RF TEST REPORT

Applicant	Panasonic Corporation of North America
FCC ID	ACJ-TNPA7911
Product	Wireless module
Brand	Panasonic
Model	P24VS_01
Report No.	R2306A0670-R1V2
Issue Date	October 13, 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.

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Approved by: Xu Kai

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Version	Revision Description	Issue Date
Rev.0	Initial issue of report.	August 31, 2023
Rev.1	Update information.	September 15, 2023
Rev.2	Update information and description.	October 13, 2023
Note: This revised report (Report No.: R2306A0670-R1V2) supersedes and replaces the previously issued report (Report No.: R2306A0670-R1V1). 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
Date of Testing: July 6, 2023 ~ August 9, 2023 Date of Sample Received: June 12, 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
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E-mail:	xukai@ta-shanghai.com

2. General Description of Equipment Under Test

2.1. Applicant and Manufacturer Information

Applicant	Panasonic Corporation of North America
Applicant address	Two Riverfront Plaza, Newark, NJ 07102-5490, United States
Manufacturer	Panasonic Entertainment & Communication Co., Ltd.
Manufacturer address	1-10-12 Yagumo-higashi-machi, Moriguchi City, Osaka 570-0021, Japan

2.2. General Information

EUT Description		
Model	P24VS_01	
Lab internal SN	R2306A0670/S01	
Hardware Version	1	
Software Version	1	
Power Supply	External power supply	
Antenna Type	Bluetooth LE: Internal Antenna / External Antenna Wi-Fi 2.4G: Internal Antenna	
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)	
Antenna Gain	Bluetooth LE	Internal Antenna 1: -8.1 dBi
		External Antenna 2: 0.6 dBi
	Wi-Fi 2.4G	Antenna 1: -1.2 dBi
		Antenna 2: -0.2 dBi
Additional Beamforming Gain	NA	
Direction Gain	Power: -0.20 dBi PSD: 2.81 dBi	
Operating Frequency Range(s)	802.11b/g/n(HT20)/ax(HE20): 2412 ~ 2462 MHz 802.11n(HT40)/ax(HE40): 2422 ~ 2452 MHz Bluetooth LE V5.2: 2402 ~2480 MHz	
Modulation Type	802.11b: DSSS 802.11g/n: OFDM 802.11ax TB: OFDMA Bluetooth LE: GFSK	
Max. Output Power	Wi-Fi 2.4G: 18.70dBm Bluetooth LE: 7.74dBm	
Note: 1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant. 2. The EUT is connected to 5V DC power supply. And EUT is connected a computer was used to configure the DUT using the tool QA Tool_Dbg to transmit all different modes		

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

KDB 662911 D01 Multiple Transmitter Output v02r01

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.

The test software is used MT7921.

Worst-case data rates are shown as following table.

Test Mode	Data Rate	
	Internal Antenna	External Antenna
Bluetooth(Low Energy)	1Mbps; 2Mbps; S=2; S=8	1Mbps; 2Mbps; S=2; S=8

Test Mode	Data Rate		
	Antenna 1	Antenna 2	MIMO
802.11b	1 Mbps	1 Mbps	1 Mbps
802.11g	6 Mbps	6 Mbps	6 Mbps
802.11n HT20	MCS0	MCS0	MCS8
802.11n HT40	MCS0	MCS0	MCS8
802.11ax HE20	MCS0	MCS0	MCS0
802.11ax HE40	MCS0	MCS0	MCS0

The worst case Antenna mode for each of the following tests for Wi-Fi:

Test Cases	Antenna 1	Antenna 2	MIMO
Maximum output power	O	O	O
6dB Bandwidth	--	--	O
Band Edge	--	--	O
Power Spectral Density	O	O	O
Spurious RF Conducted Emissions	--	--	O
Unwanted Emissions	--	--	O
Conducted Emission	--	--	--
Note：“O”: test all bands			

TB Mode

Test Cases	Antenna 1	Antenna 2	MIMO
Maximum output power	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)
6dB Bandwidth	--	--	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)
Band Edge	--	--	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)
Power Spectral Density	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)
Spurious RF Conducted Emissions	--	--	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)
Unwanted Emissions	--	--	802.11ax HE20 (26Tone; 52Tone; 106Tone; 242Tone)
Conducted Emission	--	--	--

5. Test Case Results

5.1. Maximum output power

Ambient Condition

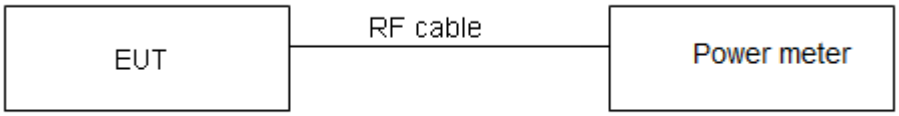
Temperature	Relative humidity
20°C ~ 25°C	45% ~ 50%

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.

The conducted Power is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically.

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

SISO Antenna Power Index								
Antenna	Channel	802.11b	802.11g	802.11n HT20	802.11ax HE20	Channel	802.11n HT40	802.11ax HE40
Antenna 1	CH1	15	15	15	15	CH3	15	15
	CH6	15	15	15	15	CH6	15	15
	CH11	15	15	15	15	CH9	15	15
Antenna 2	CH1	15	15	15	15	CH3	15	15
	CH6	15	15	15	15	CH6	15	15
	CH11	15	15	15	15	CH9	15	15
MIMO Antenna Power Index								
Antenna	Channel	802.11b	802.11g	802.11n HT20	802.11ax HE20	Channel	802.11n HT40	802.11ax HE40
Antenna 1	CH1	15	15	15	15	CH3	15	15
	CH6	15	15	15	15	CH6	15	15
	CH11	15	15	15	15	CH9	15	15
Antenna 2	CH1	15	15	15	15	CH3	15	15
	CH6	15	15	15	15	CH6	15	15
	CH11	15	15	15	15	CH9	15	15

Test Mode	Duty cycle	Duty cycle correction Factor (dB)
802.11b	0.957	0.19
802.11g	0.787	1.04
802.11n HT20	0.775	1.11
802.11n HT40	0.356	4.49
802.11ax HE20	0.464	3.34
802.11ax HE40	0.466	3.32
Note: when Duty cycle≥0.98, Duty cycle correction Factor not required.		

SISO Antenna 1

Test Mode	Carrier frequency (MHz) / Channel	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412/CH 1	15.16	15.35	30	PASS
	2437/CH 6	15.08	15.27	30	PASS
	2462/CH11	15.05	15.24	30	PASS
802.11g	2412/CH 1	14.37	15.41	30	PASS
	2437/CH 6	14.63	15.67	30	PASS
	2462/CH11	14.22	15.26	30	PASS
802.11n HT20	2412/CH 1	14.20	15.31	30	PASS
	2437/CH 6	14.27	15.38	30	PASS
	2462/CH11	14.26	15.37	30	PASS
802.11n HT40	2422/CH3	10.88	15.37	30	PASS
	2437/CH6	11.06	15.55	30	PASS
	2452/CH9	11.03	15.52	30	PASS
802.11ax HE20	2412/CH 1	12.00	15.34	30	PASS
	2437/CH 6	12.39	15.73	30	PASS
	2462/CH11	12.28	15.62	30	PASS
802.11ax HE40	2422/CH3	12.30	15.62	30	PASS
	2437/CH6	12.41	15.73	30	PASS
	2452/CH9	12.43	15.75	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

SISO Antenna 2

Test Mode	Carrier frequency (MHz) / Channel	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412/CH 1	14.86	15.05	30	PASS
	2437/CH 6	15.26	15.45	30	PASS
	2462/CH11	14.85	15.04	30	PASS
802.11g	2412/CH 1	14.28	15.32	30	PASS
	2437/CH 6	14.43	15.47	30	PASS
	2462/CH11	14.28	15.32	30	PASS
802.11n HT20	2412/CH 1	14.07	15.18	30	PASS
	2437/CH 6	14.43	15.54	30	PASS
	2462/CH11	14.30	15.41	30	PASS
802.11n HT40	2422/CH3	10.92	15.41	30	PASS
	2437/CH6	11.16	15.65	30	PASS
	2452/CH9	10.82	15.31	30	PASS
802.11ax HE20	2412/CH 1	12.06	15.40	30	PASS
	2437/CH 6	12.34	15.68	30	PASS
	2462/CH11	12.07	15.41	30	PASS
802.11ax HE40	2422/CH3	12.41	15.73	30	PASS
	2437/CH6	12.56	15.88	30	PASS
	2452/CH9	12.28	15.60	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

MIMO

Test Mode	Carrier frequency (MHz) / Channel	MIMO Antenna 1		MIMO Antenna 2		Total Power (dBm)	Limit (dBm)	Conclusion
		Average Power Measured (dBm)	Average Power with duty factor (dBm)	Average Power Measured (dBm)	Average Power with duty factor (dBm)			
802.11b	2412/CH 1	14.83	15.02	14.94	15.13	18.09	30	PASS
	2437/CH 6	14.97	15.16	14.88	15.07	18.13	30	PASS
	2462/CH11	14.90	15.09	14.83	15.02	18.07	30	PASS
802.11g	2412/CH 1	14.28	15.32	14.53	15.57	18.46	30	PASS
	2437/CH 6	14.38	15.42	14.44	15.48	18.46	30	PASS
	2462/CH11	14.49	15.53	14.26	15.30	18.43	30	PASS
802.11n HT20	2412/CH 1	14.06	15.17	14.17	15.28	18.24	30	PASS
	2437/CH 6	14.33	15.44	14.17	15.28	18.37	30	PASS
	2462/CH11	14.23	15.34	14.19	15.30	18.33	30	PASS
802.11n HT40	2422/CH3	10.78	15.27	10.76	15.25	18.27	30	PASS
	2437/CH6	10.90	15.39	10.77	15.26	18.34	30	PASS
	2452/CH9	10.97	15.46	10.92	15.41	18.45	30	PASS
802.11ax HE20	2412/CH 1	11.83	15.17	11.95	15.29	18.24	30	PASS
	2437/CH 6	12.16	15.50	12.10	15.44	18.48	30	PASS
	2462/CH11	12.11	15.45	12.16	15.50	18.49	30	PASS
802.11ax HE40	2422/CH3	12.22	15.54	12.29	15.61	18.59	30	PASS
	2437/CH6	12.38	15.70	12.26	15.58	18.65	30	PASS
	2452/CH9	12.39	15.71	12.35	15.67	18.70	30	PASS

Note: 1.Average Power with duty factor = Average Power Measured +Duty cycle correction factor

2. For Total Power, according to KDB 662911 D01 Multiple Transmitter Output v02r01 1),

The Total Power $=10\log(10^{(\text{Power antenna1 in dBm}/10)}+10^{(\text{Power antenna2 in dBm}/10)})$.

3. According to KDB 662911 D01 Multiple Transmitter Output v02r01 F)2)f)(ii): If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream: Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain.

Directional gain = $G_{ANT\ MAX}$ + Array Gain,

For power measurements on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;

Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};

Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less, for 20-MHz channel widths with $N_{ANT} \geq 5$.

So directional gain = $G_{ANT\ MAX}$ + Array Gain =-0.2+0=-0.2 dBi<6dBi. So the power limit is 30dBm

TB Mode

SISO Antenna Power Index				
Antenna	**Channel**	**802.11ax HE20 26-Tone**	**802.11ax HE20 52-Tone**	**802.11ax HE20 106-Tone**
Antenna 1	**CH1**	15	15	15
	CH6	15	15	15
	CH11	15	15	15
Antenna 2	**CH1**	15	15	15
	CH6	15	15	15
	CH11	15	15	15
MIMO Antenna Power Index				
Antenna	**Channel**	**802.11ax HE20 26-Tone**	**802.11ax HE20 52-Tone**	**802.11ax HE20 106-Tone**
Antenna 1	**CH1**	15	15	15
	CH6	15	15	15
	CH11	15	15	15
Antenna 2	**CH1**	15	15	15
	CH6	15	15	15
	CH11	15	15	15

Test Mode	Duty cycle	Duty cycle correction Factor (dB)
802.11ax HE20 26-Tone:RU Index 0	0.81	0.89
802.11ax HE20 26-Tone:RU Index 4	0.83	0.83
802.11ax HE20 26-Tone:RU Index 8	0.64	1.95
802.11ax HE20 52-Tone:RU Index 37	0.59	2.30
802.11ax HE20 52-Tone:RU Index 38	0.58	2.35
802.11ax HE20 52-Tone:RU Index 40	0.58	2.35
02.11ax HE20 106-Tone:RU Index 53	0.57	2.45
02.11ax HE20 106-Tone:RU Index 54	0.55	2.60
Note: when Duty cycle≥0.98, Duty cycle correction Factor not required.		

SISO Antenna 1

Test Mode	Carrier frequency (MHz) / Channel	RU Index	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11ax HE20 26-Tone	2412/CH 1	0	12.77	13.66	30	PASS
	2437/CH 6	4	13.52	14.35	30	PASS
	2462/CH11	8	13.13	15.08	30	PASS
802.11ax HE20 52-Tone	2412/CH 1	37	12.91	15.21	30	PASS
	2437/CH 6	38	13.38	15.73	30	PASS
	2462/CH11	40	12.96	15.31	30	PASS
802.11ax HE20 106-Tone	2412/CH 1	53	13.13	15.58	30	PASS
	2437/CH 6	53	12.90	15.35	30	PASS
	2462/CH11	54	12.80	15.40	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor						

SISO Antenna 2

Test Mode	Carrier frequency (MHz) / Channel	RU Index	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11ax HE20 26-Tone	2412/CH 1	0	12.43	13.32	30	PASS
	2437/CH 6	4	13.95	14.78	30	PASS
	2462/CH11	8	13.36	15.31	30	PASS
802.11ax HE20 52-Tone	2412/CH 1	37	13.33	15.63	30	PASS
	2437/CH 6	38	13.53	15.88	30	PASS
	2462/CH11	40	13.28	15.63	30	PASS
802.11ax HE20 106-Tone	2412/CH 1	53	13.10	15.55	30	PASS
	2437/CH 6	53	13.35	15.80	30	PASS
	2462/CH11	54	12.97	15.57	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor						

MIMO

Test Mode	Carrier frequency (MHz) / Channel	RU Index	MIMO Antenna 1		MIMO Antenna 2		Total Power (dBm)	Limit (dBm)	Conclusion
			Average Power Measured (dBm)	Average Power with duty factor (dBm)	Average Power Measured (dBm)	Average Power with duty factor (dBm)			
802.11ax HE20 26-Tone	2412/CH 1	0	12.98	13.87	13.00	13.89	16.89	30	PASS
	2437/CH 6	4	13.31	14.14	13.79	14.62	17.40	30	PASS
	2462/CH11	8	13.60	15.55	13.76	15.71	18.64	30	PASS
802.11ax HE20 52-Tone	2412/CH 1	37	12.90	15.20	13.50	15.80	18.52	30	PASS
	2437/CH 6	38	13.20	15.55	13.37	15.72	18.65	30	PASS
	2462/CH11	40	12.73	15.08	13.15	15.50	18.31	30	PASS
802.11ax HE20 106-Tone	2412/CH 1	53	12.74	15.19	13.43	15.88	18.56	30	PASS
	2437/CH 6	53	12.54	14.99	12.42	14.87	17.94	30	PASS
	2462/CH11	54	13.17	15.77	12.93	15.53	18.66	30	PASS

Note: 1.Average Power with duty factor = Average Power Measured +Duty cycle correction factor

2. For Total Power, according to KDB 662911 D01 Multiple Transmitter Output v02r01 1),

The Total Power $=10\log(10^{(\text{Power antenna1 in dBm}/10)}+10^{(\text{Power antenna2 in dBm}/10)})$.

3. According to KDB 662911 D01 Multiple Transmitter Output v02r01 F)2)f)(ii): If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream: Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain.

Directional gain = $G_{ANT\ MAX}$ + Array Gain,

For power measurements on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;

Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};

Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less, for 20-MHz channel widths with $N_{ANT} \geq 5$.

So directional gain = $G_{ANT\ MAX}$ + Array Gain =-0.2+0=-0.2 dBi<6dBi. So the power limit is 30dBm

Power Index		
Channel		Bluetooth (Low Energy)
Internal Antenna	CH0	7
	CH19	7
	CH39	7
External Antenna	CH0	7
	CH19	7
	CH39	7

Internal Antenna

Test Mode	Duty cycle	Duty cycle correction Factor (dB)
Bluetooth LE (1M)	0.614	2.12
Bluetooth LE (2M)	0.571	2.43
Bluetooth LE (S=2)	0.910	0.41
Bluetooth LE (S=8)	0.974	0.11
Note: when Duty cycle⩾0.98, Duty cycle correction Factor not required.		

External Antenna

Test Mode	Duty cycle	Duty cycle correction Factor (dB)
Bluetooth LE (1M)	0.614	2.12
Bluetooth LE (2M)	0.571	2.43
Bluetooth LE (S=2)	0.851	0.70
Bluetooth LE (S=8)	0.851	0.70
Note: when Duty cycle⩾0.98, Duty cycle correction Factor not required.		

Internal Antenna

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	5.12	7.24	30	PASS
	2440/CH19	4.99	7.12	30	PASS
	2480/CH39	4.81	6.93	30	PASS
Bluetooth (Low Energy) (2M)	2402/CH0	4.87	7.30	30	PASS
	2440/CH19	4.62	7.05	30	PASS
	2480/CH39	4.41	6.84	30	PASS
Bluetooth (Low Energy) (S=2)	2402/CH0	6.95	7.36	30	PASS
	2440/CH19	6.67	7.08	30	PASS
	2480/CH39	6.43	6.84	30	PASS
Bluetooth (Low Energy) (S=8)	2402/CH0	7.31	7.42	30	PASS
	2440/CH19	7.07	7.18	30	PASS
	2480/CH39	7.01	7.12	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

External Antenna

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	5.54	7.66	30	PASS
	2440/CH19	5.30	7.42	30	PASS
	2480/CH39	5.40	7.52	30	PASS
Bluetooth (Low Energy) (2M)	2402/CH0	5.21	7.64	30	PASS
	2440/CH19	4.94	7.38	30	PASS
	2480/CH39	5.05	7.48	30	PASS
Bluetooth (Low Energy) (S=2)	2402/CH0	6.96	7.66	30	PASS
	2440/CH19	6.74	7.44	30	PASS
	2480/CH39	6.75	7.45	30	PASS
Bluetooth (Low Energy) (S=8)	2402/CH0	7.04	7.74	30	PASS
	2440/CH19	6.61	7.31	30	PASS
	2480/CH39	6.65	7.35	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

5.2. 99% Bandwidth and 6dB Bandwidth

Ambient Condition

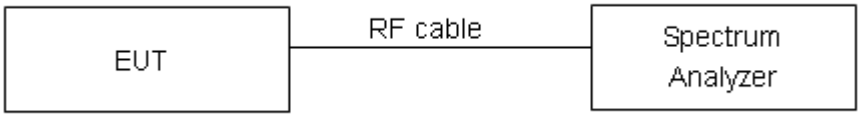
Temperature	Relative humidity
20°C ~ 25°C	45% ~ 50%

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	12.577	7.59	500	PASS
	2437	12.559	7.97	500	PASS
	2462	12.527	7.07	500	PASS
802.11g	2412	16.466	13.85	500	PASS
	2437	16.987	15.02	500	PASS
	2462	16.944	15.38	500	PASS
802.11n HT20	2412	17.589	15.10	500	PASS
	2437	18.024	15.14	500	PASS
	2462	18.091	15.99	500	PASS
802.11n HT40	2422	36.014	33.86	500	PASS
	2437	36.071	35.10	500	PASS
	2452	36.038	35.05	500	PASS
802.11ax HE20	2412	18.812	15.95	500	PASS
	2437	18.944	17.69	500	PASS
	2462	18.909	17.54	500	PASS
802.11ax HE40	2422	37.692	36.59	500	PASS
	2437	37.598	35.85	500	PASS
	2452	37.615	35.30	500	PASS

TB Mode

Test Mode	Carrier frequency (MHz)	RU Index	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11ax HE20 26-Tone	2412	0	18.095	2.09	500	PASS
	2437	4	17.020	2.66	500	PASS
	2462	8	18.519	2.06	500	PASS
802.11ax HE20 52-Tone	2412	37	18.107	3.99	500	PASS
	2437	38	17.092	13.80	500	PASS
	2462	40	18.255	14.54	500	PASS
802.11ax HE20 106-Tone	2412	53	18.088	17.11	500	PASS
	2437	53	18.211	17.70	500	PASS
	2462	54	17.784	17.12	500	PASS

Internal Antenna

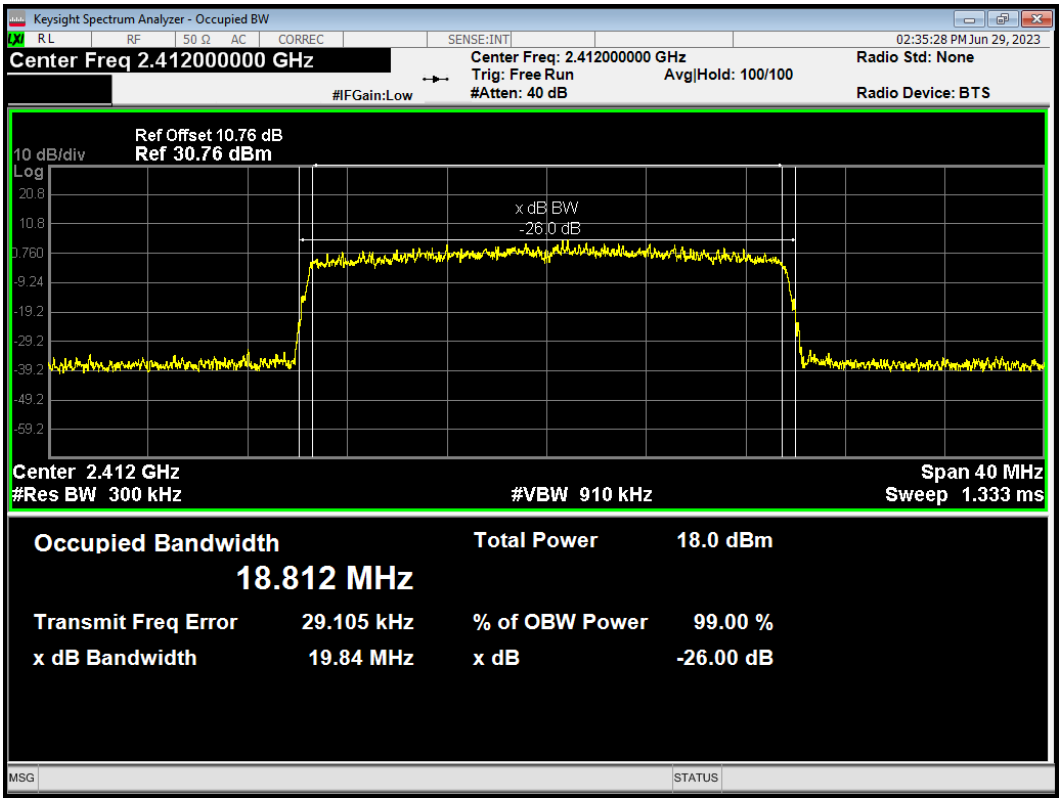
Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy) (1M)	2402	1.043	0.71	500	PASS
	2440	1.038	0.70	500	PASS
	2480	1.033	0.69	500	PASS
Bluetooth (Low Energy) (2M)	2402	2.075	1.35	500	PASS
	2440	2.076	1.23	500	PASS
	2480	2.079	1.34	500	PASS
Bluetooth (Low Energy) (S=2)	2402	1.029	0.66	500	PASS
	2440	1.019	0.69	500	PASS
	2480	1.031	0.66	500	PASS
Bluetooth (Low Energy) (S=8)	2402	1.049	0.68	500	PASS
	2440	1.052	0.68	500	PASS
	2480	1.060	0.68	500	PASS

External Antenna

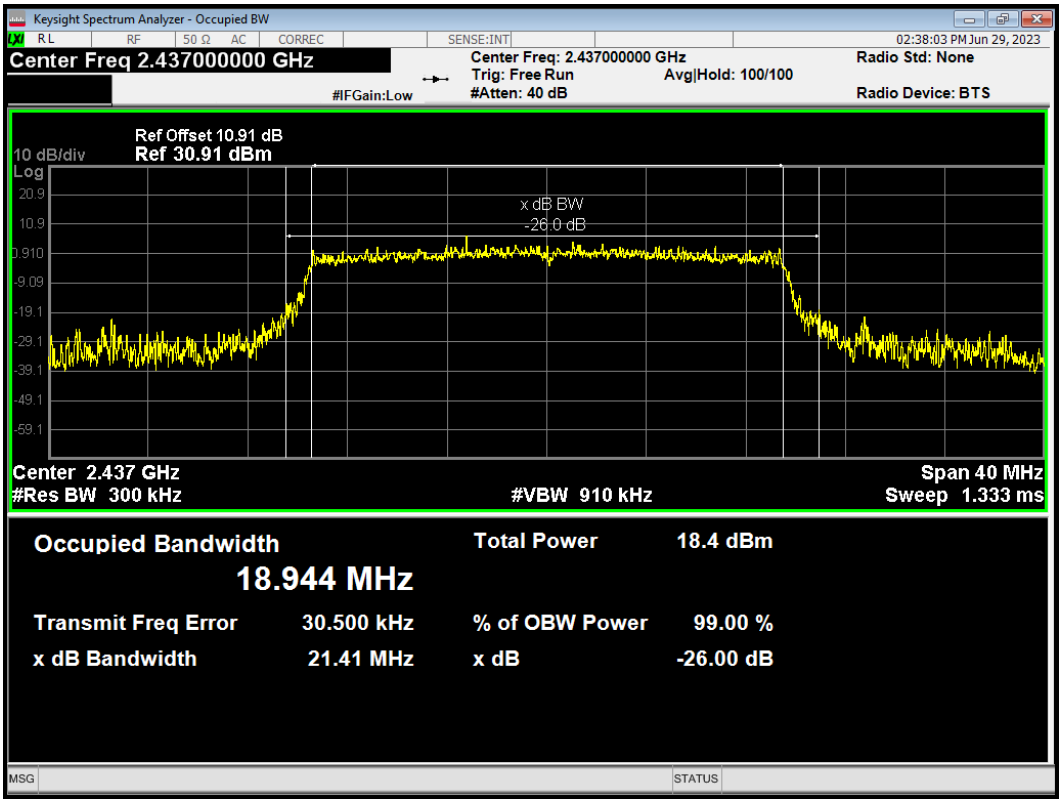
Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
Bluetooth (Low Energy) (1M)	2402	1.039	0.69	500	PASS
	2440	1.039	0.70	500	PASS
	2480	1.039	0.70	500	PASS
Bluetooth (Low Energy) (2M)	2402	2.080	1.23	500	PASS
	2440	2.078	1.22	500	PASS
	2480	2.079	1.18	500	PASS
Bluetooth (Low Energy) (S=2)	2402	1.041	0.65	500	PASS
	2440	1.041	0.71	500	PASS
	2480	1.042	0.65	500	PASS
Bluetooth (Low Energy) (S=8)	2402	1.043	0.64	500	PASS
	2440	1.038	0.68	500	PASS
	2480	1.042	0.67	500	PASS

99%bandwidth

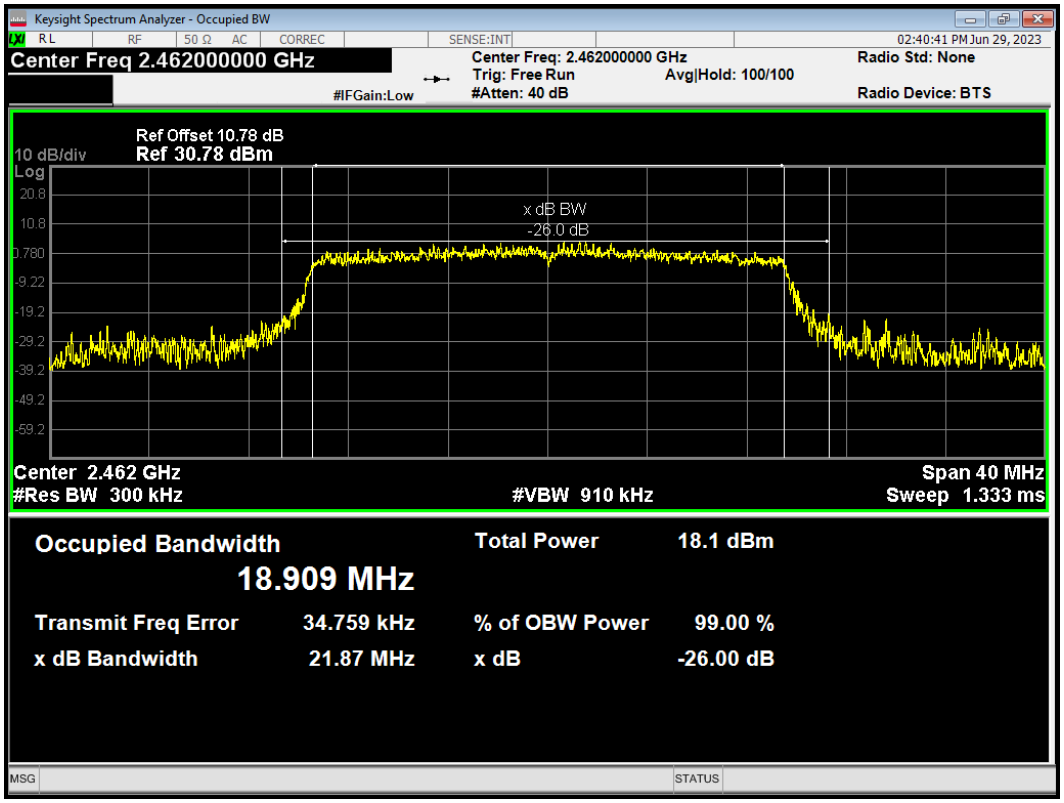
OBW 802.11ax (HE20) 2412MHz



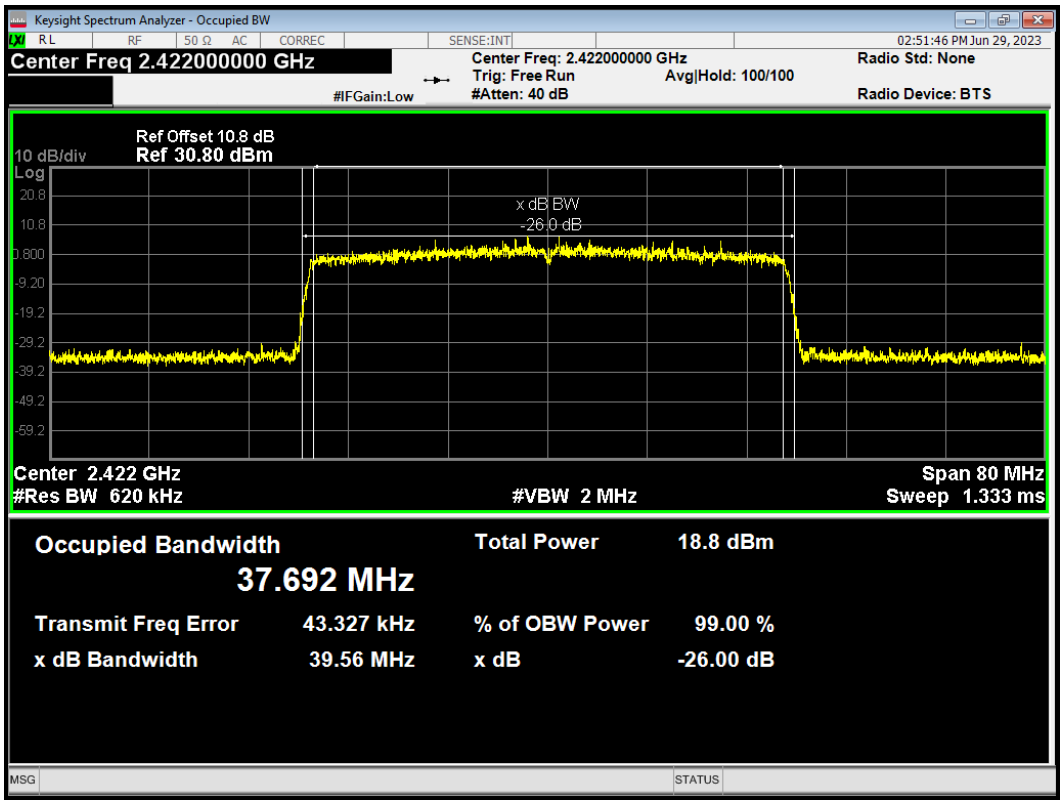
OBW 802.11ax (HE20) 2437MHz



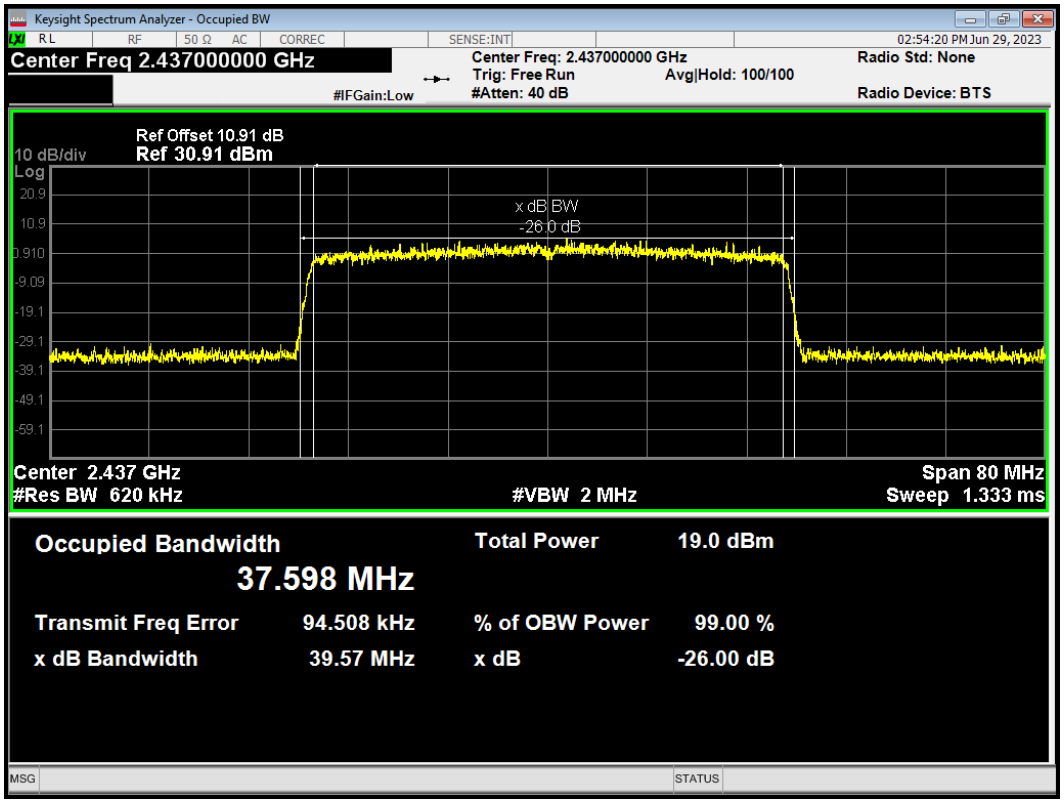
OBW 802.11ax (HE20) 2462MHz



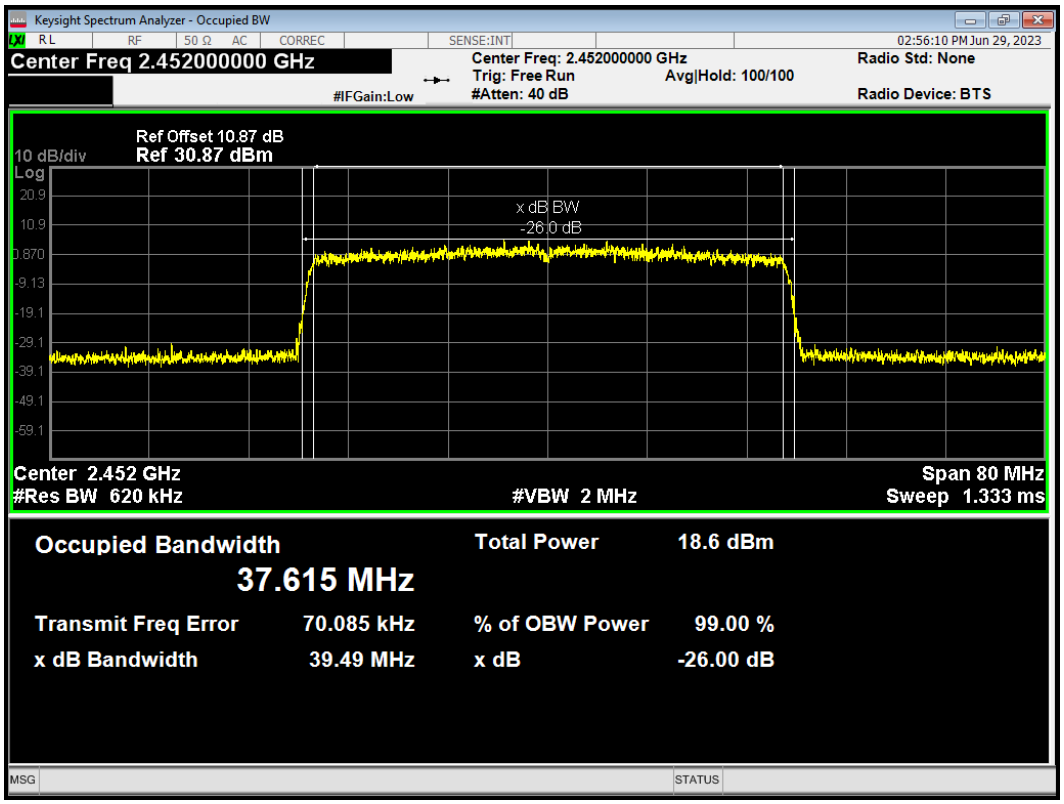
OBW 802.11ax (HE40) 2422MHz



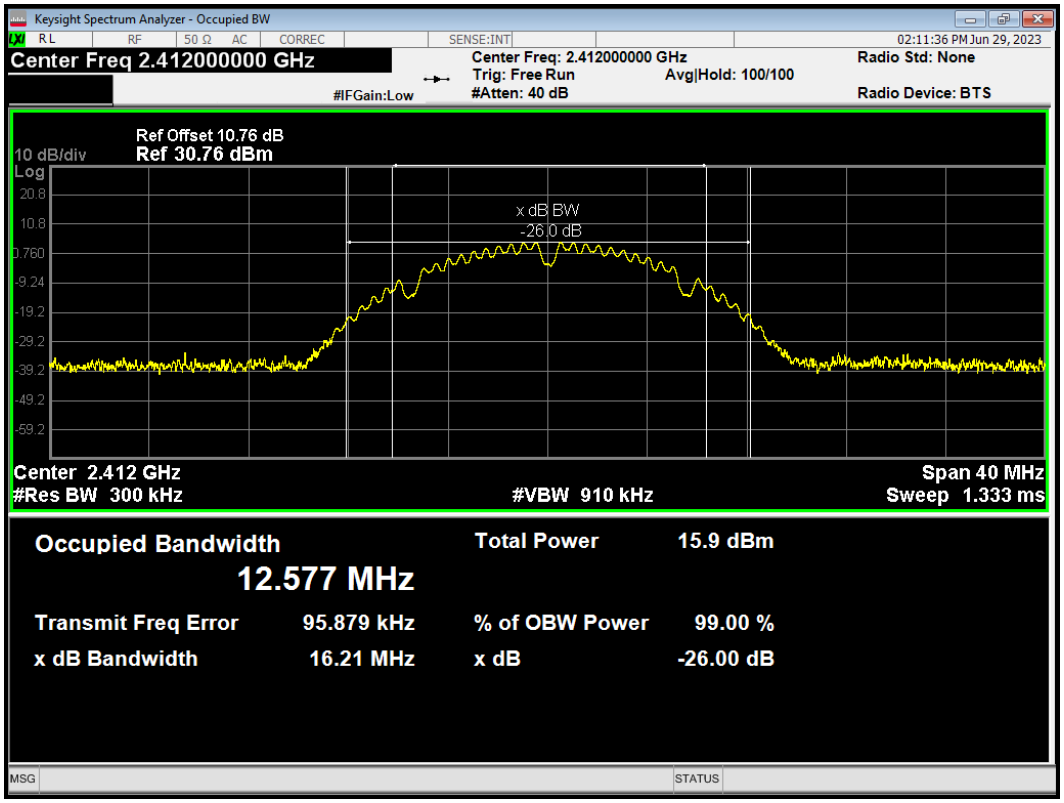
OBW 802.11ax (HE40) 2437MHz



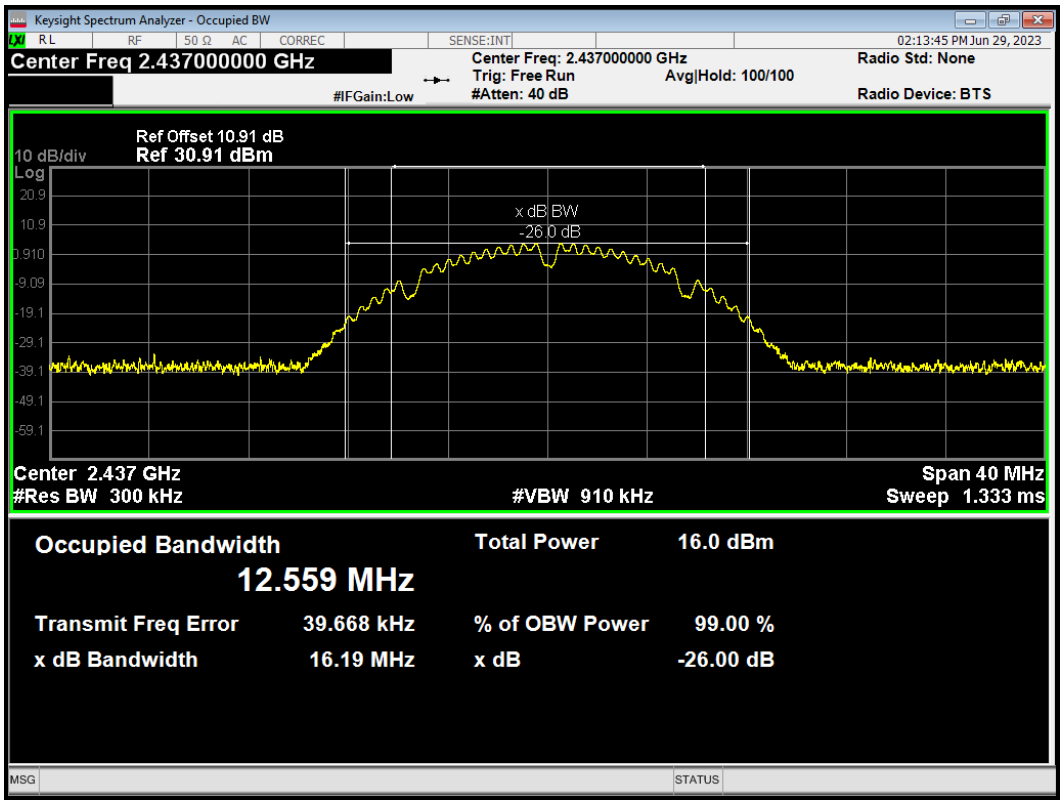
OBW 802.11ax (HE40) 2452MHz



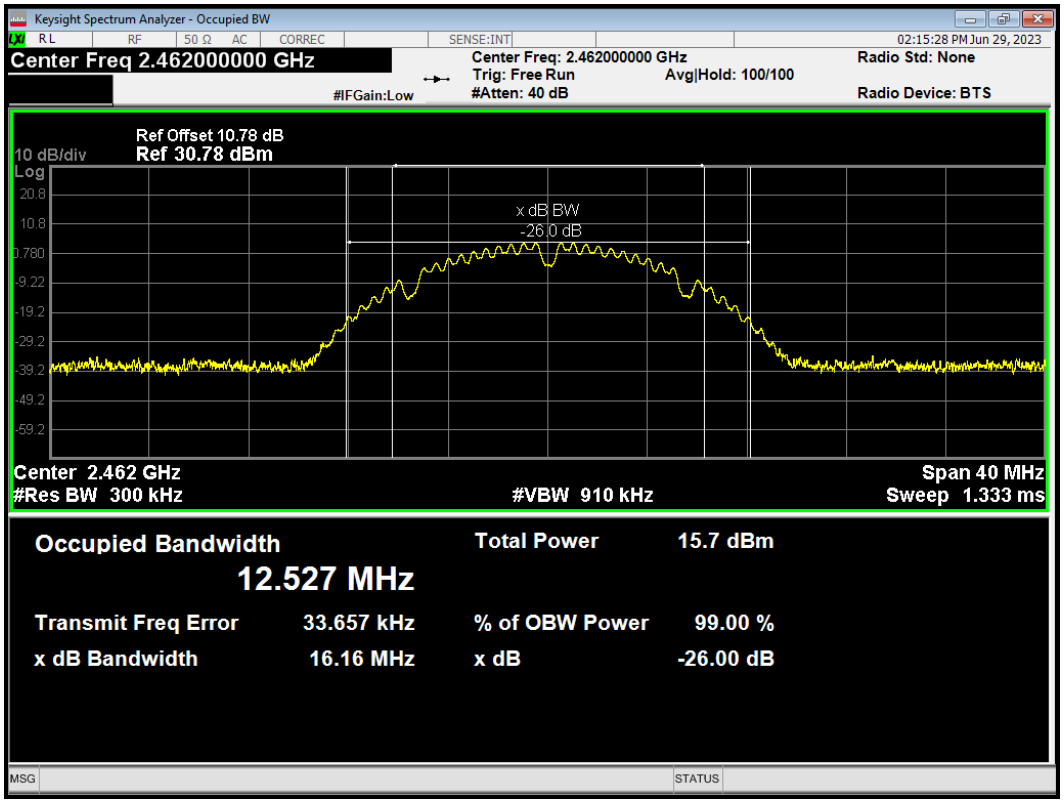
OBW 802.11b 2412MHz



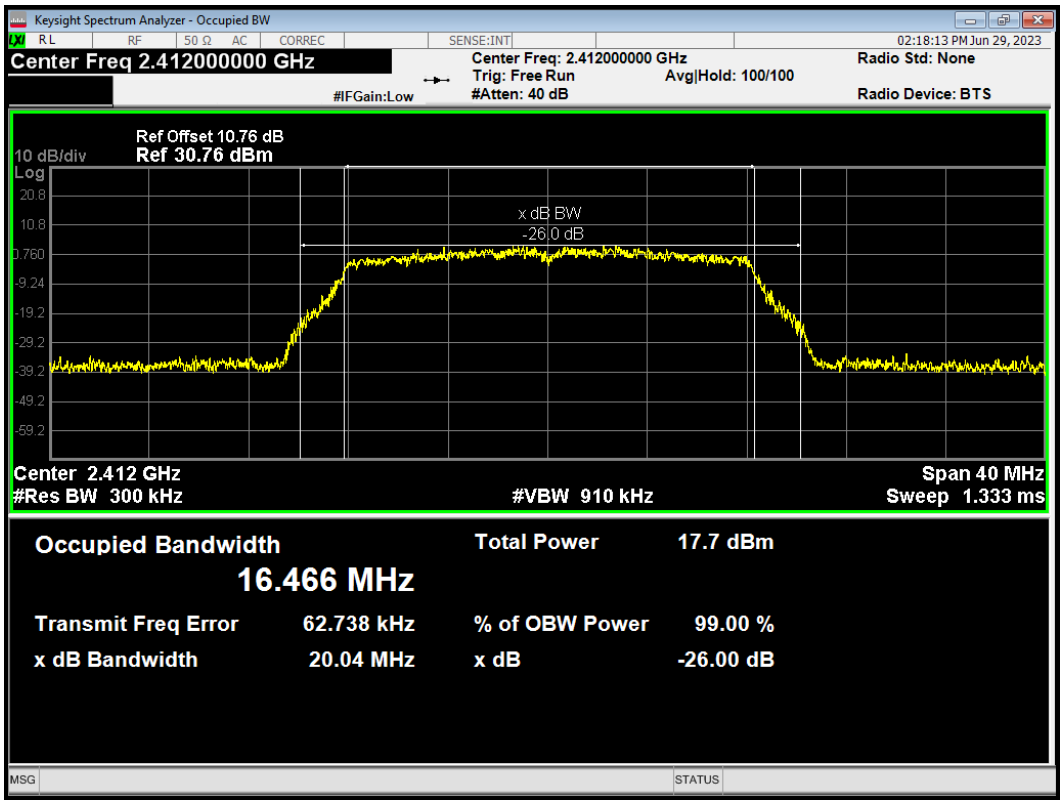
OBW 802.11b 2437MHz



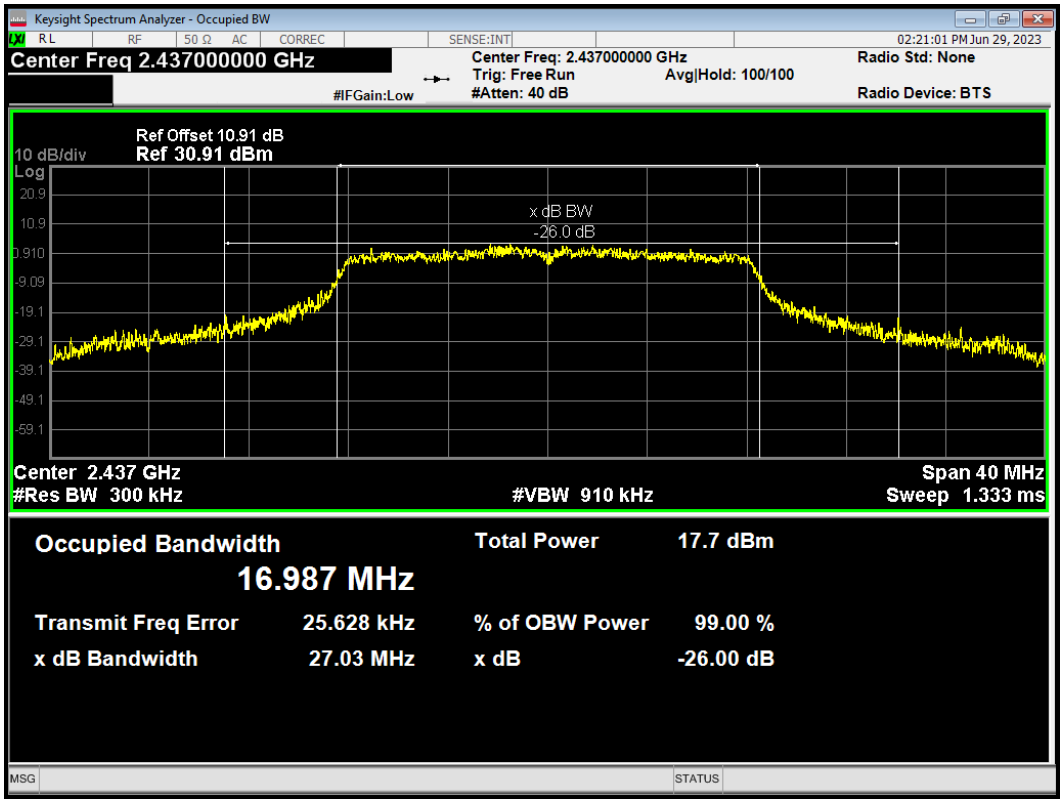
OBW 802.11b 2462MHz



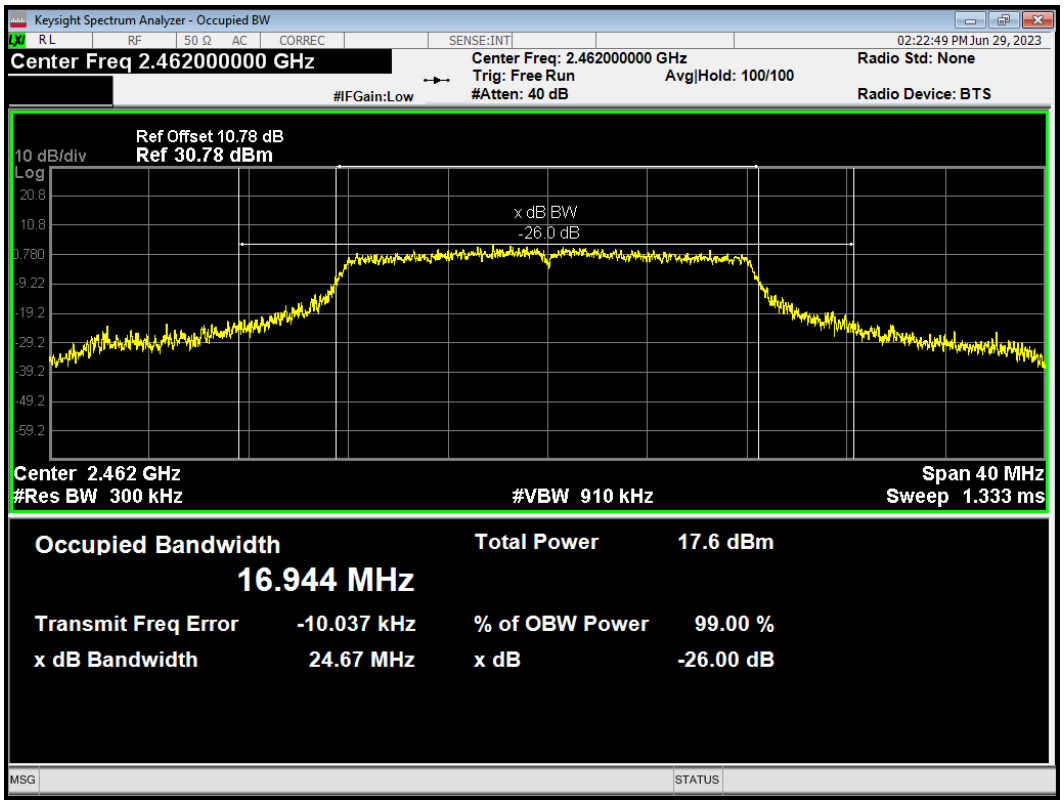
OBW 802.11g 2412MHz



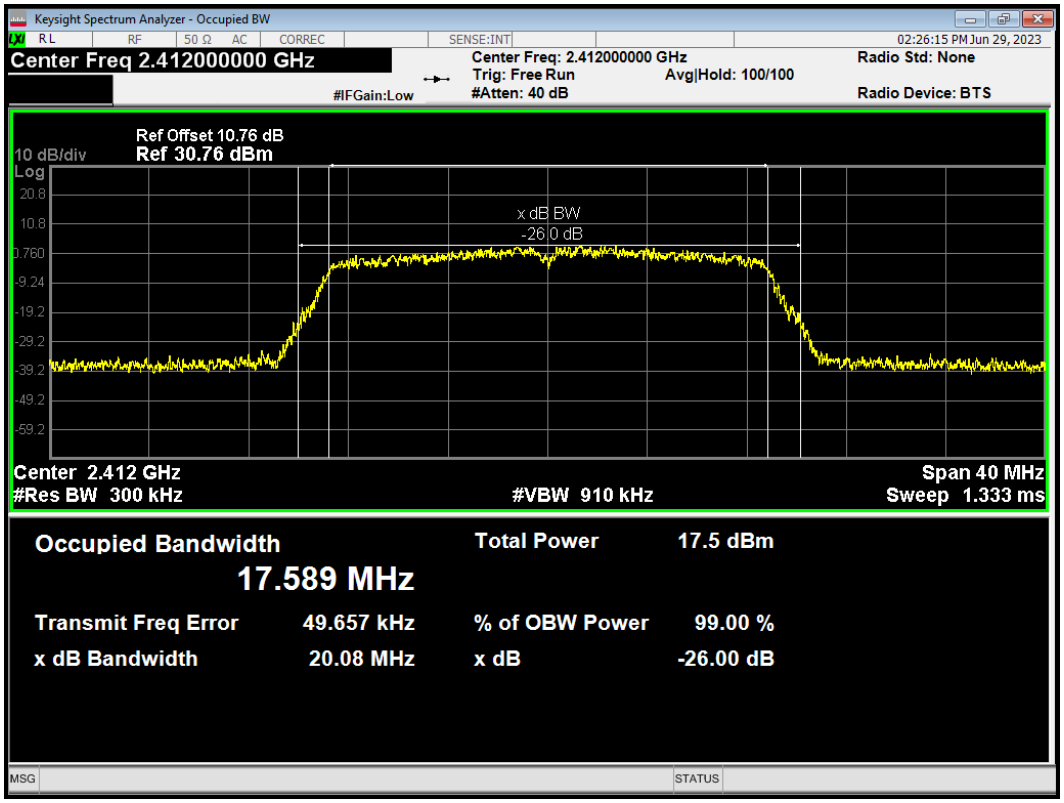
OBW 802.11g 2437MHz



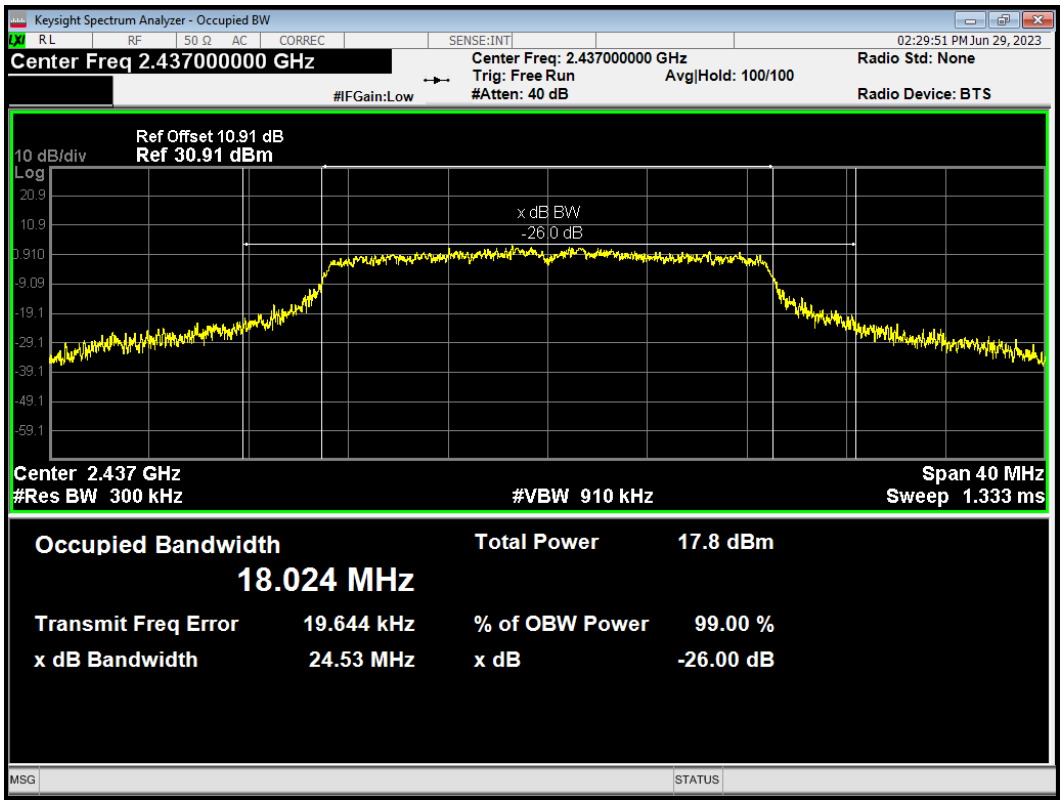
OBW 802.11g 2462MHz



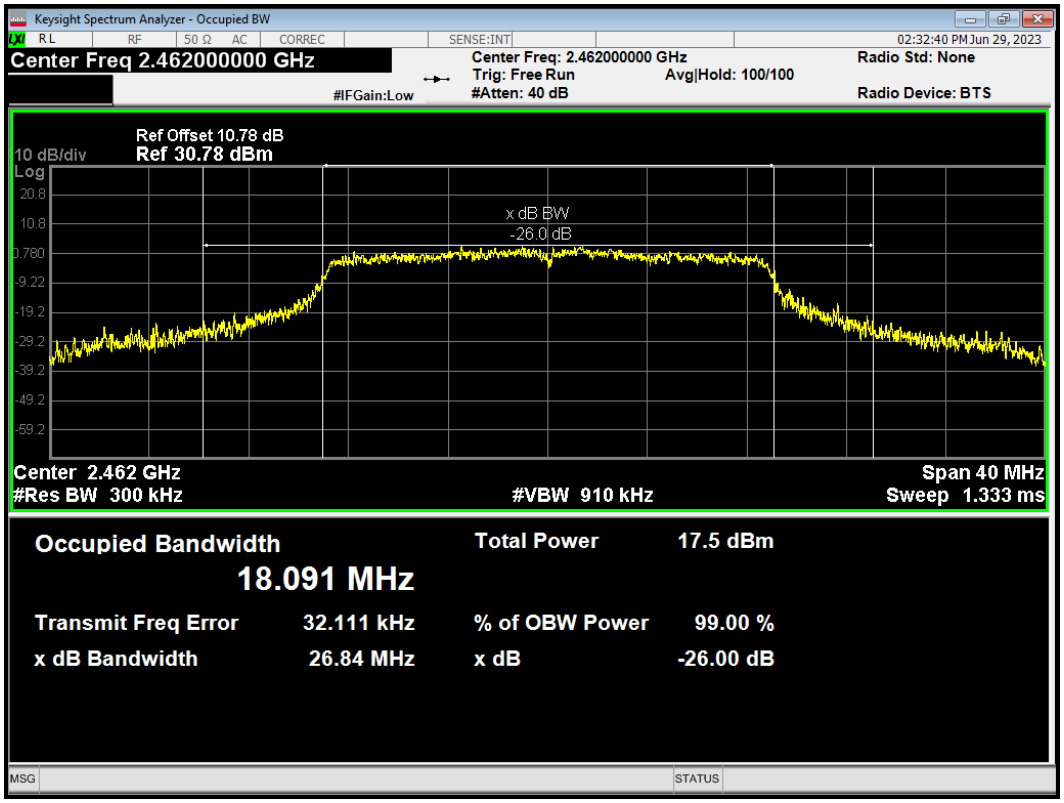
OBW 802.11n (HT20) 2412MHz



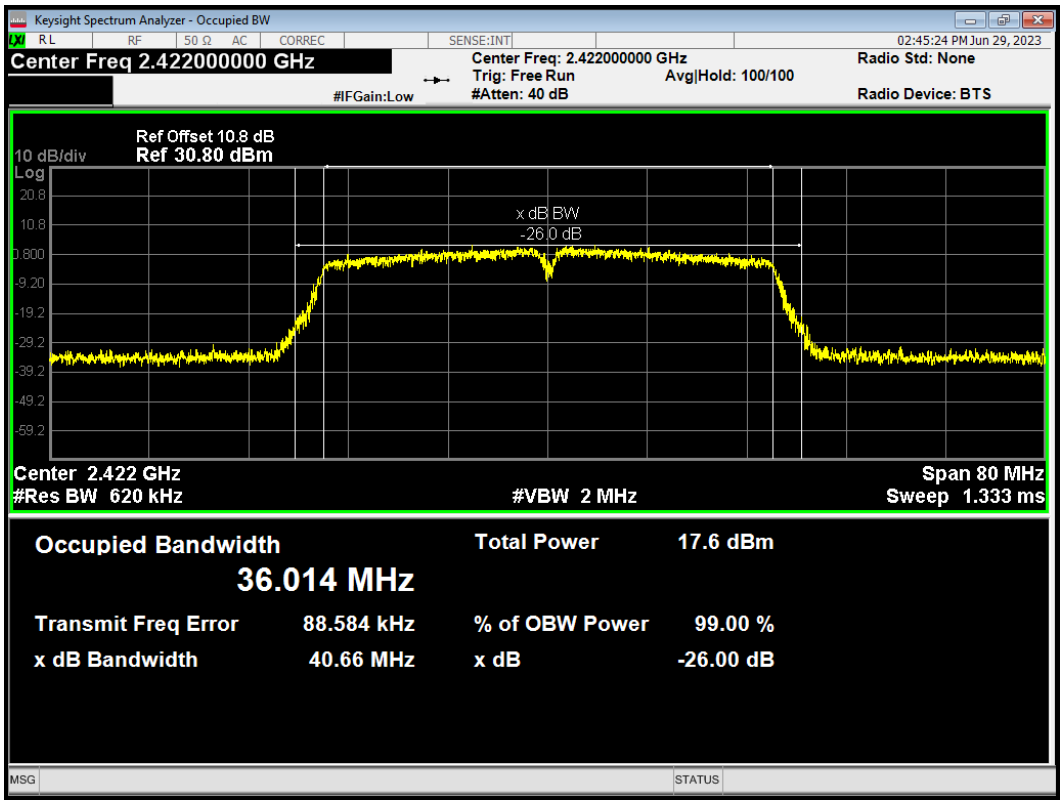
OBW 802.11n (HT20) 2437MHz



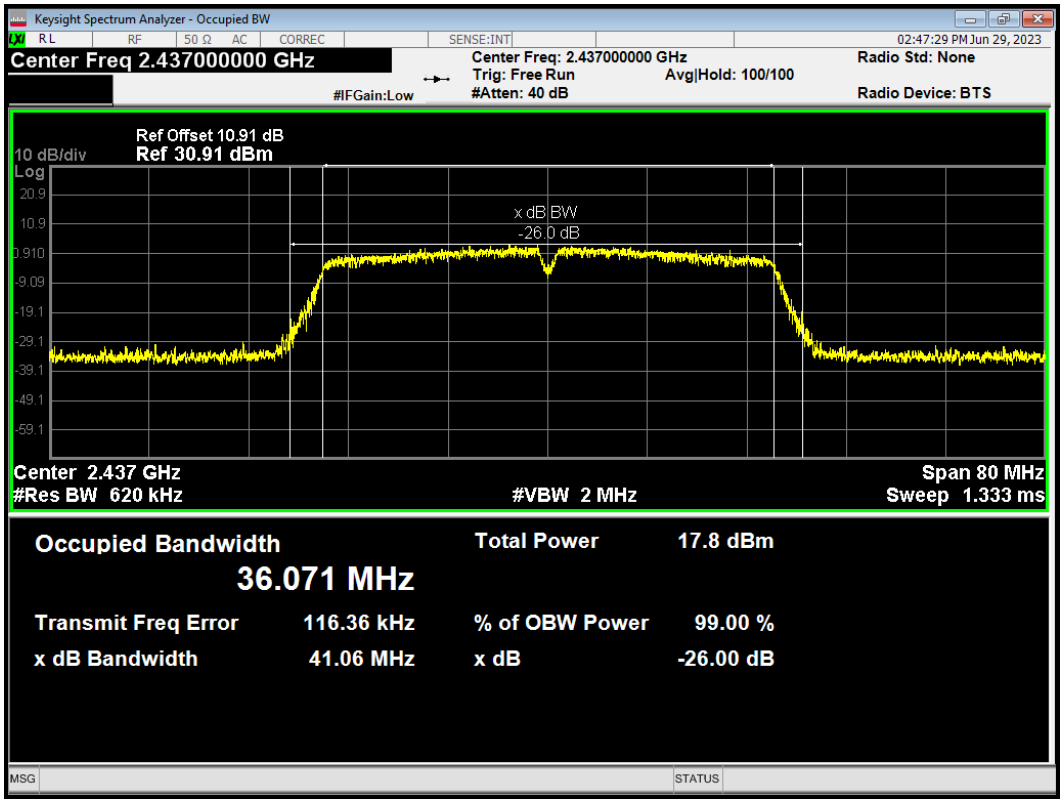
OBW 802.11n (HT20) 2462MHz



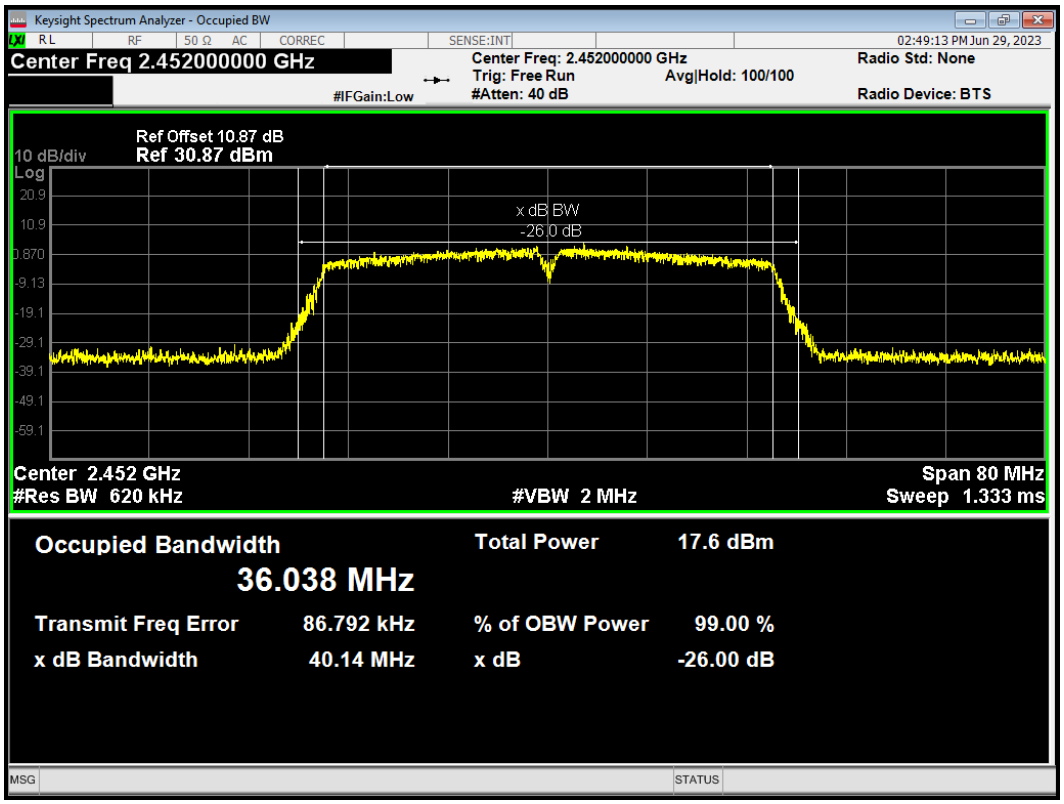
OBW 802.11n (HT40) 2422MHz



OBW 802.11n (HT40) 2437MHz

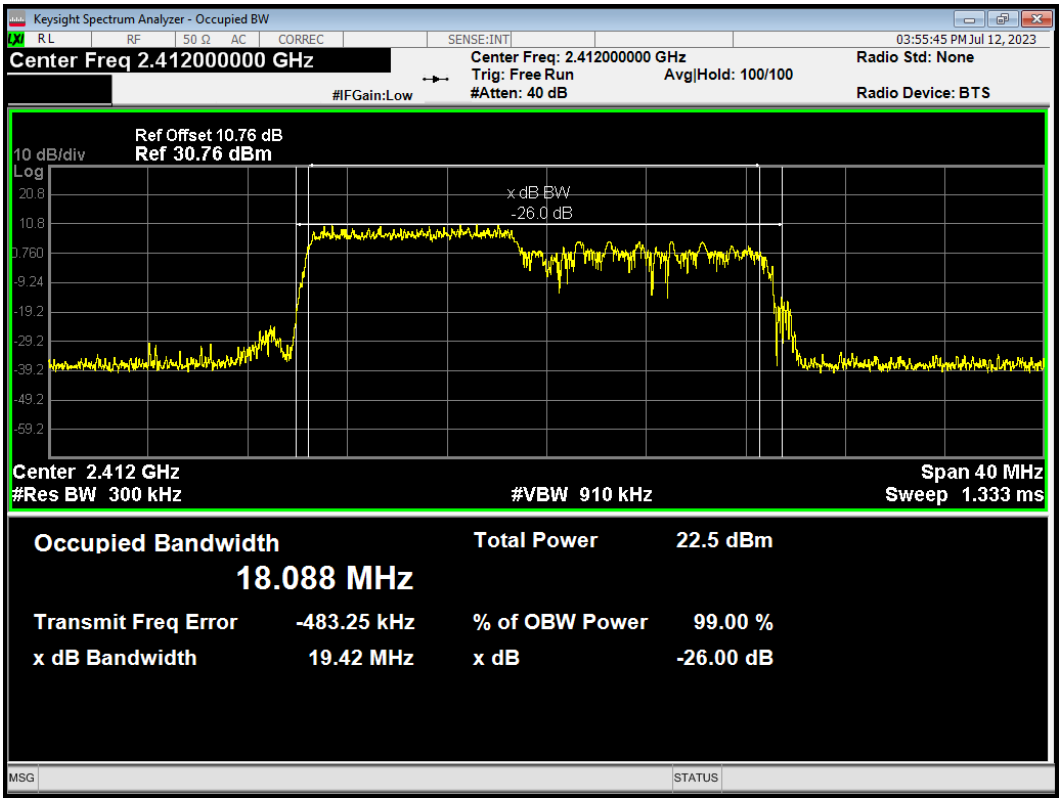


OBW 802.11n (HT40) 2452MHz

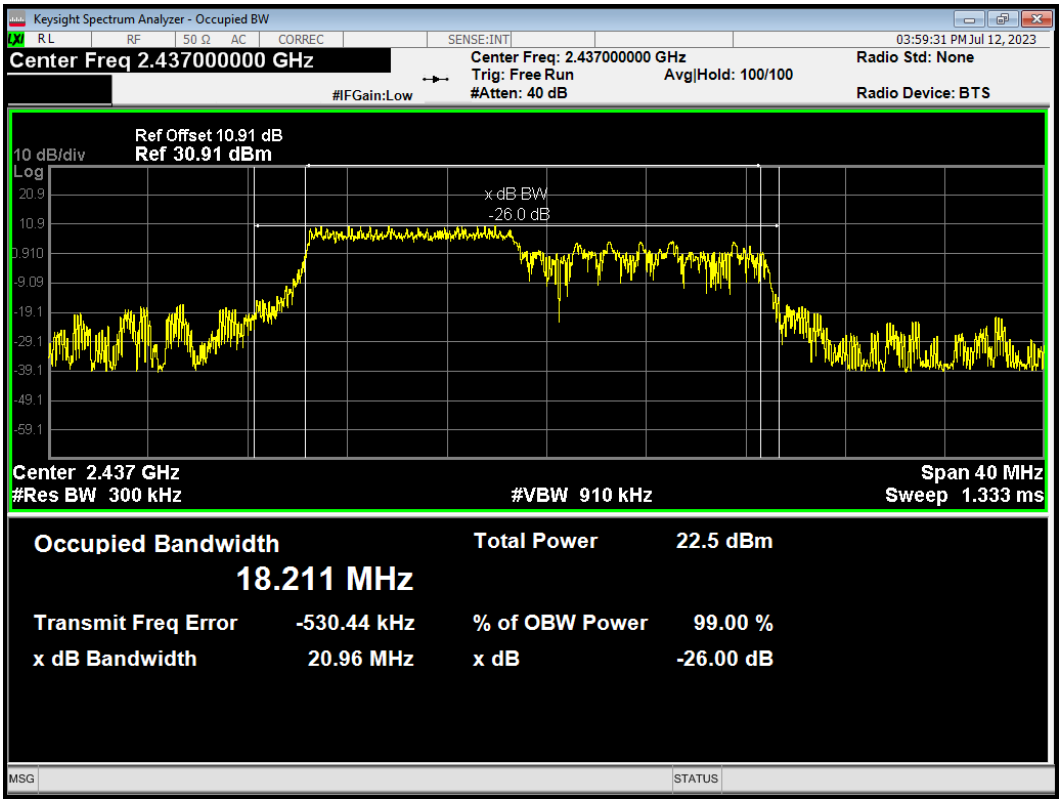


TB Mode

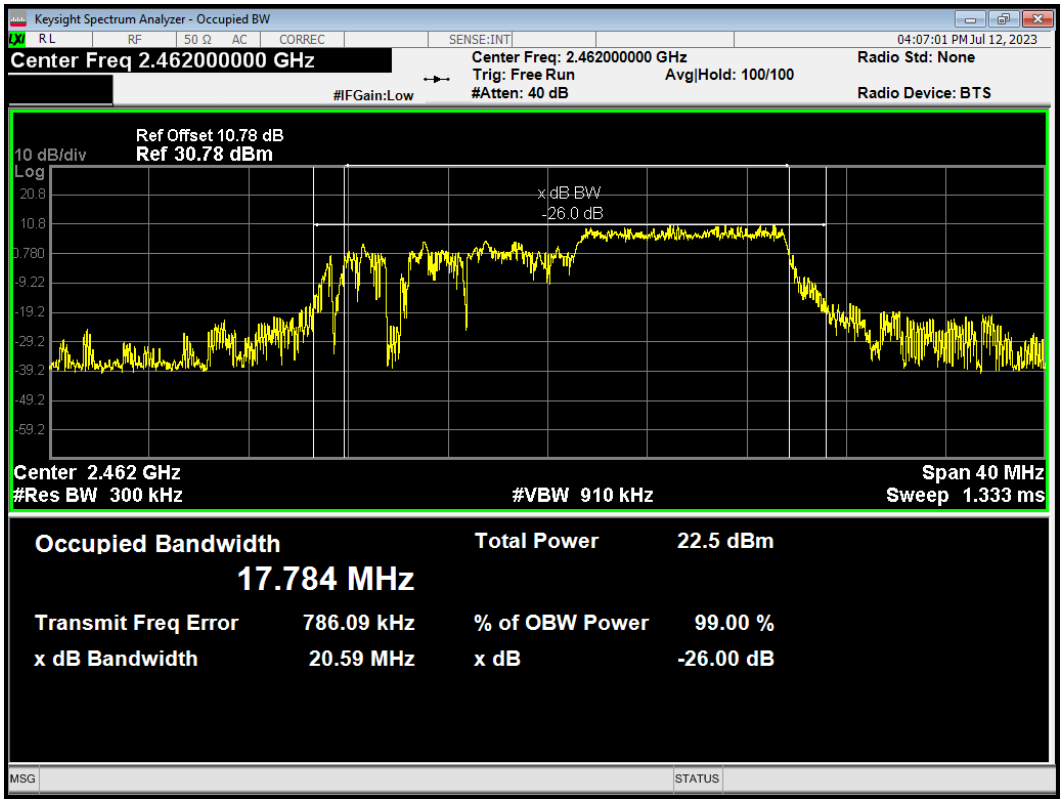
OBW 802.11ax (20M) RU106 IDX53 2412MHz



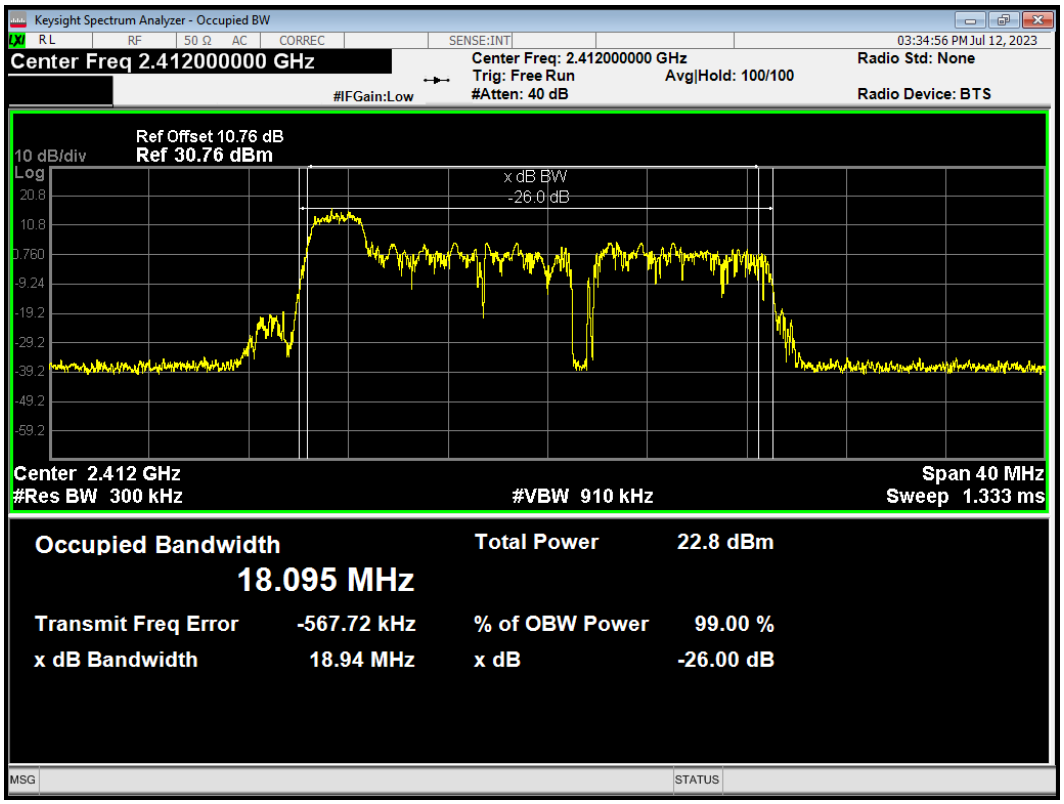
OBW 802.11ax (20M) RU106 IDX53 2437MHz



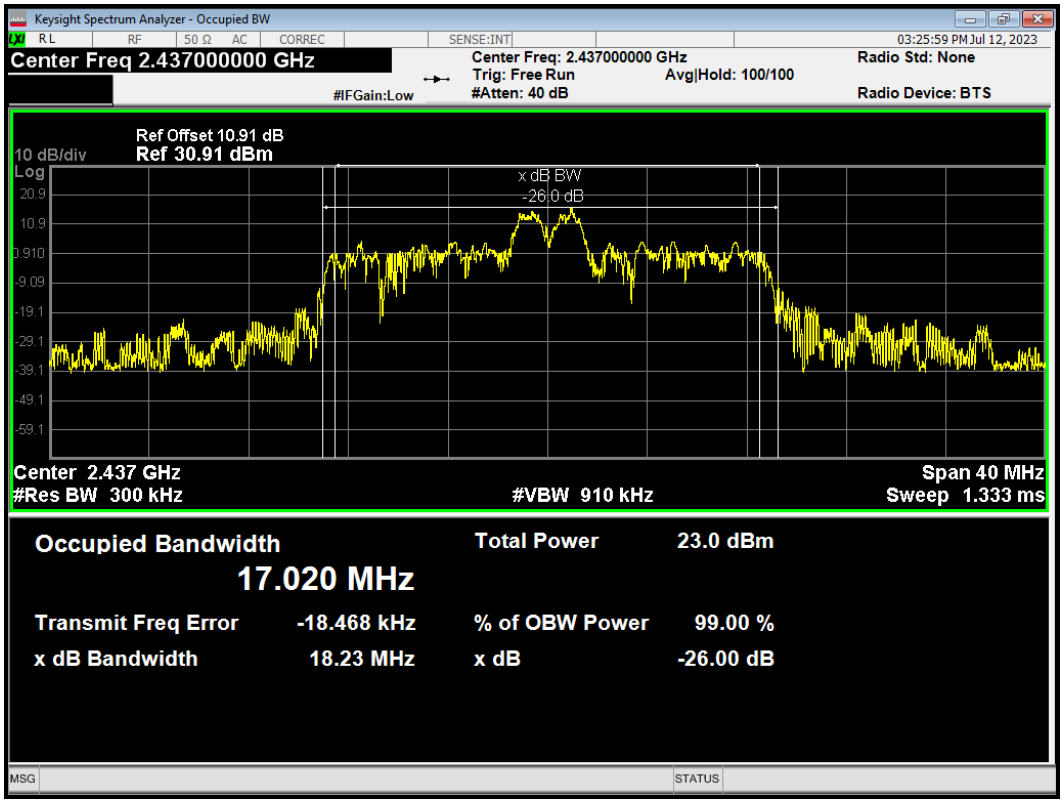
OBW 802.11ax (20M) RU106 IDX54 2462MHz



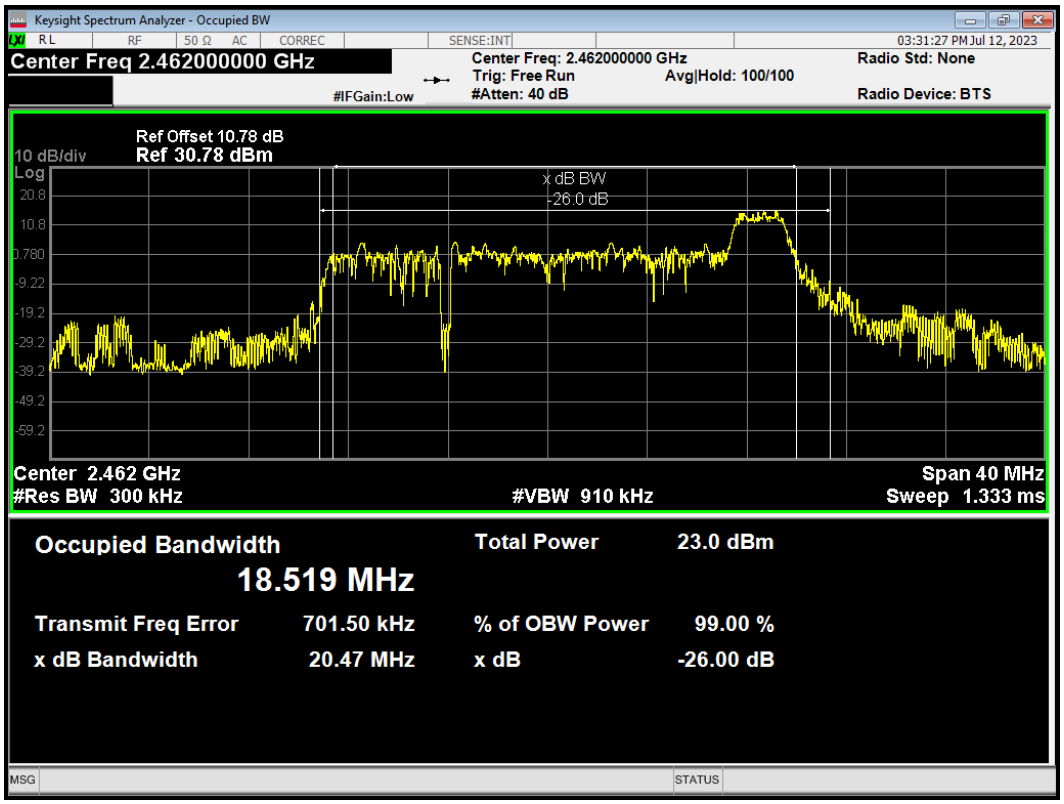
OBW 802.11ax (20M) RU26 IDX0 2412MHz



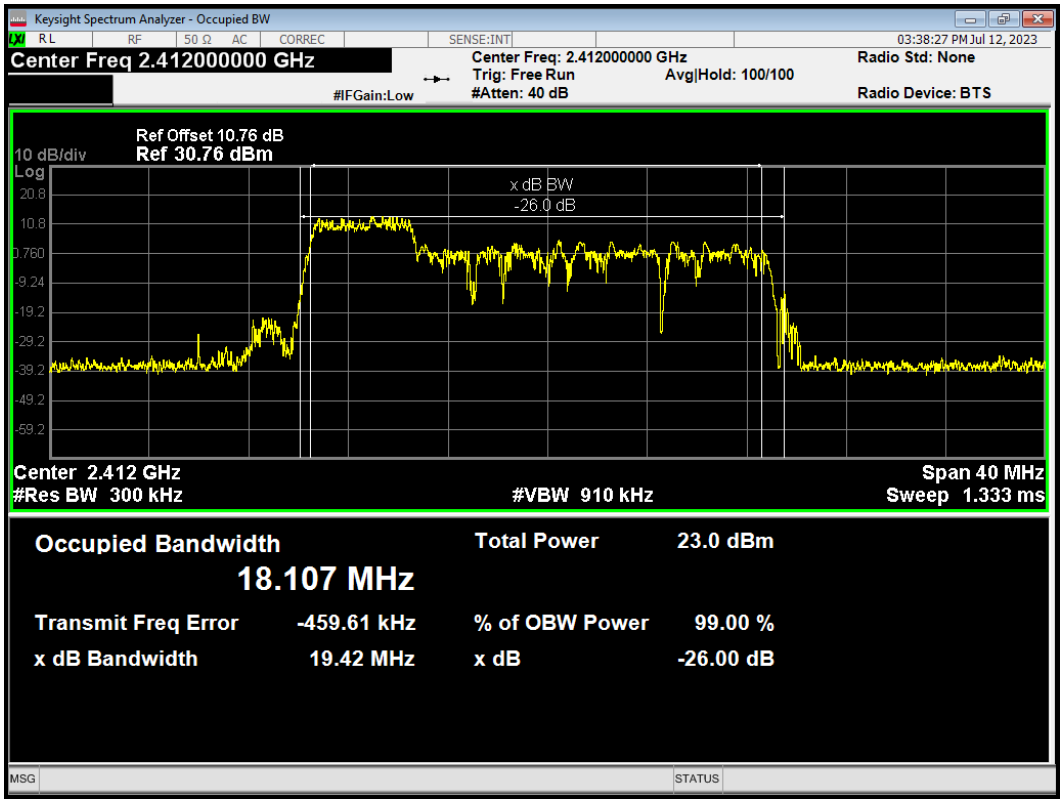
OBW 802.11ax (20M) RU26 IDX4 2437MHz



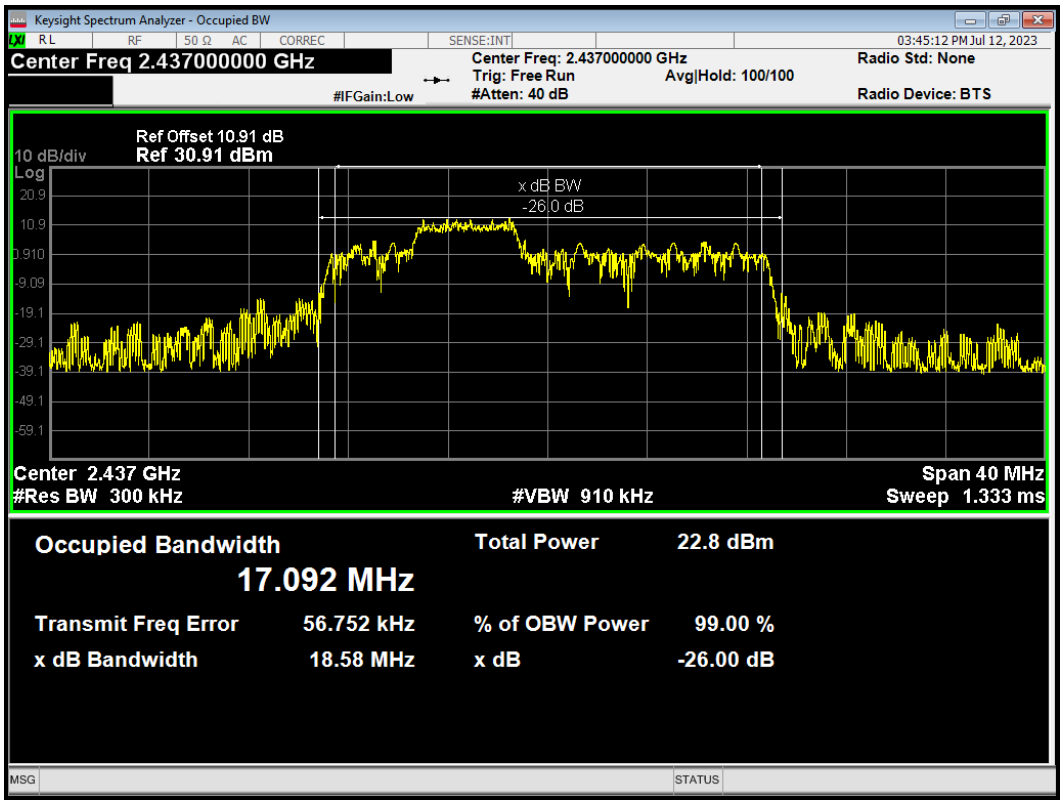
OBW 802.11ax (20M) RU26 IDX8 2462MHz



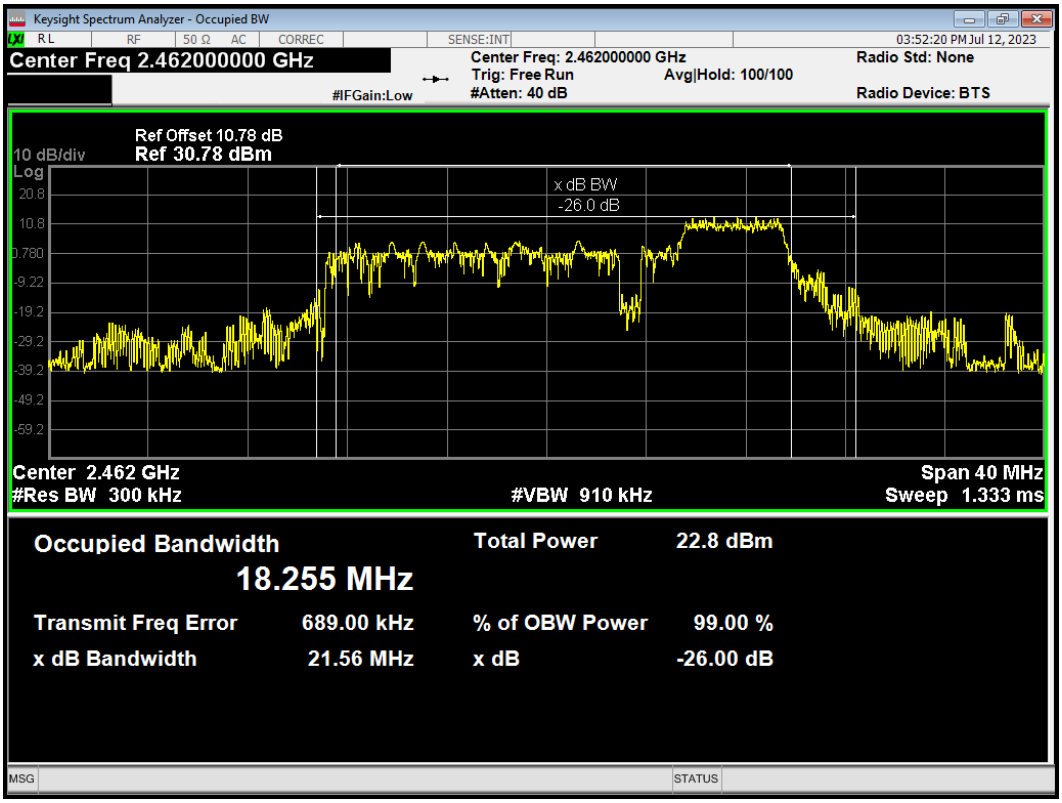
OBW 802.11ax (20M) RU52 IDX37 2412MHz



OBW 802.11ax (20M) RU52 IDX38 2437MHz

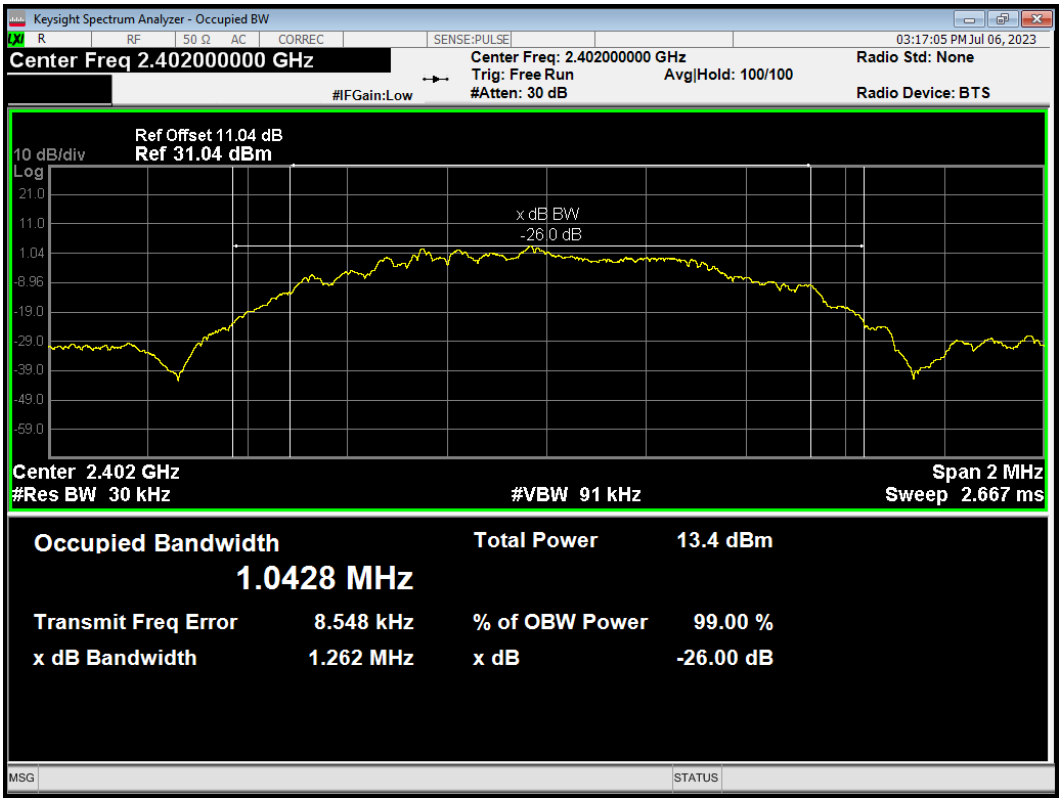


OBW 802.11ax (20M) RU52 IDX40 2462MHz

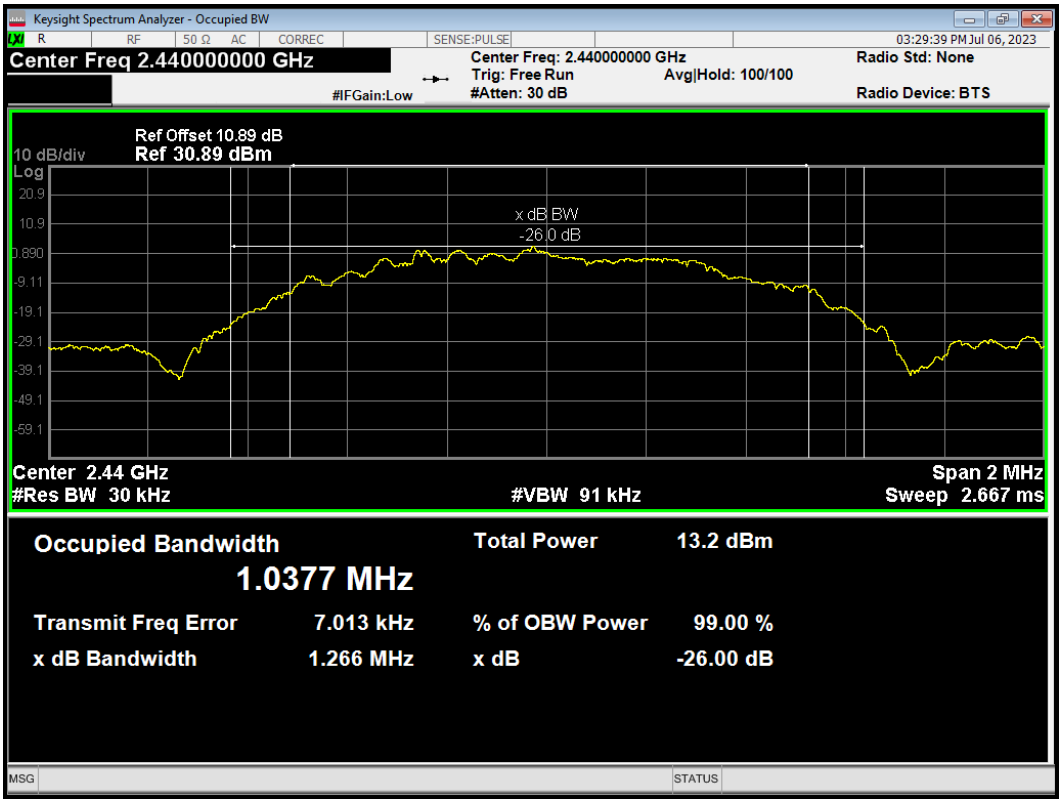


Internal Antenna

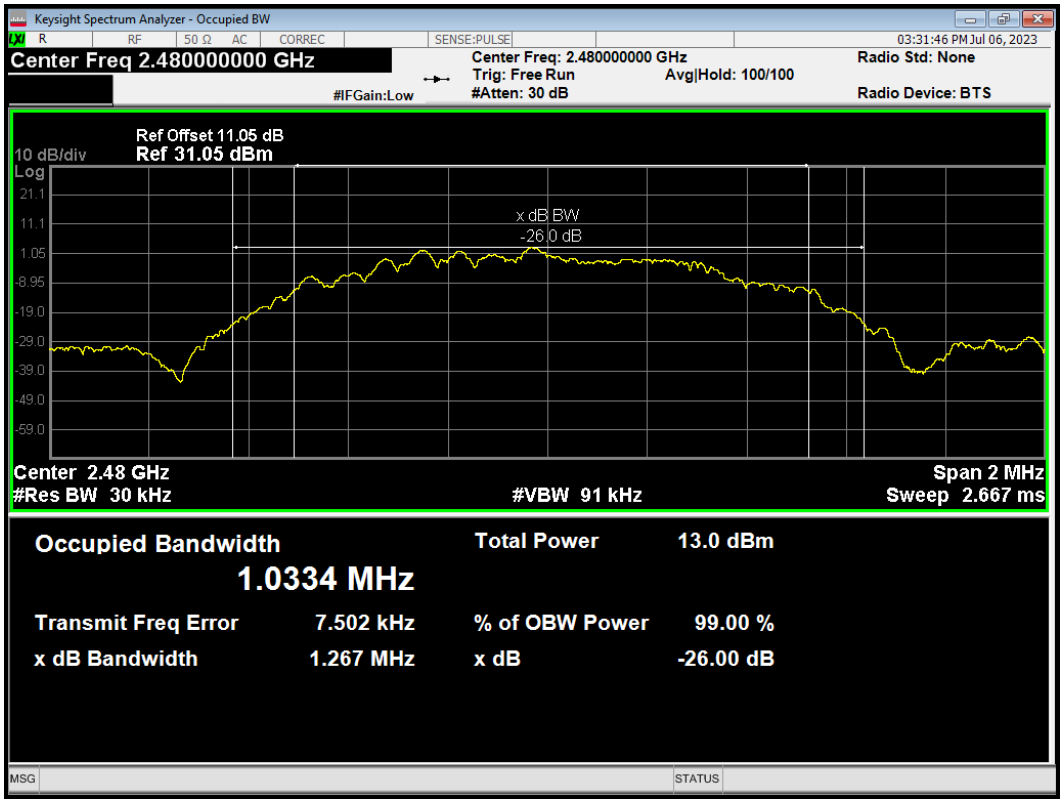
OBW BLE (1M) 2402MHz



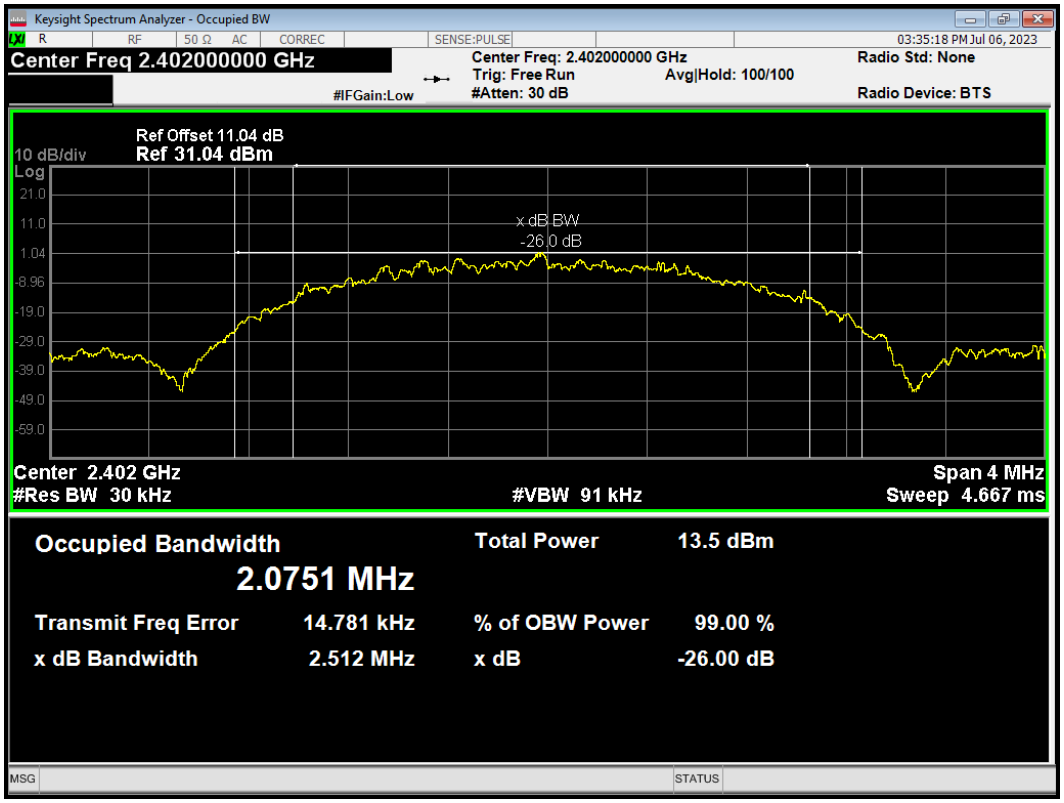
OBW BLE (1M) 2440MHz



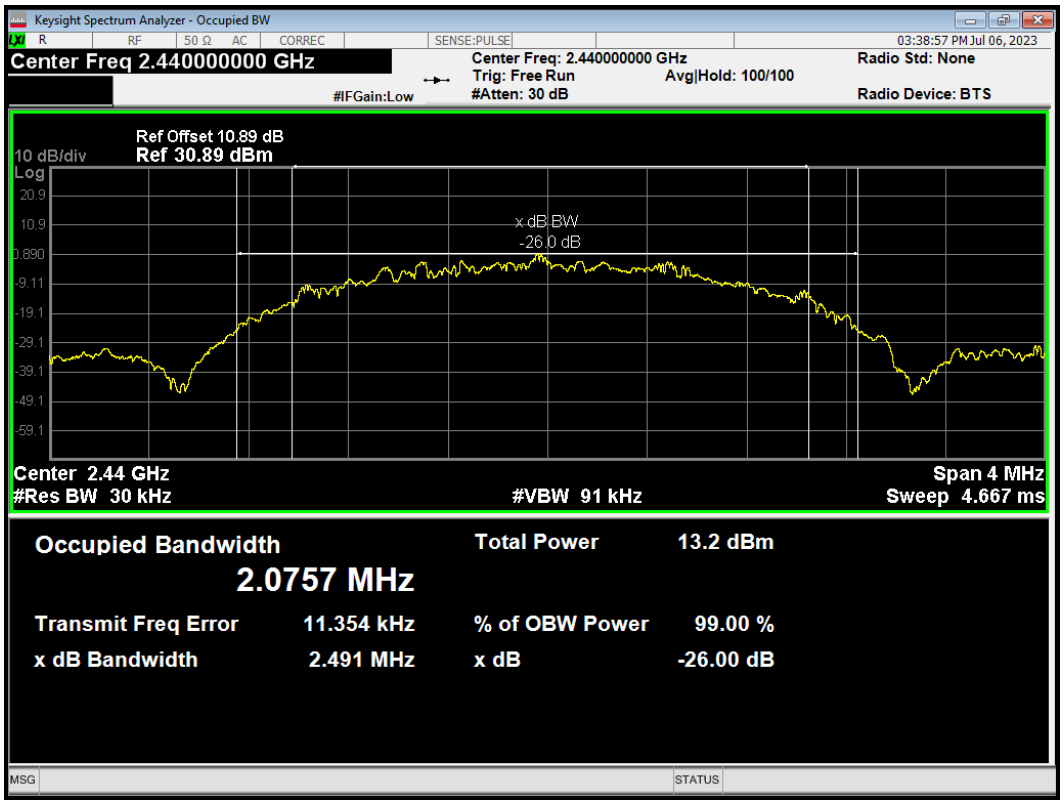
OBW BLE (1M) 2480MHz



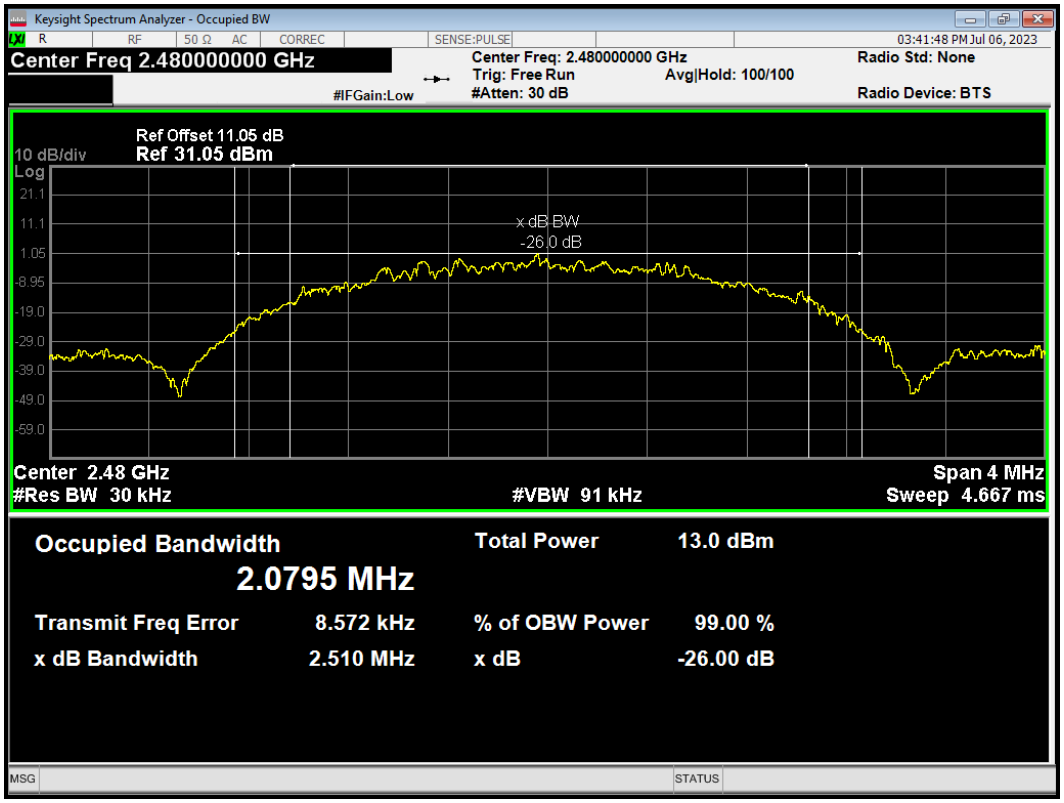
OBW BLE (2M) 2402MHz



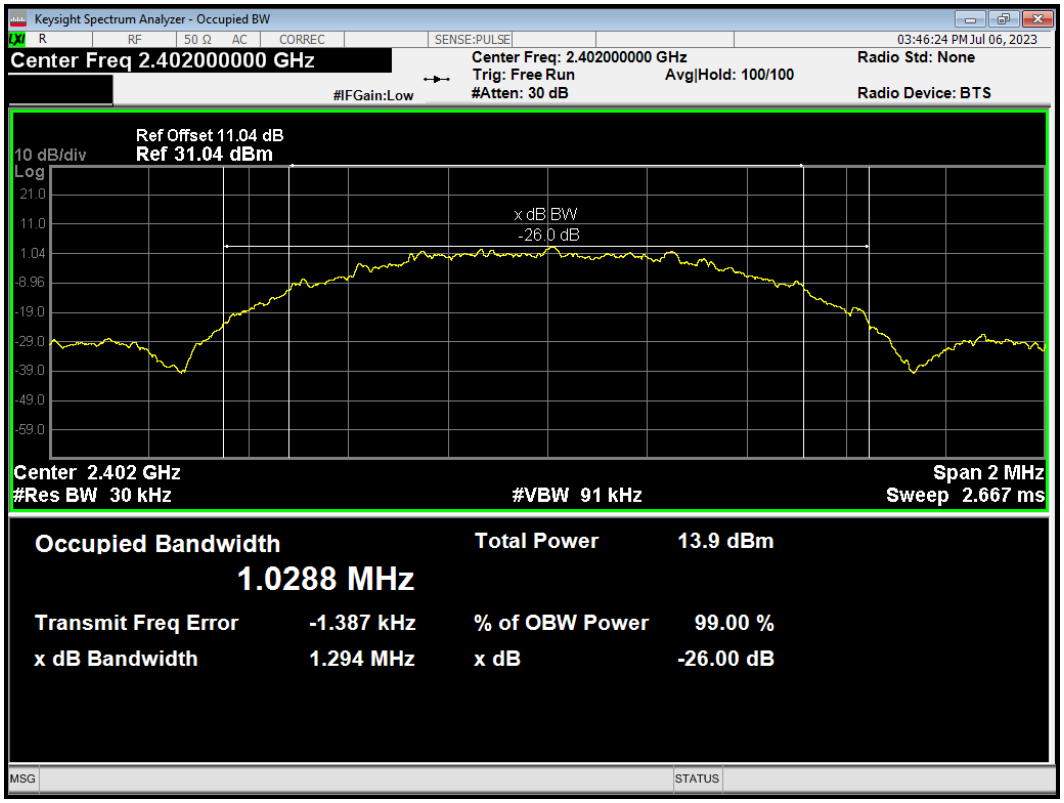
OBW BLE (2M) 2440MHz



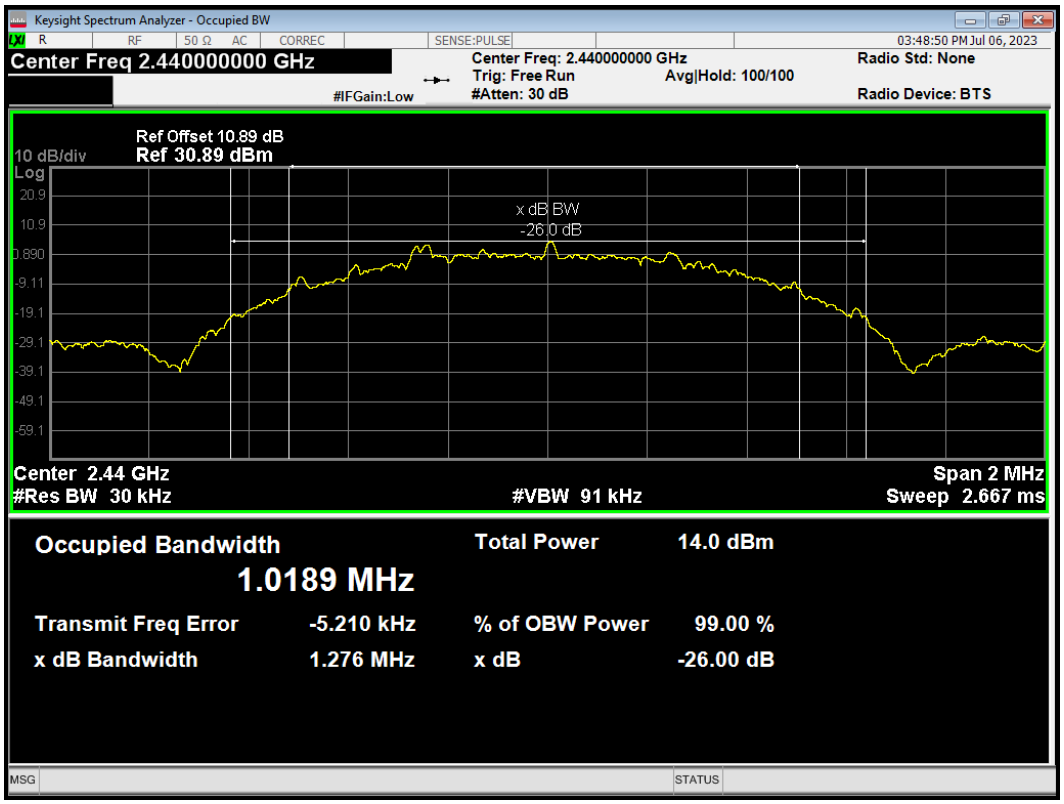
OBW BLE (2M) 2480MHz



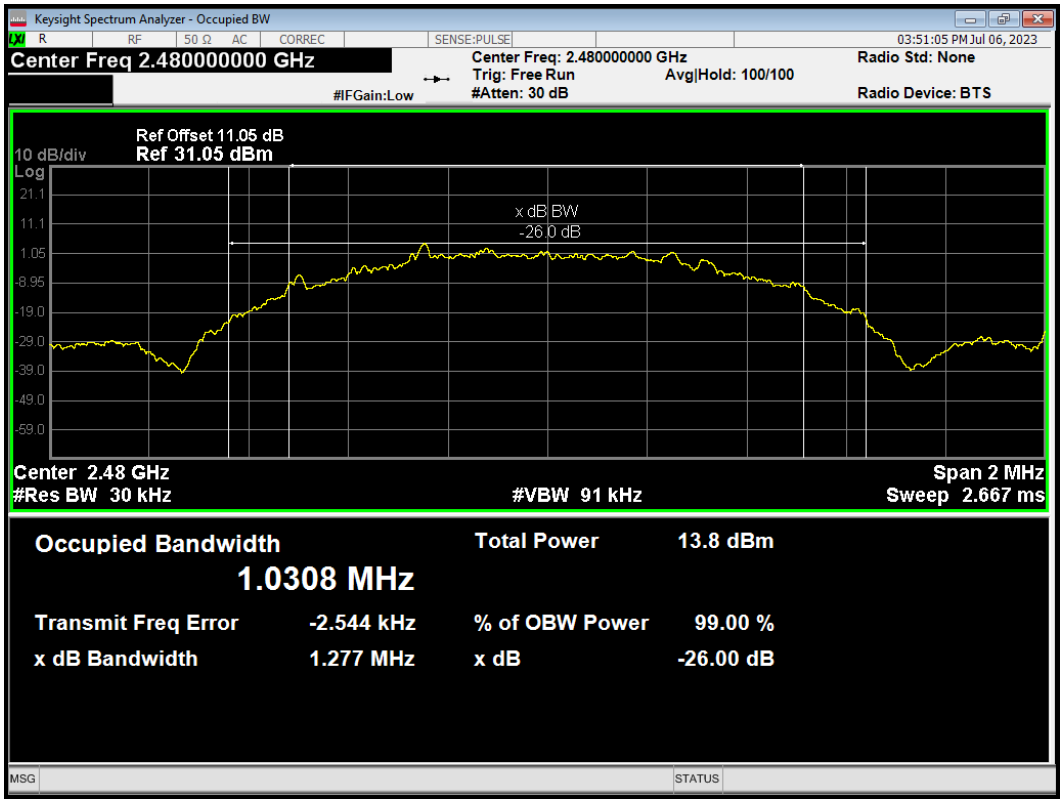
OBW BLE (S=2) 2402MHz



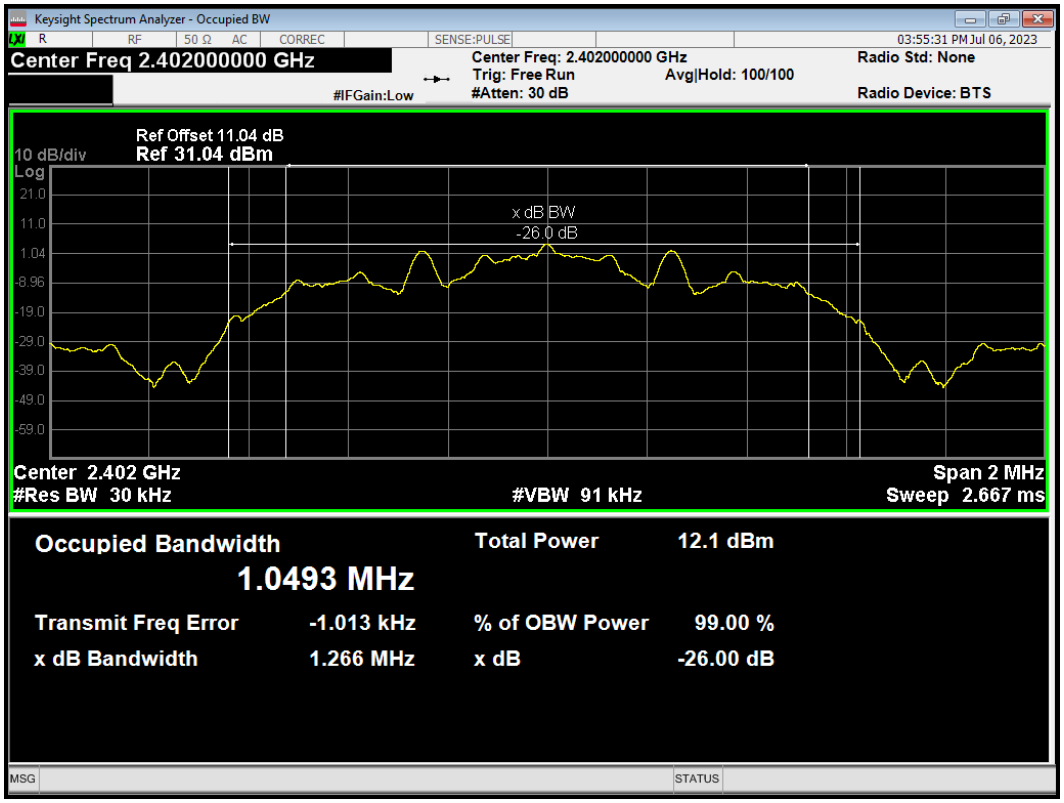
OBW BLE (S=2) 2440MHz



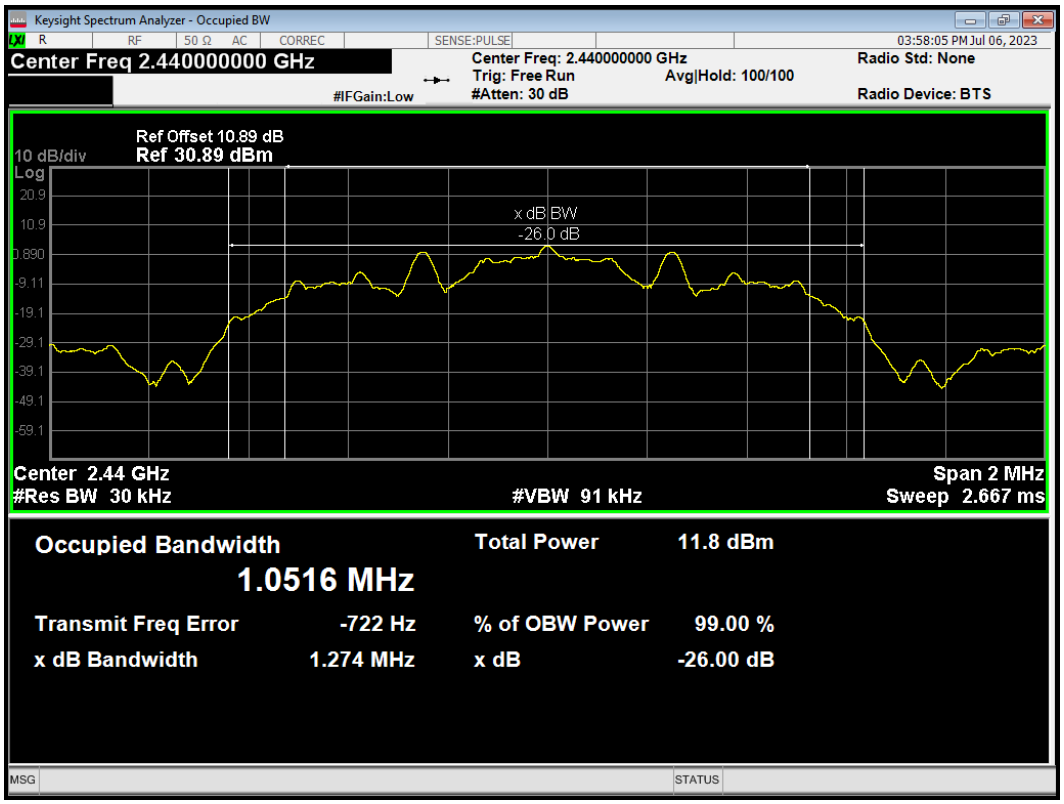
OBW BLE (S=2) 2480MHz



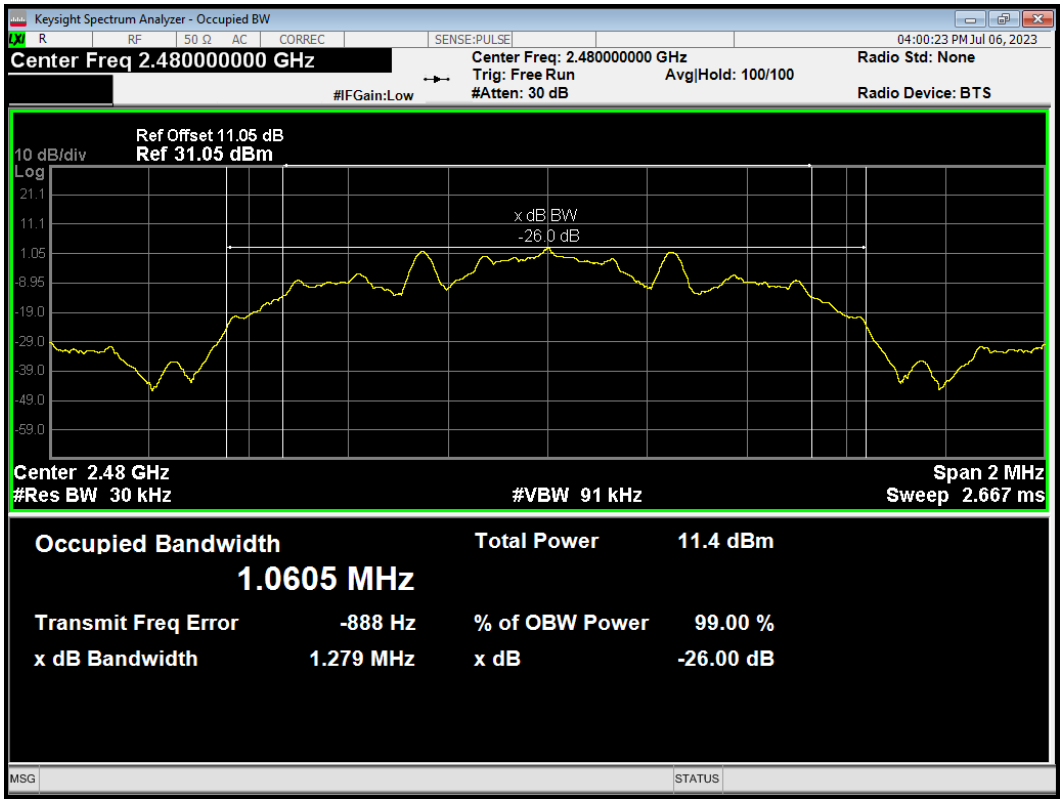
OBW BLE (S=8) 2402MHz



OBW BLE (S=8) 2440MHz

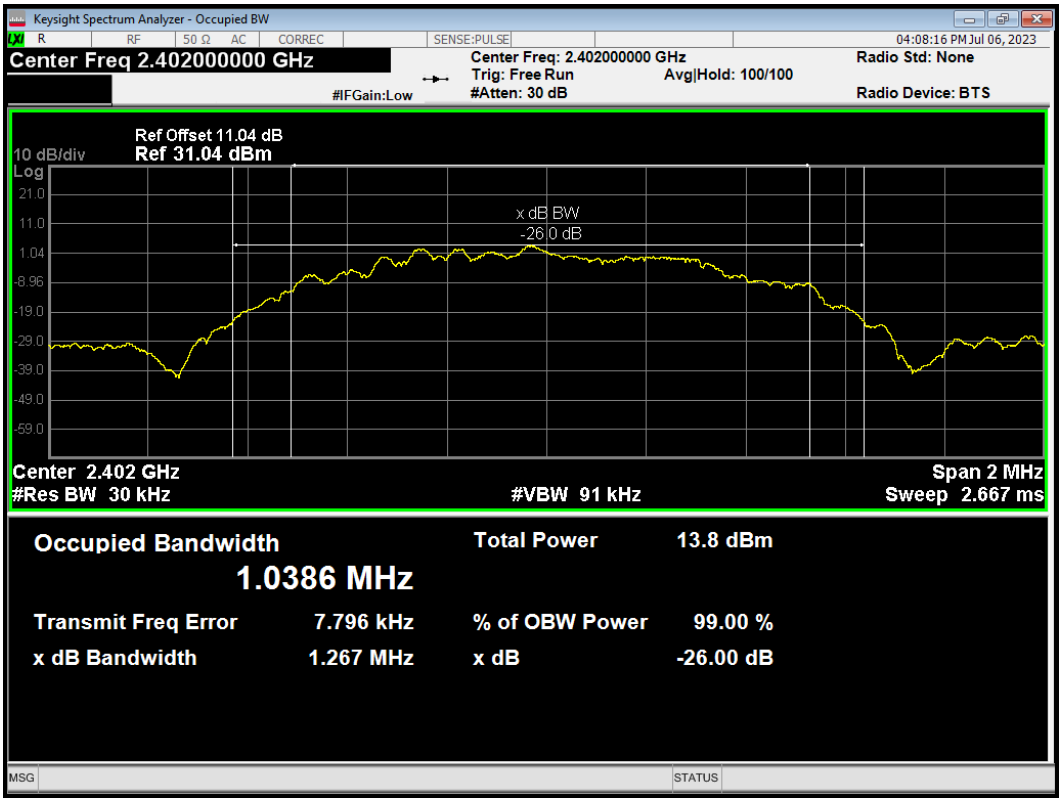


OBW BLE (S=8) 2480MHz

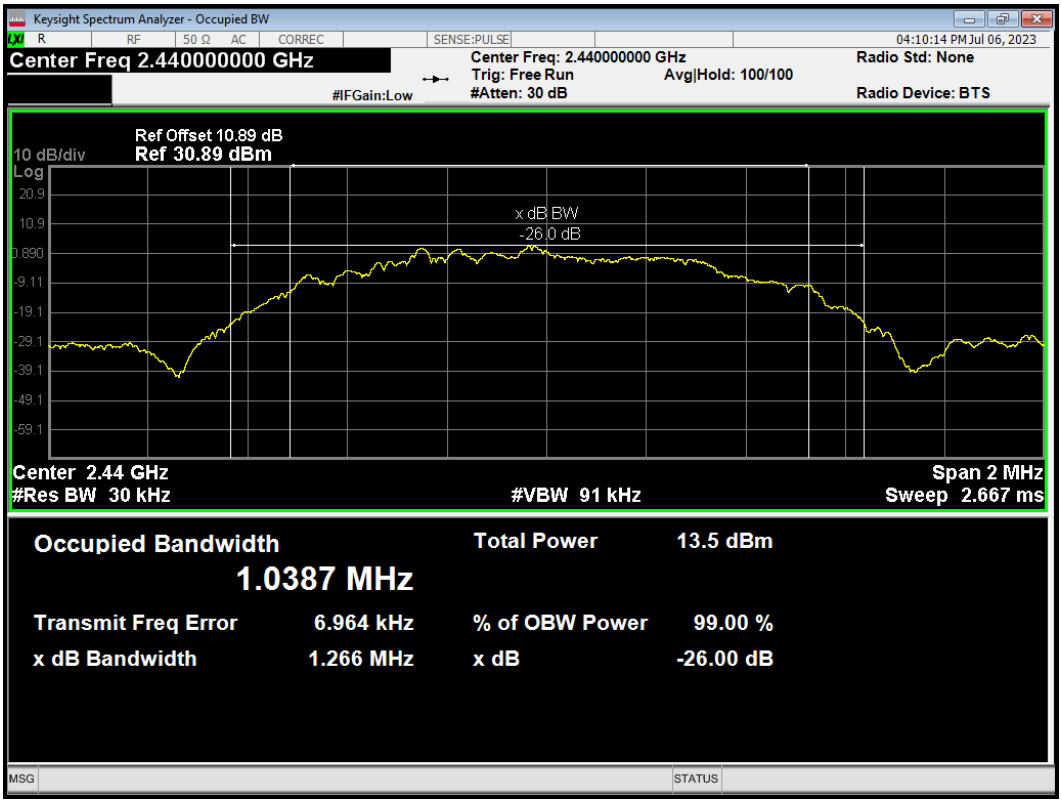


External Antenna

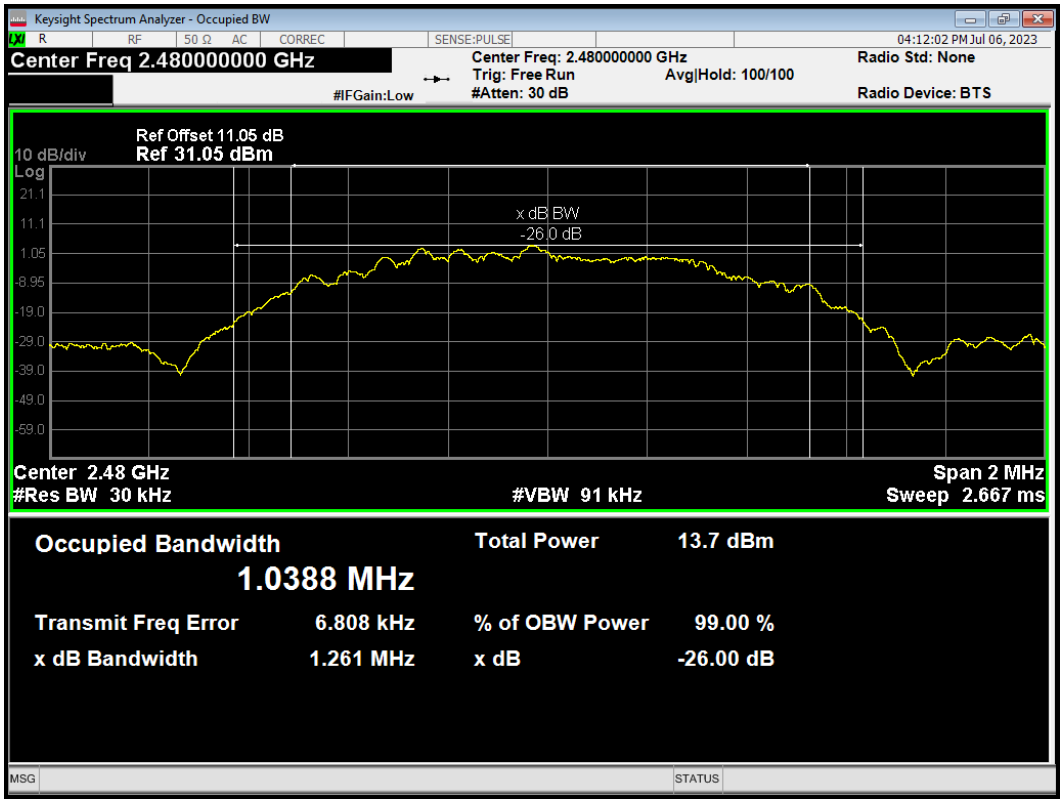
OBW BLE (1M) 2402MHz



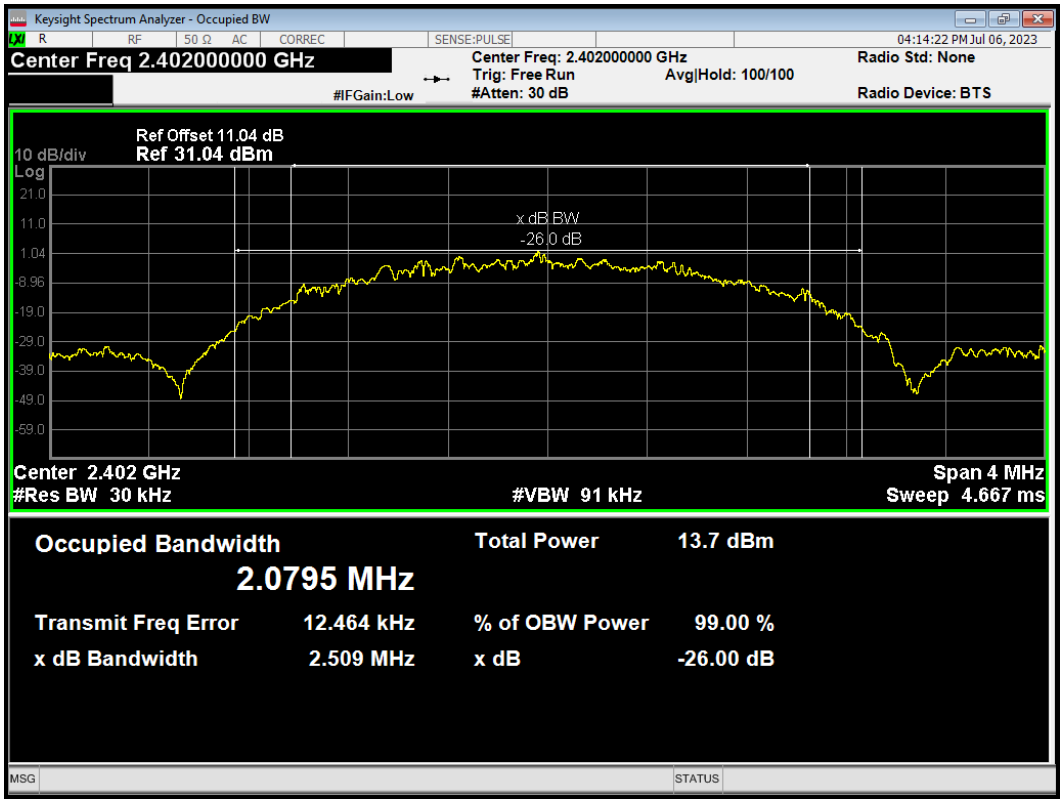
OBW BLE (1M) 2440MHz



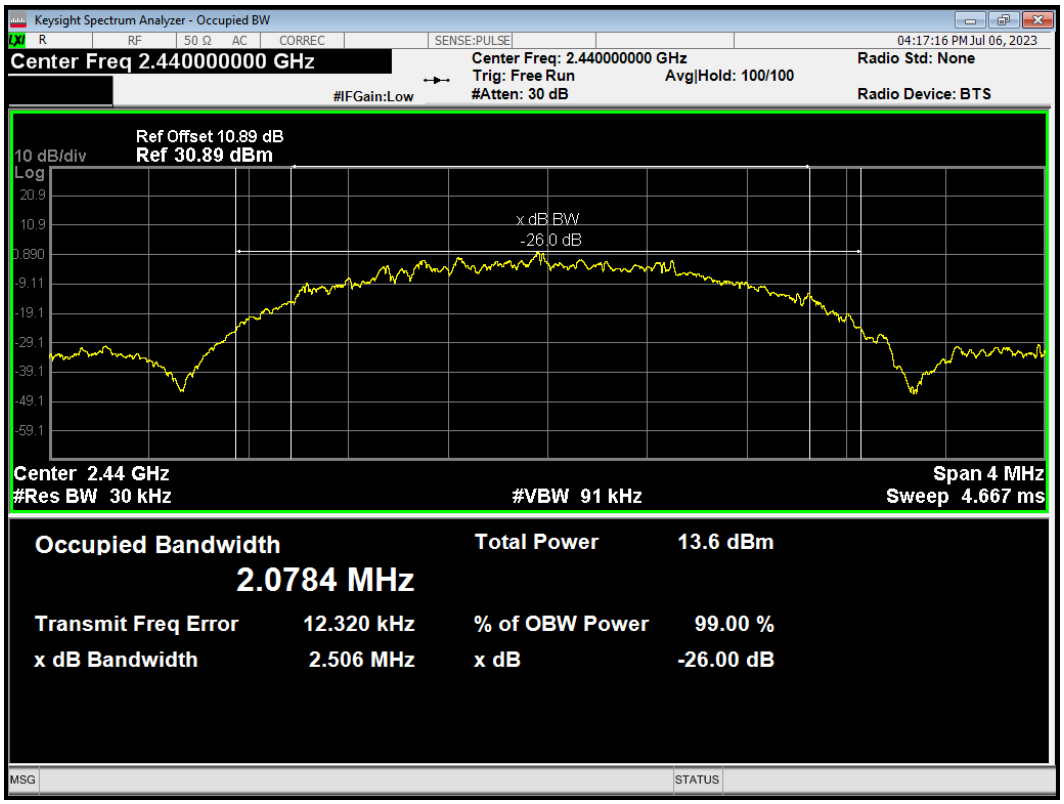
OBW BLE (1M) 2480MHz



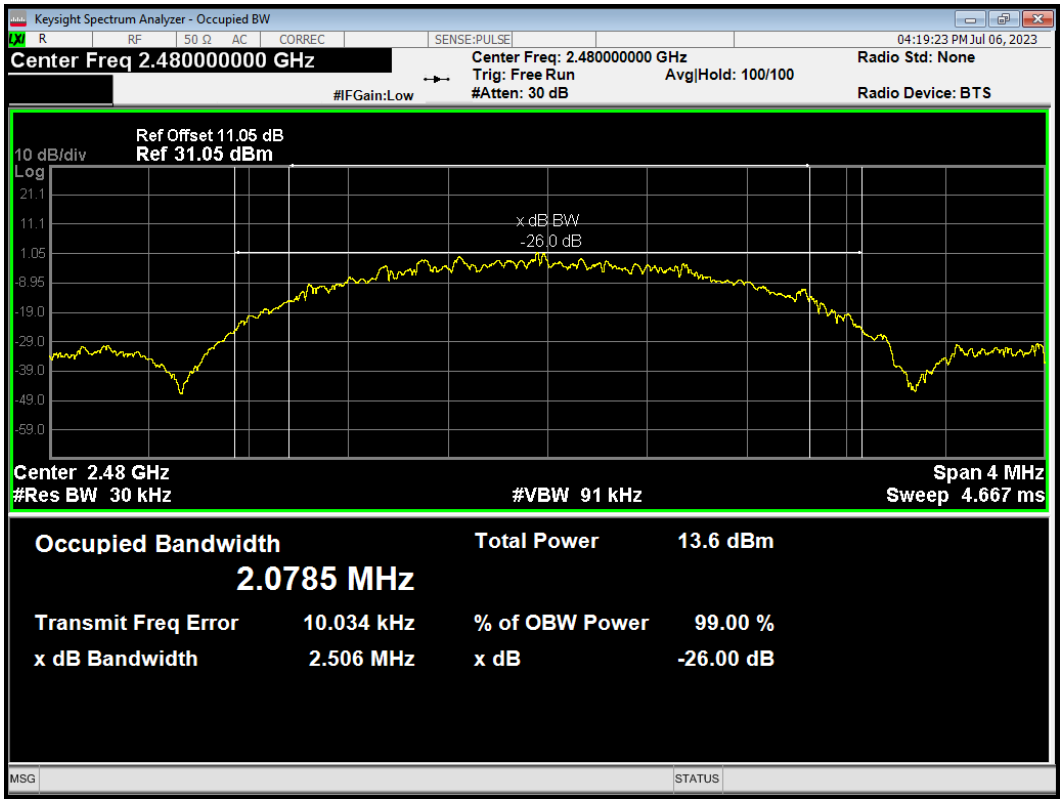
OBW BLE (2M) 2402MHz



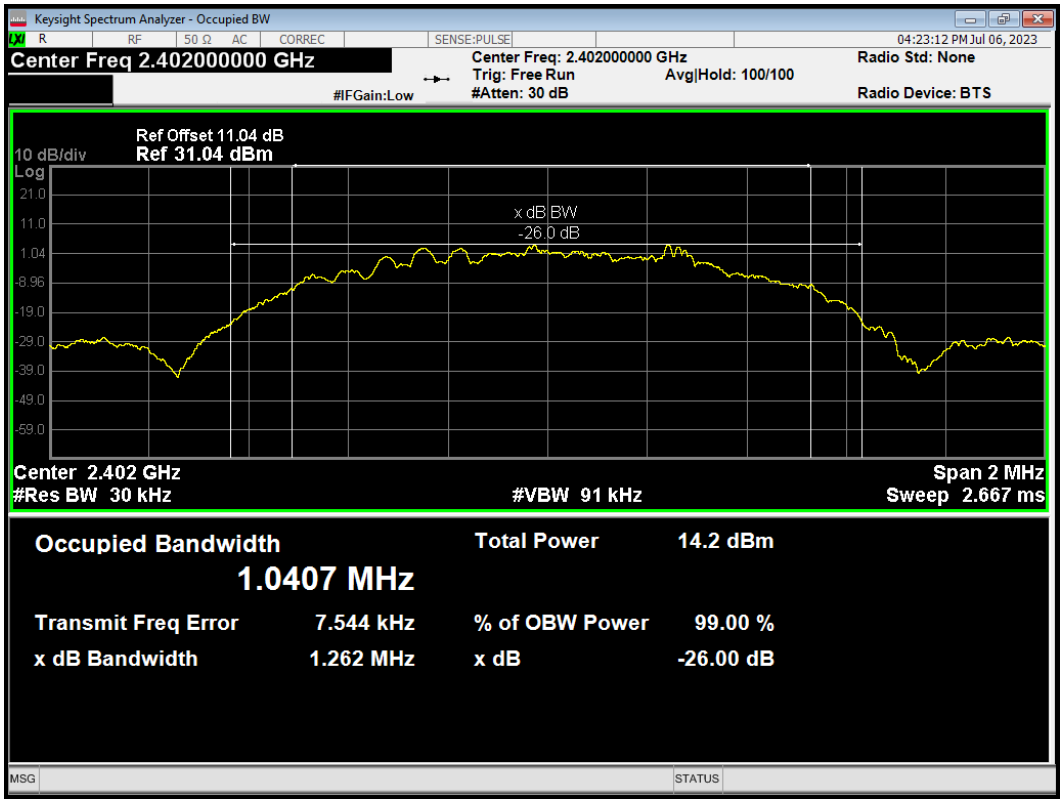
OBW BLE (2M) 2440MHz



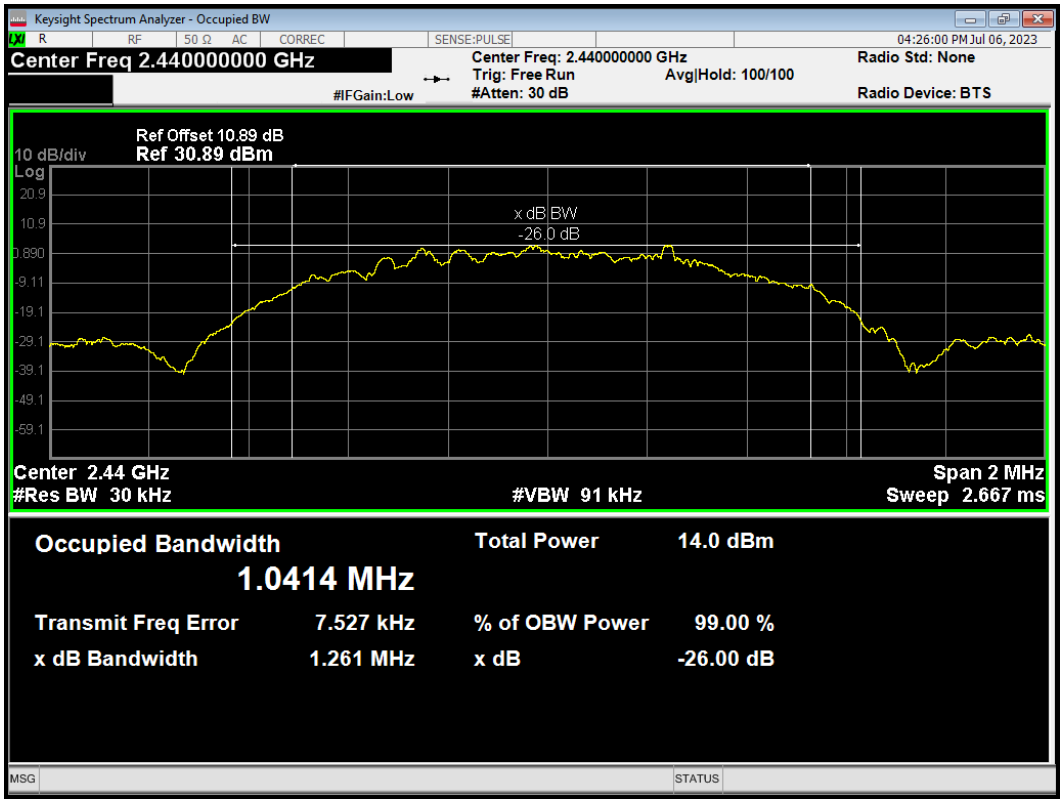
OBW BLE (2M) 2480MHz



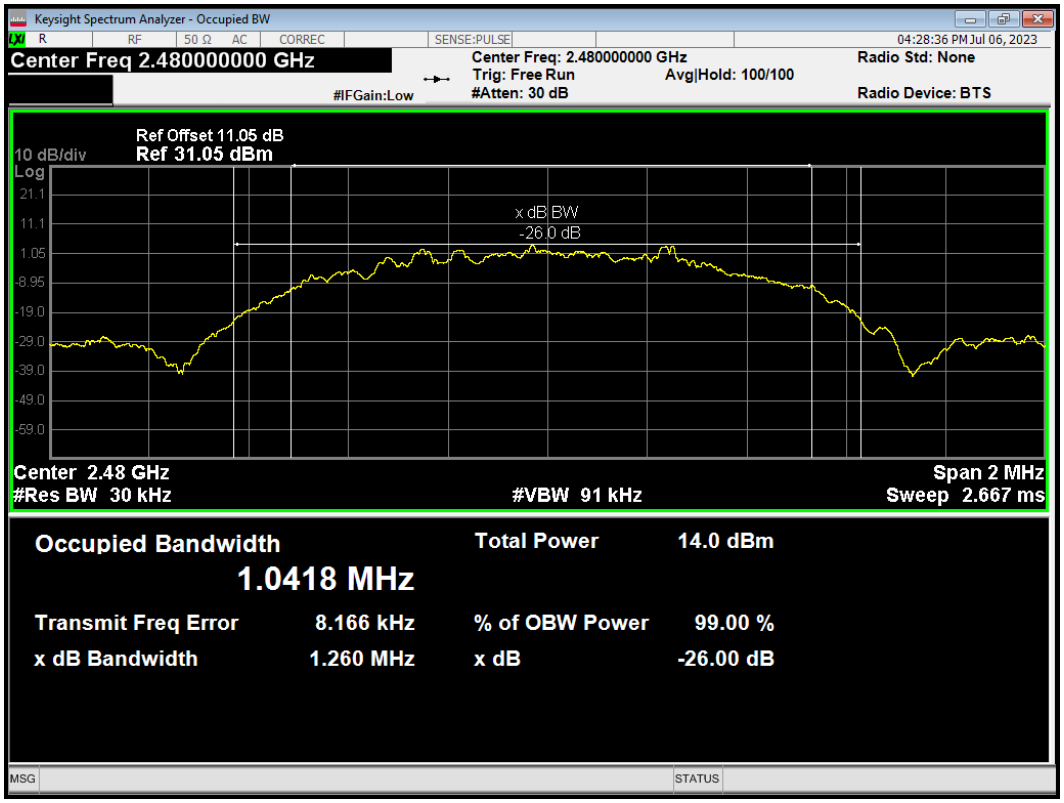
OBW BLE (S=2) 2402MHz



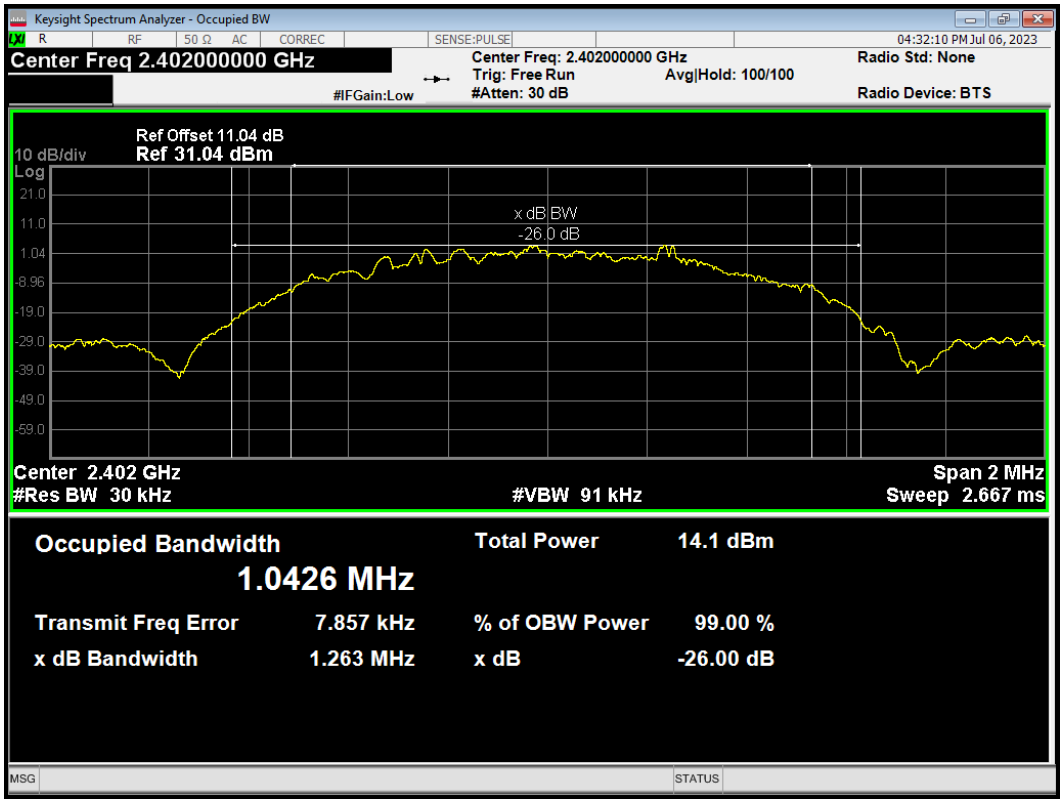
OBW BLE (S=2) 2440MHz



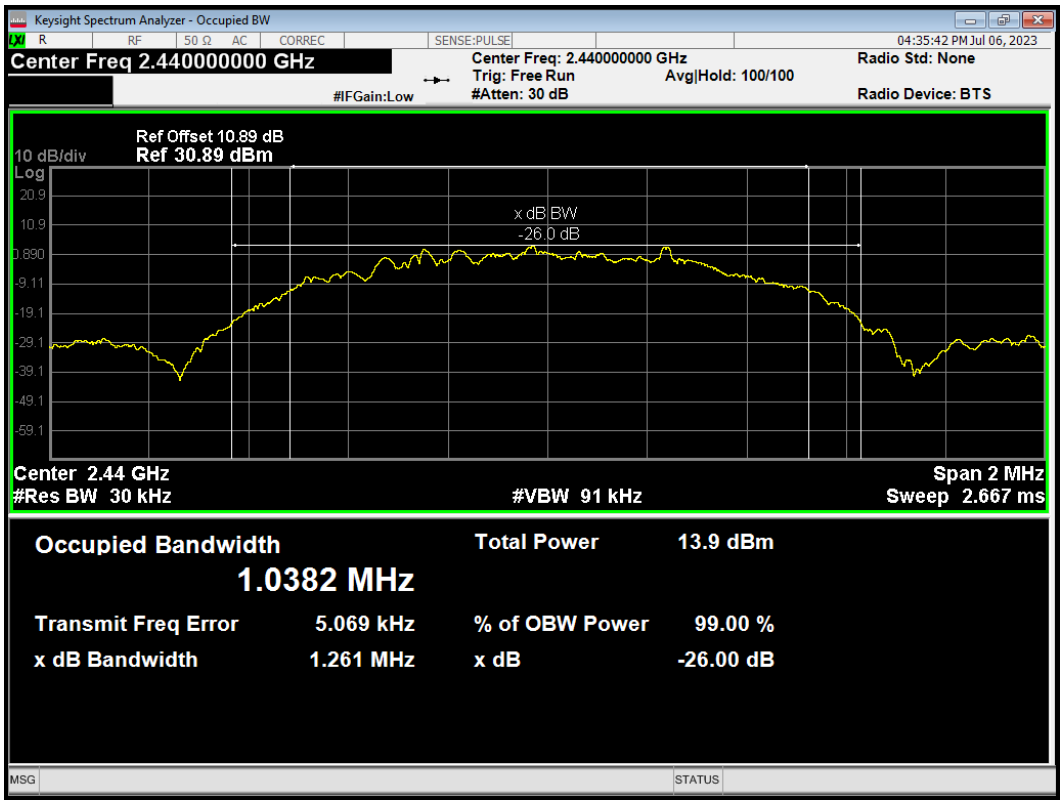
OBW BLE (S=2) 2480MHz



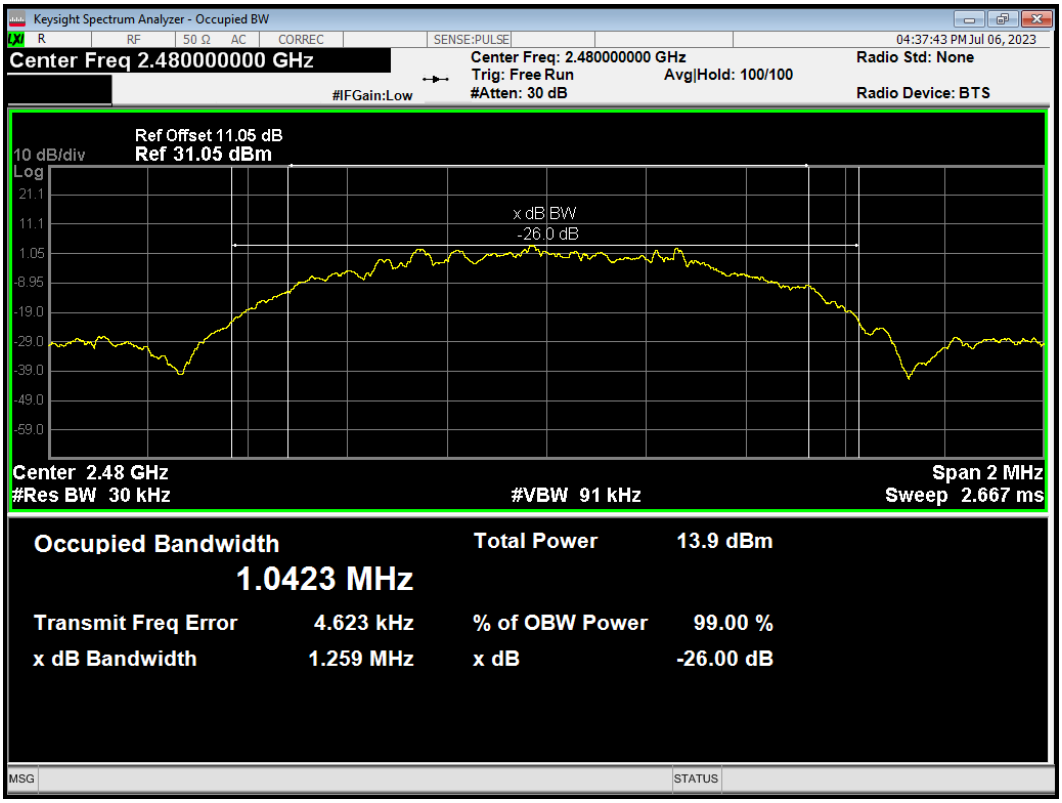
OBW BLE (S=8) 2402MHz



OBW BLE (S=8) 2440MHz

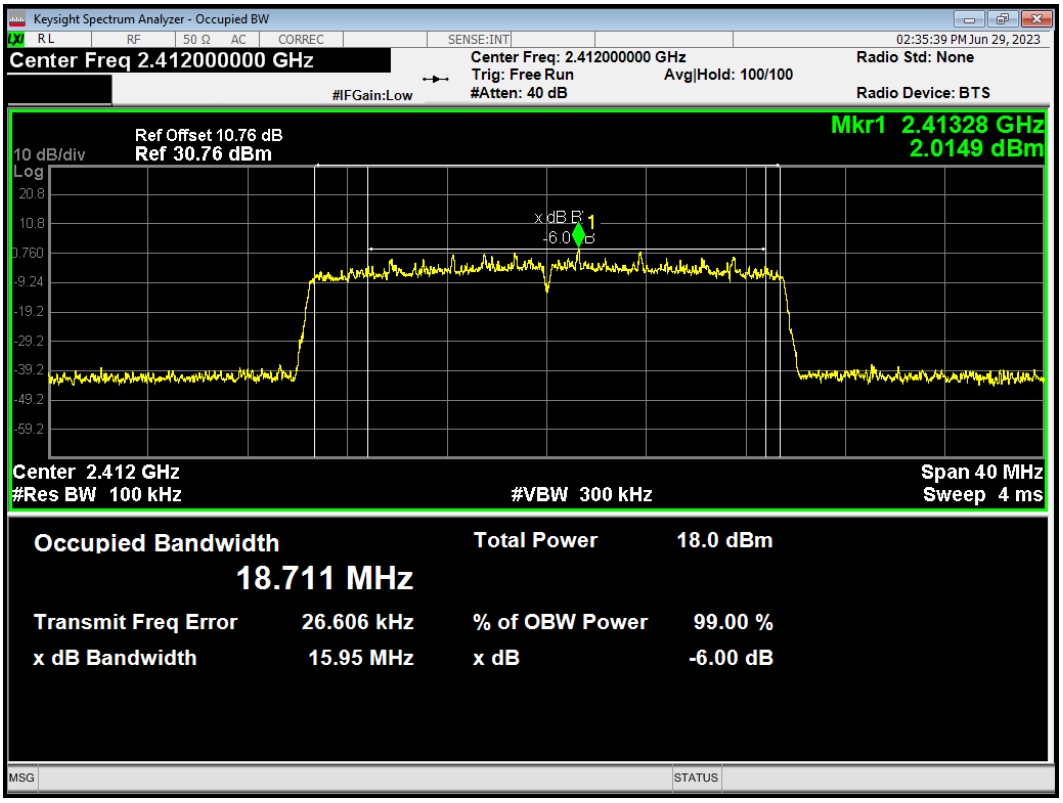


OBW BLE (S=8) 2480MHz

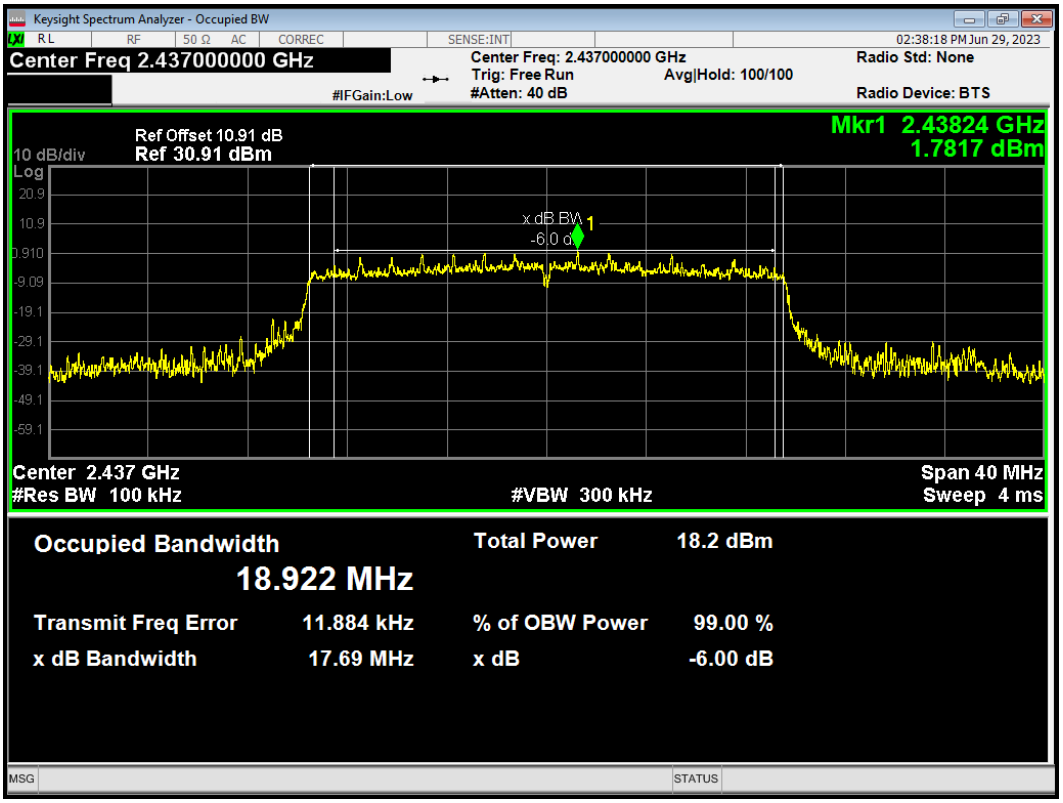


6 dB bandwidth

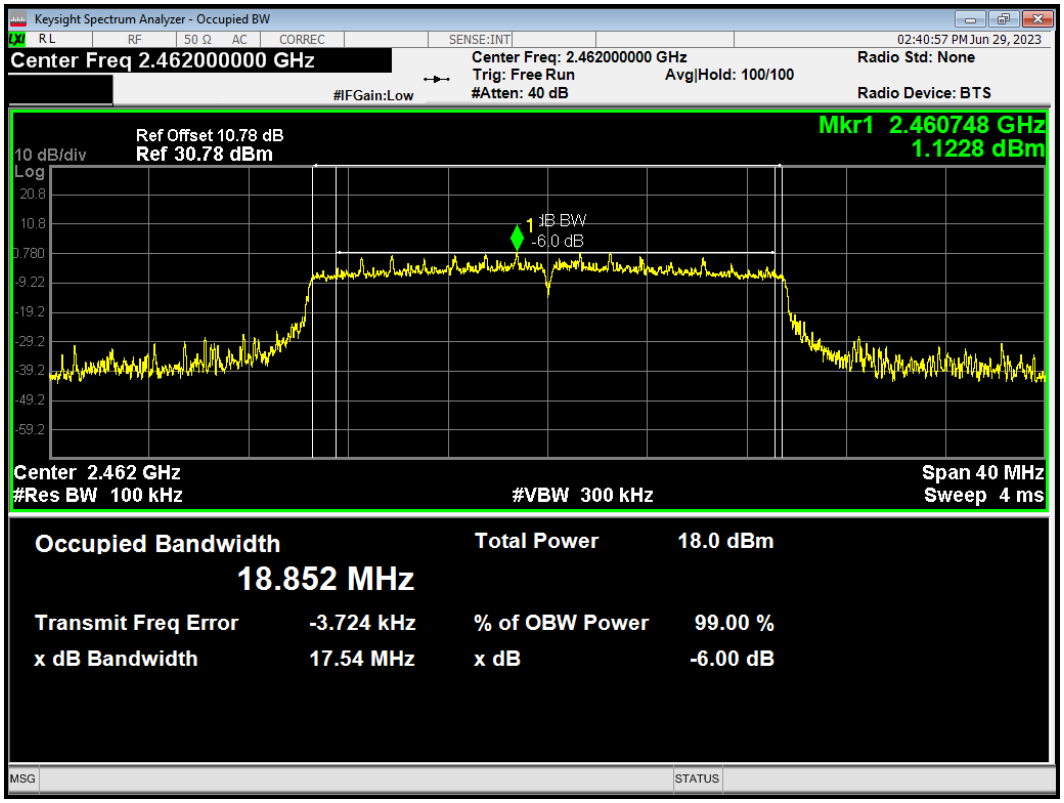
-6dB Bandwidth 802.11ax(HE20) 2412MHz



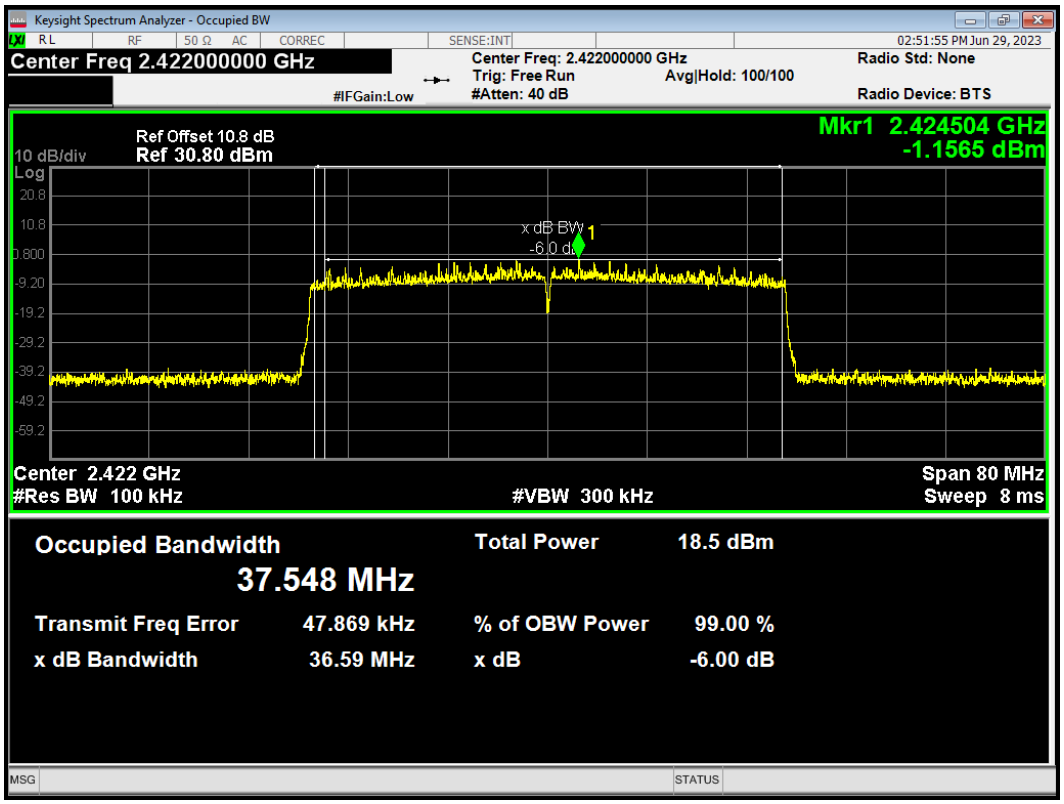
-6dB Bandwidth 802.11ax(HE20) 2437MHz



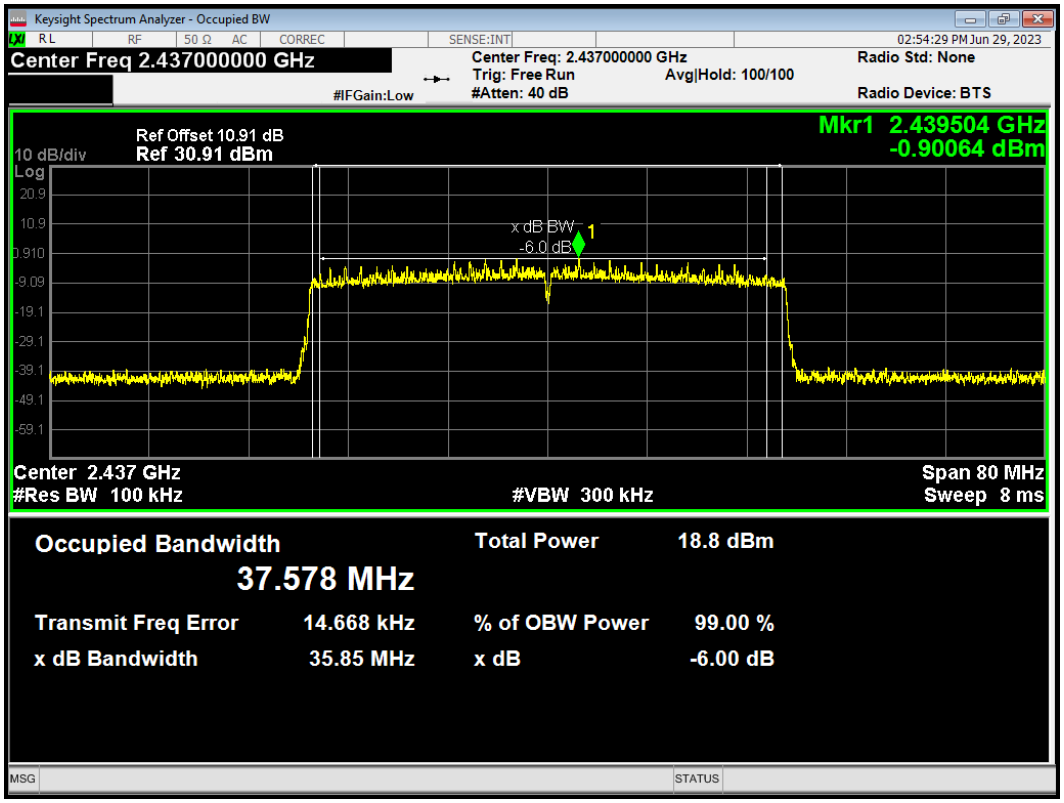
-6dB Bandwidth 802.11ax(HE20) 2462MHz



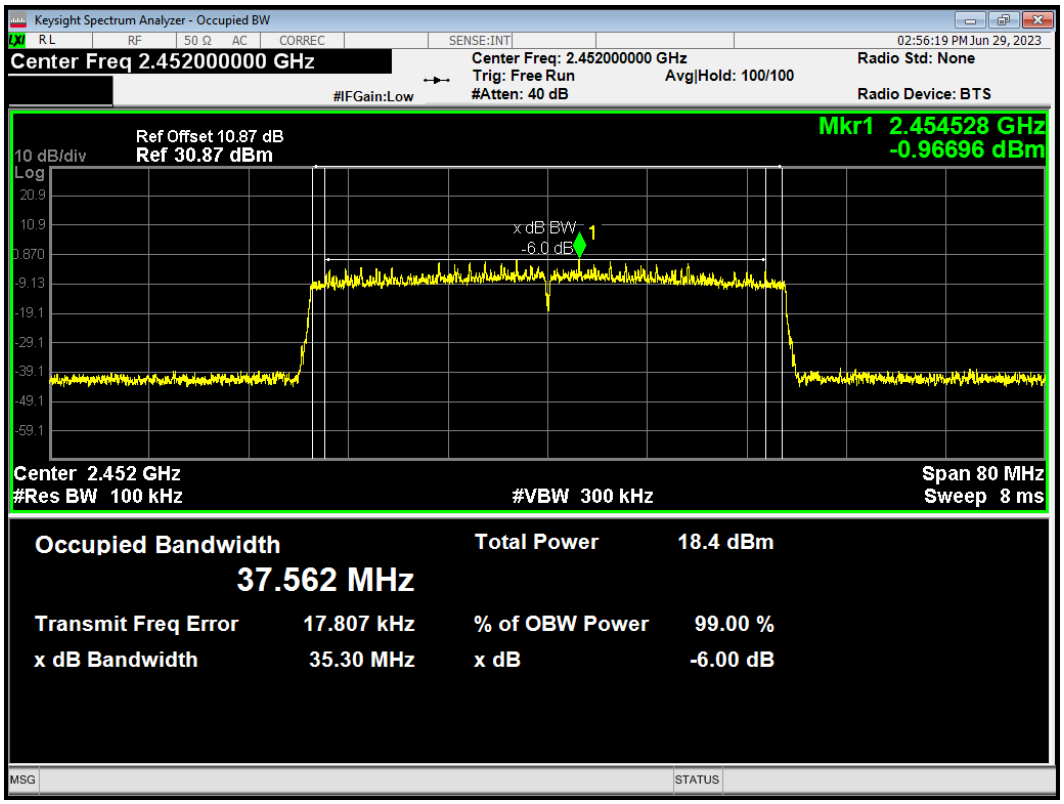
-6dB Bandwidth 802.11ax(HE40) 2422MHz



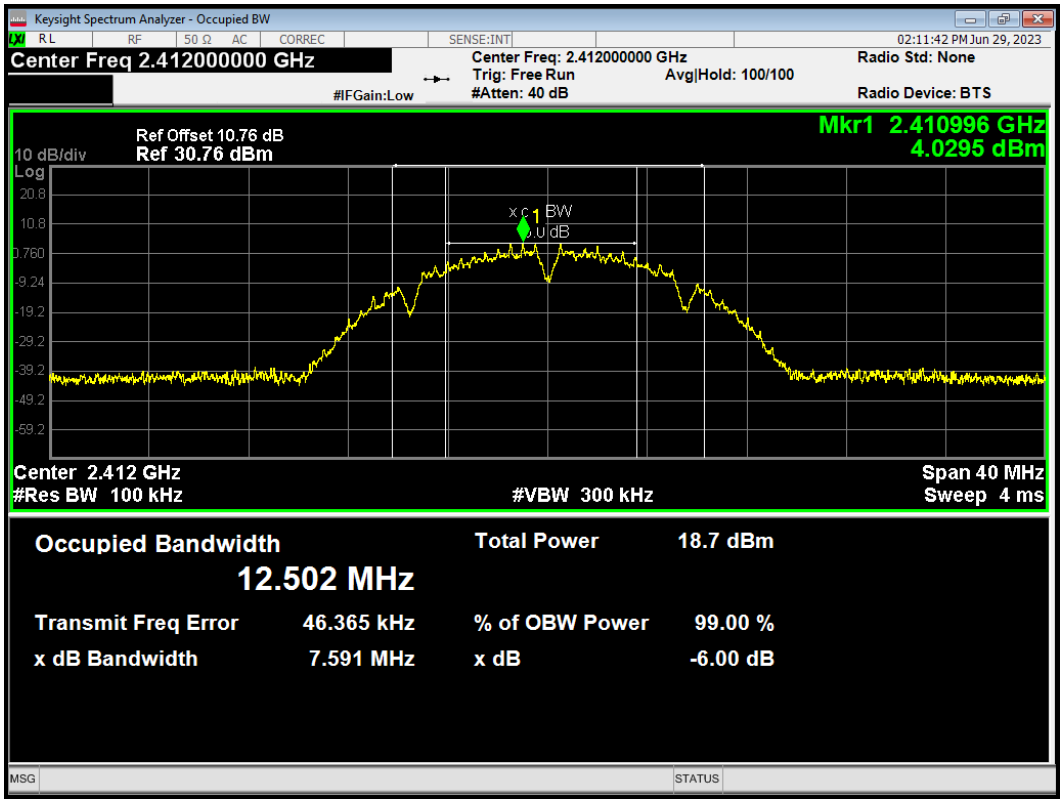
-6dB Bandwidth 802.11ax(HE40) 2437MHz



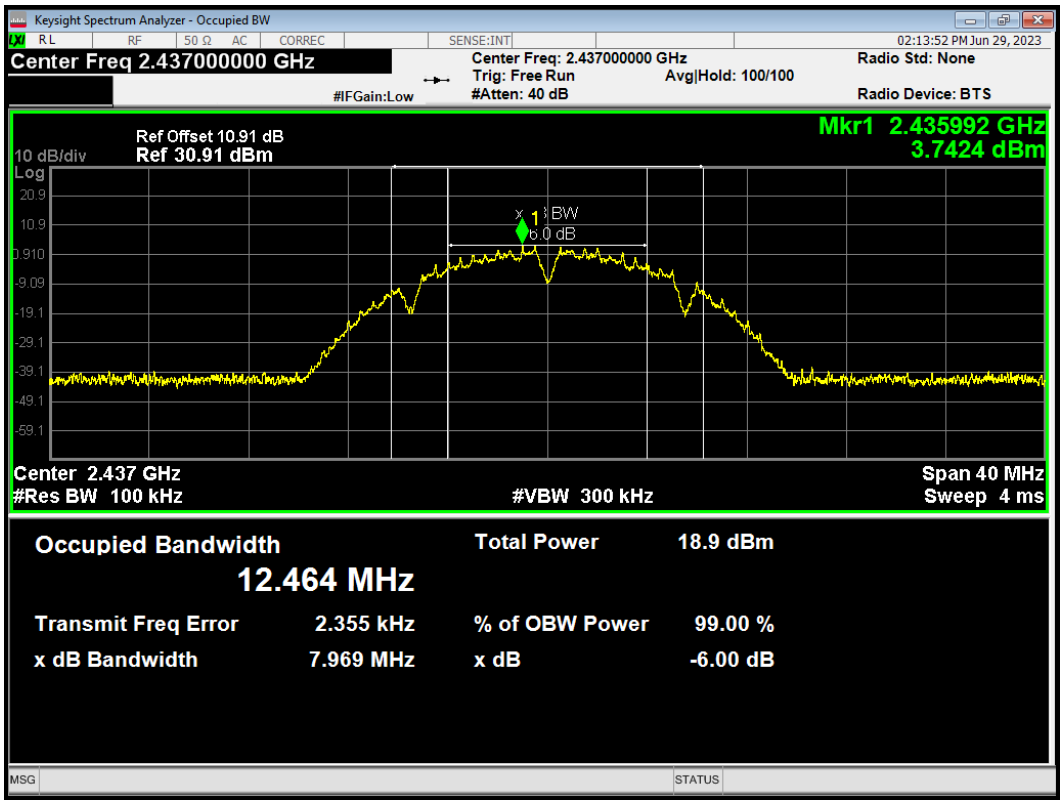
-6dB Bandwidth 802.11ax(HE40) 2452MHz



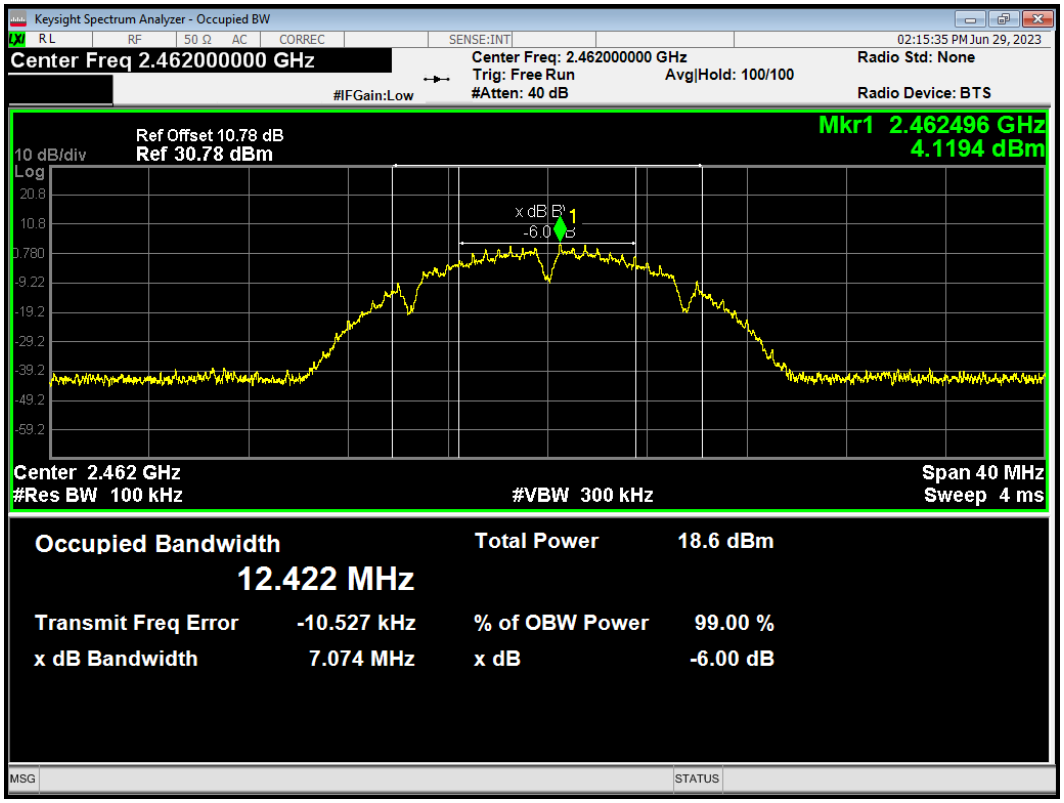
-6dB Bandwidth 802.11b 2412MHz



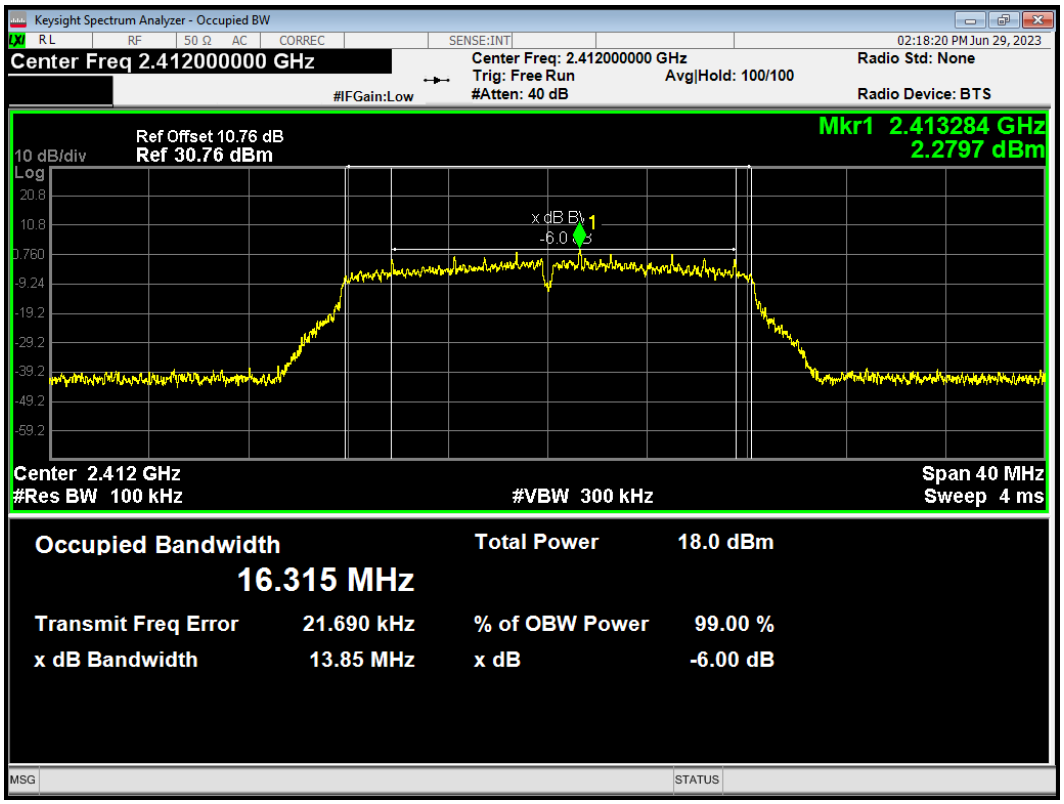
-6dB Bandwidth 802.11b 2437MHz



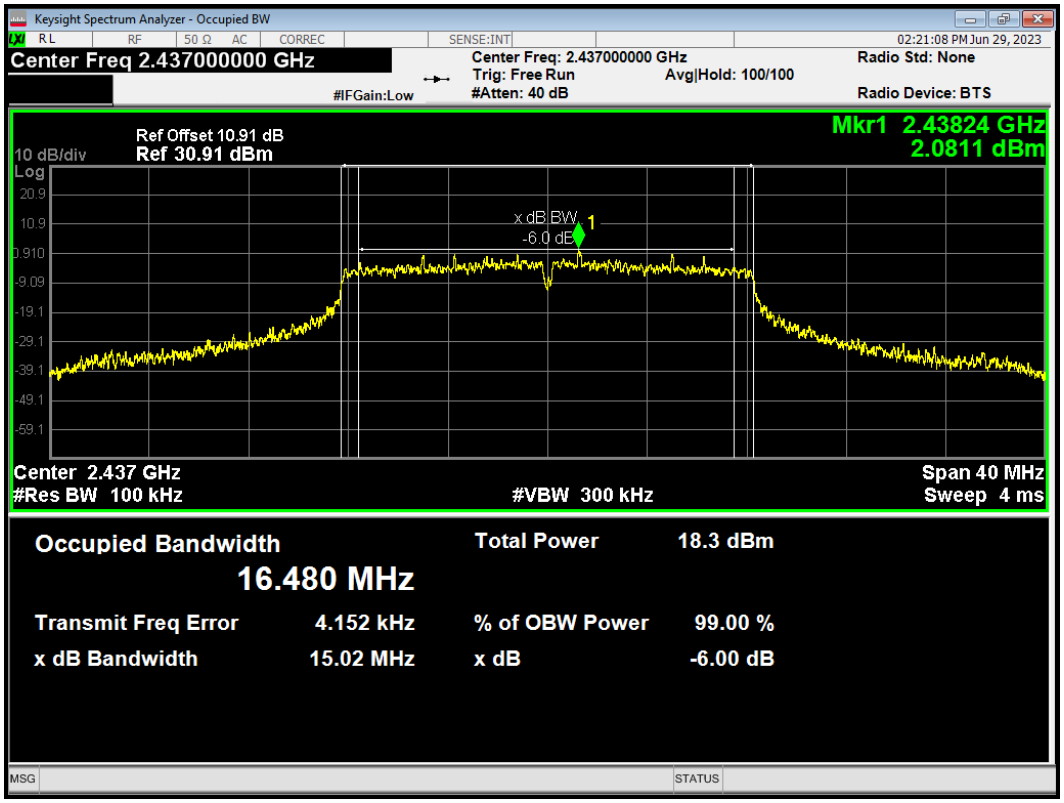
-6dB Bandwidth 802.11b 2462MHz



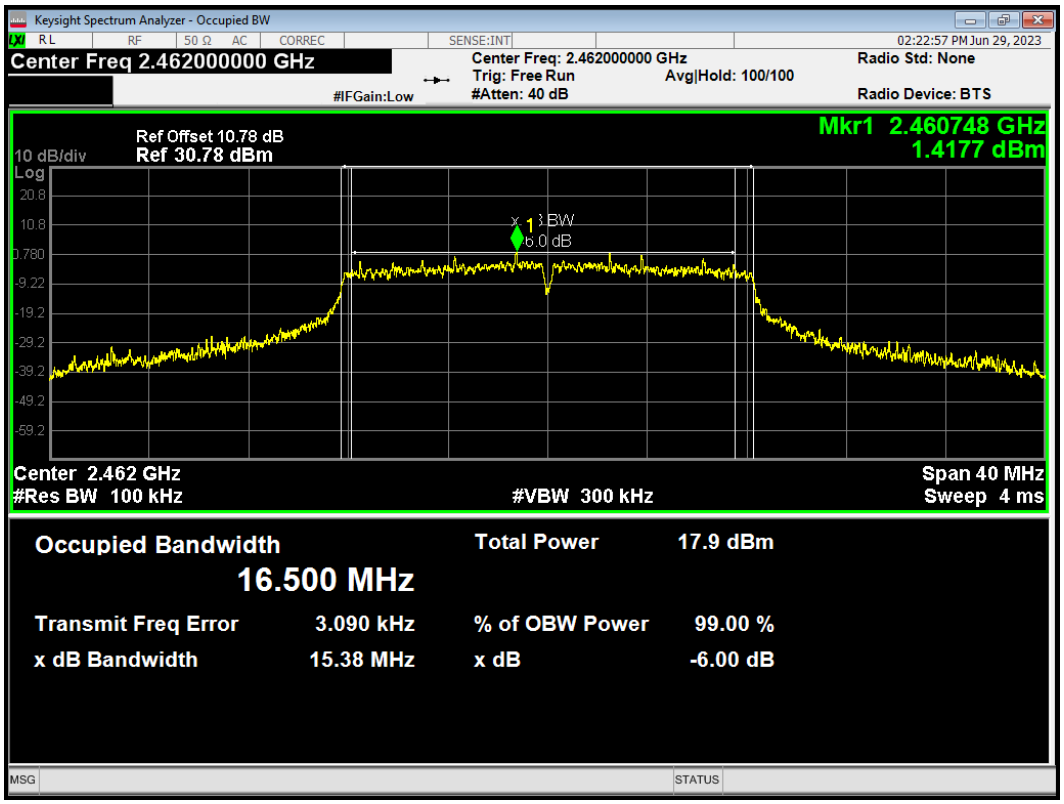
-6dB Bandwidth 802.11g 2412MHz



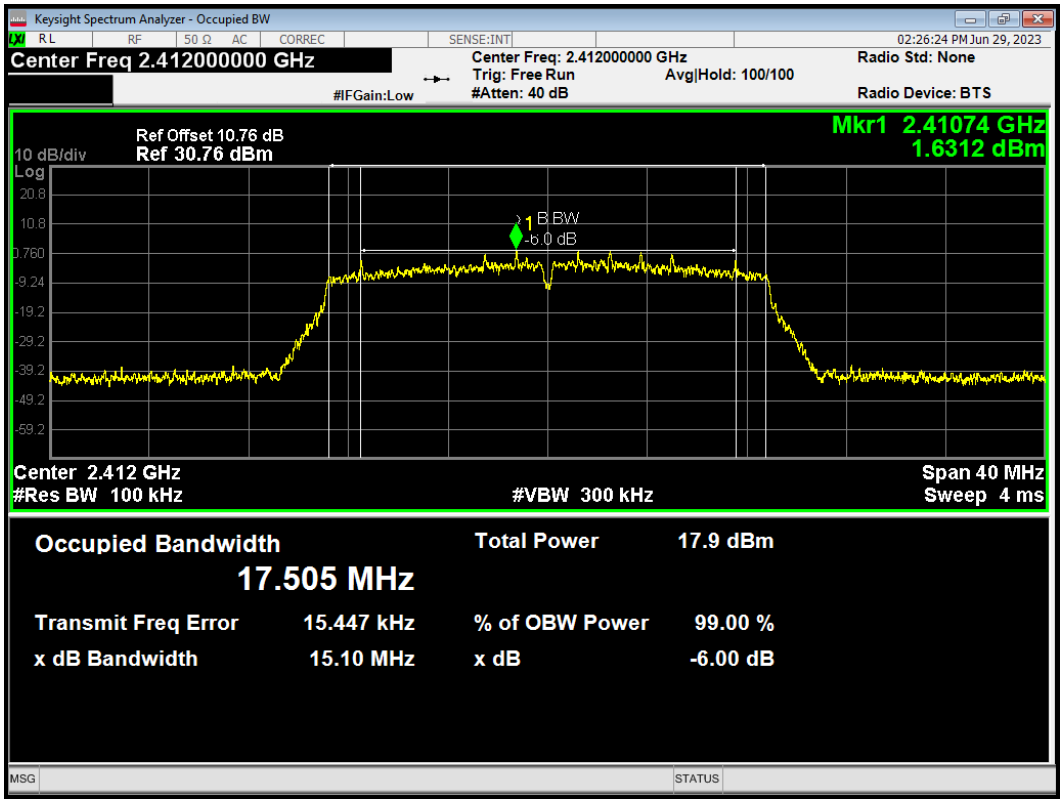
-6dB Bandwidth 802.11g 2437MHz



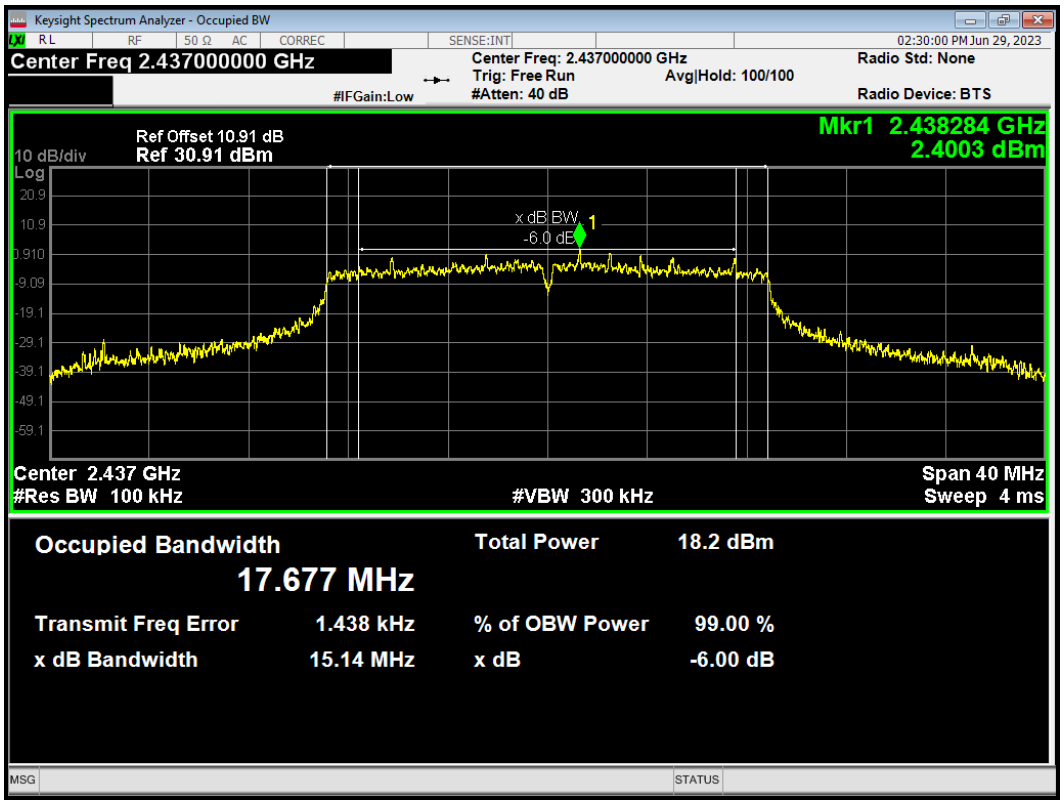
-6dB Bandwidth 802.11g 2462MHz



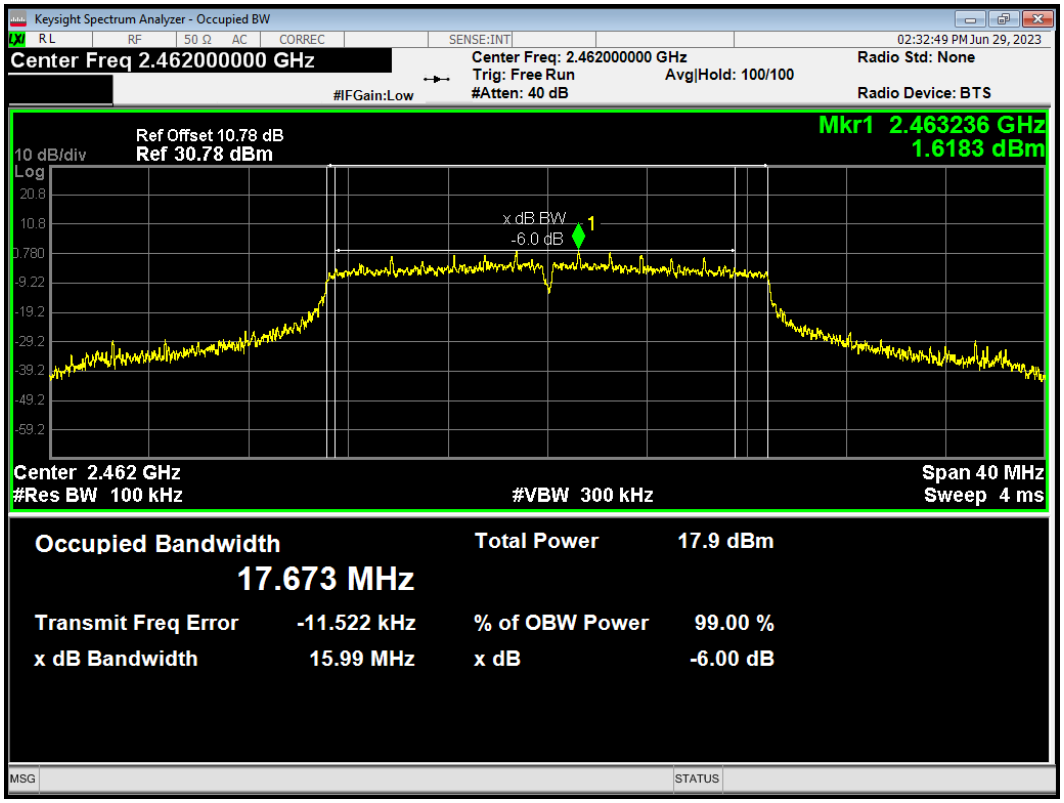
-6dB Bandwidth 802.11n(HT20) 2412MHz



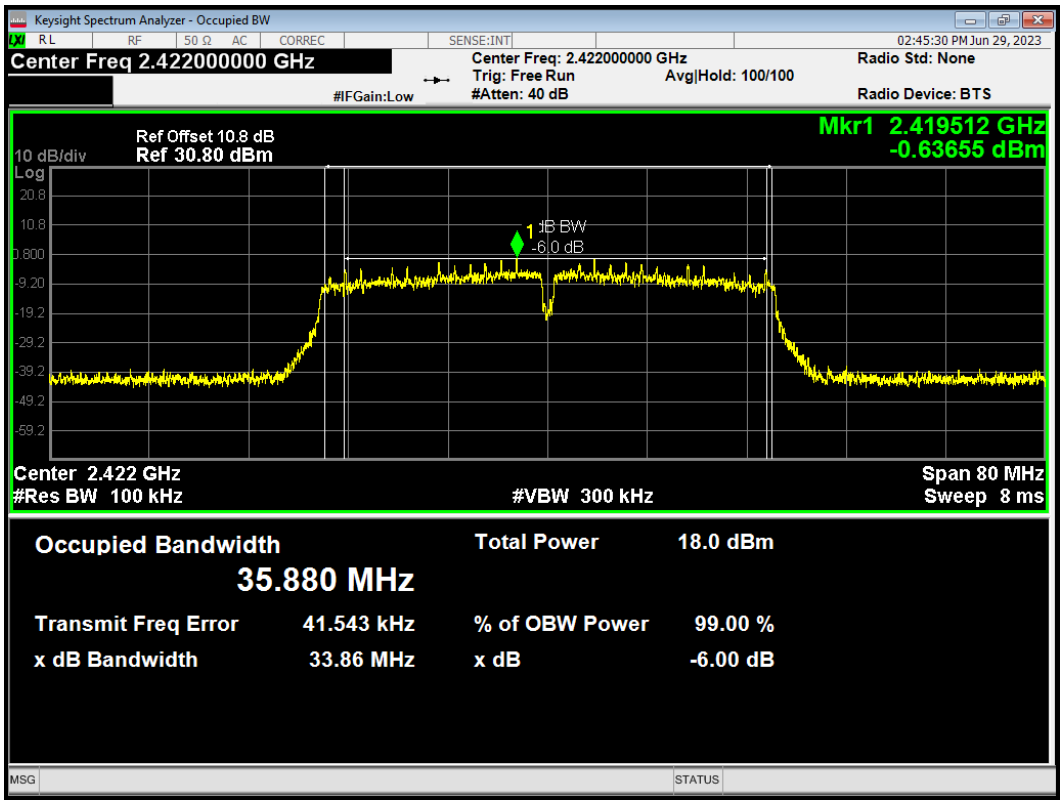
-6dB Bandwidth 802.11n(HT20) 2437MHz



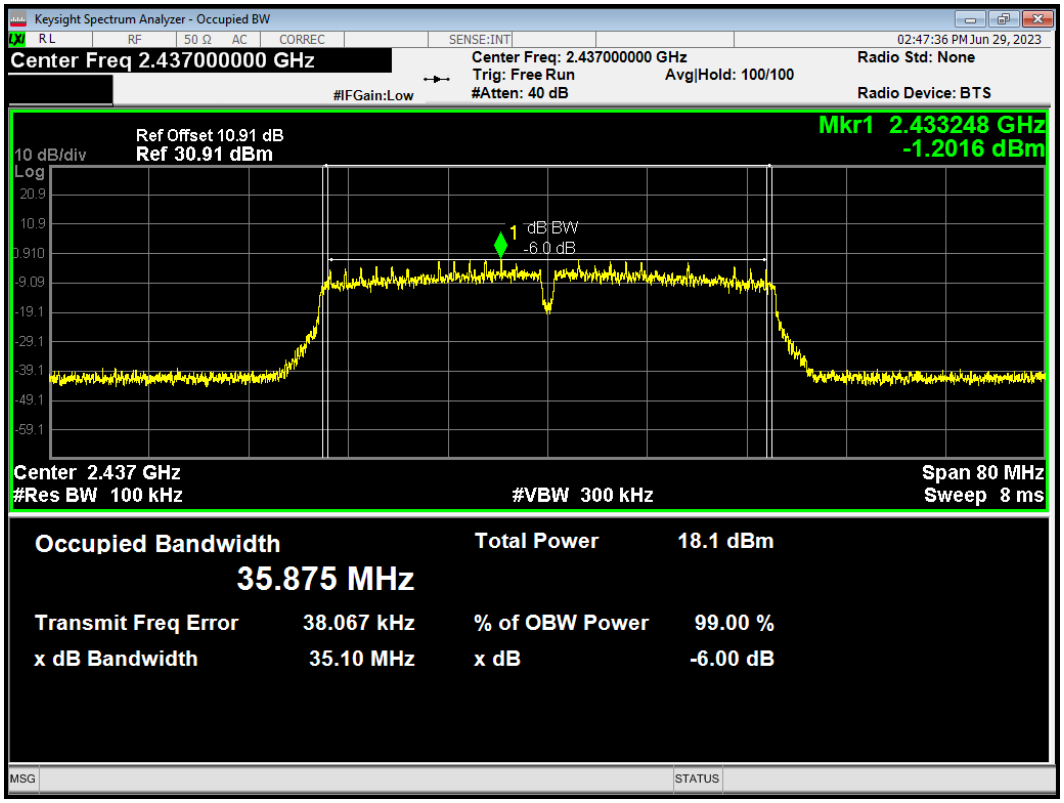
-6dB Bandwidth 802.11n(HT20) 2462MHz



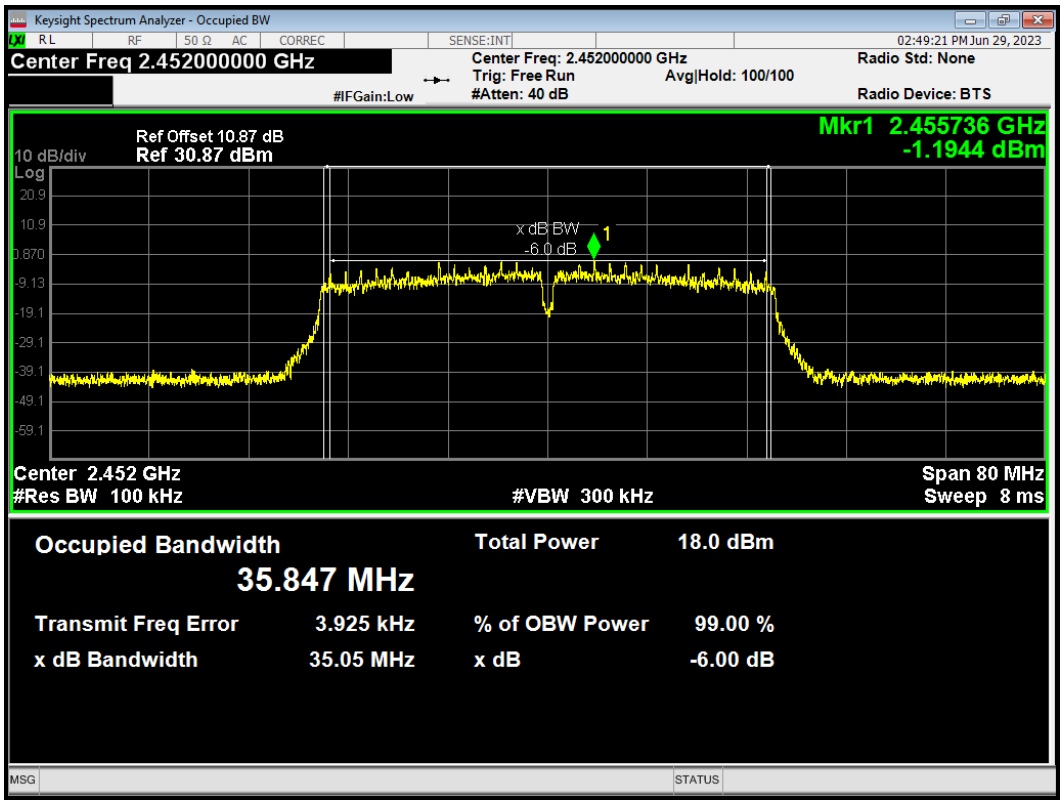
-6dB Bandwidth 802.11n(HT40) 2422MHz



-6dB Bandwidth 802.11n(HT40) 2437MHz

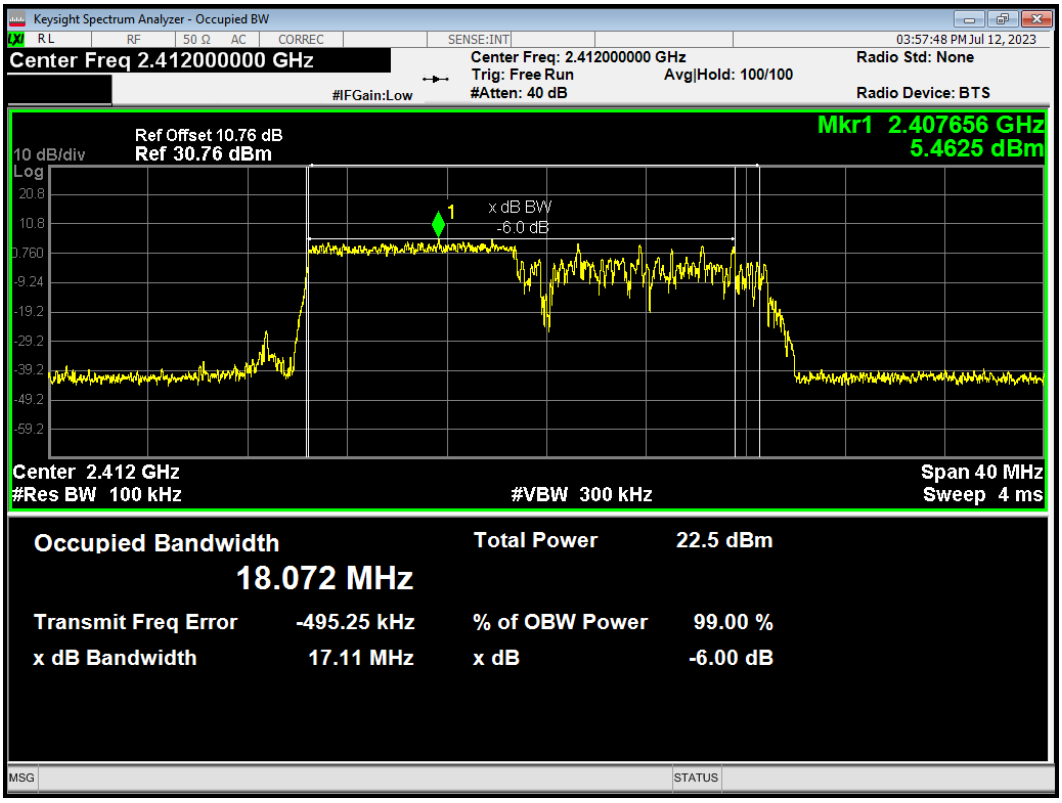


-6dB Bandwidth 802.11n(HT40) 2452MHz

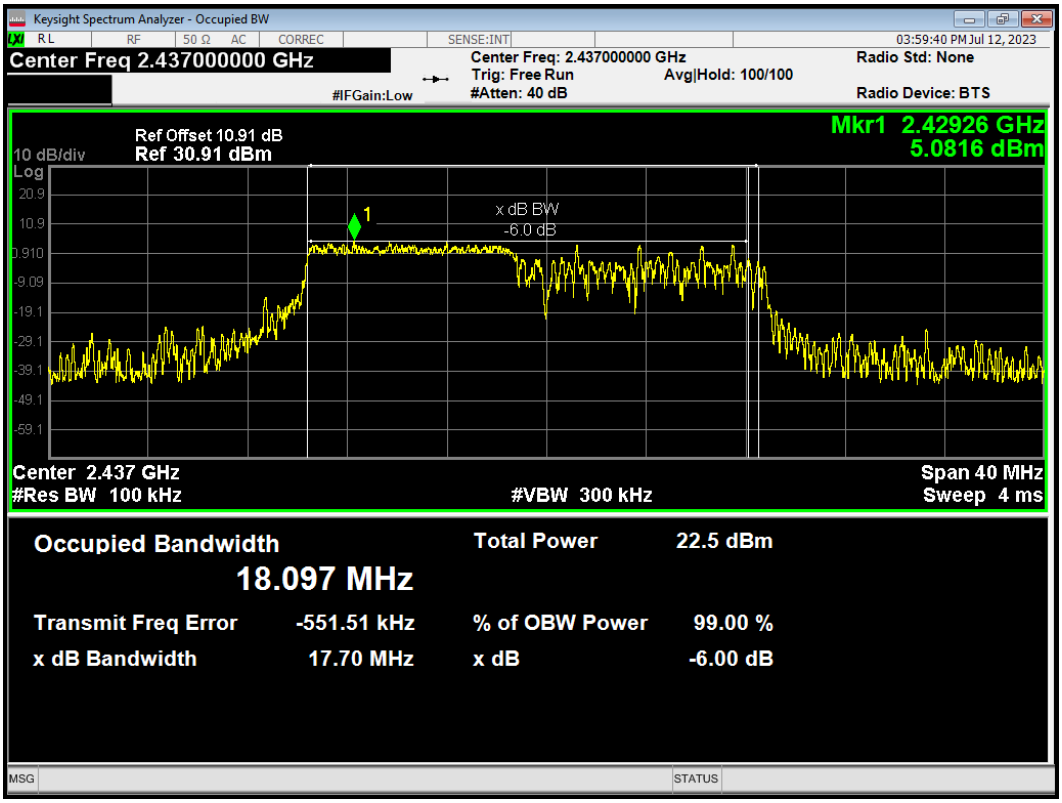


TB Mode

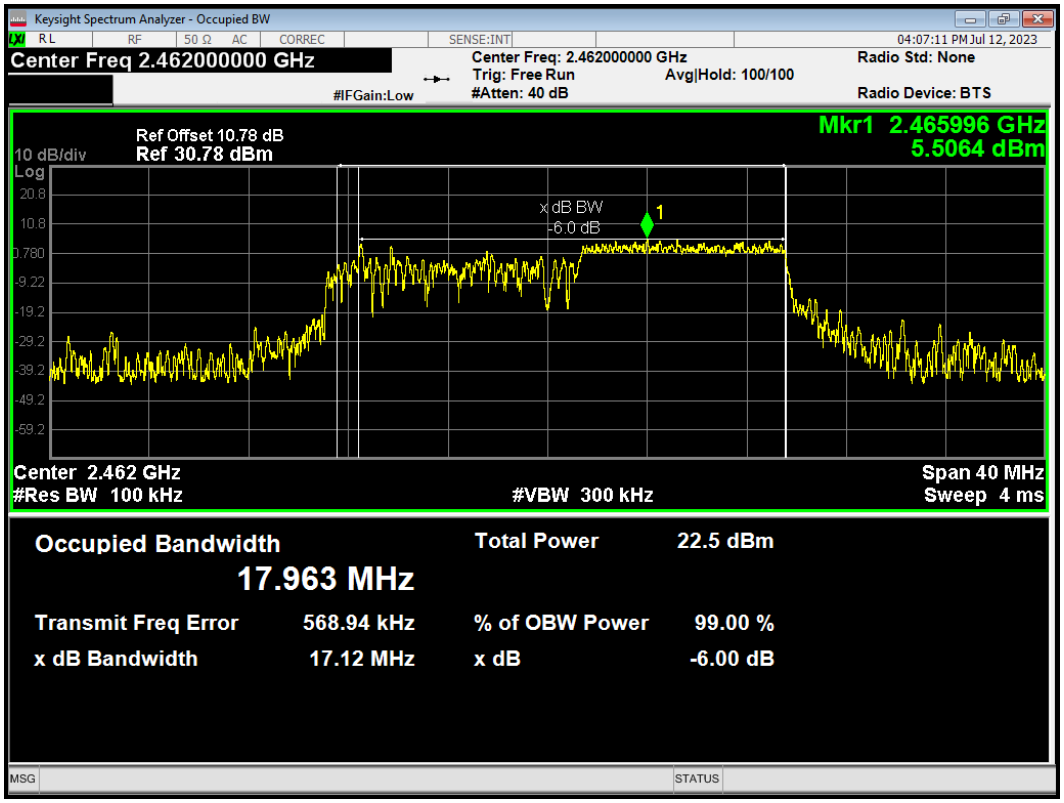
-6dB Bandwidth 802.11ax (20M) RU106 IDX53 2412MHz



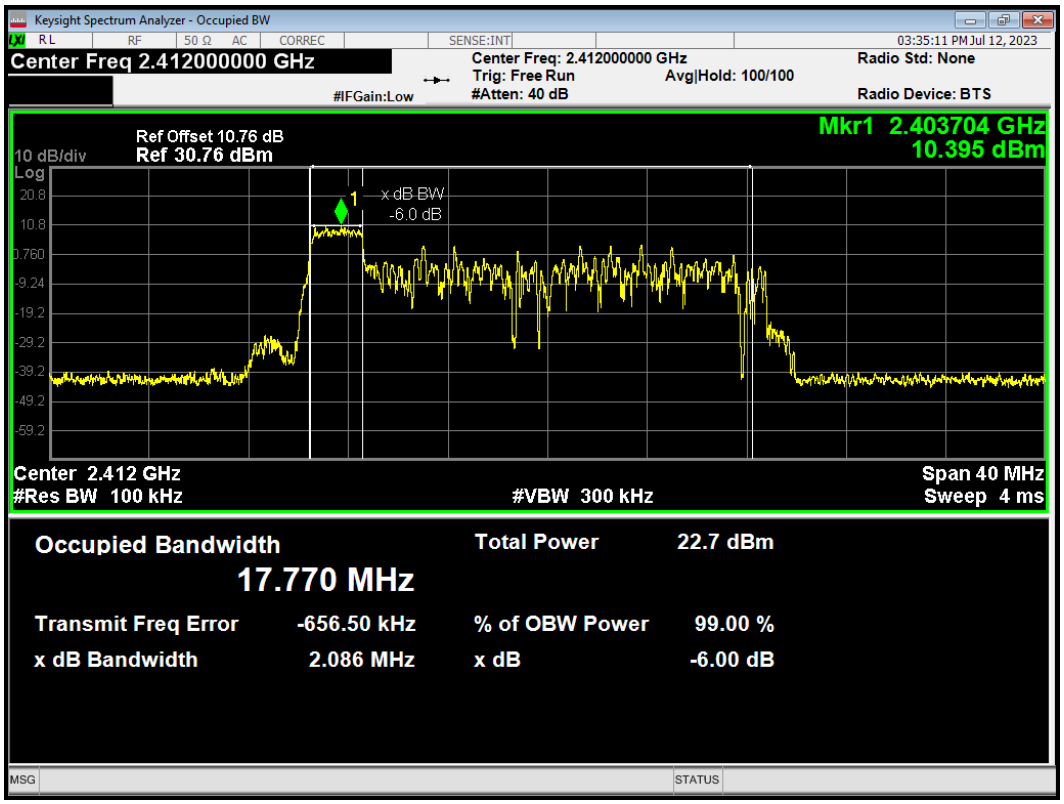
-6dB Bandwidth 802.11ax (20M) RU106 IDX53 2437MHz



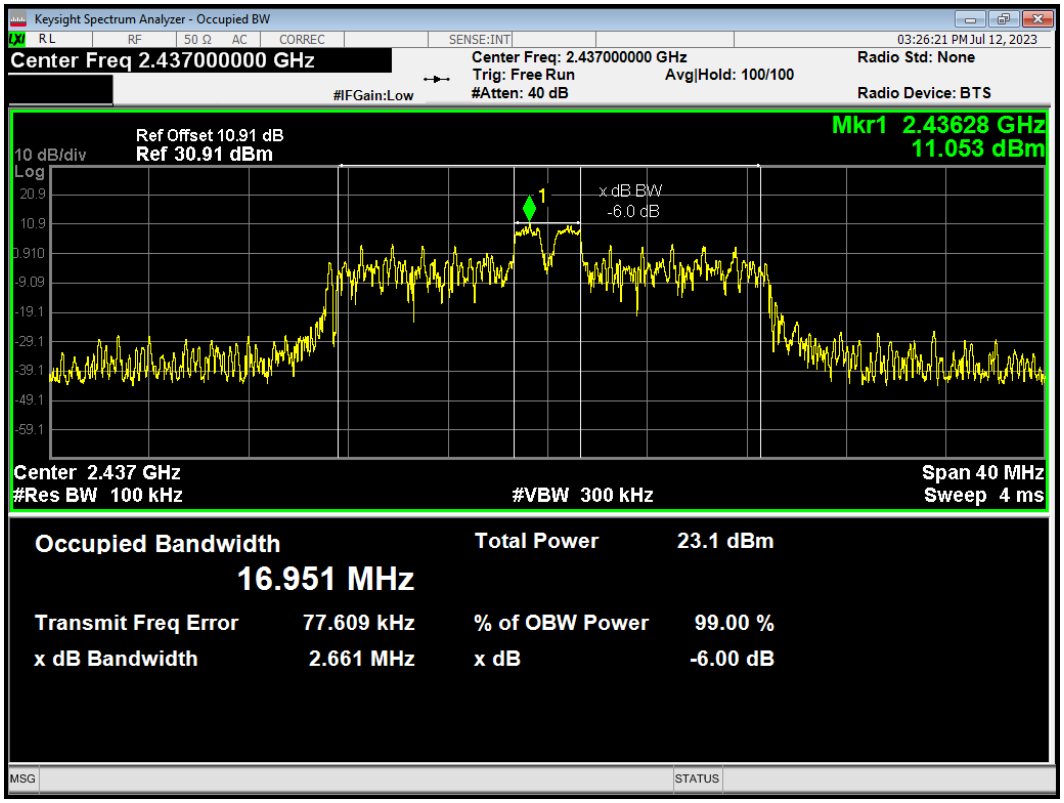
-6dB Bandwidth 802.11ax (20M) RU106 IDX54 2462MHz



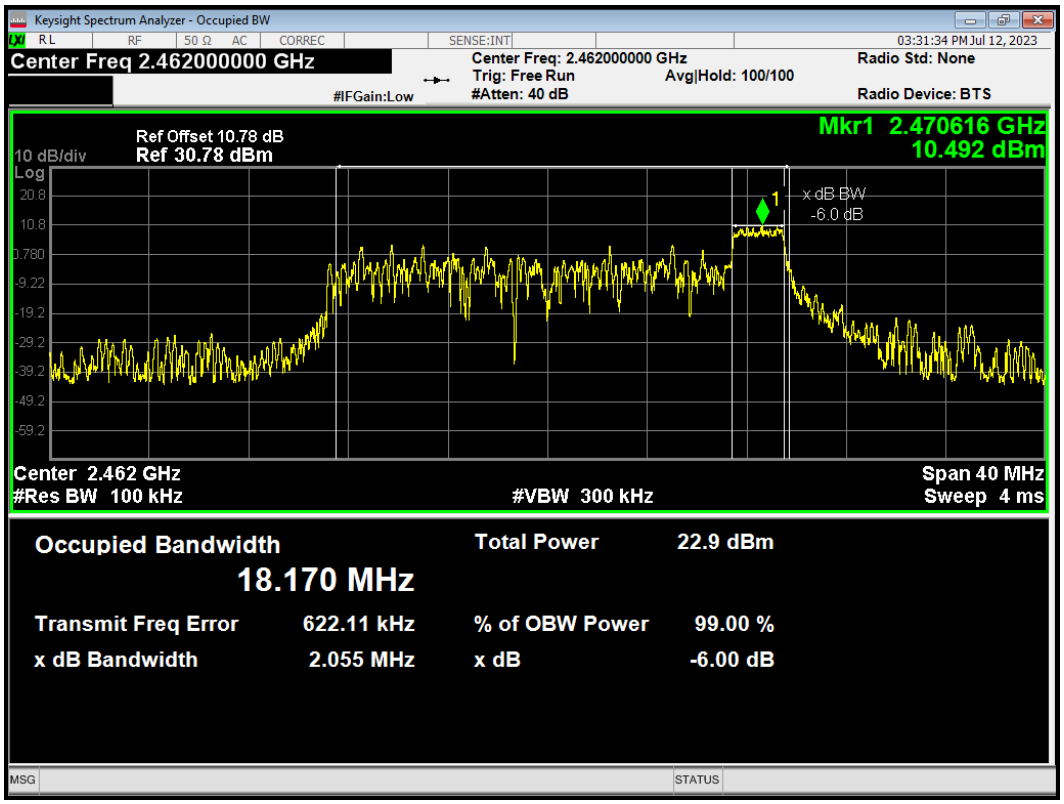
-6dB Bandwidth 802.11ax (20M) RU26 IDX0 2412MHz



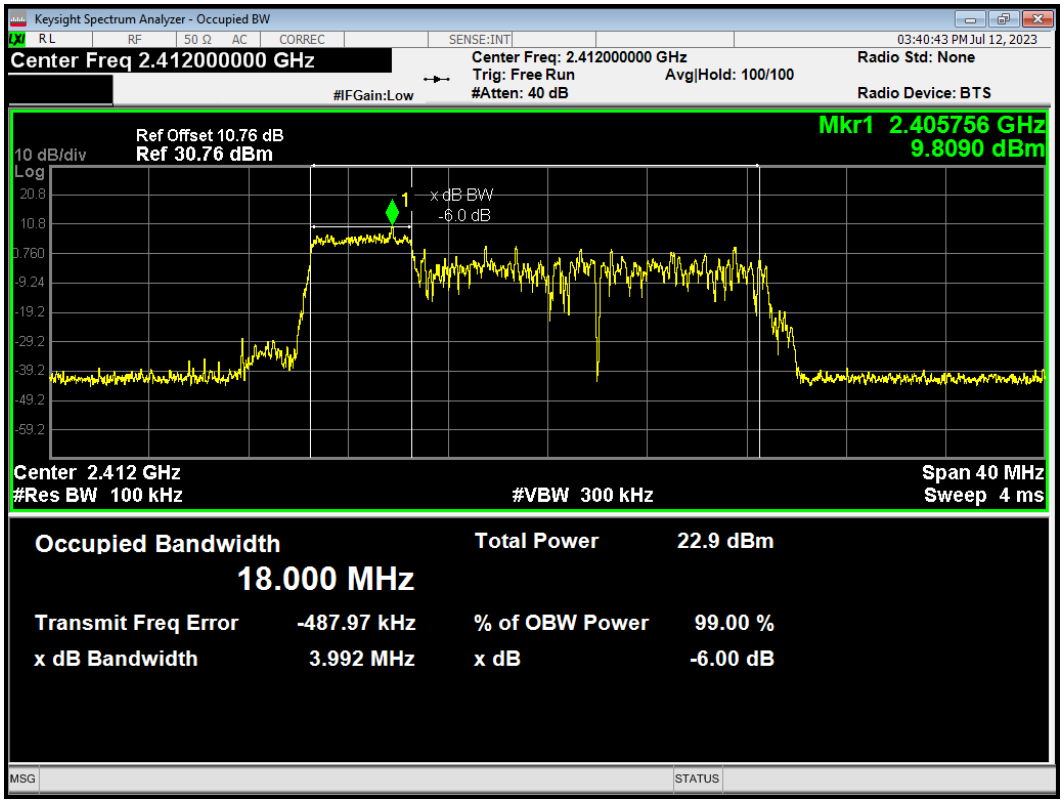
-6dB Bandwidth 802.11ax (20M) RU26 IDX4 2437MHz



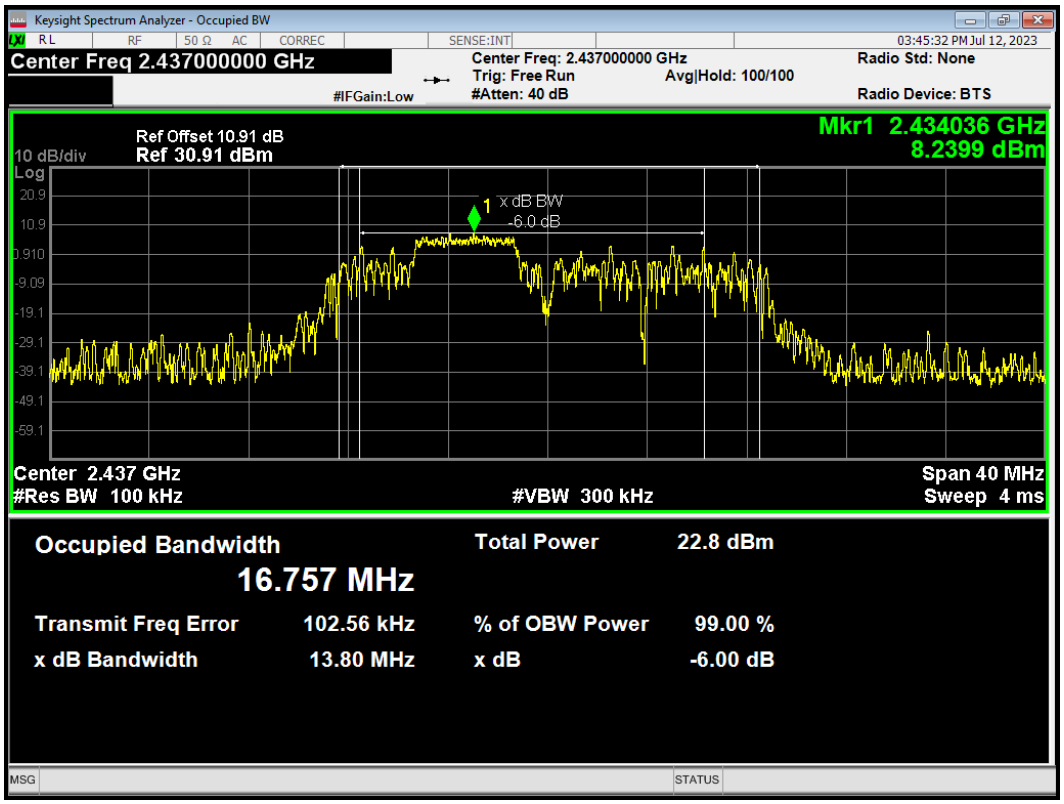
-6dB Bandwidth 802.11ax (20M) RU26 IDX8 2462MHz



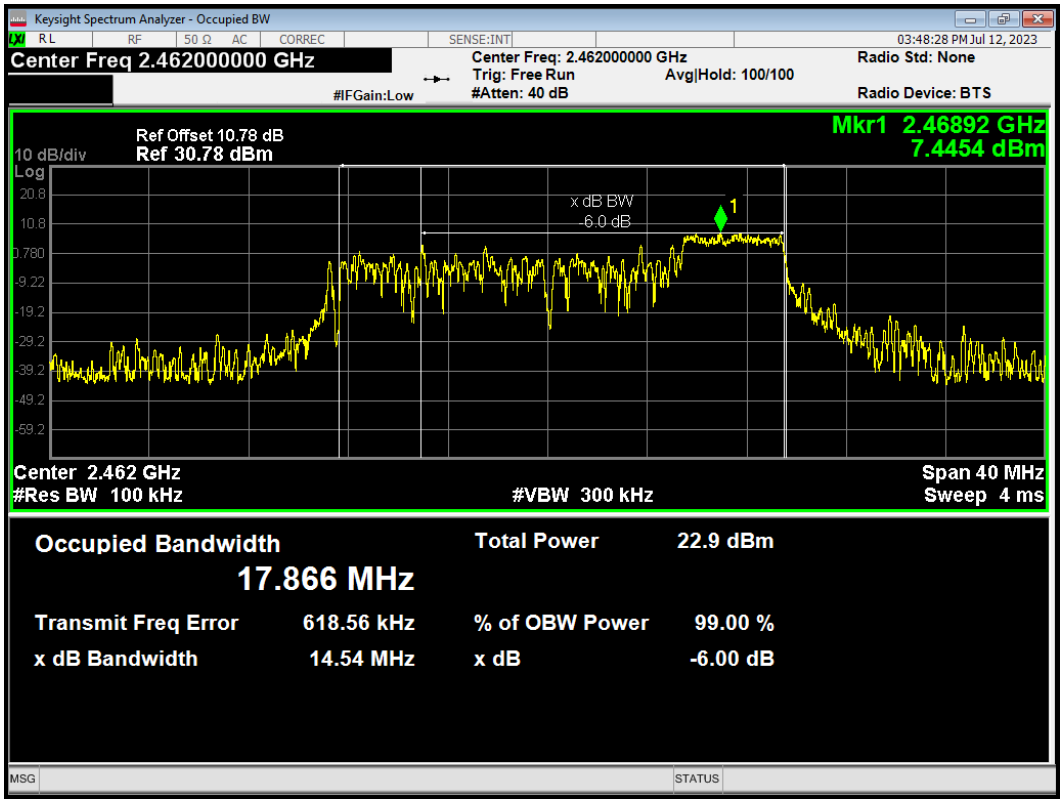
-6dB Bandwidth 802.11ax (20M) RU52 IDX37 2412MHz



-6dB Bandwidth 802.11ax (20M) RU52 IDX38 2437MHz

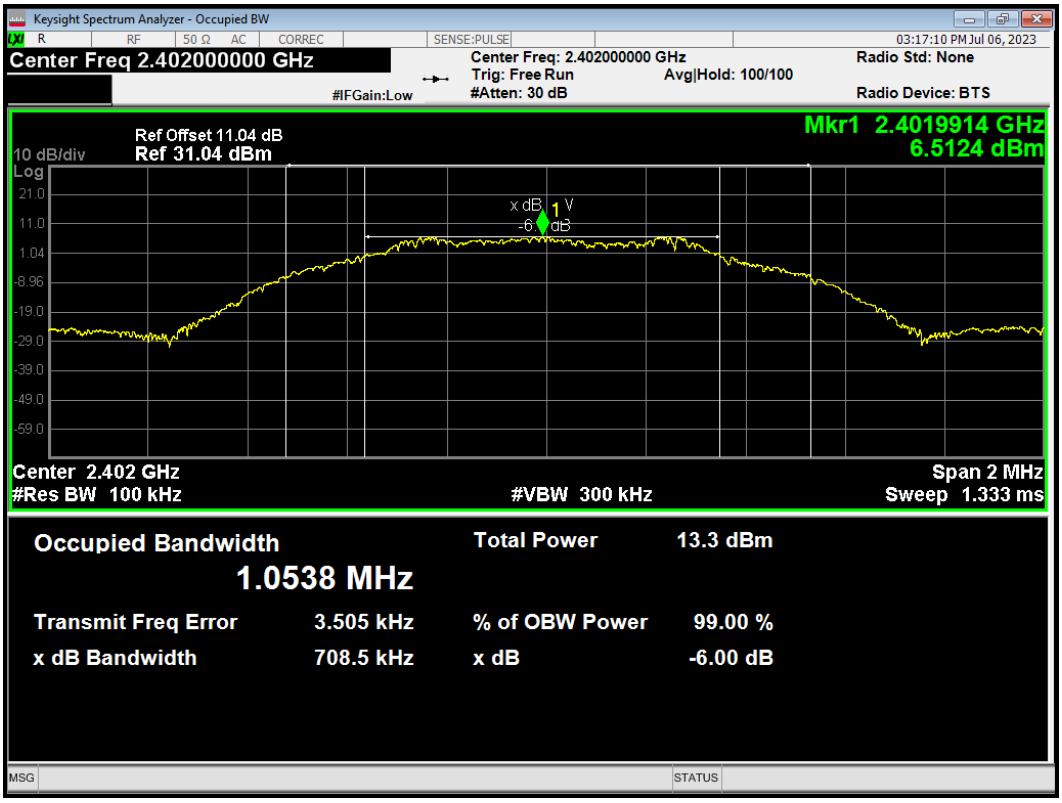


-6dB Bandwidth 802.11ax (20M) RU52 IDX40 2462MHz

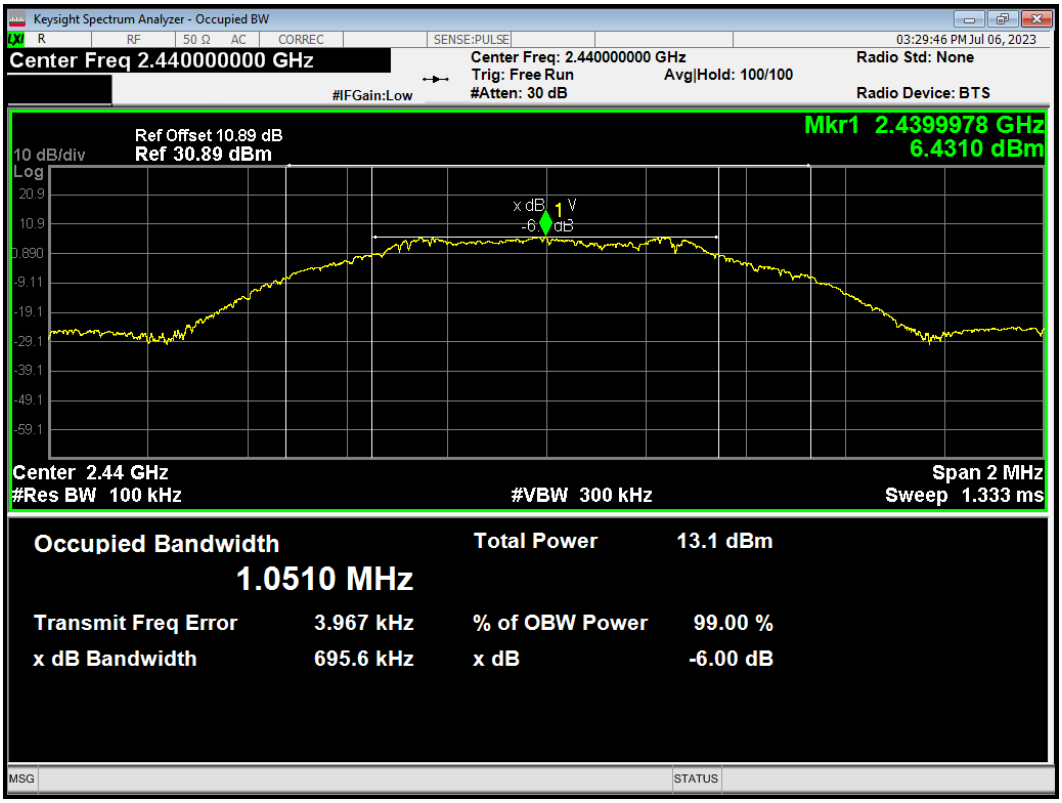


Internal Antenna

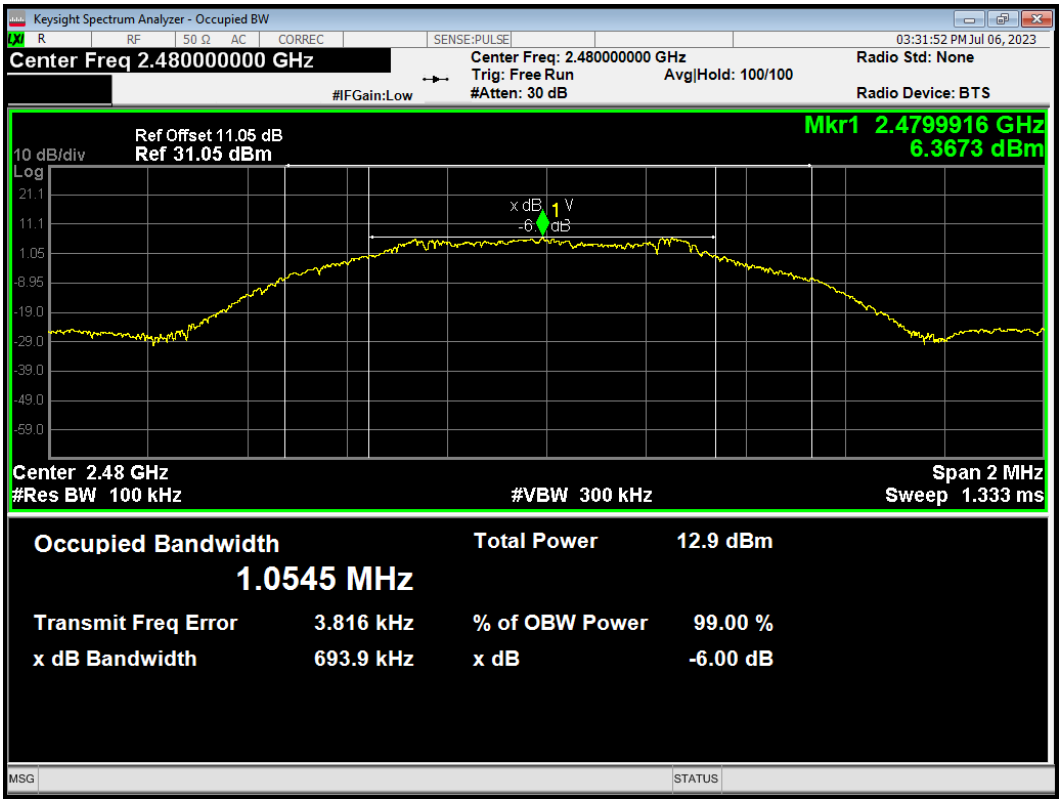
-6dB Bandwidth BLE (1M) 2402MHz



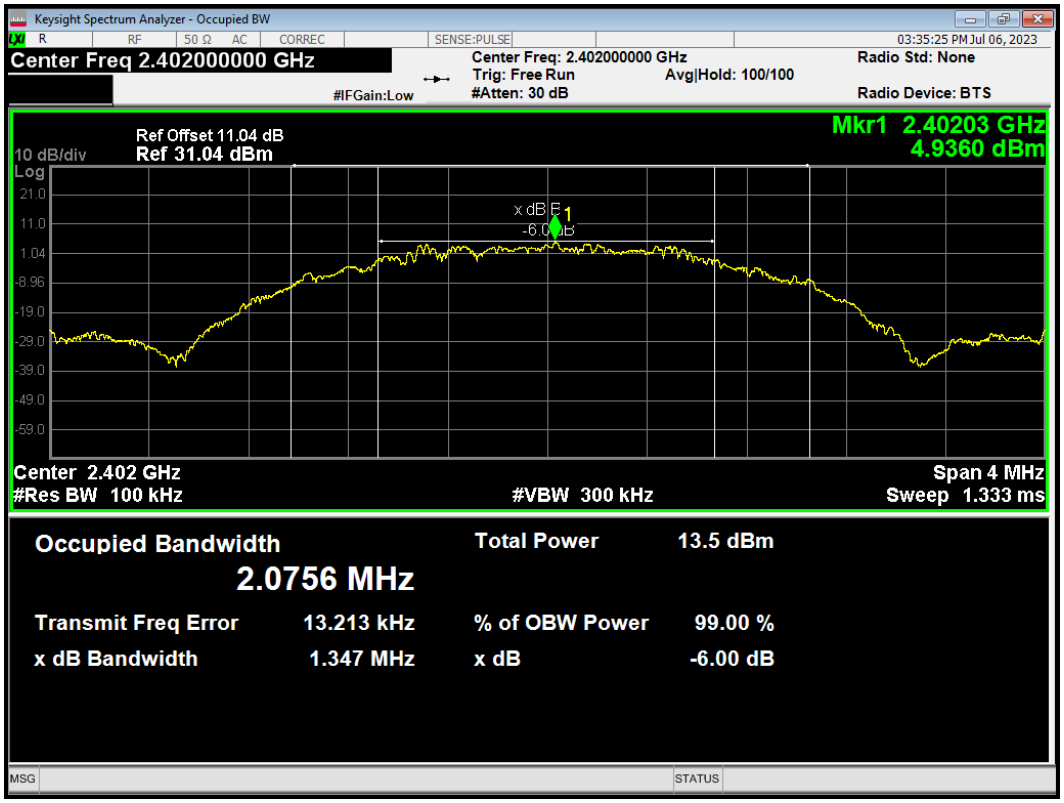
-6dB Bandwidth BLE (1M) 2440MHz



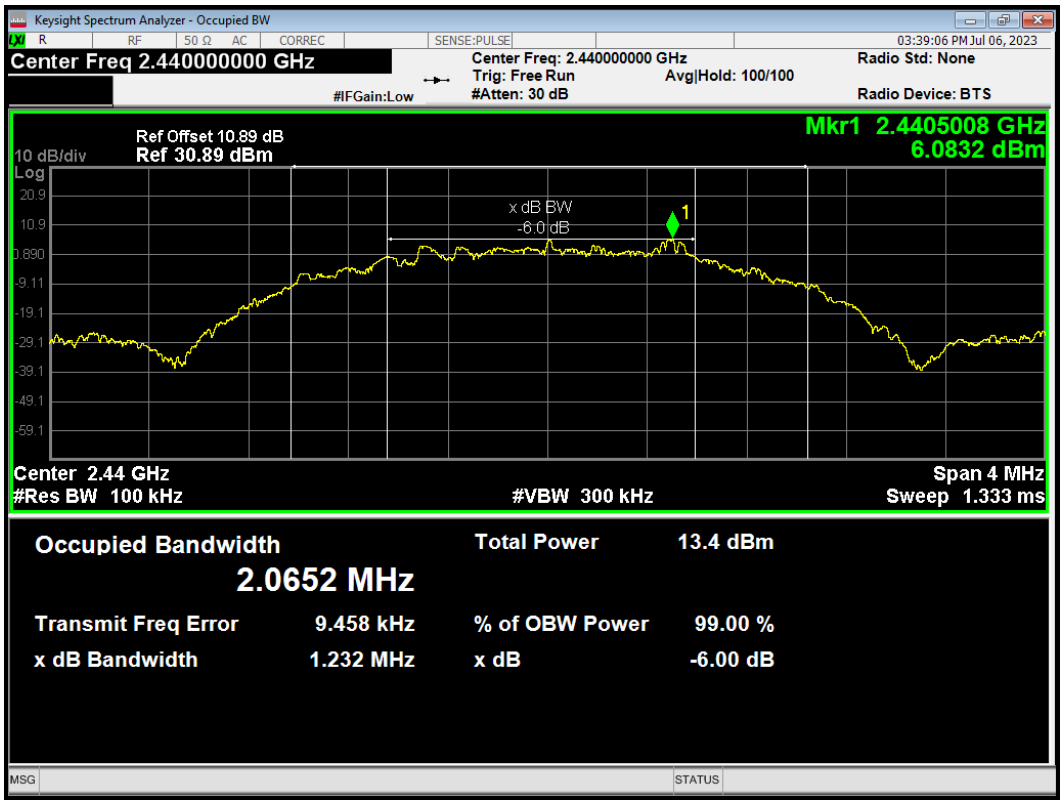
-6dB Bandwidth BLE (1M) 2480MHz



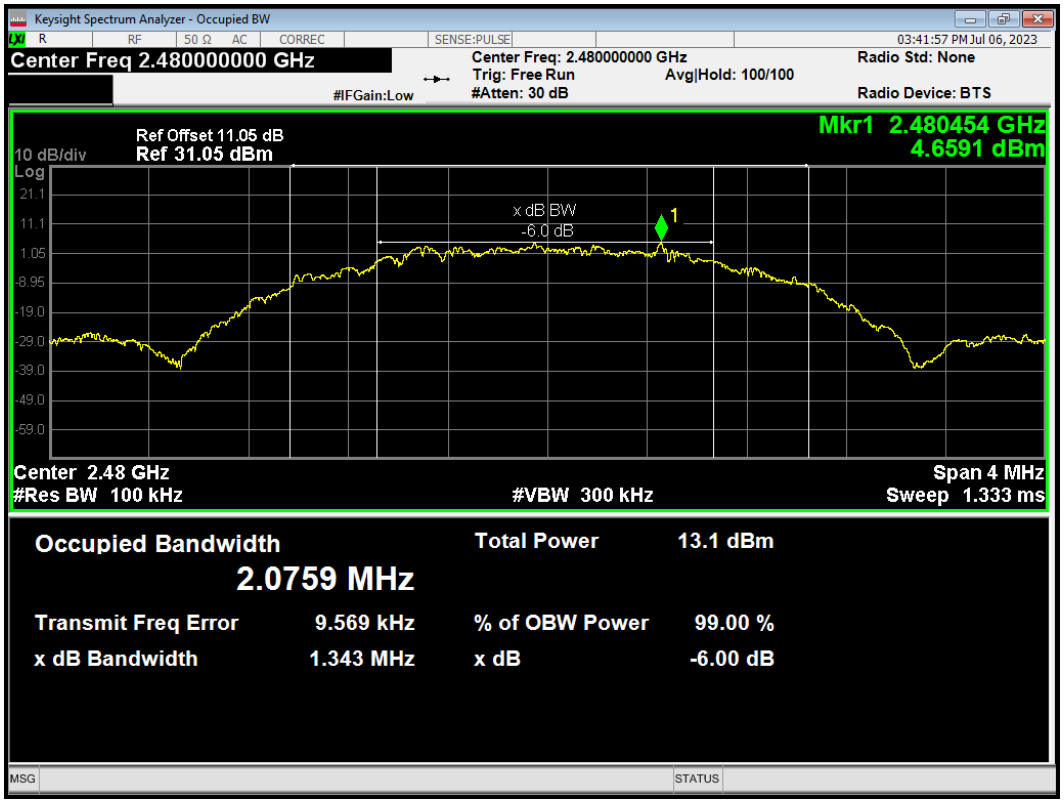
-6dB Bandwidth BLE (2M) 2402MHz



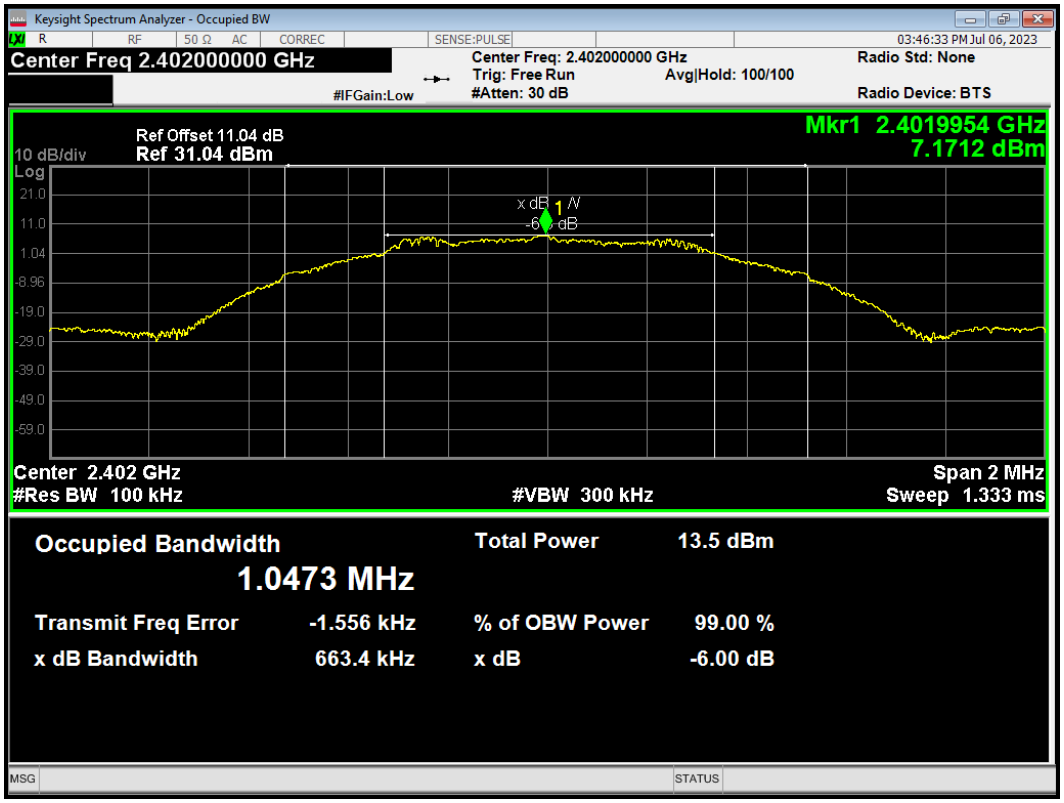
-6dB Bandwidth BLE (2M) 2440MHz



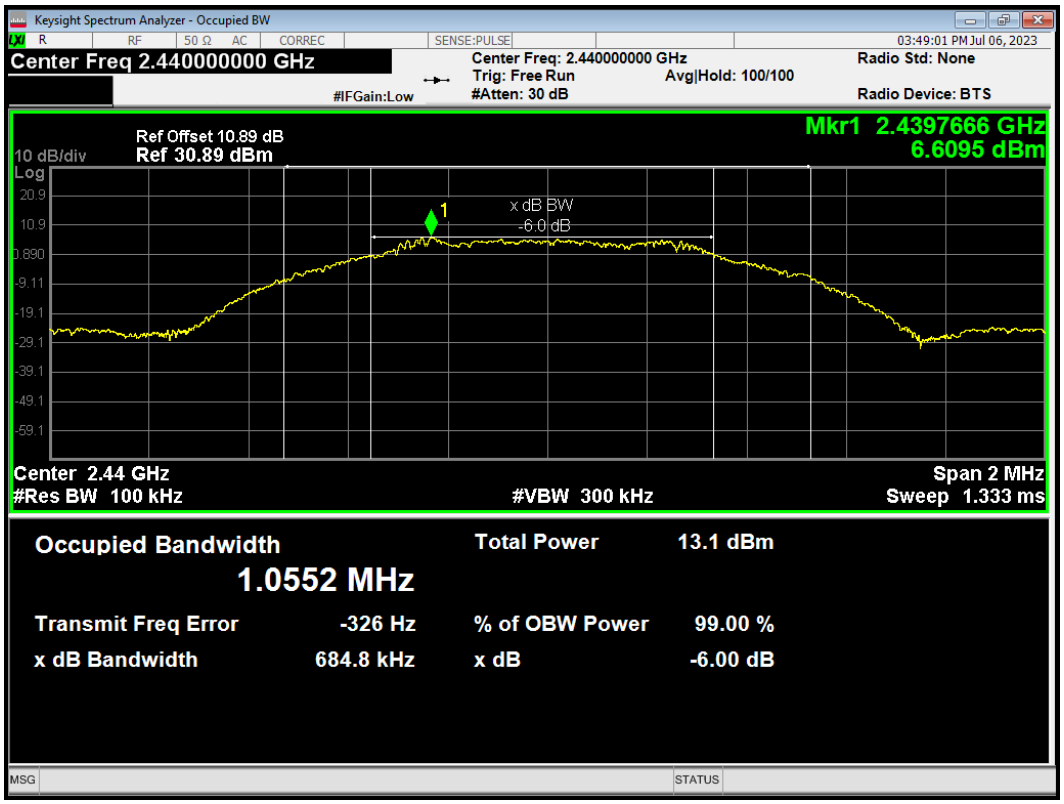
-6dB Bandwidth BLE (2M) 2480MHz



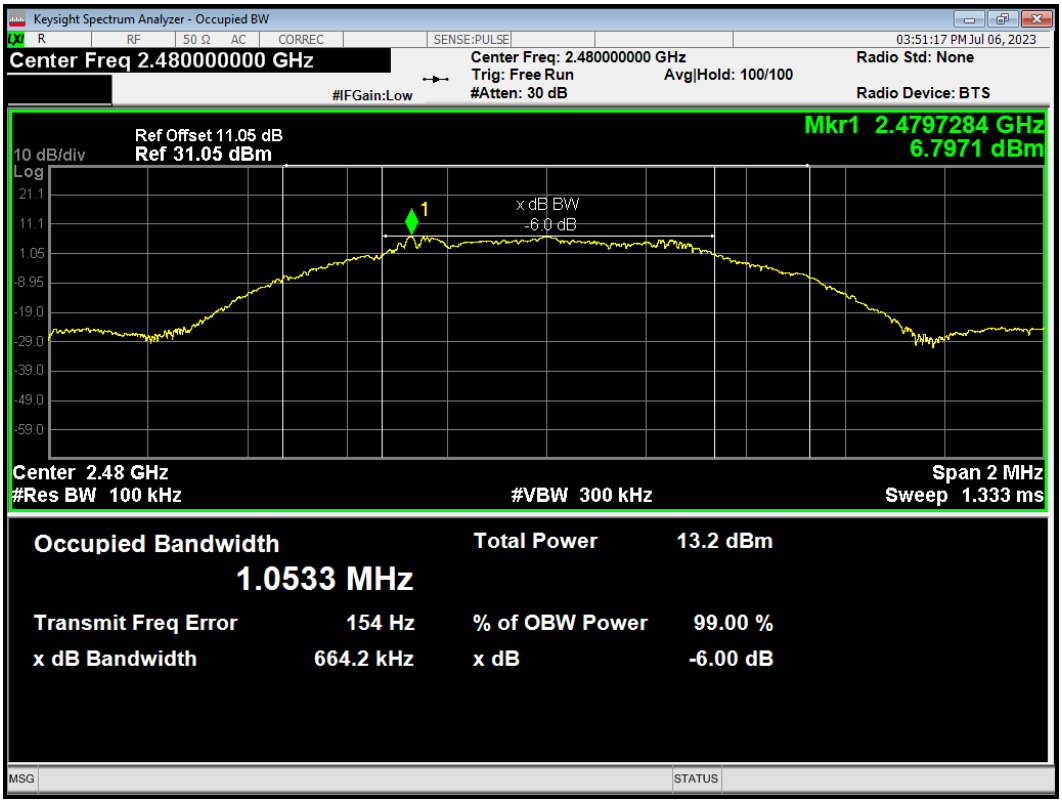
-6dB Bandwidth BLE (S=2) 2402MHz



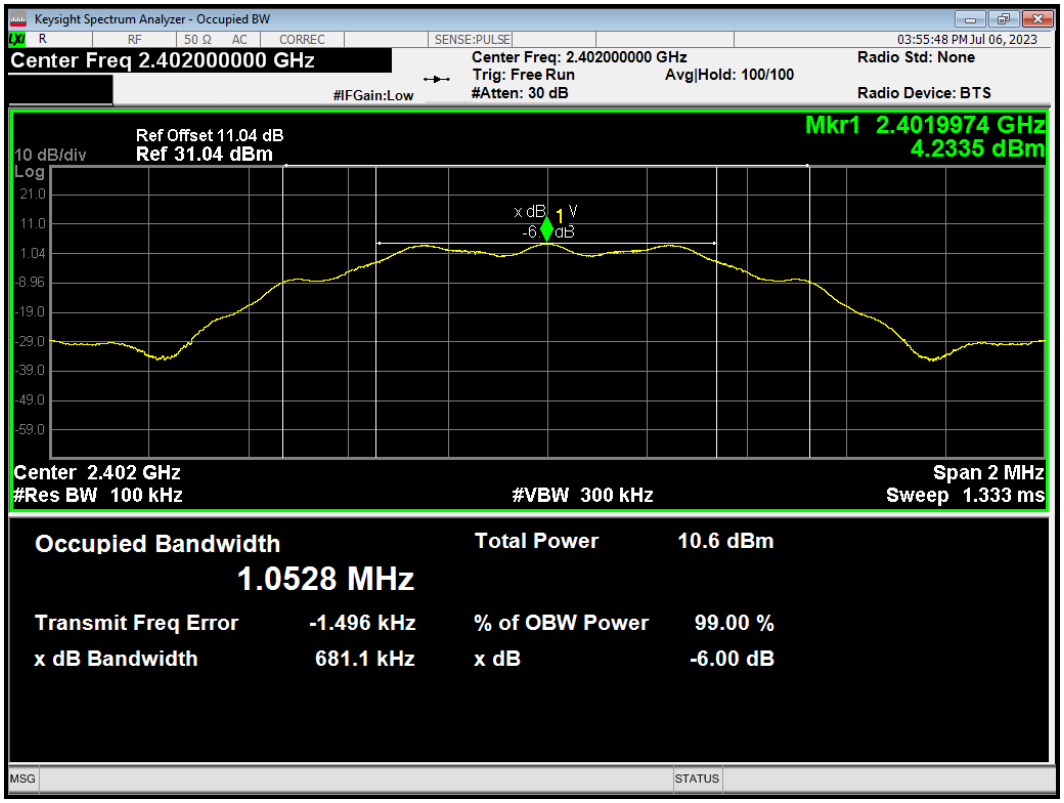
-6dB Bandwidth BLE (S=2) 2440MHz



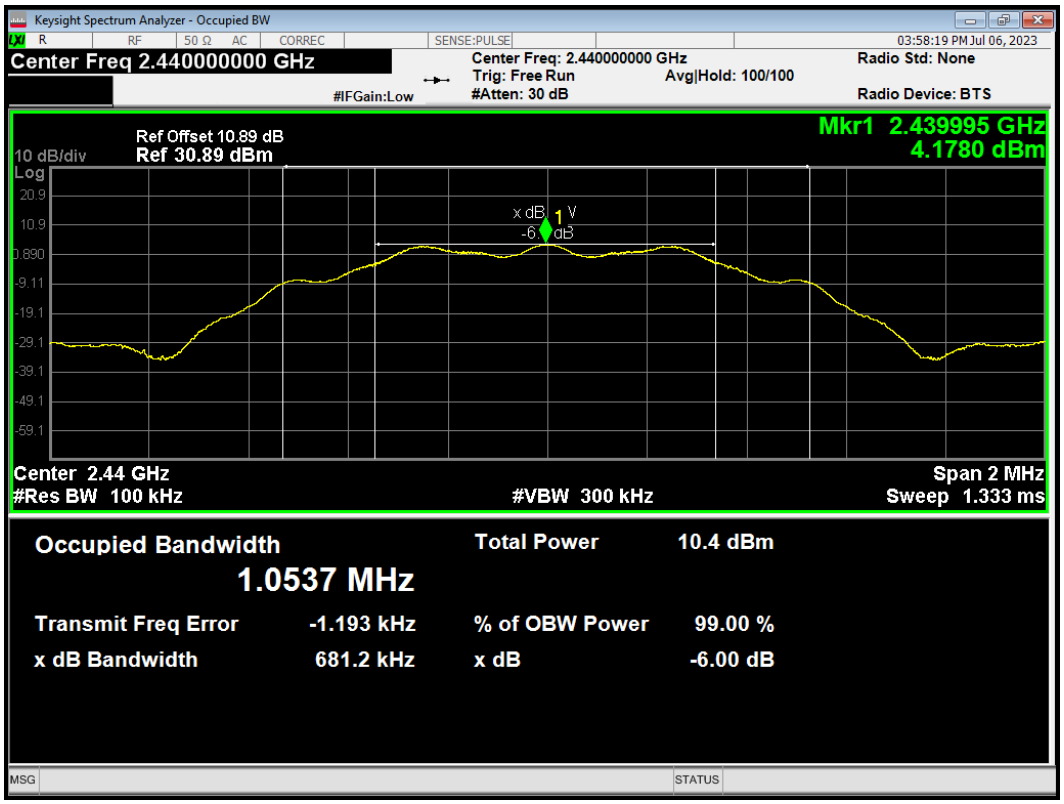
-6dB Bandwidth BLE (S=2) 2480MHz



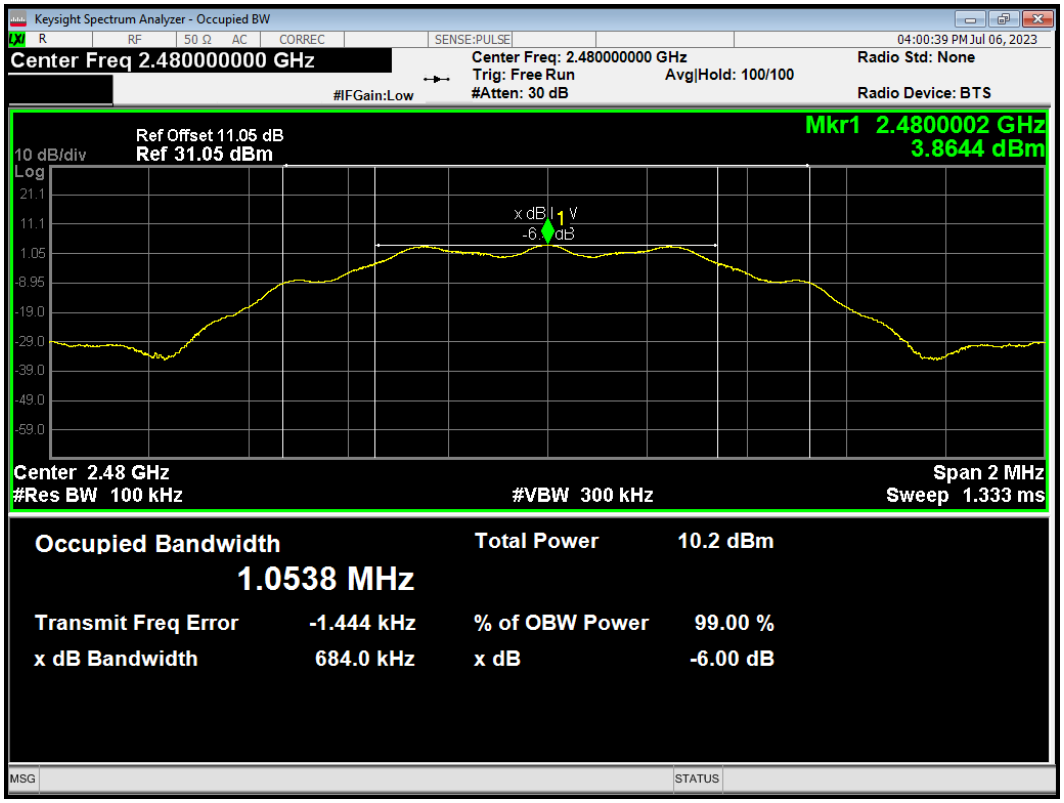
-6dB Bandwidth BLE (S=8) 2402MHz



-6dB Bandwidth BLE (S=8) 2440MHz

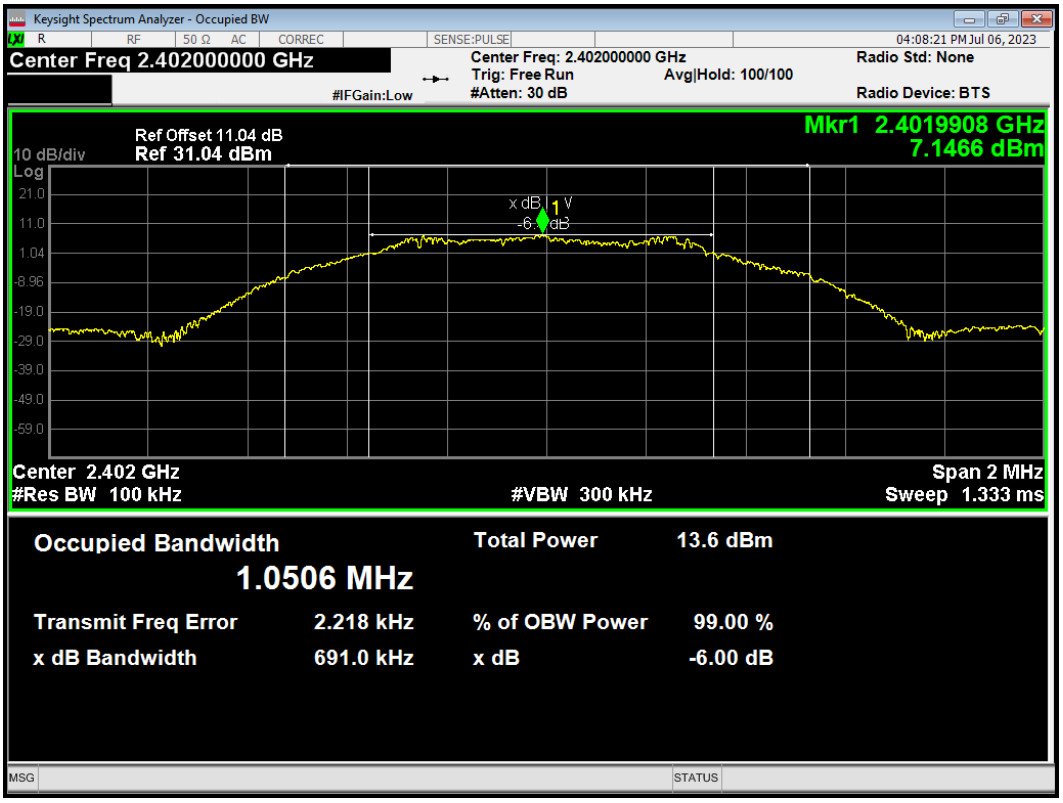


-6dB Bandwidth BLE (S=8) 2480MHz

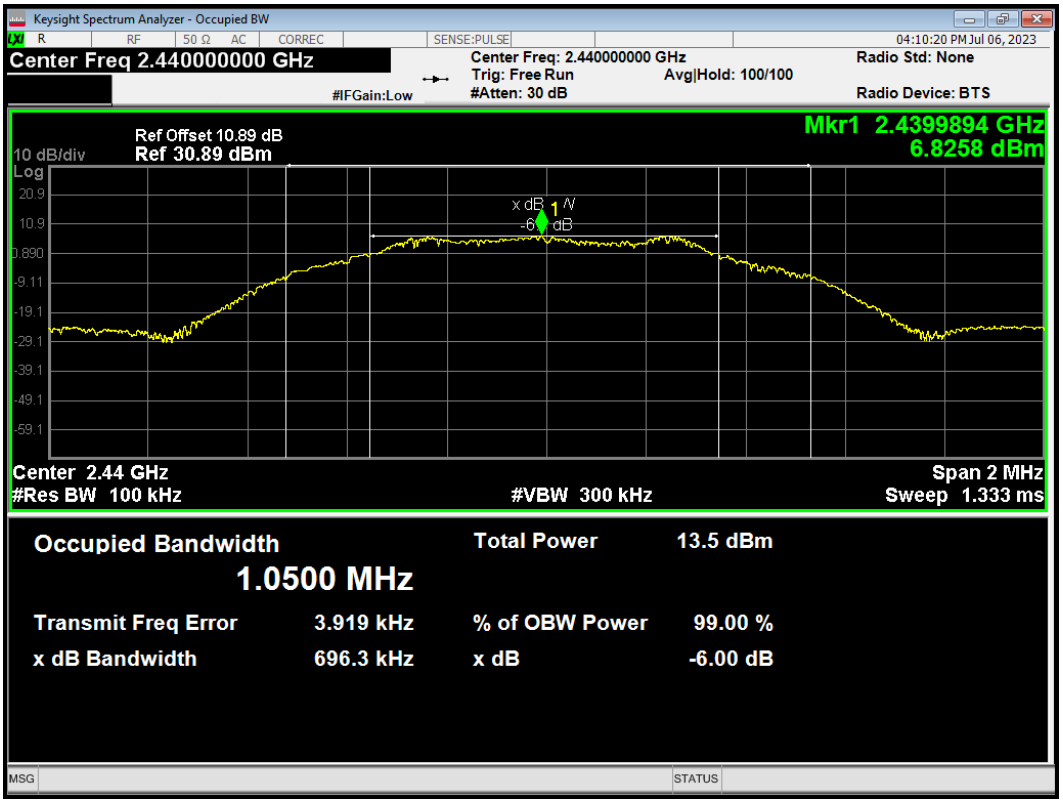


External Antenna

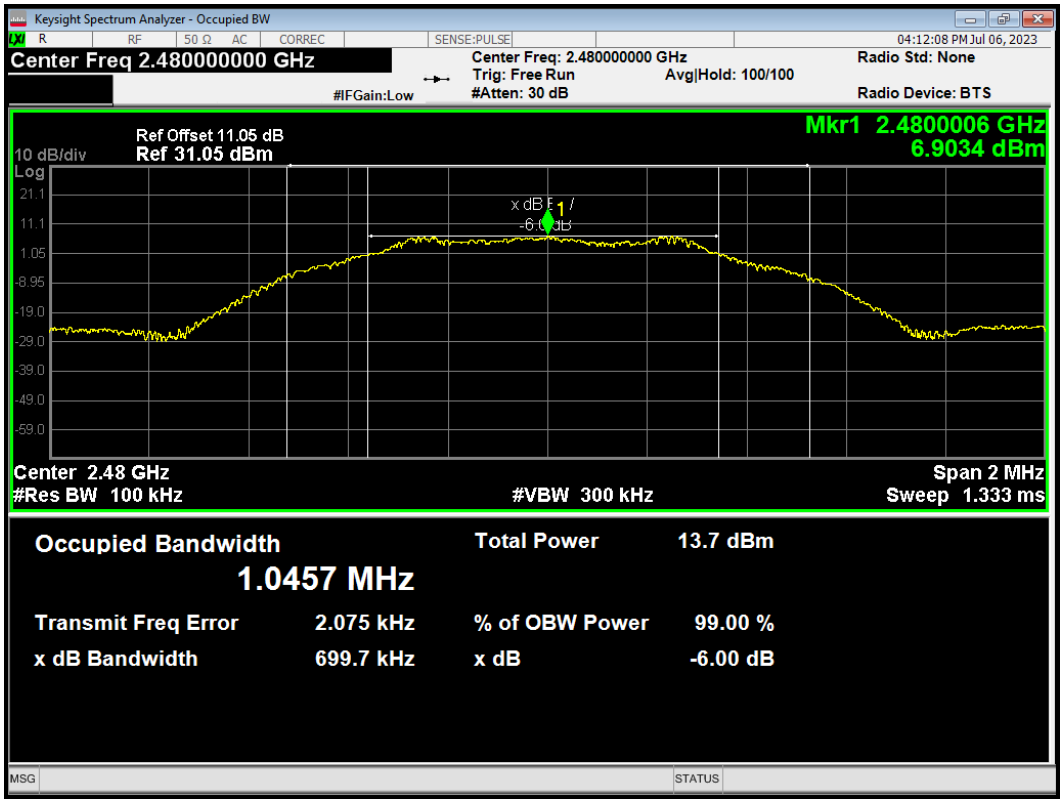
-6dB Bandwidth BLE (1M) 2402MHz



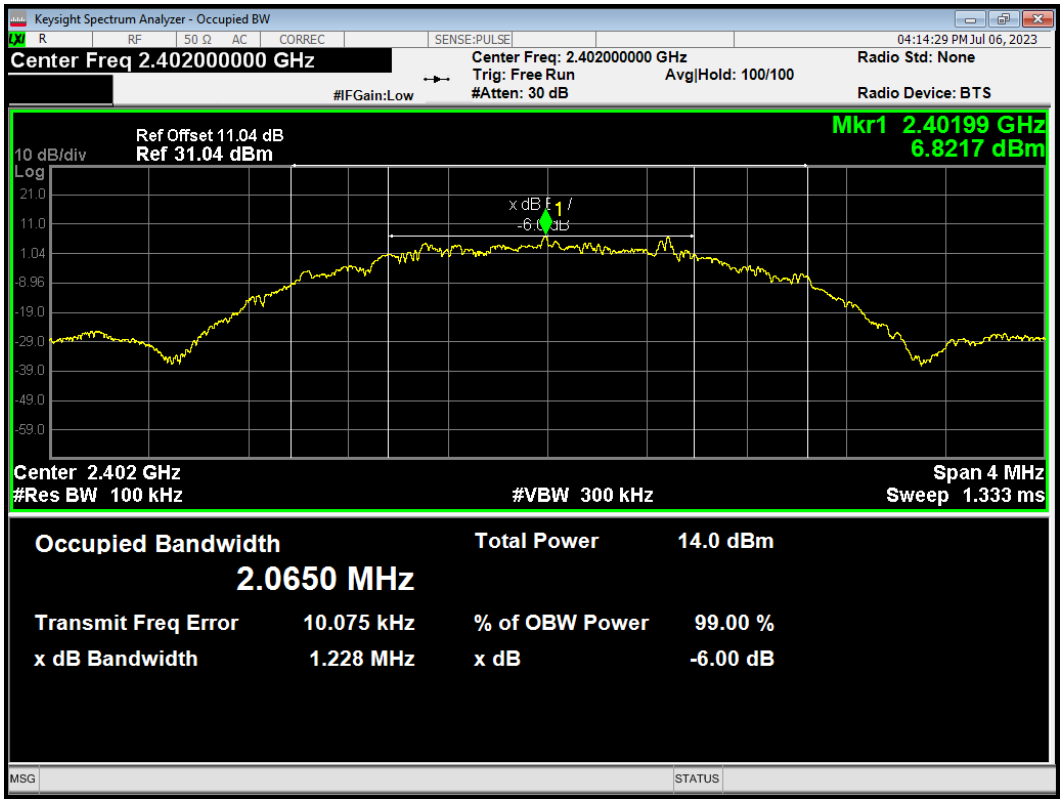
-6dB Bandwidth BLE (1M) 2440MHz



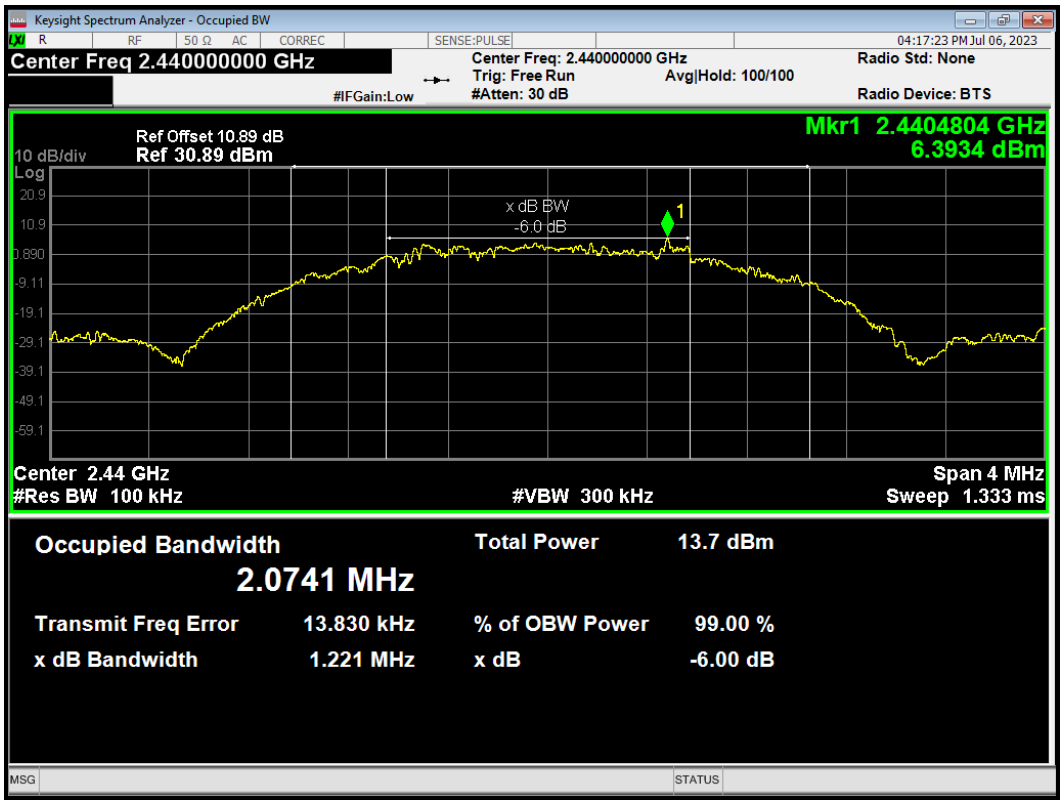
-6dB Bandwidth BLE (1M) 2480MHz



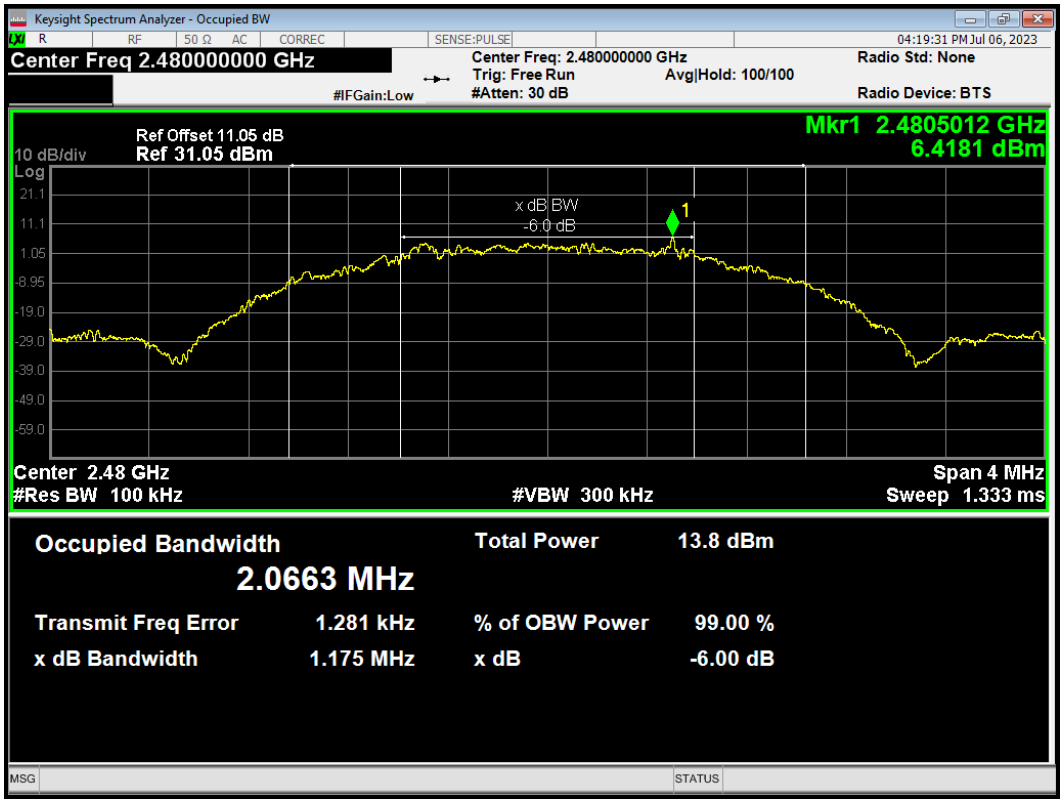
-6dB Bandwidth BLE (2M) 2402MHz



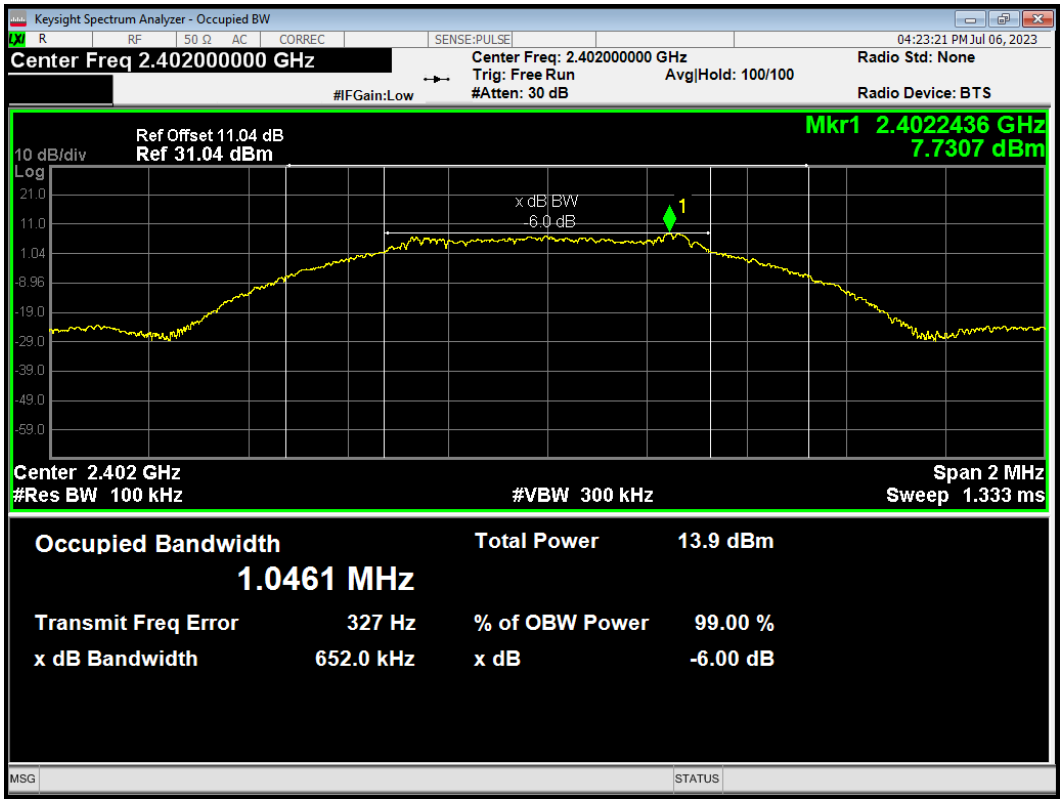
-6dB Bandwidth BLE (2M) 2440MHz



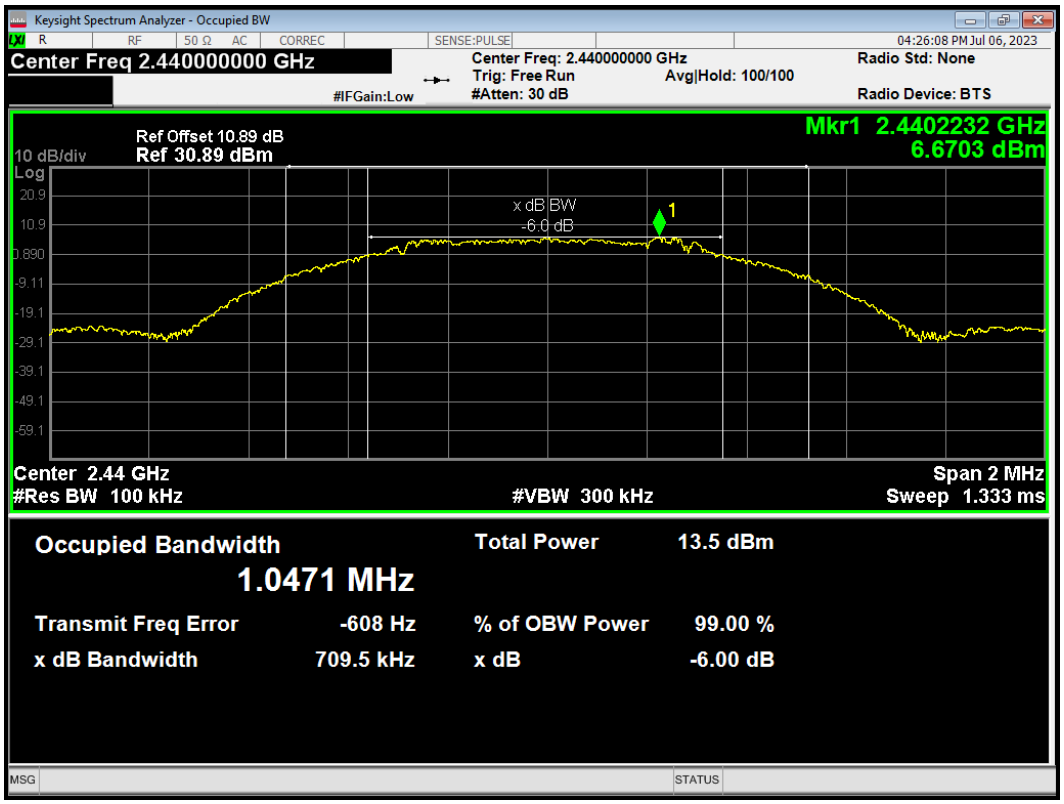
-6dB Bandwidth BLE (2M) 2480MHz



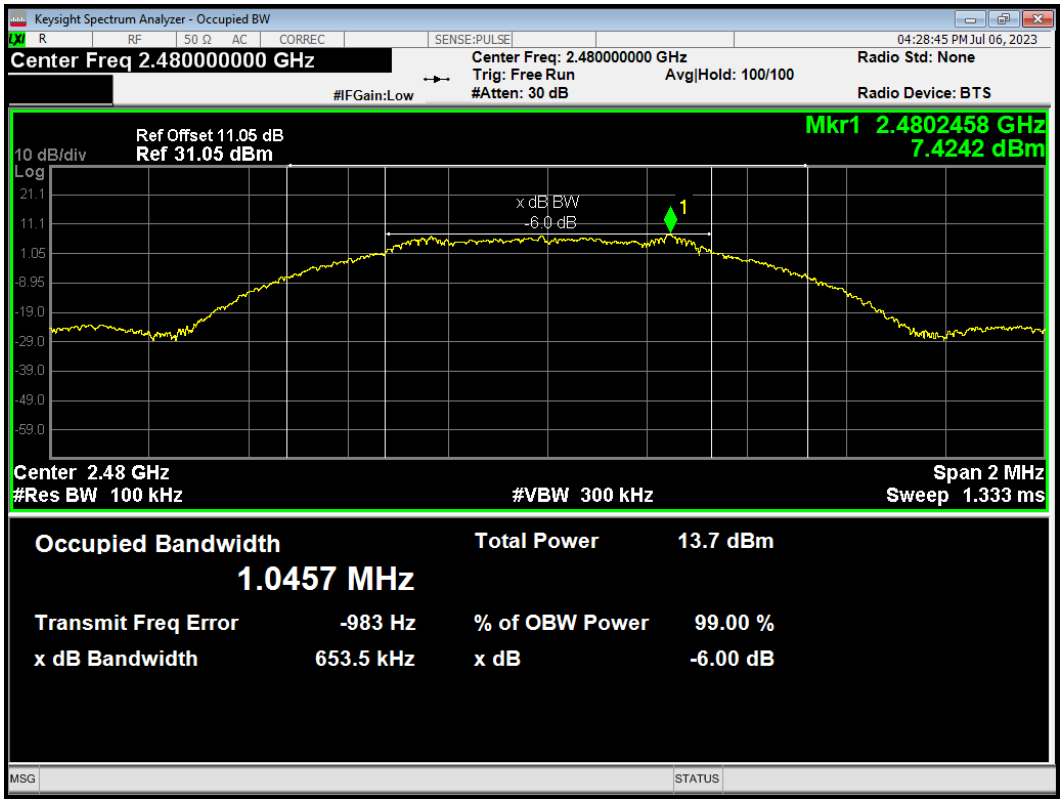
-6dB Bandwidth BLE (S=2) 2402MHz



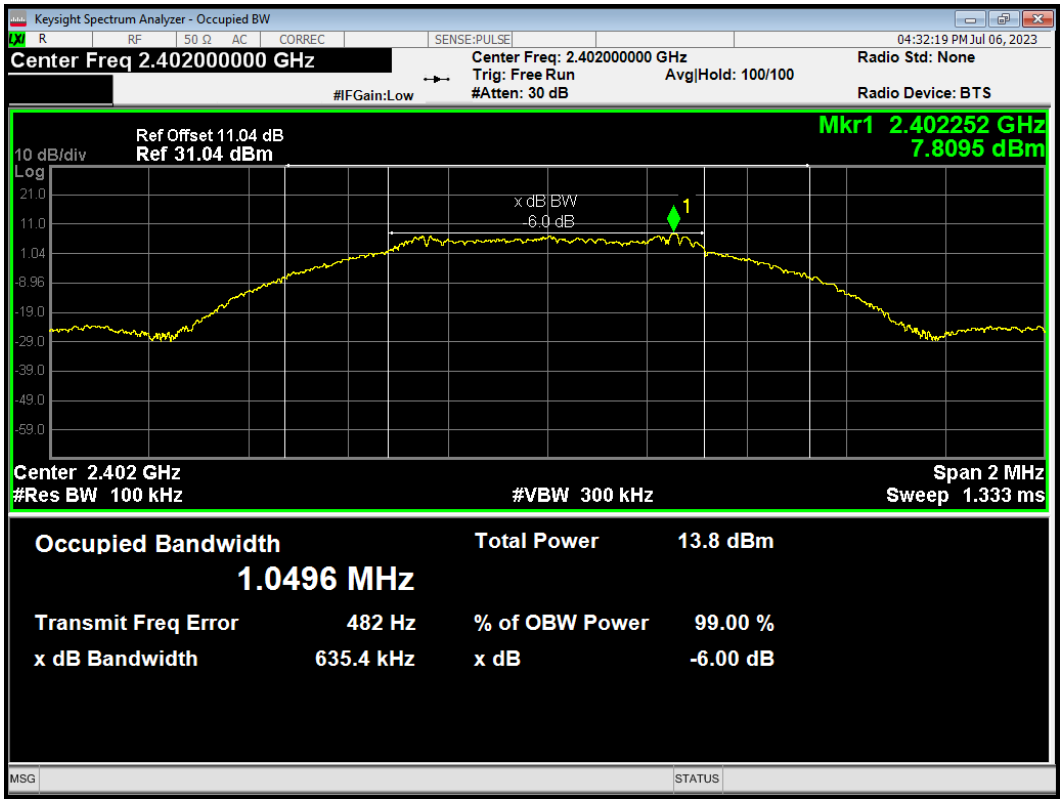
-6dB Bandwidth BLE (S=2) 2440MHz



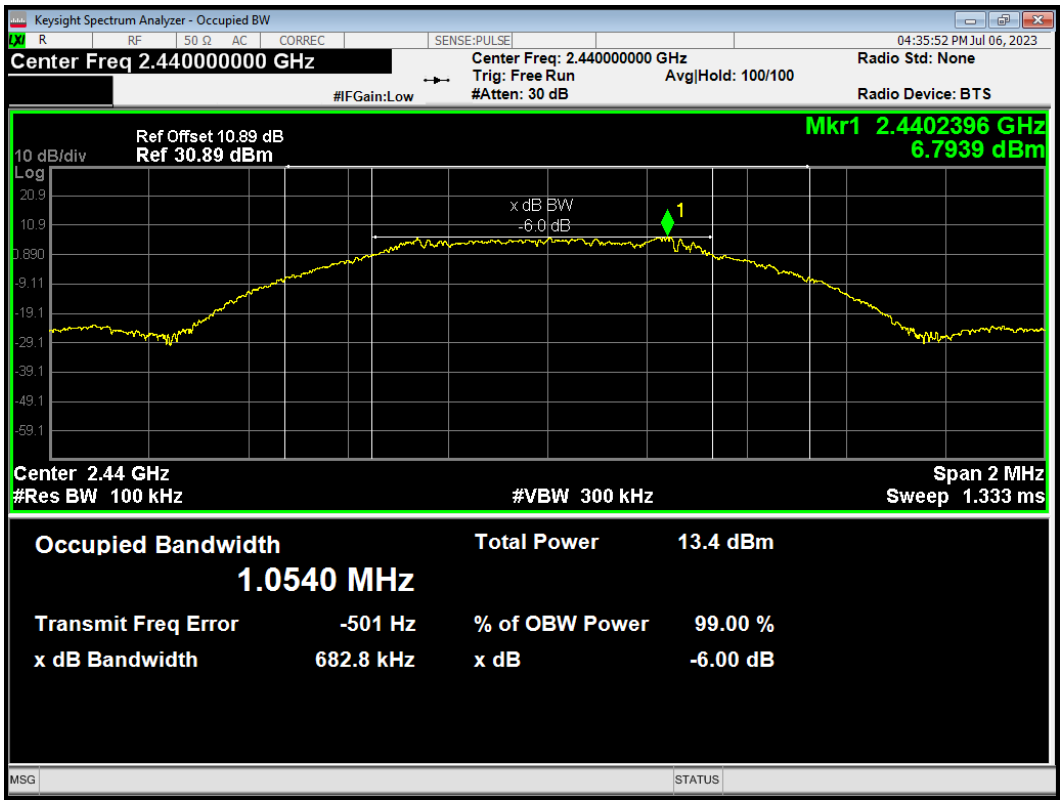
-6dB Bandwidth BLE (S=2) 2480MHz



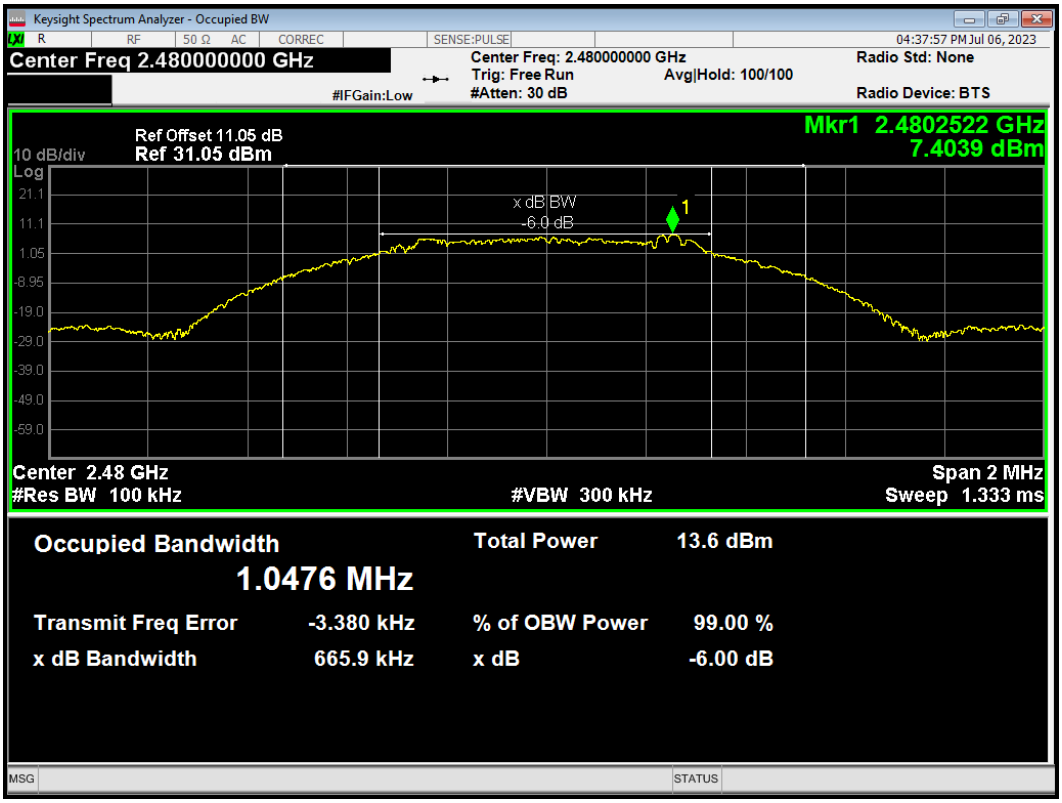
-6dB Bandwidth BLE (S=8) 2402MHz



-6dB Bandwidth BLE (S=8) 2440MHz



-6dB Bandwidth BLE (S=8) 2480MHz



5.3. Band Edge

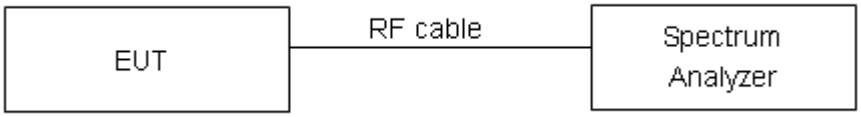
Ambient Condition

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.”

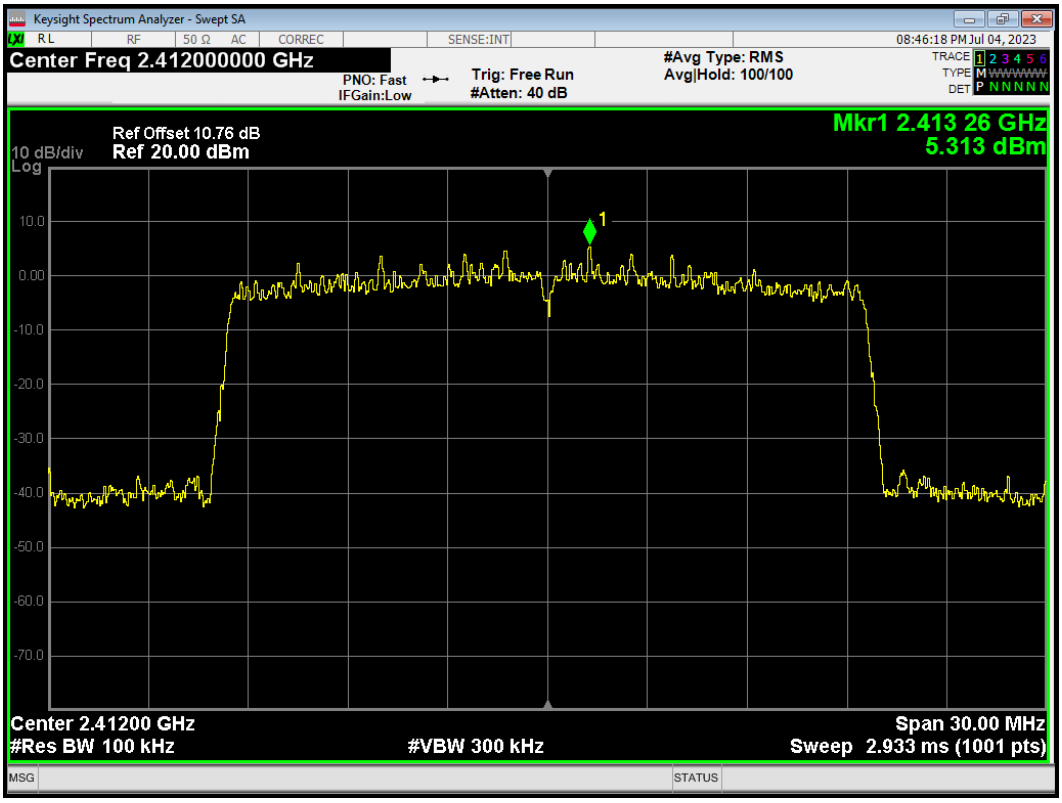
Measurement Uncertainty

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

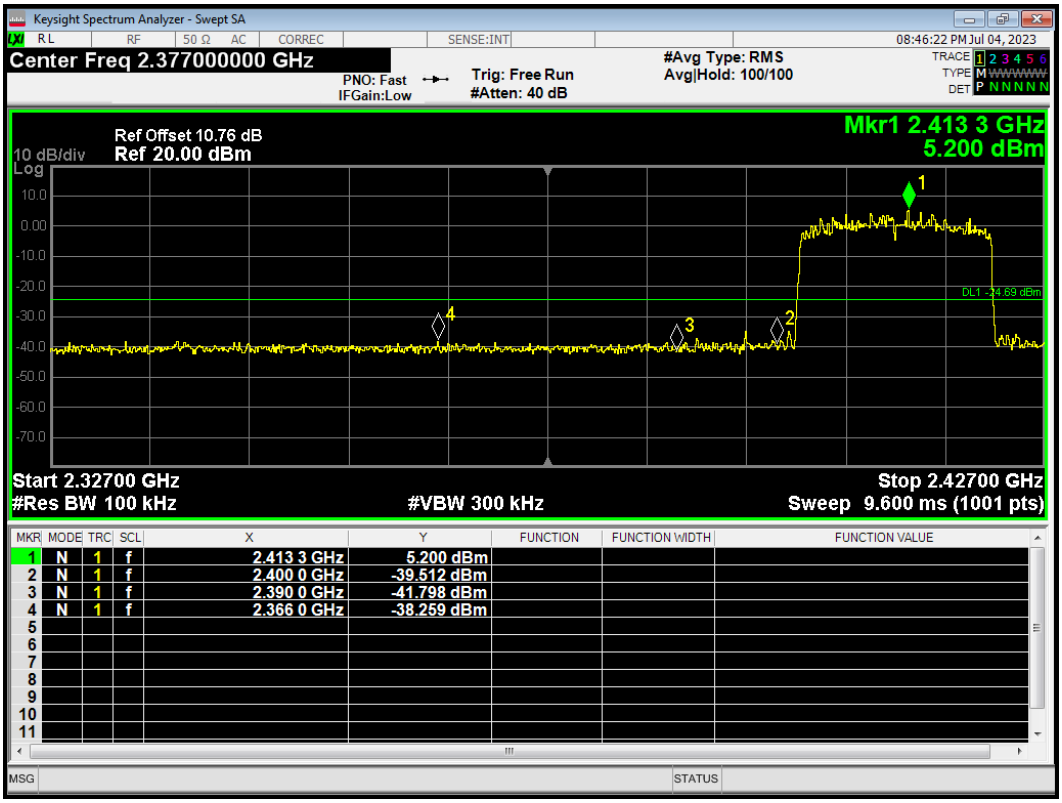
Frequency	Uncertainty
2GHz-3GHz	1.407 dB

Test Results: PASS

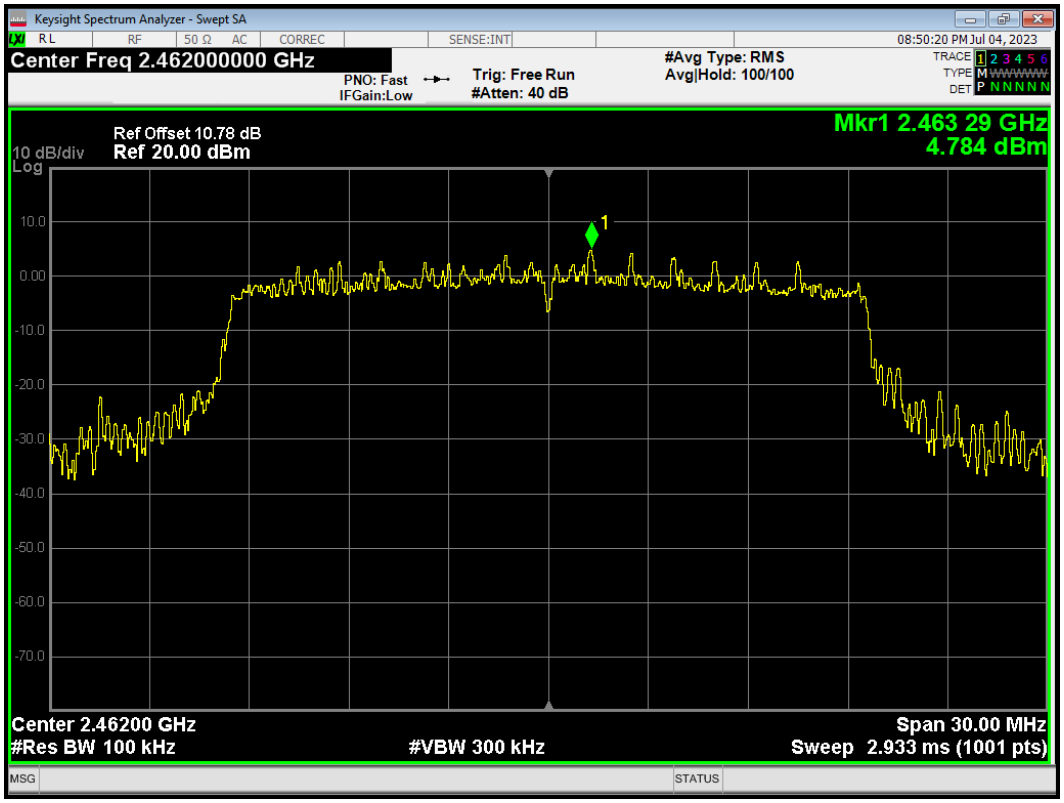
Band Edge 802.11ax(HE20) 2412MHz Ref



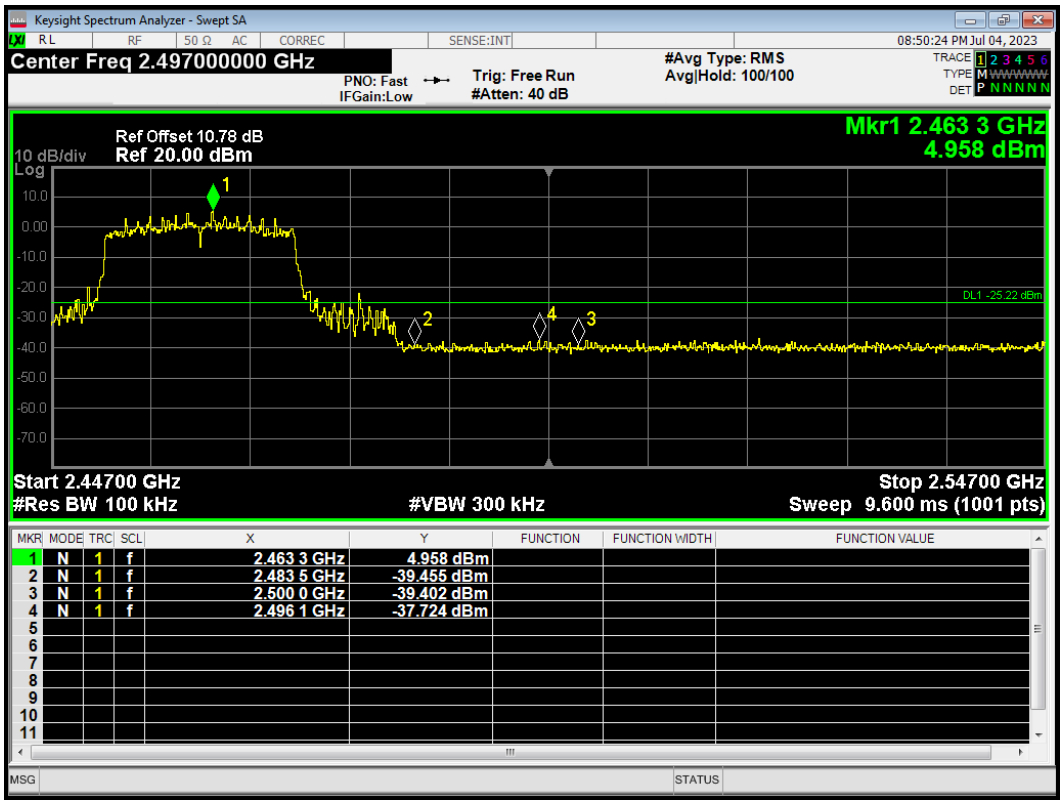
Band Edge 802.11ax(HE20) 2412MHz Emission



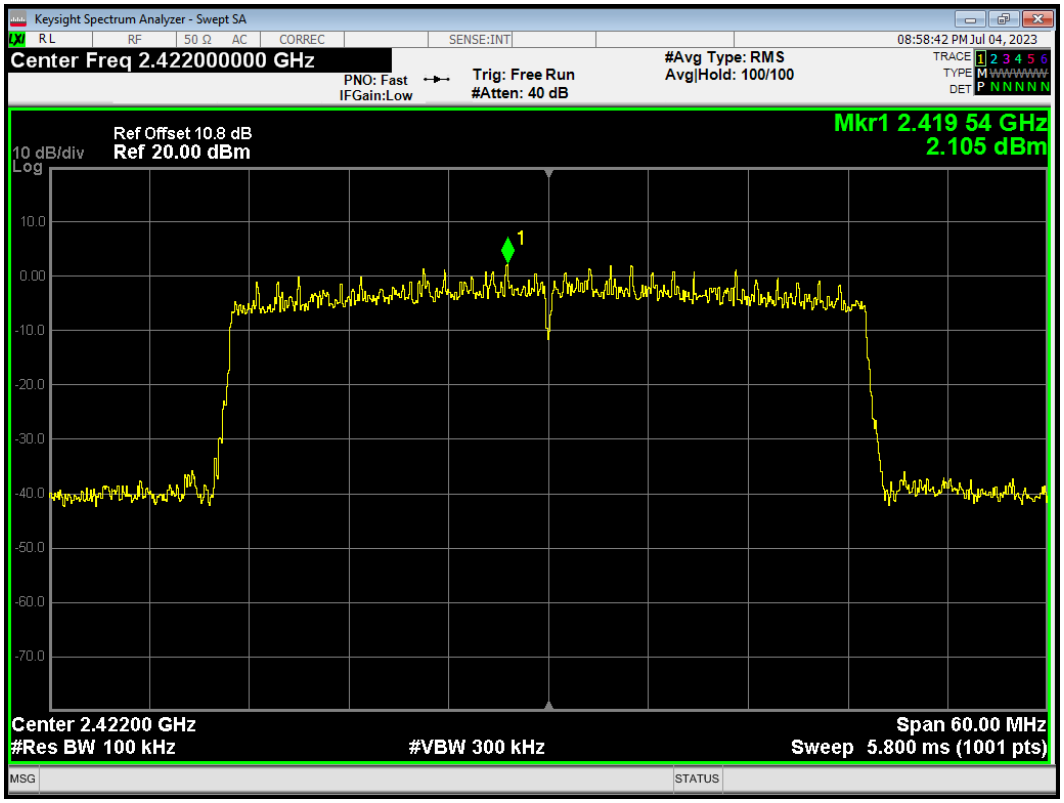
Band Edge 802.11ax(HE20) 2462MHz Ref



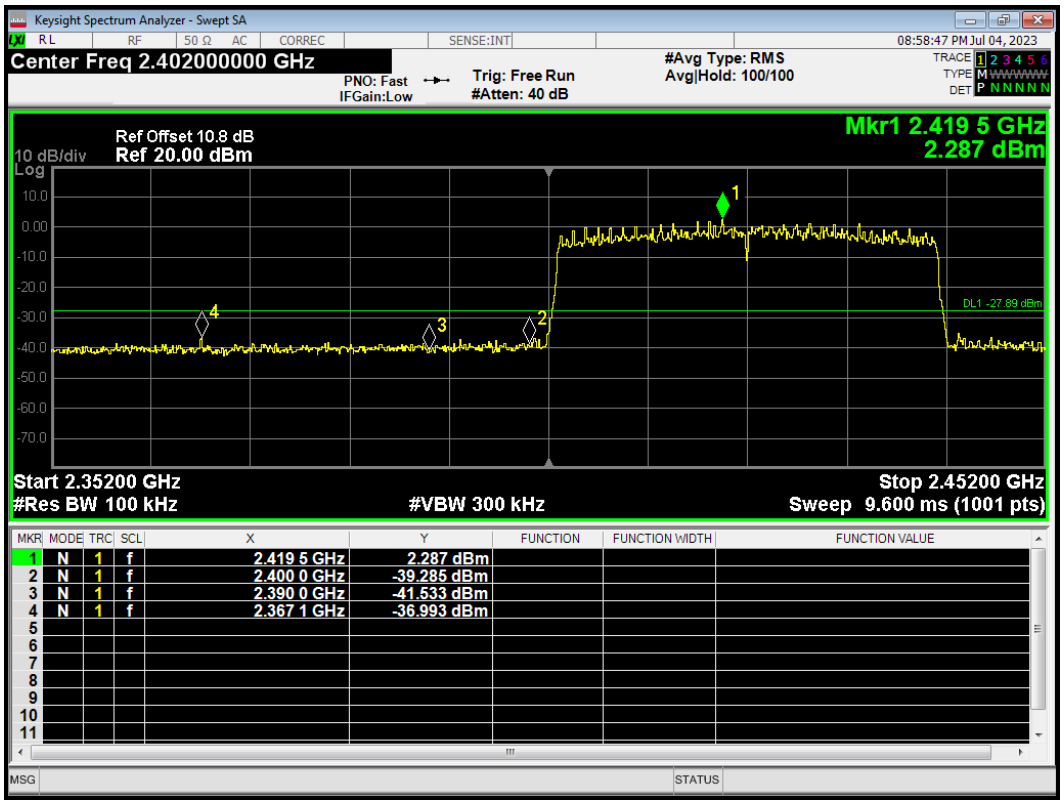
Band Edge 802.11ax(HE20) 2462MHz Emission



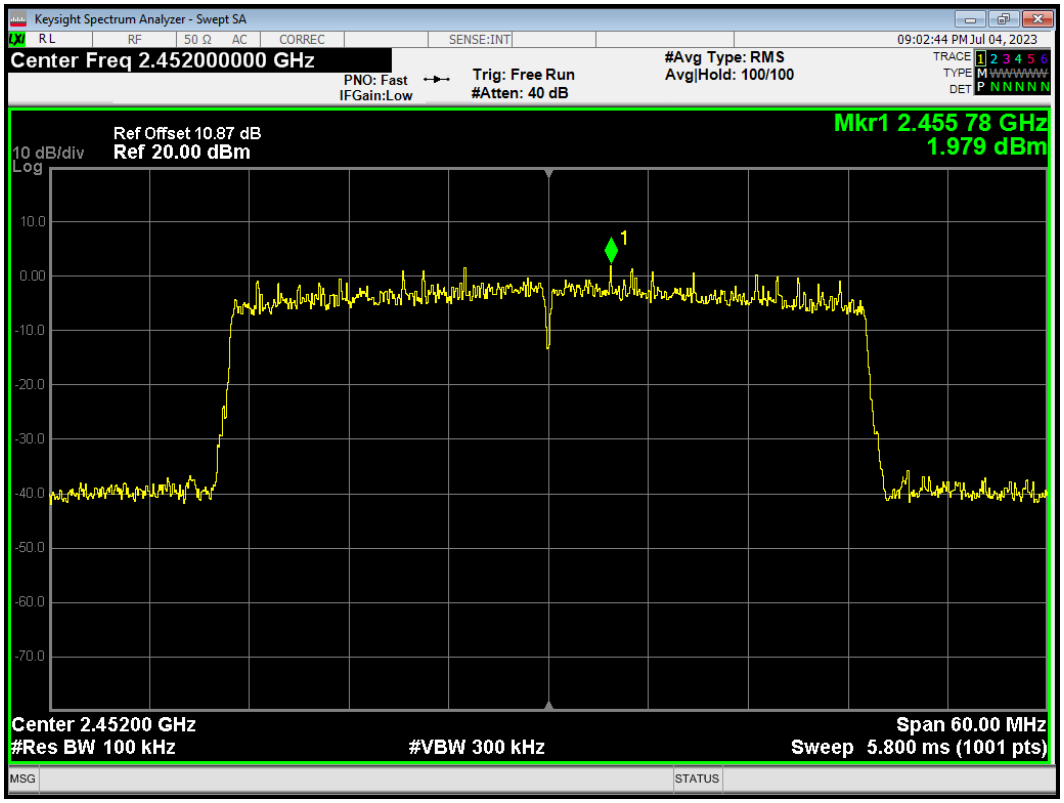
Band Edge 802.11ax(HE40) 2422MHz Ref



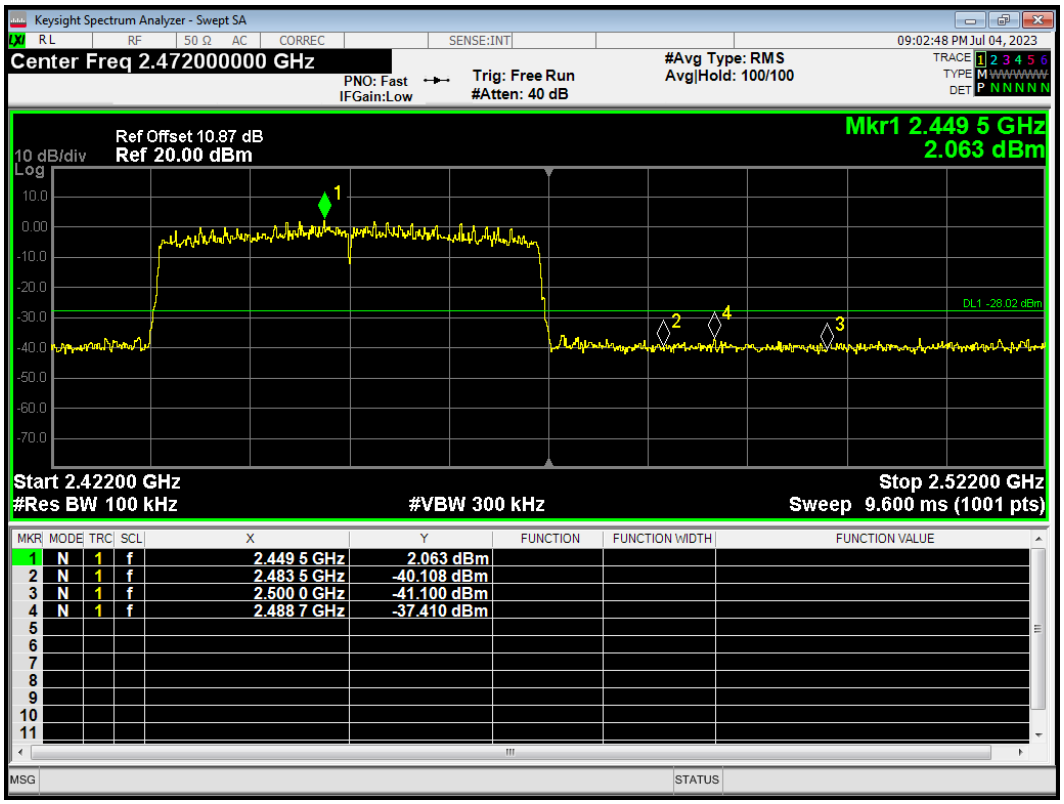
Band Edge 802.11ax(HE40) 2422MHz Emission



Band Edge 802.11ax(HE40) 2452MHz Ref

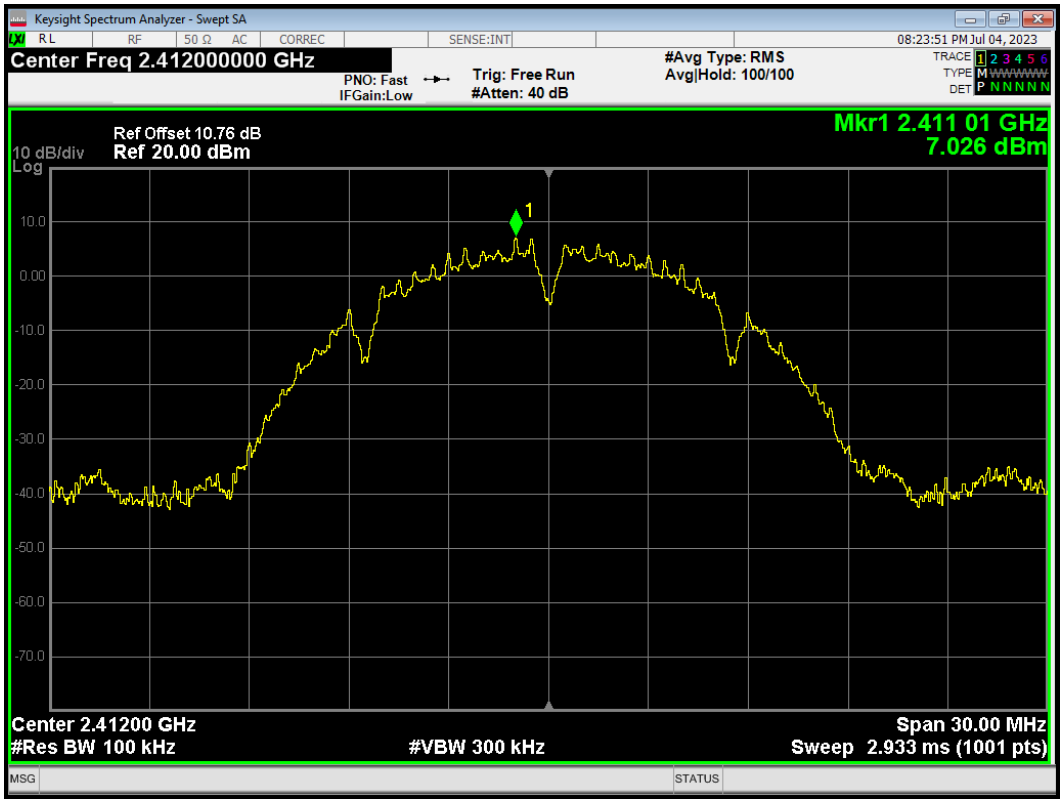


Band Edge 802.11ax(HE40) 2452MHz Emission

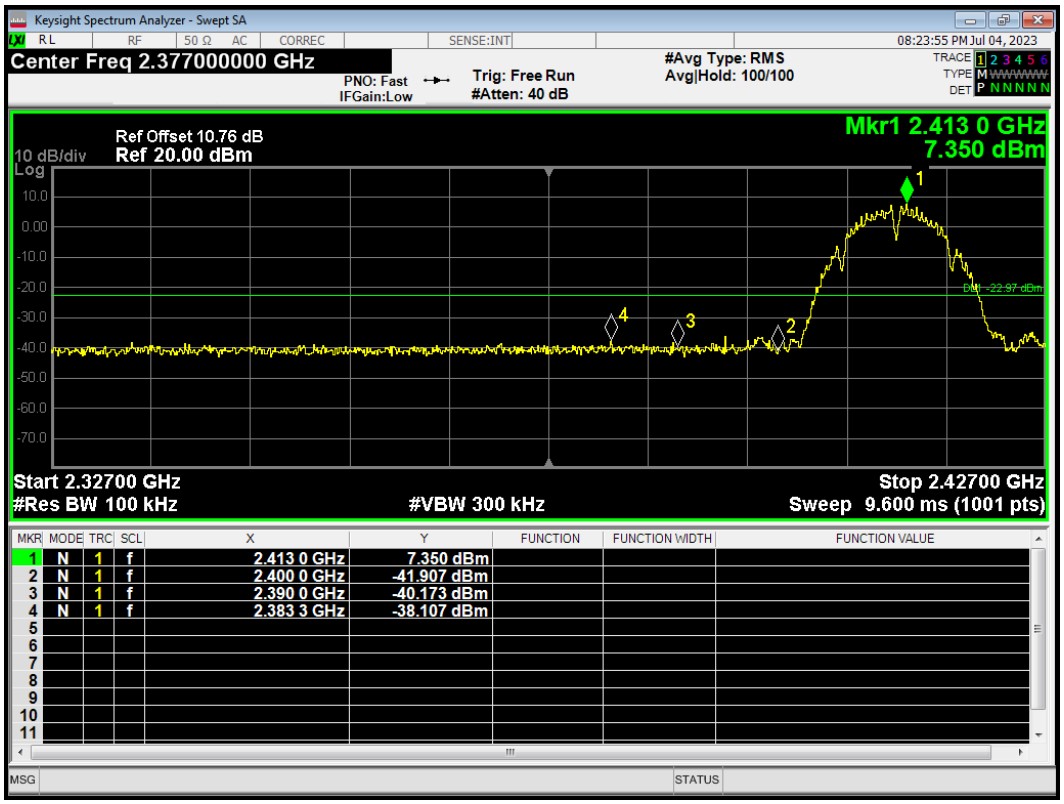


MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.449 5 GHz	2.063 dBm			
2	N	1	f	2.483 5 GHz	-40.108 dBm			
3	N	1	f	2.500 0 GHz	-41.100 dBm			
4	N	1	f	2.488 7 GHz	-37.410 dBm			

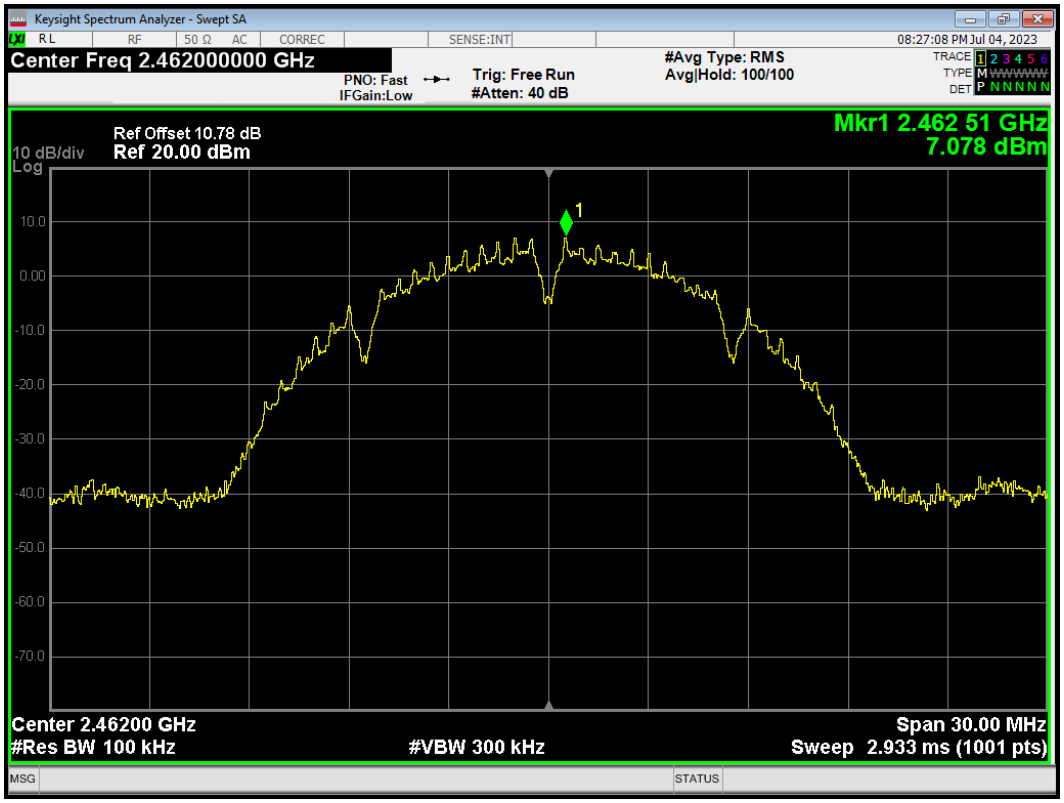
Band Edge 802.11b 2412MHz Ref



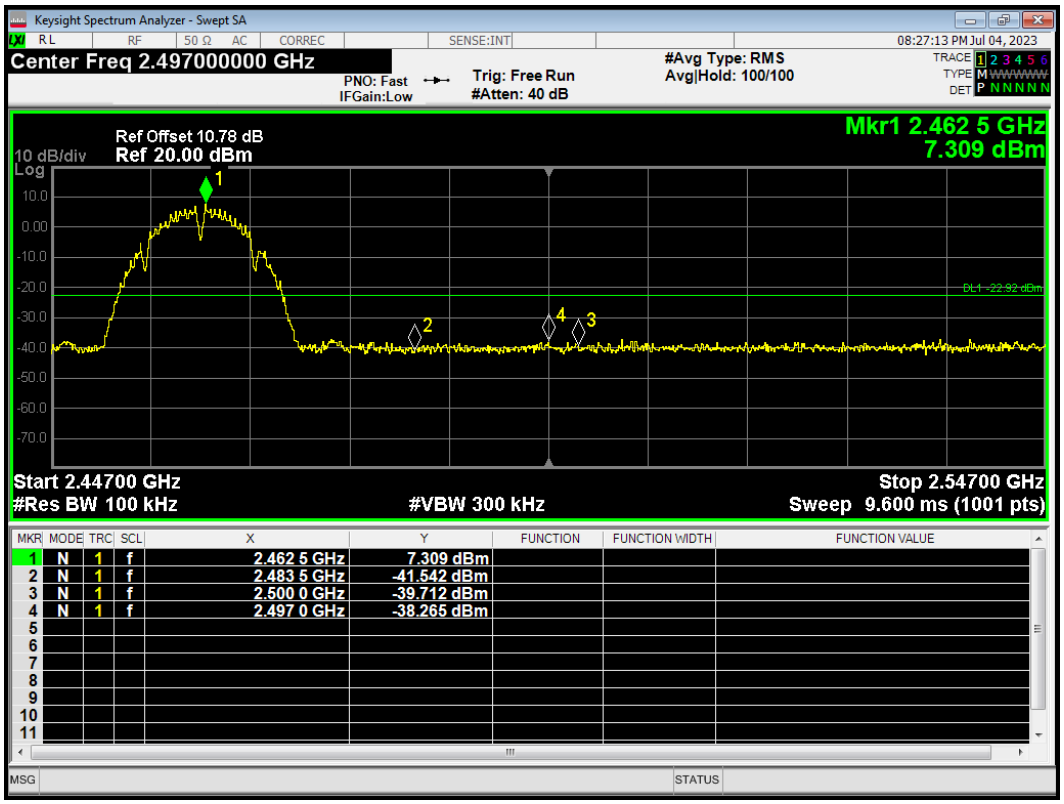
Band Edge 802.11b 2412MHz Emission



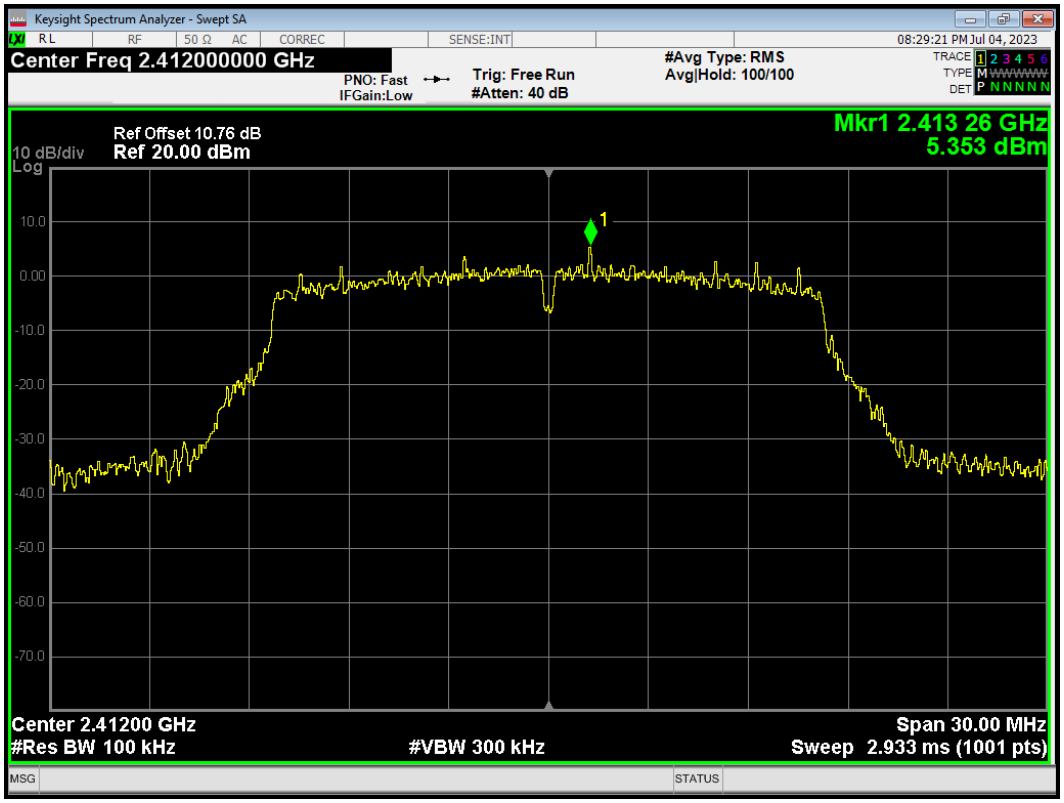
Band Edge 802.11b 2462MHz Ref



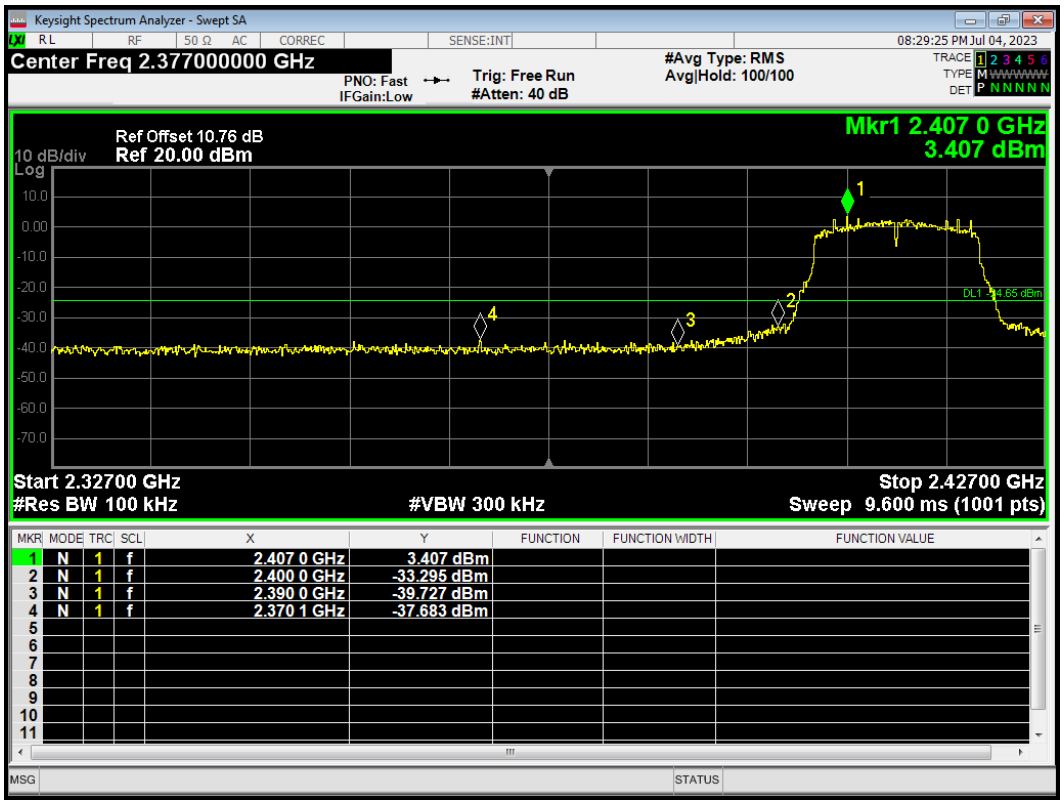
Band Edge 802.11b 2462MHz Emission



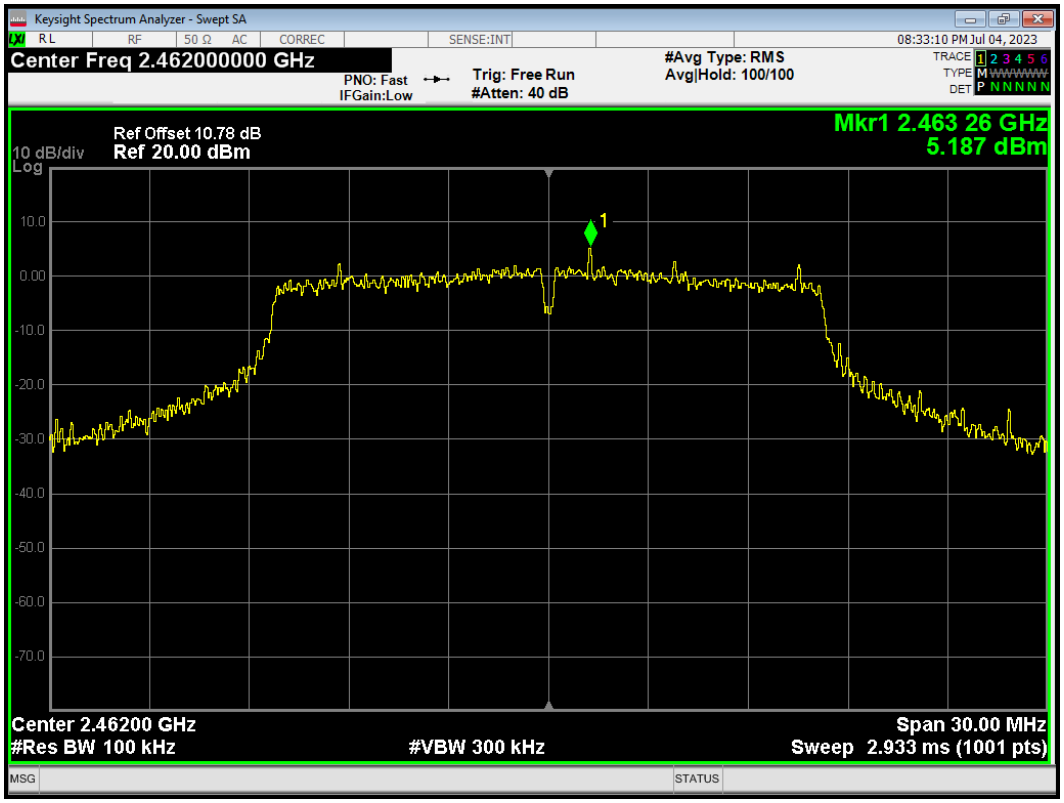
Band Edge 802.11g 2412MHz Ref



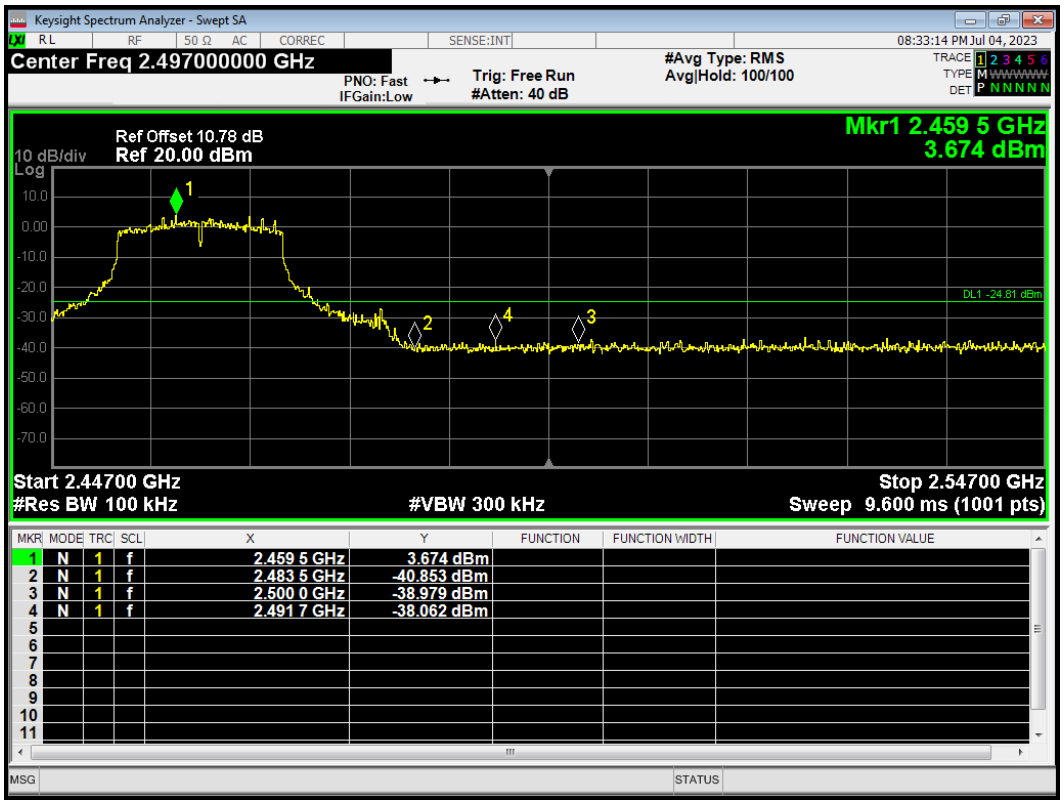
Band Edge 802.11g 2412MHz Emission



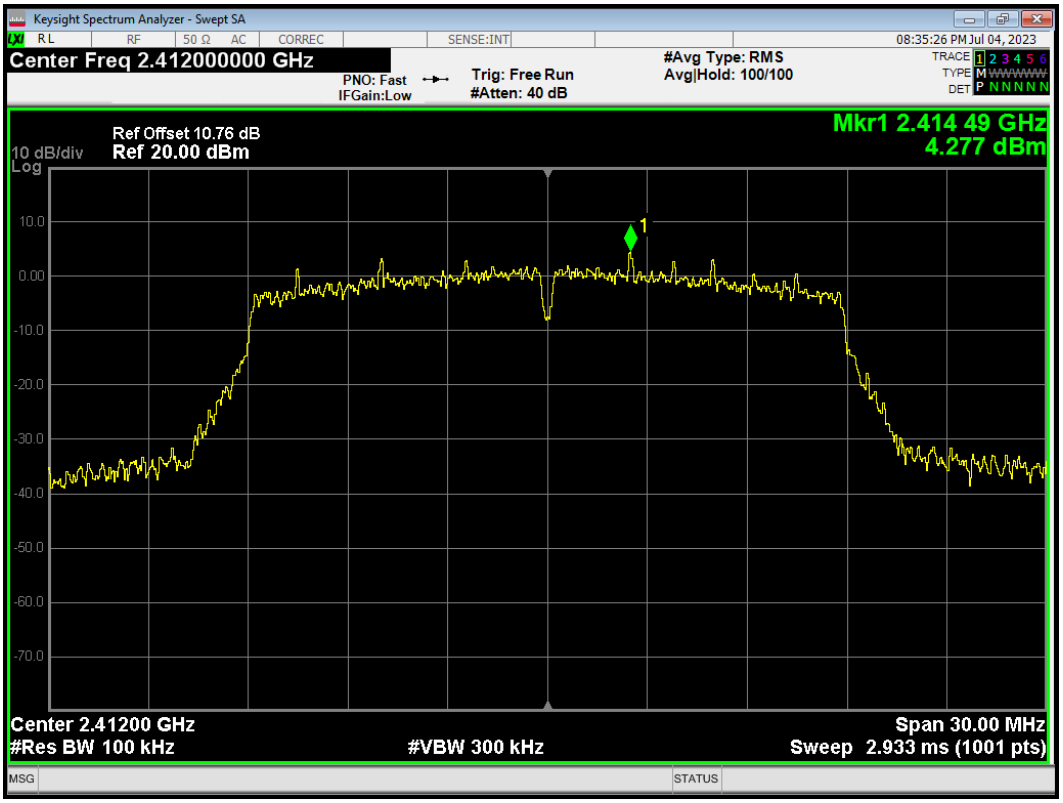
Band Edge 802.11g 2462MHz Ref



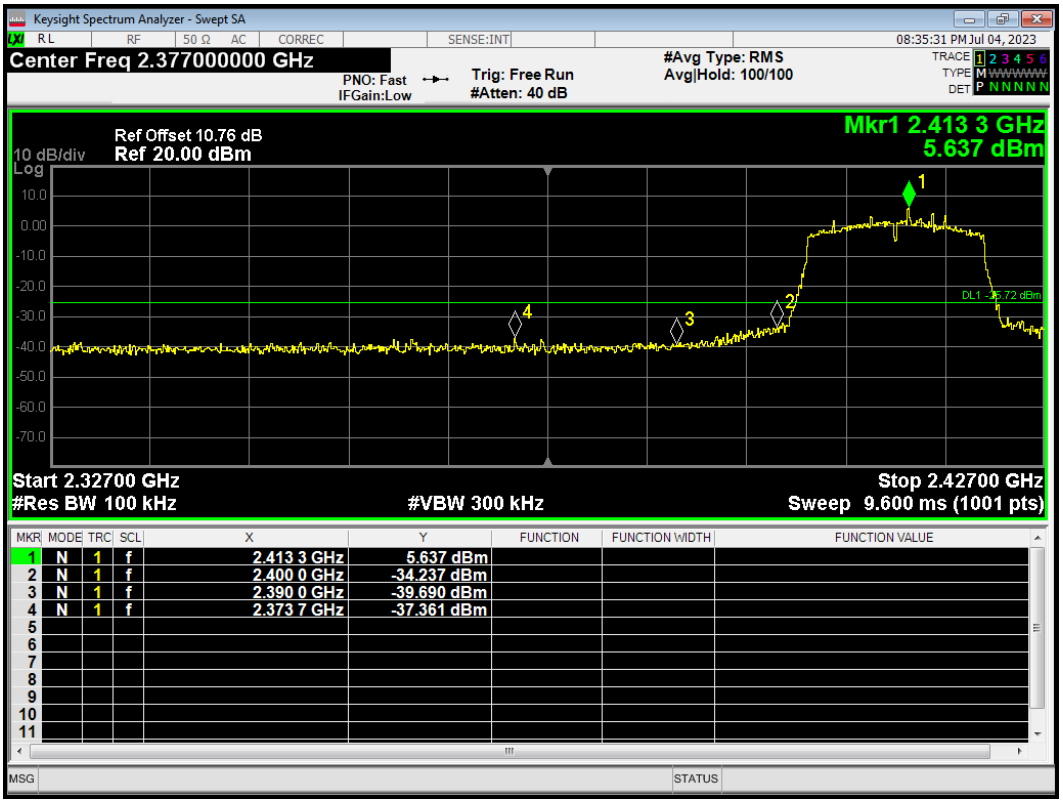
Band Edge 802.11g 2462MHz Emission



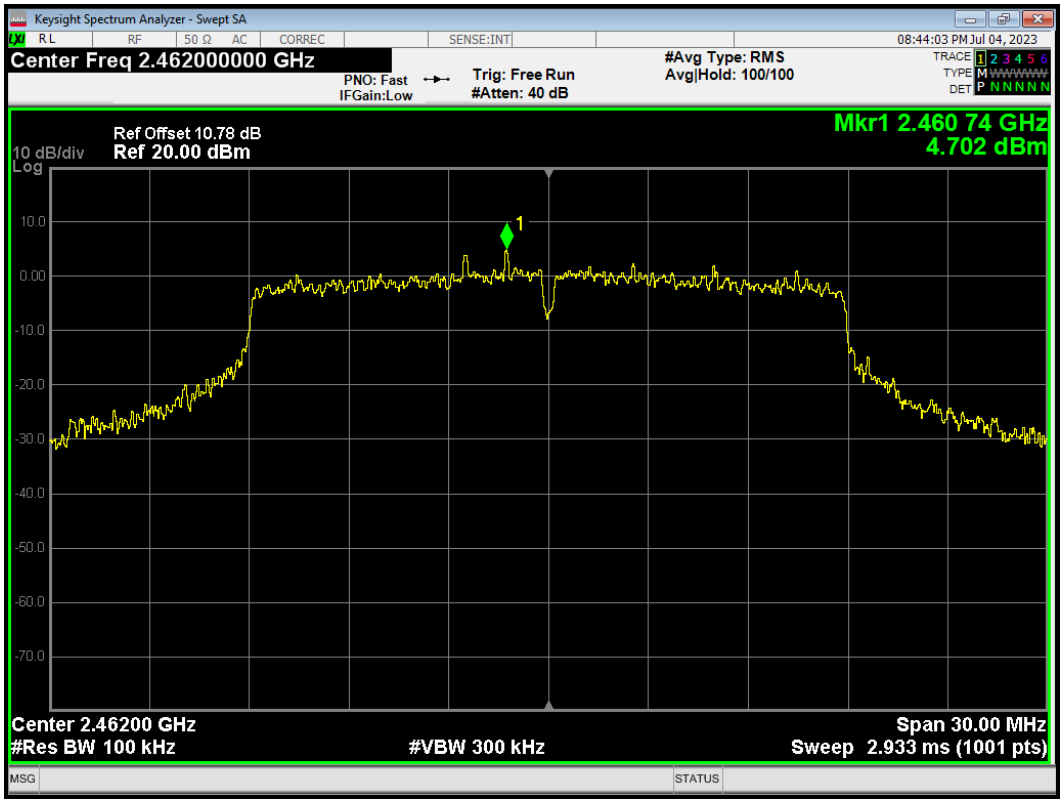
Band Edge 802.11n(HT20) 2412MHz Ref



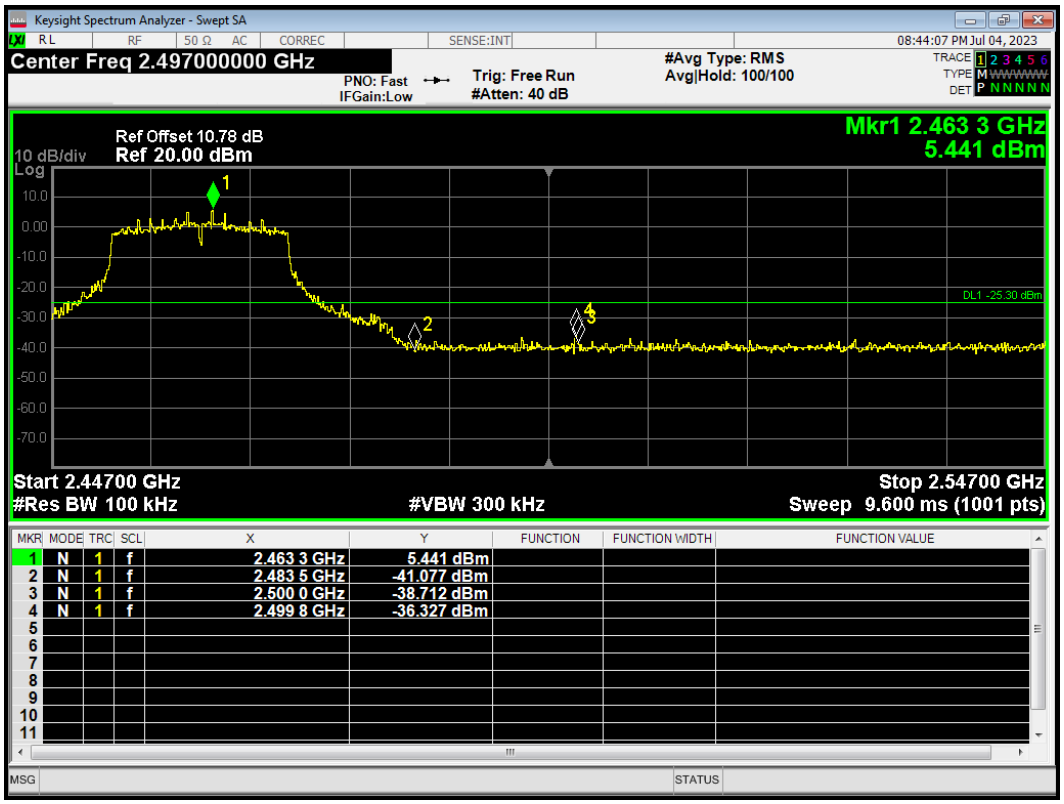
Band Edge 802.11n(HT20) 2412MHz Emission



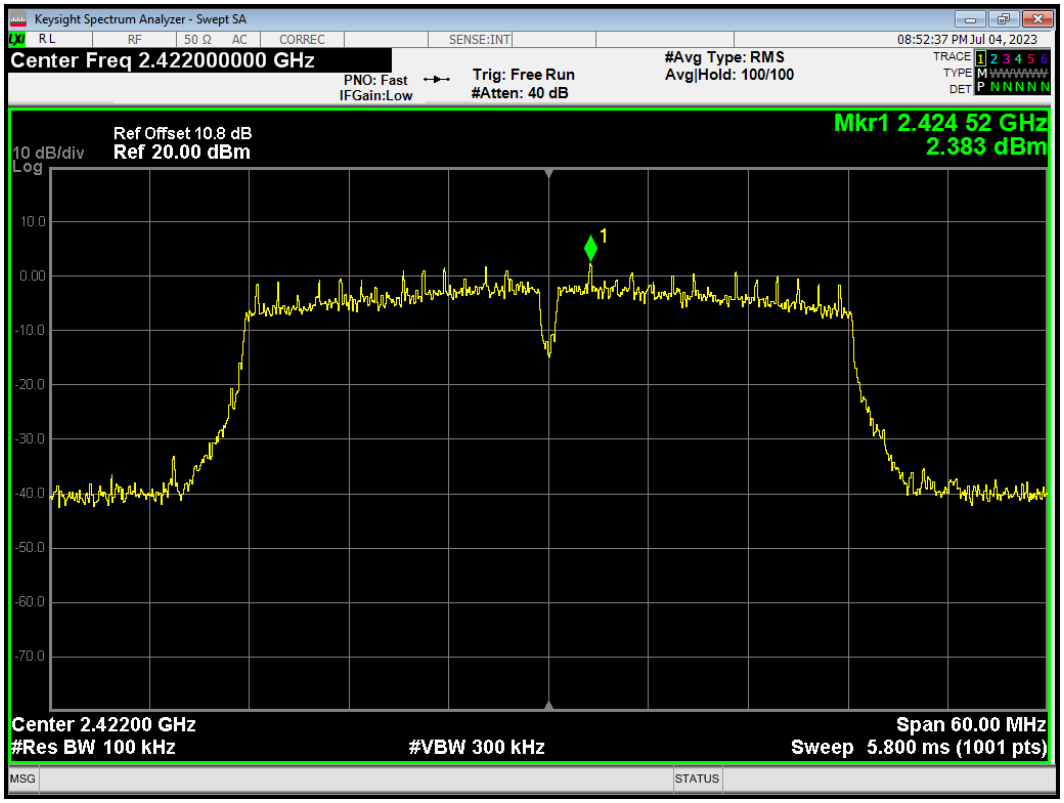
Band Edge 802.11n(HT20) 2462MHz Ref



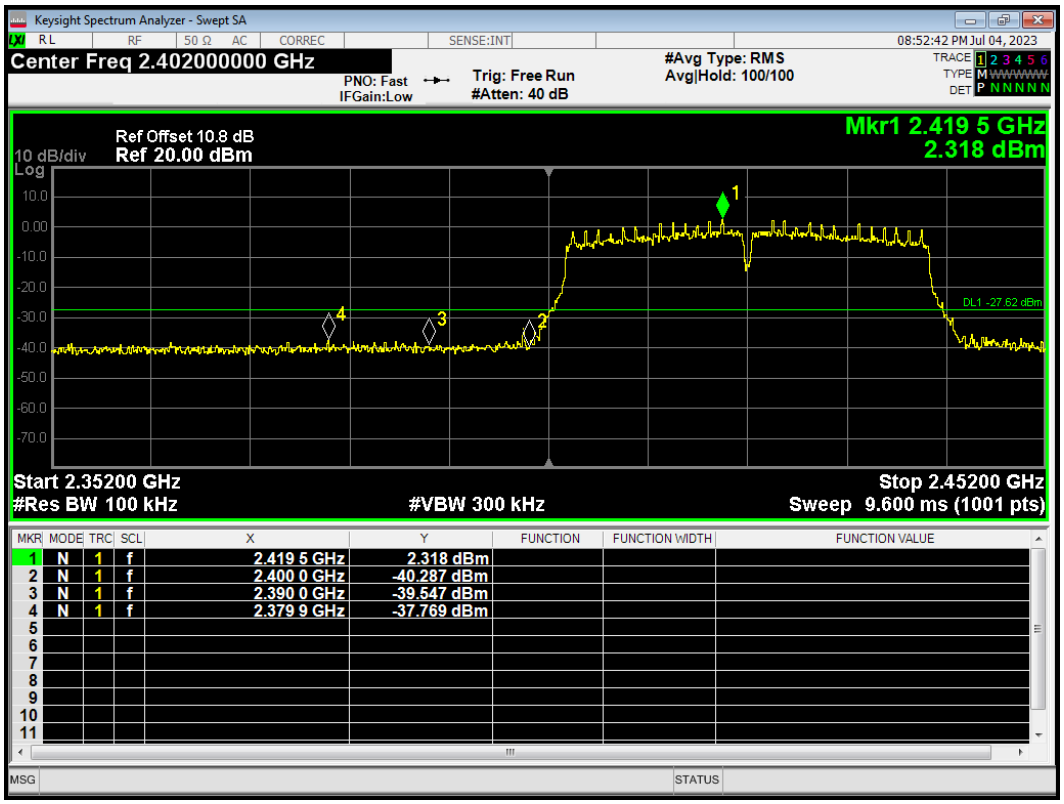
Band Edge 802.11n(HT20) 2462MHz Emission



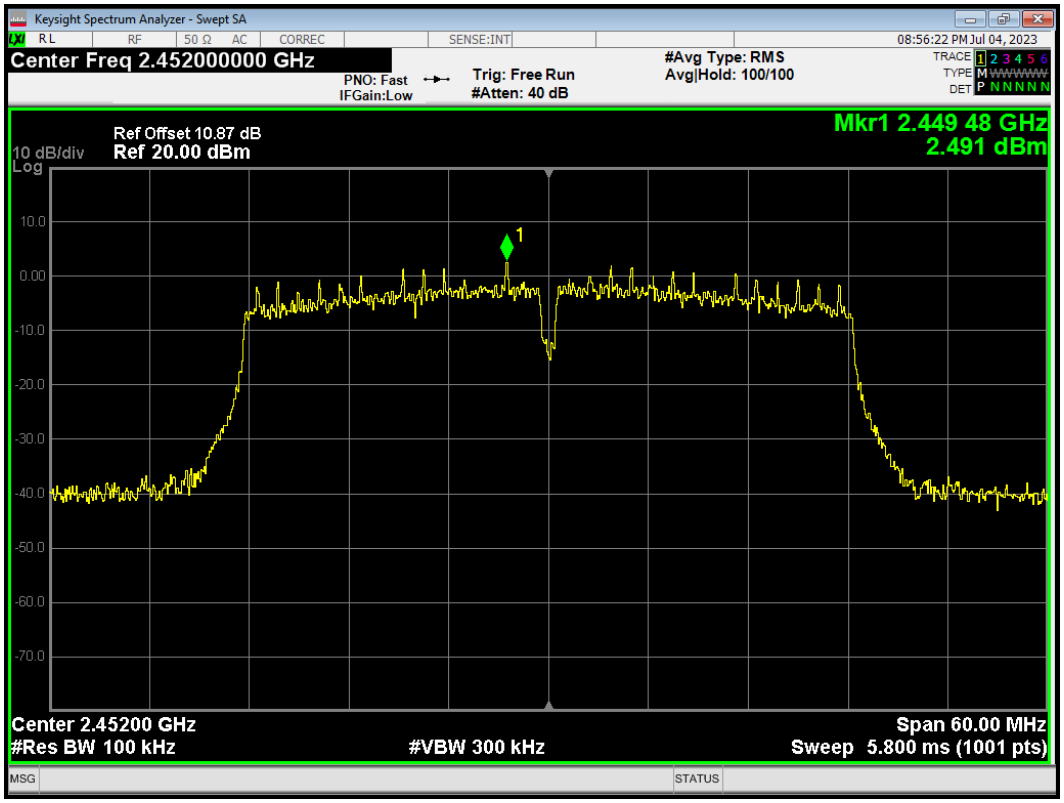
Band Edge 802.11n(HT40) 2422MHz Ref



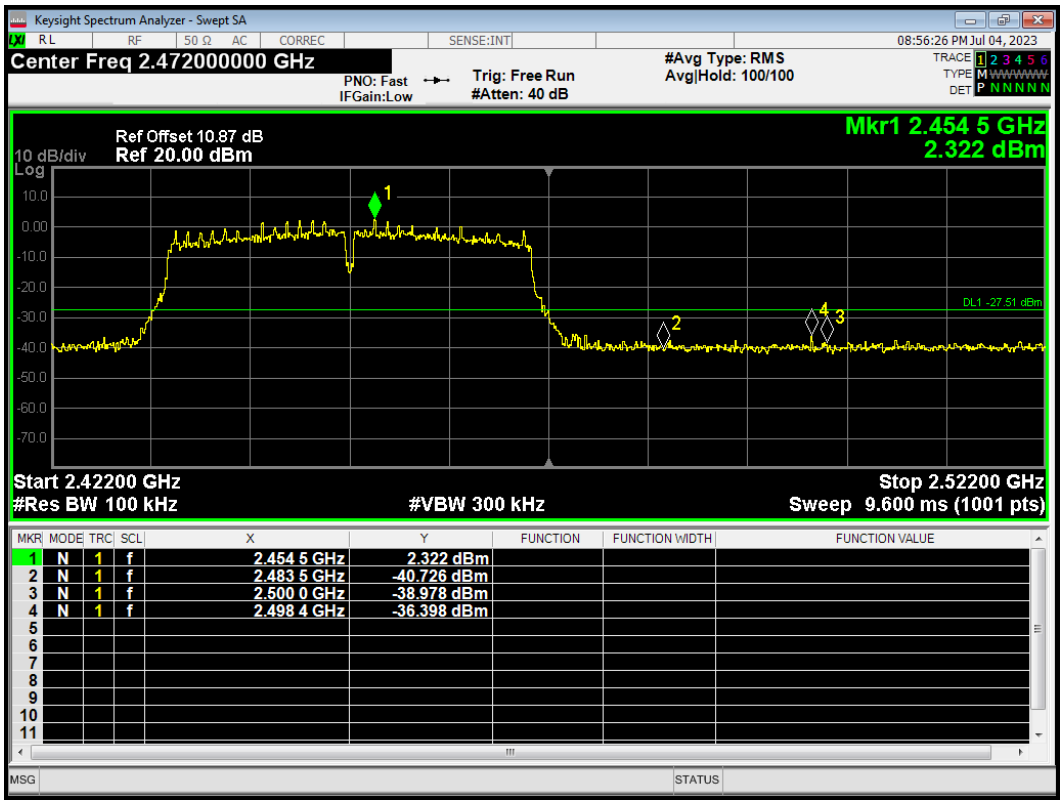
Band Edge 802.11n(HT40) 2422MHz Emission



Band Edge 802.11n(HT40) 2452MHz Ref

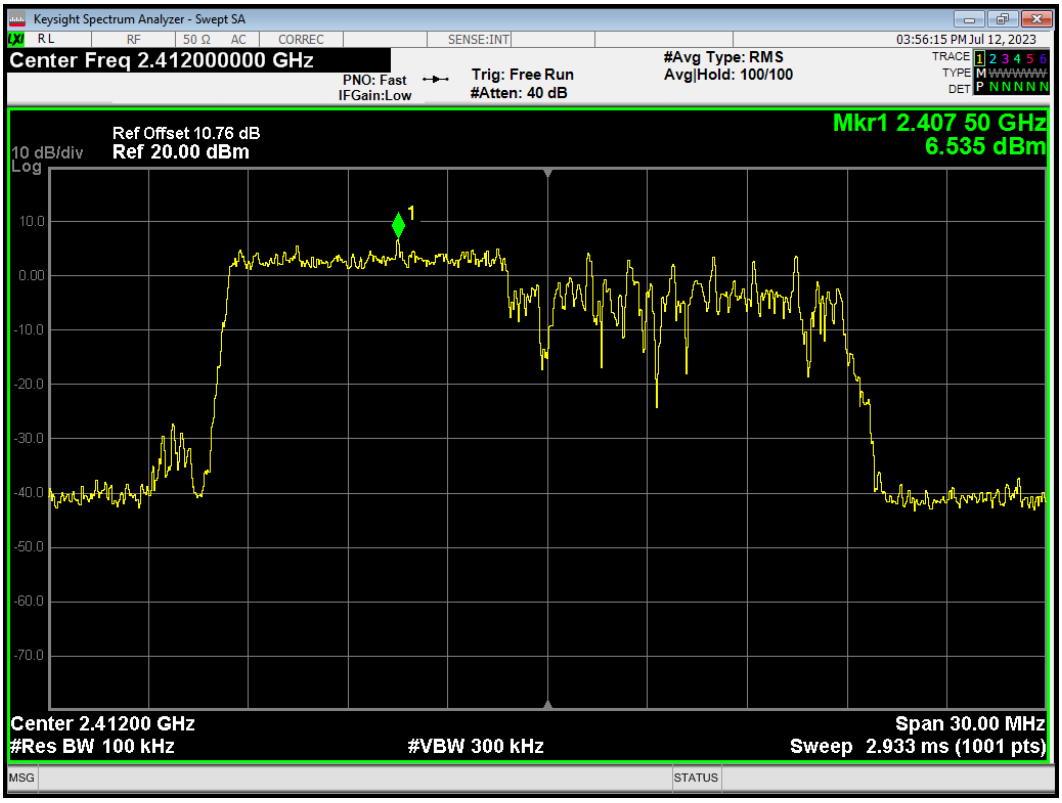


Band Edge 802.11n(HT40) 2452MHz Emission

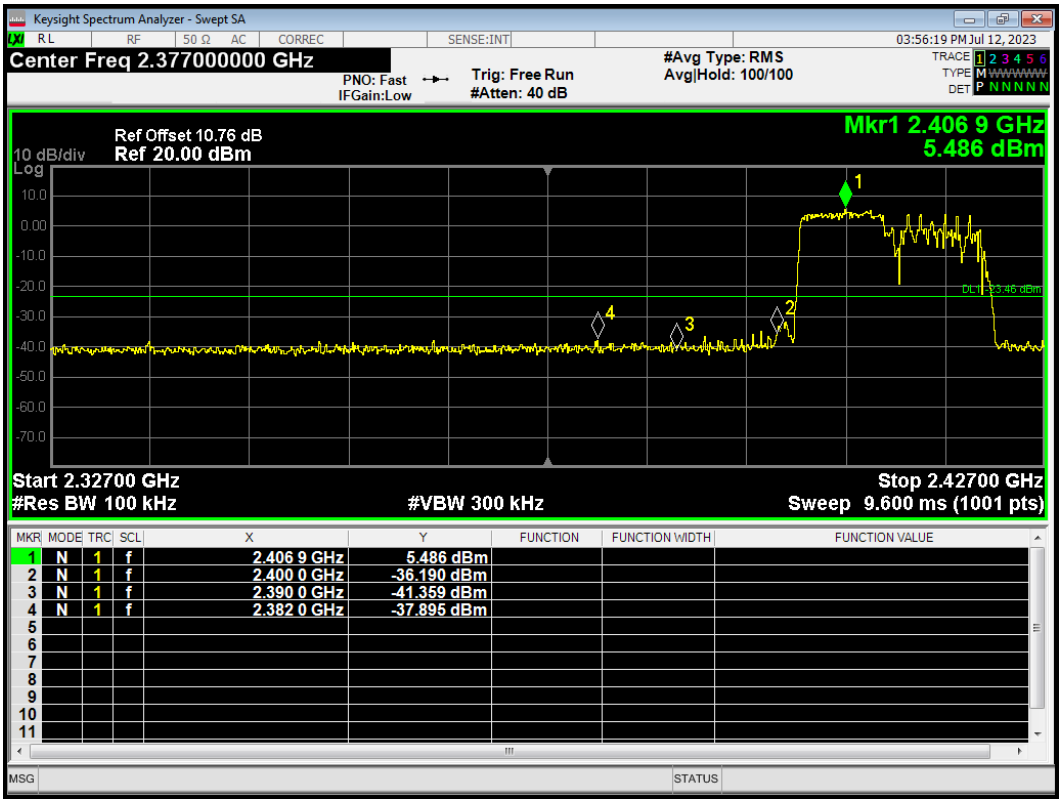


TB Mode

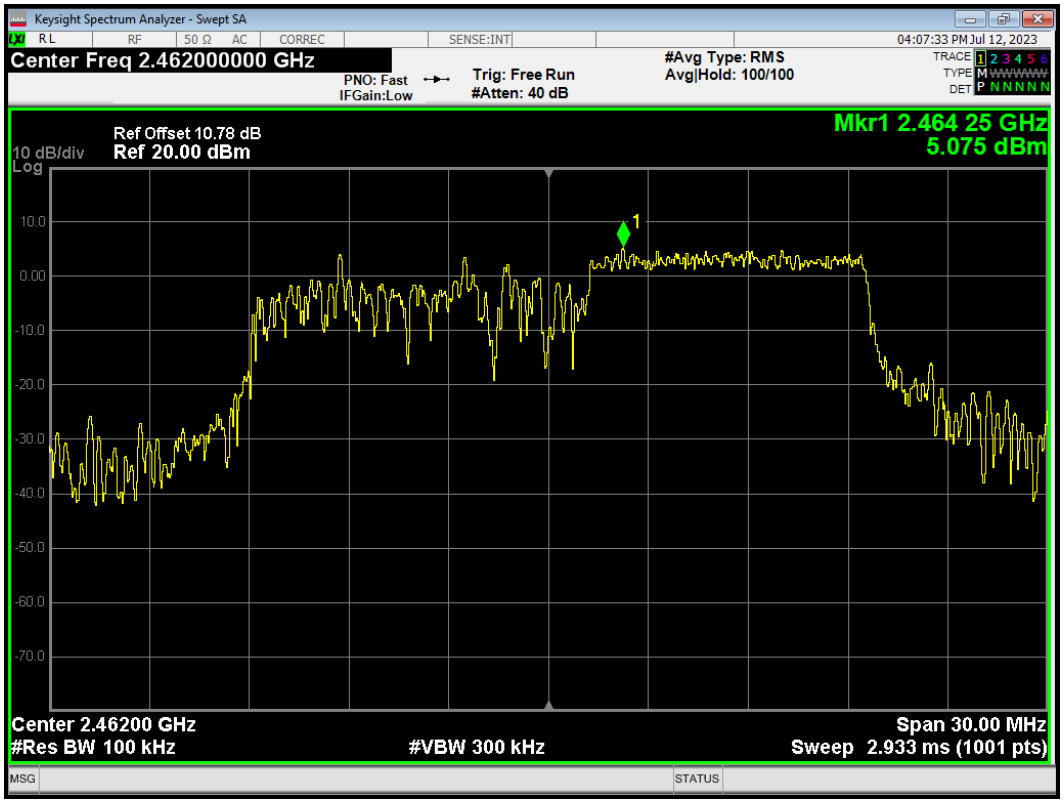
Band Edge 802.11ax (20M) RU106 IDX53 2412MHz Ref



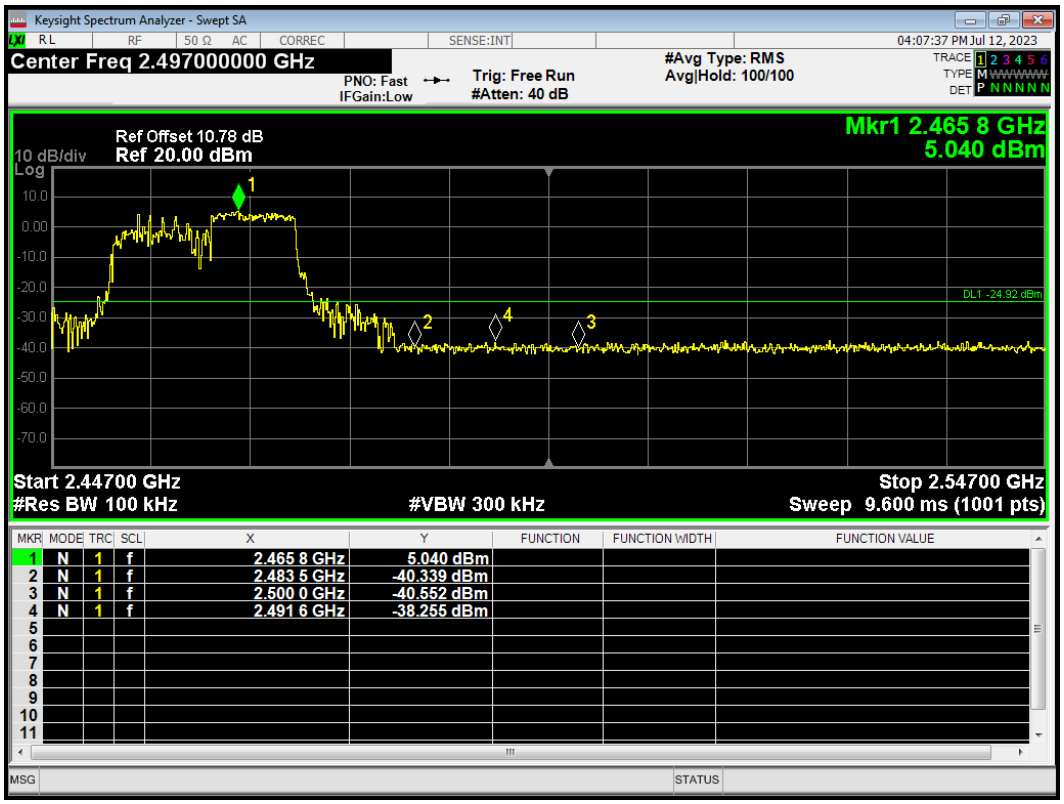
Band Edge 802.11ax (20M) RU106 IDX53 2412MHz Emission



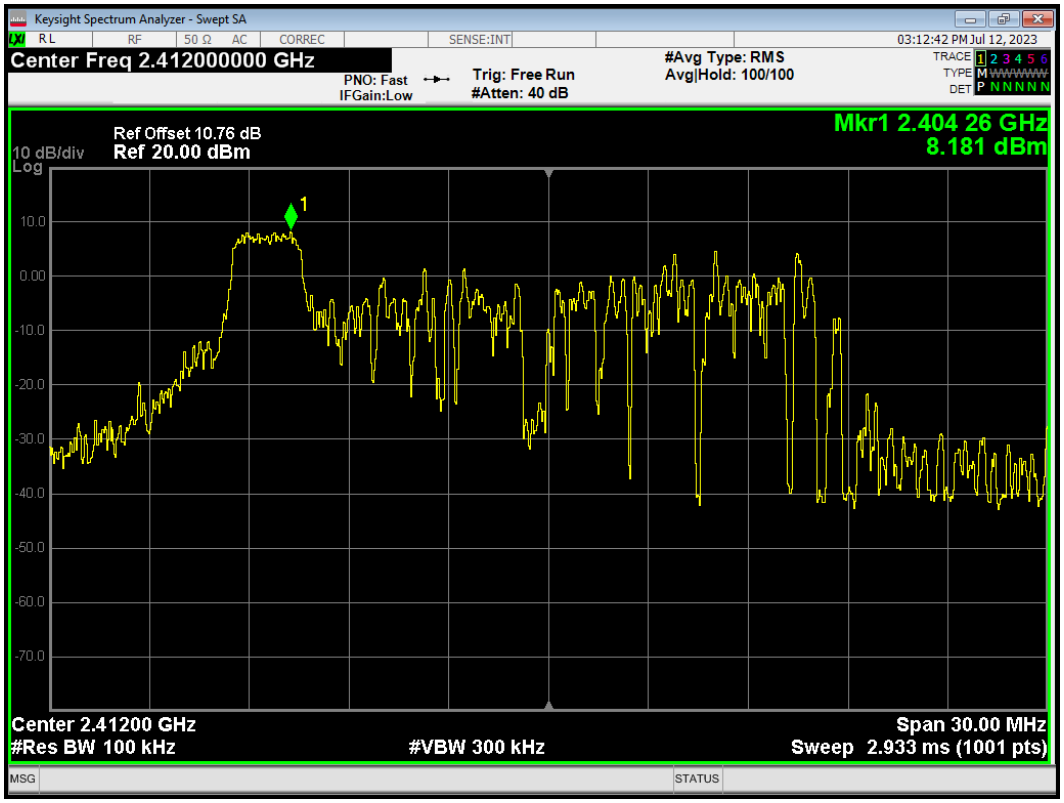
Band Edge 802.11ax (20M) RU106 IDX54 2462MHz Ref



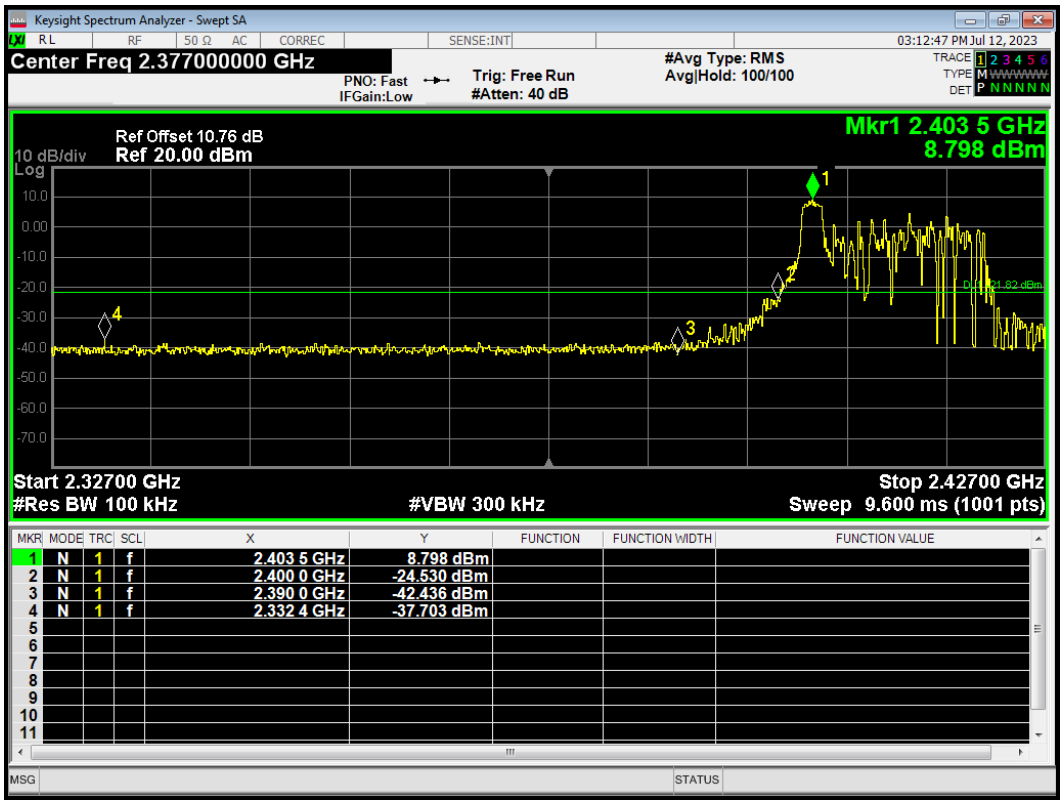
Band Edge 802.11ax (20M) RU106 IDX54 2462MHz Emission



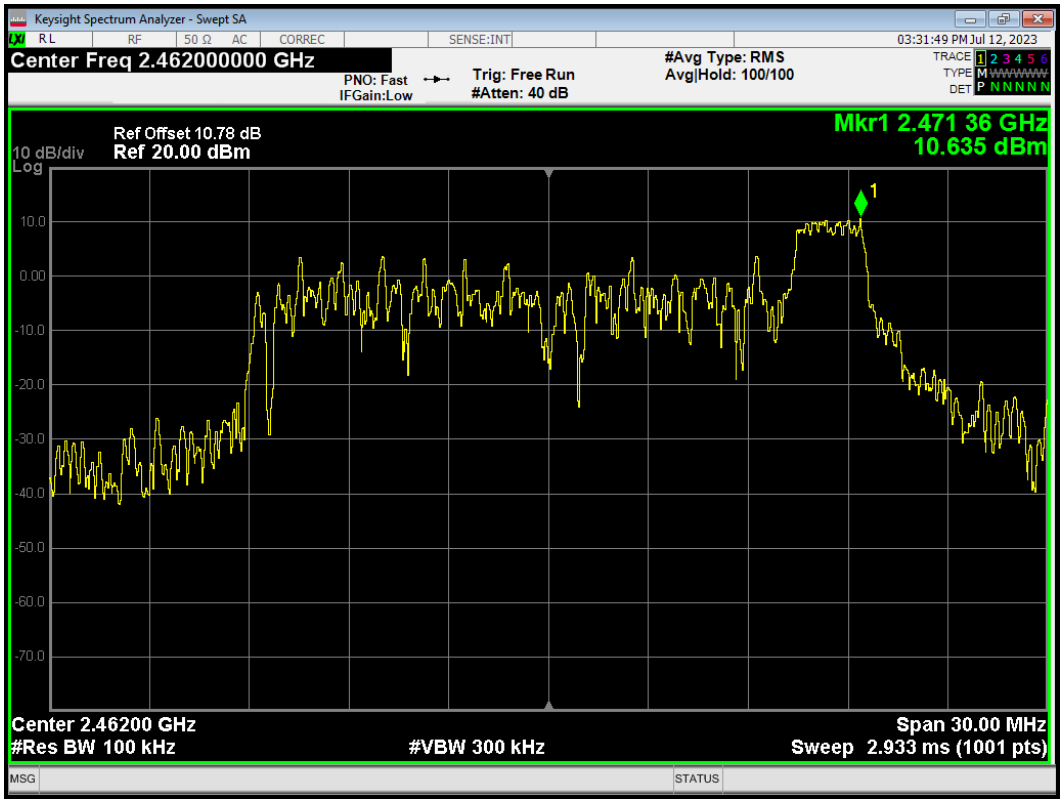
Band Edge 802.11ax (20M) RU26 IDX0 2412MHz Ref



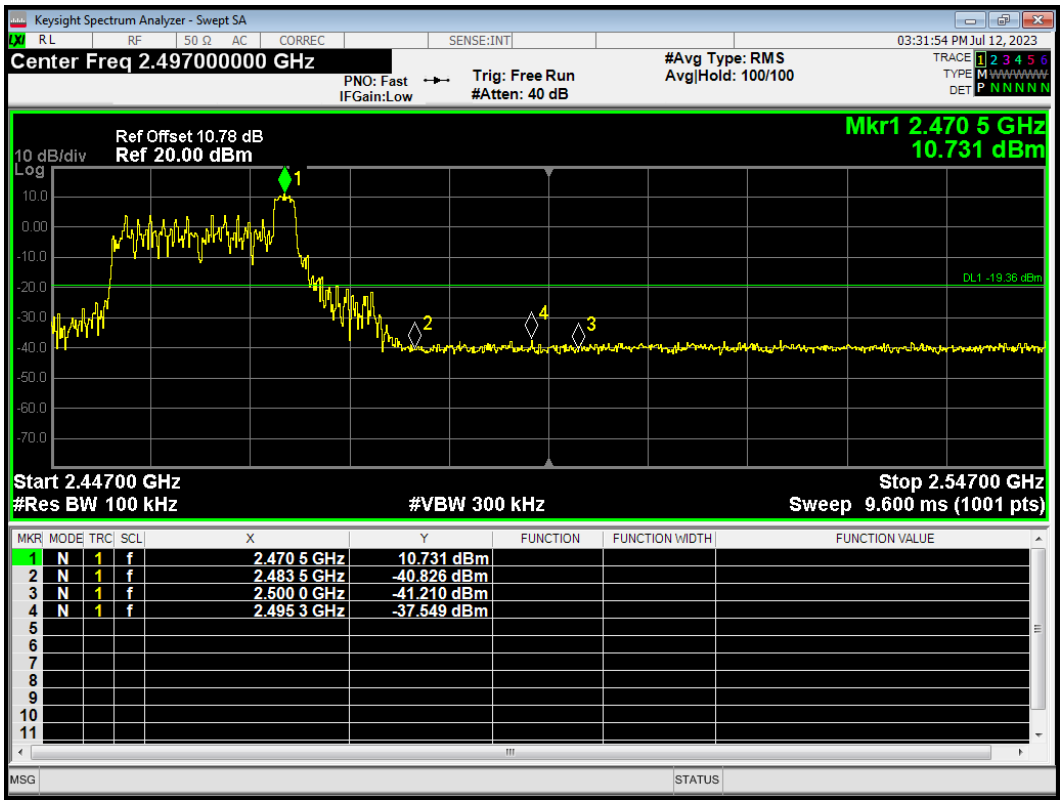
Band Edge 802.11ax (20M) RU26 IDX0 2412MHz Emission



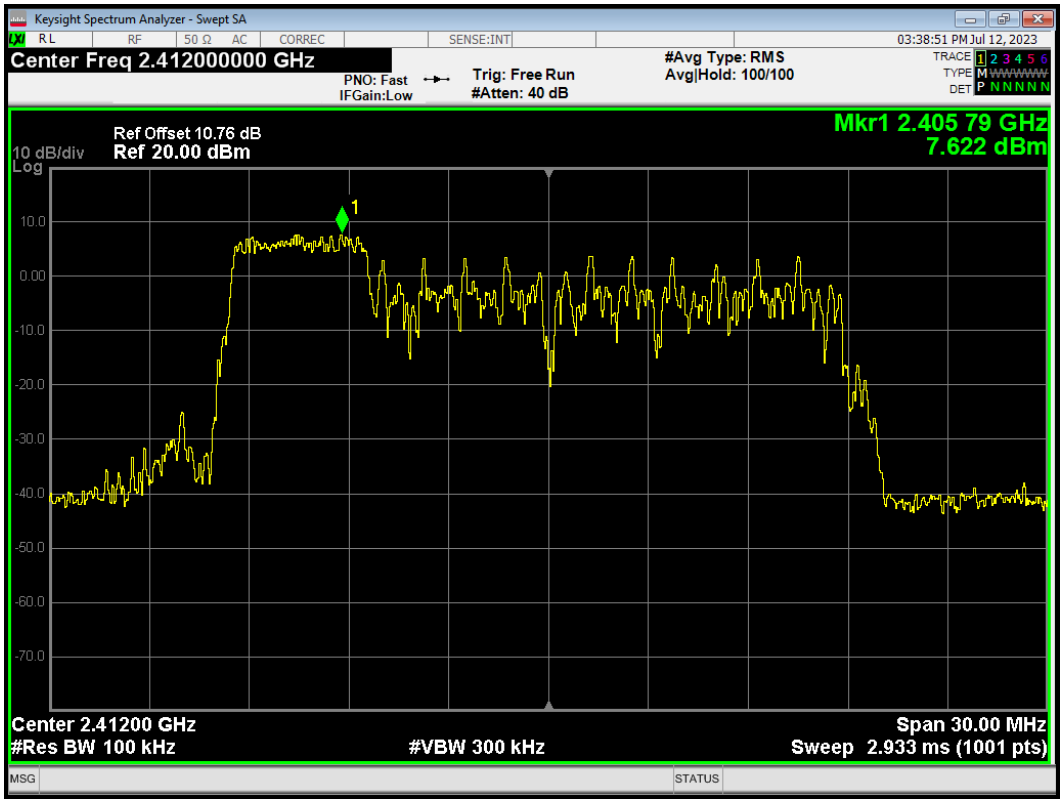
Band Edge 802.11ax (20M) RU26 IDX8 2462MHz Ref



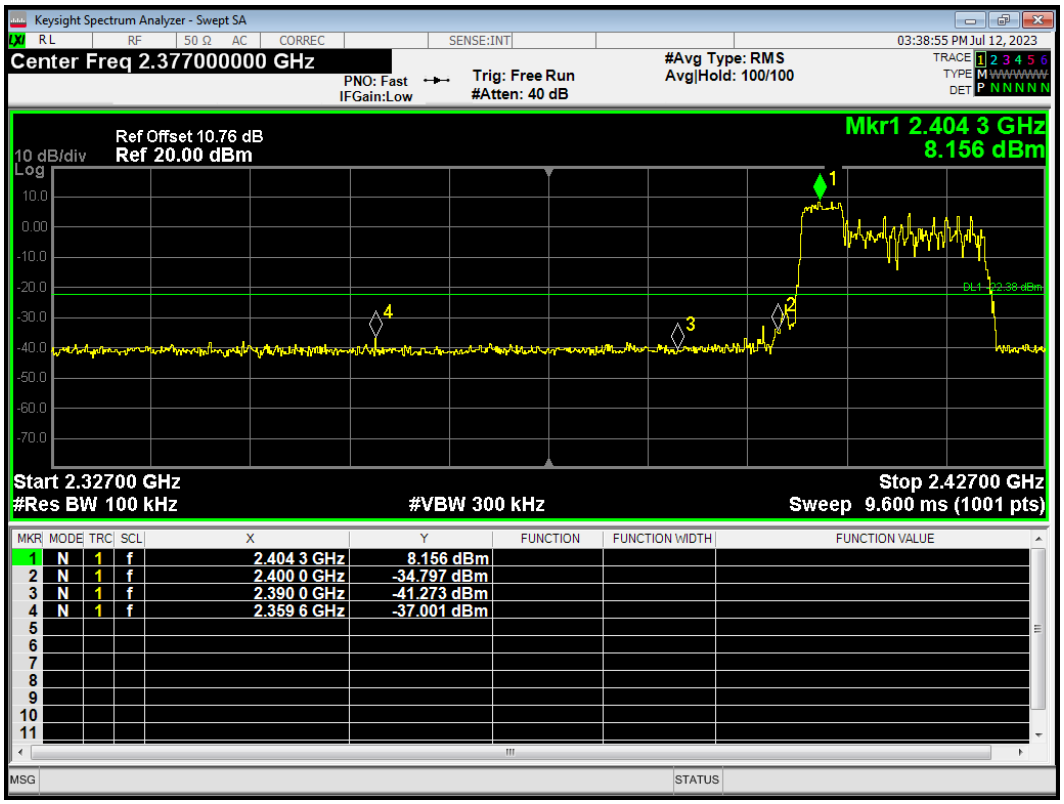
Band Edge 802.11ax (20M) RU26 IDX8 2462MHz Emission



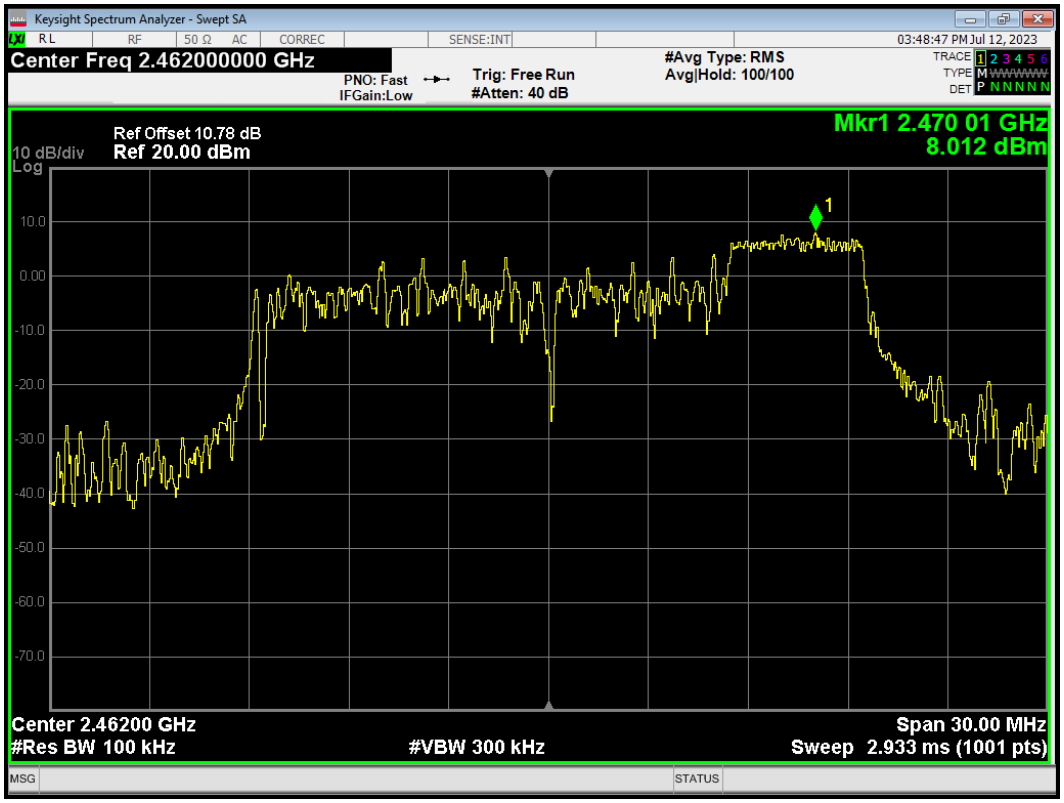
Band Edge 802.11ax (20M) RU52 IDX37 2412MHz Ref



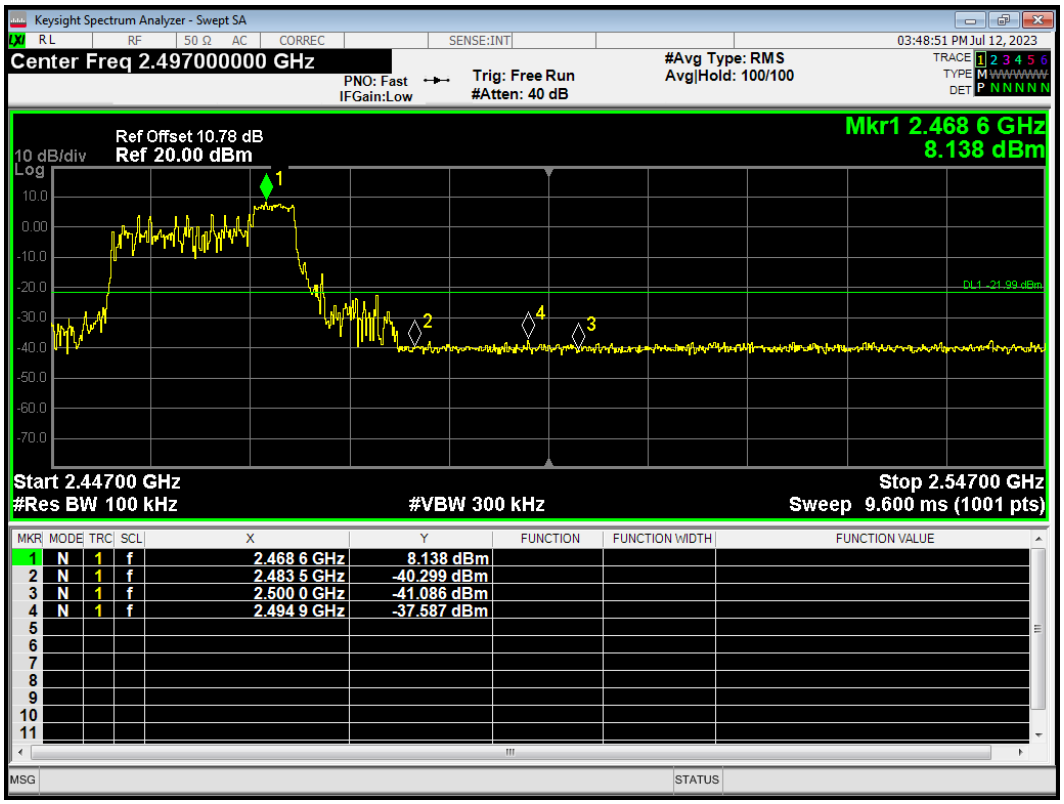
Band Edge 802.11ax (20M) RU52 IDX37 2412MHz Emission



Band Edge 802.11ax (20M) RU52 IDX40 2462MHz Ref

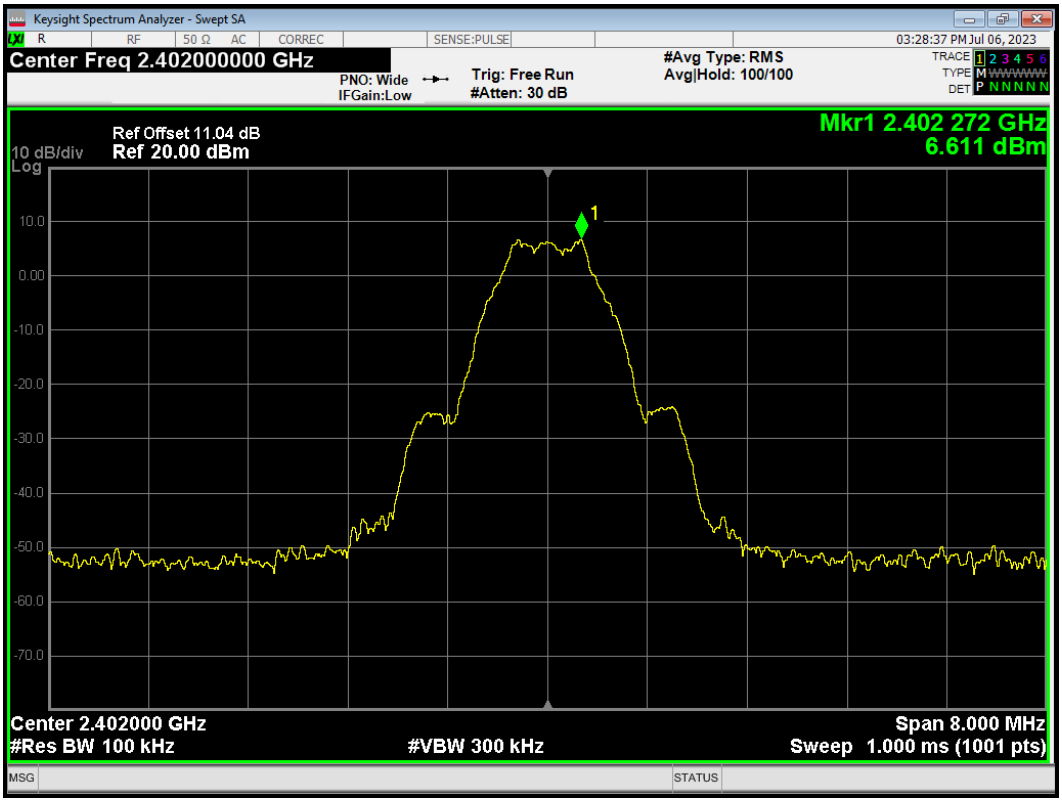


Band Edge 802.11ax (20M) RU52 IDX40 2462MHz Emission

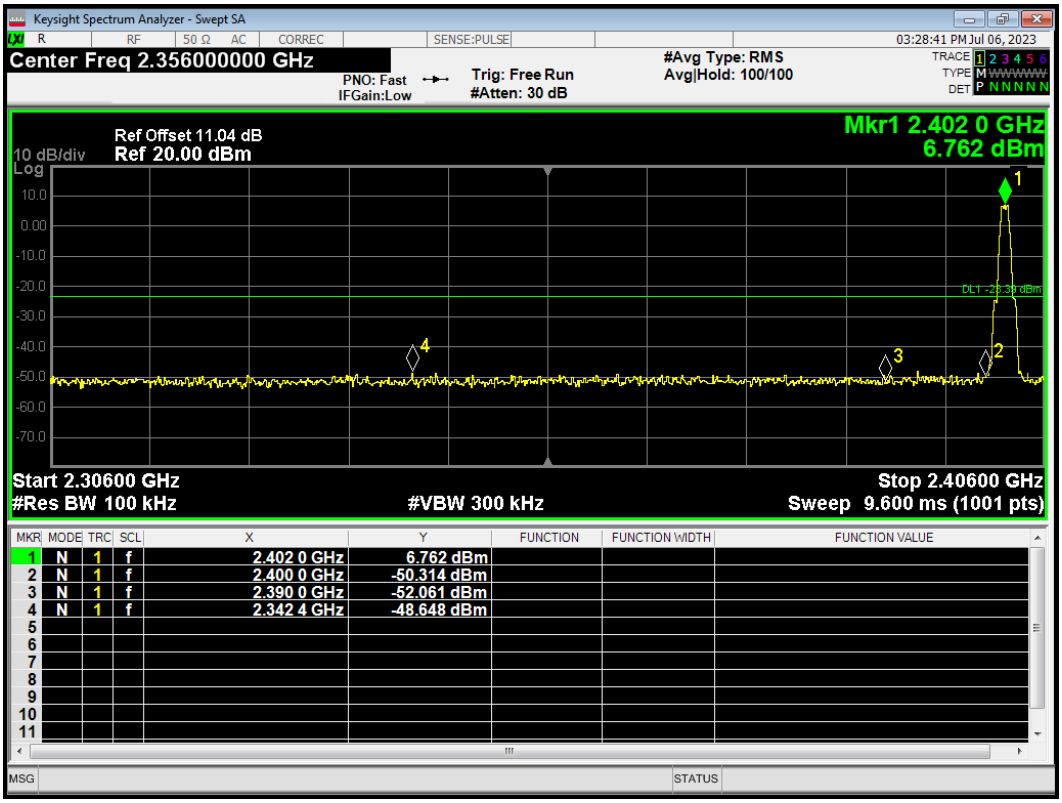


Internal Antenna

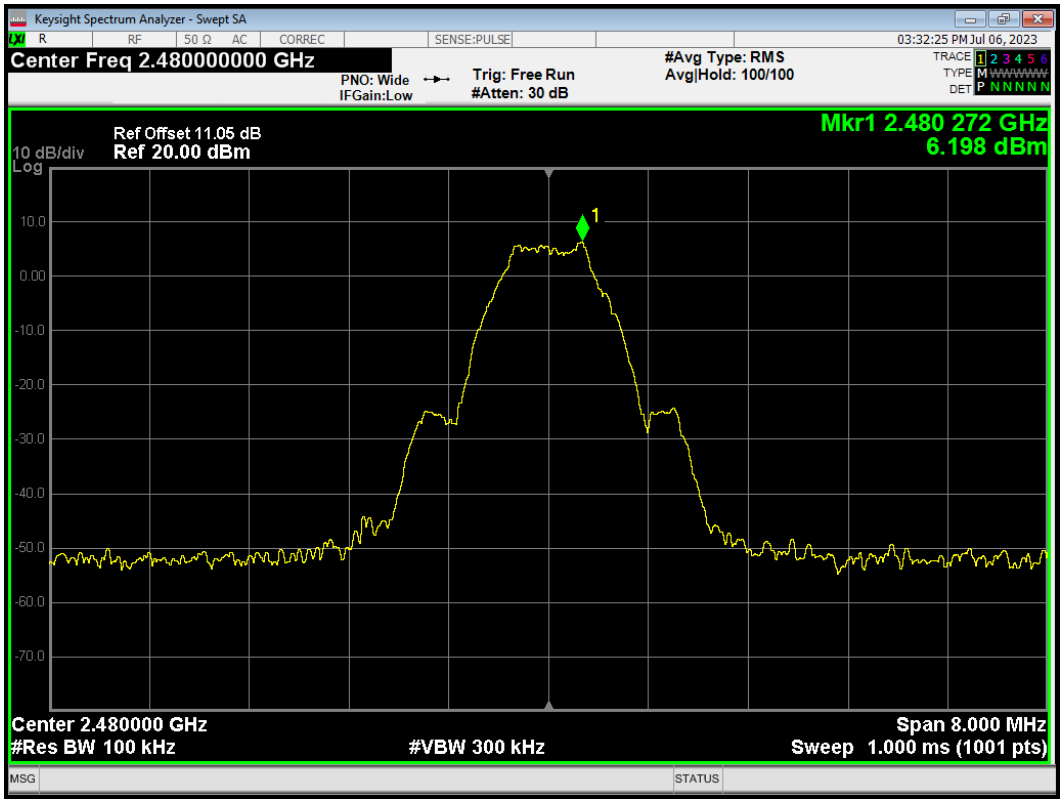
Band Edge BLE (1M) 2402MHz Ref



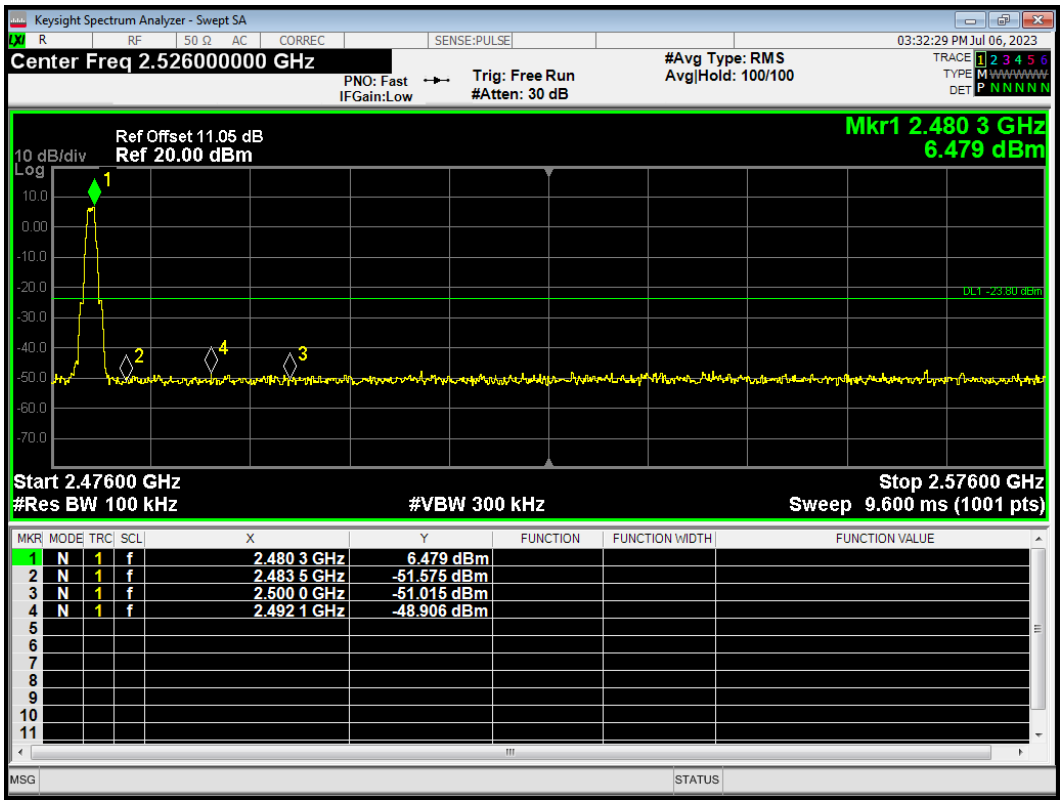
Band Edge BLE (1M) 2402MHz Emission



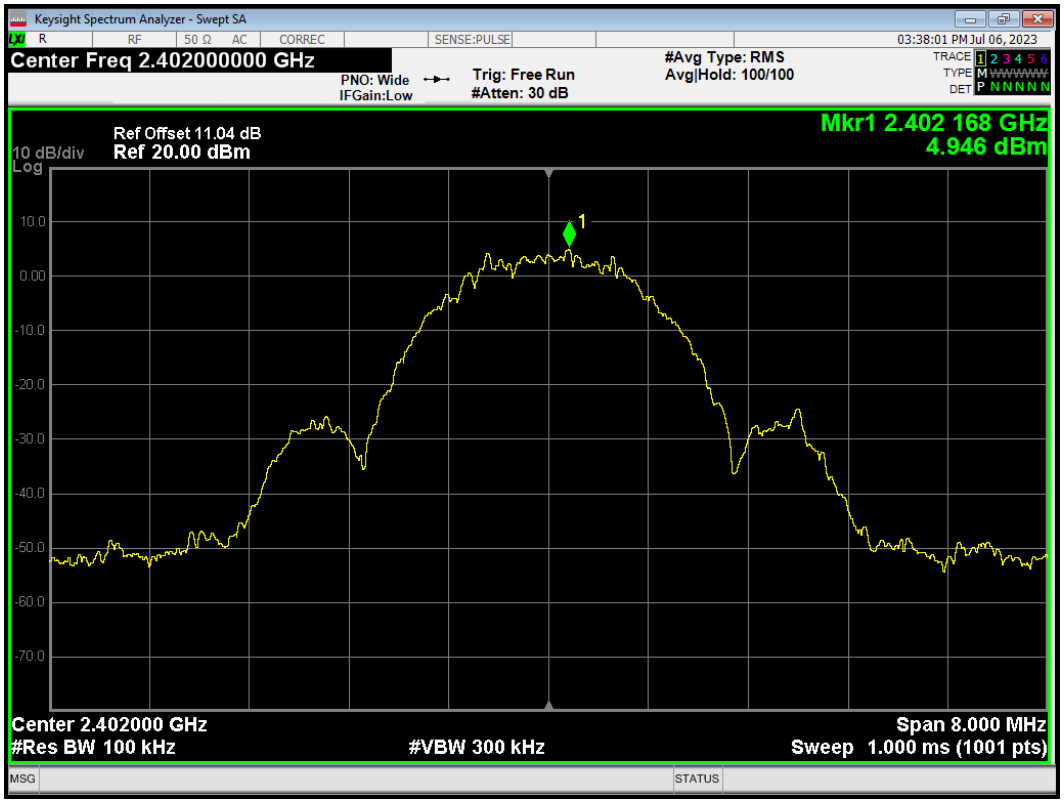
Band Edge BLE (1M) 2480MHz Ref



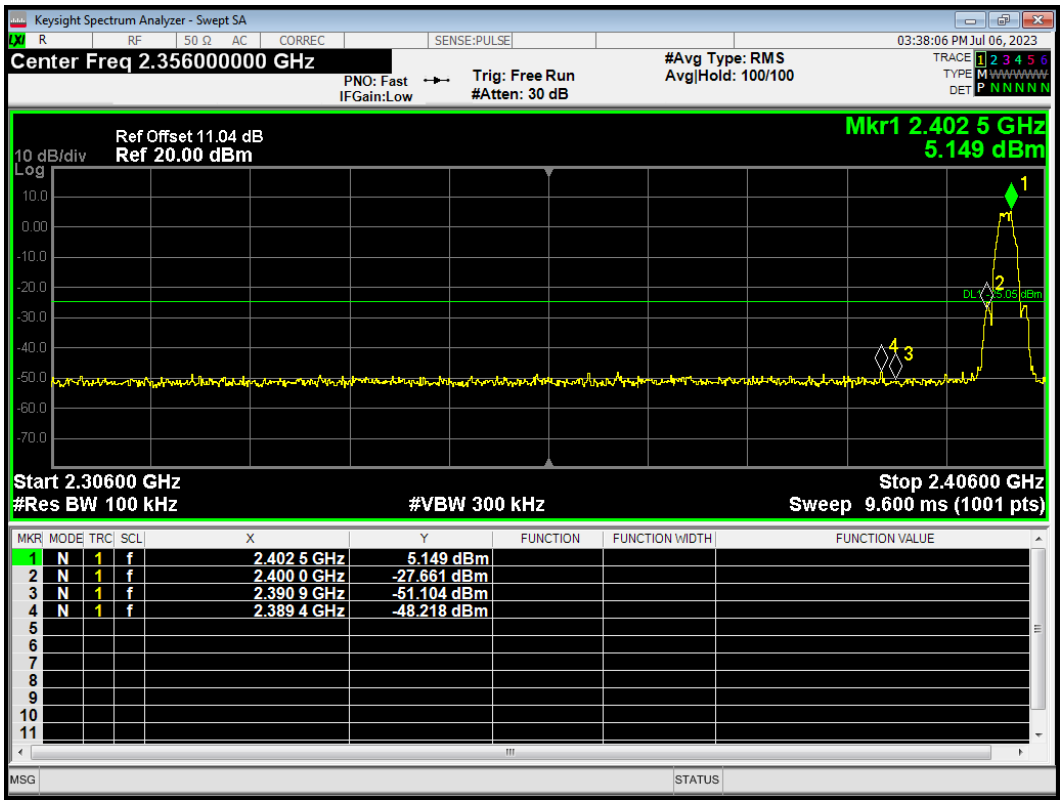
Band Edge BLE (1M) 2480MHz Emission



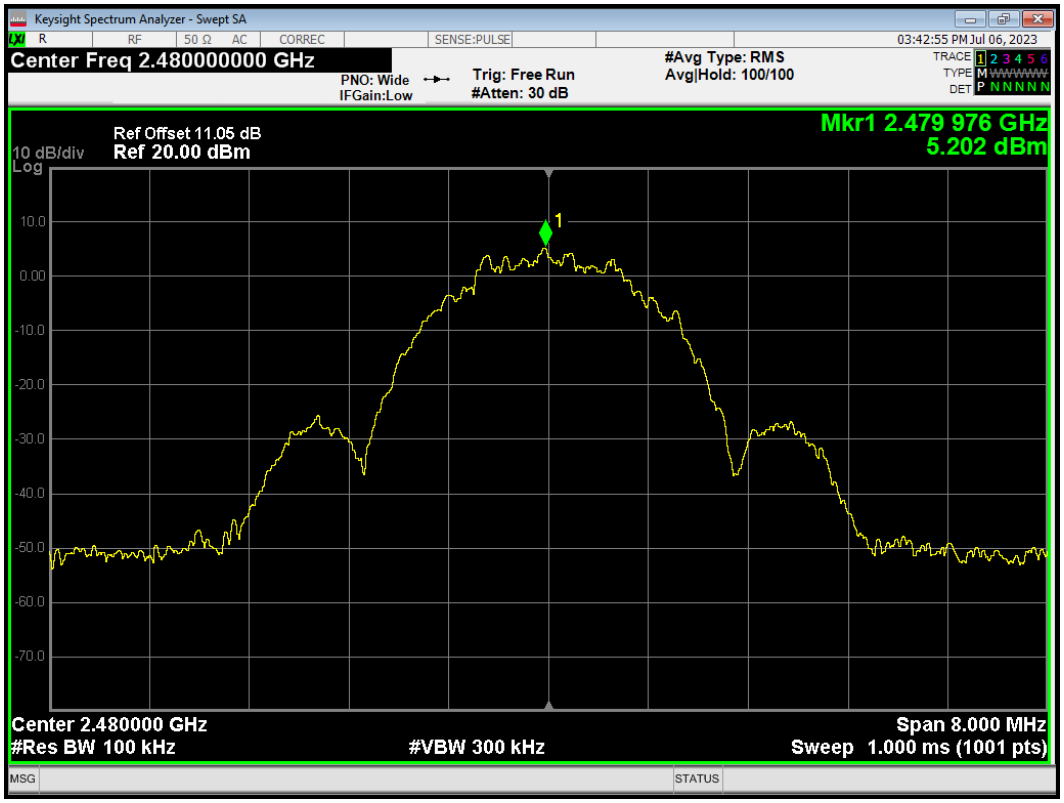
Band Edge BLE (2M) 2402MHz Ref



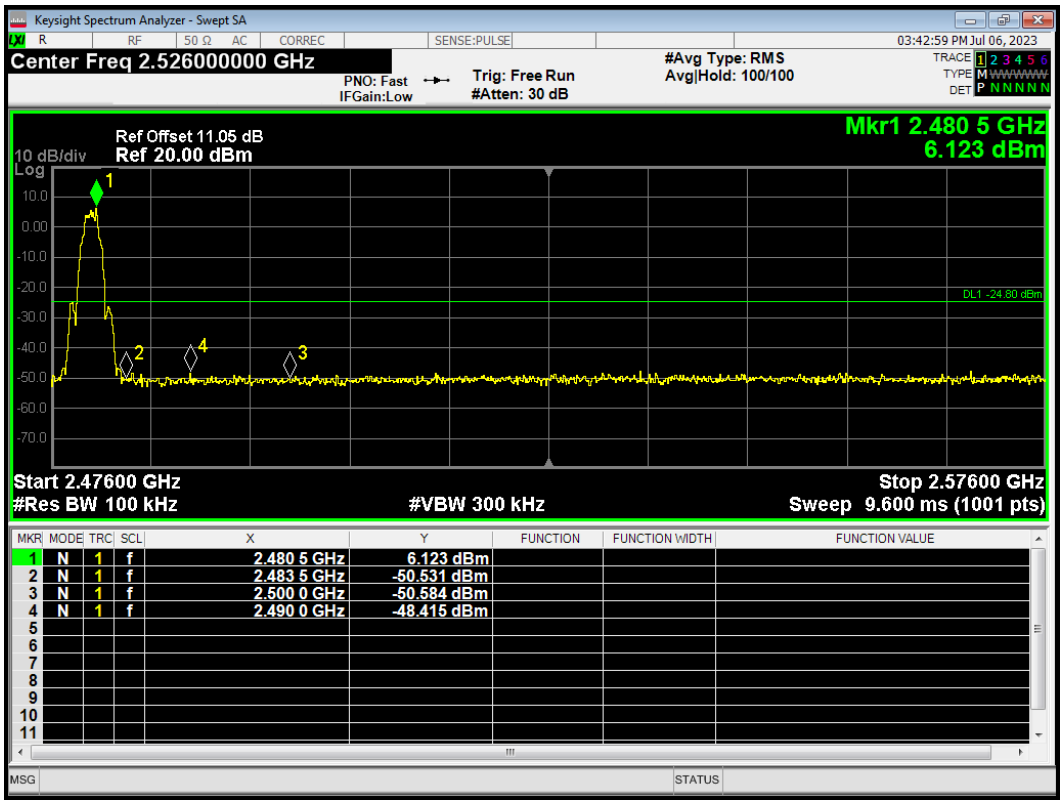
Band Edge BLE (2M) 2402MHz Emission



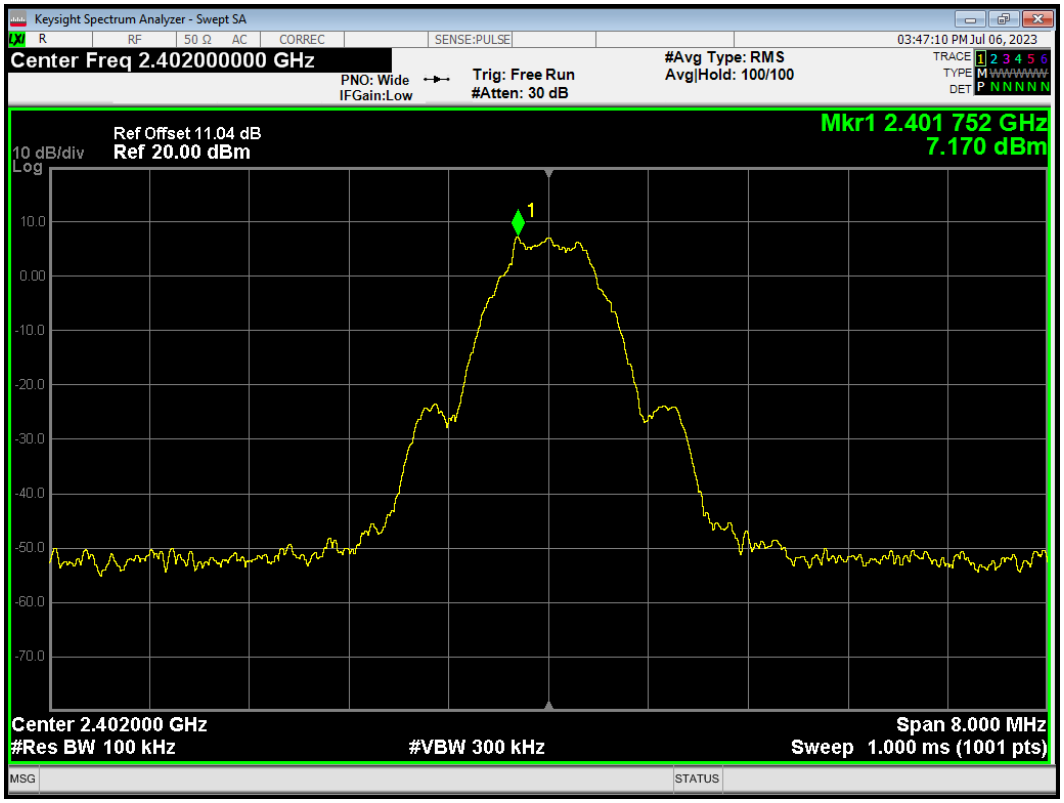
Band Edge BLE (2M) 2480MHz Ref



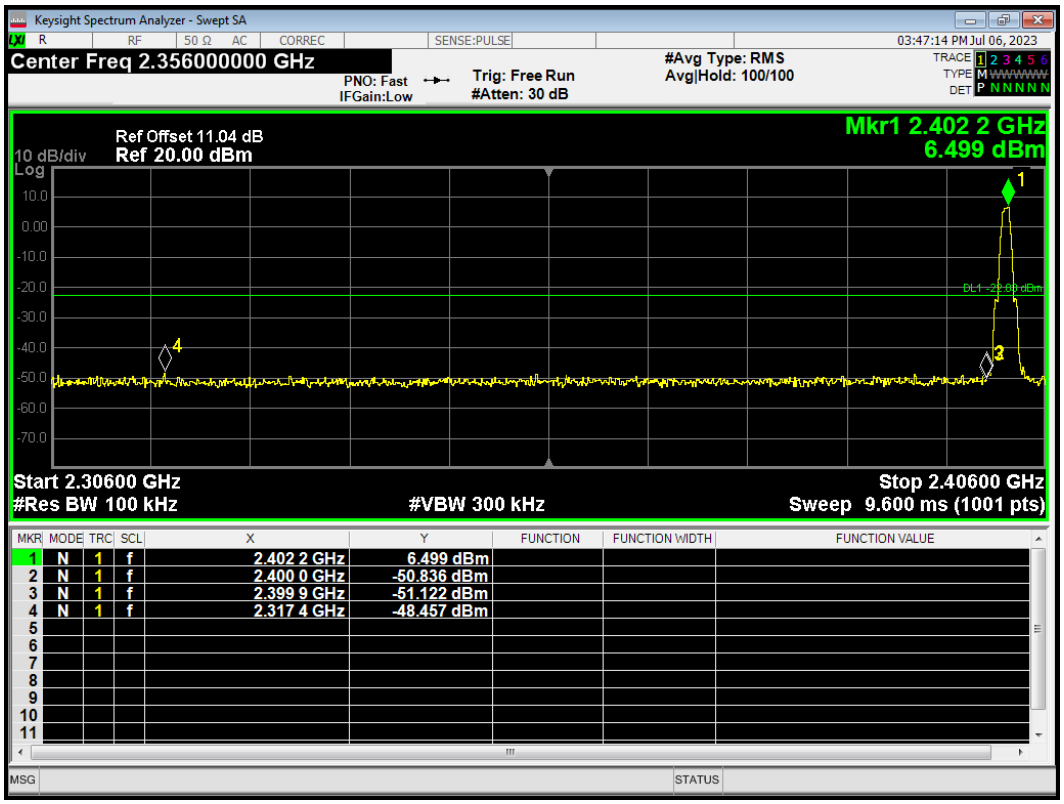
Band Edge BLE (2M) 2480MHz Emission



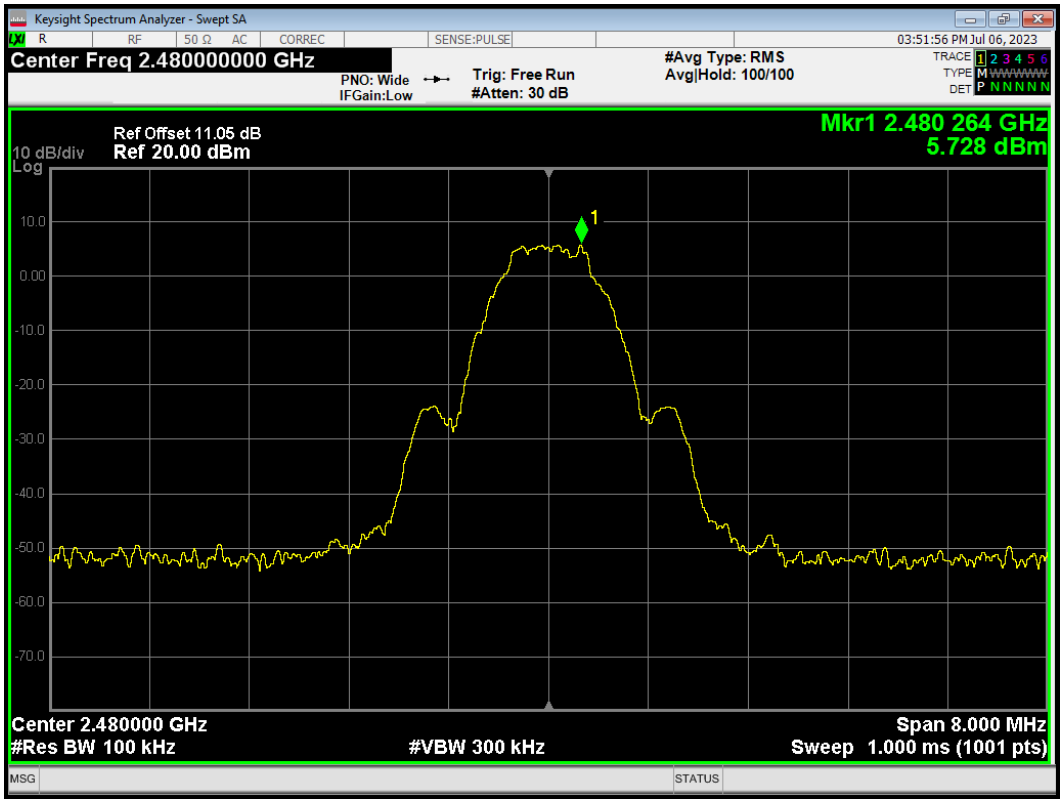
Band Edge BLE (S=2) 2402MHz Ref



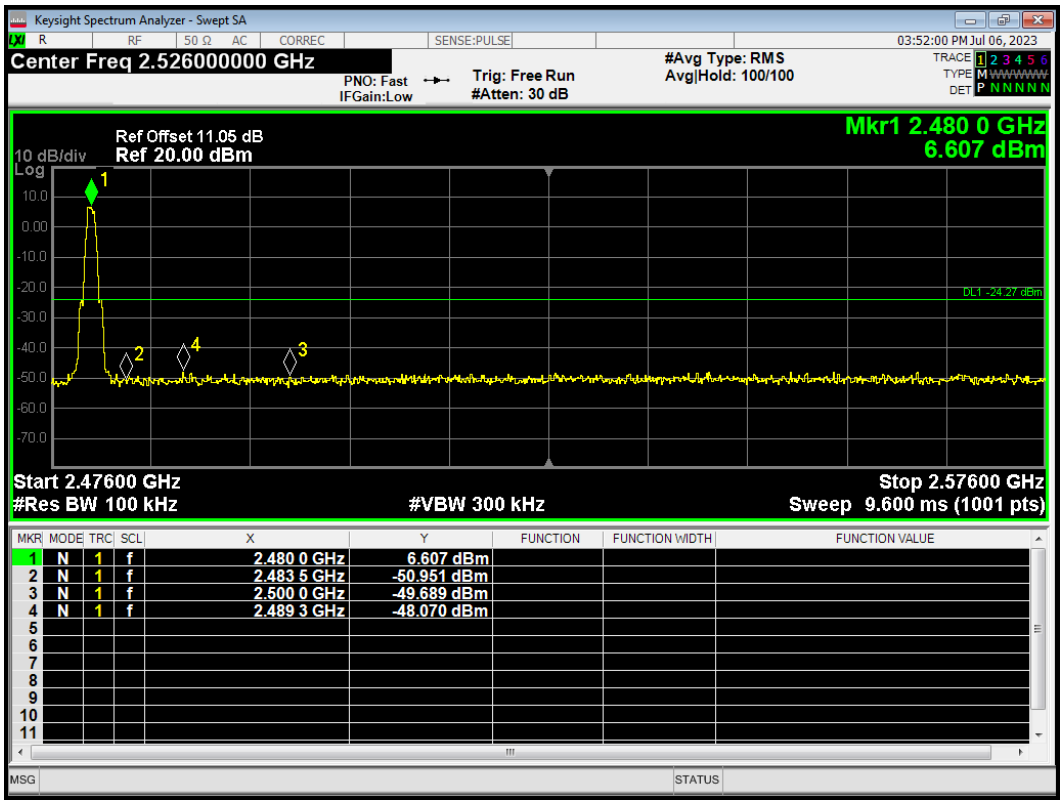
Band Edge BLE (S=2) 2402MHz Emission



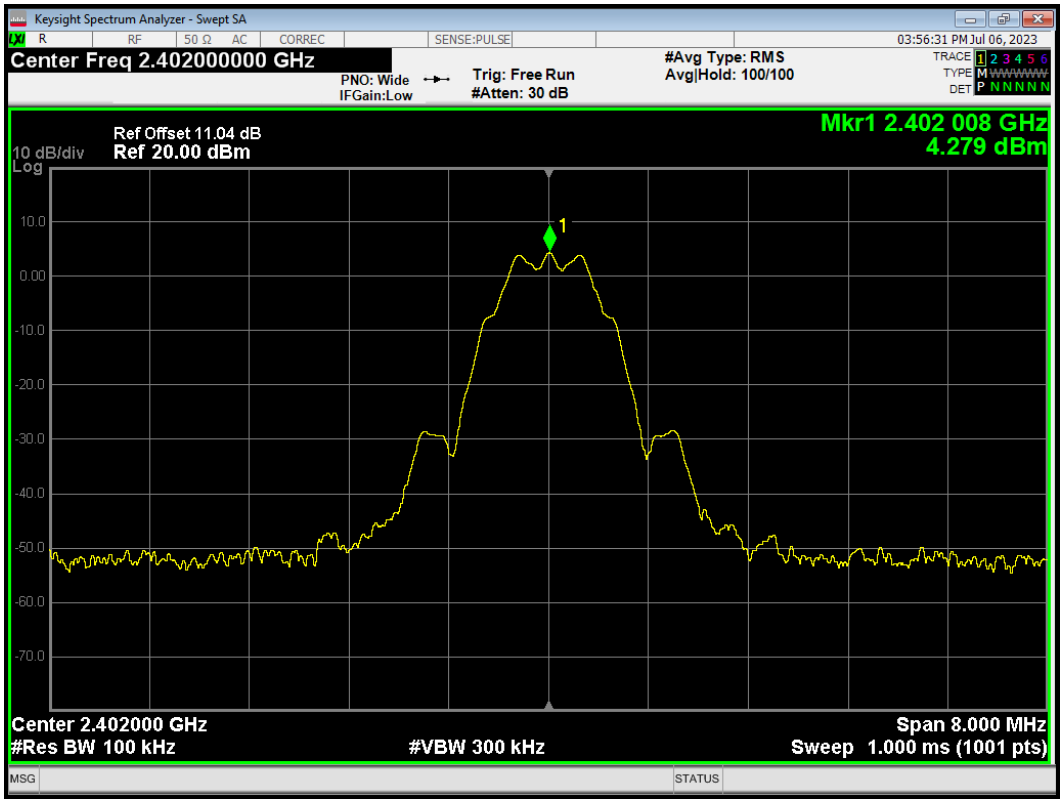
Band Edge BLE (S=2) 2480MHz Ref



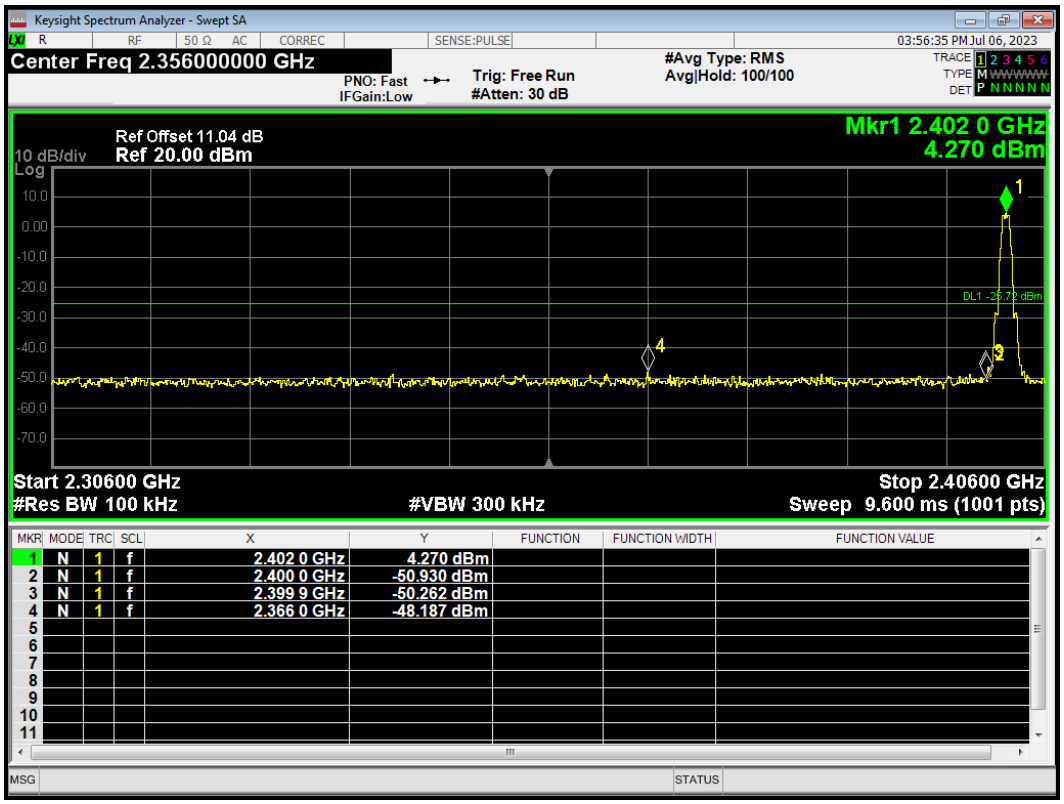
Band Edge BLE (S=2) 2480MHz Emission



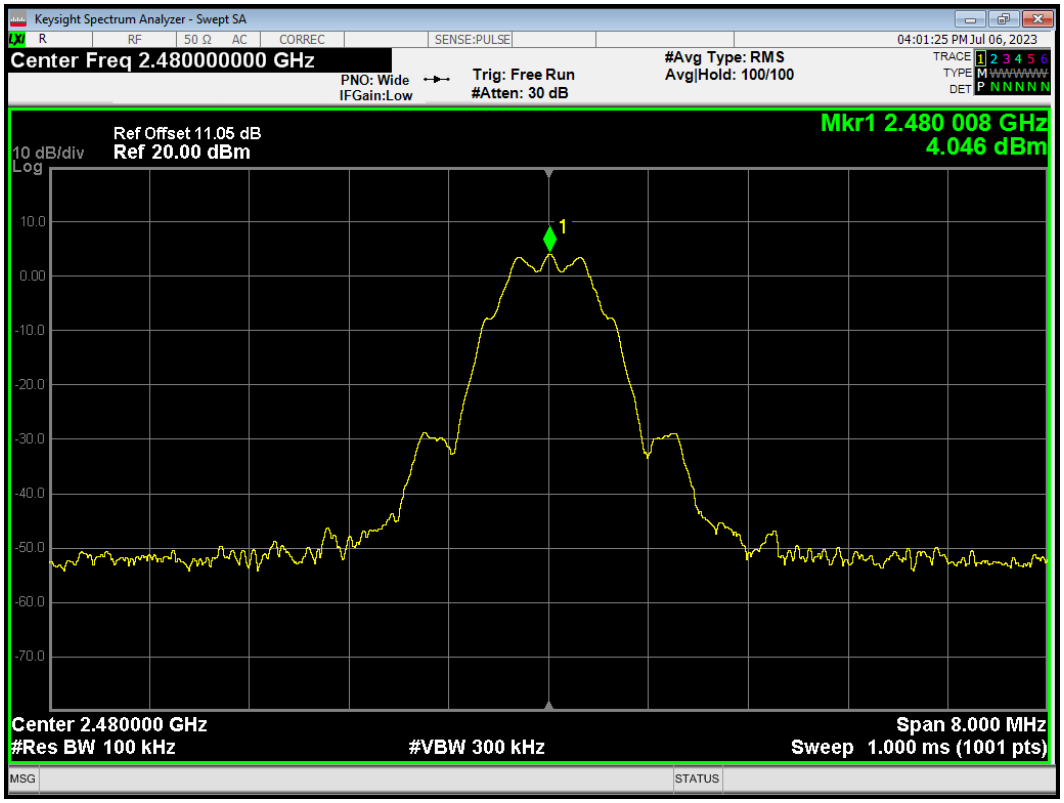
Band Edge BLE (S=8) 2402MHz Ref



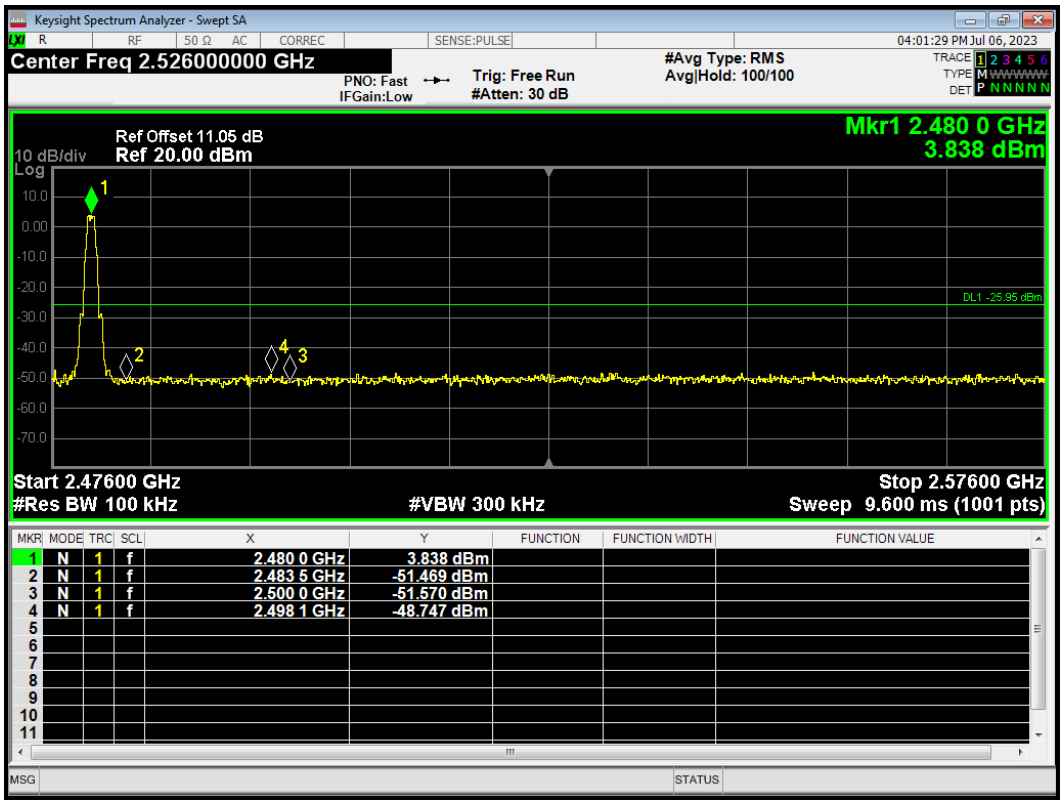
Band Edge BLE (S=8) 2402MHz Emission



Band Edge BLE (S=8) 2480MHz Ref

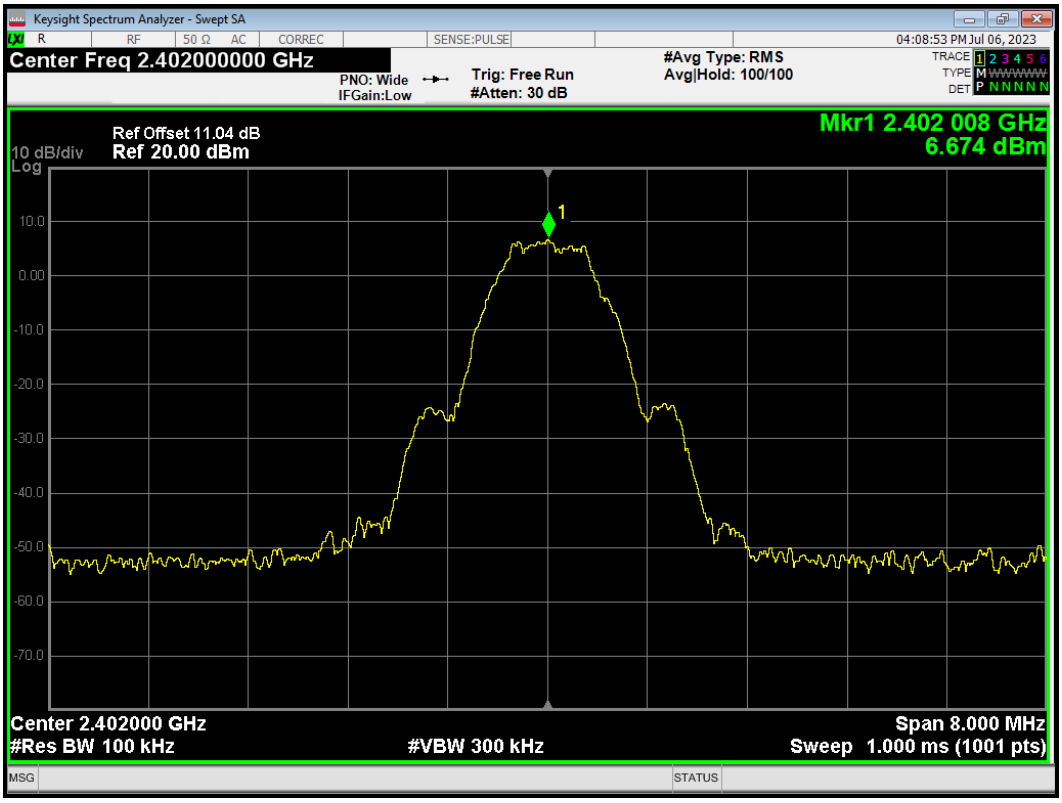


Band Edge BLE (S=8) 2480MHz Emission

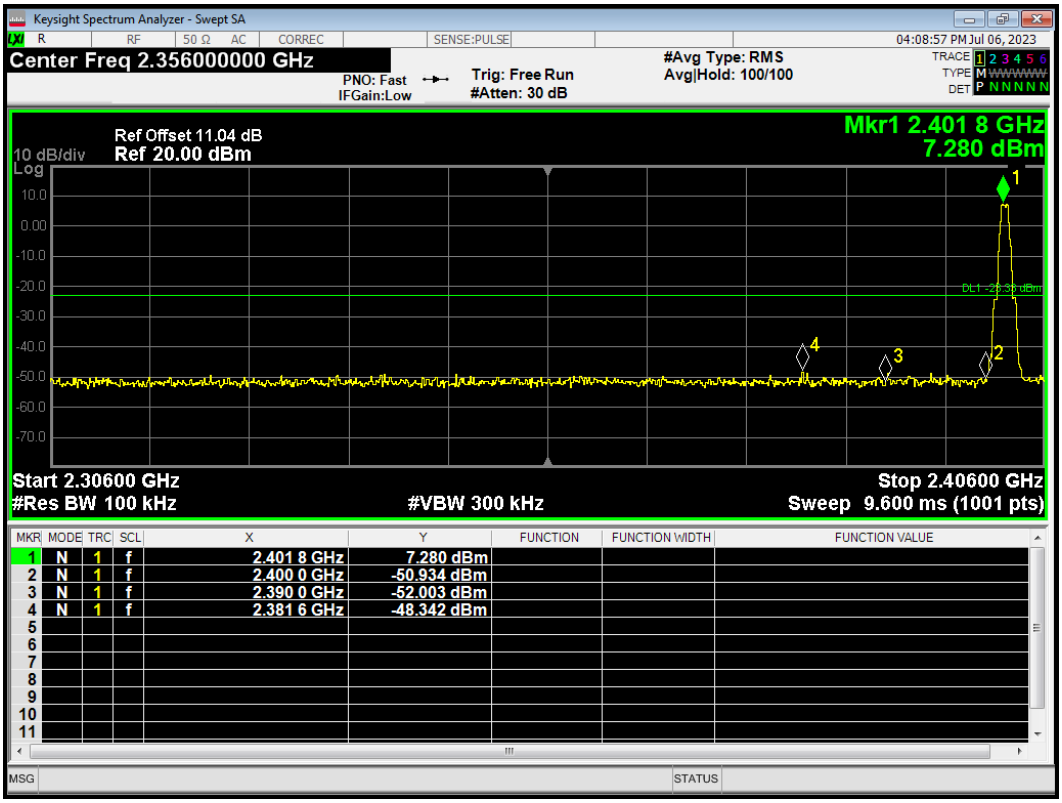


External Antenna

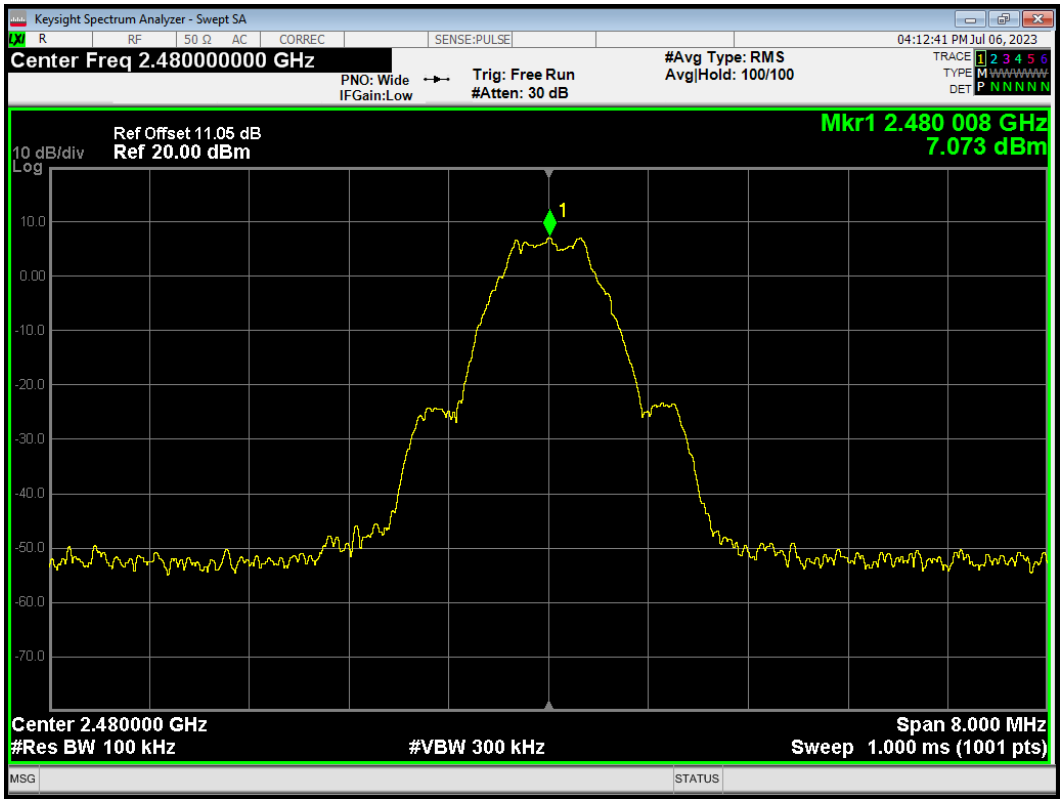
Band Edge BLE (1M) 2402MHz Ref



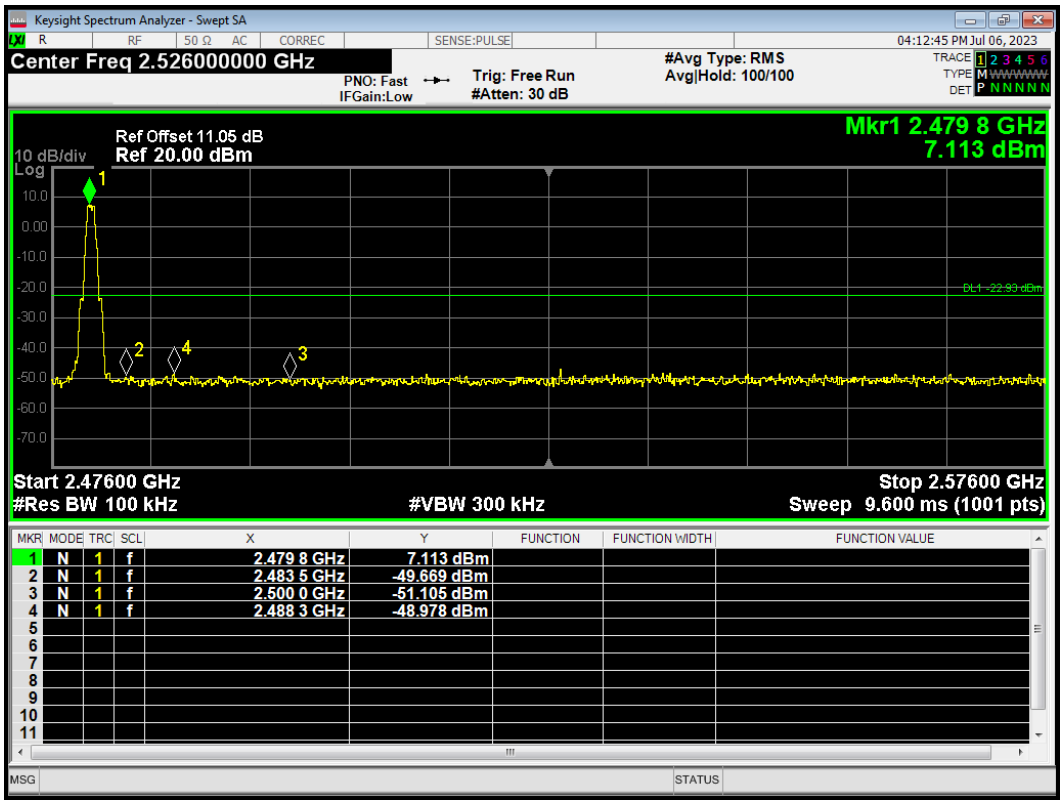
Band Edge BLE (1M) 2402MHz Emission



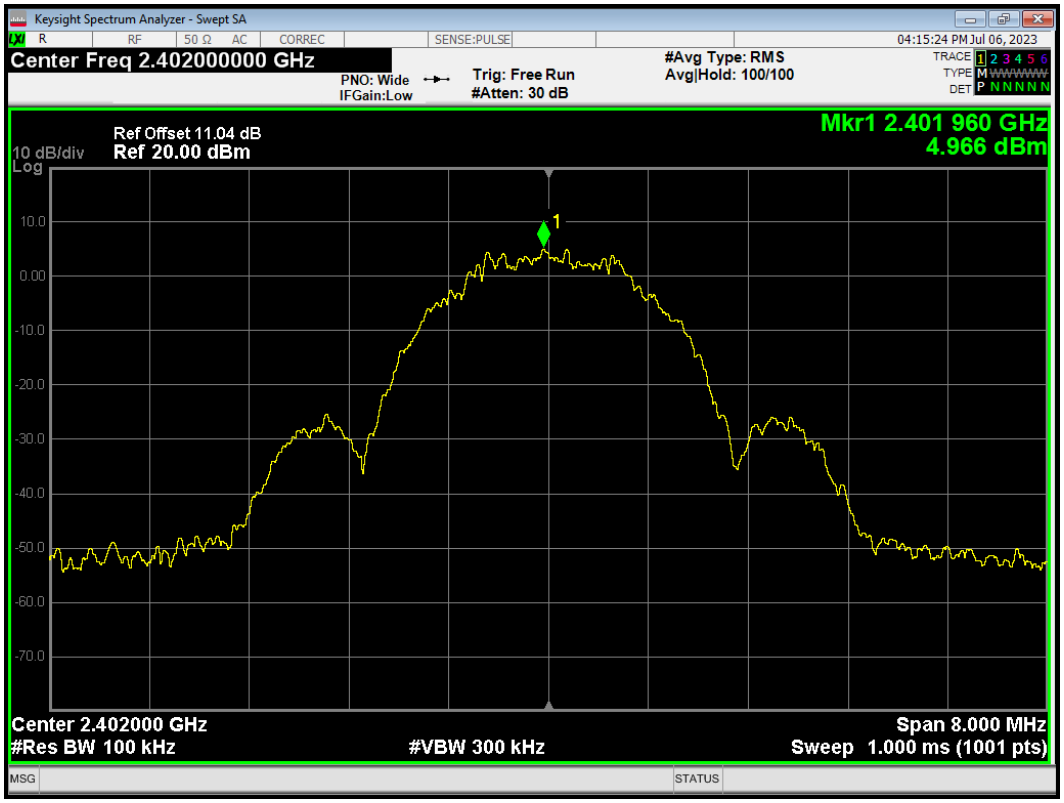
Band Edge BLE (1M) 2480MHz Ref



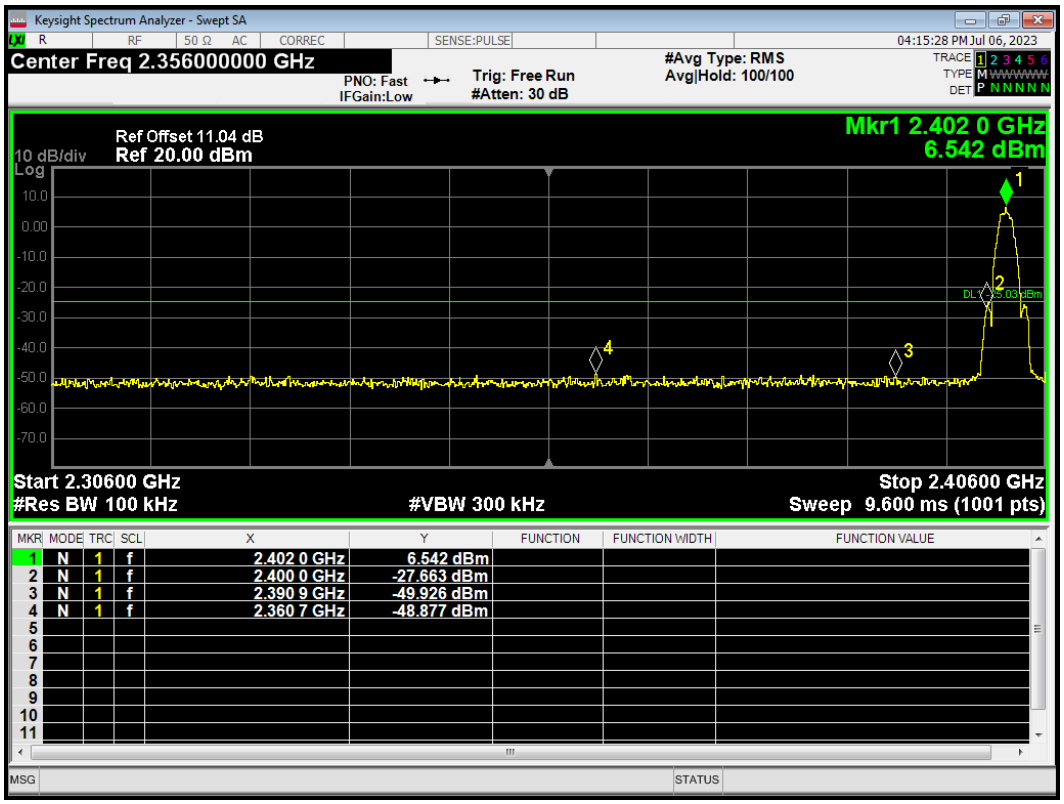
Band Edge BLE (1M) 2480MHz Emission



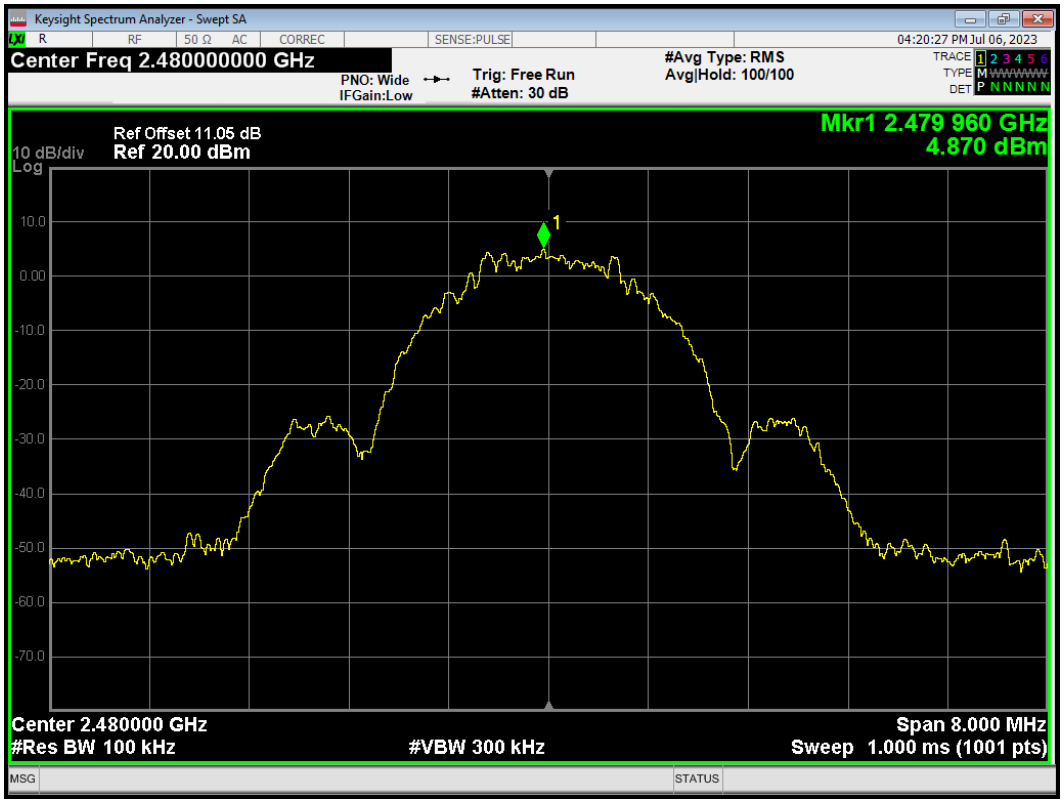
Band Edge BLE (2M) 2402MHz Ref



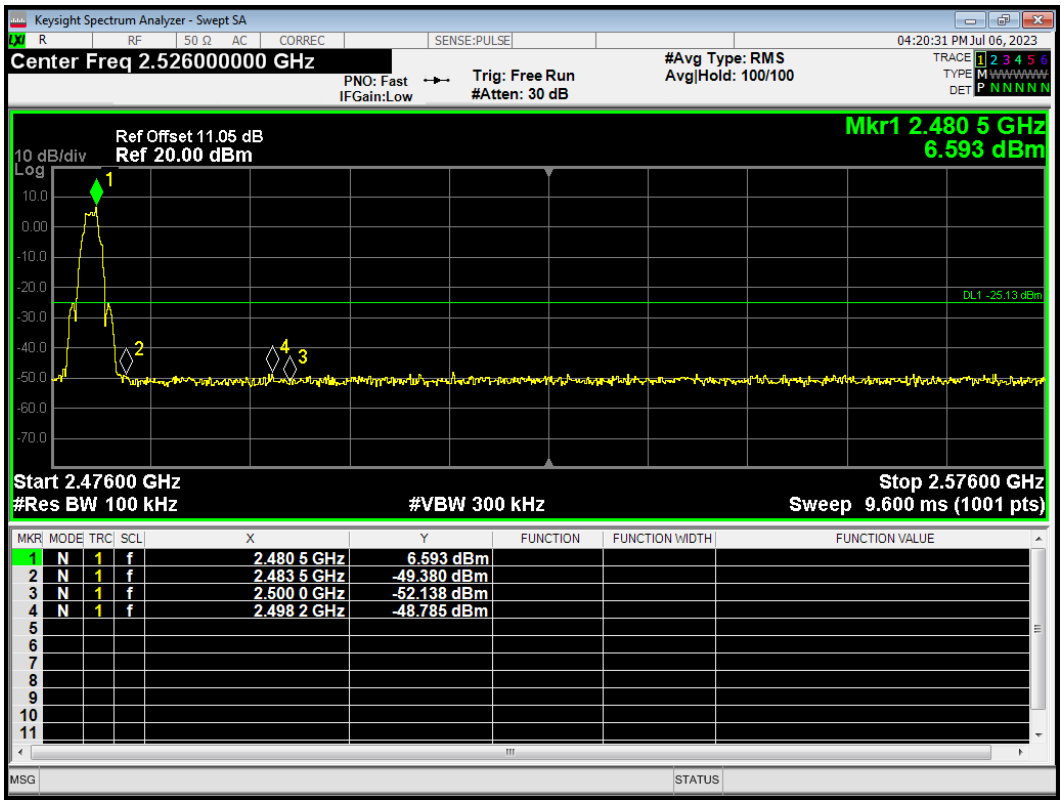
Band Edge BLE (2M) 2402MHz Emission



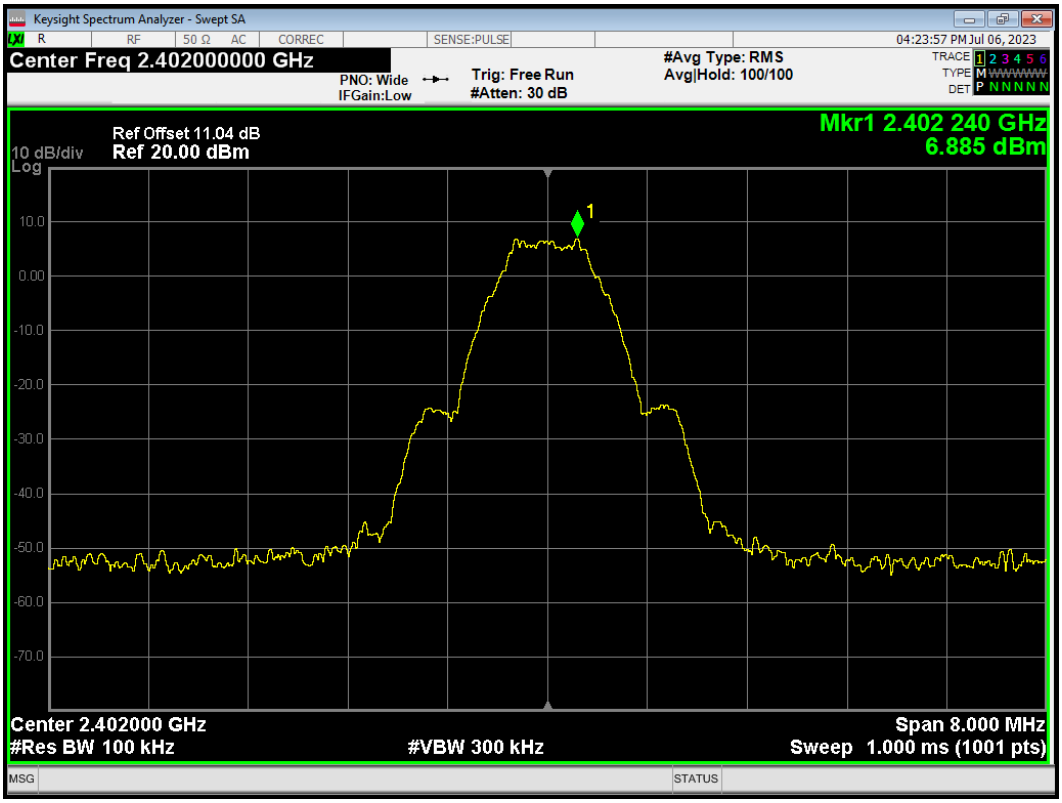
Band Edge BLE (2M) 2480MHz Ref



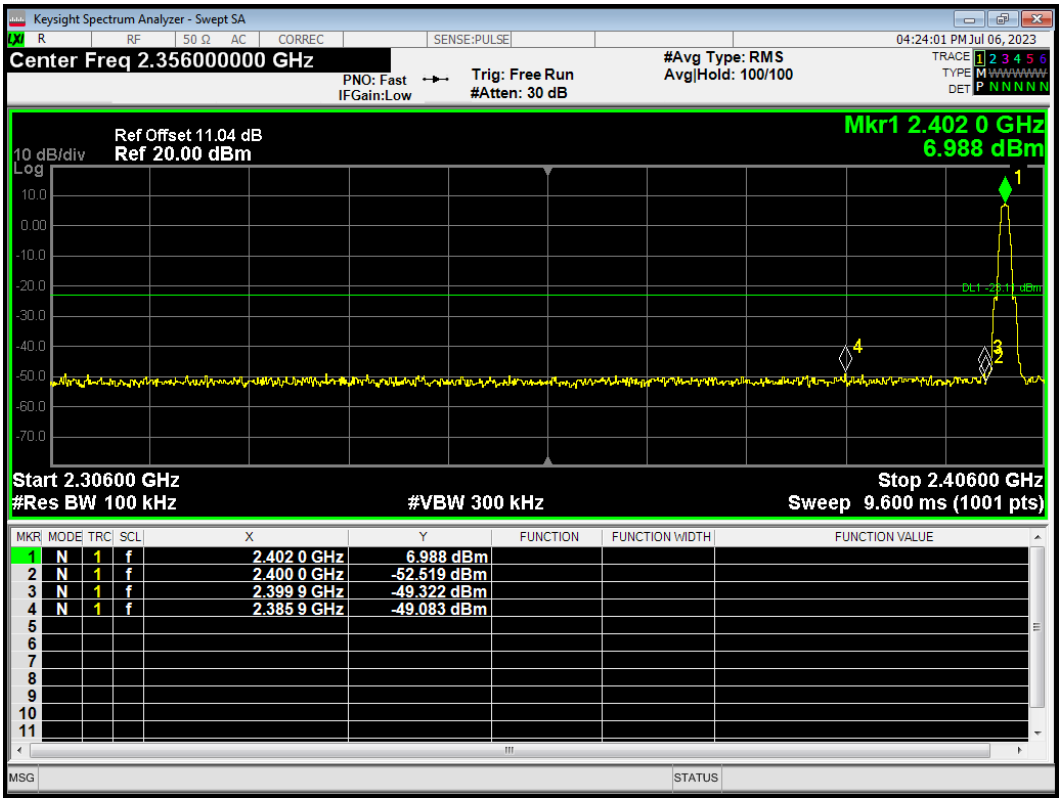
Band Edge BLE (2M) 2480MHz Emission



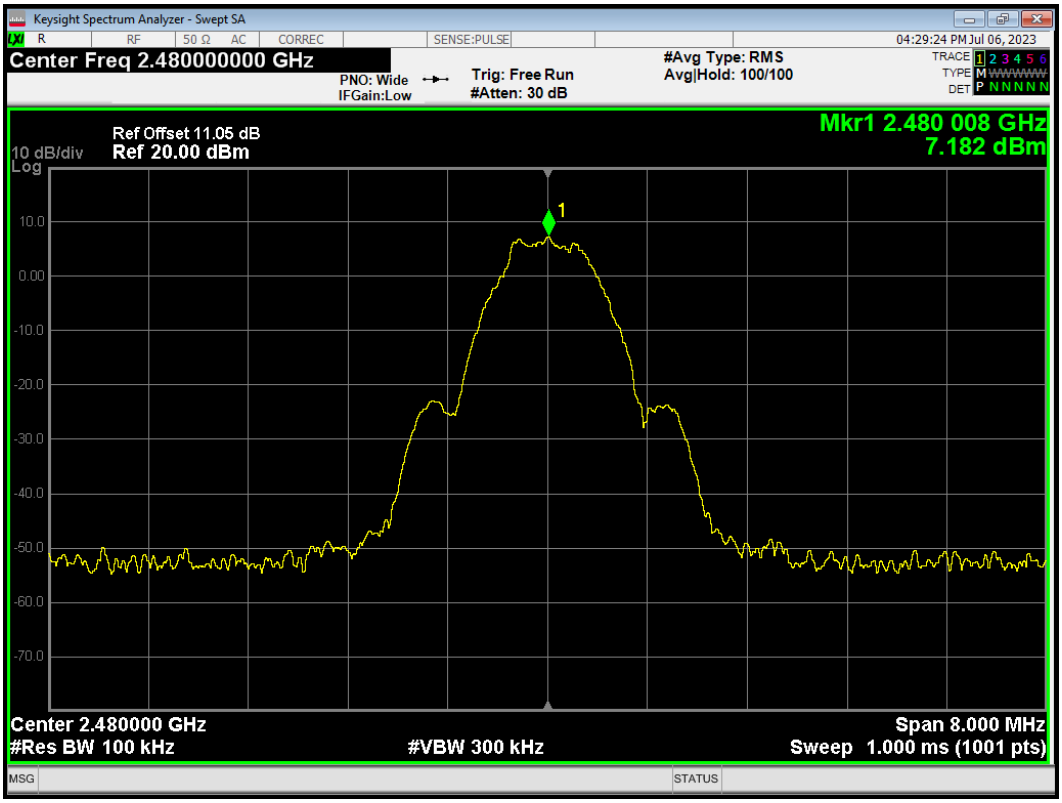
Band Edge BLE (S=2) 2402MHz Ref



Band Edge BLE (S=2) 2402MHz Emission



Band Edge BLE (S=2) 2480MHz Ref



Band Edge BLE (S=2) 2480MHz Emission