RF TEST REPORT

Applicant	Quectel Wireless Solutions Company Limited
FCC ID	XMR2024FCS960KNL
Product	Wi-Fi & Bluetooth Module
Brand	Quectel
Model	FCS960K-NL
Report No.	R2404A0429-R1V1
Issue Date	June 19, 2024

Eurofins TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2023)**. 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*

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TABLE OF CONTENT

Version	Revision Description	Issue Date
Rev.0	Initial issue of report.	June 12, 2024
Rev.1	Updated data and information.	June 19, 2024
Note: This revised report (Report No.: R2404A0429-R1V1) supersedes and replaces the previously issued report (Report No.: R2404A0429-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 6.9	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 Note 1
Date of Testing: May 30, 2024 ~ June 7, 2024 Date of Sample Received: April 18, 2024			
Note: 1. The equipment is not connected to the public network, so test items do not apply. 2. indications of Pass/Fail in this report are opinions expressed by Eurofins 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 **Eurofins 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)

Eurofins 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)

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

1.3. Testing Location

Company:	Eurofins TA Technology (Shanghai) Co., Ltd.
Address:	Building 3, No.145, Jintang Rd, Pudong Shanghai, P.R.China
City:	Shanghai
Post code:	201201
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E-mail:	Kain.Xu@cpt.eurofinscn.com

2. General Description of Equipment Under Test

2.1. Applicant and Manufacturer Information

Applicant	Quectel Wireless Solutions Company Limited
Applicant address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China, 200233
Manufacturer	Quectel Wireless Solutions Company Limited
Manufacturer address	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China, 200233

2.2. General Information

EUT Description	
Model	FCS960K-NL
SN	Conducted: E1M24AR00000066
	Radiated: E1M24EF04000047
Hardware Version	R1.0
Software Version	FCS960KAAMD
Power Supply	External power supply
Antenna Type	External Antenna
Antenna Connector	RP SMA Male (meet with the standard FCC Part 15.203 requirement)
Antenna Gain	Wi-Fi 2.4G: 0.20 dBi Bluetooth LE: 0.20 dBi
Additional Beamforming Gain	NA
Operating Frequency Range(s)	802.11b/g/n(HT20)/ax(HE20): 2412 ~ 2462 MHz 802.11n(HT40)/ax(HE40): 2422 ~ 2452 MHz Bluetooth LE V5.4: 2402 ~2480 MHz
Modulation Type	802.11b: DSSS 802.11g/n: OFDM 802.11ax: OFDMA (Only Support Full Ru) Bluetooth LE: GFSK
Max. Output Power	Wi-Fi 2.4G: 17.37 dBm Bluetooth LE: 12.24 dBm
EUT Accessory	
Mother board	Manufacturer: Quectel Wireless Solutions Co., Ltd. Model: /
Note: 1. The EUT is sent from the applicant to Eurofins 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 (2023) 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 (vertical), lie-down position (horizontal). The worst emission was found in stand-up position (vertical) 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
Bluetooth (Low Energy) (S=2)	500kbps
Bluetooth (Low Energy) (S=8)	125kbps
802.11b	1 Mbps
802.11g	6 Mbps
802.11n HT20	MCS0
802.11n HT40	MCS0
802.11ax HE20	MCS0
802.11ax HE40	MCS0

5. Test Case Results

5.1. Maximum output power

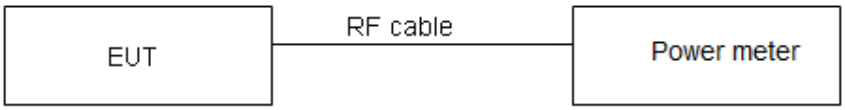
Ambient Condition

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	≤ 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							
Channel	802.11b	802.11g	802.11n HT20	802.11ax HE20	Channel	802.11n HT40	802.11ax HE40
CH1	16	15	15	15	CH3	14	14
CH2	-	16	17	17	CH4	15	15
CH3	16	17	-	-	CH5	15	-
CH6	-	17	17	17	CH6	16	15
CH9	-	17	17	17	CH7	15	15
CH10	-	16	16	16	CH8	14	14
CH11	16	14	14	14	CH9	13	13

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

Test Mode	Duty cycle	Duty cycle correction Factor (dB)
802.11b	0.457	3.400
802.11g	0.122	9.130
802.11n HT20	0.337	4.730
802.11n HT40	0.328	4.840
802.11ax HE20	0.279	5.550
802.11ax HE40	0.281	5.520
Bluetooth LE (1M)	0.849	0.710
Bluetooth LE (2M)	0.568	2.460
Bluetooth LE (S=2)	0.974	0.110
Bluetooth LE (S=2)	0.909	0.420
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	13.08	16.48	30	PASS
	2437/CH 6	12.78	16.18	30	PASS
	2462/CH11	12.74	16.14	30	PASS
802.11g	2412/CH 1	5.55	14.68	30	PASS
	2417/CH 2	6.55	15.68	30	PASS
	2422/CH 3	6.91	16.04	30	PASS
	2437/CH 6	6.49	15.62	30	PASS
	2452/CH 9	6.73	15.86	30	PASS
	2457/CH 10	3.50	12.63	30	PASS
	2462/CH11	2.08	11.21	30	PASS
802.11n HT20	2412/CH 1	10.23	14.96	30	PASS
	2417/CH 2	12.64	17.37	30	PASS
	2437/CH 6	11.62	16.35	30	PASS
	2452/CH 9	12.58	17.31	30	PASS
	2457/CH 10	9.68	14.41	30	PASS
	2462/CH11	8.24	12.97	30	PASS
802.11n HT40	2422/CH3	8.85	13.69	30	PASS
	2427/CH4	10.03	14.87	30	PASS
	2432/CH5	9.96	14.80	30	PASS
	2437/CH6	10.86	15.70	30	PASS
	2442/CH7	9.58	14.42	30	PASS
	2447/CH8	8.81	13.65	30	PASS
	2452/CH9	8.23	13.07	30	PASS
802.11ax HE20	2412/CH 1	9.23	14.78	30	PASS
	2417/CH 2	11.76	17.31	30	PASS
	2437/CH 6	11.35	16.90	30	PASS
	2452/CH 9	11.28	16.83	30	PASS
	2457/CH 10	7.92	13.47	30	PASS
	2462/CH11	6.74	12.29	30	PASS
802.11ax HE40	2422/CH3	8.72	14.24	30	PASS
	2427/CH4	9.89	15.41	30	PASS
	2437/CH6	8.93	14.45	30	PASS
	2442/CH7	9.47	14.99	30	PASS
	2447/CH8	8.41	13.93	30	PASS
	2452/CH9	7.51	13.03	30	PASS

Test Mode	Carrier frequency (MHz) / Channel	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Bluetooth (Low Energy) (1M)	2402/CH0	11.53	12.24	30	PASS
	2440/CH19	9.79	10.50	30	PASS
	2480/CH39	7.54	8.25	30	PASS
Bluetooth (Low Energy) (2M)	2402/CH0	9.59	12.05	30	PASS
	2440/CH19	8.05	10.51	30	PASS
	2480/CH39	5.89	8.35	30	PASS
Bluetooth (Low Energy) (S=2)	2402/CH0	11.63	11.74	30	PASS
	2440/CH19	10.20	10.31	30	PASS
	2480/CH39	8.08	8.19	30	PASS
Bluetooth (Low Energy) (S=8)	2402/CH0	11.50	11.92	30	PASS
	2440/CH19	9.96	10.38	30	PASS
	2480/CH39	8.03	8.45	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

5.2. 99% Bandwidth and 6dB Bandwidth

Ambient Condition

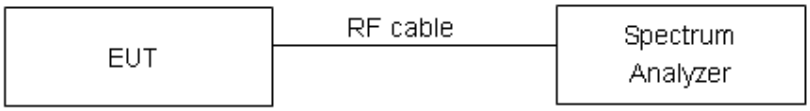
Temperature	Relative humidity
15°C ~ 35°C	20% ~ 80%

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

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.

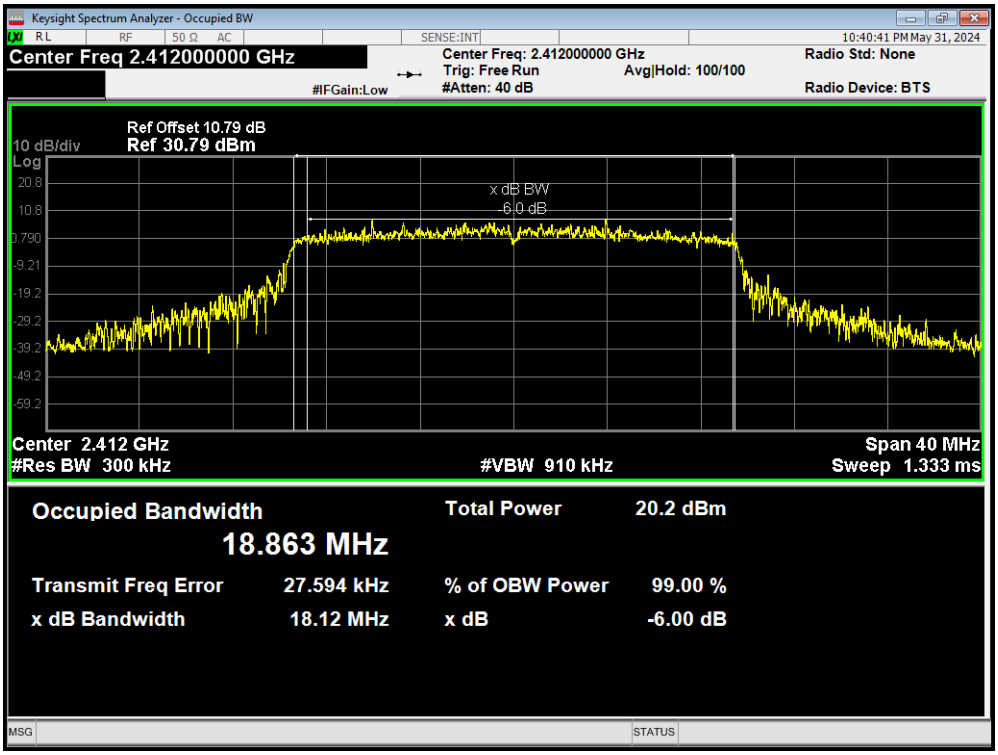
Test Results:

Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11b	2412	14.937	9.540	500	PASS
	2437	14.926	10.037	500	PASS
	2462	14.953	9.531	500	PASS
802.11g	2412	16.675	16.393	500	PASS
	2417	16.771	16.279	500	PASS
	2422	16.746	16.292	500	PASS
	2437	16.659	13.529	500	PASS
	2452	16.775	16.338	500	PASS
	2457	16.667	16.354	500	PASS
	2462	16.657	14.622	500	PASS
802.11n HT20	2412	17.928	17.607	500	PASS
	2417	17.873	16.312	500	PASS
	2437	17.892	14.765	500	PASS
	2452	17.912	16.912	500	PASS
	2457	17.912	13.160	500	PASS
	2462	17.815	14.142	500	PASS
802.11n HT40	2422	36.256	35.640	500	PASS
	2427	36.325	34.420	500	PASS
	2432	36.284	35.473	500	PASS
	2437	36.186	35.007	500	PASS
	2442	36.280	34.122	500	PASS
	2447	36.311	36.330	500	PASS
	2452	36.274	36.369	500	PASS
802.11ax HE20	2412	18.863	17.855	500	PASS
	2417	18.912	17.637	500	PASS
	2437	18.958	18.857	500	PASS
	2452	18.921	17.700	500	PASS
	2457	18.986	14.289	500	PASS
	2462	18.885	18.652	500	PASS
802.11ax HE40	2422	37.720	35.709	500	PASS
	2427	37.791	35.299	500	PASS
	2437	37.764	37.404	500	PASS
	2442	37.732	36.532	500	PASS
	2447	37.669	37.035	500	PASS
	2452	37.700	34.083	500	PASS

Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy) (1M)	2402	1.025	0.660	500	PASS
	2440	1.032	0.662	500	PASS
	2480	1.032	0.665	500	PASS
Bluetooth (Low Energy) (2M)	2402	2.061	1.255	500	PASS
	2440	2.059	1.241	500	PASS
	2480	2.061	1.383	500	PASS
Bluetooth (Low Energy) (S=2)	2402	1.059	0.676	500	PASS
	2440	1.060	0.672	500	PASS
	2480	1.073	0.675	500	PASS
Bluetooth (Low Energy) (S=8)	2402	1.018	0.669	500	PASS
	2440	1.017	0.662	500	PASS
	2480	1.023	0.656	500	PASS

99%bandwidth

OBW 802.11ax(HE20) 2412MHz



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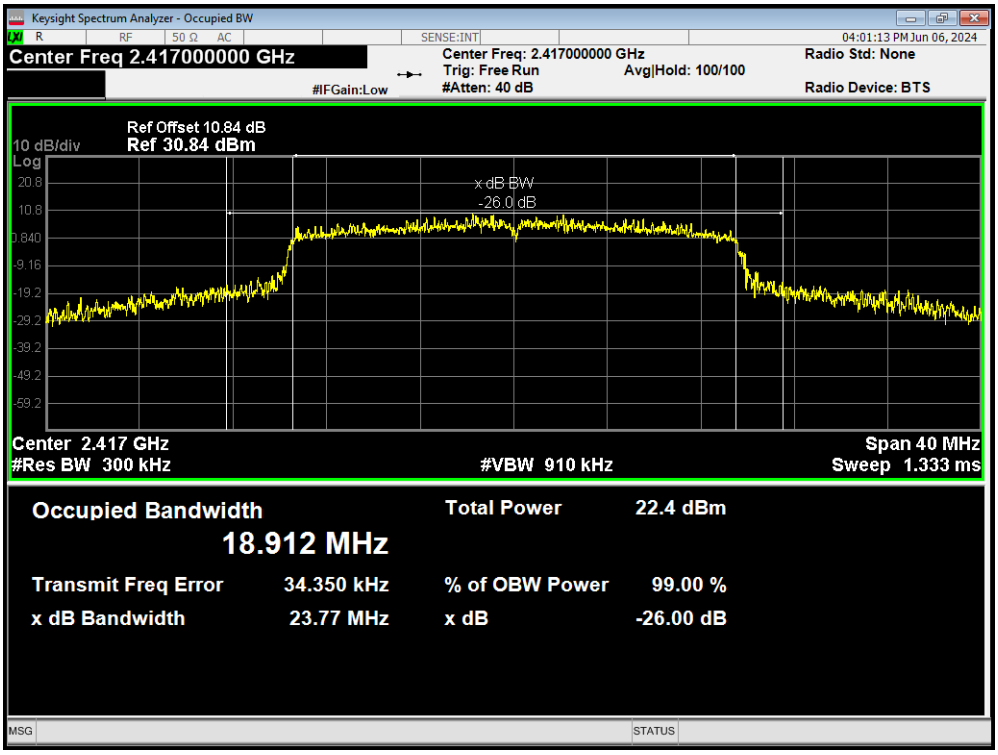
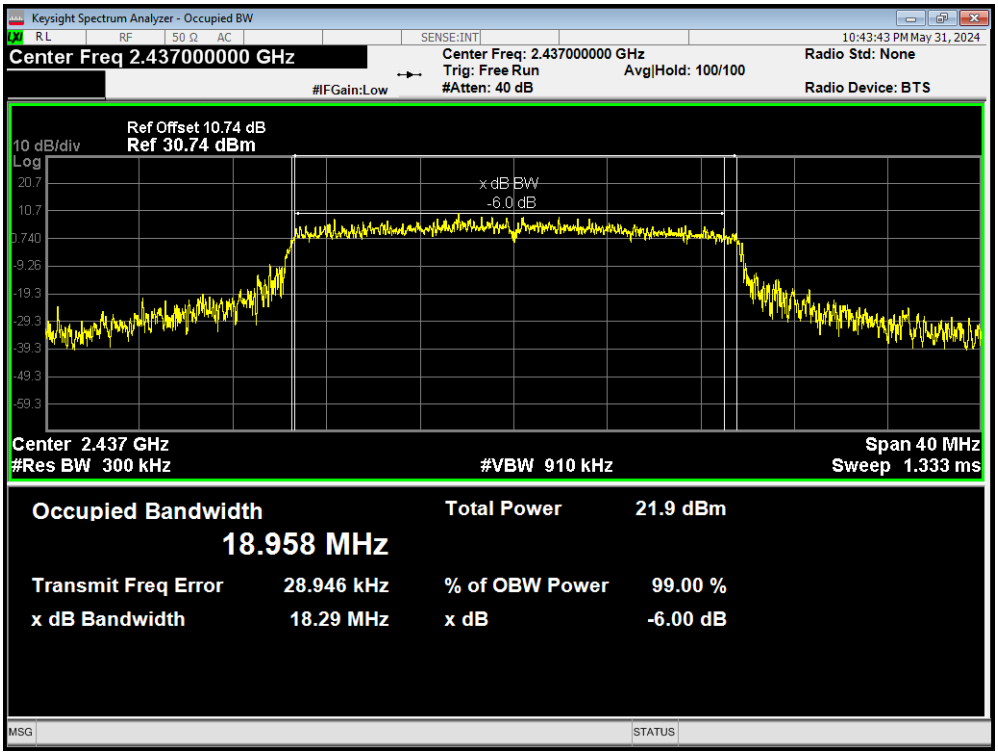


OBW 802.11ax(HE20) 2437MHz



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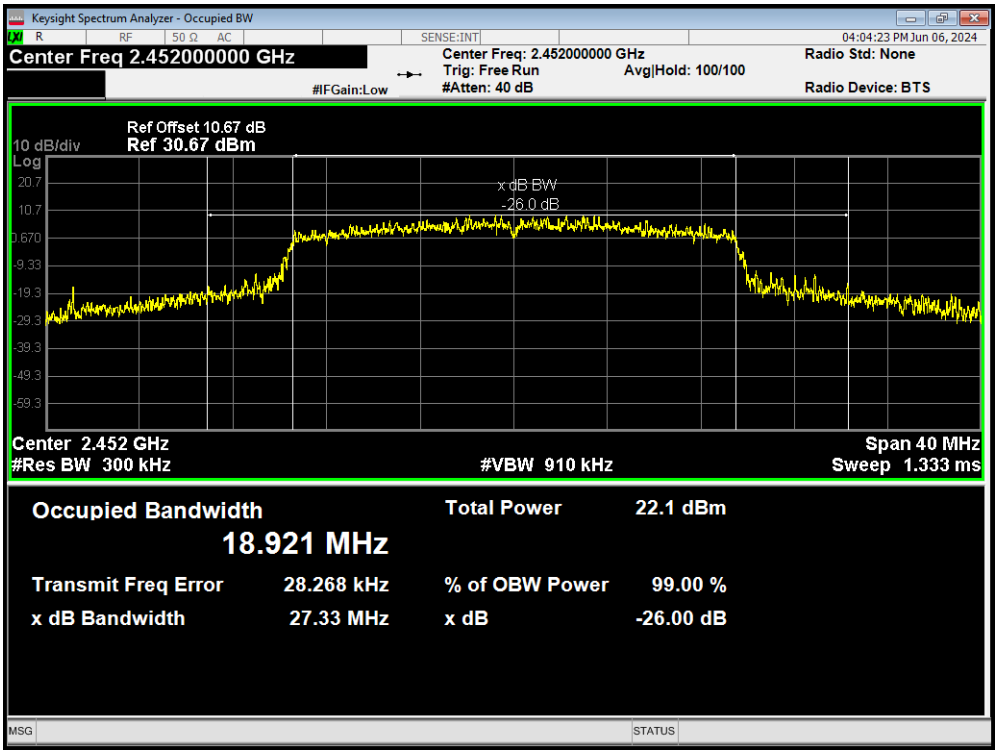
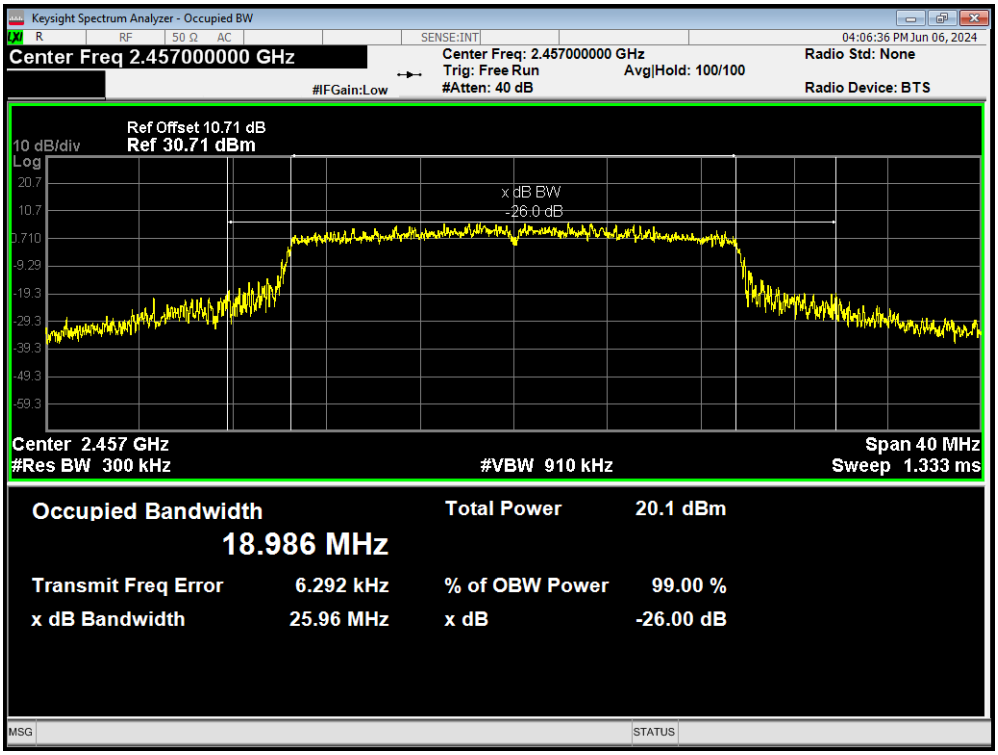
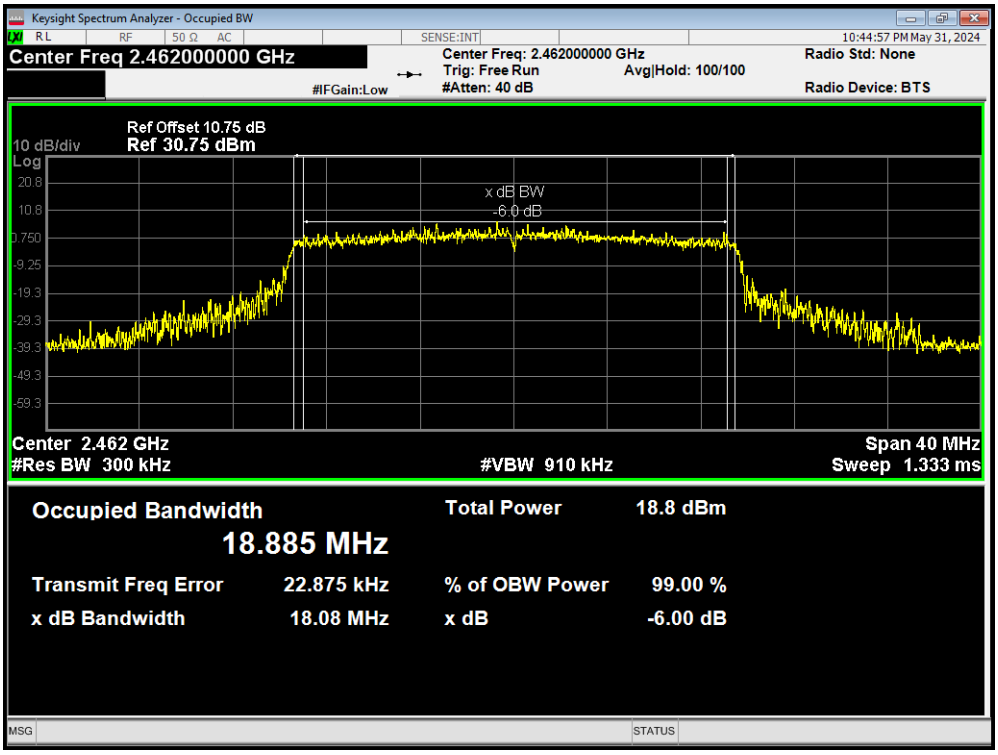


OBW 802.11ax(HE20) 2457MHz



OBW 802.11ax(HE20) 2462MHz



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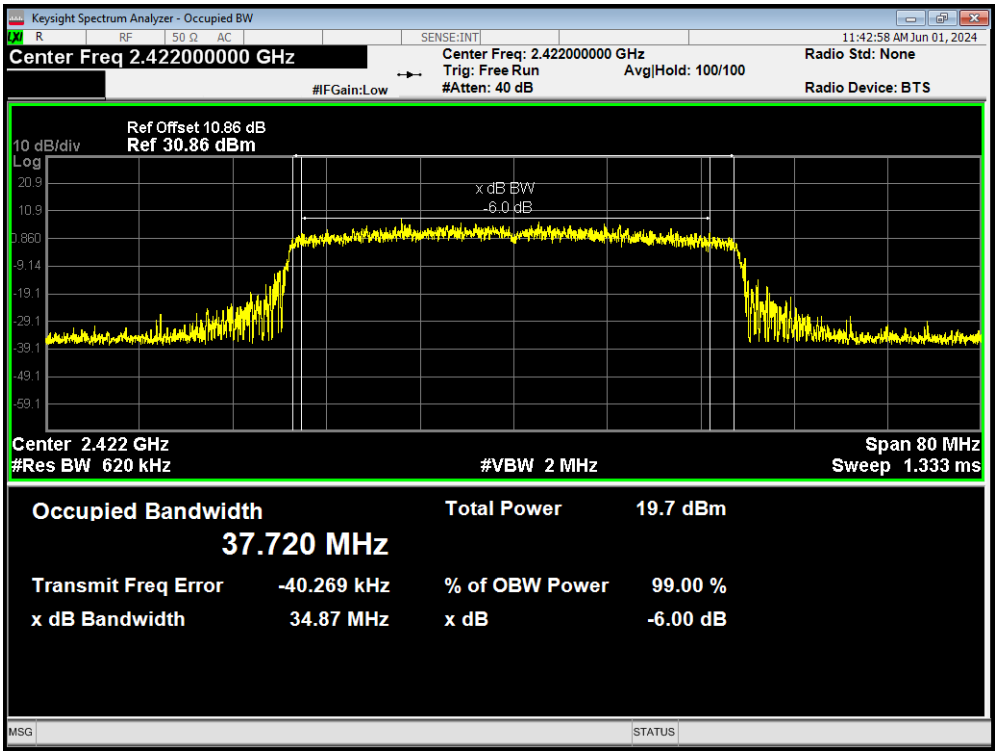

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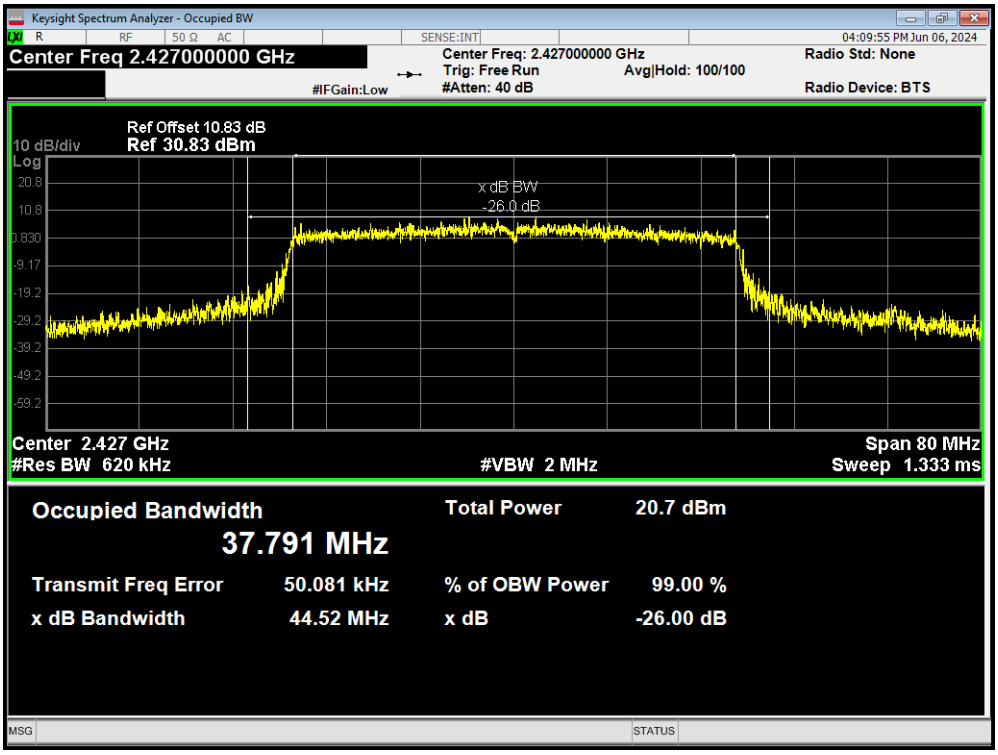
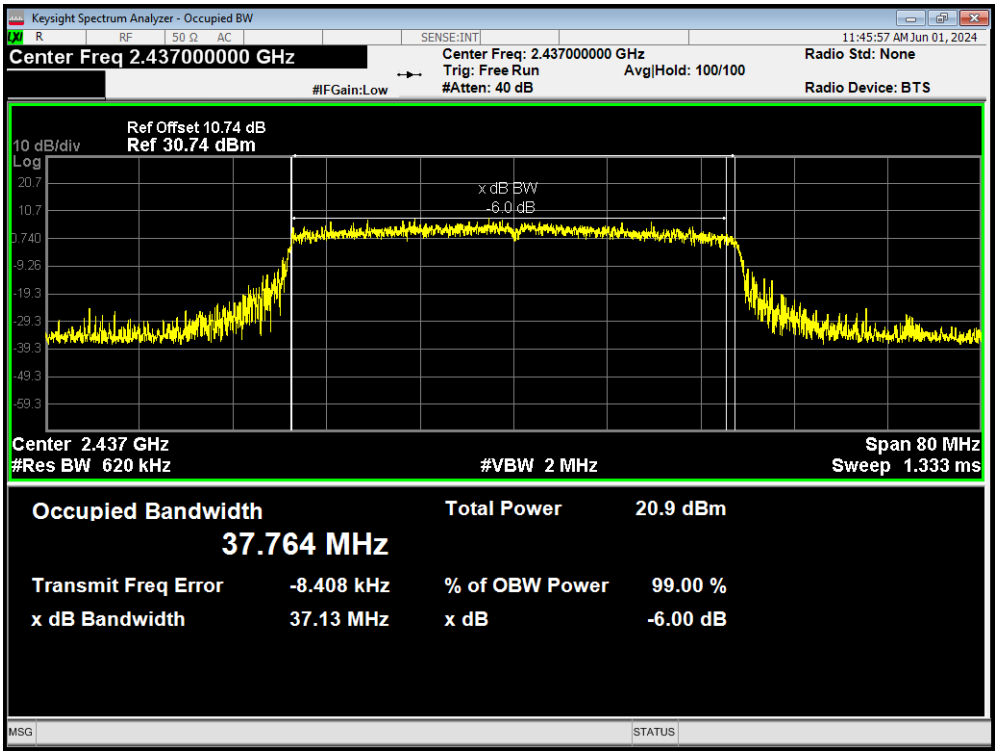


OBW 802.11ax(HE40) 2437MHz



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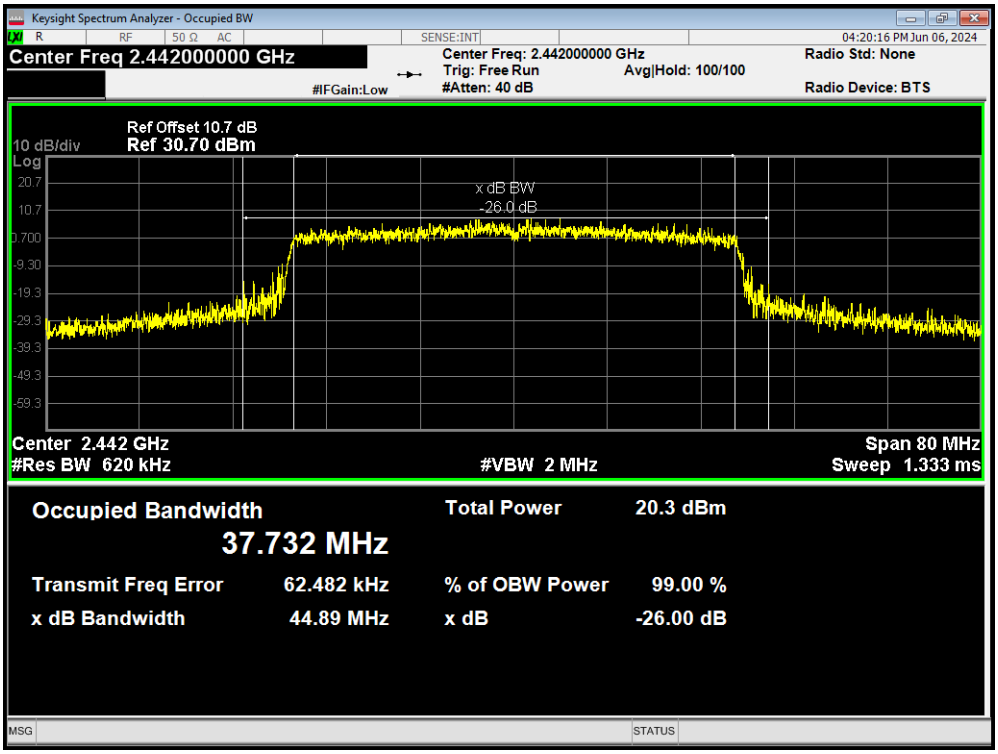
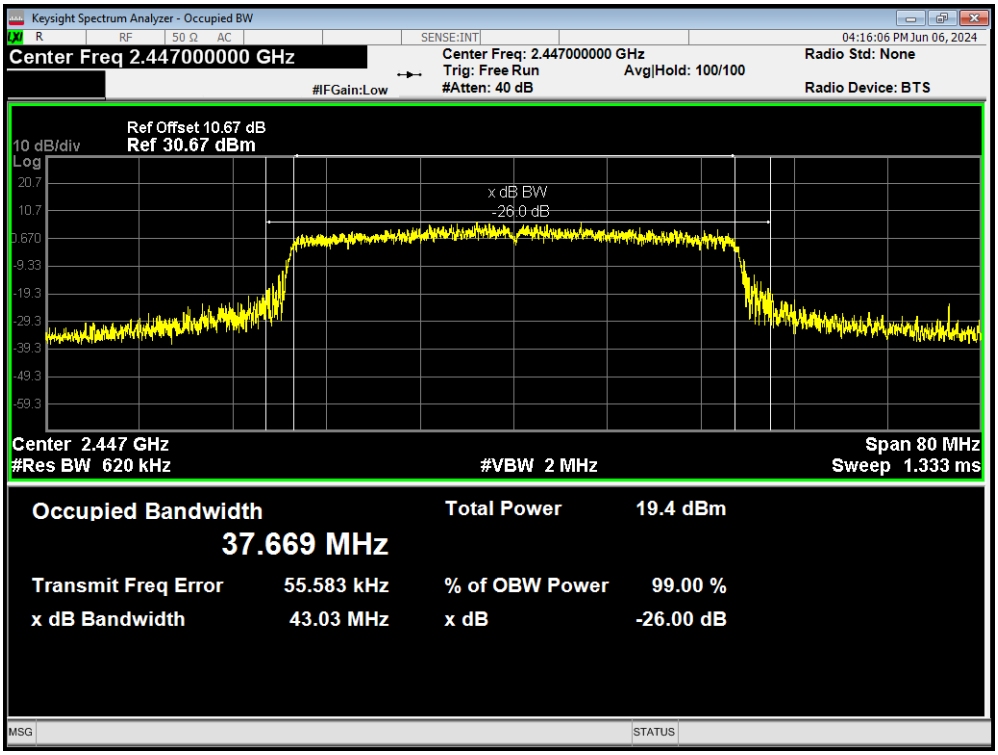
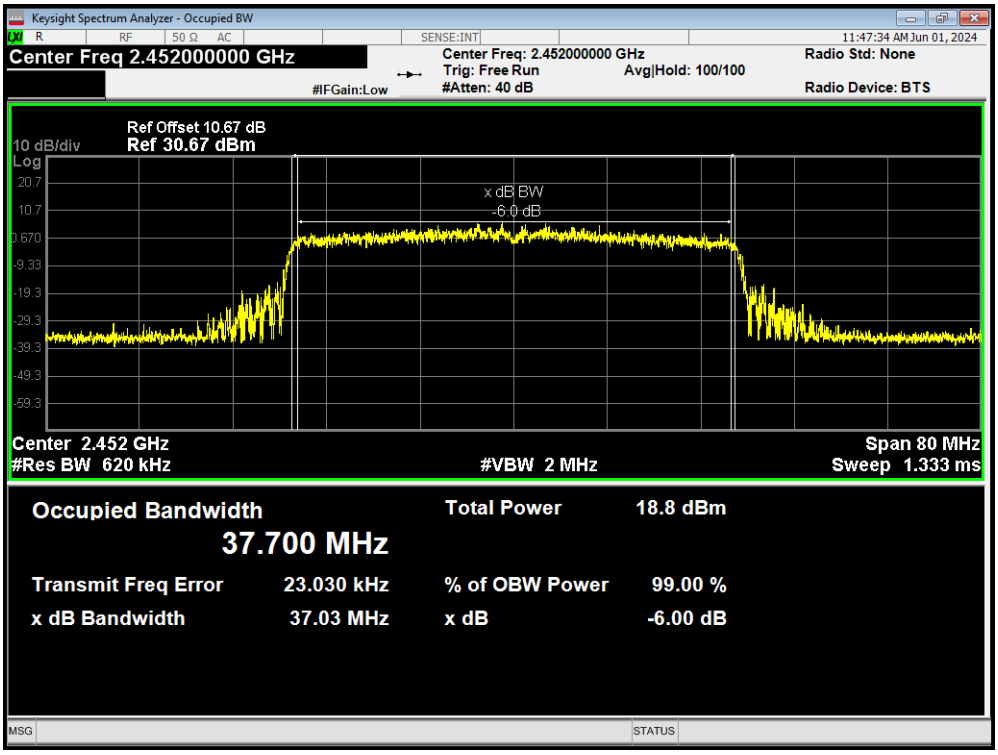


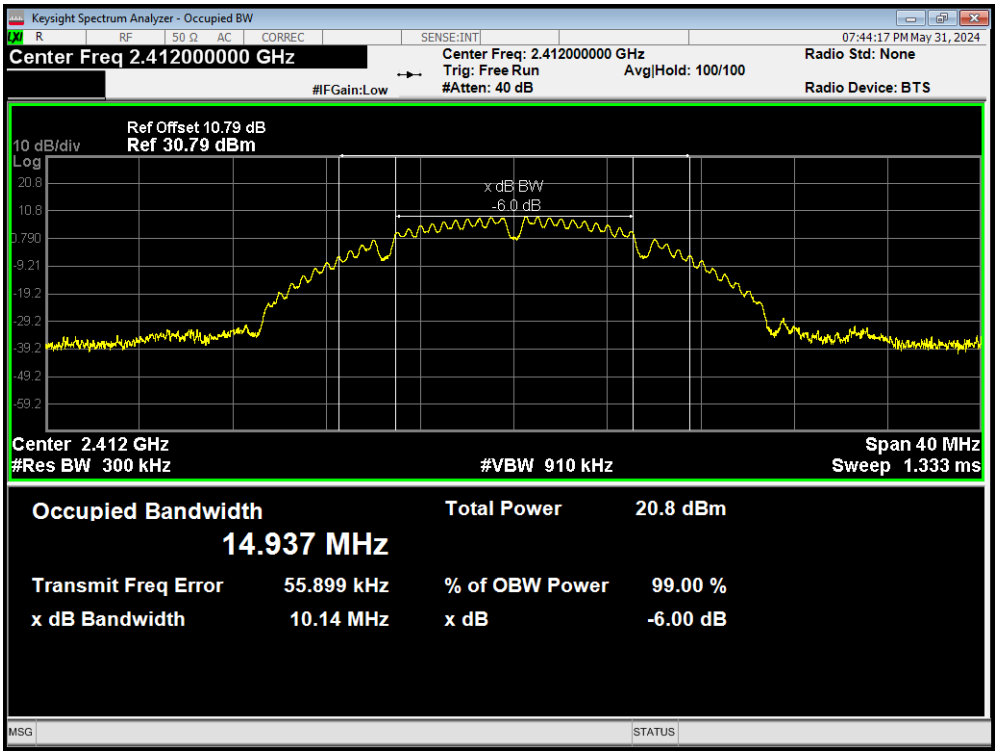
OBW 802.11ax(HE40) 2447MHz



OBW 802.11ax(HE40) 2452MHz



OBW 802.11b 2412MHz



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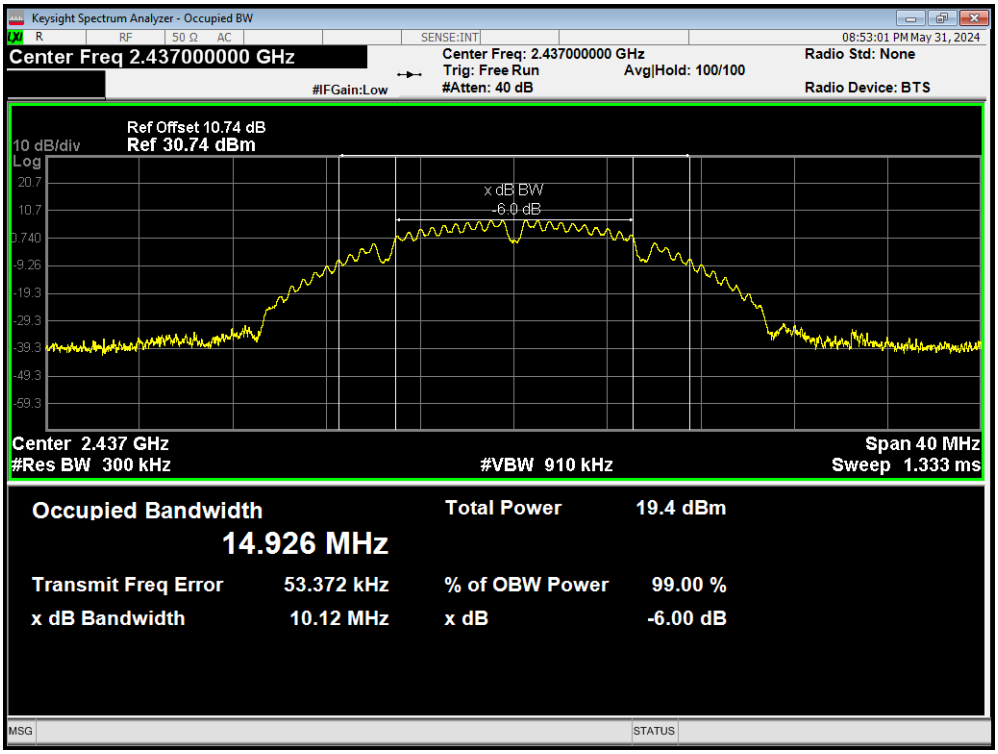
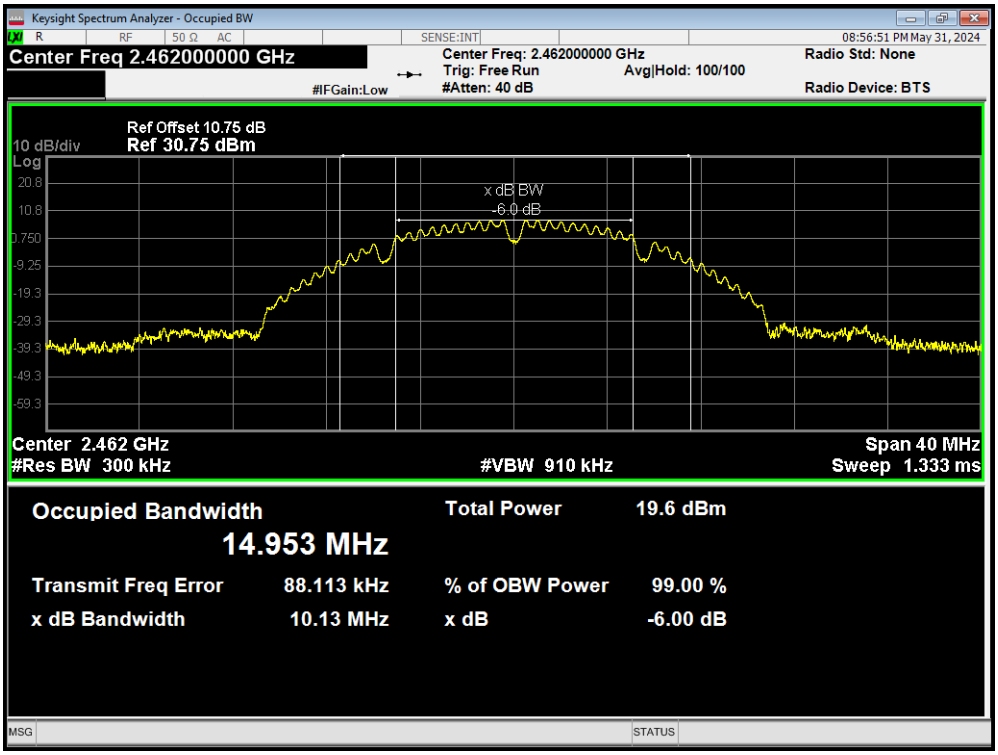
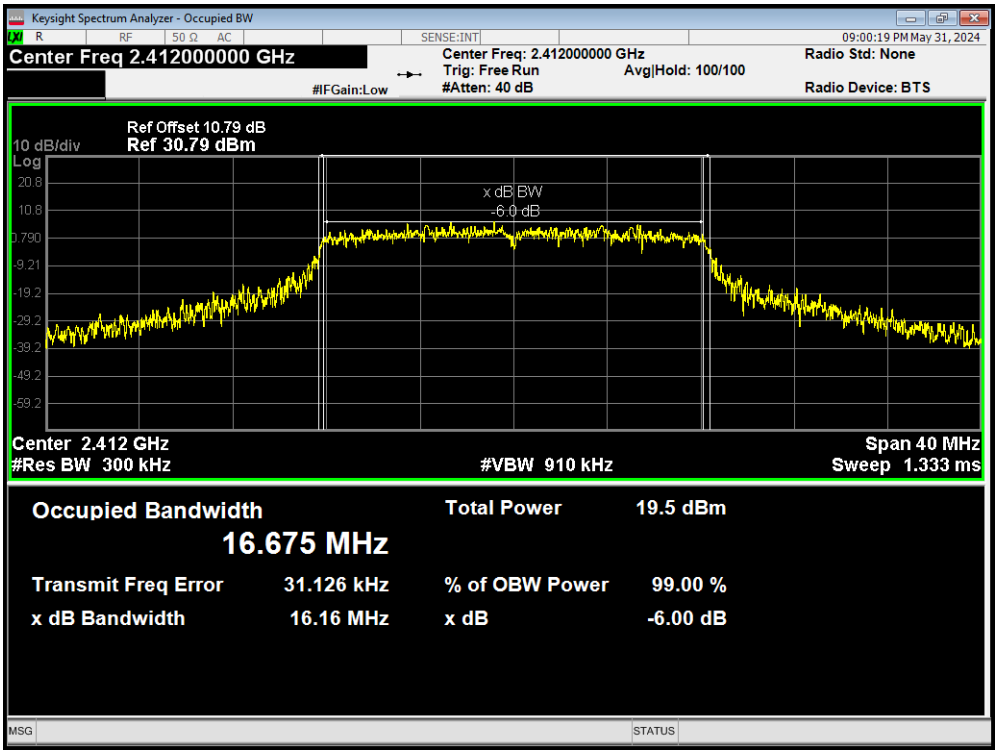


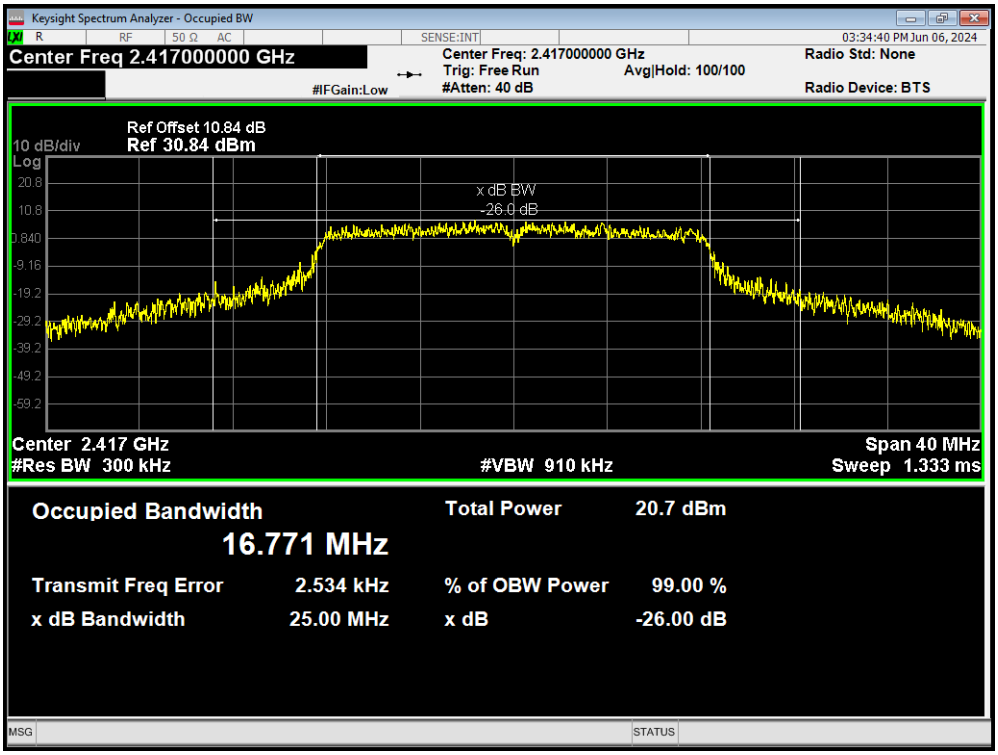
OBW 802.11b 2462MHz



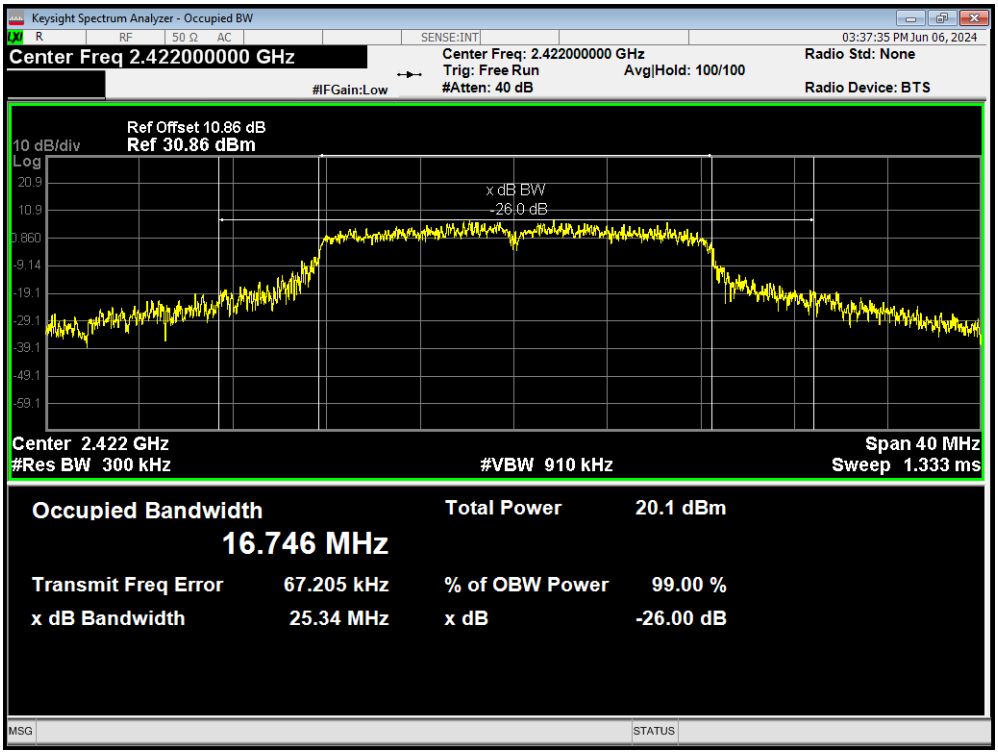
OBW 802.11g 2412MHz



OBW 802.11g 2417MHz



OBW 802.11g 2422MHz



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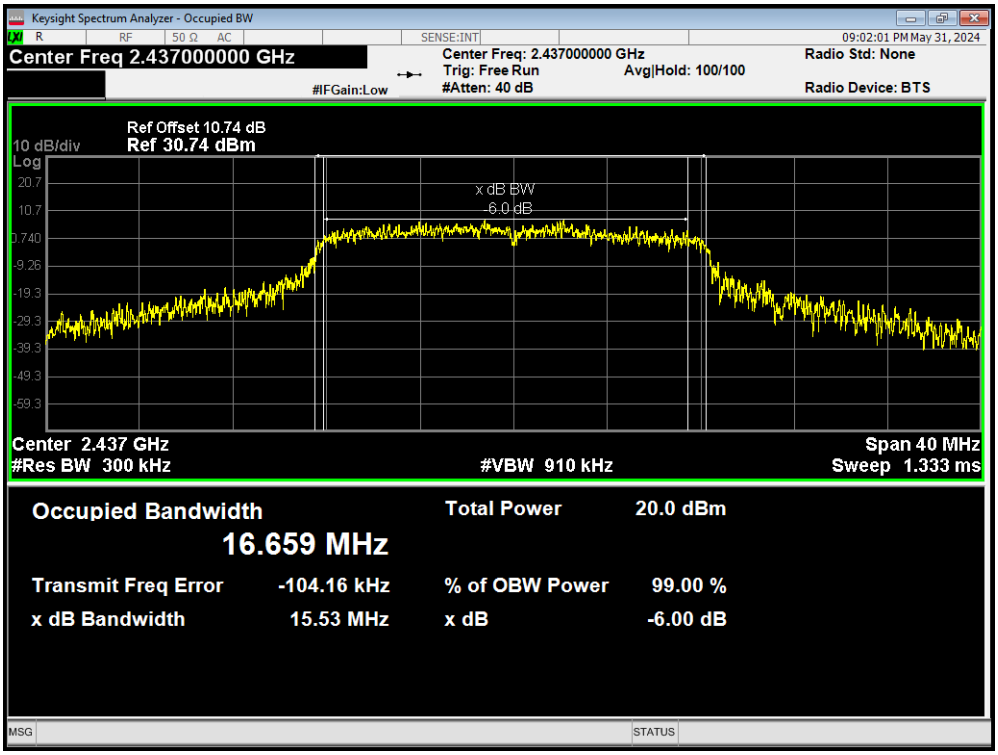
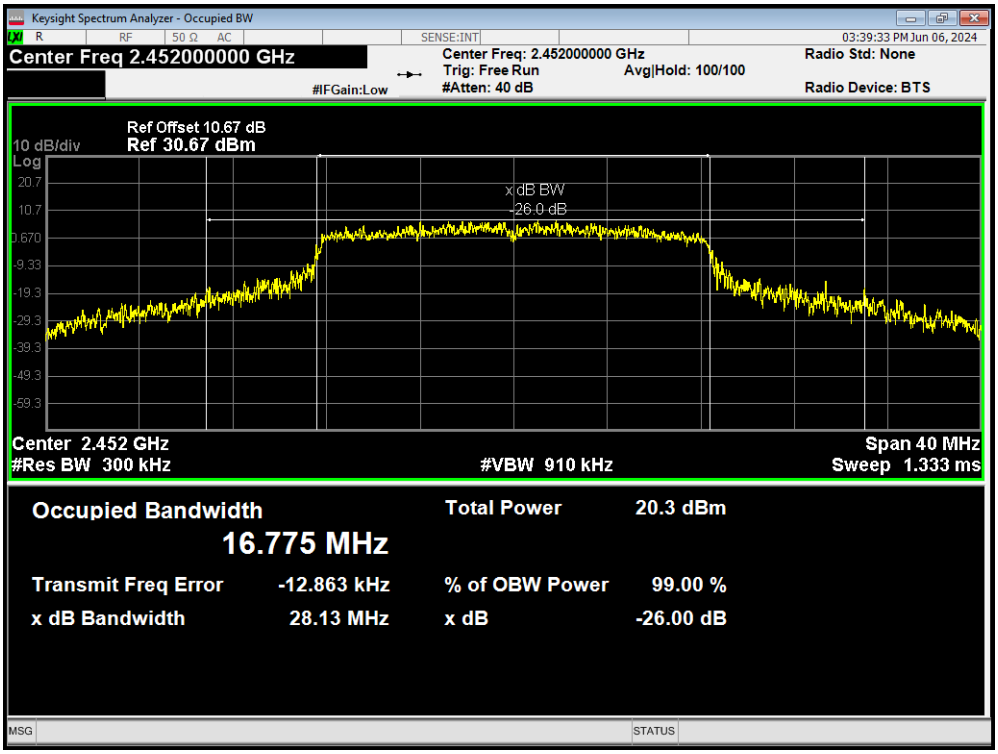
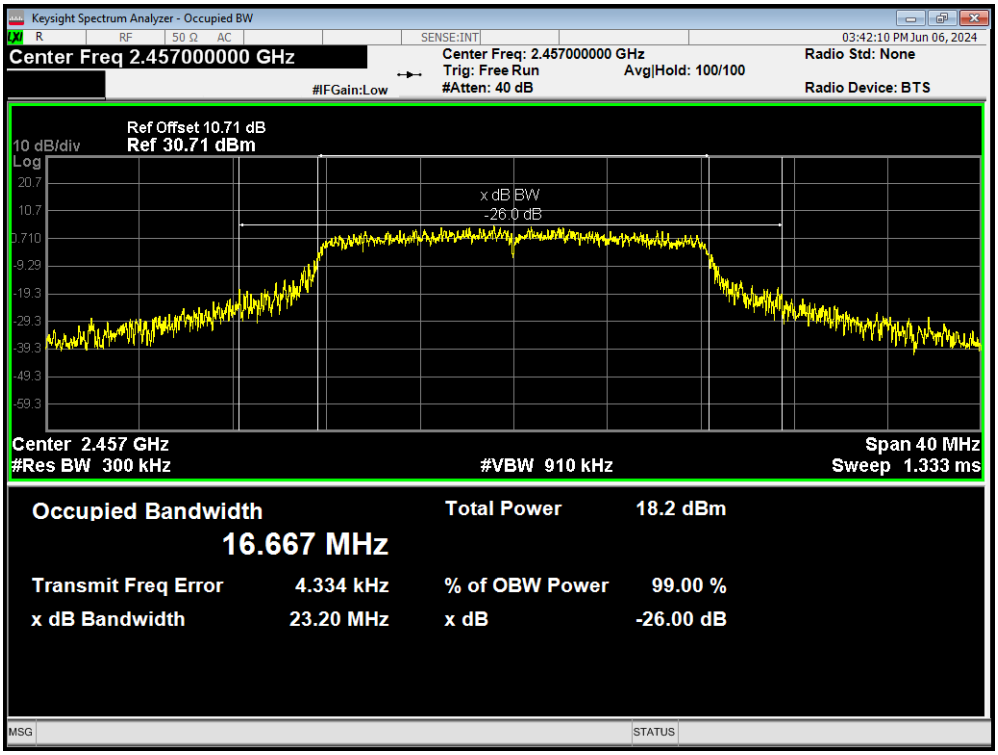


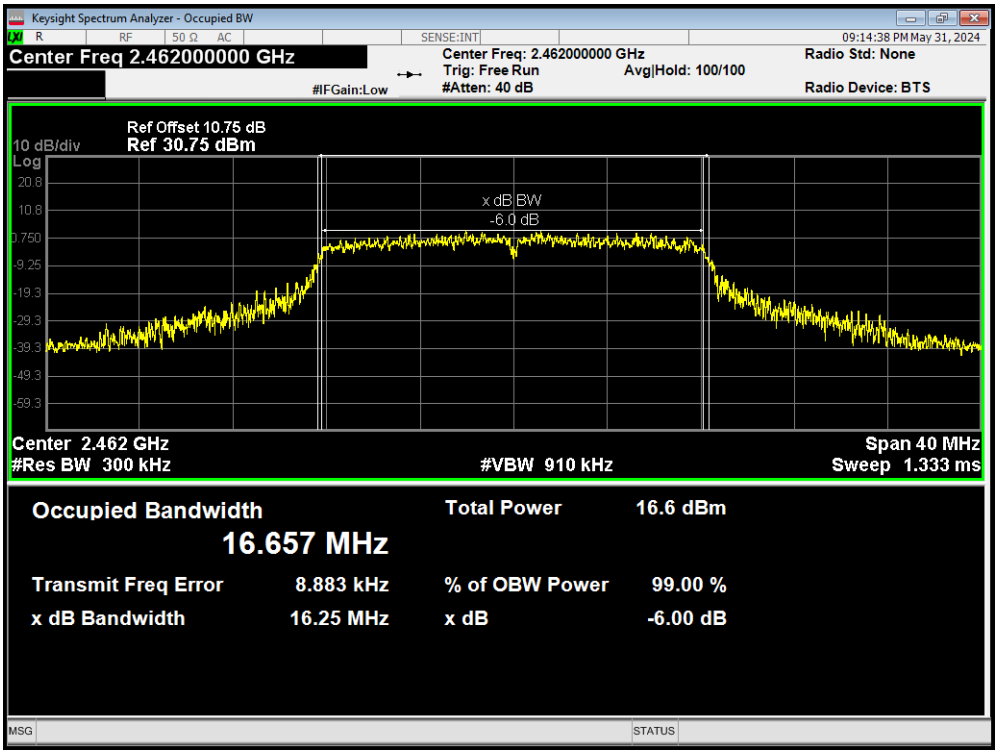
OBW 802.11g 2452MHz



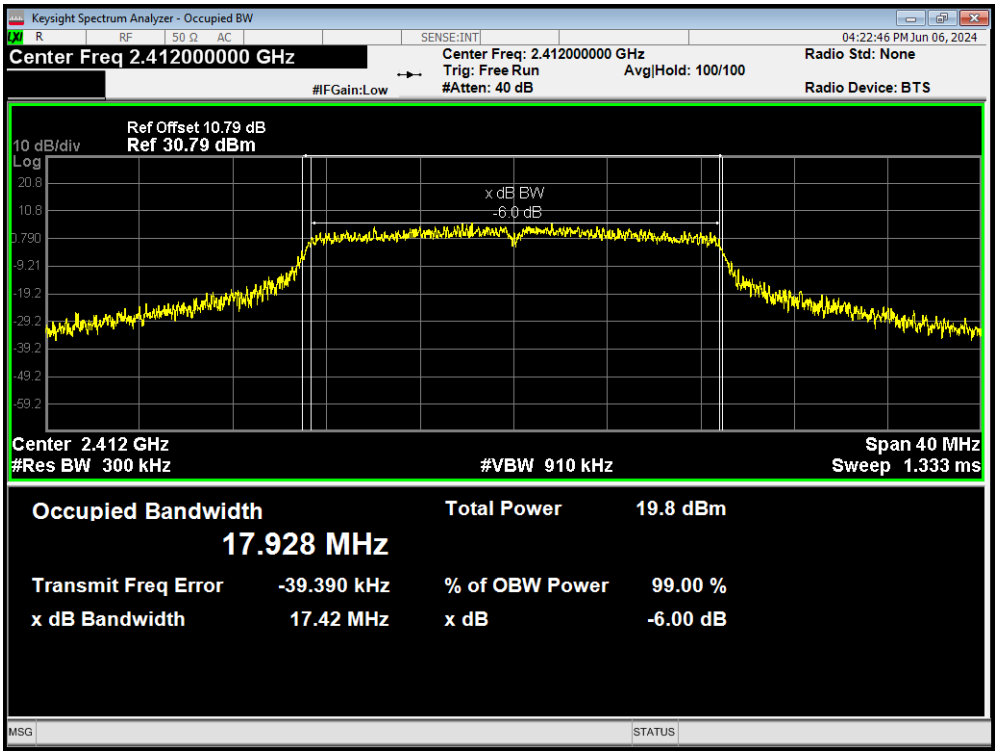
OBW 802.11g 2457MHz



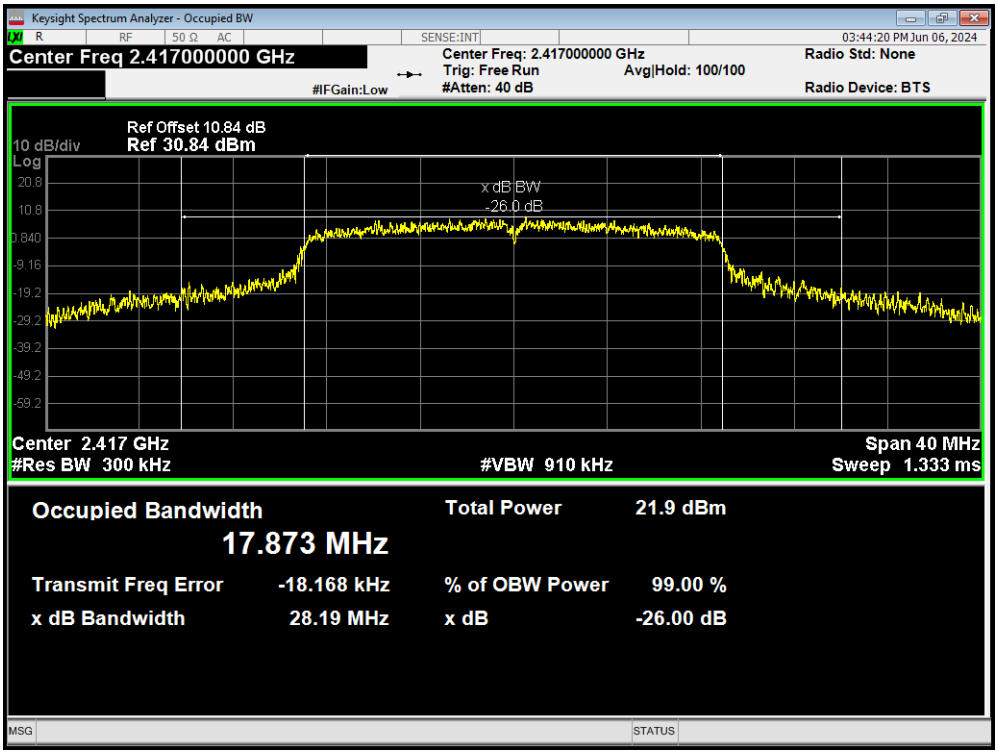
OBW 802.11g 2462MHz



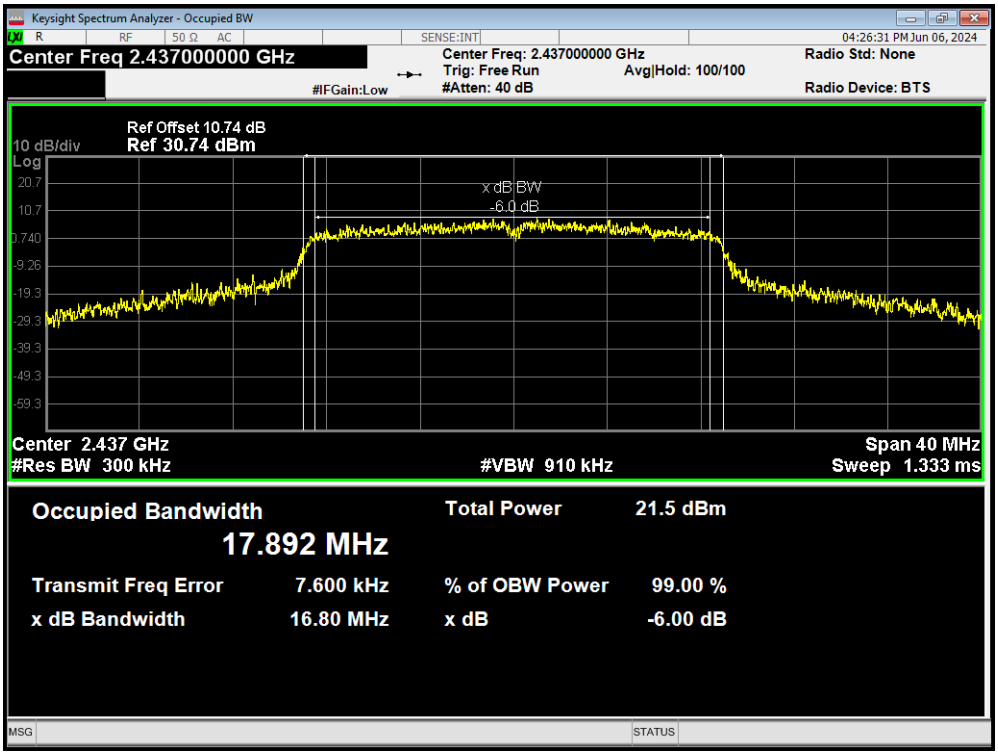
OBW 802.11n(HT20) 2412MHz



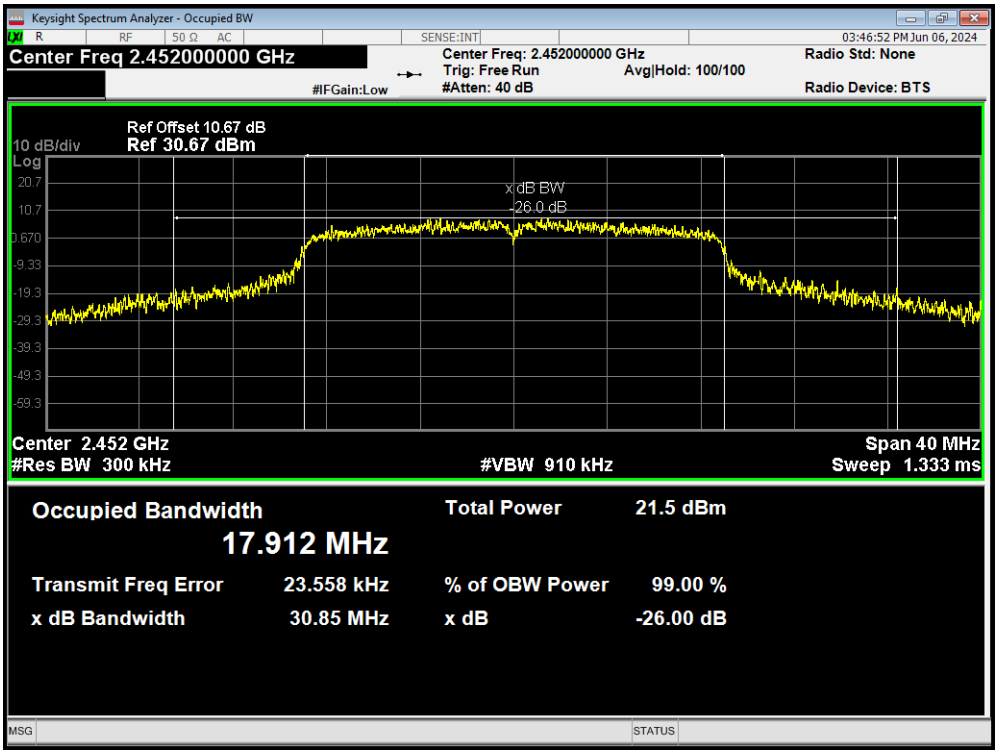
OBW 802.11n(HT20) 2417MHz



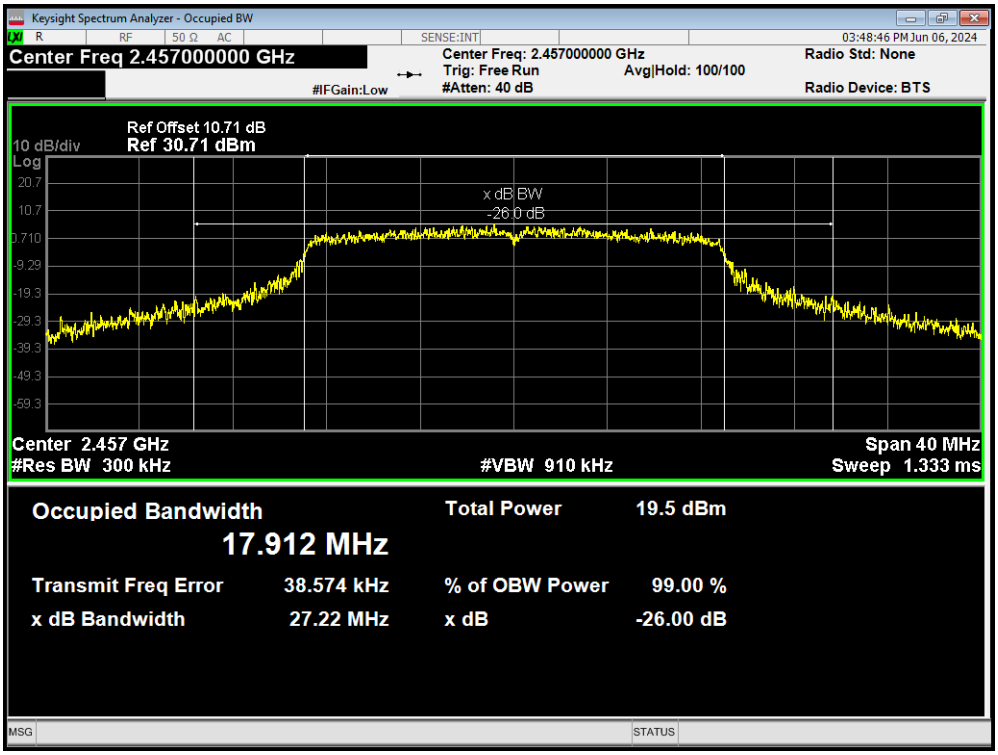
OBW 802.11n(HT20) 2437MHz



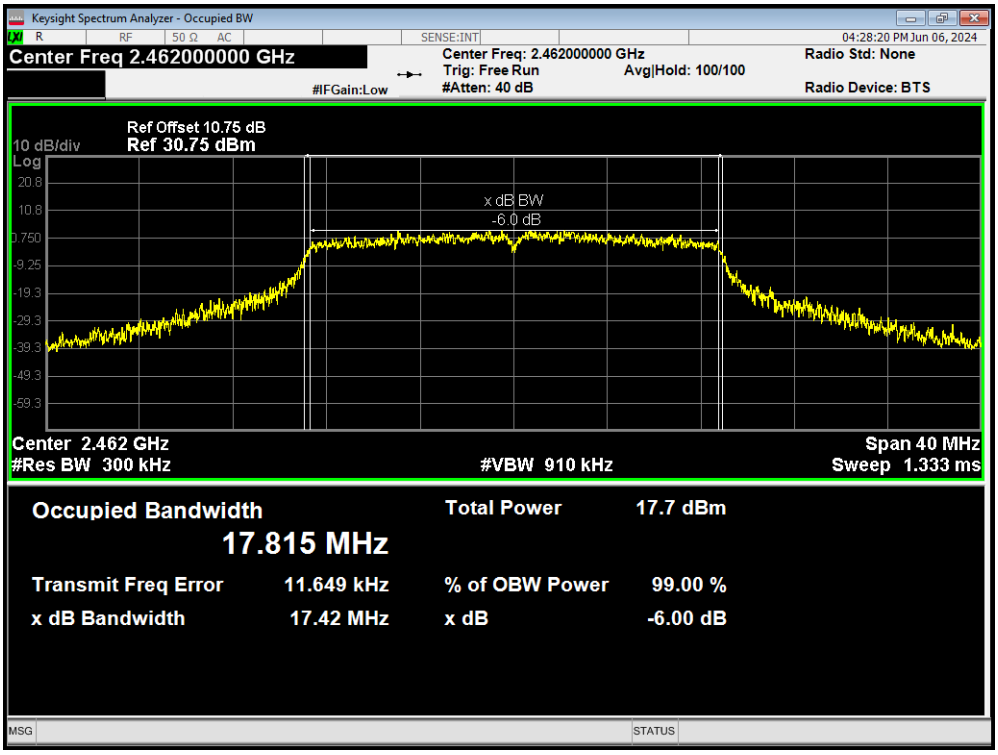
OBW 802.11n(HT20) 2452MHz



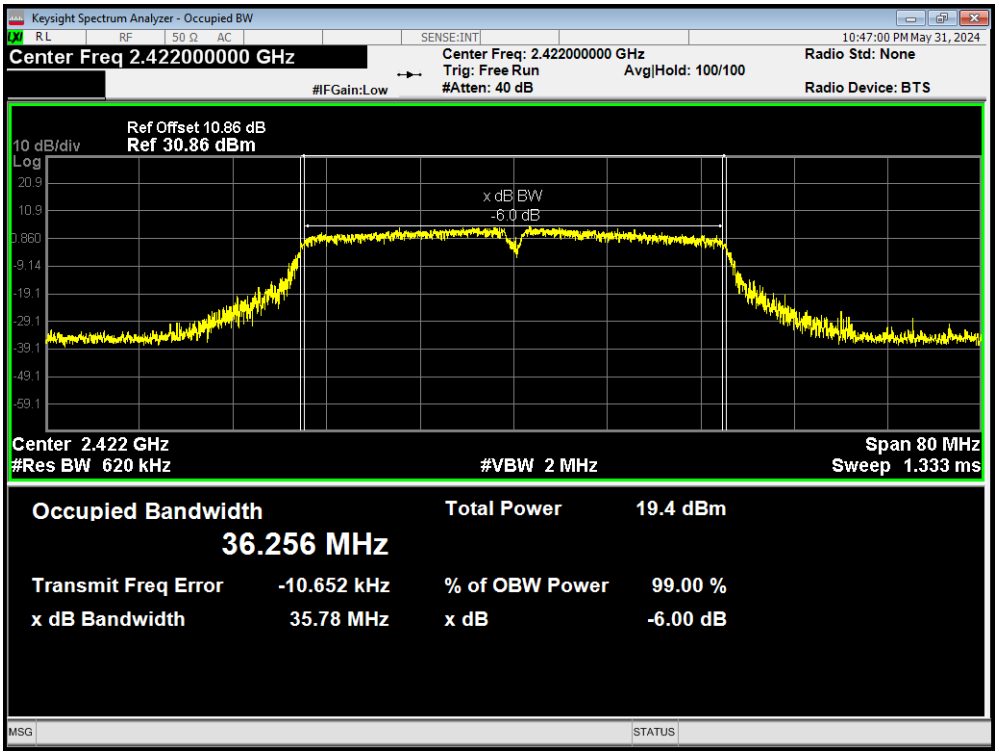
OBW 802.11n(HT20) 2457MHz



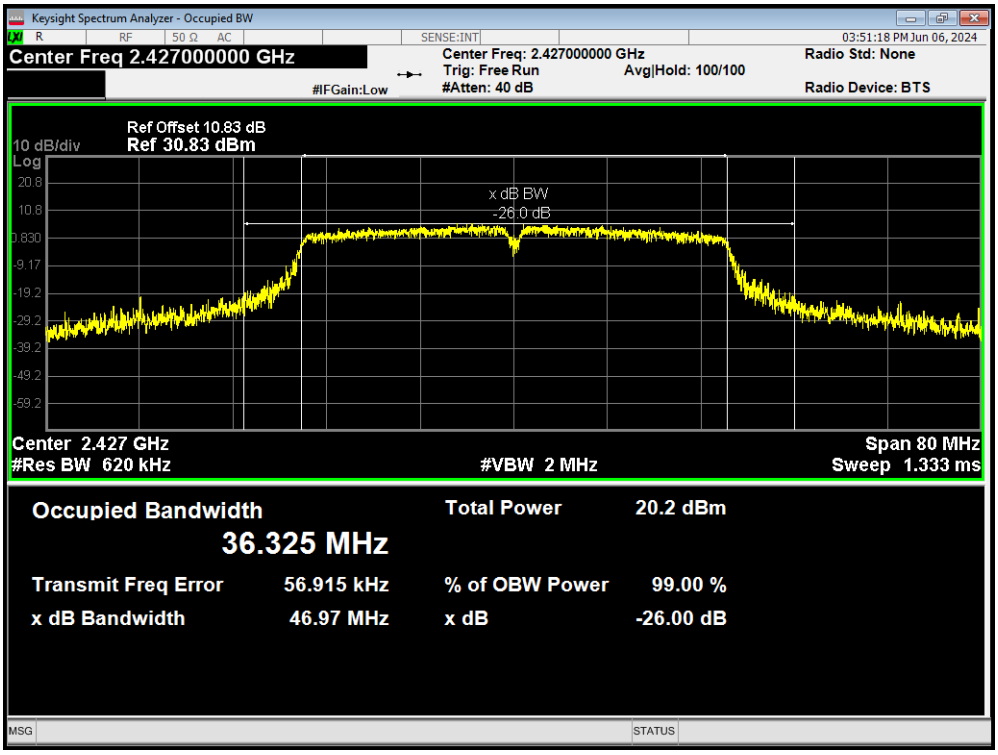
OBW 802.11n(HT20) 2462MHz



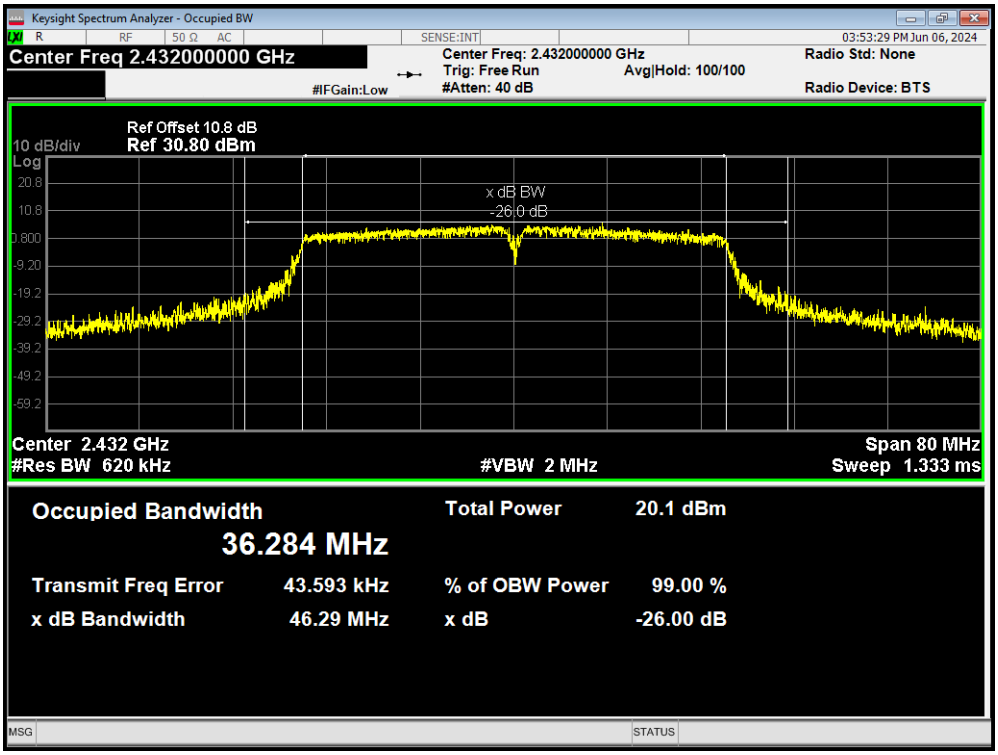
OBW 802.11n(HT40) 2422MHz



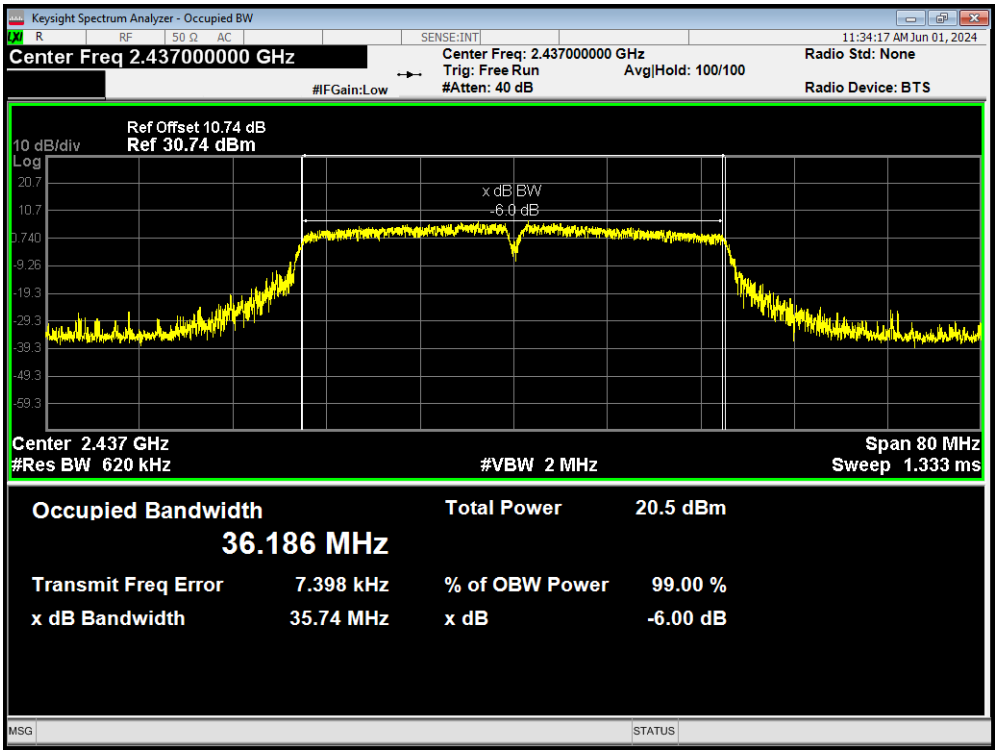
OBW 802.11n(HT40) 2427MHz



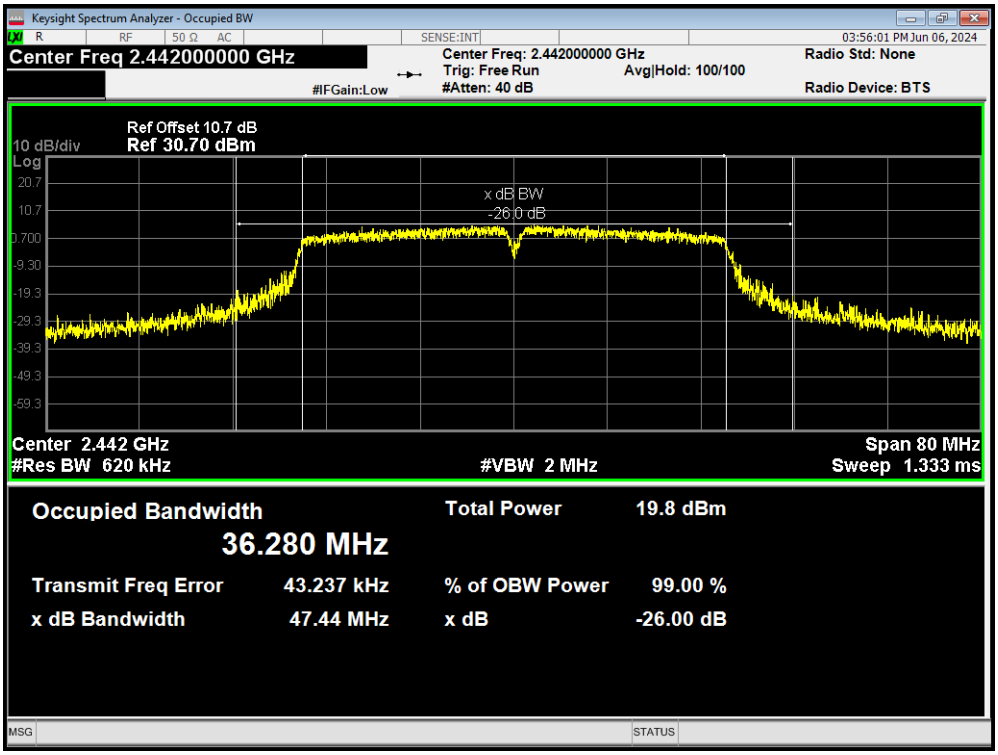
OBW 802.11n(HT40) 2432MHz



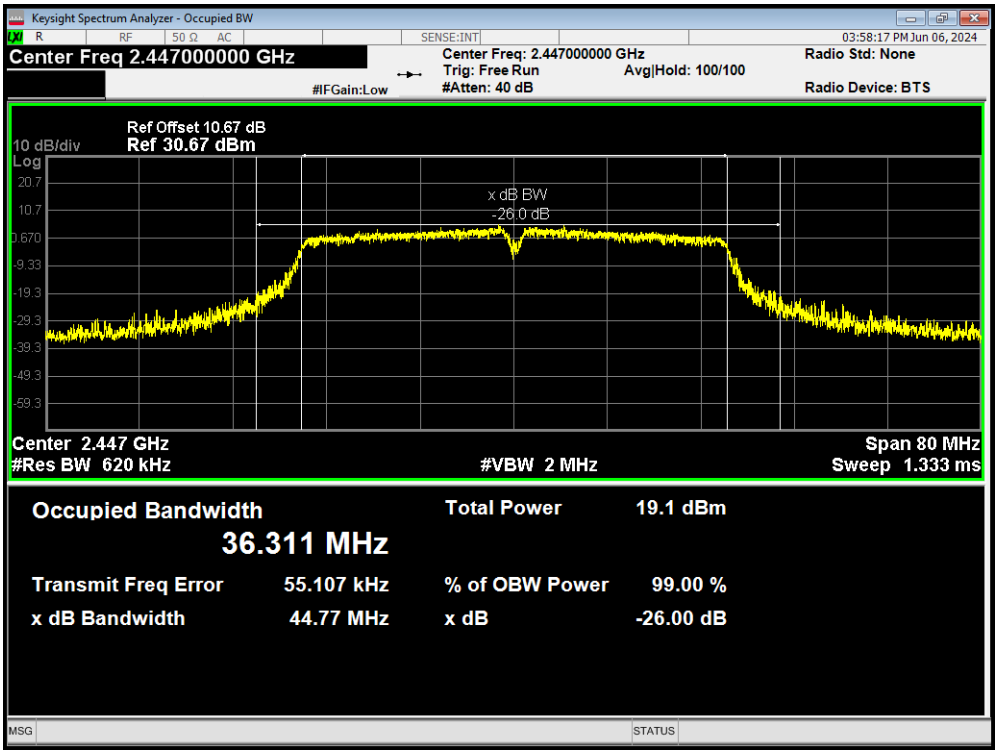
OBW 802.11n(HT40) 2437MHz



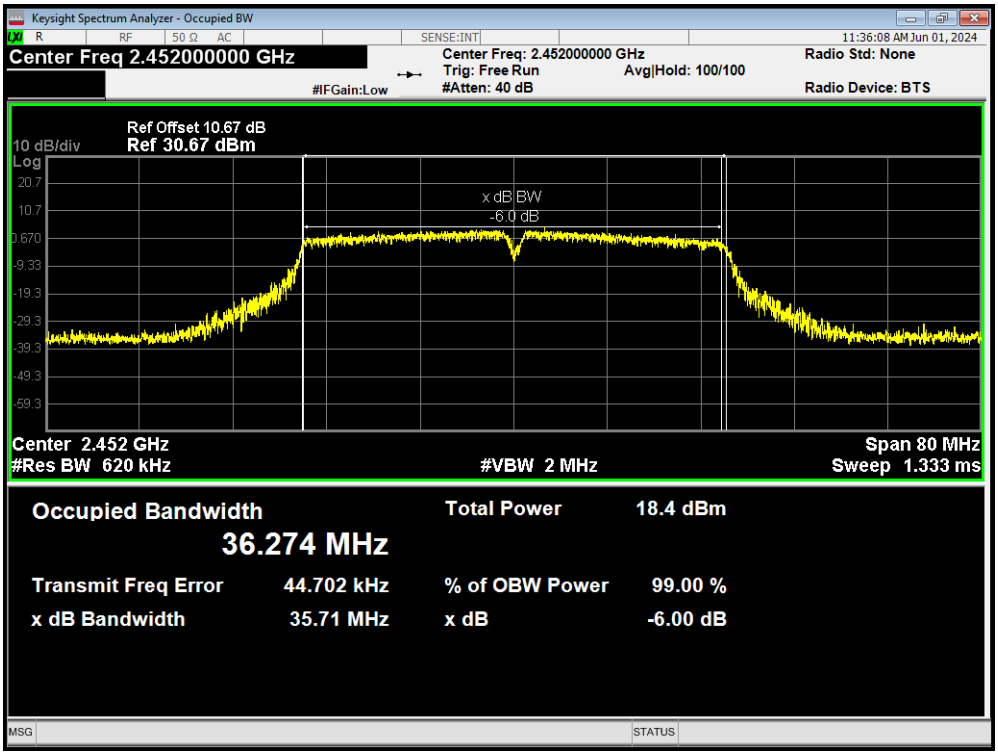
OBW 802.11n(HT40) 2442MHz



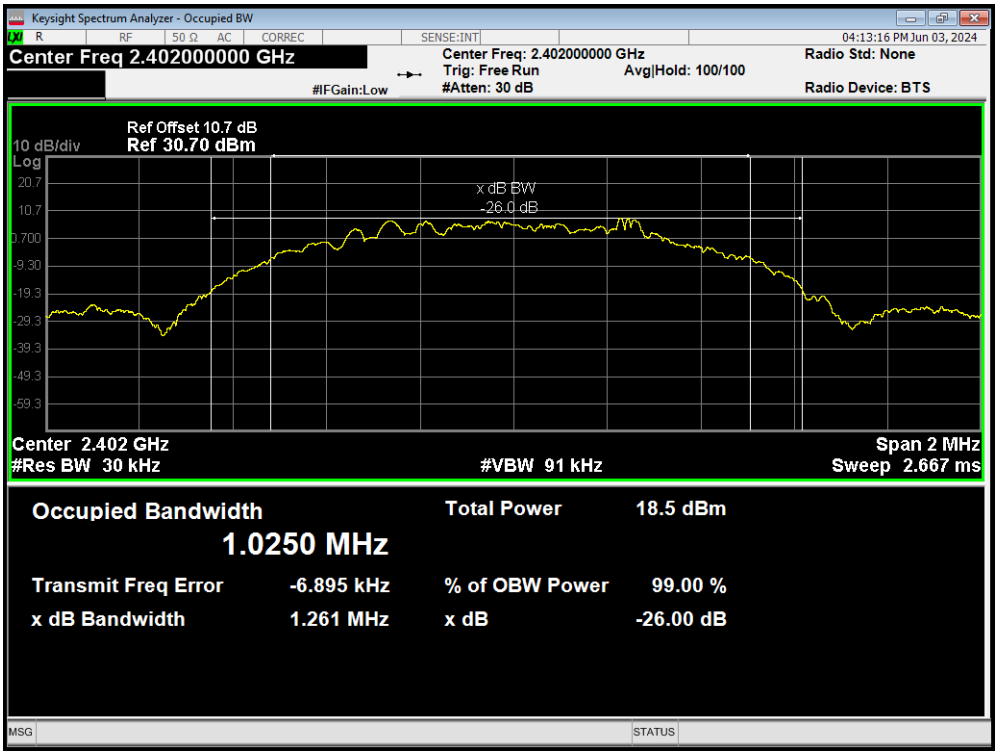
OBW 802.11n(HT40) 2447MHz



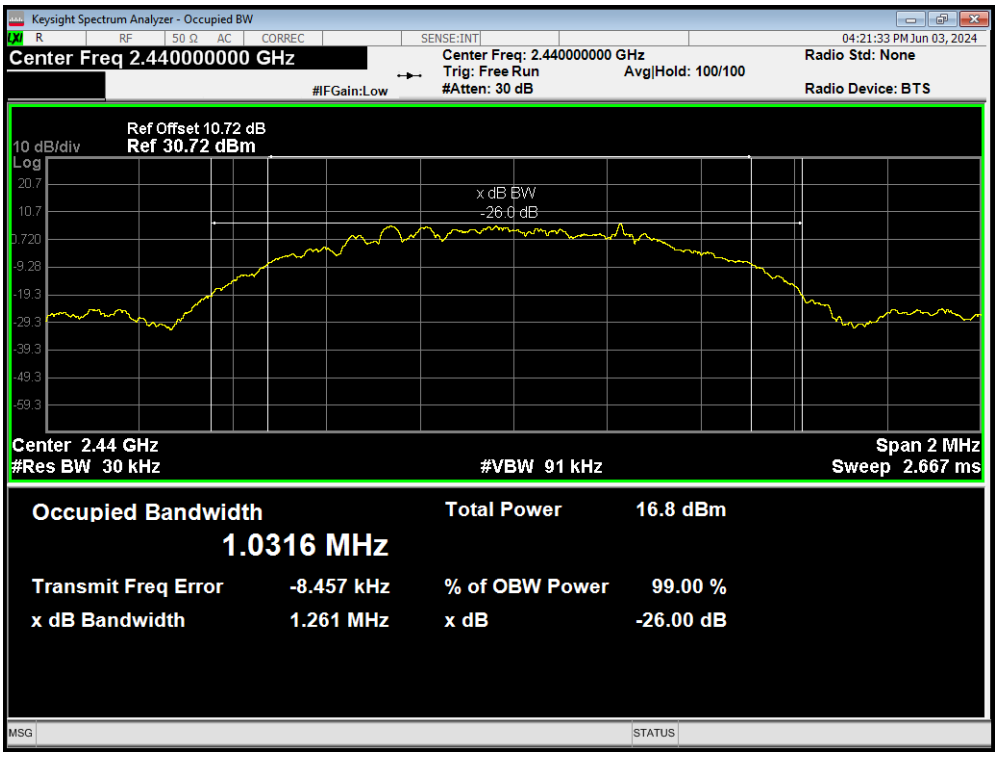
OBW 802.11n(HT40) 2452MHz



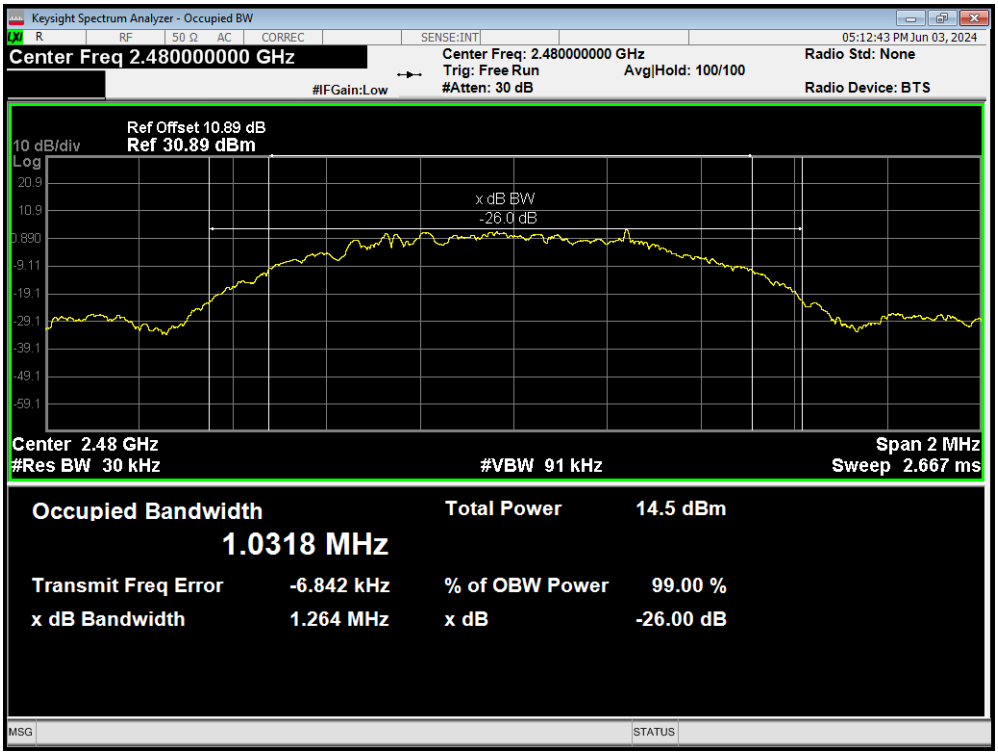
OBW Bluetooth LE (1M) 2402MHz



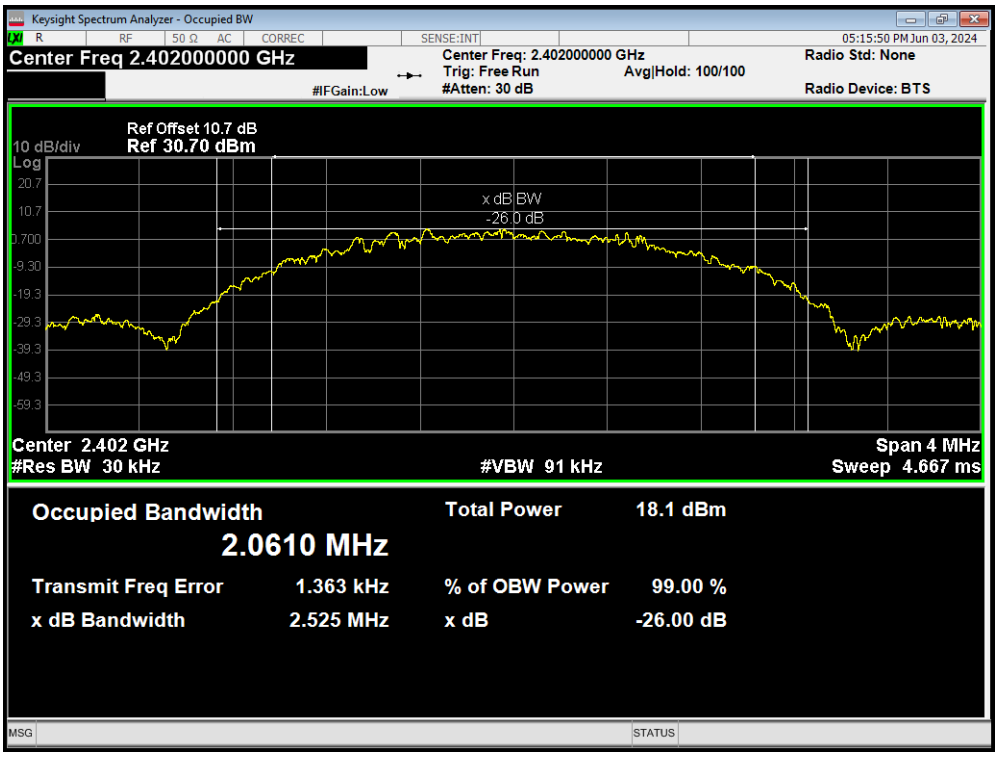
OBW Bluetooth LE (1M) 2440MHz



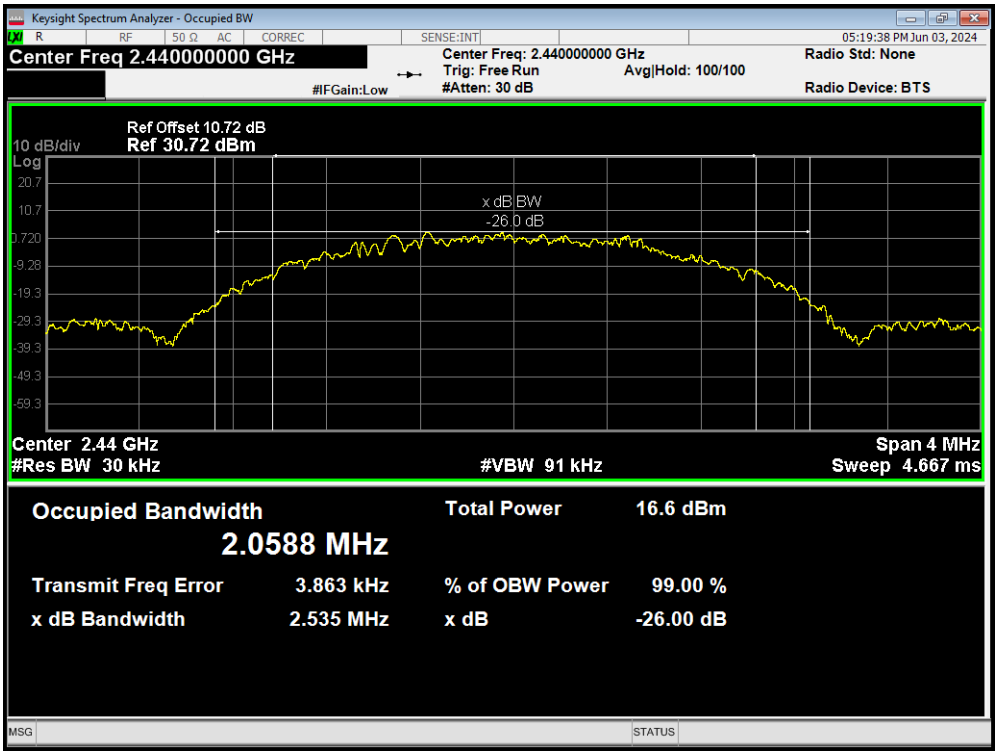
OBW Bluetooth LE (1M) 2480MHz



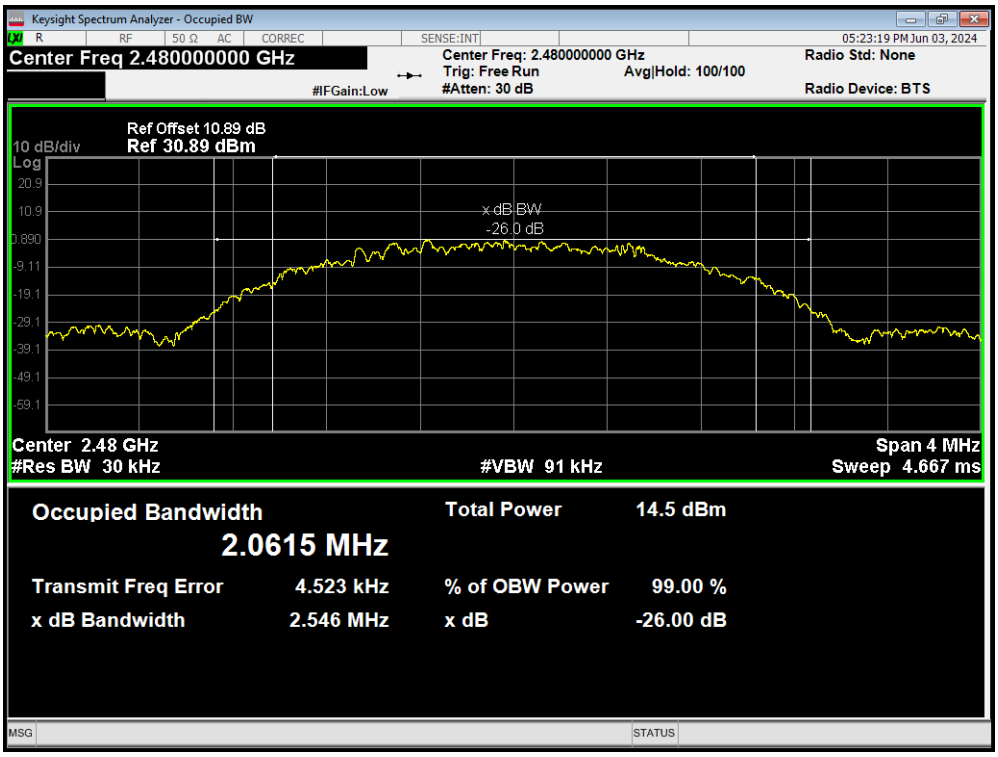
OBW Bluetooth LE (2M) 2402MHz



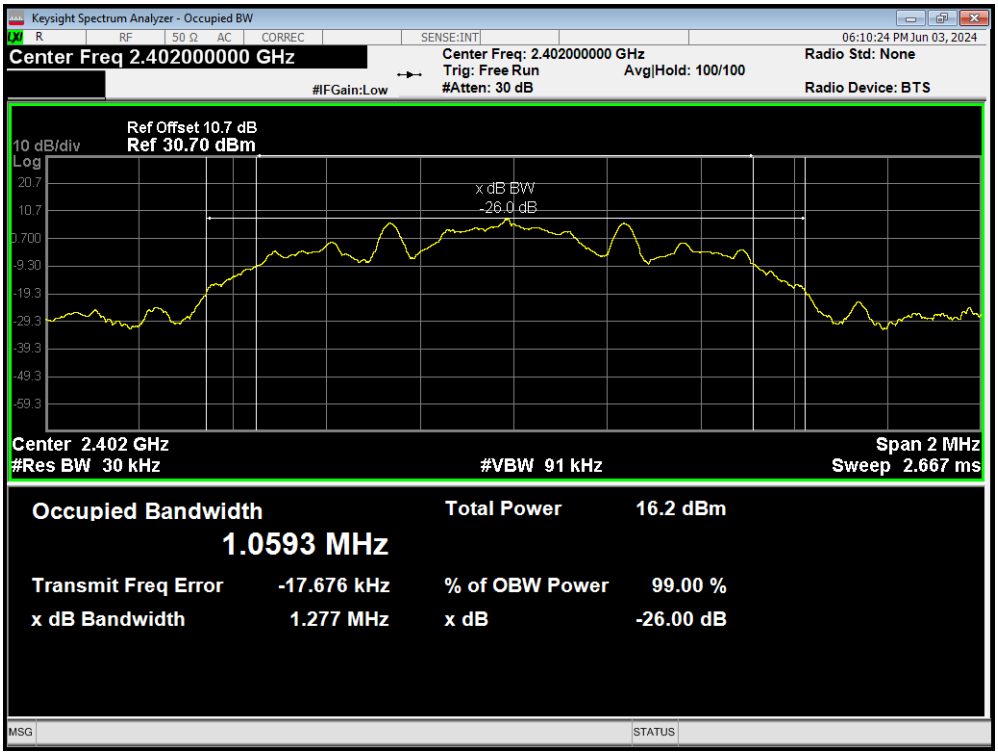
OBW Bluetooth LE (2M) 2440MHz



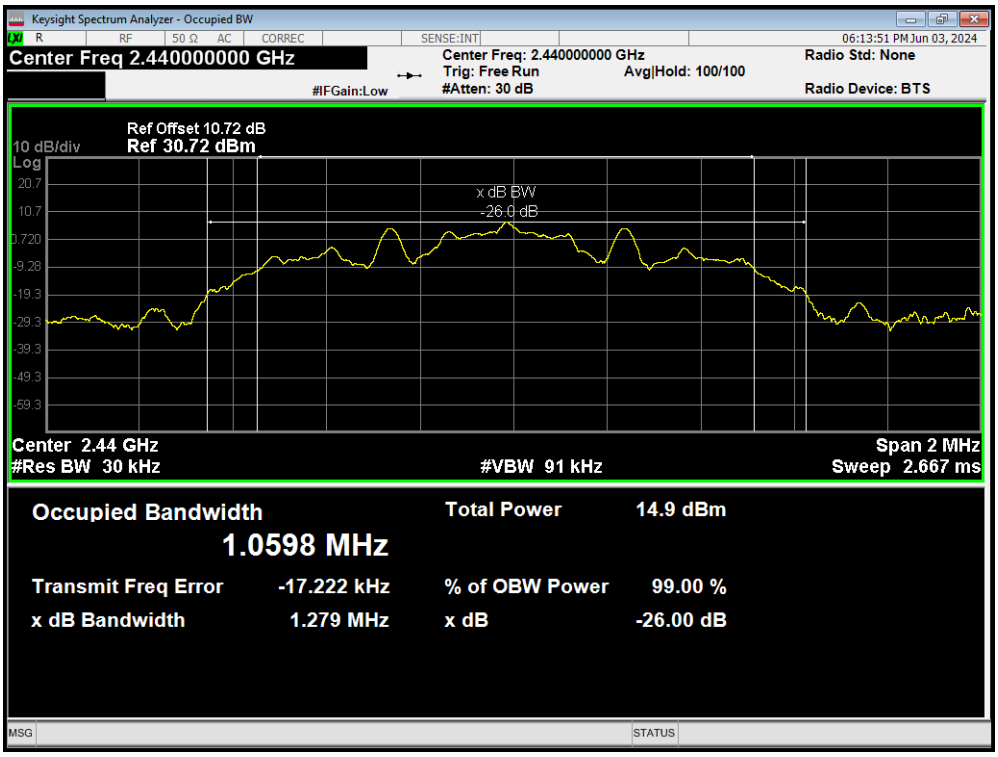
OBW Bluetooth LE (2M) 2480MHz



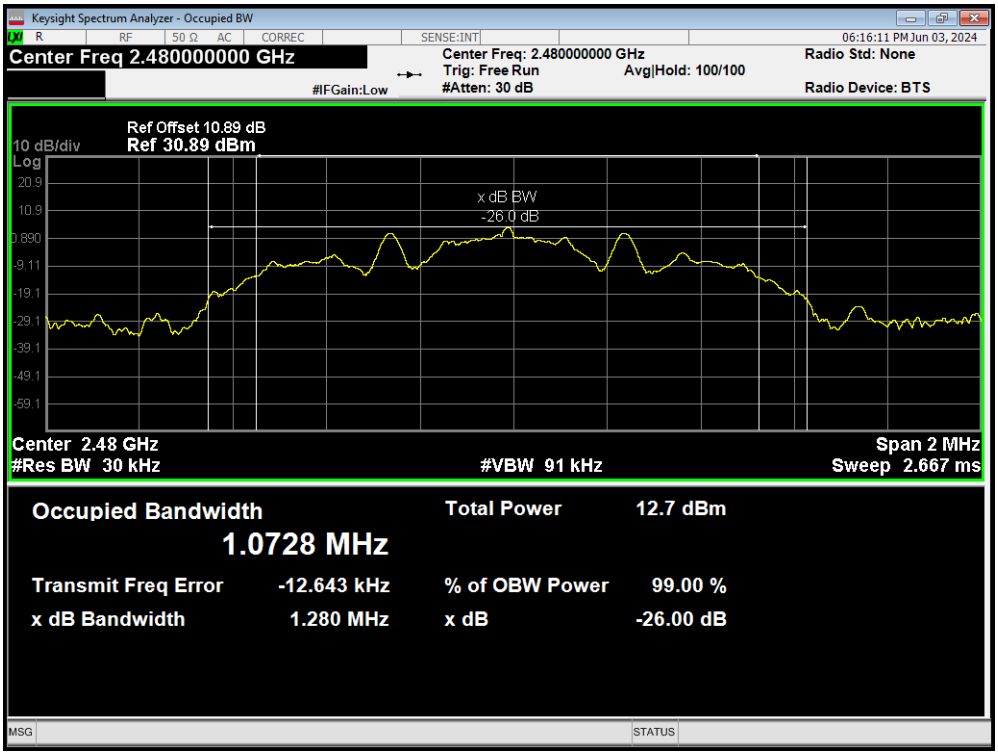
OBW Bluetooth LE (S=2) 2402MHz



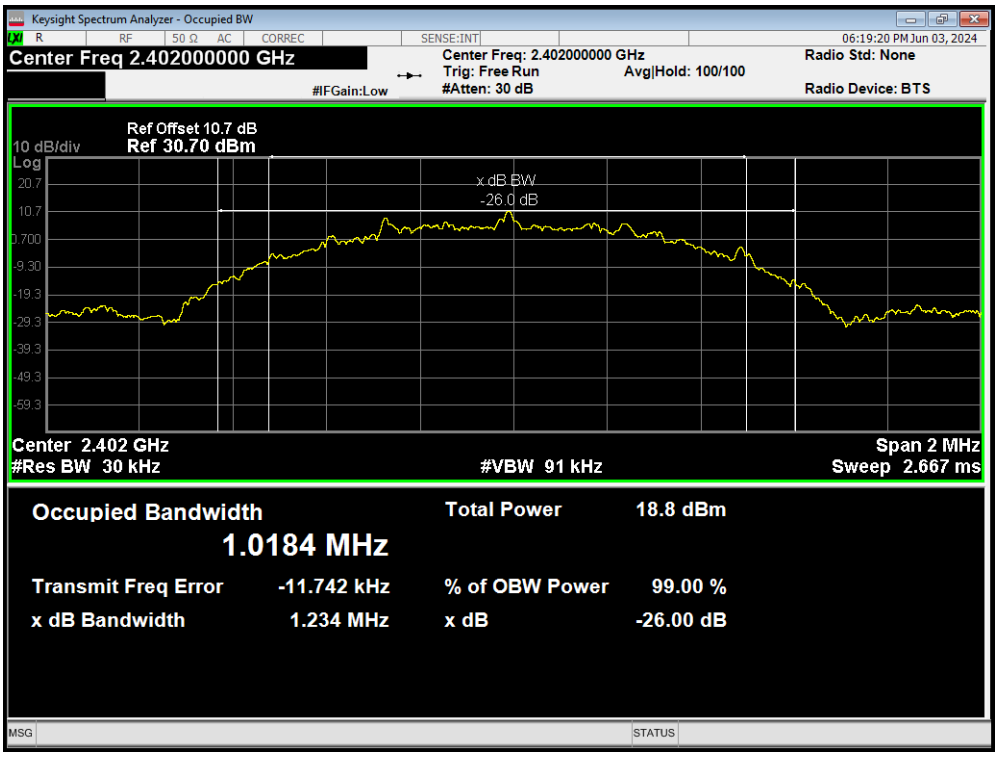
OBW Bluetooth LE (S=2) 2440MHz



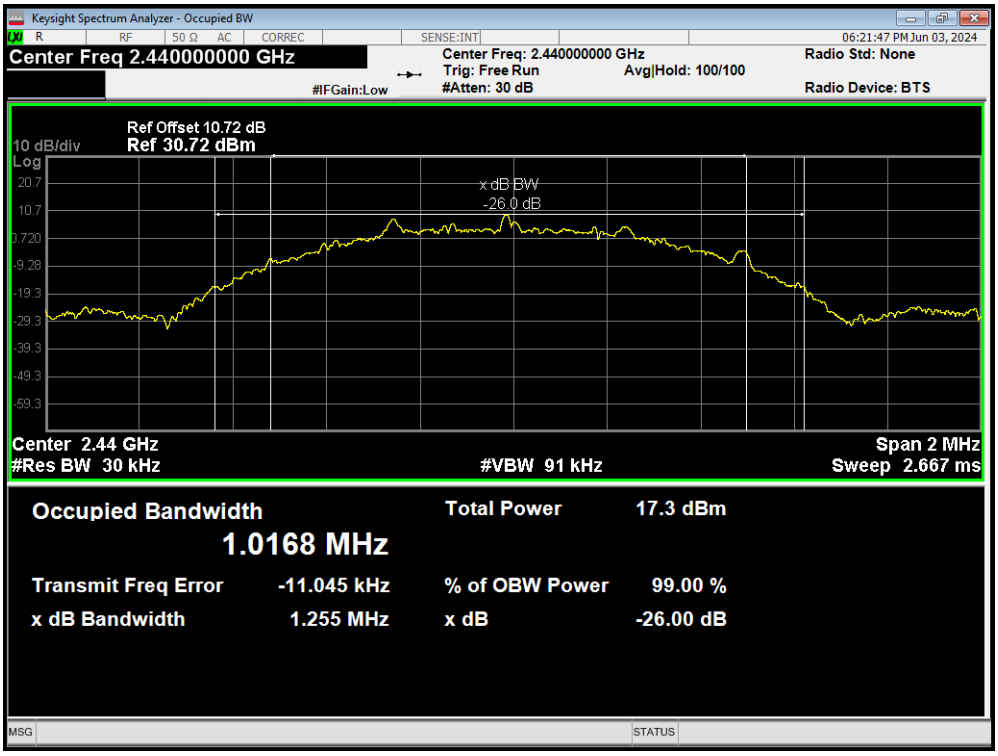
OBW Bluetooth LE (S=2) 2480MHz



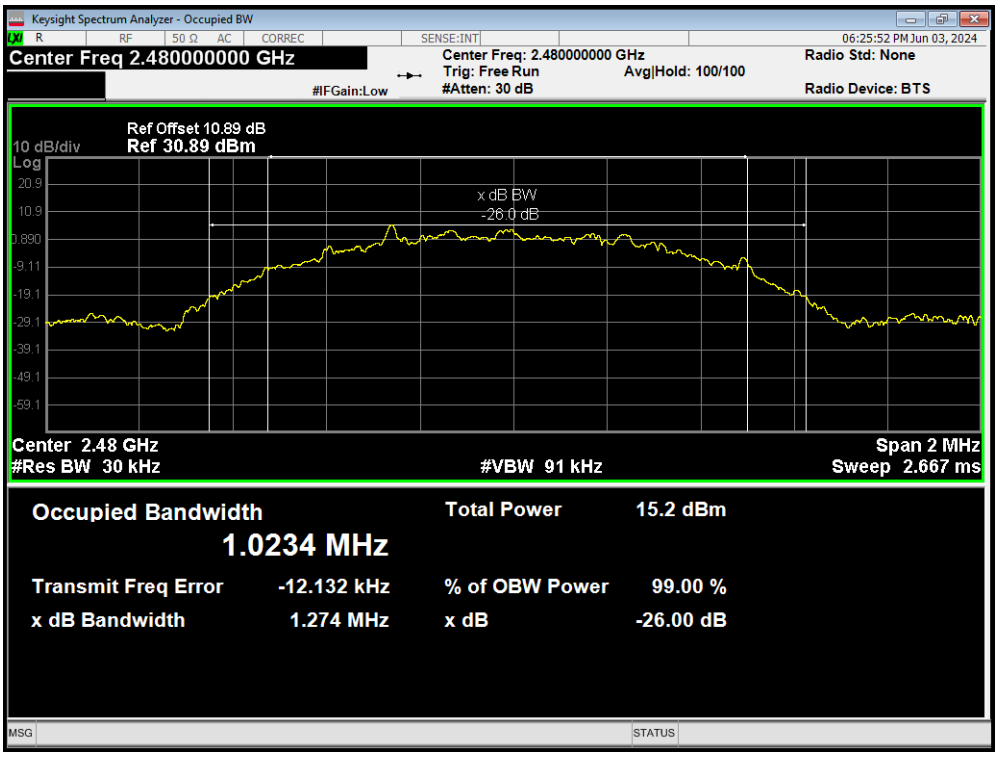
OBW Bluetooth LE (S=8) 2402MHz



OBW Bluetooth LE (S=8) 2440MHz

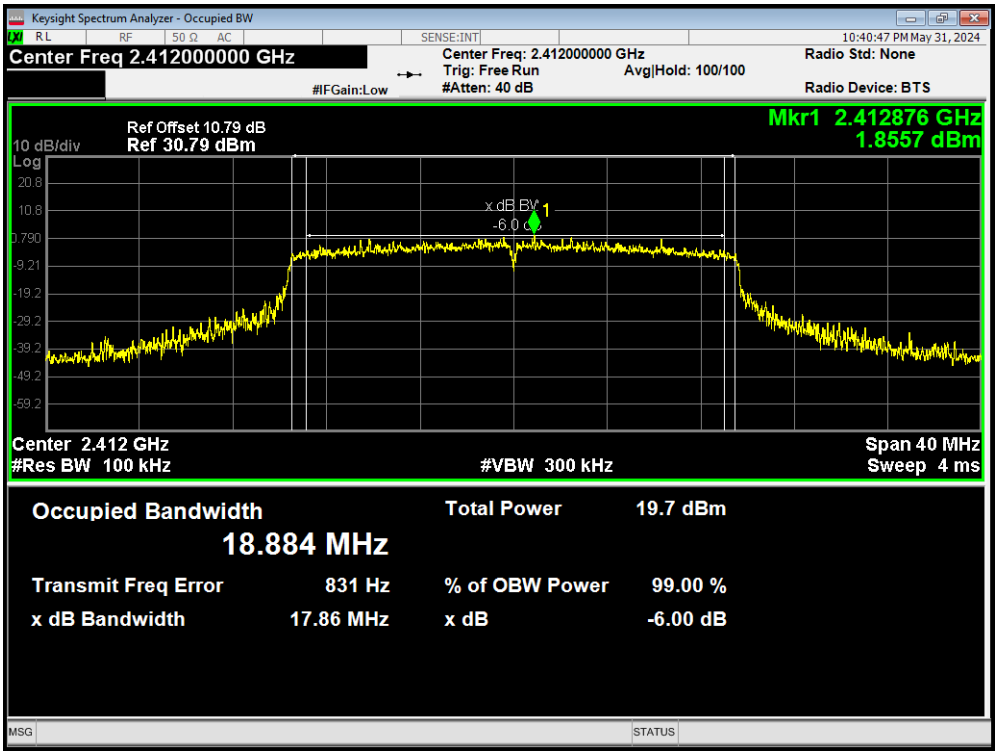


OBW Bluetooth LE (S=8) 2480MHz

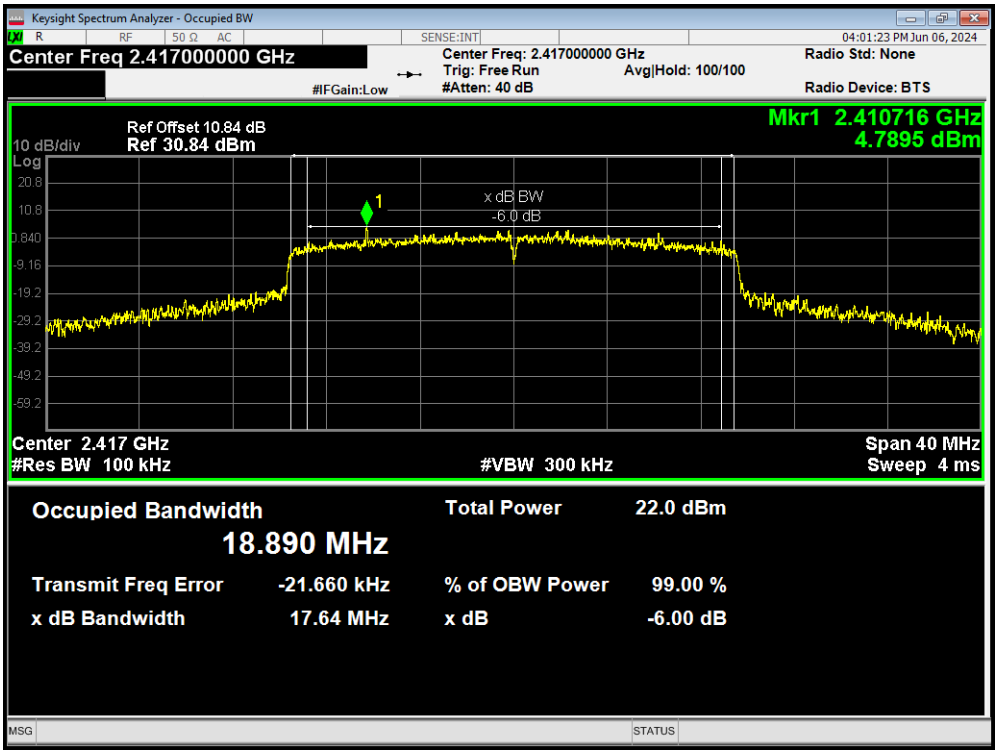


6 dB bandwidth

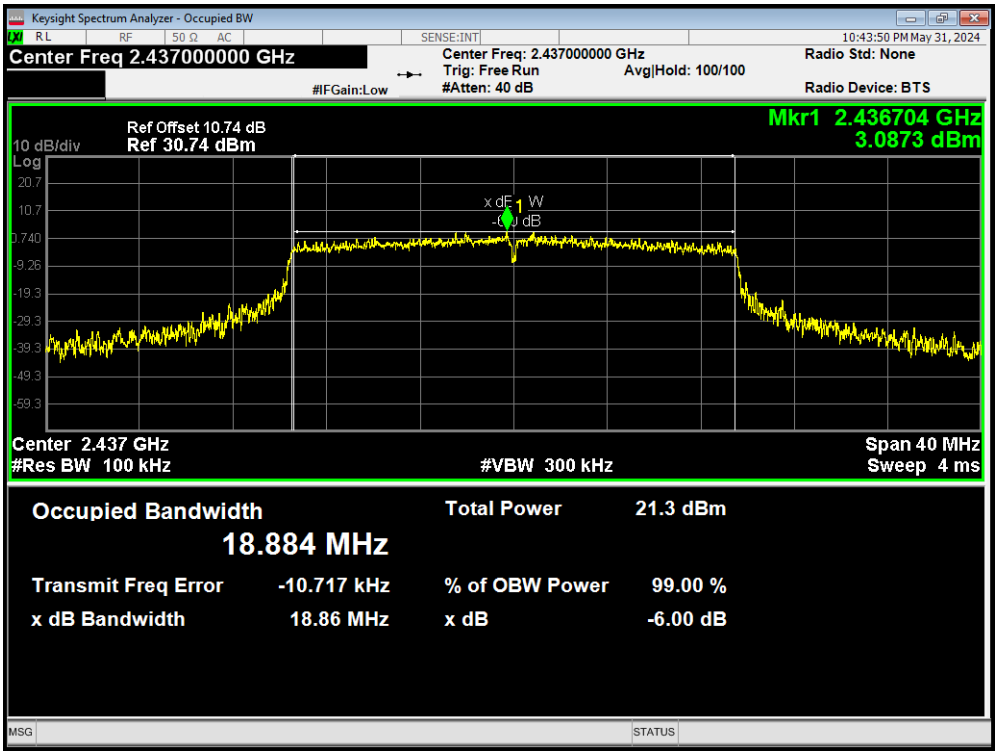
-6dB Bandwidth 802.11ax(HE20) 2412MHz



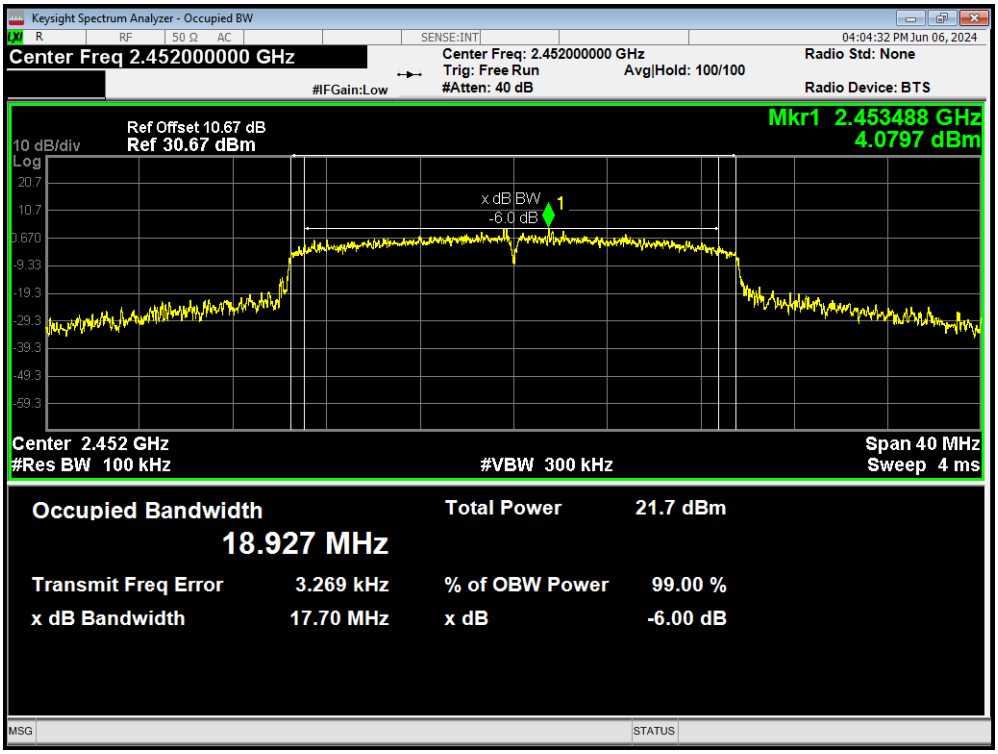
-6dB Bandwidth 802.11ax(HE20) 2417MHz



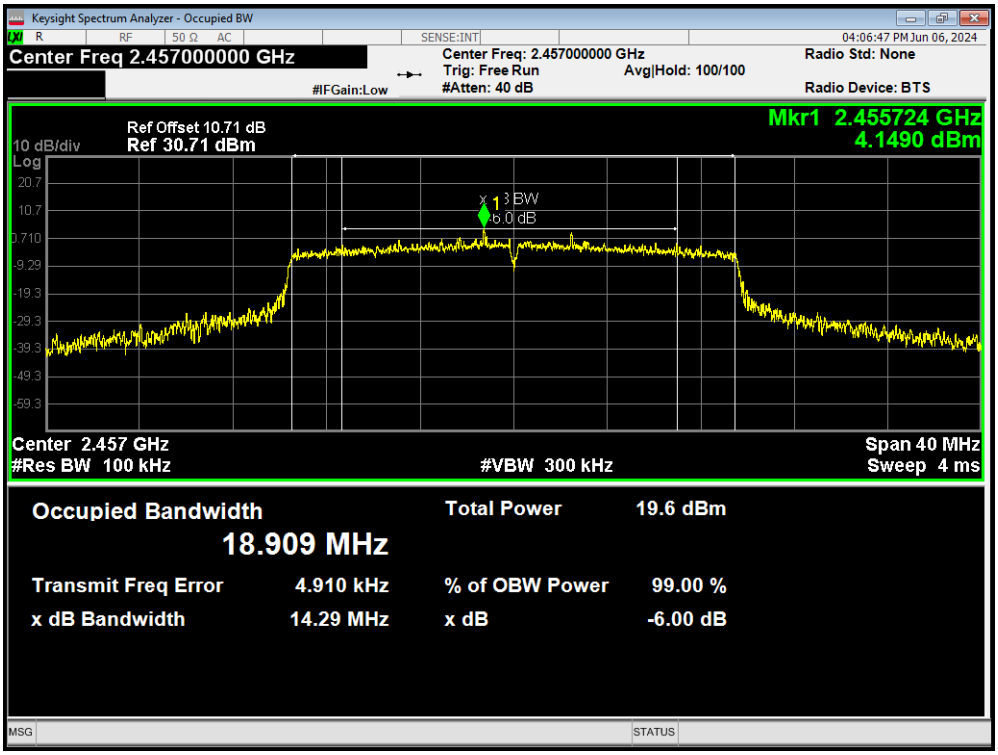
-6dB Bandwidth 802.11ax(HE20) 2437MHz



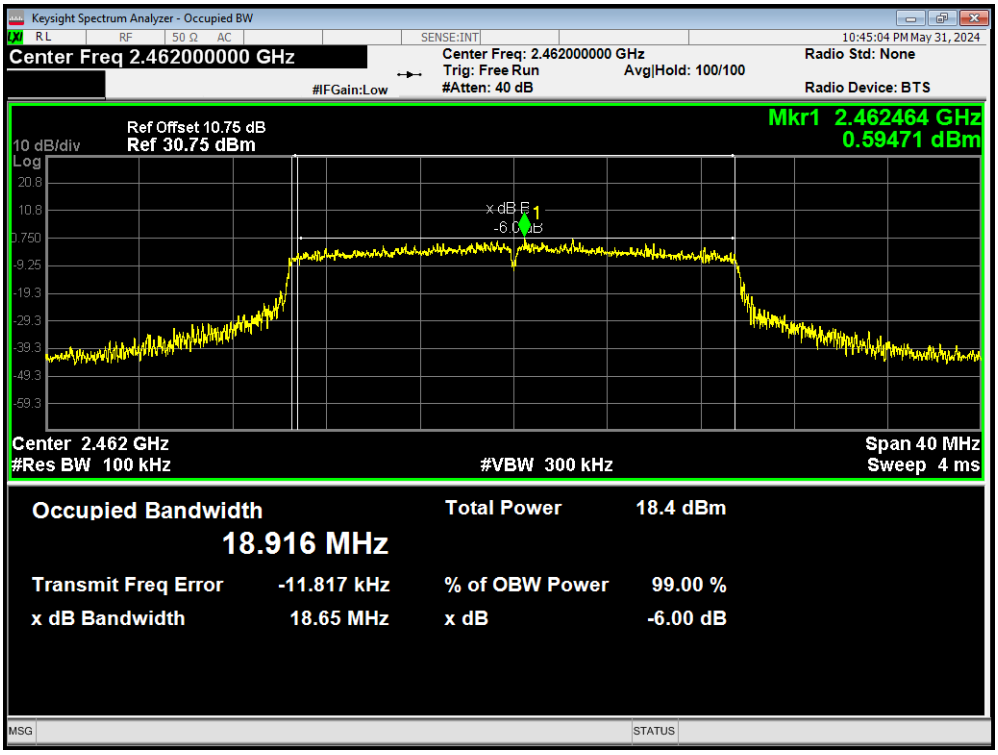
-6dB Bandwidth 802.11ax(HE20) 2452MHz



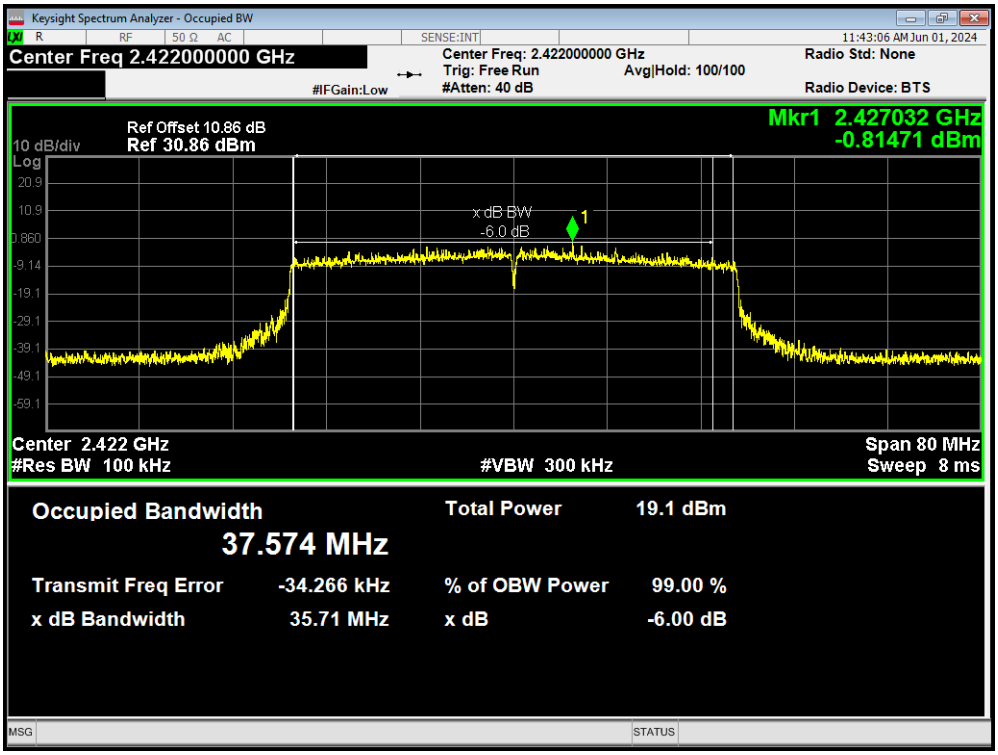
-6dB Bandwidth 802.11ax(HE20) 2457MHz



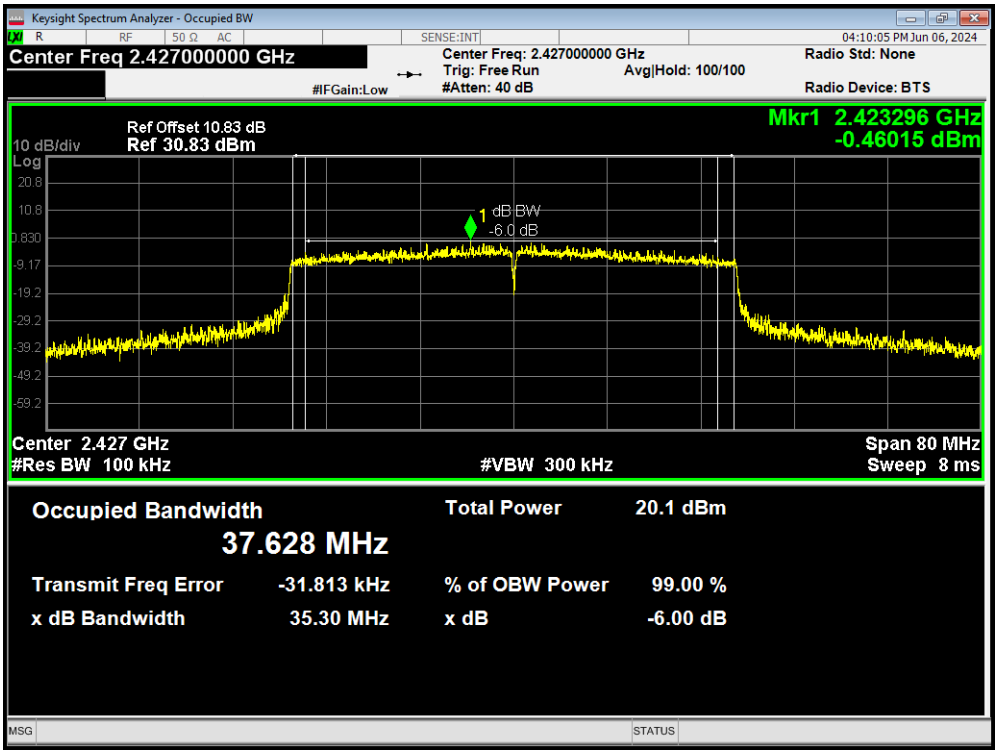
-6dB Bandwidth 802.11ax(HE20) 2462MHz



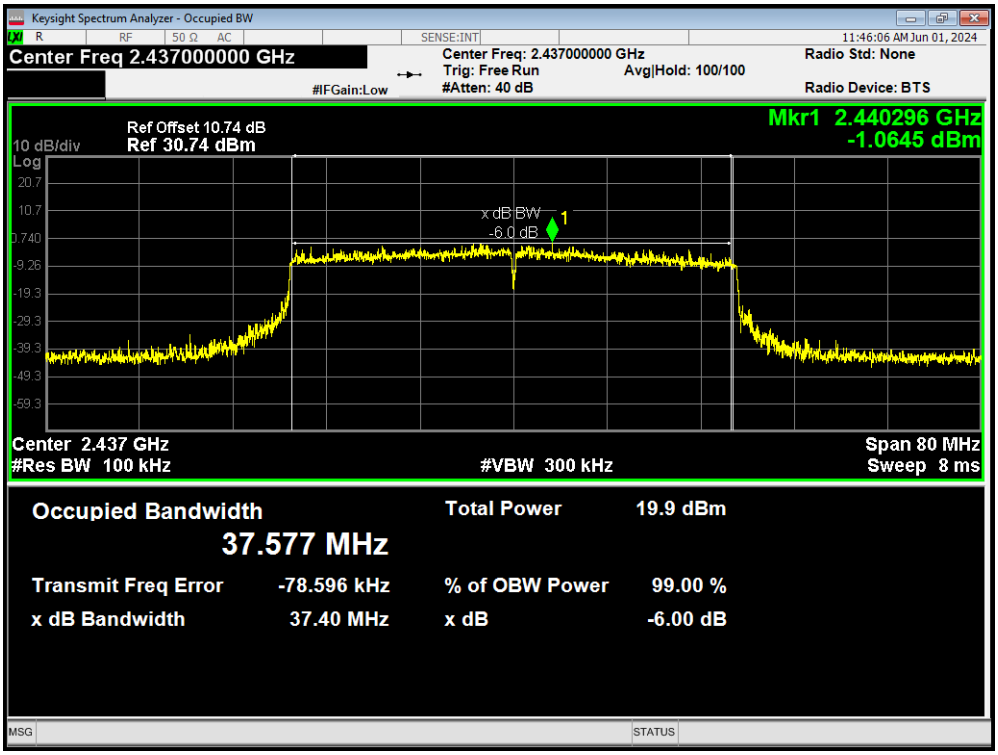
-6dB Bandwidth 802.11ax(HE40) 2422MHz



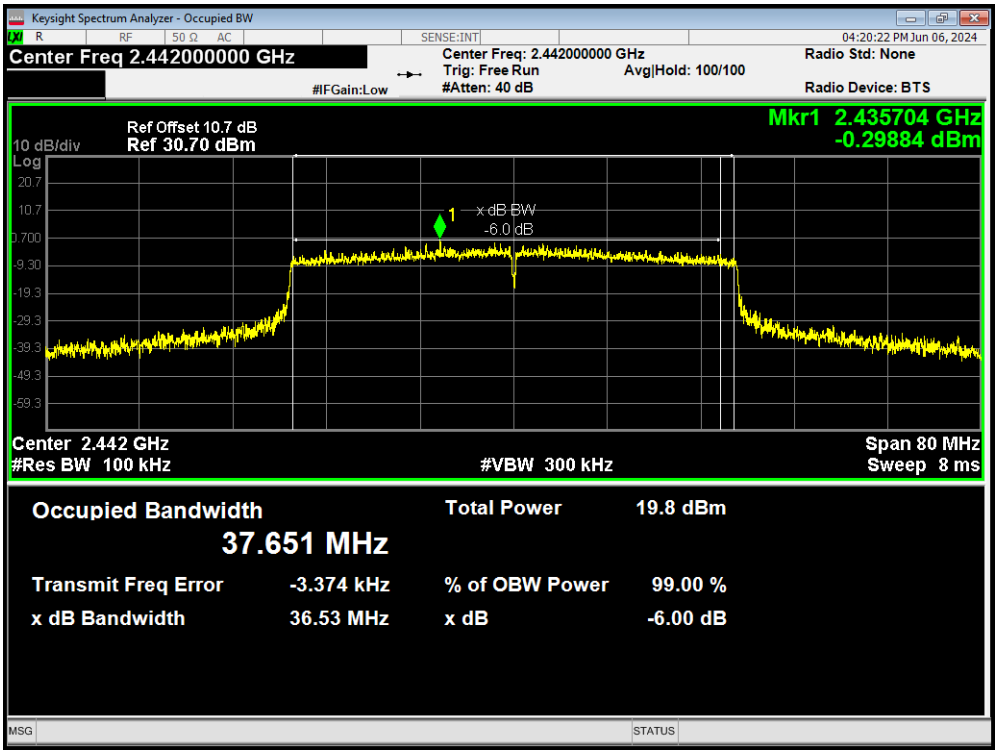
-6dB Bandwidth 802.11ax(HE40) 2427MHz



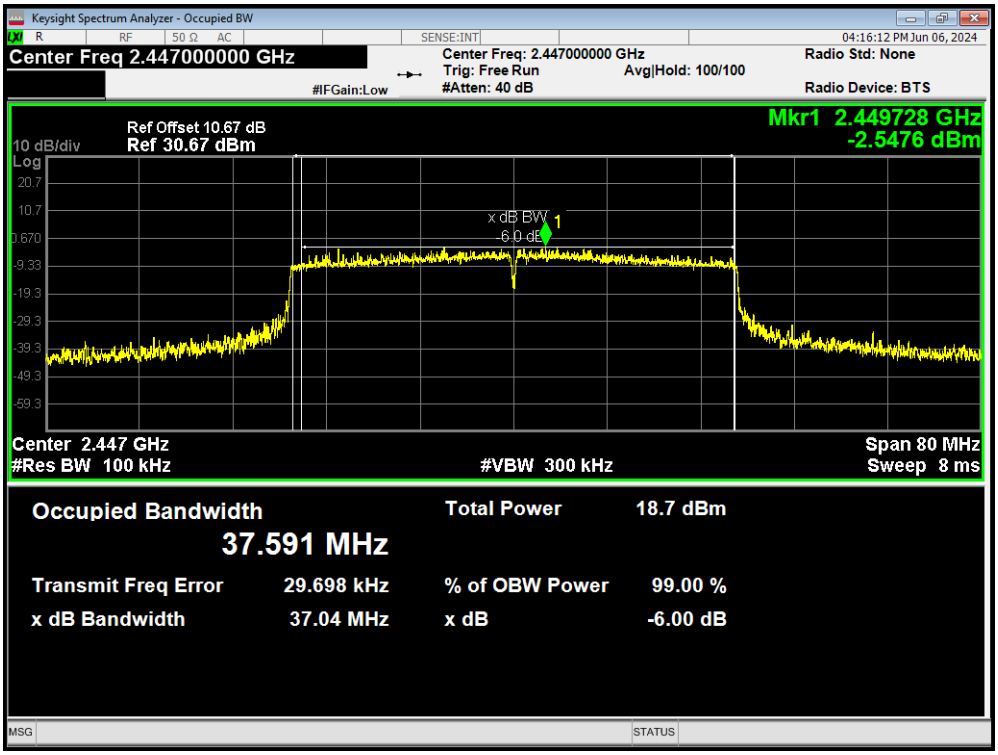
-6dB Bandwidth 802.11ax(HE40) 2437MHz



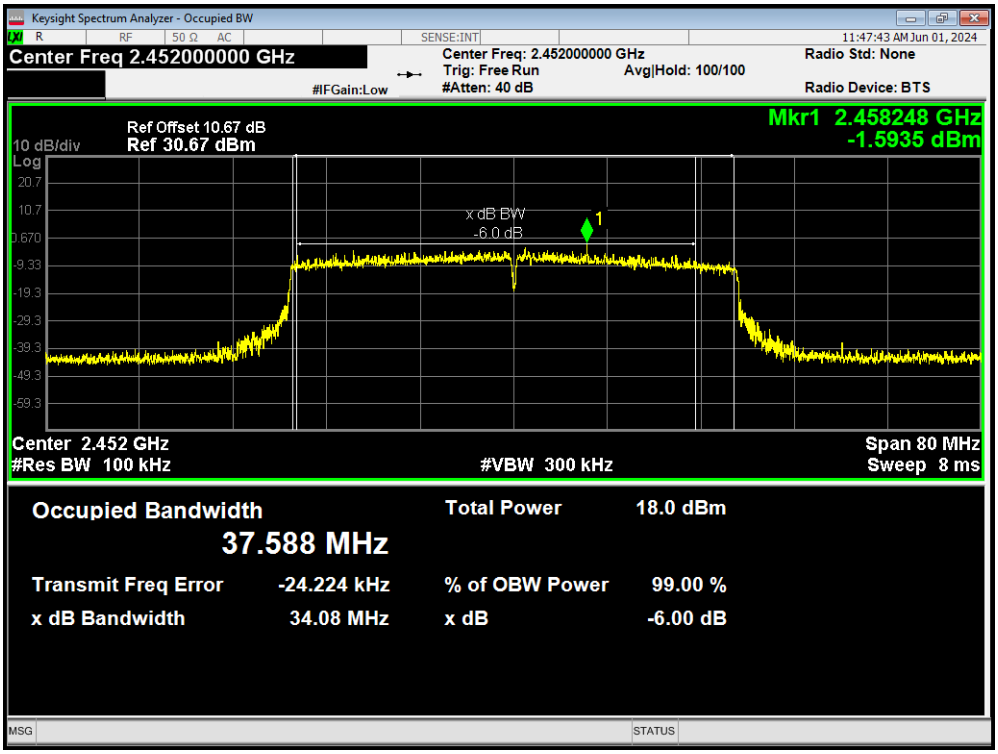
-6dB Bandwidth 802.11ax(HE40) 2442MHz



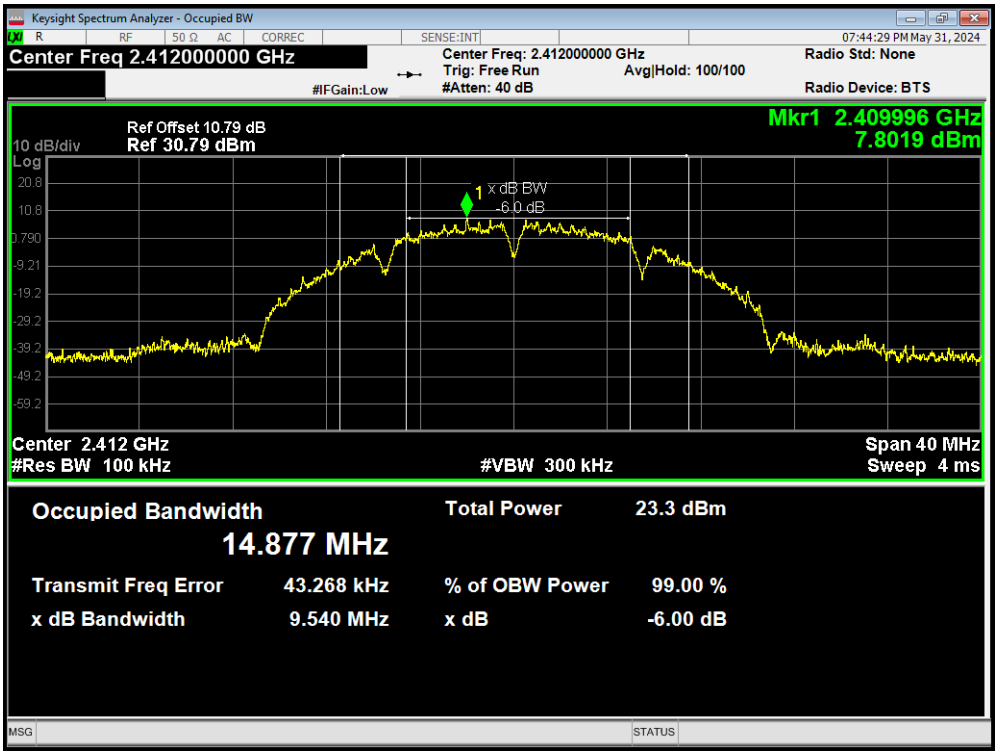
-6dB Bandwidth 802.11ax(HE40) 2447MHz



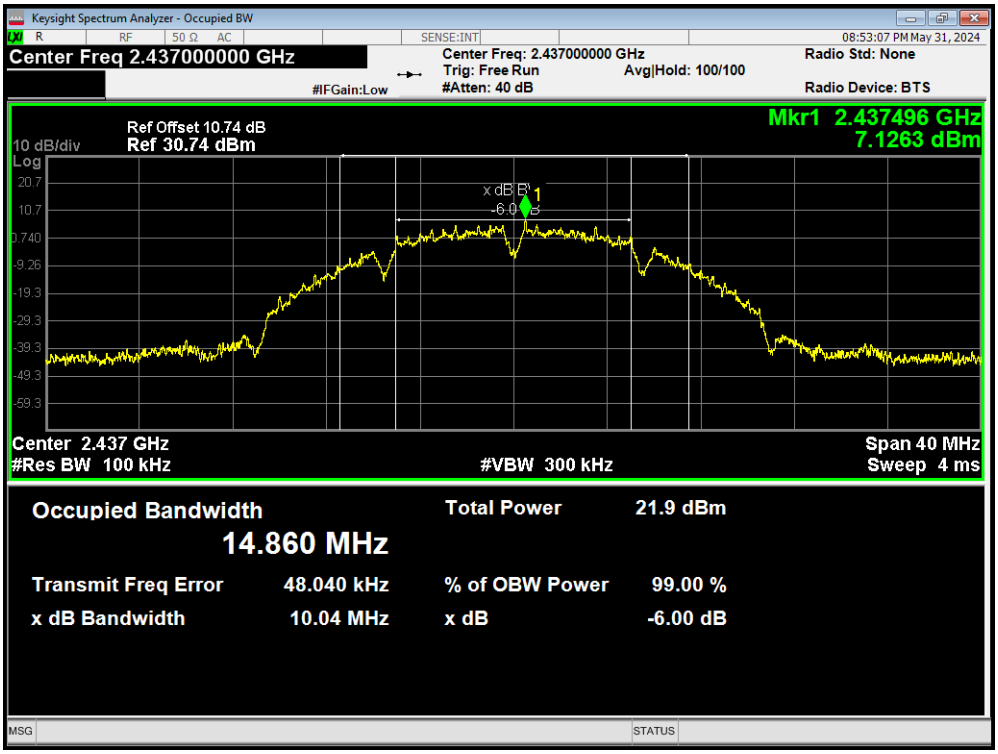
-6dB Bandwidth 802.11ax(HE40) 2452MHz



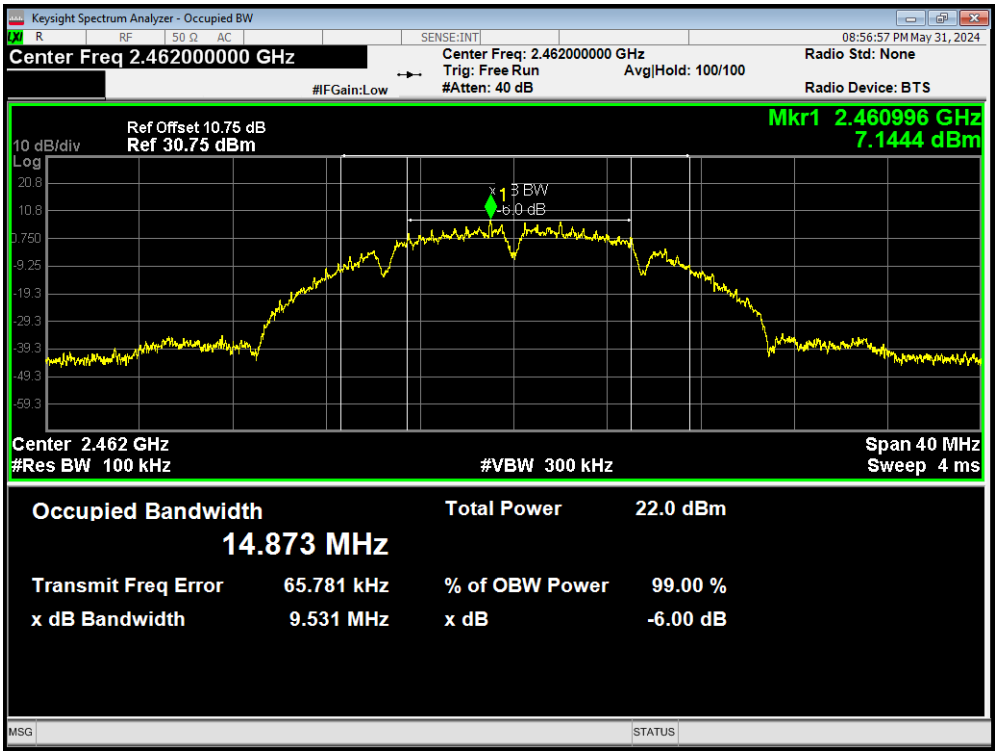
-6dB Bandwidth 802.11b 2412MHz



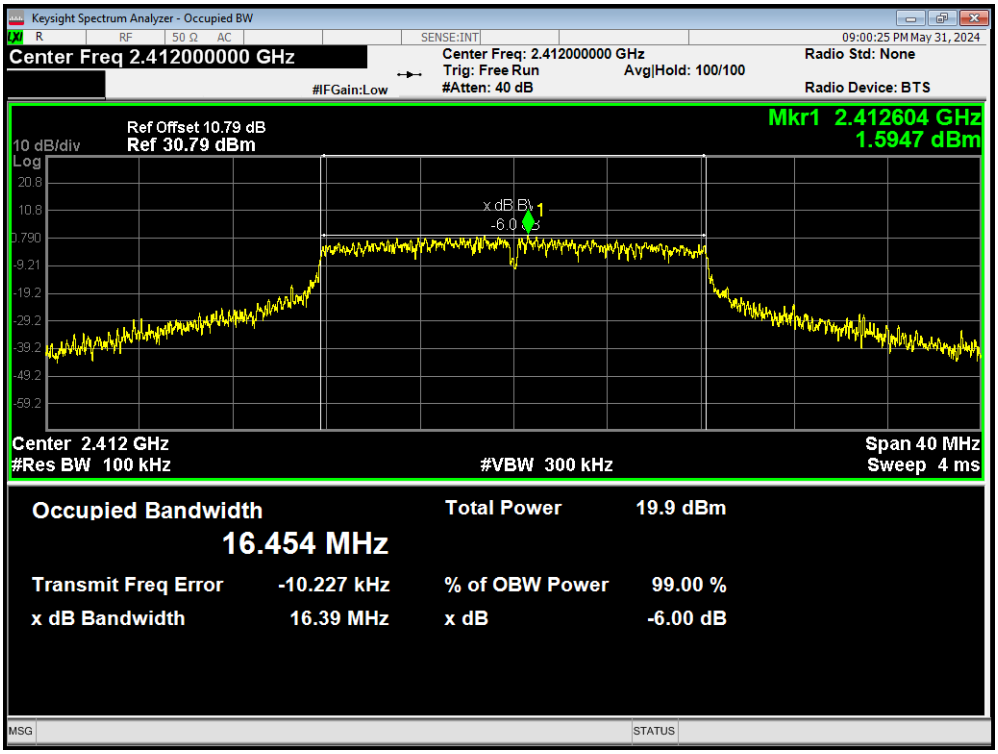
-6dB Bandwidth 802.11b 2437MHz



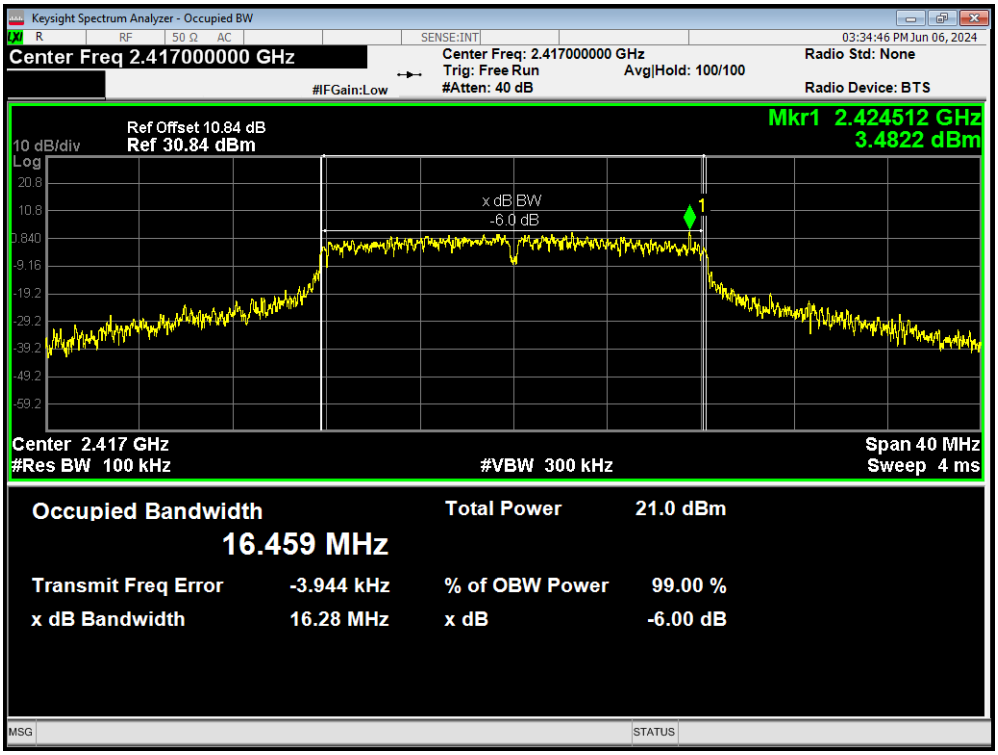
-6dB Bandwidth 802.11b 2462MHz



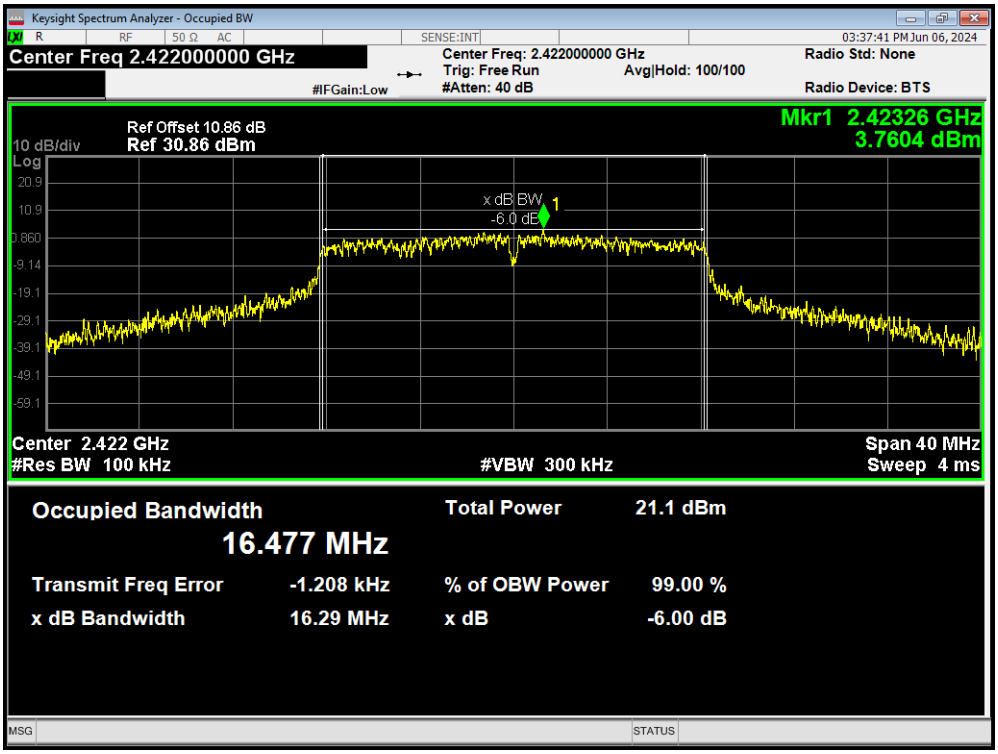
-6dB Bandwidth 802.11g 2412MHz



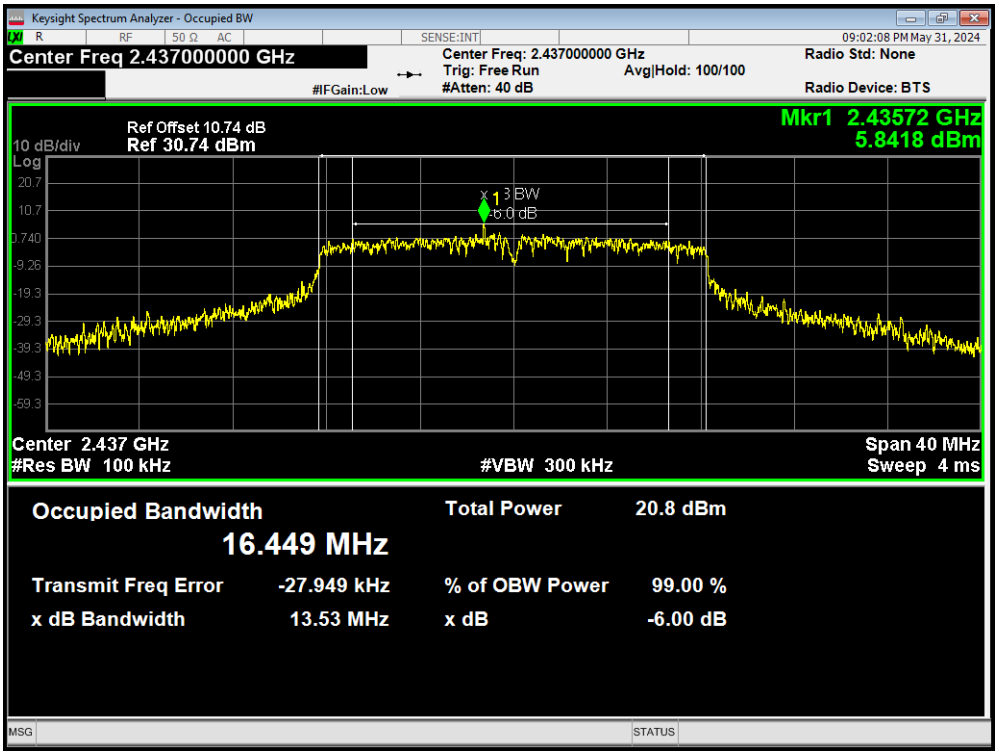
-6dB Bandwidth 802.11g 2417MHz



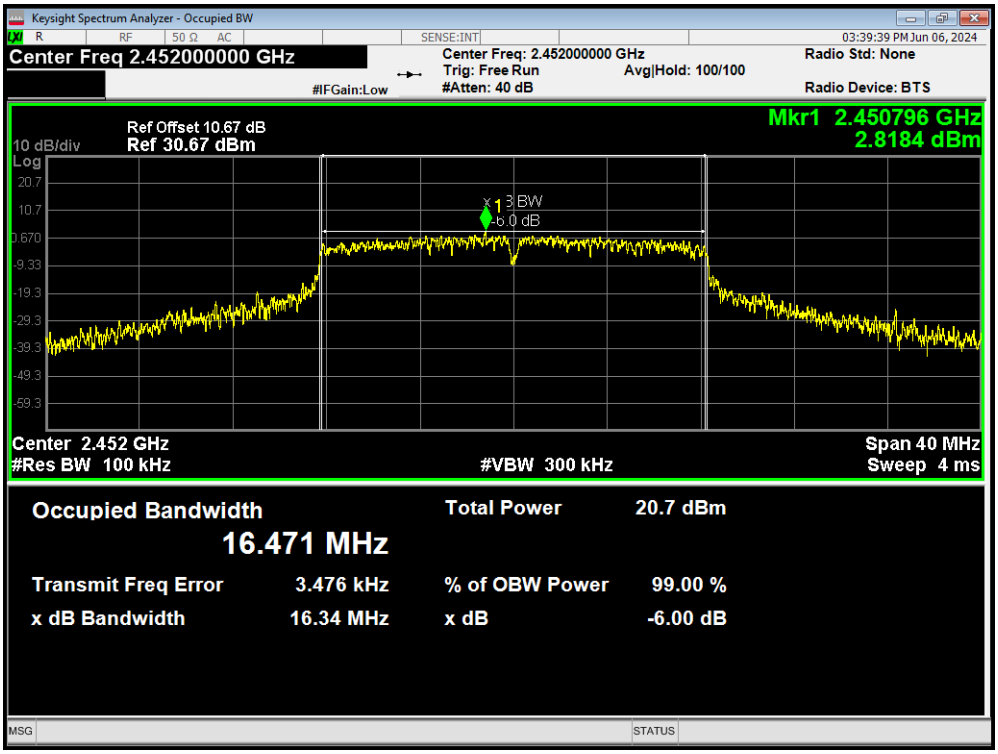
-6dB Bandwidth 802.11g 2422MHz



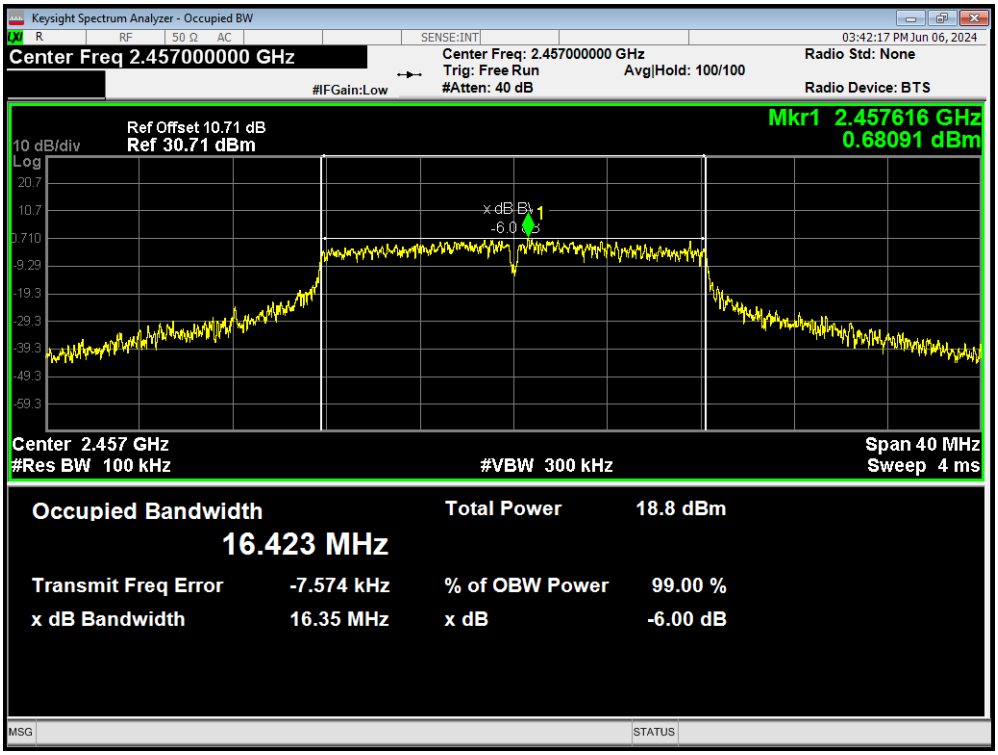
-6dB Bandwidth 802.11g 2437MHz



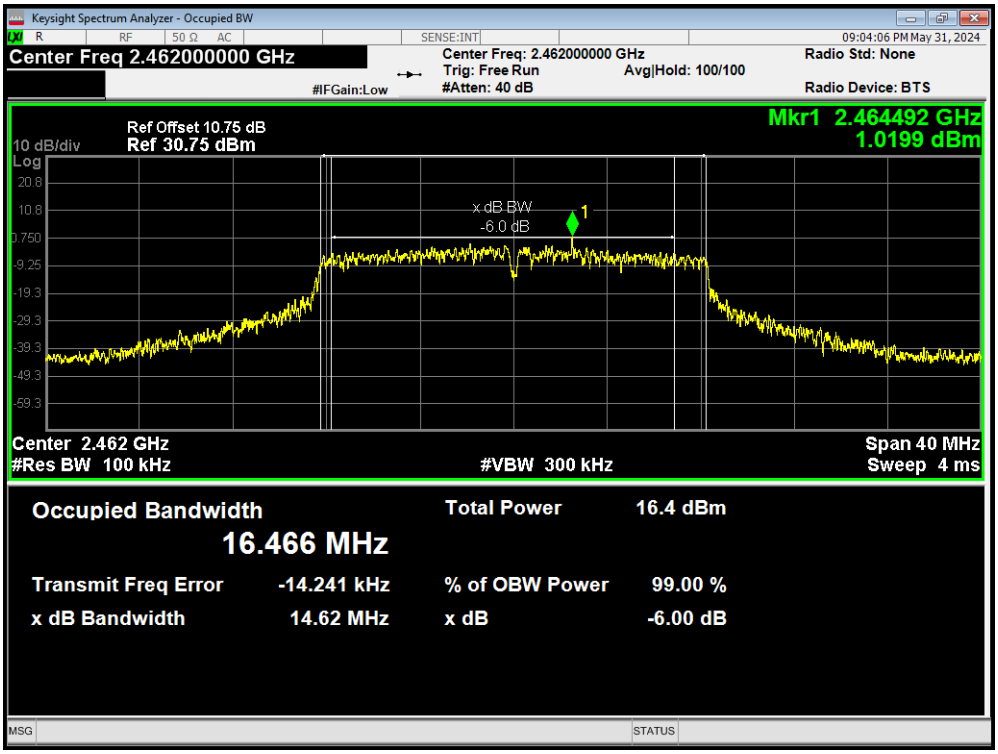
-6dB Bandwidth 802.11g 2452MHz



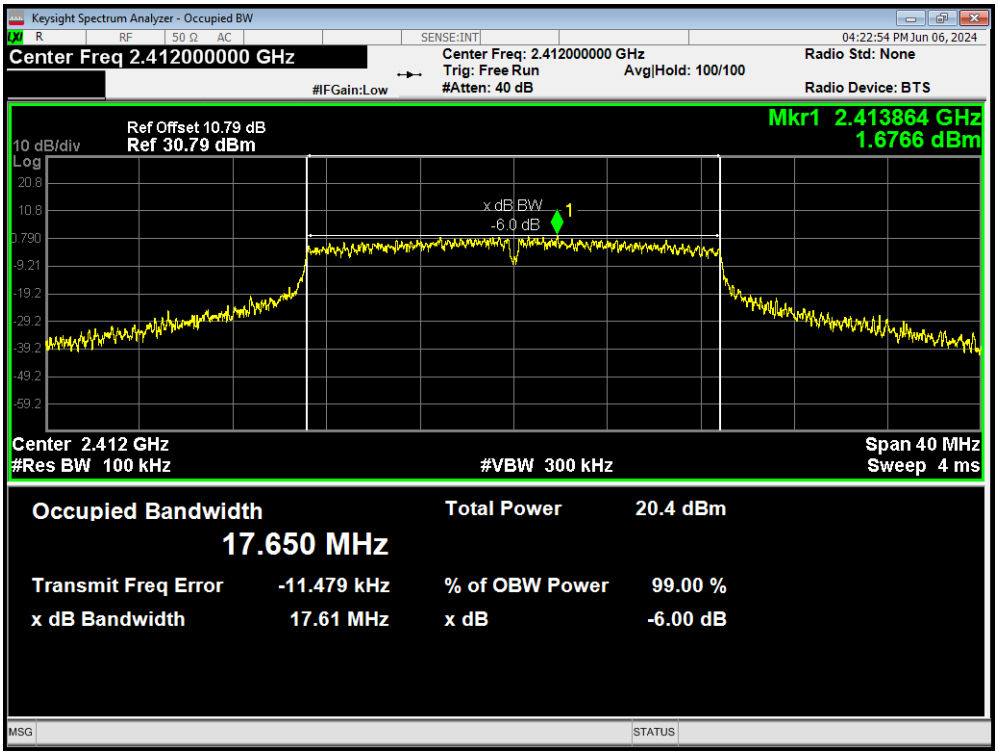
-6dB Bandwidth 802.11g 2457MHz



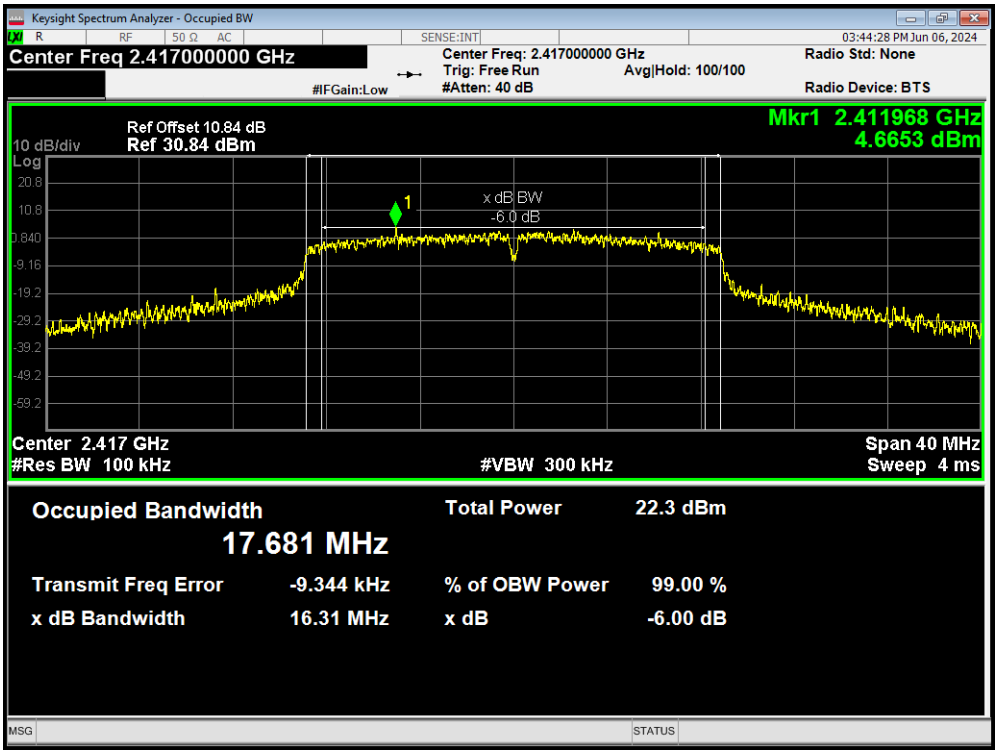
-6dB Bandwidth 802.11g 2462MHz



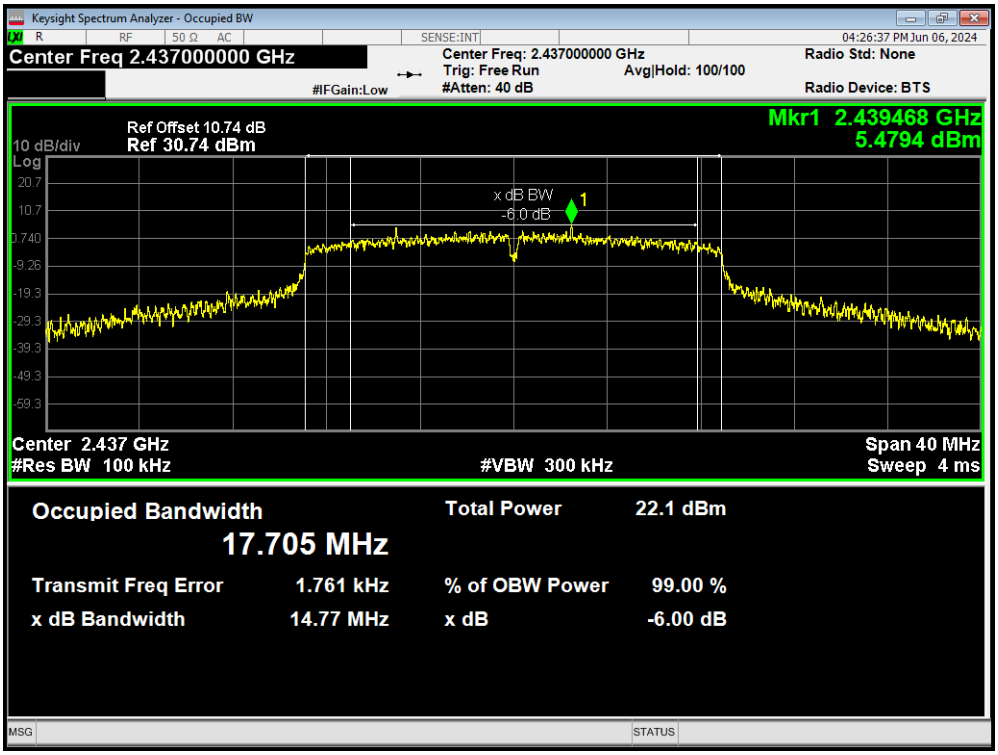
-6dB Bandwidth 802.11n(HT20) 2412MHz



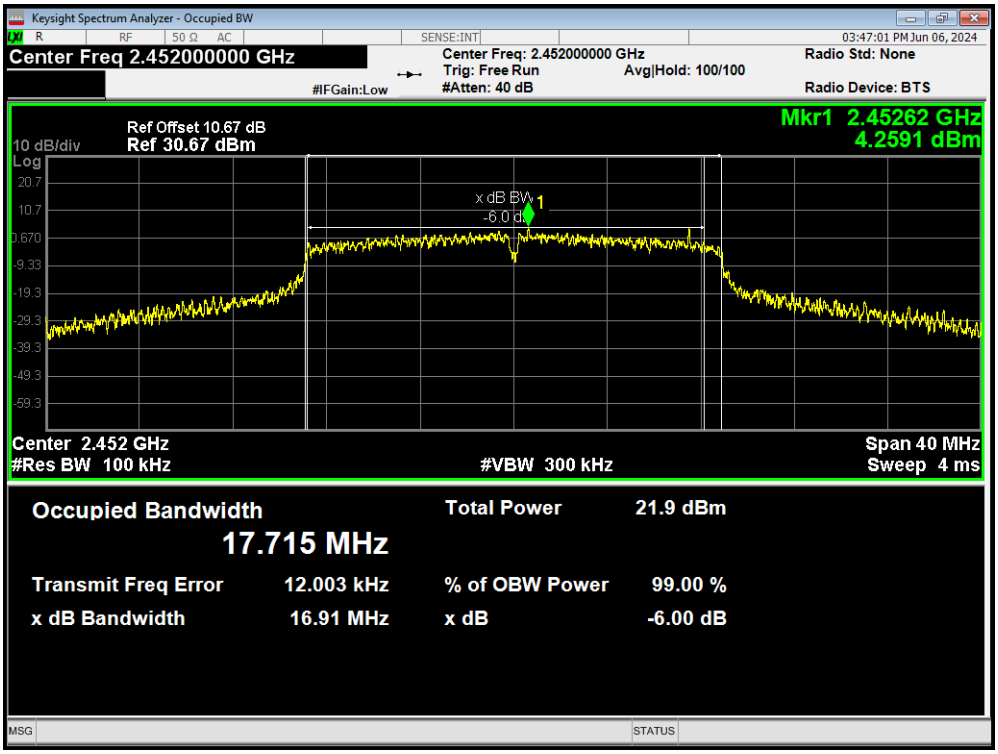
-6dB Bandwidth 802.11n(HT20) 2417MHz



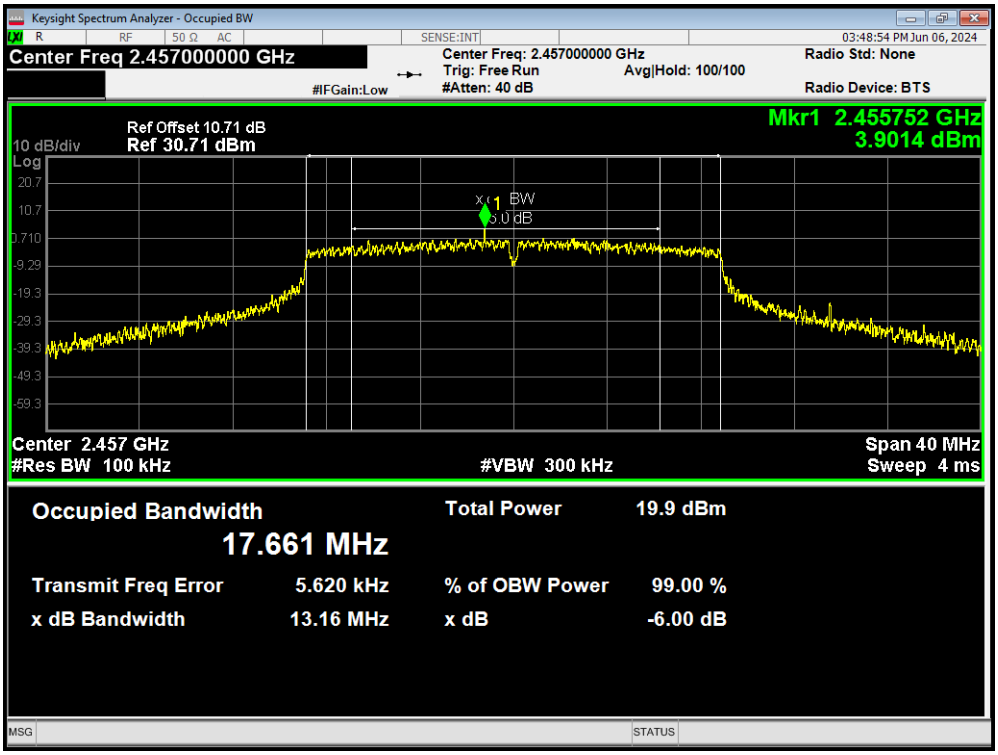
-6dB Bandwidth 802.11n(HT20) 2437MHz



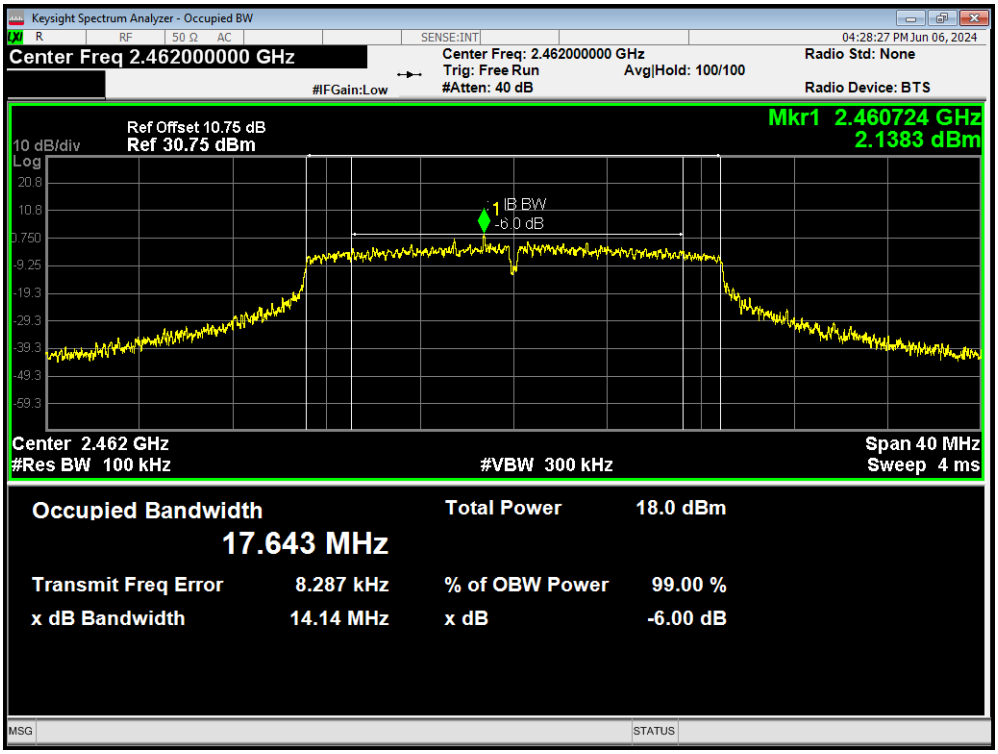
-6dB Bandwidth 802.11n(HT20) 2452MHz



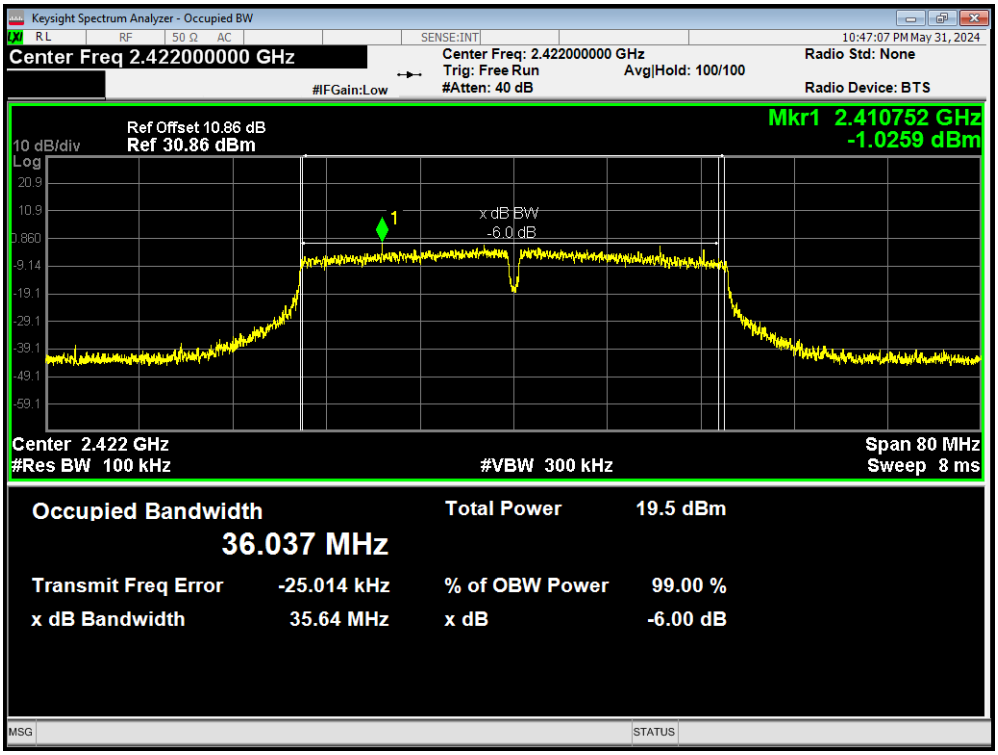
-6dB Bandwidth 802.11n(HT20) 2457MHz



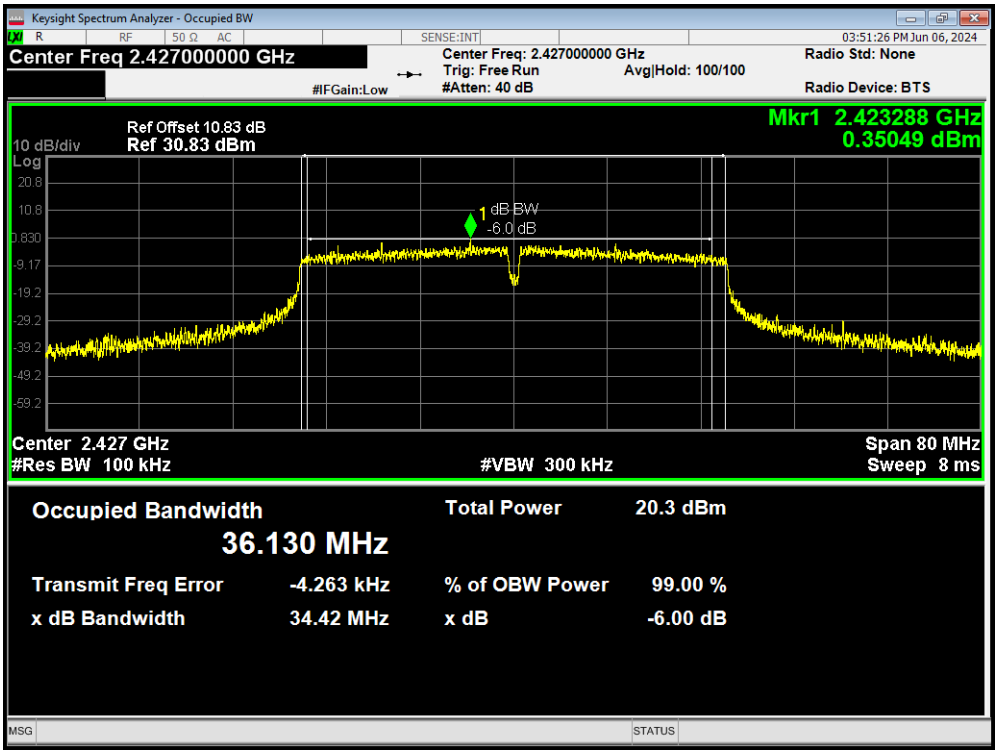
-6dB Bandwidth 802.11n(HT20) 2462MHz



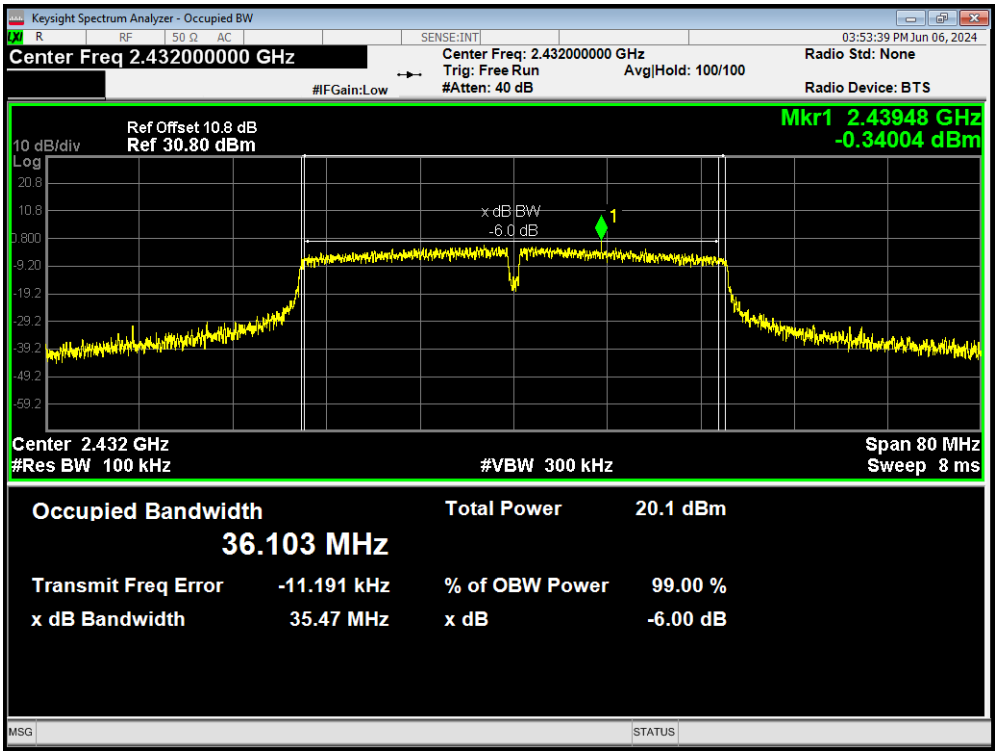
-6dB Bandwidth 802.11n(HT40) 2422MHz



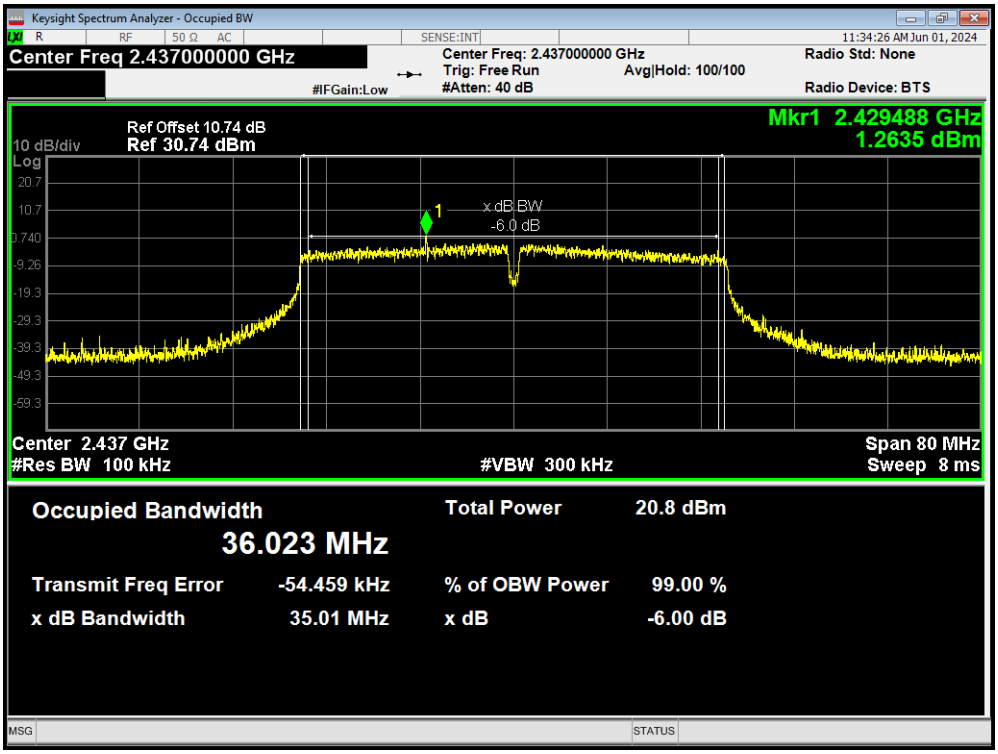
-6dB Bandwidth 802.11n(HT40) 2427MHz



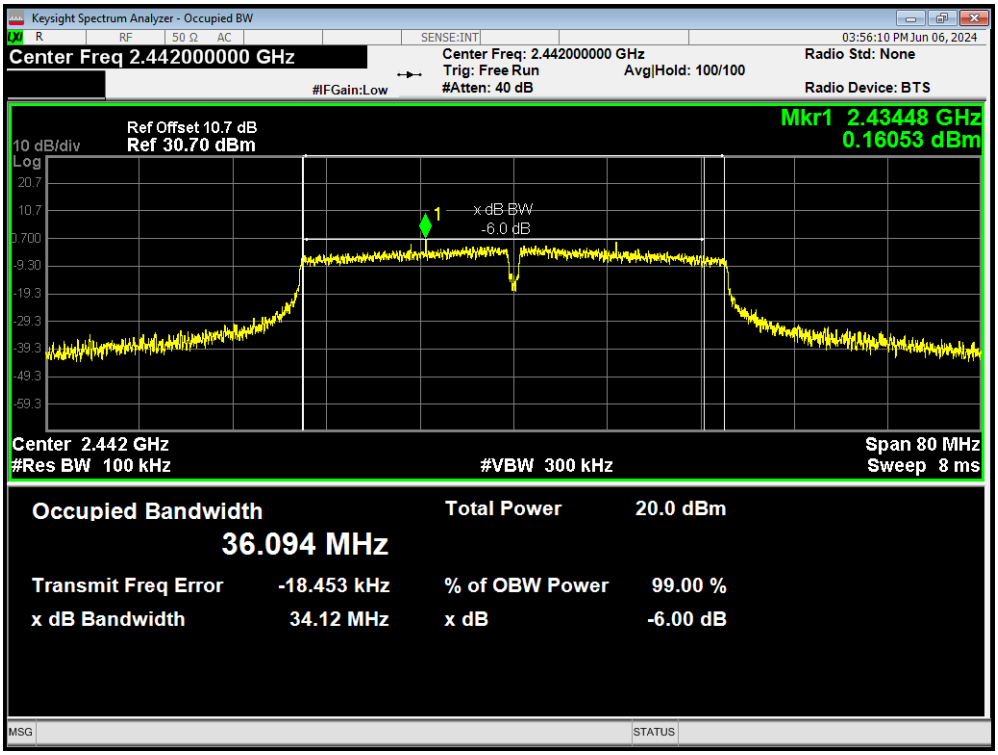
-6dB Bandwidth 802.11n(HT40) 2432MHz



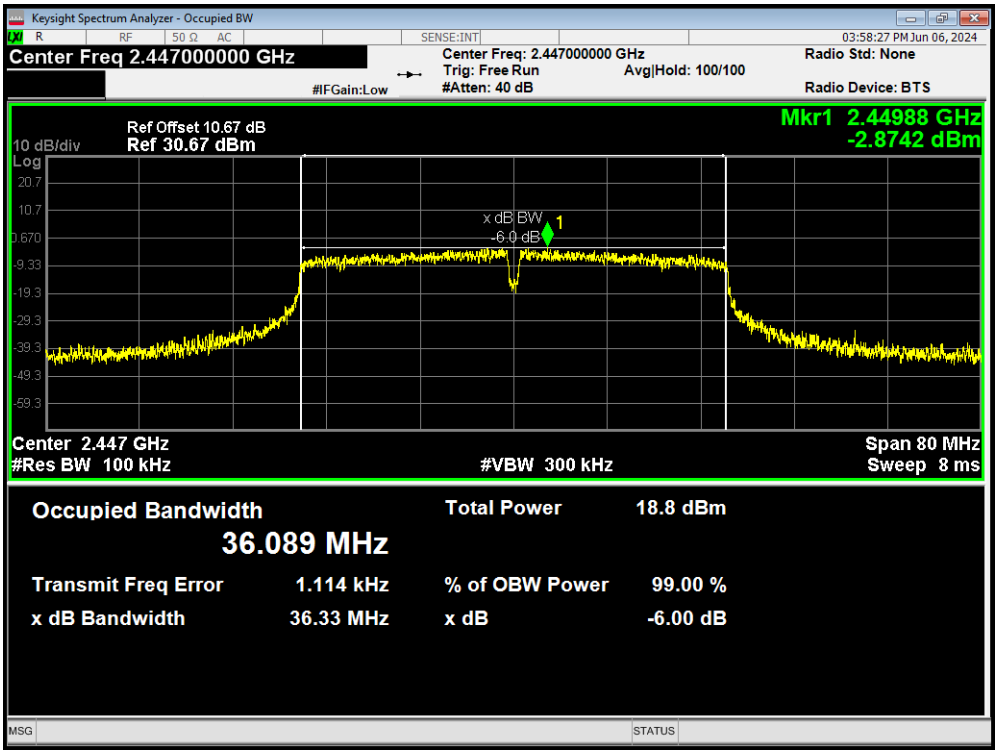
-6dB Bandwidth 802.11n(HT40) 2437MHz



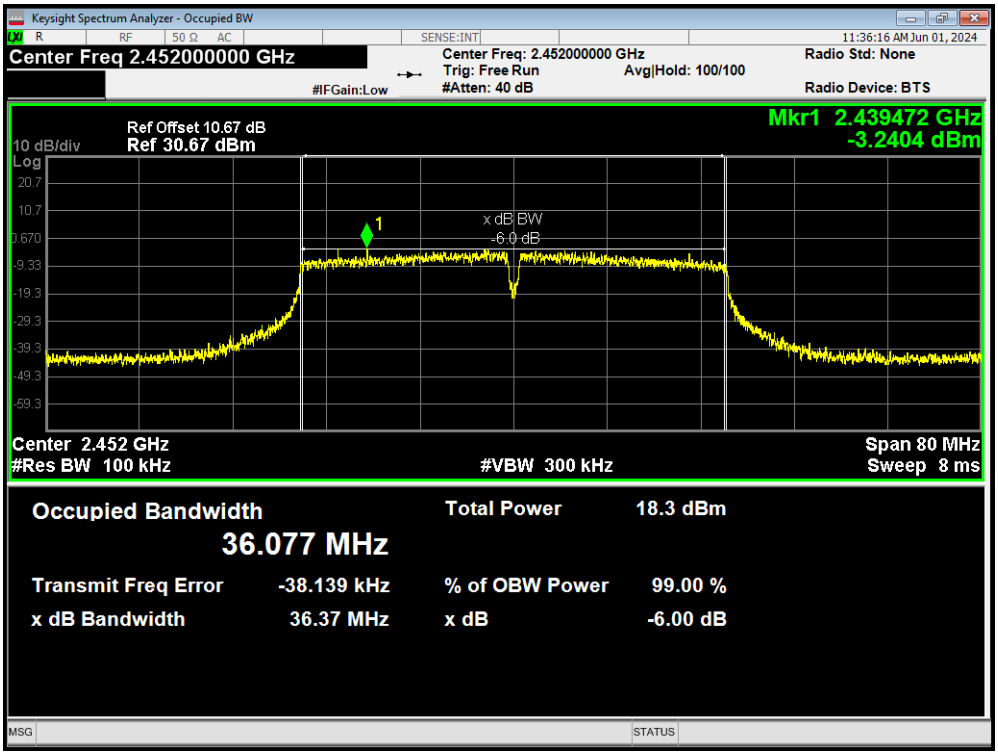
-6dB Bandwidth 802.11n(HT40) 2442MHz



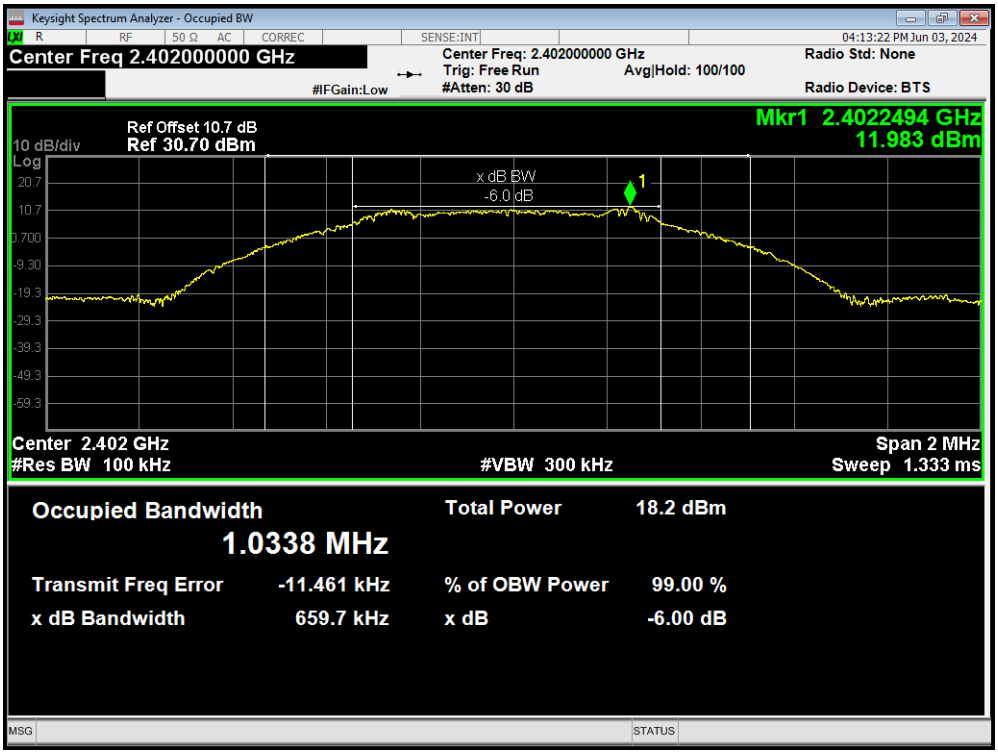
-6dB Bandwidth 802.11n(HT40) 2447MHz



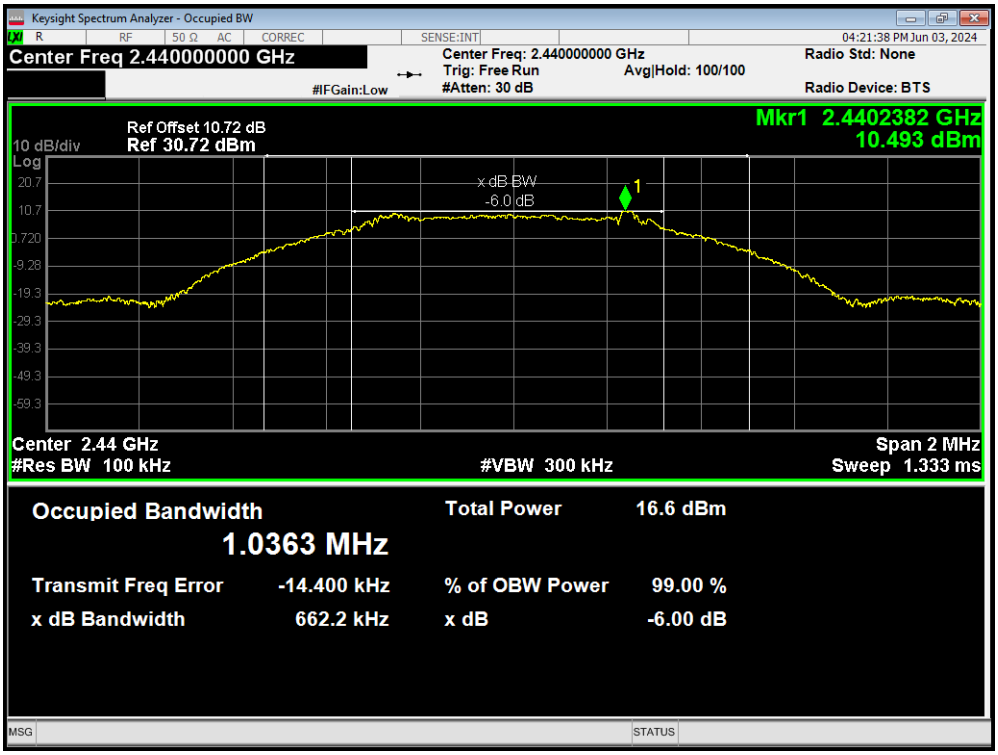
-6dB Bandwidth 802.11n(HT40) 2452MHz



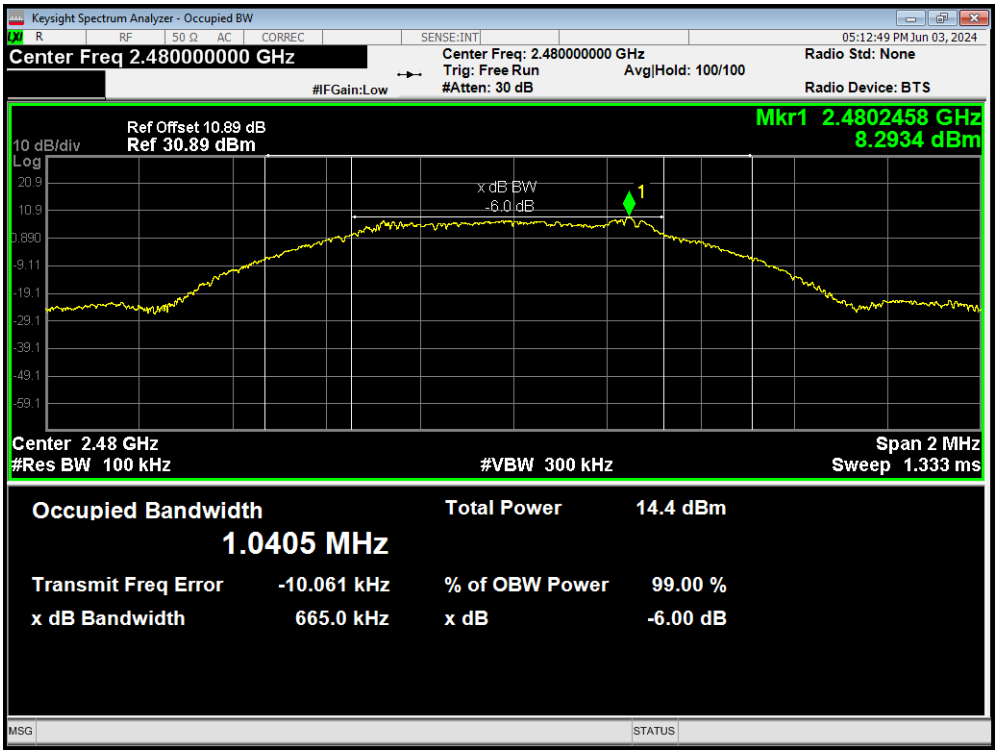
-6dB Bandwidth Bluetooth LE (1M) 2402MHz



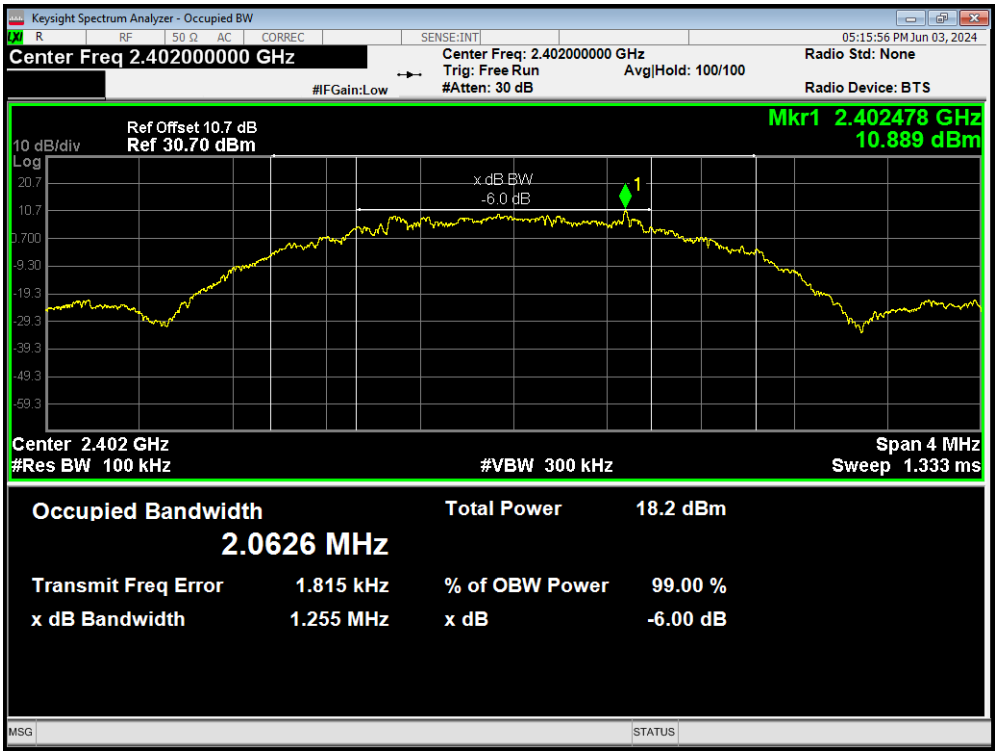
-6dB Bandwidth Bluetooth LE (1M) 2440MHz



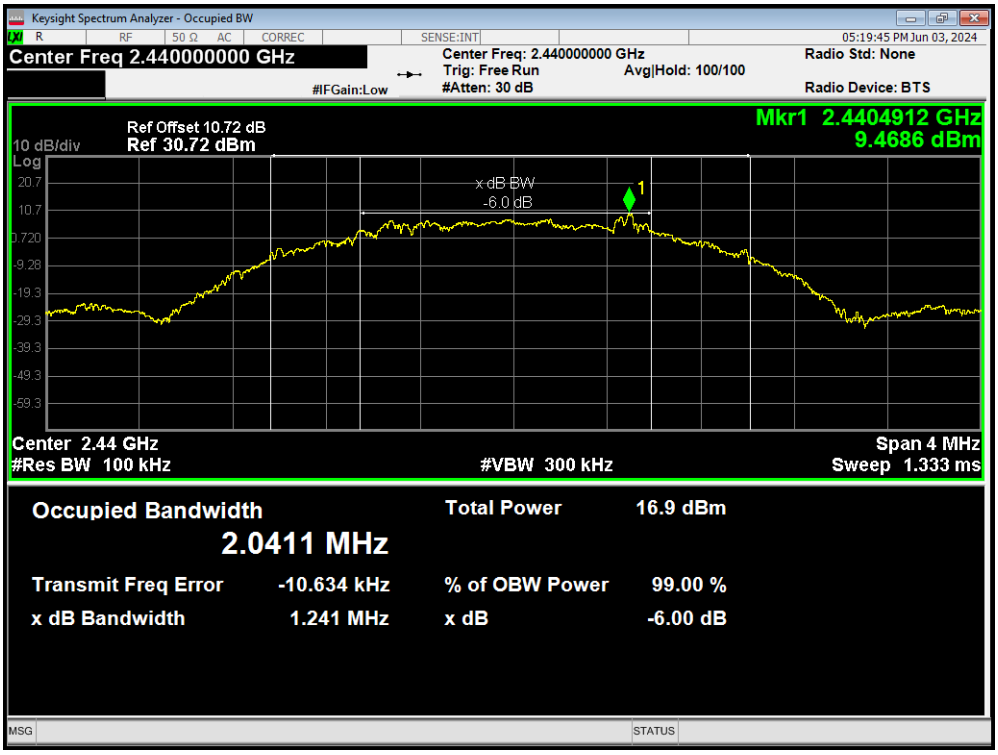
-6dB Bandwidth Bluetooth LE (1M) 2480MHz



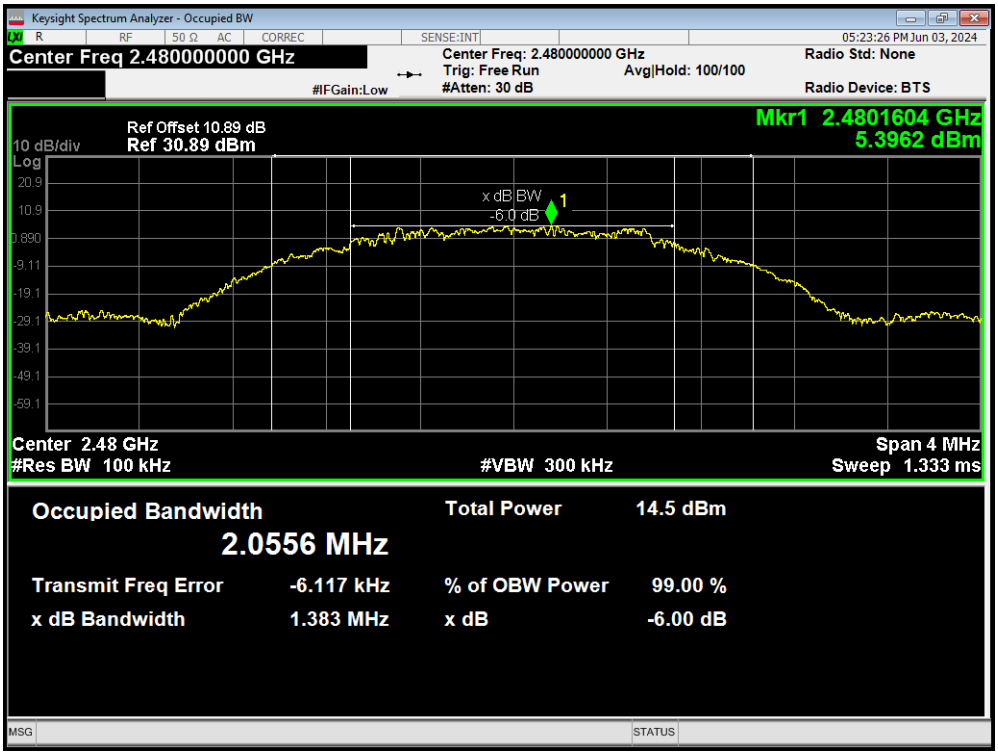
-6dB Bandwidth Bluetooth LE (2M) 2402MHz



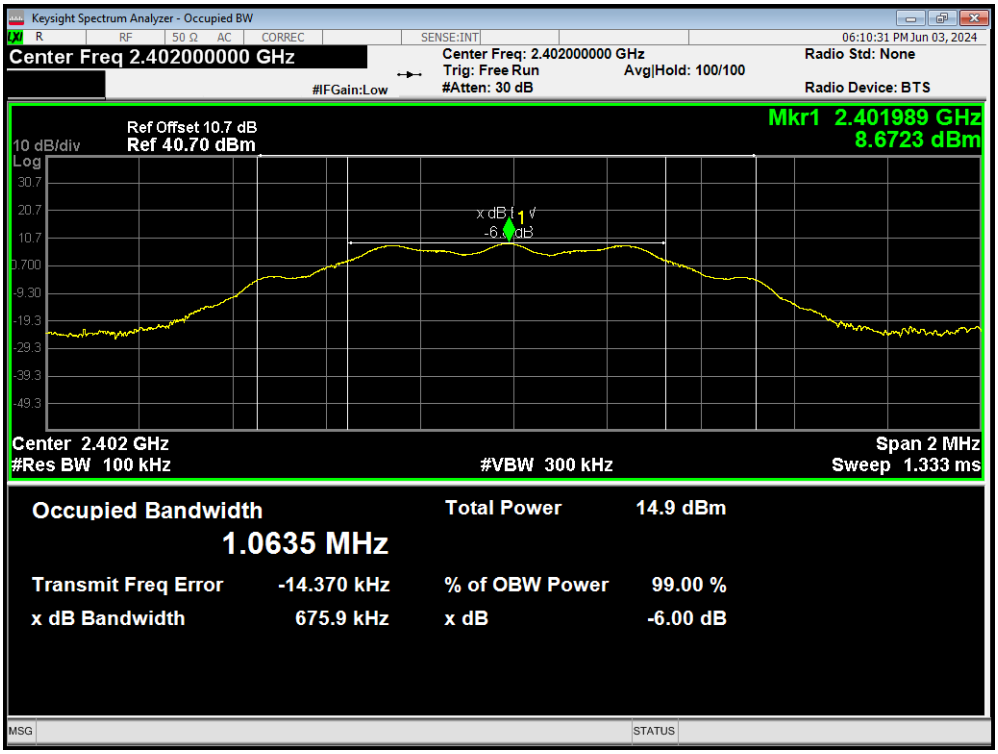
-6dB Bandwidth Bluetooth LE (2M) 2440MHz



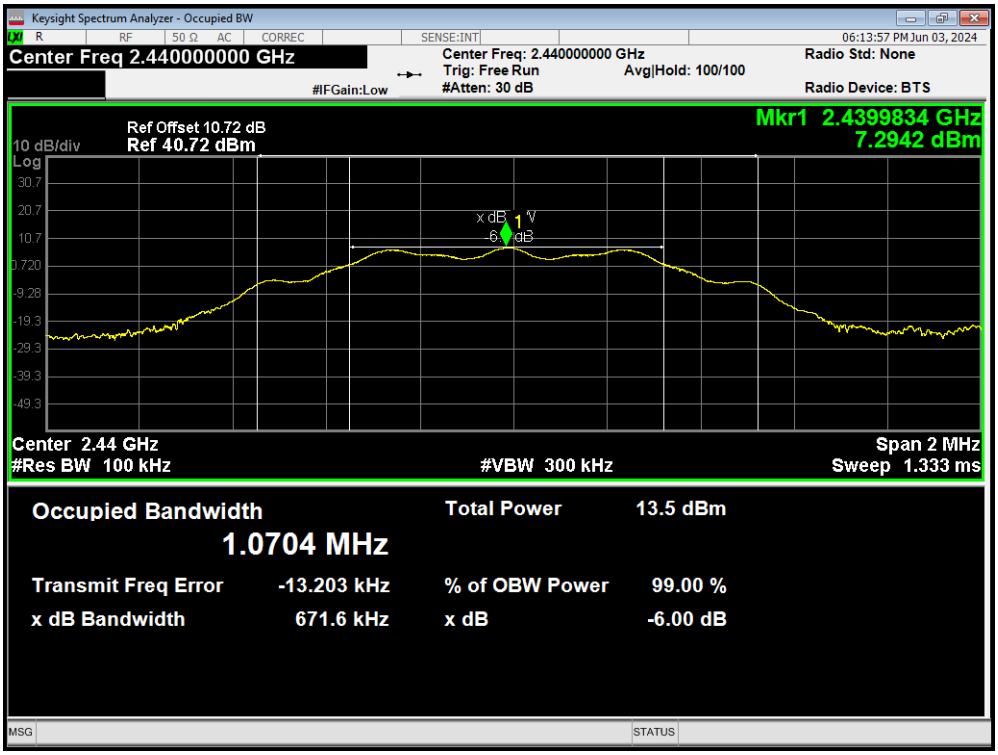
-6dB Bandwidth Bluetooth LE (2M) 2480MHz



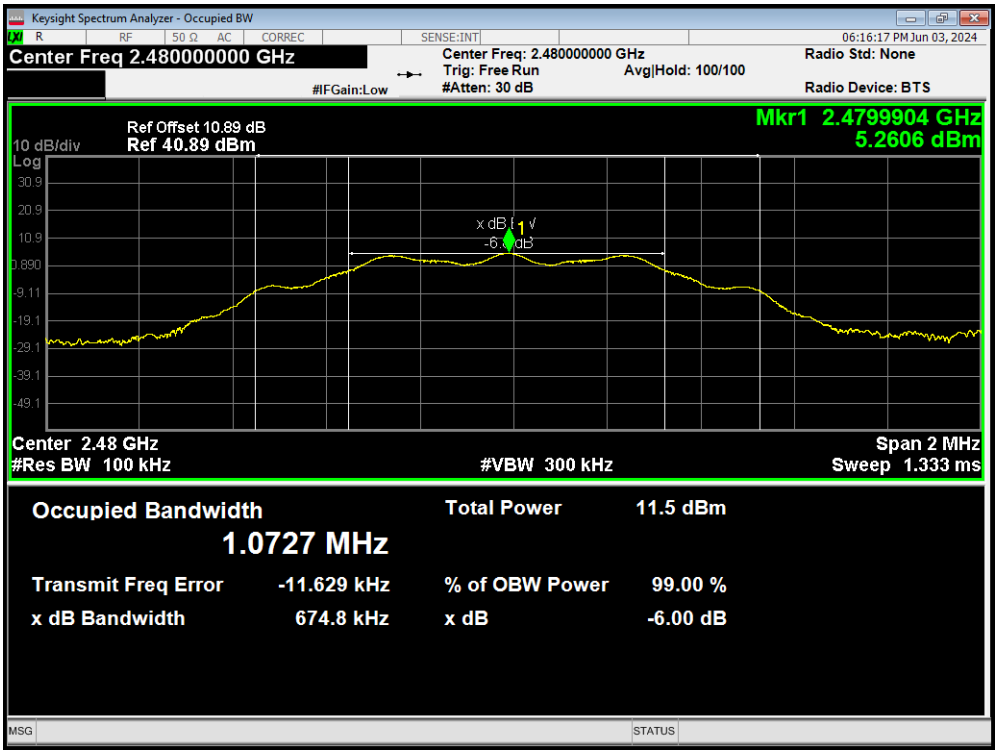
-6dB Bandwidth Bluetooth LE (S=2) 2402MHz



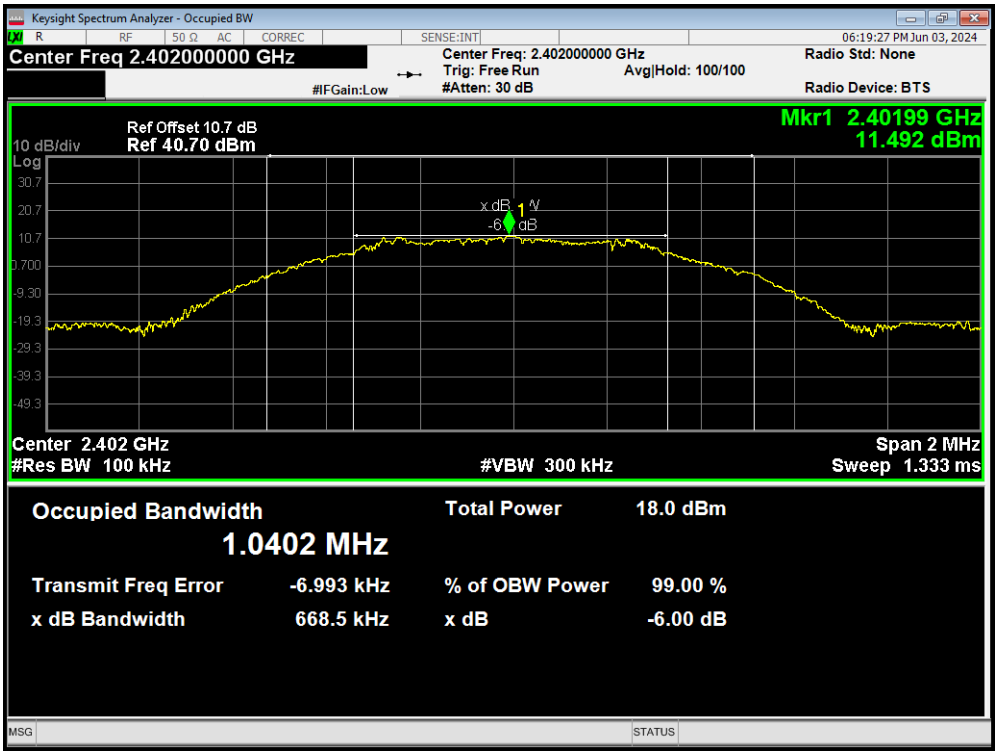
-6dB Bandwidth Bluetooth LE (S=2) 2440MHz



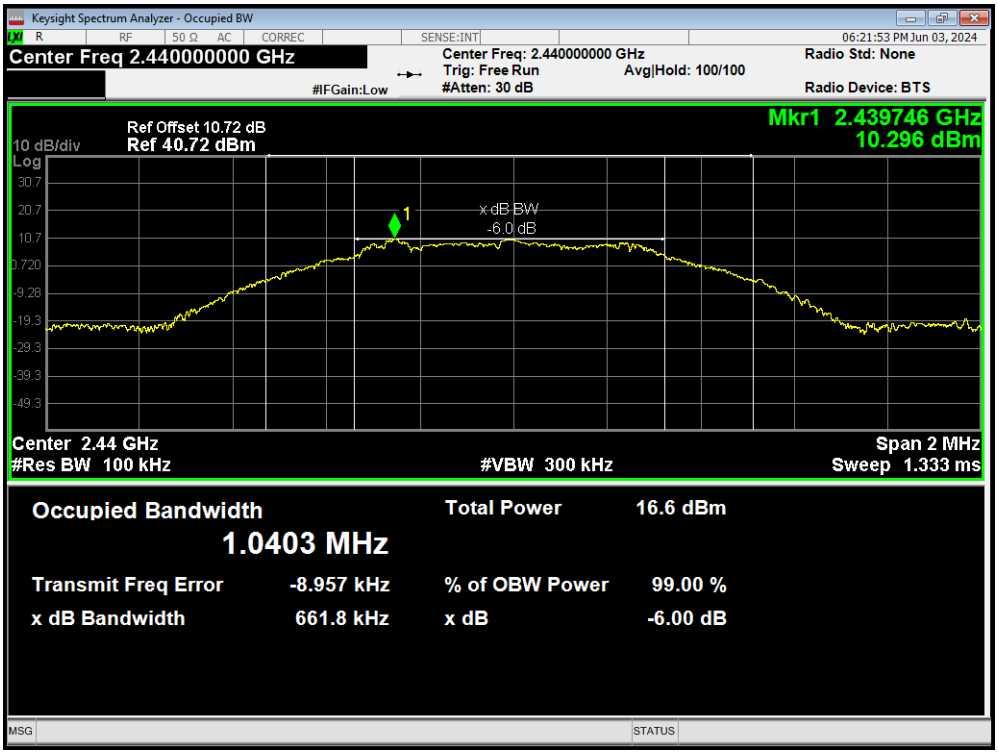
-6dB Bandwidth Bluetooth LE (S=2) 2480MHz



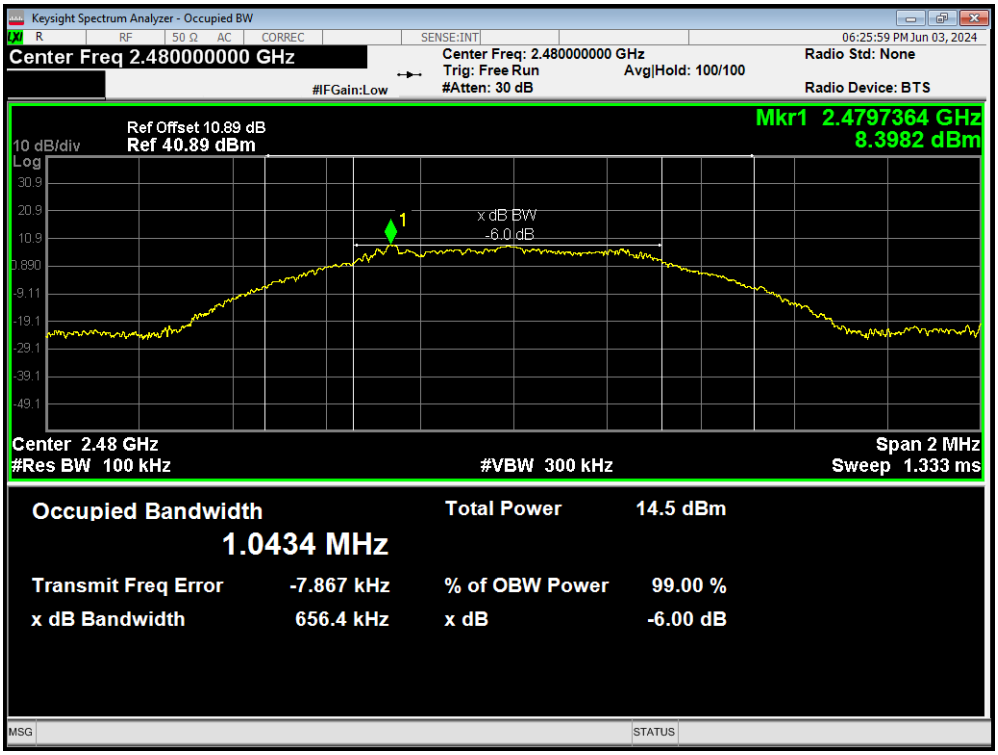
-6dB Bandwidth Bluetooth LE (S=8) 2402MHz



-6dB Bandwidth Bluetooth LE (S=8) 2440MHz



-6dB Bandwidth Bluetooth LE (S=8) 2480MHz



5.3. Band Edge

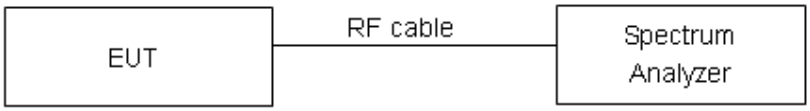
Ambient Condition

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.”

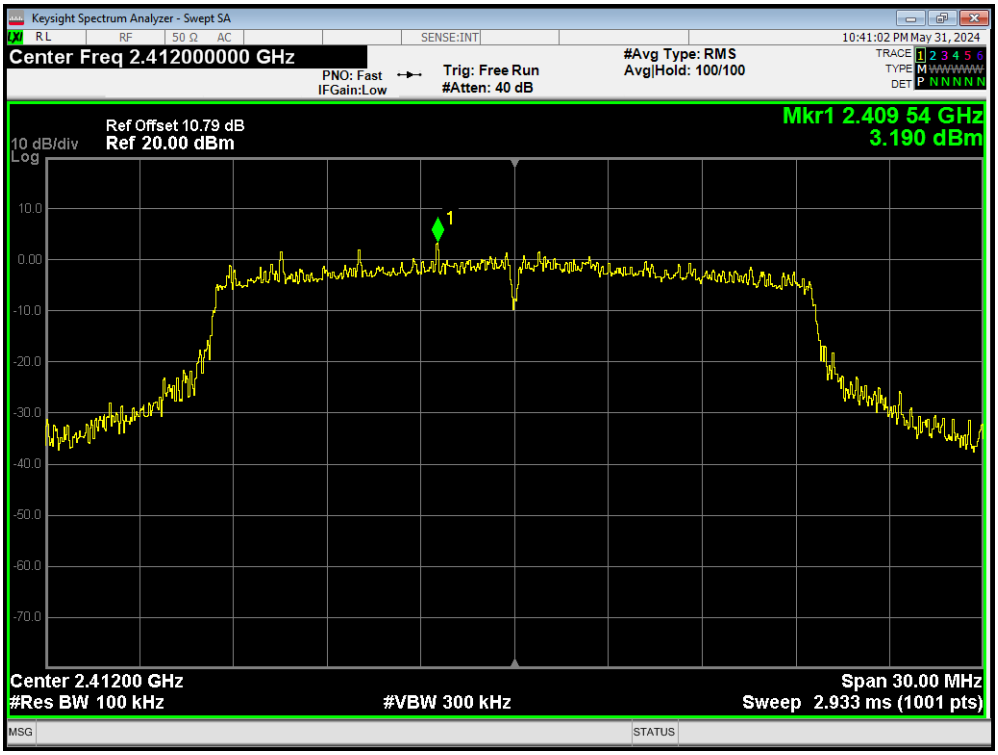
Measurement Uncertainty

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

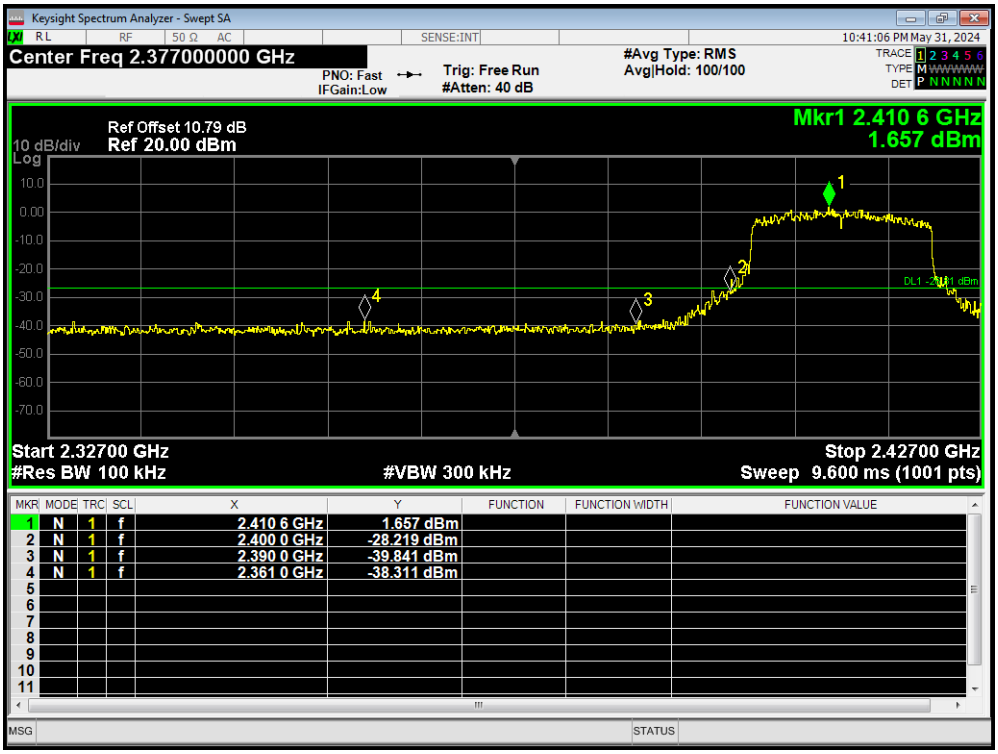
Frequency	Uncertainty
2GHz-3GHz	1.407 dB

Test Results: PASS

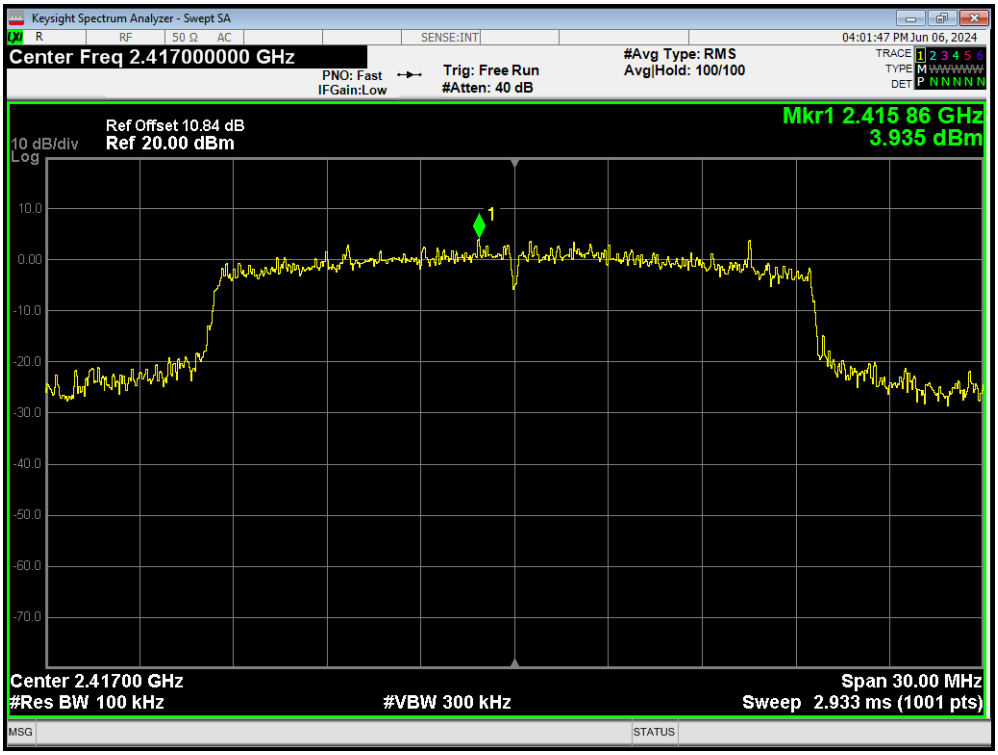
Band Edge 802.11ax(HE20) 2412MHz Ref



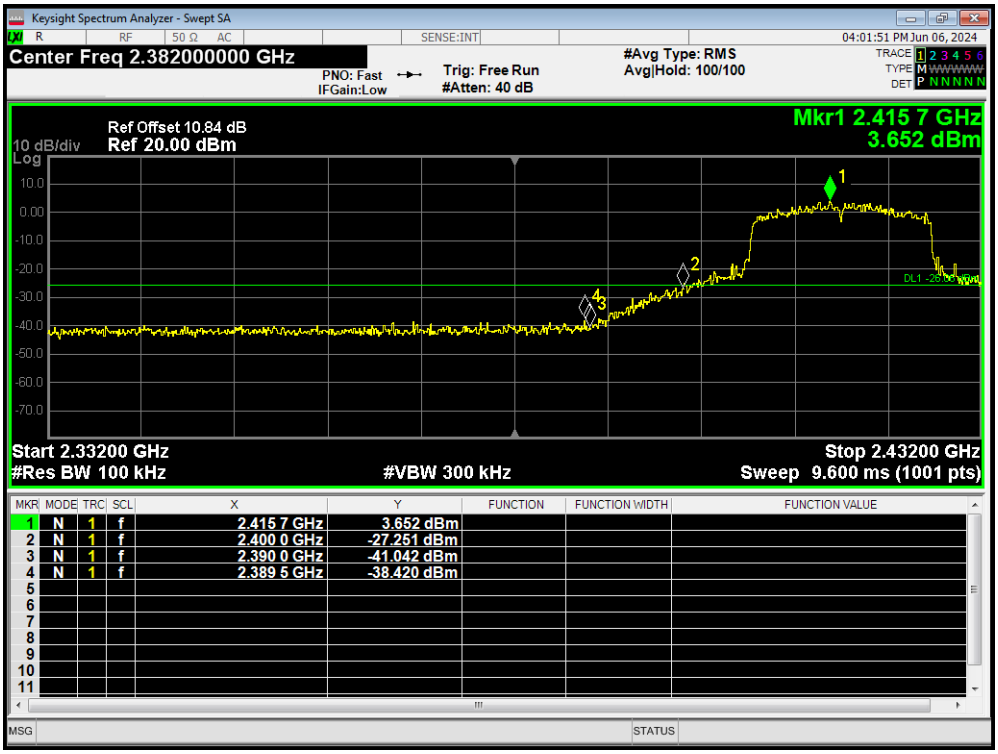
Band Edge 802.11ax(HE20) 2412MHz Emission



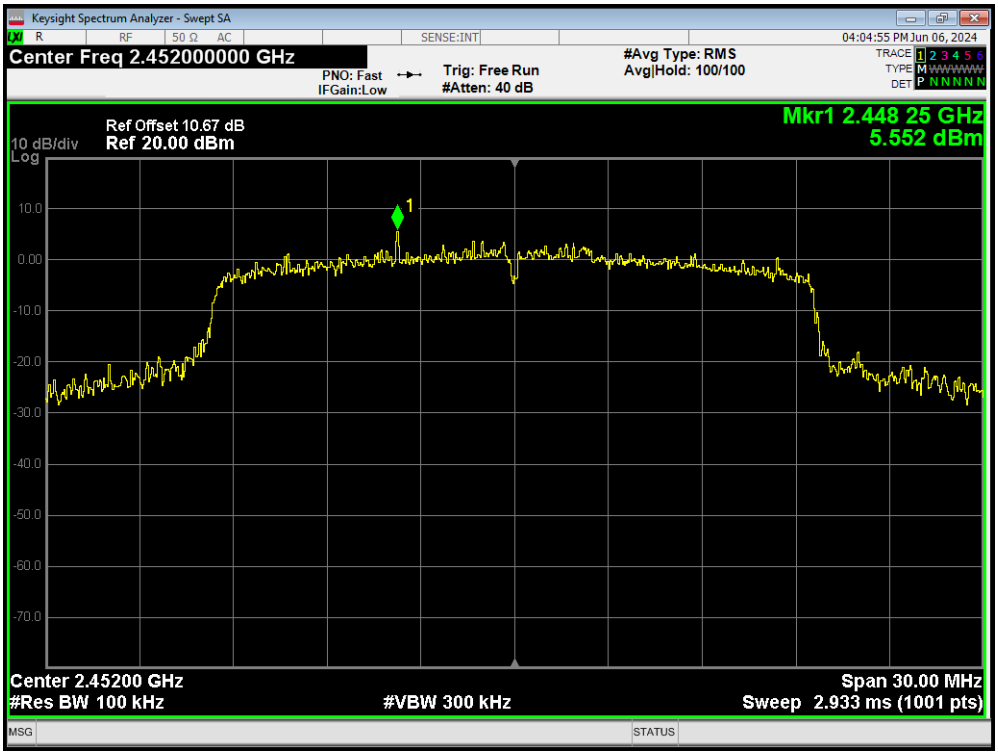
Band Edge 802.11ax(HE20) 2417MHz Ref



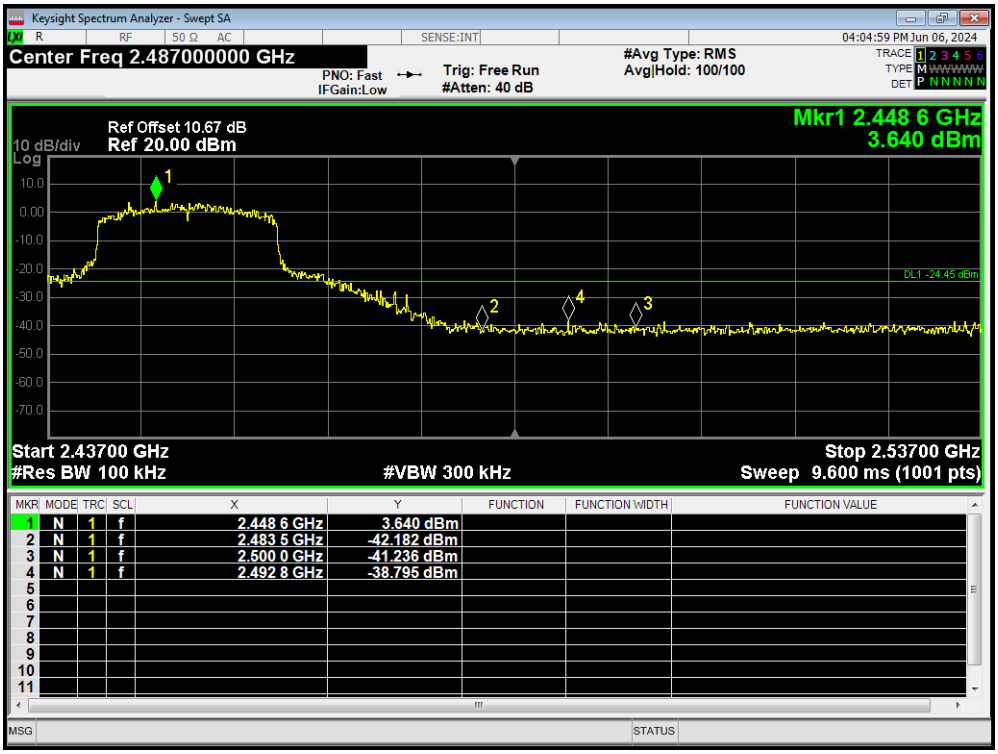
Band Edge 802.11ax(HE20) 2417MHz Emission



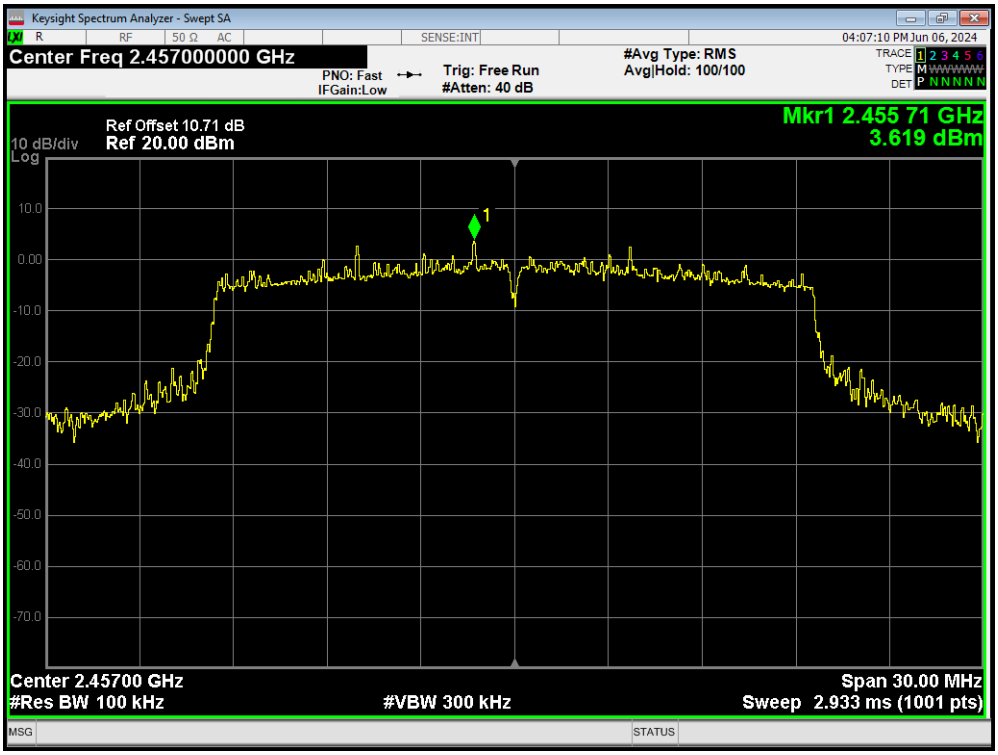
Band Edge 802.11ax(HE20) 2452MHz Ref



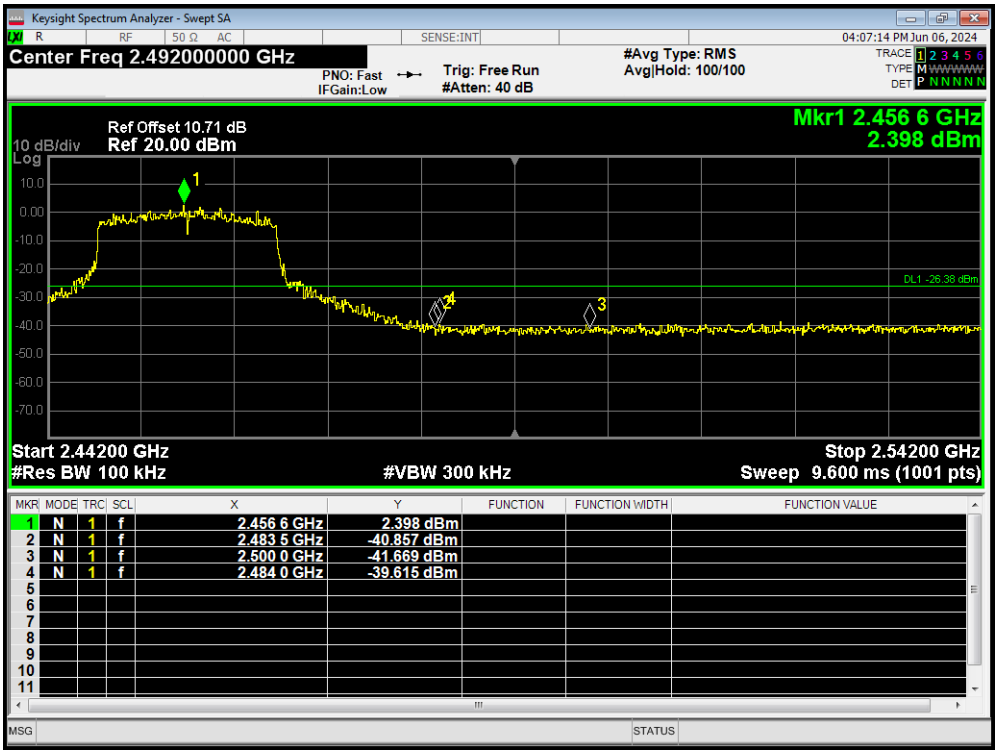
Band Edge 802.11ax(HE20) 2452MHz Emission



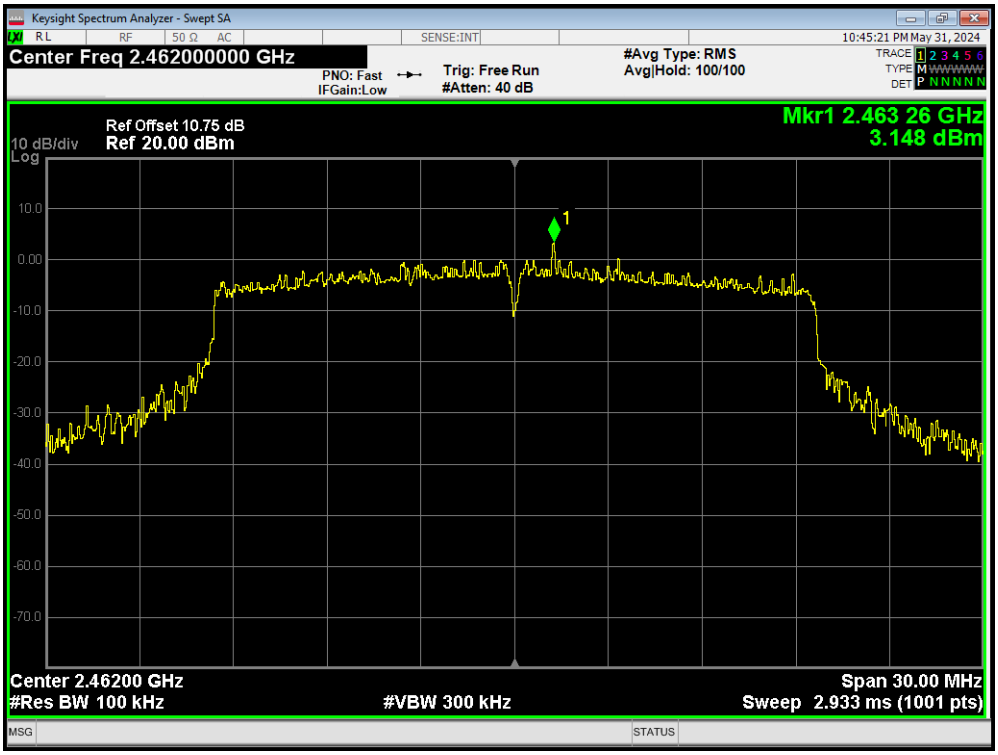
Band Edge 802.11ax(HE20) 2457MHz Ref



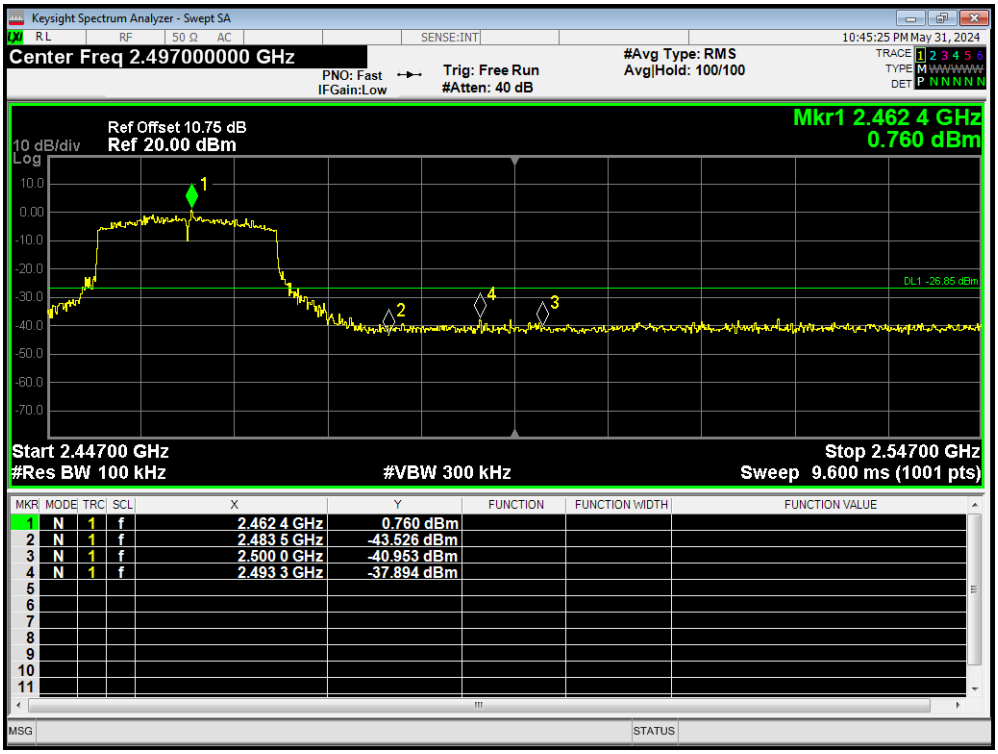
Band Edge 802.11ax(HE20) 2457MHz Emission



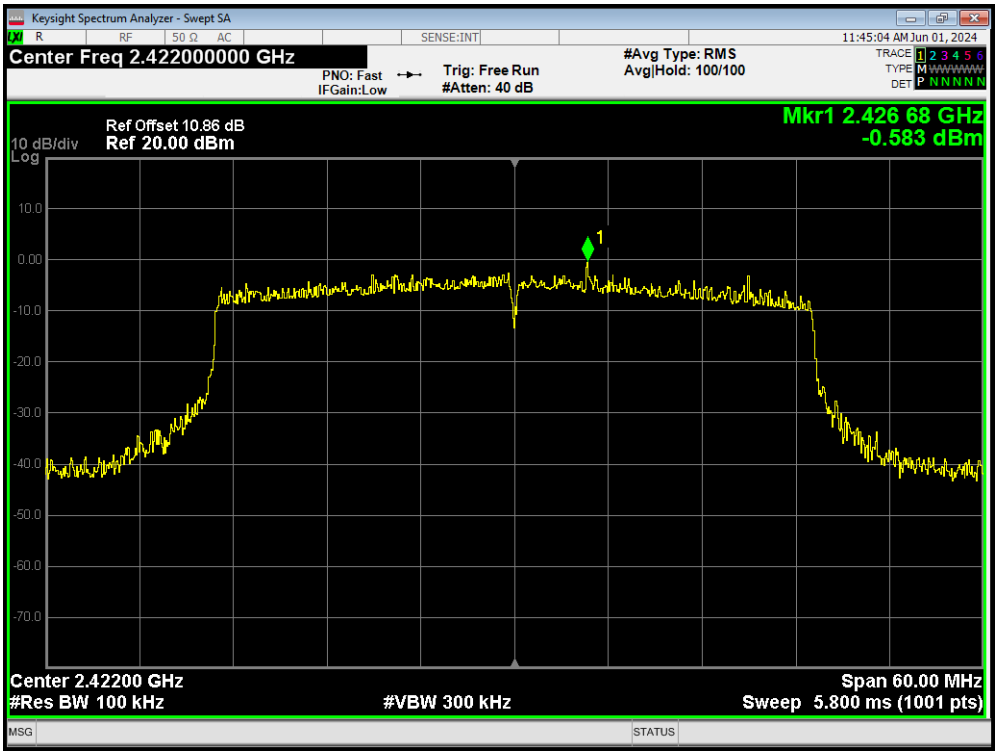
Band Edge 802.11ax(HE20) 2462MHz Ref



Band Edge 802.11ax(HE20) 2462MHz Emission



Band Edge 802.11ax(HE40) 2422MHz Ref



Band Edge 802.11ax(HE40) 2422MHz Emission