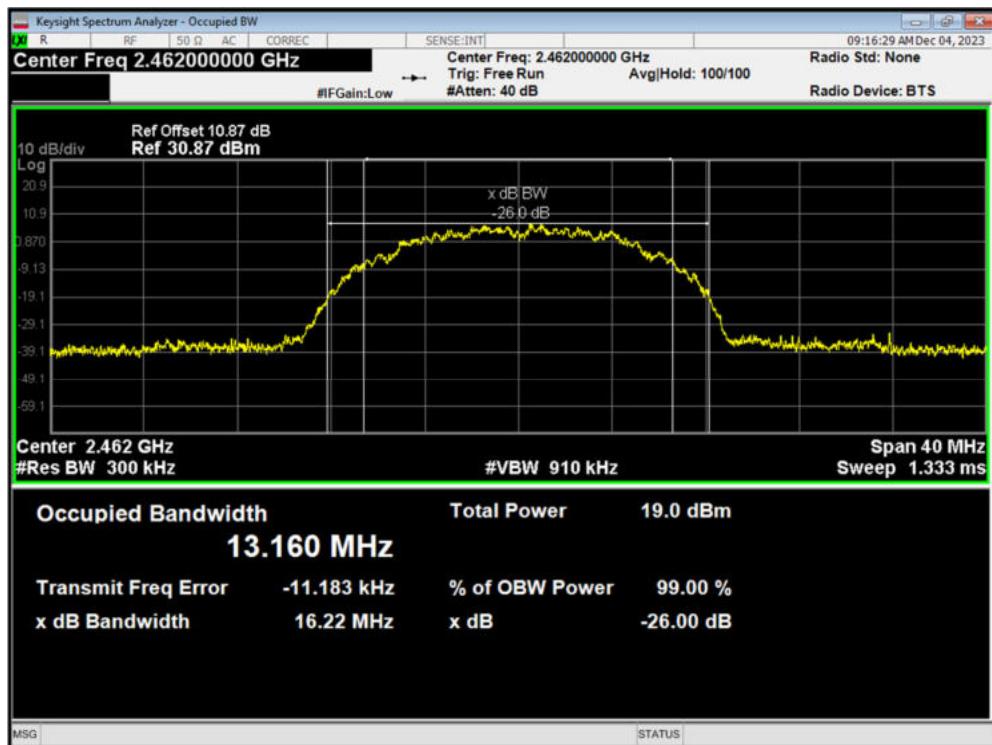
OBW 802.11b 2412MHz



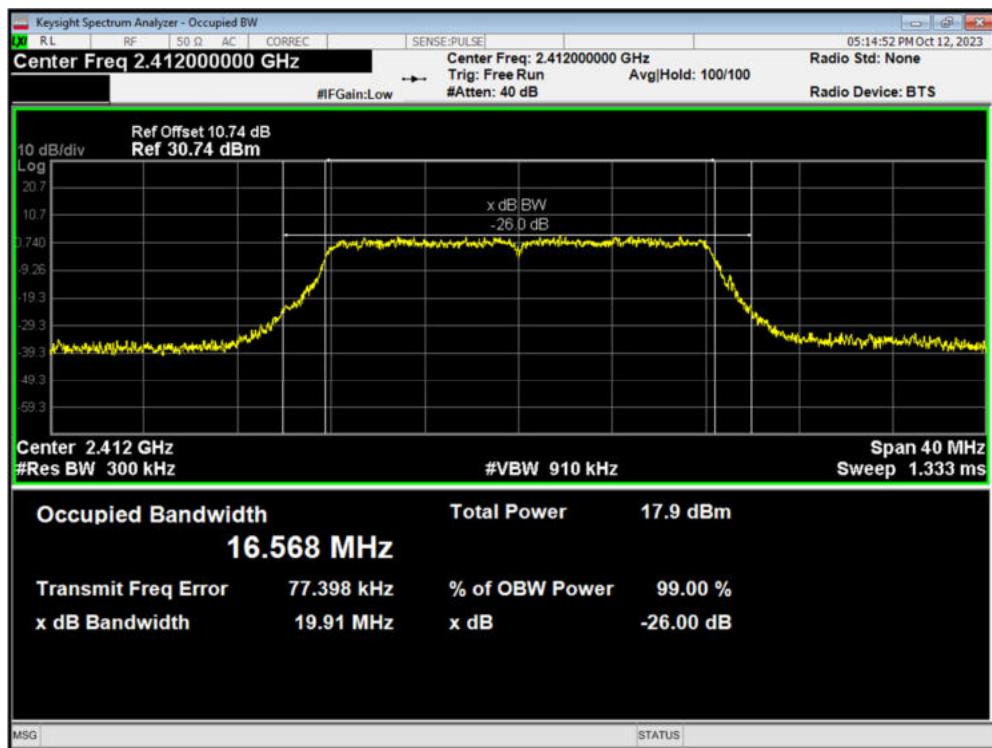
OBW 802.11b 2437MHz



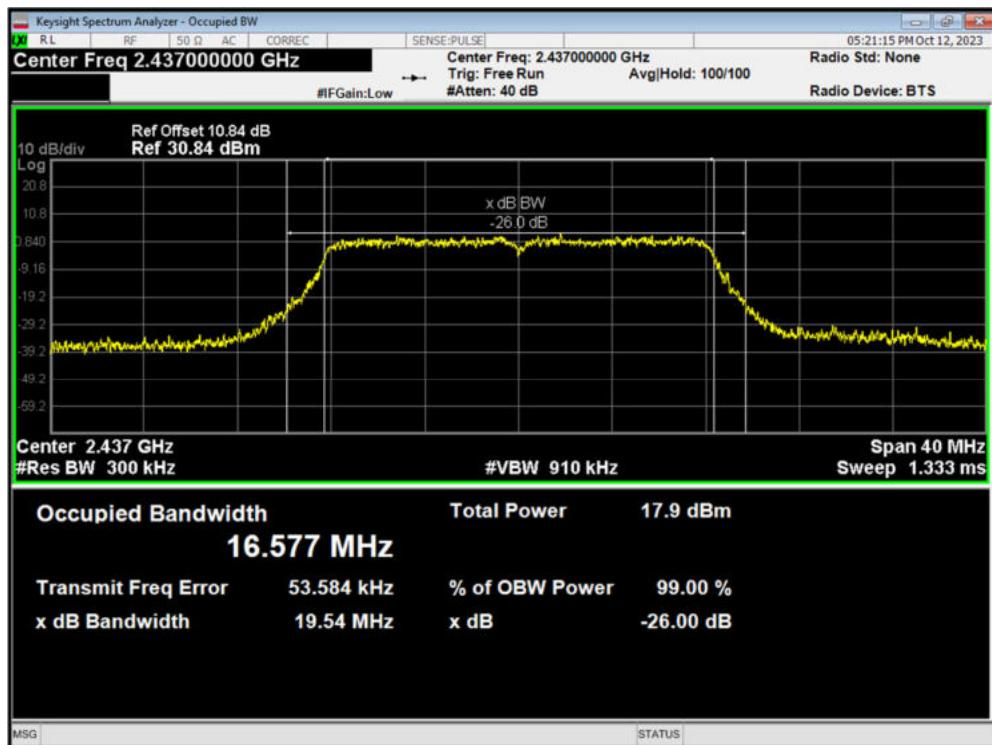
OBW 802.11b 2462MHz



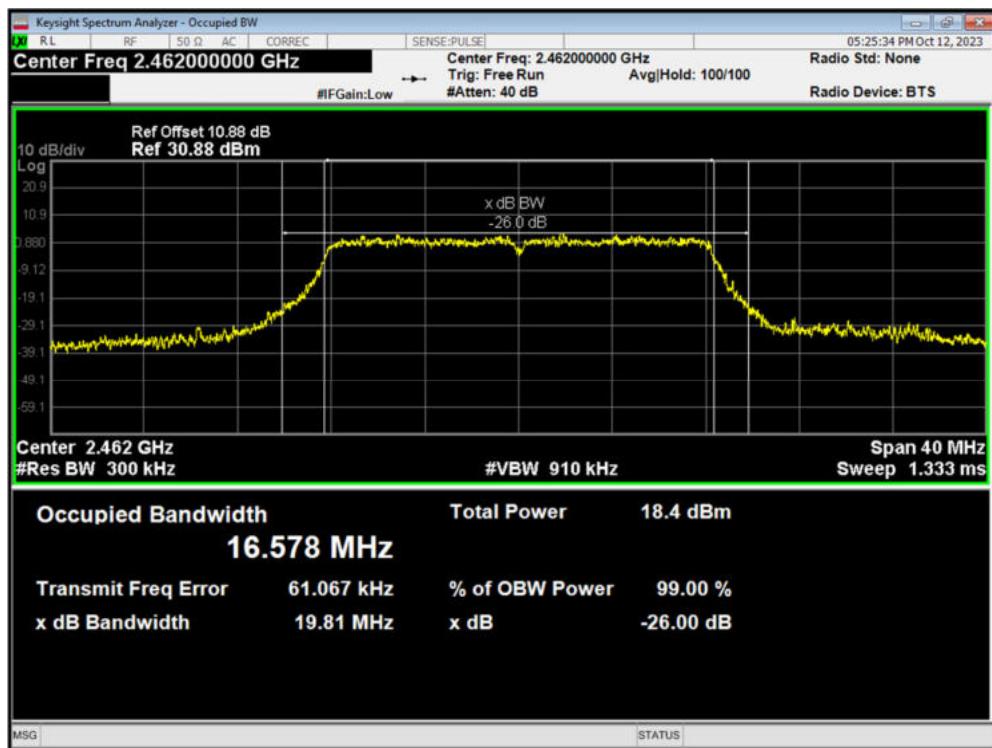
OBW 802.11g 2412MHz



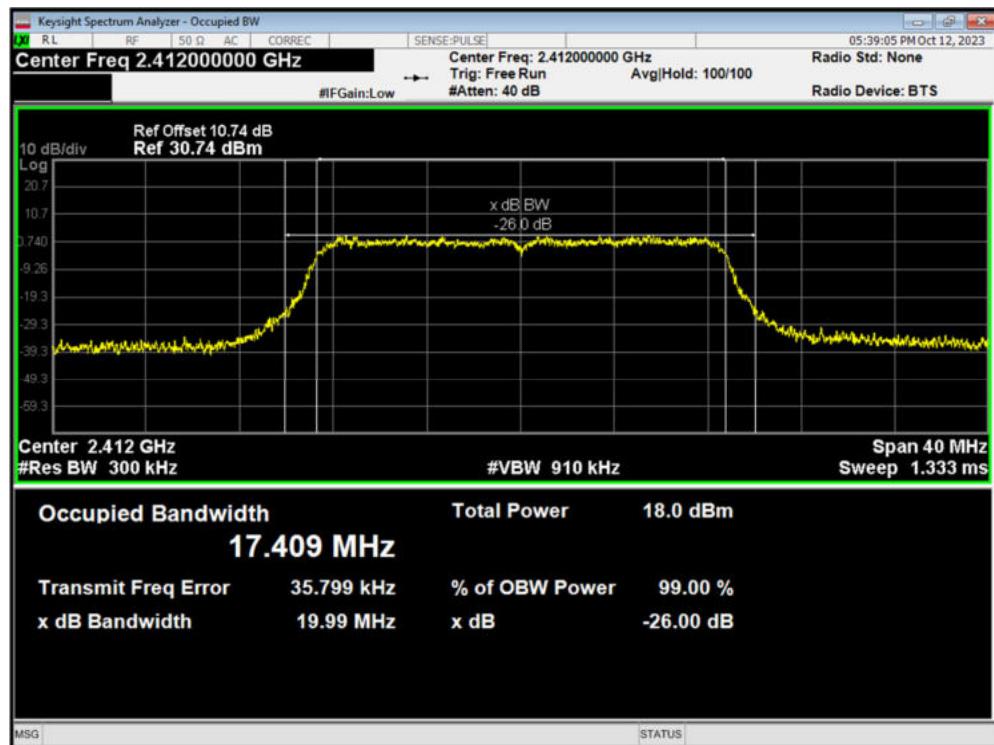
OBW 802.11g 2437MHz



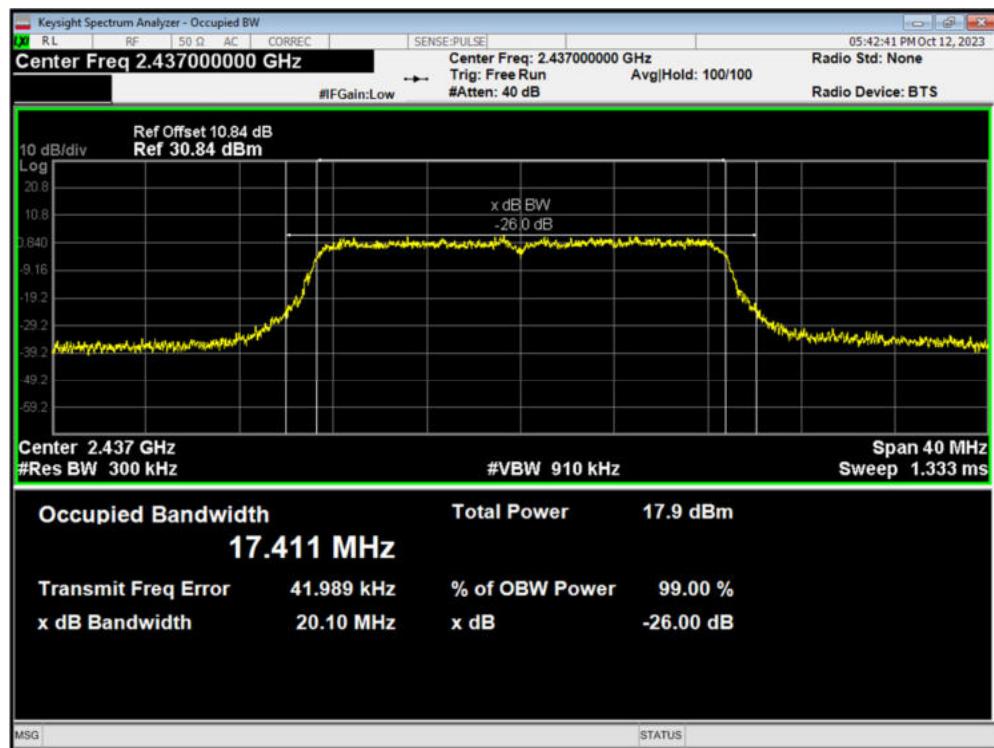
OBW 802.11g 2462MHz



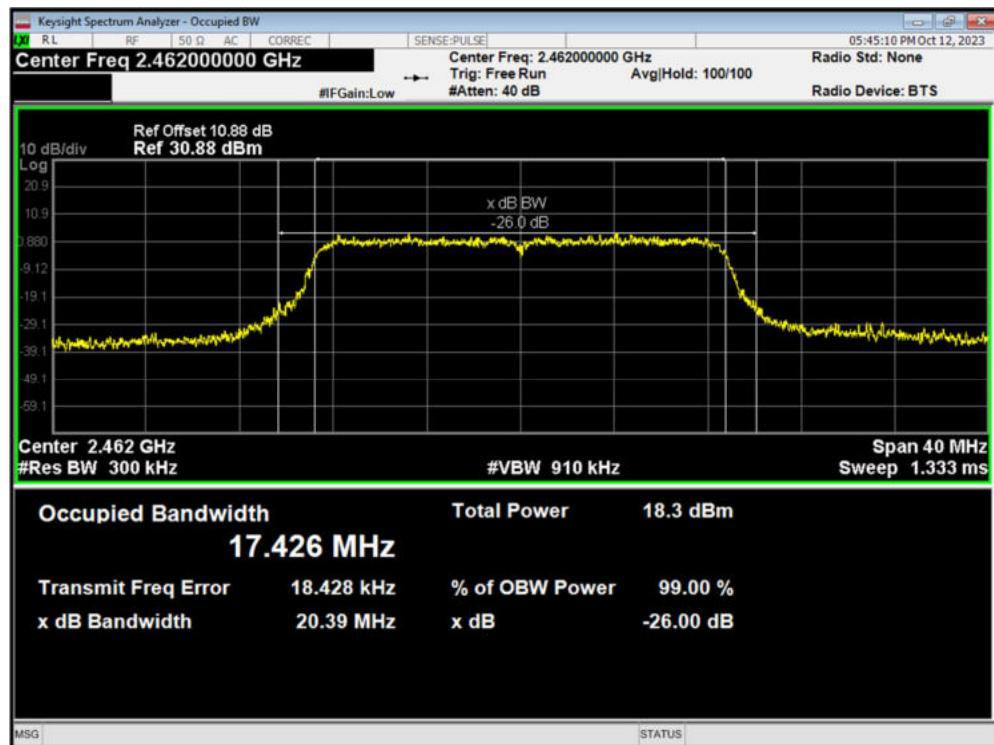
OBW 802.11n(HT20) 2412MHz



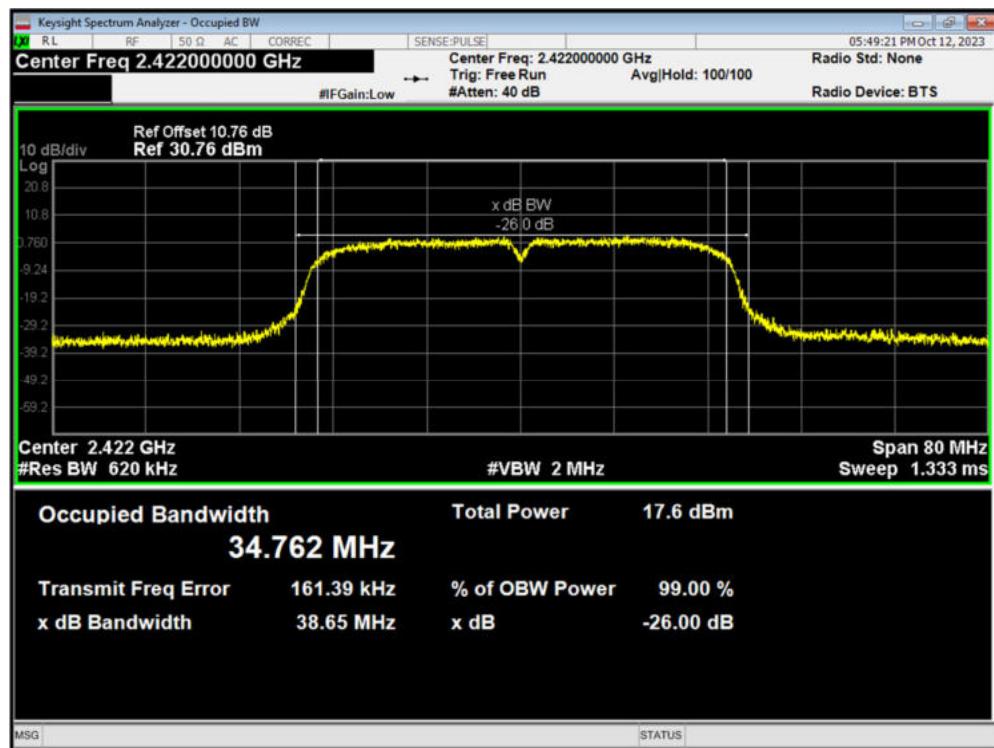
OBW 802.11n(HT20) 2437MHz



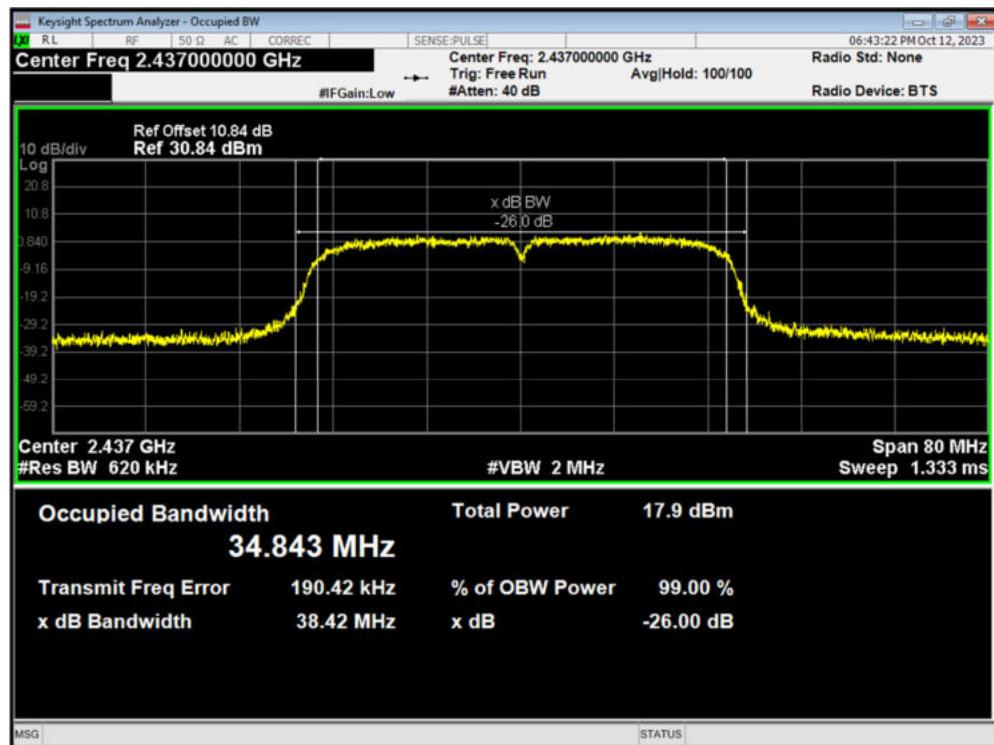
OBW 802.11n(HT20) 2462MHz



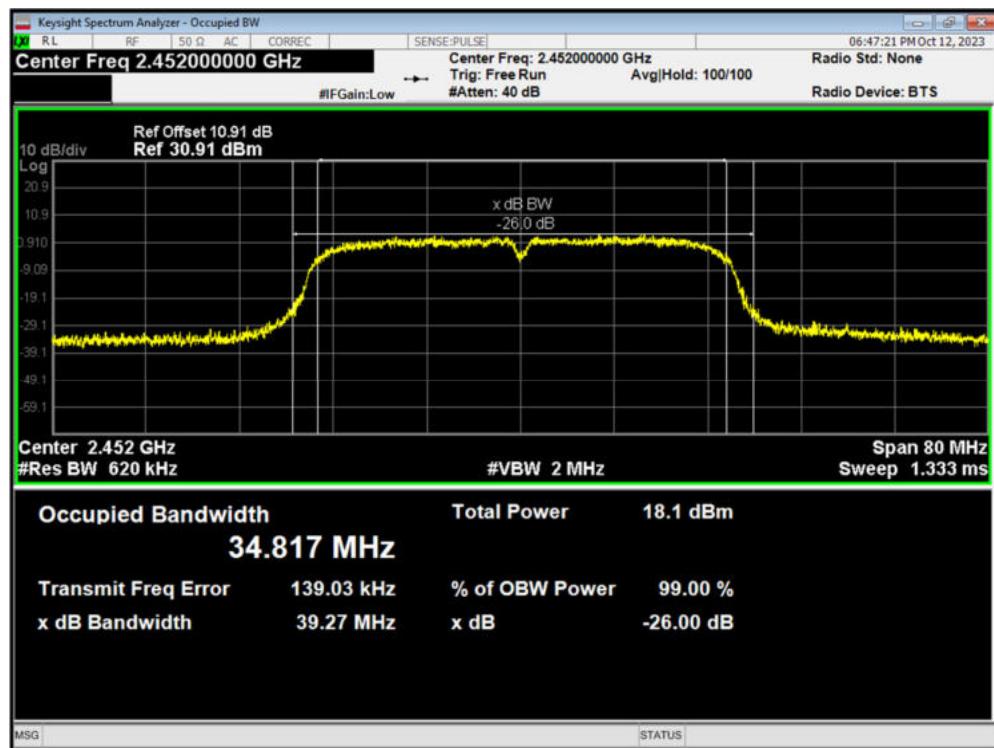
OBW 802.11n(HT40) 2422MHz



OBW 802.11n(HT40) 2437MHz



OBW 802.11n(HT40) 2452MHz



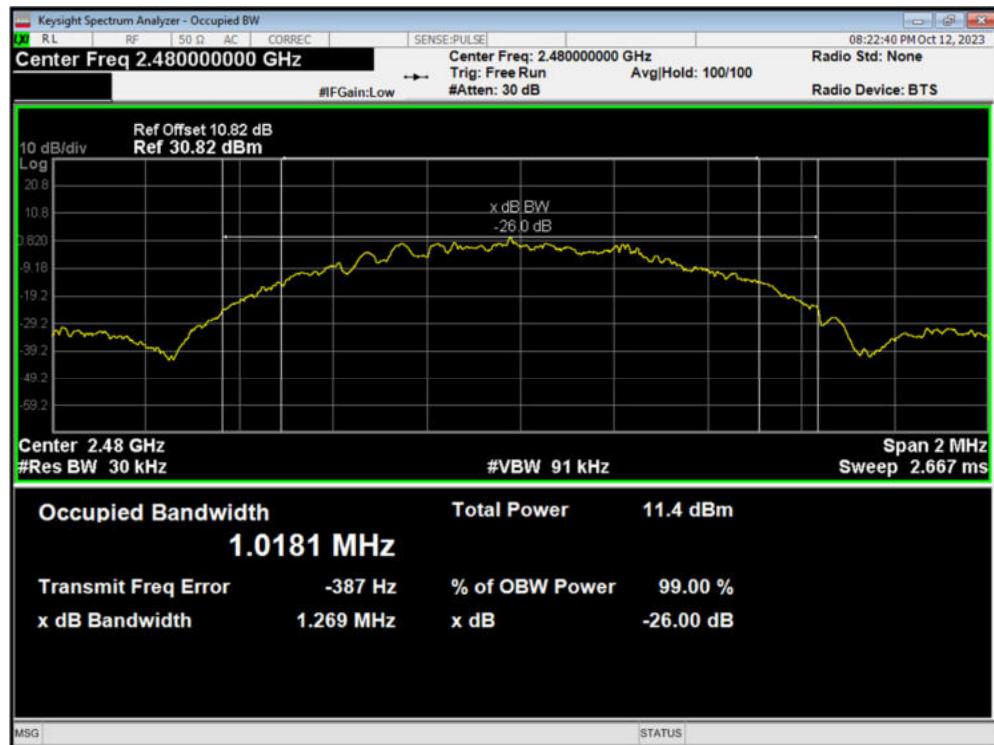
OBW Bluetooth LE 2402MHz



OBW Bluetooth LE 2440MHz

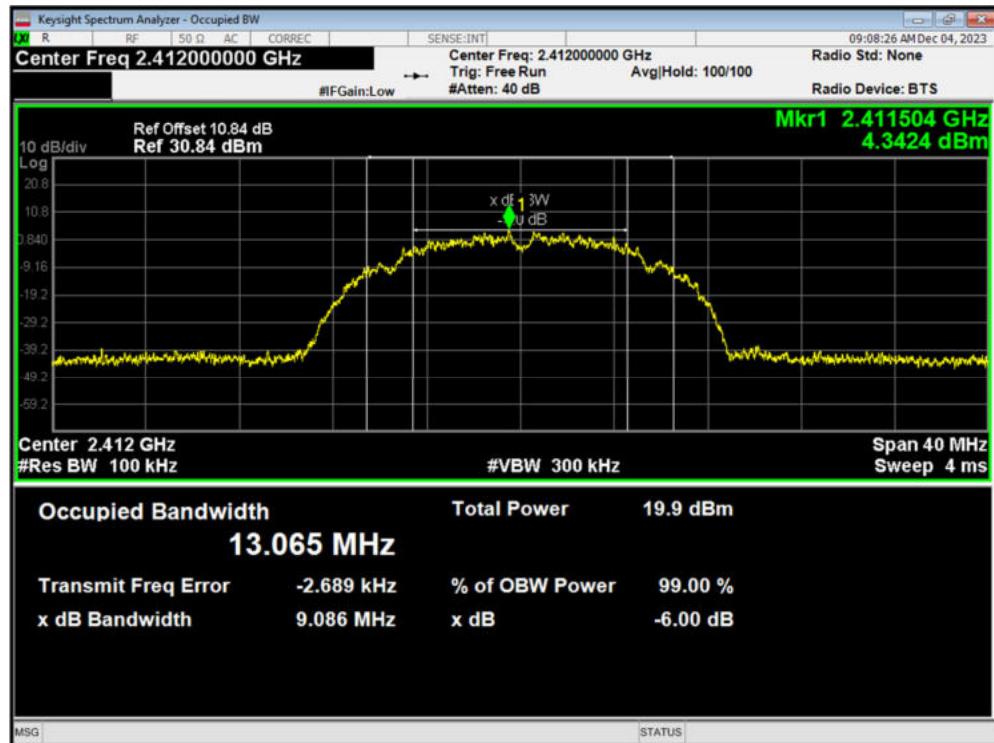


OBW Bluetooth LE 2480MHz

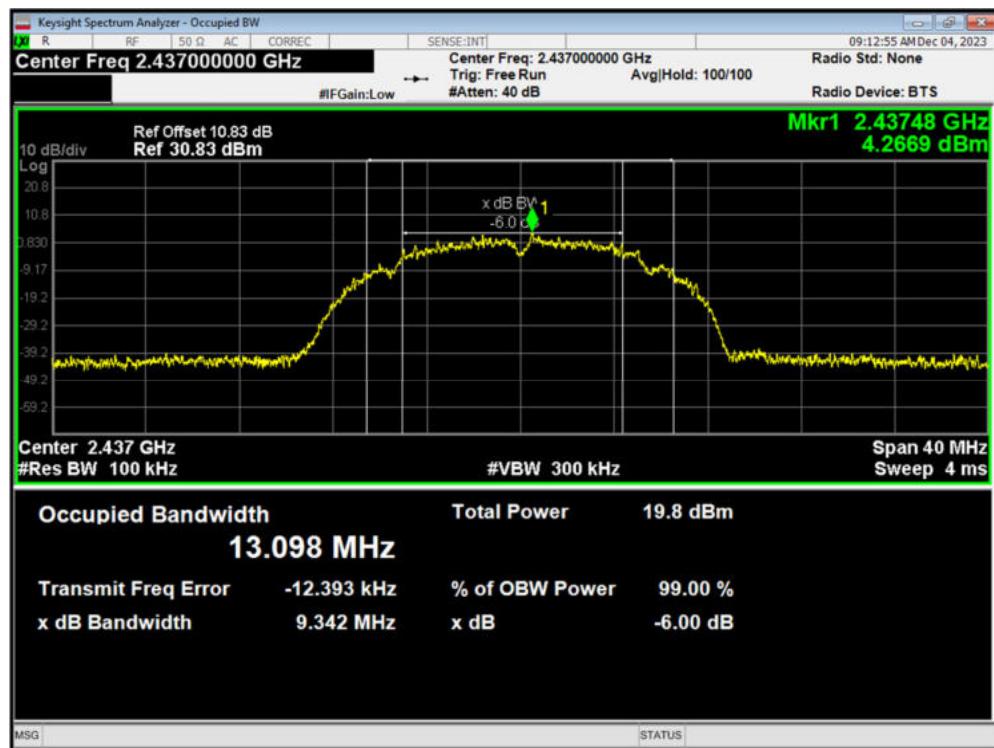


6 dB bandwidth

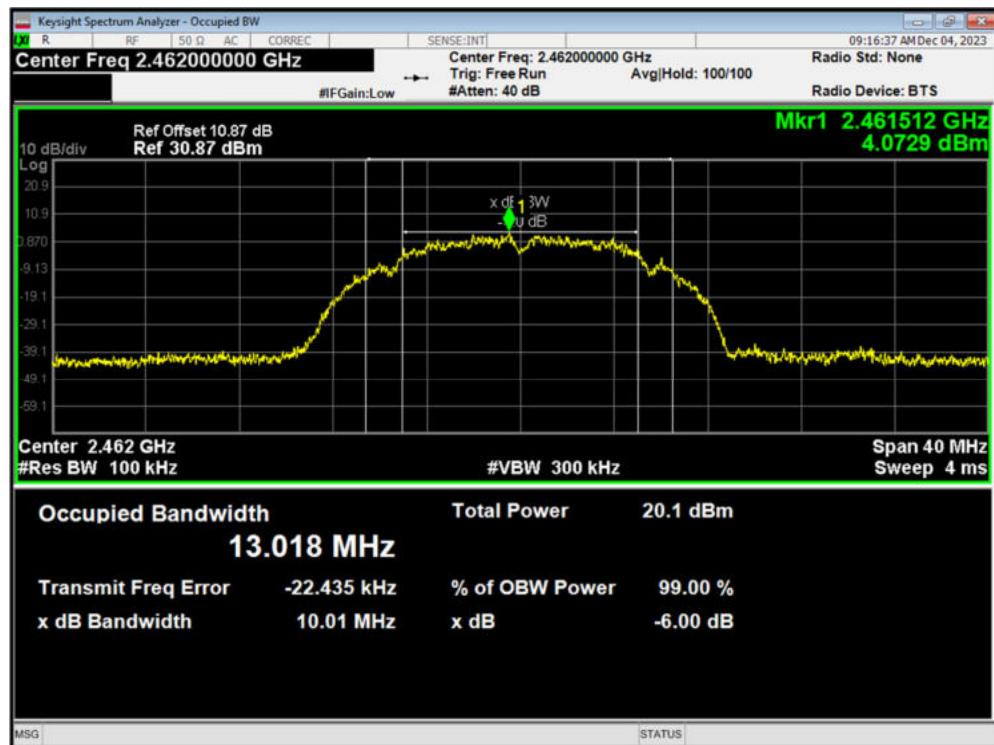
-6dB Bandwidth 802.11b 2412MHz



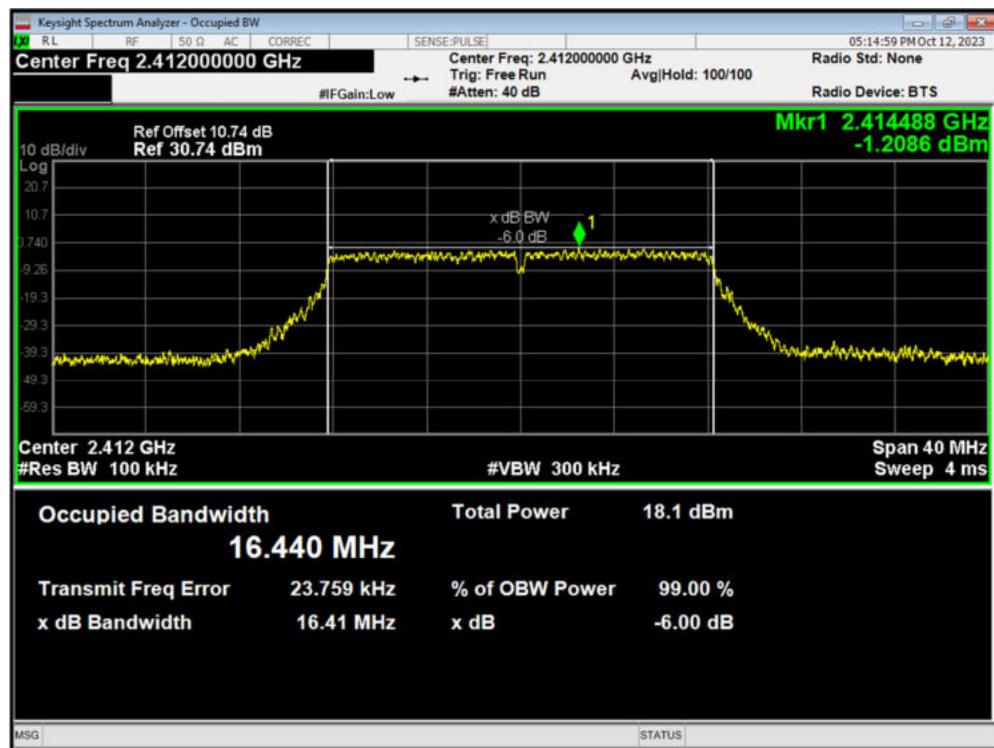
-6dB Bandwidth 802.11b 2437MHz



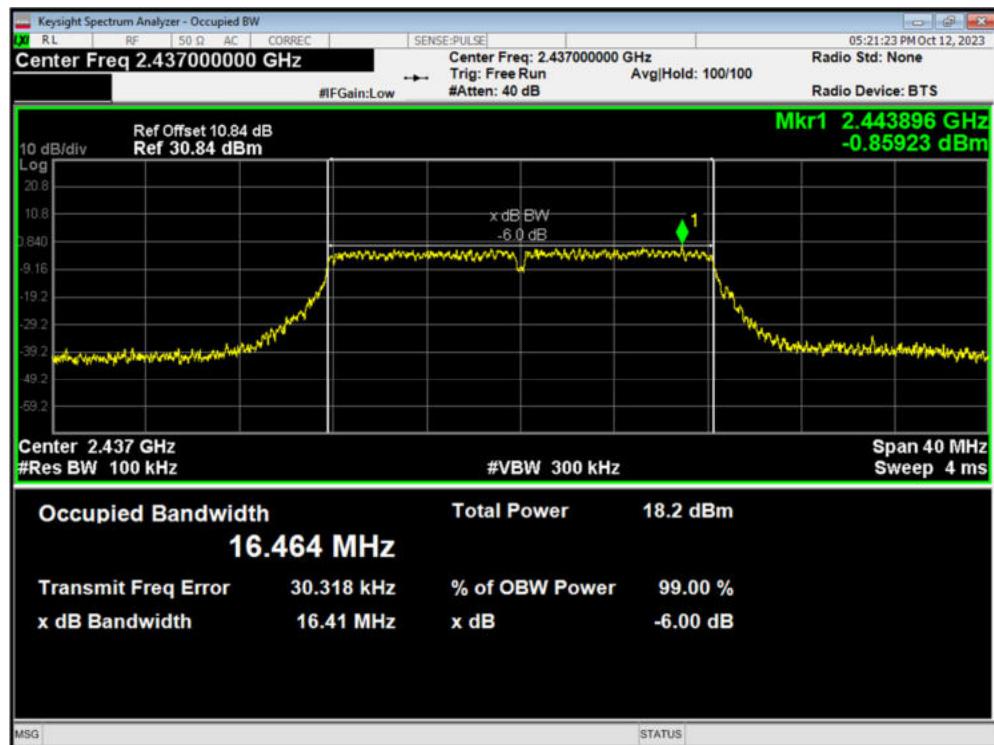
-6dB Bandwidth 802.11b 2462MHz



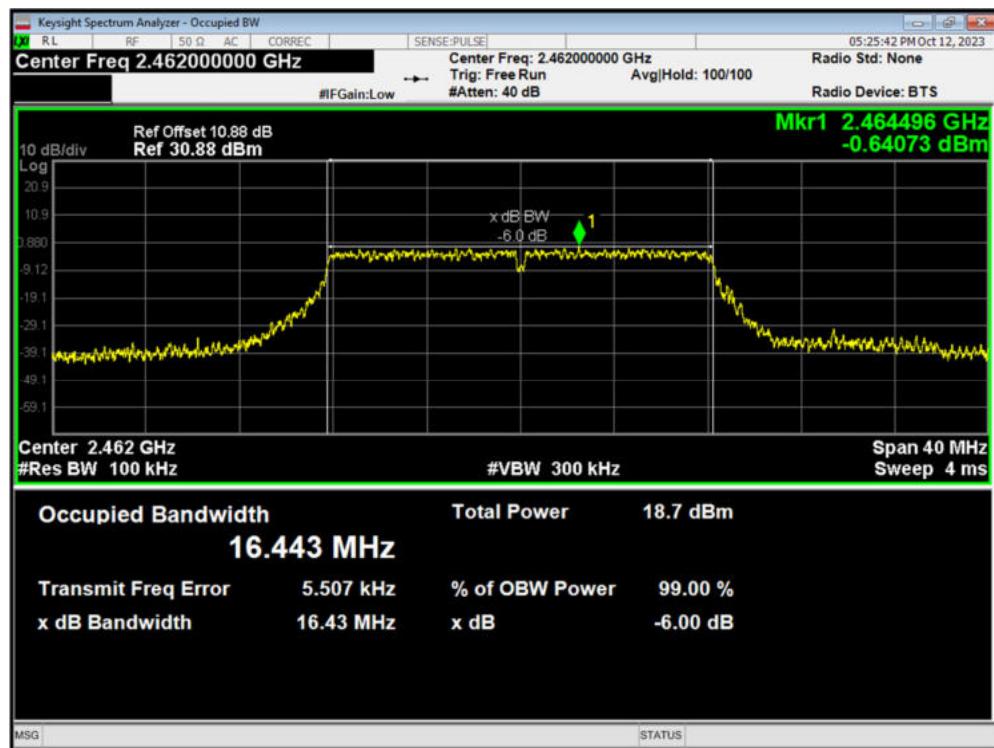
-6dB Bandwidth 802.11g 2412MHz



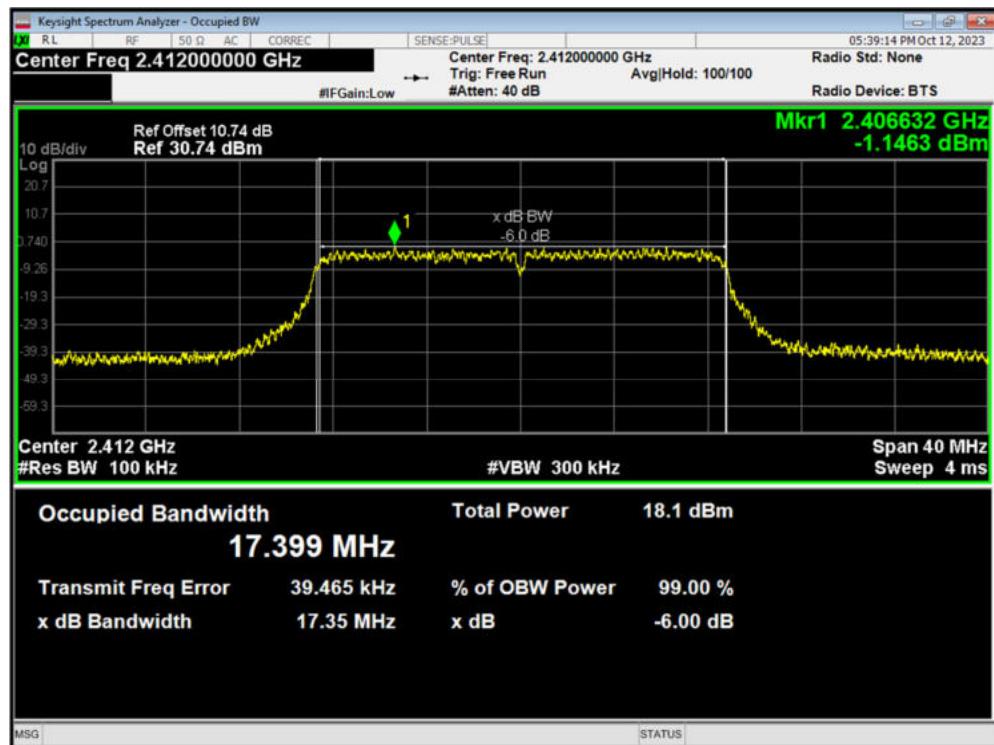
-6dB Bandwidth 802.11g 2437MHz



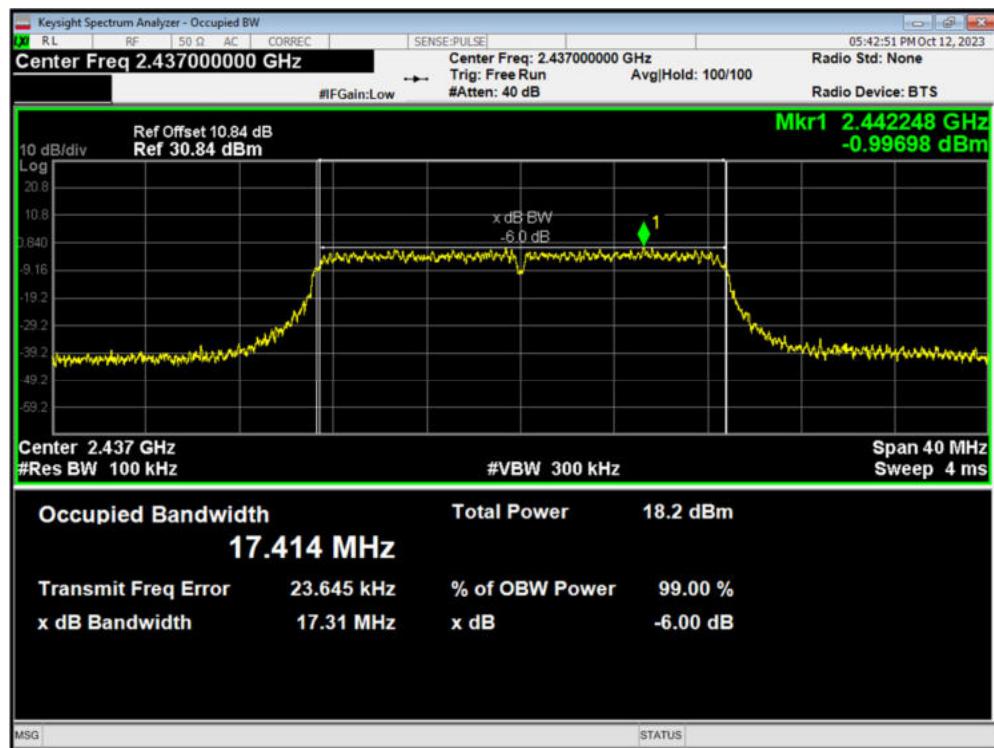
-6dB Bandwidth 802.11g 2462MHz



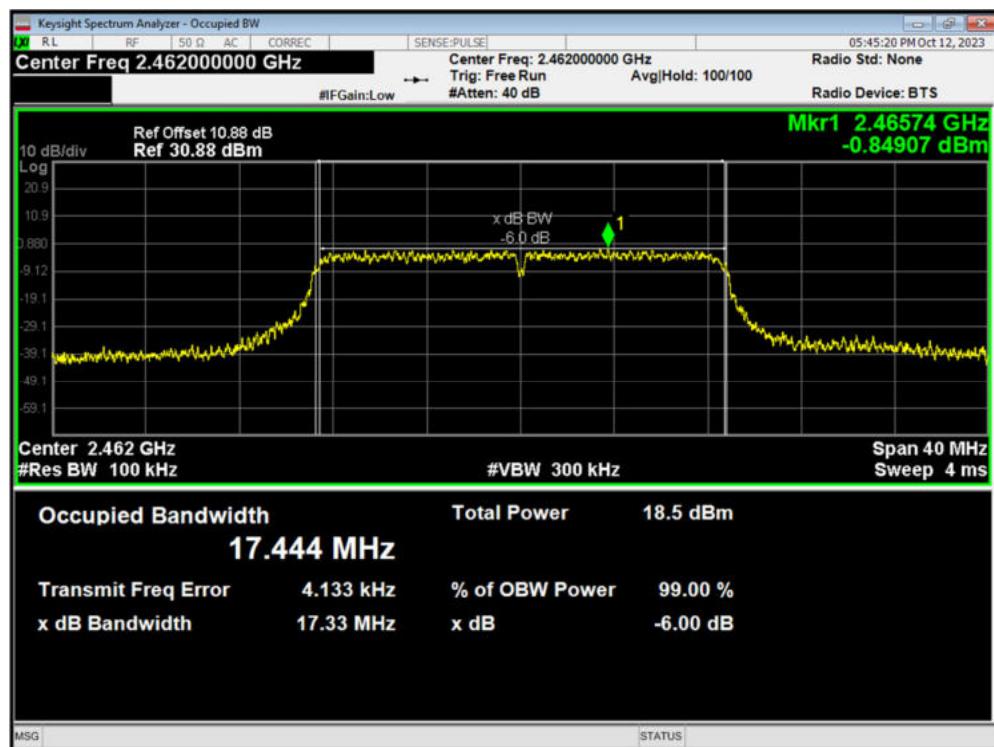
-6dB Bandwidth 802.11n(HT20) 2412MHz



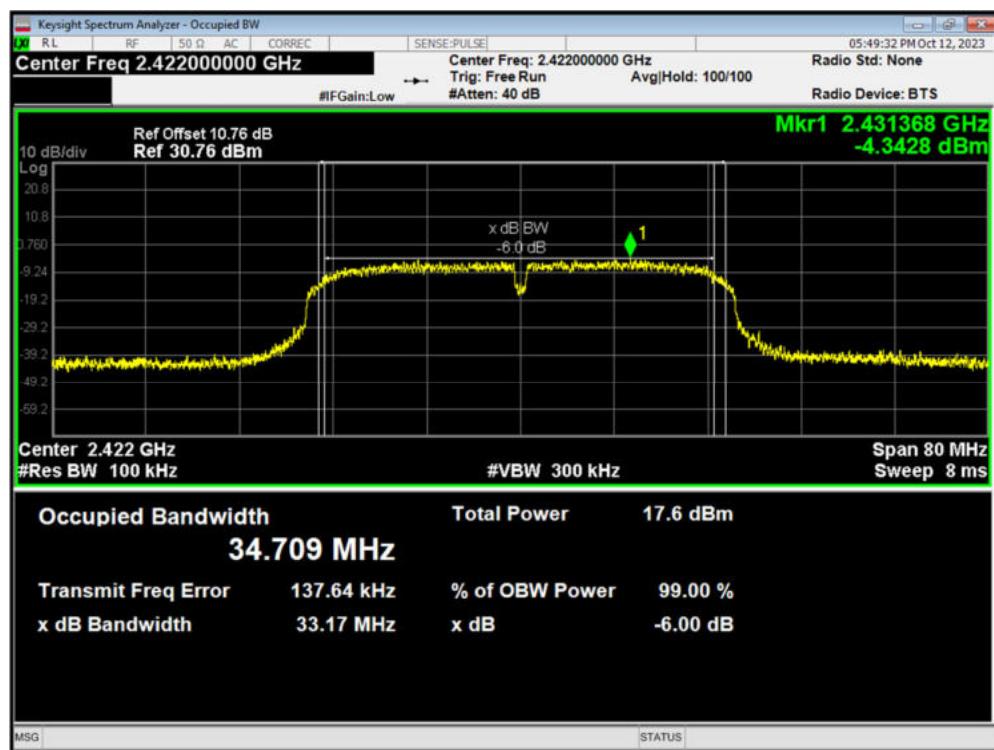
-6dB Bandwidth 802.11n(HT20) 2437MHz



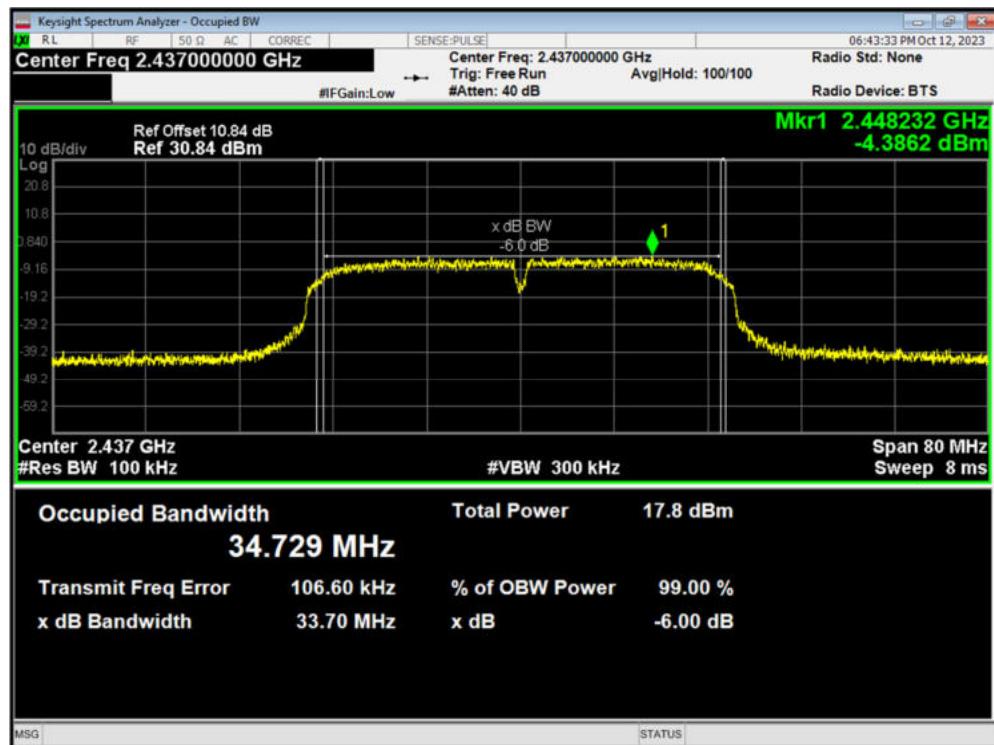
-6dB Bandwidth 802.11n(HT20) 2462MHz



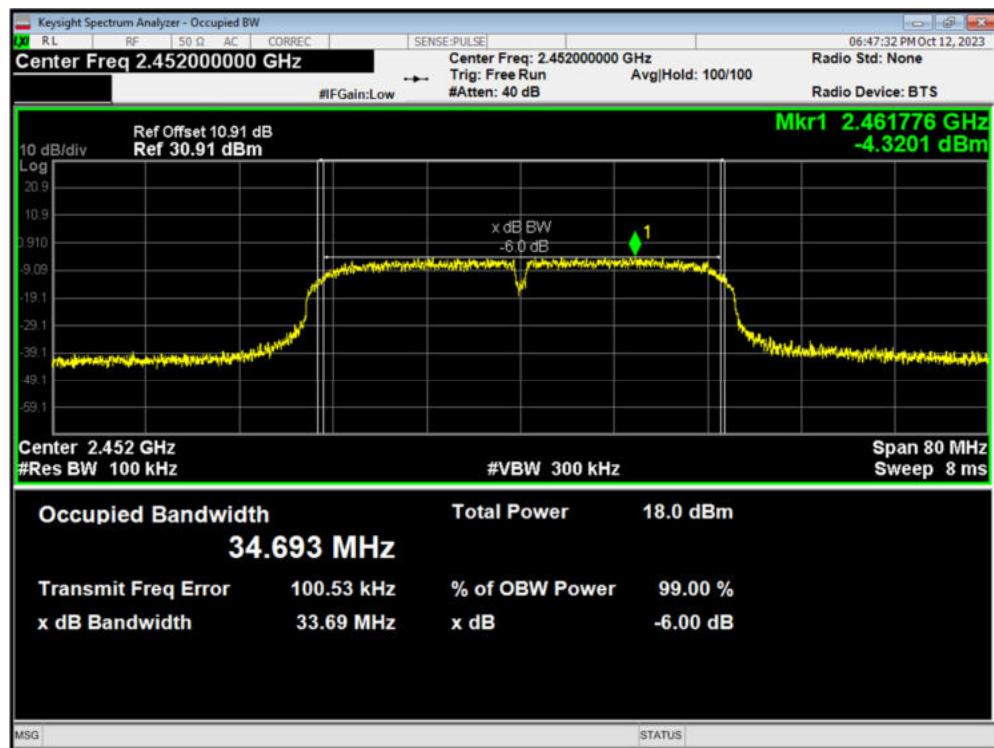
-6dB Bandwidth 802.11n(HT40) 2422MHz



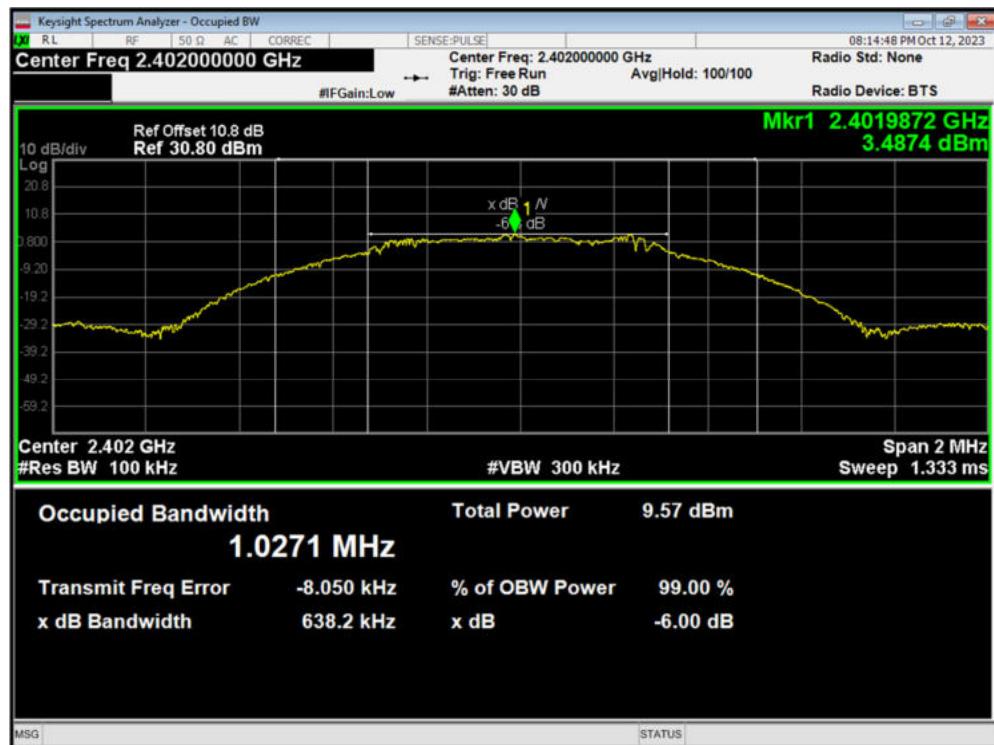
-6dB Bandwidth 802.11n(HT40) 2437MHz



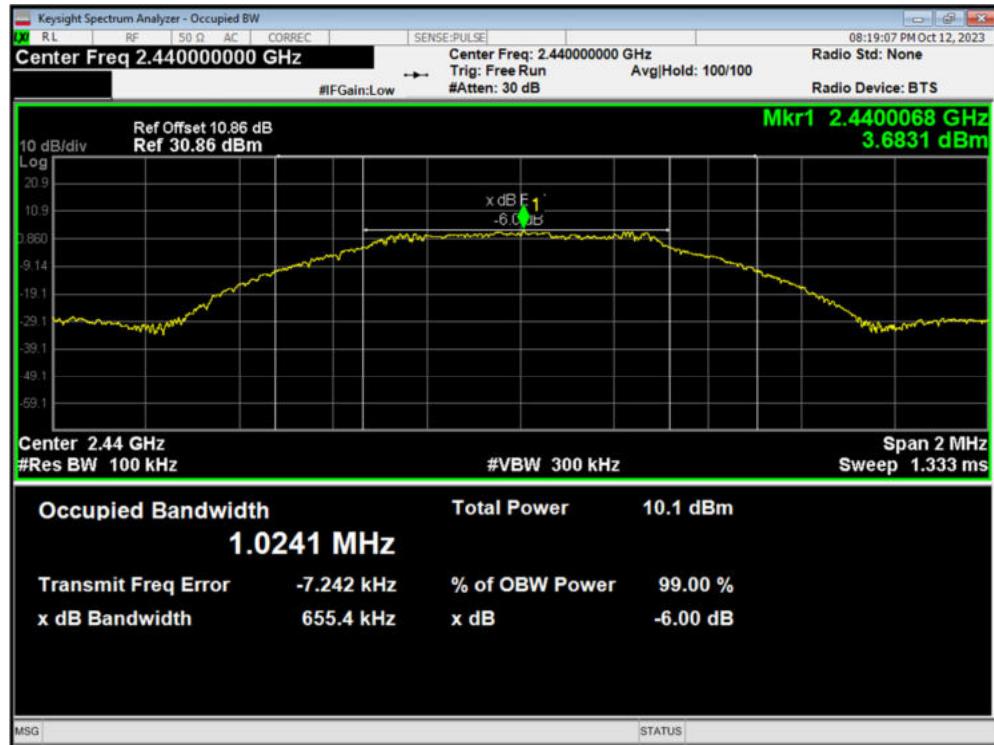
-6dB Bandwidth 802.11n(HT40) 2452MHz



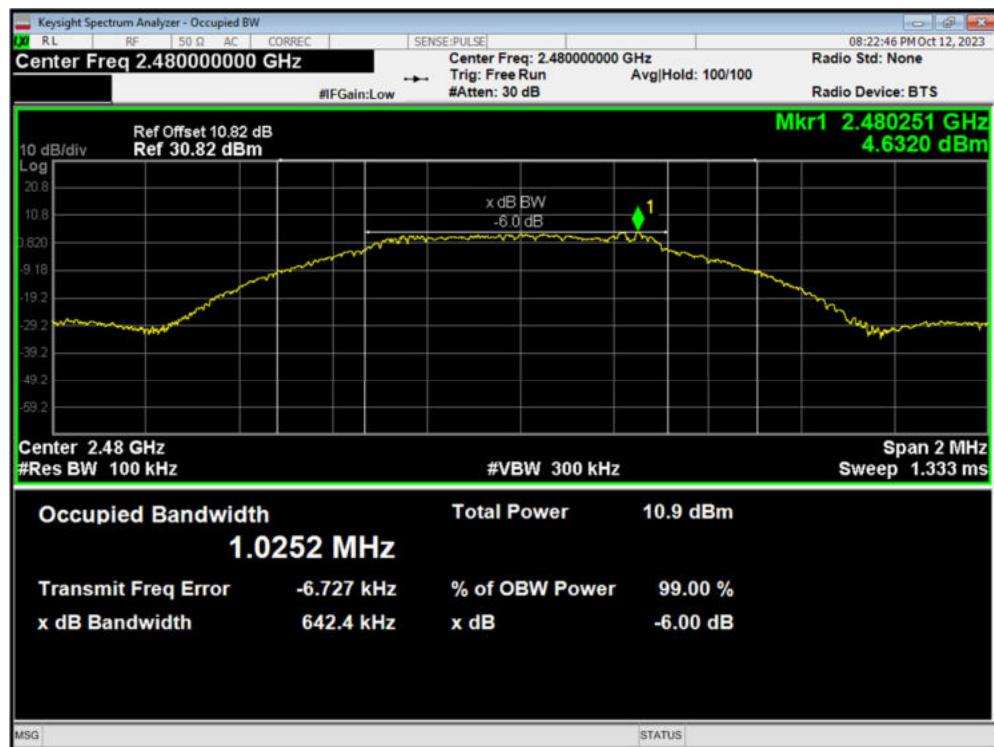
-6dB Bandwidth Bluetooth LE 2402MHz



-6dB Bandwidth Bluetooth LE 2440MHz



-6dB Bandwidth Bluetooth LE 2480MHz



5.3. Band Edge

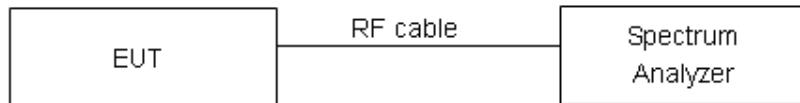
Ambient Condition

Temperature	Relative humidity
15°C ~ 35°C	20% ~ 80%

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.”

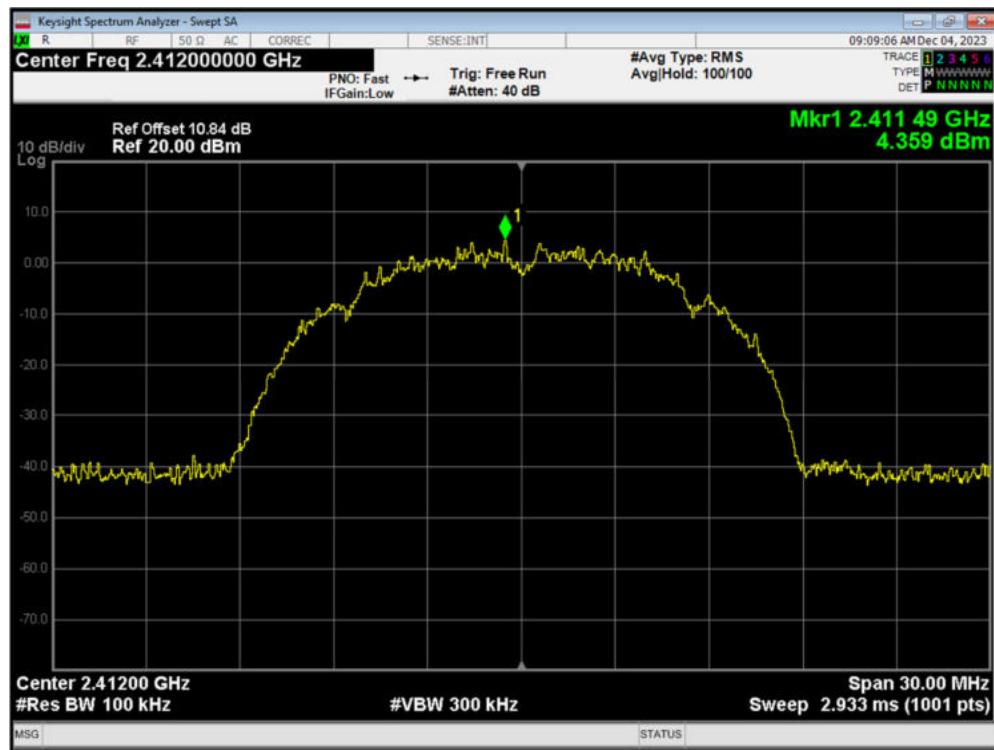
Measurement Uncertainty

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

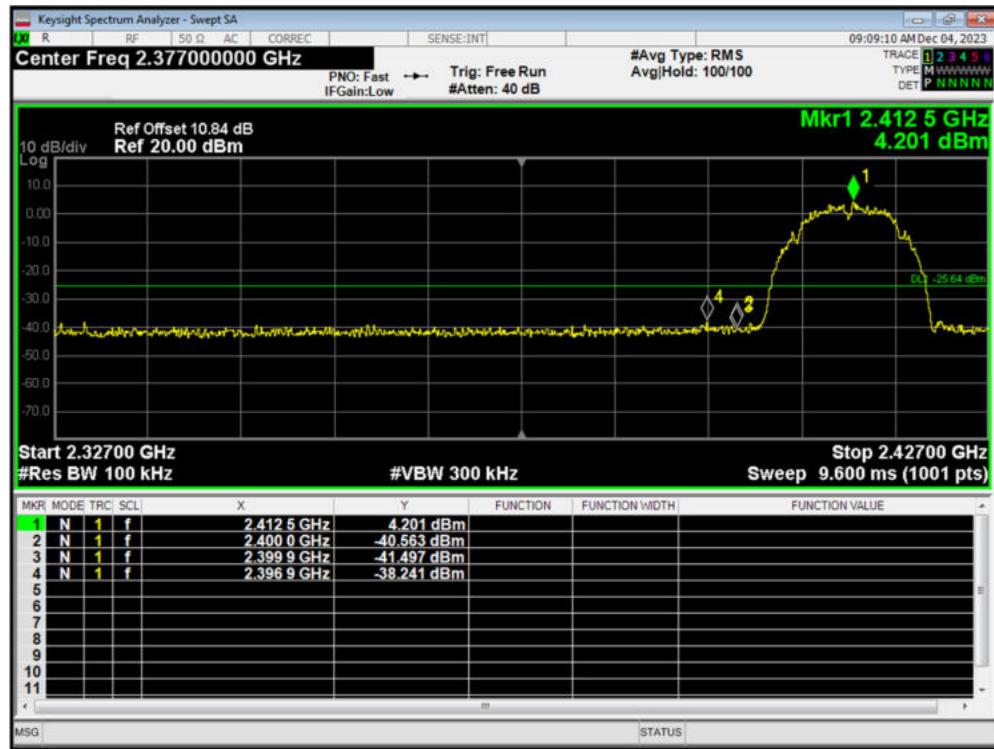
Frequency	Uncertainty
2GHz-3GHz	1.407 dB

Test Results: PASS

Band Edge 802.11b 2412MHz Ref



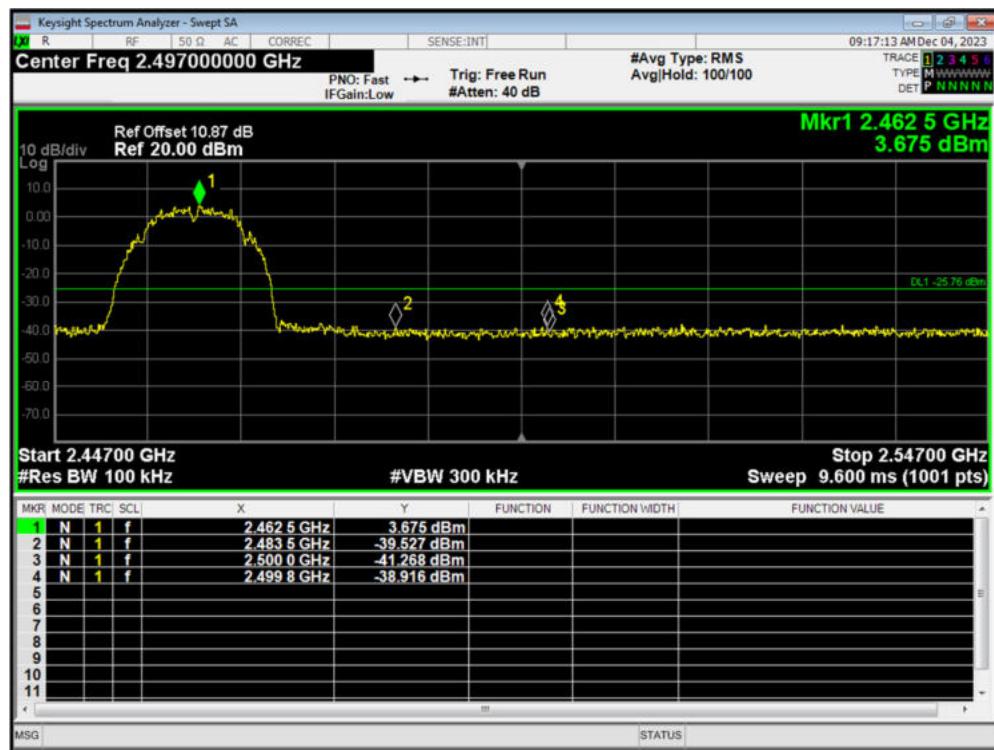
Band Edge 802.11b 2412MHz Emission



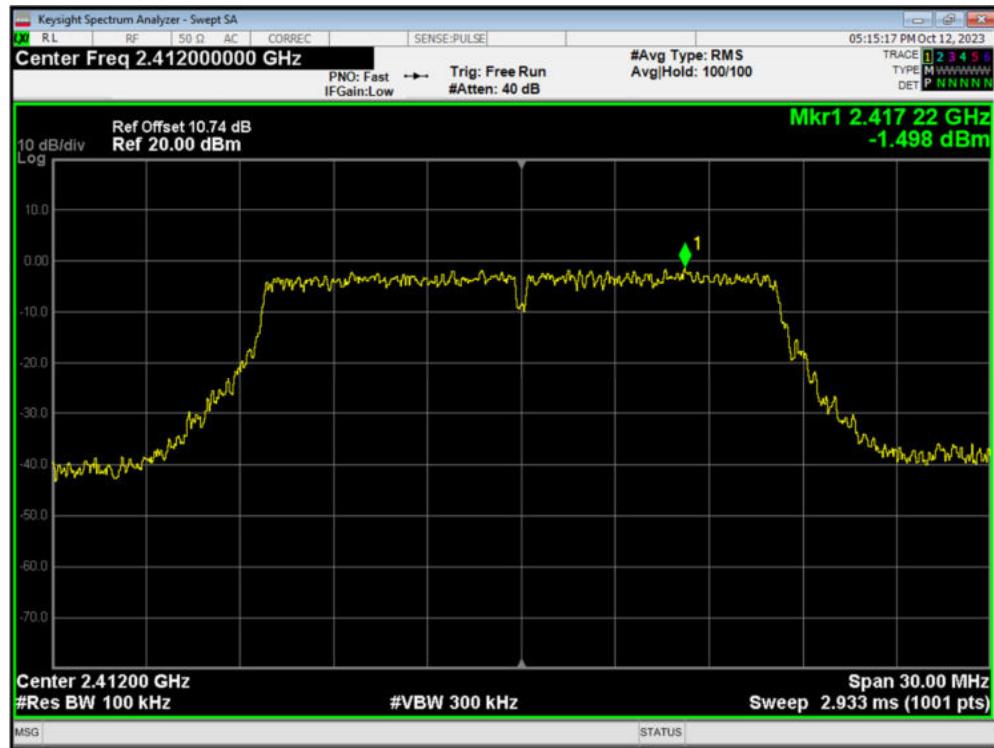
Band Edge 802.11b 2462MHz Ref



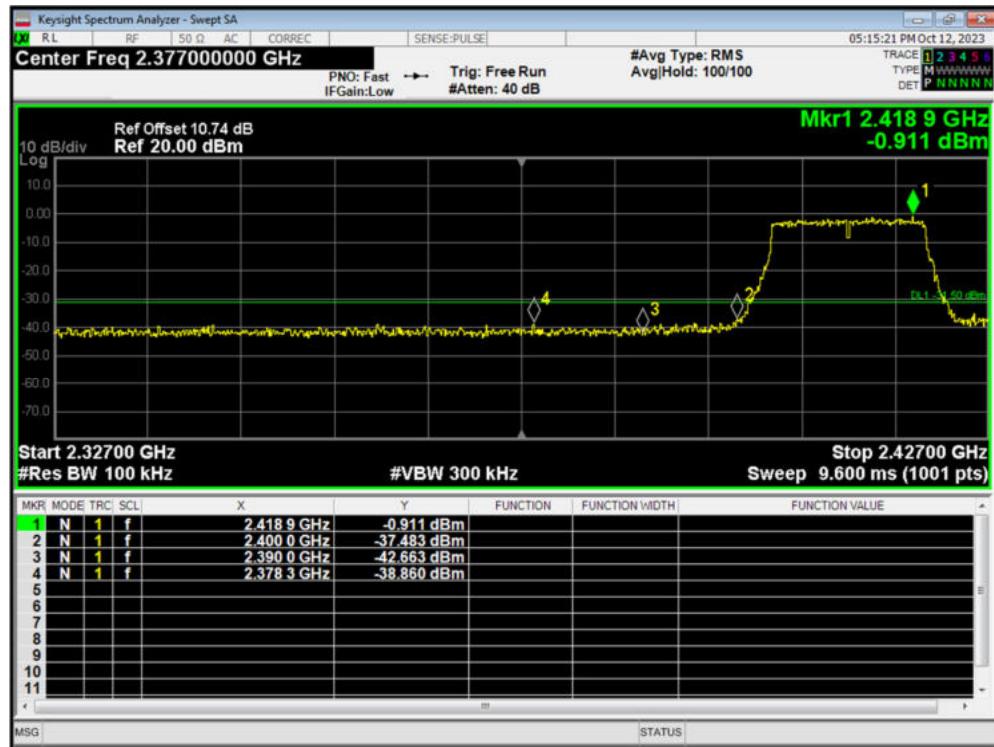
Band Edge 802.11b 2462MHz Emission



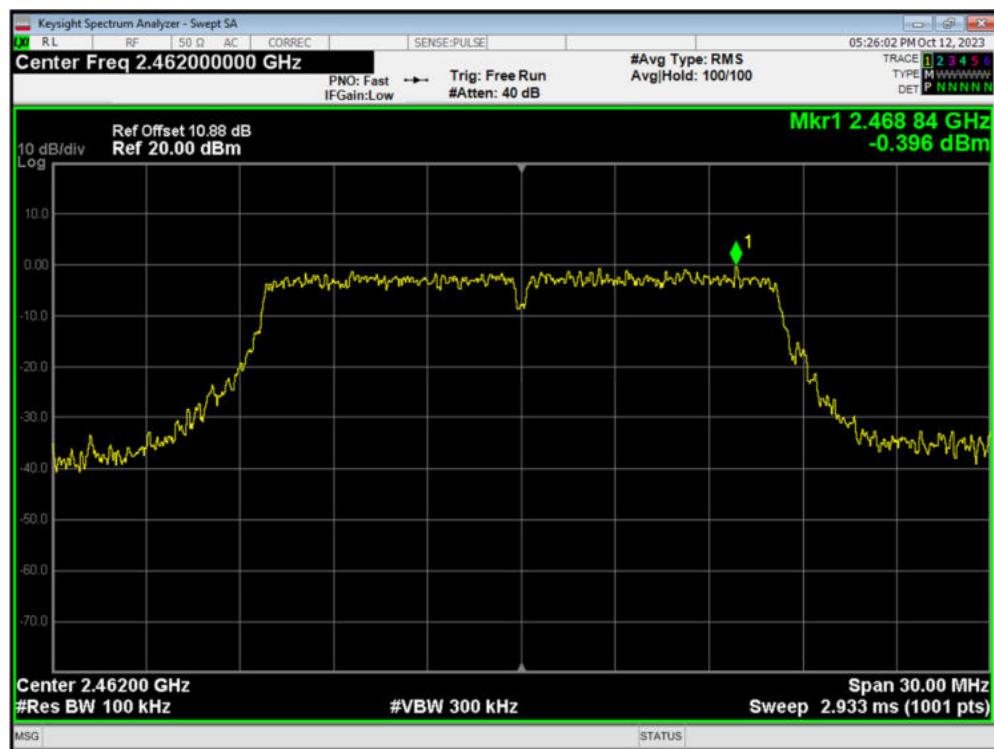
Band Edge 802.11g 2412MHz Ref



Band Edge 802.11g 2412MHz Emission



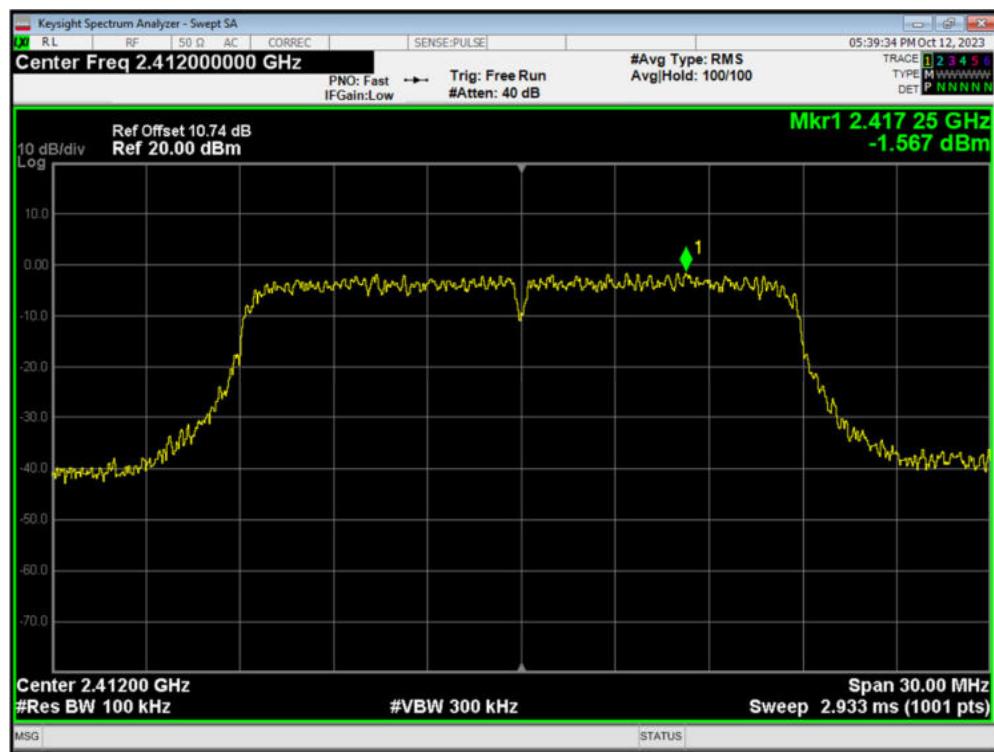
Band Edge 802.11g 2462MHz Ref



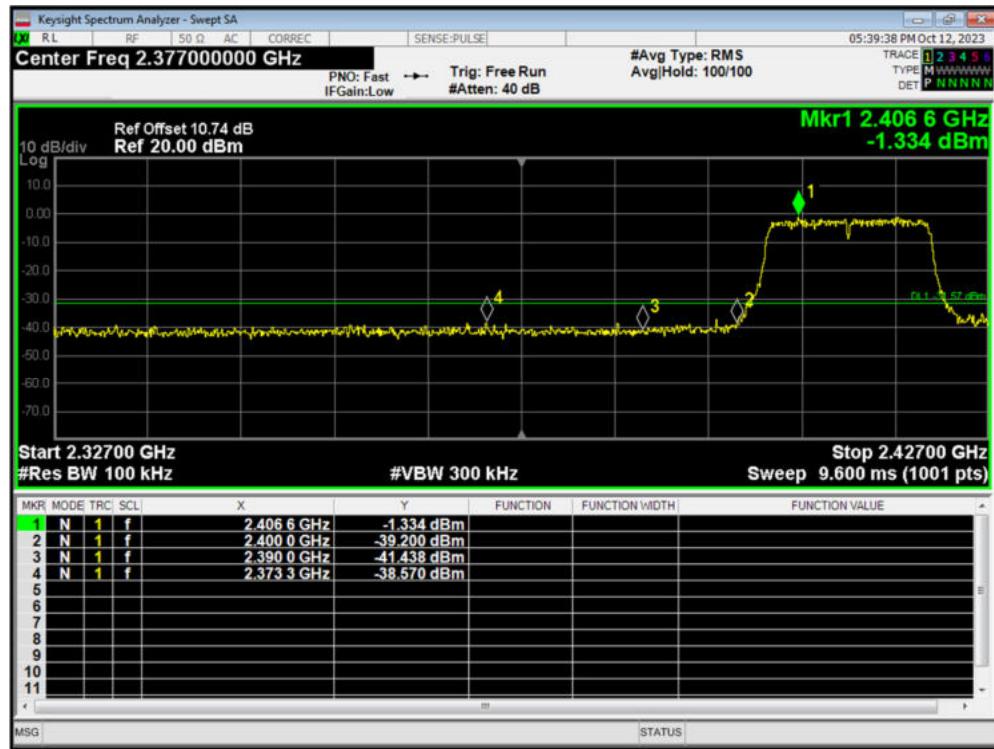
Band Edge 802.11g 2462MHz Emission



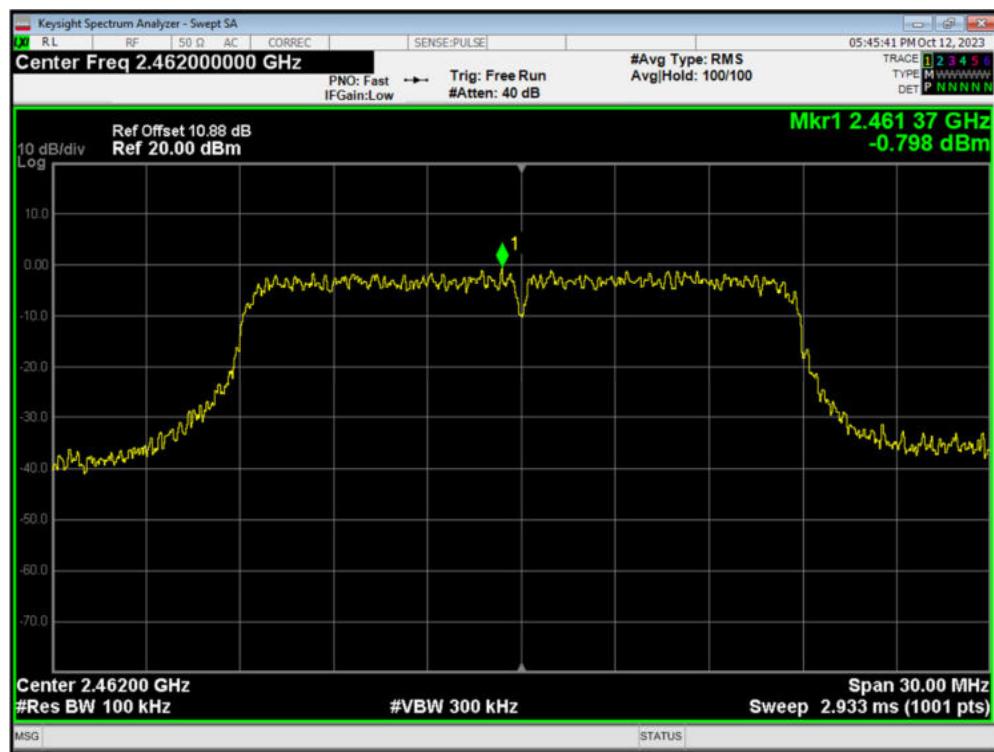
Band Edge 802.11n(HT20) 2412MHz Ref



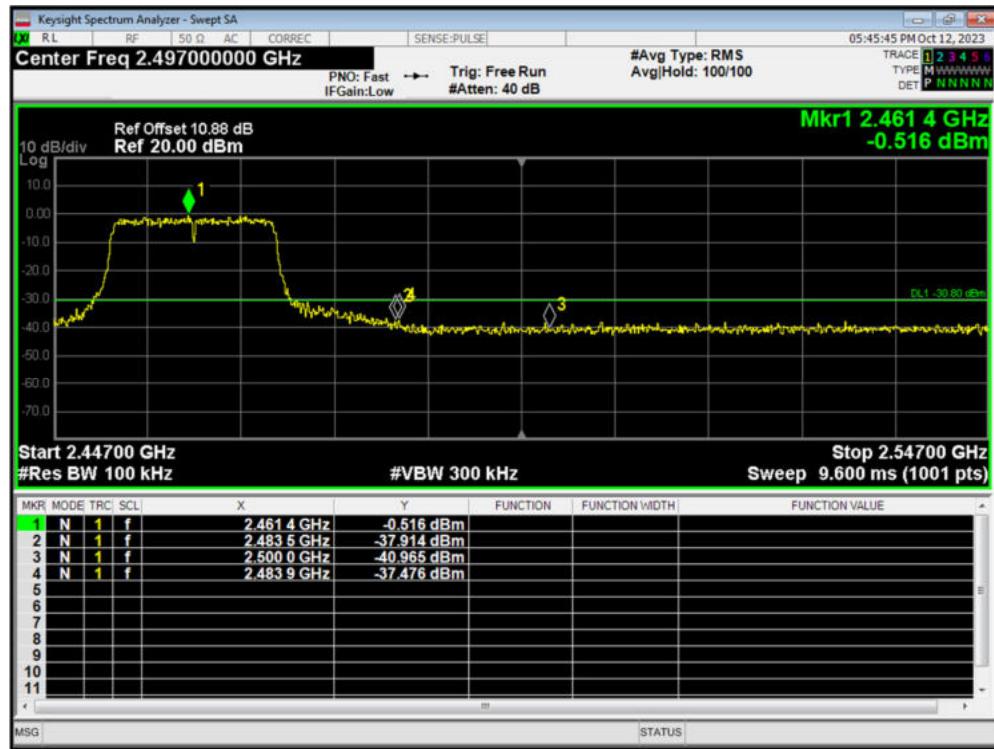
Band Edge 802.11n(HT20) 2412MHz Emission



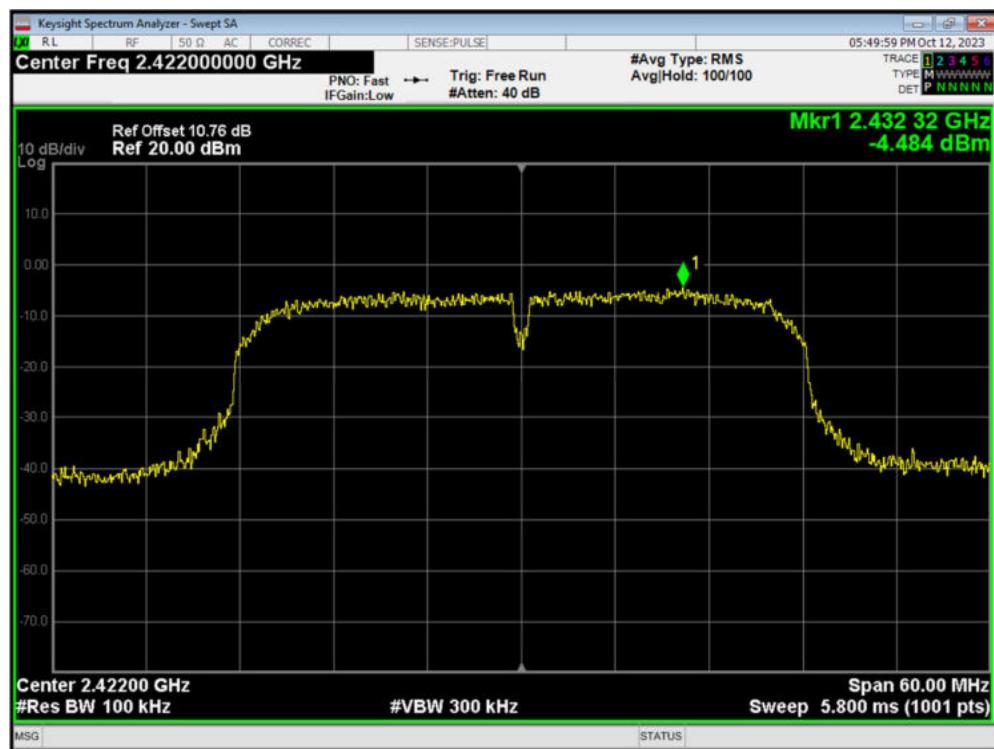
Band Edge 802.11n(HT20) 2462MHz Ref



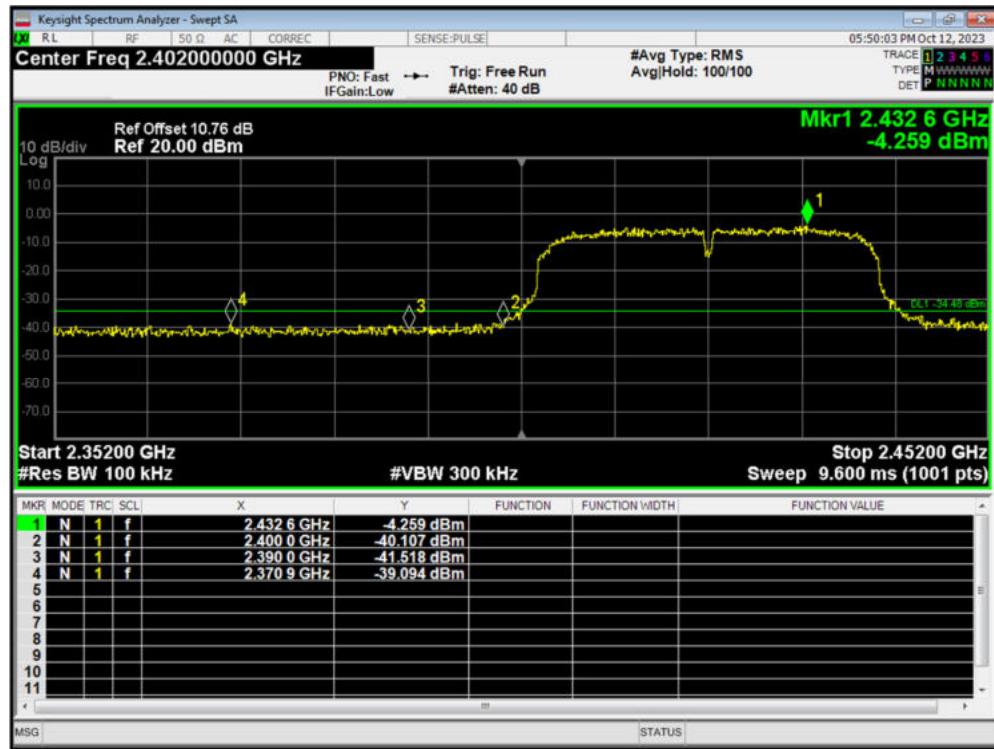
Band Edge 802.11n(HT20) 2462MHz Emission



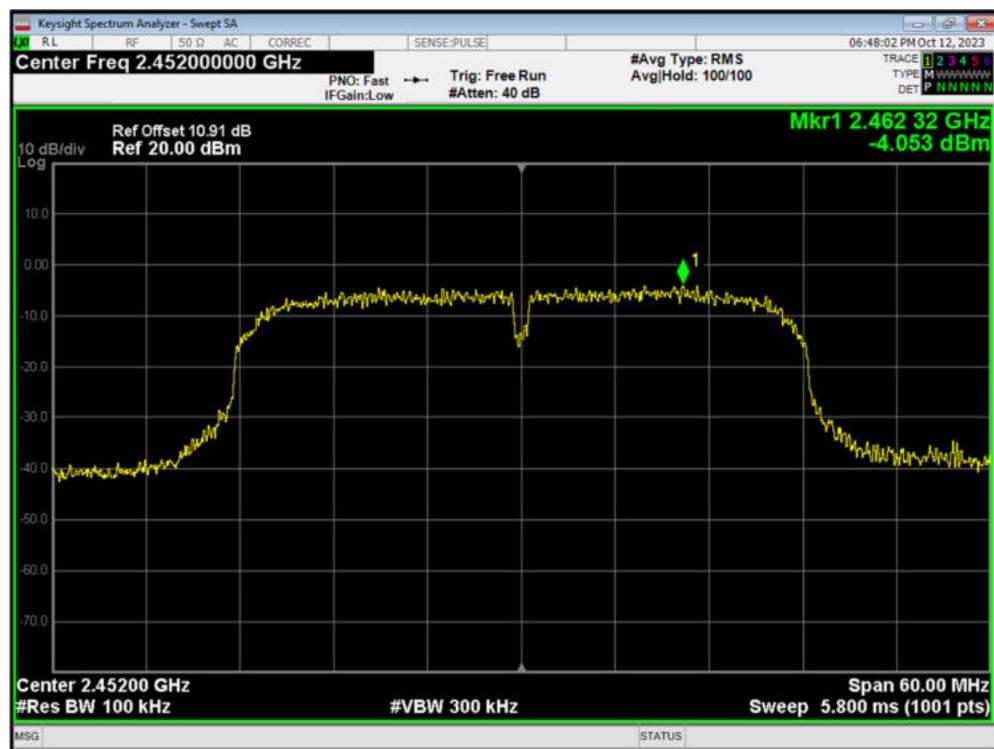
Band Edge 802.11n(HT40) 2422MHz Ref



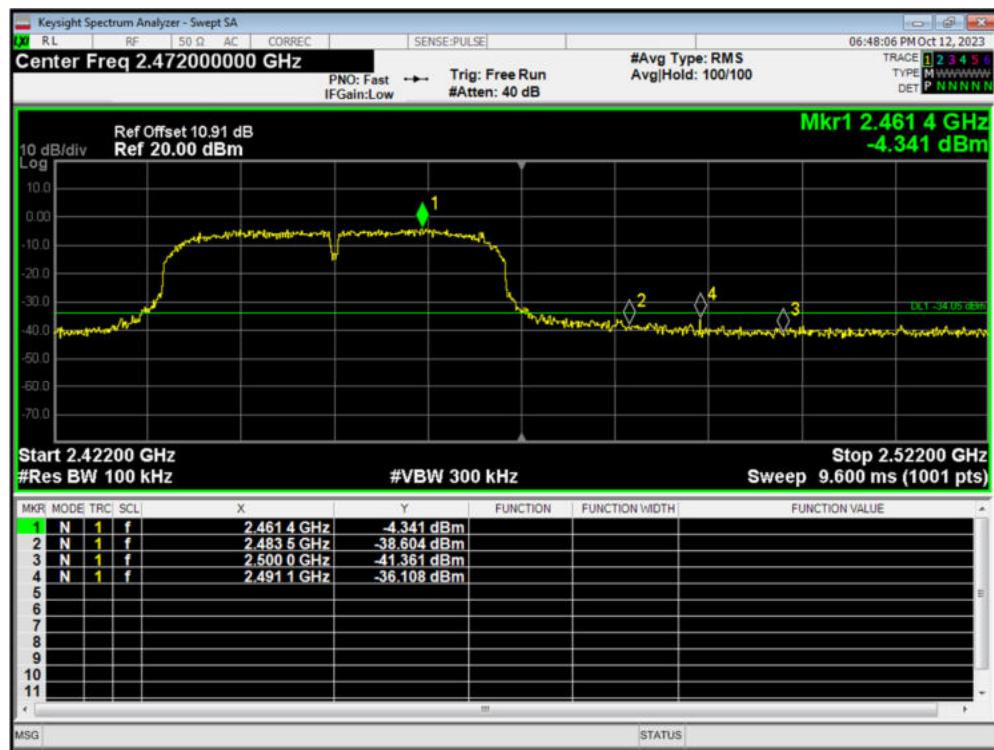
Band Edge 802.11n(HT40) 2422MHz Emission



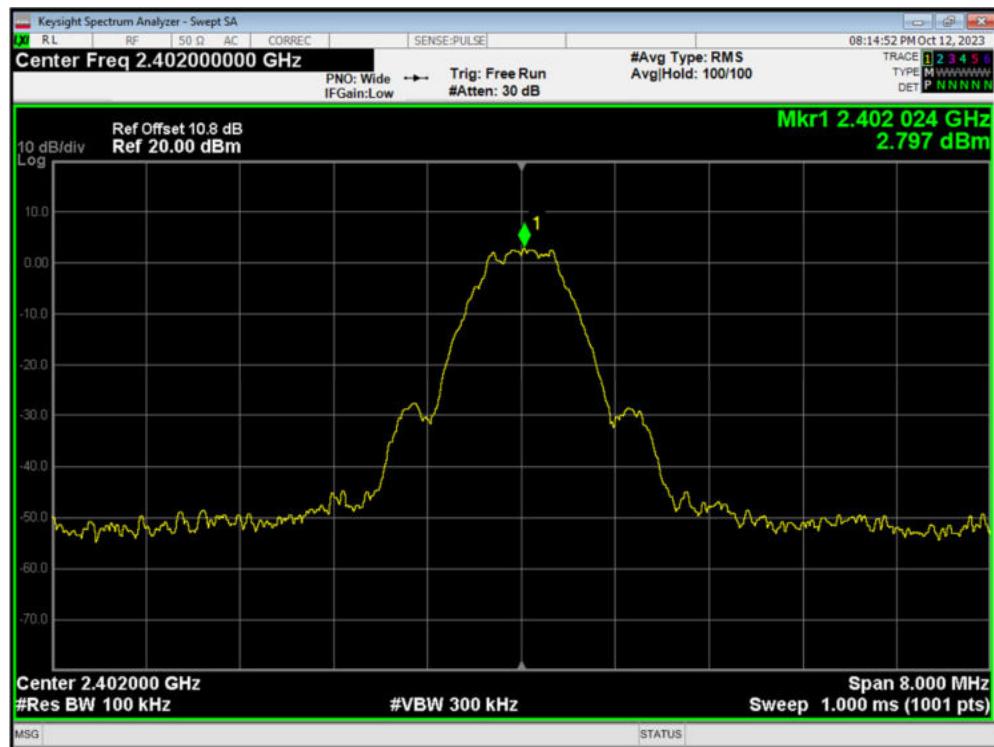
Band Edge 802.11n(HT40) 2452MHz Ref



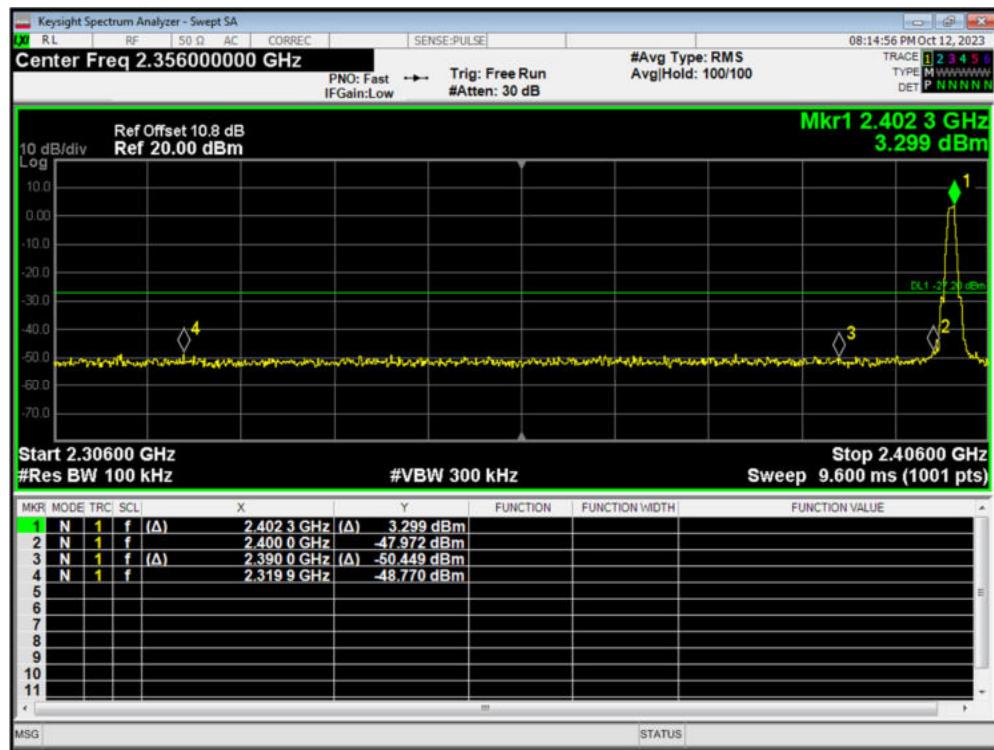
Band Edge 802.11n(HT40) 2452MHz Emission



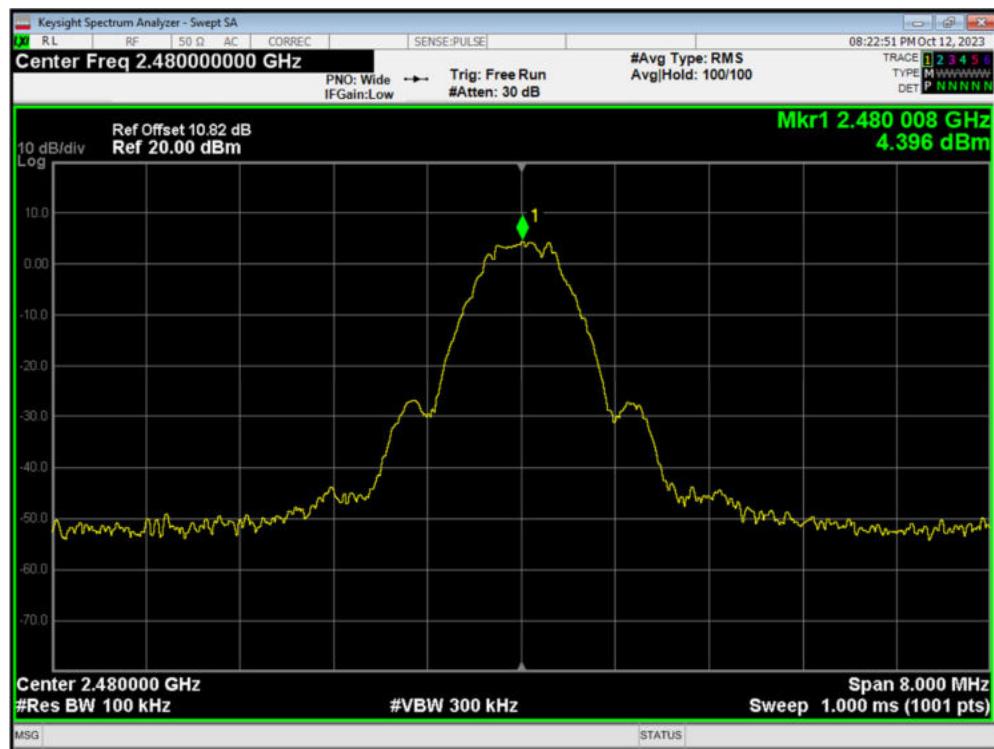
Band Edge Bluetooth LE 2402MHz Ref



Band Edge Bluetooth LE 2402MHz Emission



Band Edge Bluetooth LE 2480MHz Ref



Band Edge Bluetooth LE 2480MHz Emission

