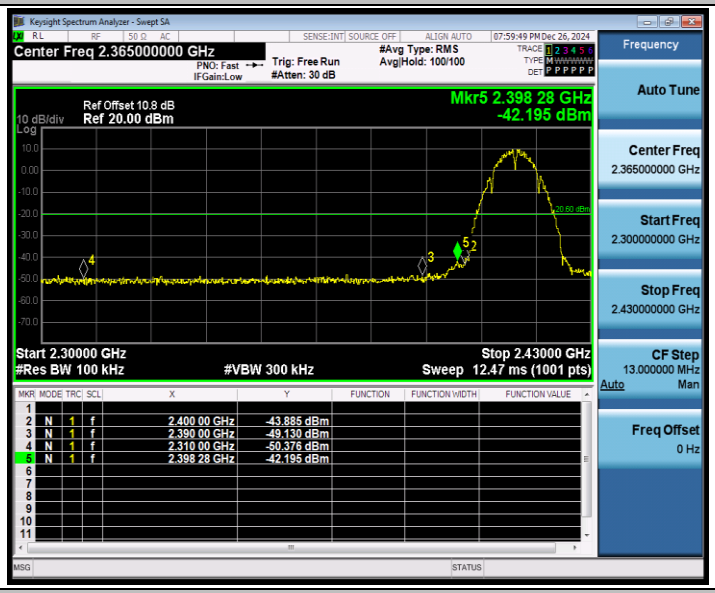
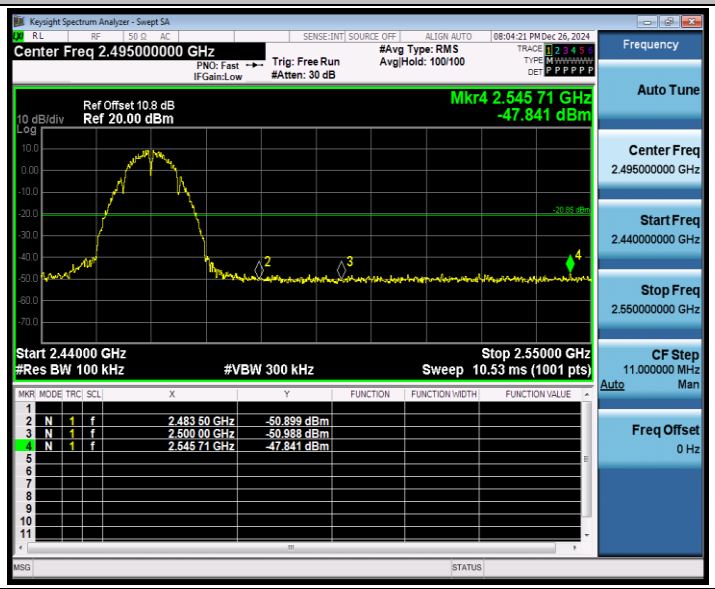
802.11b_Low_2412



802.11b_High_2462



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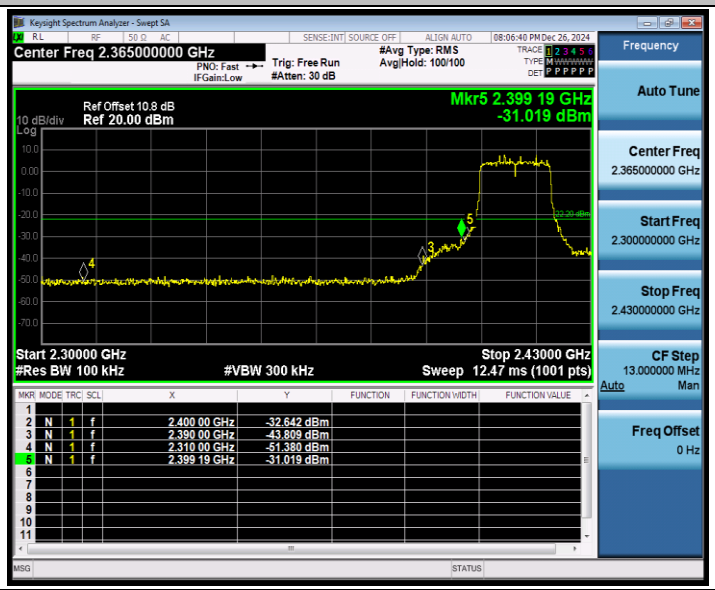
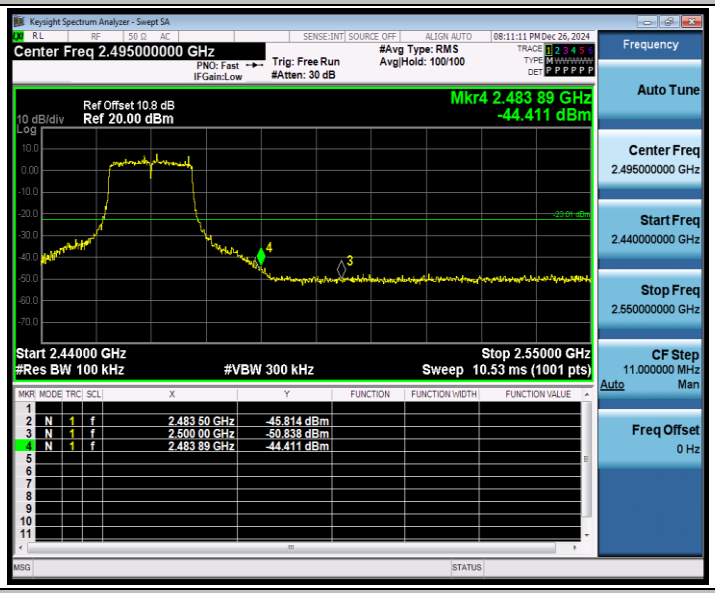
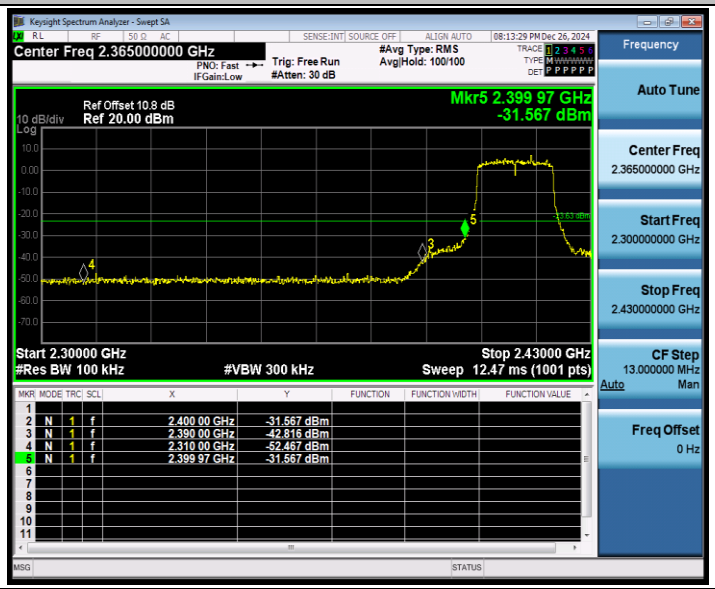


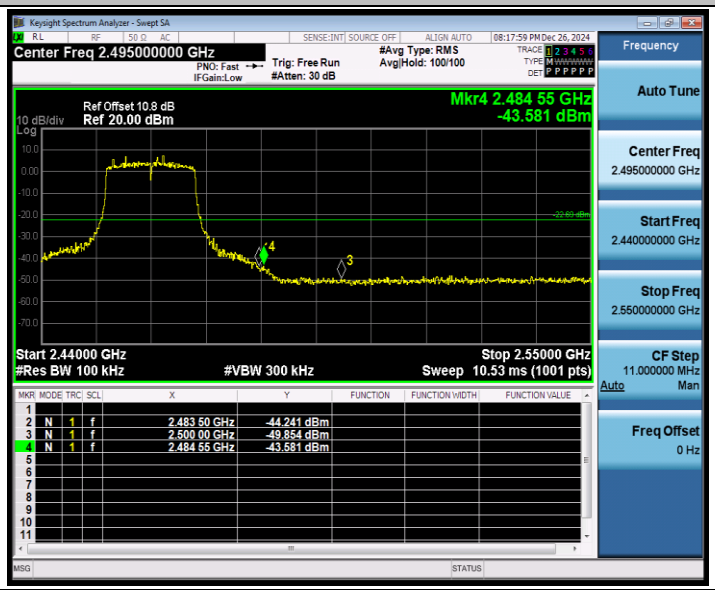
802.11g_High_2462



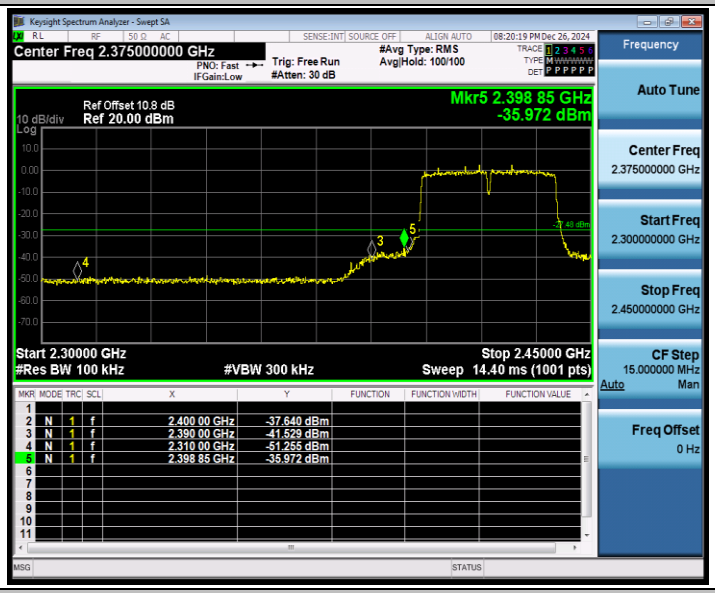
802.11n HT20_Low_2412



802.11n HT20_High_2462



802.11n HT40_Low_2422



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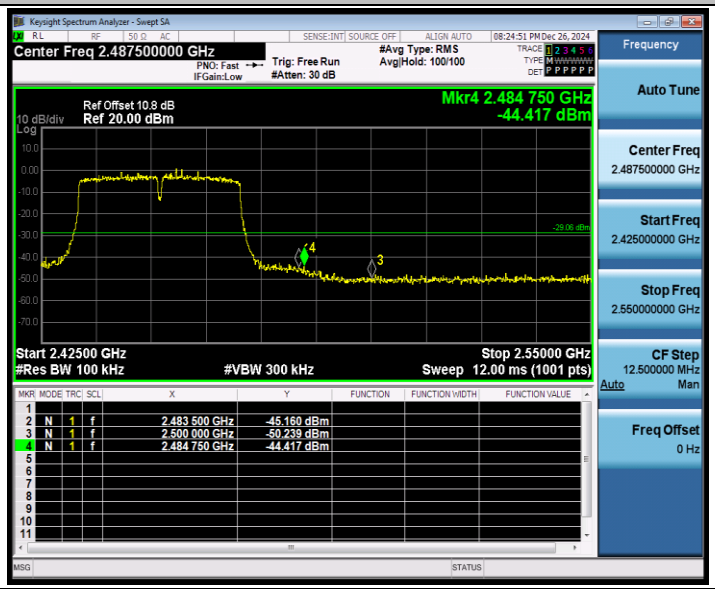
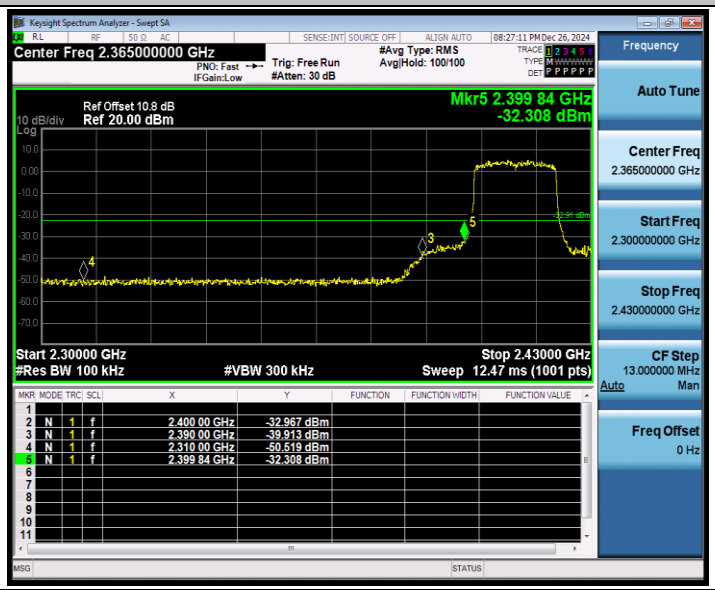
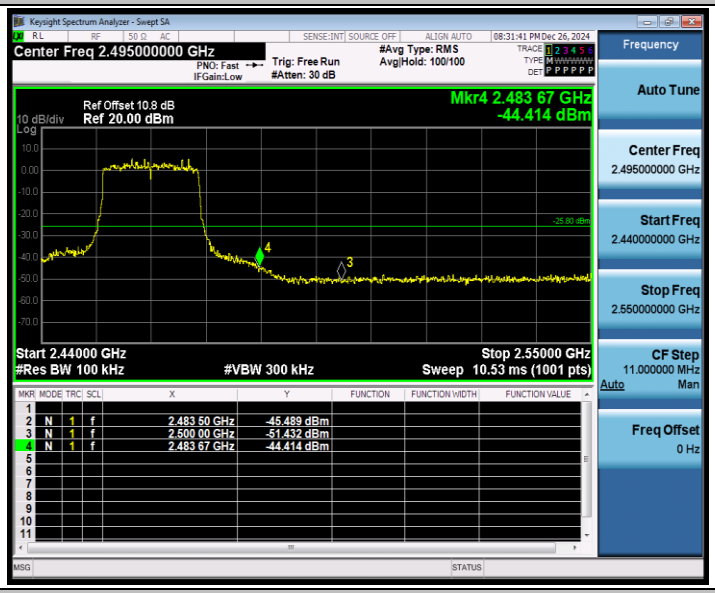


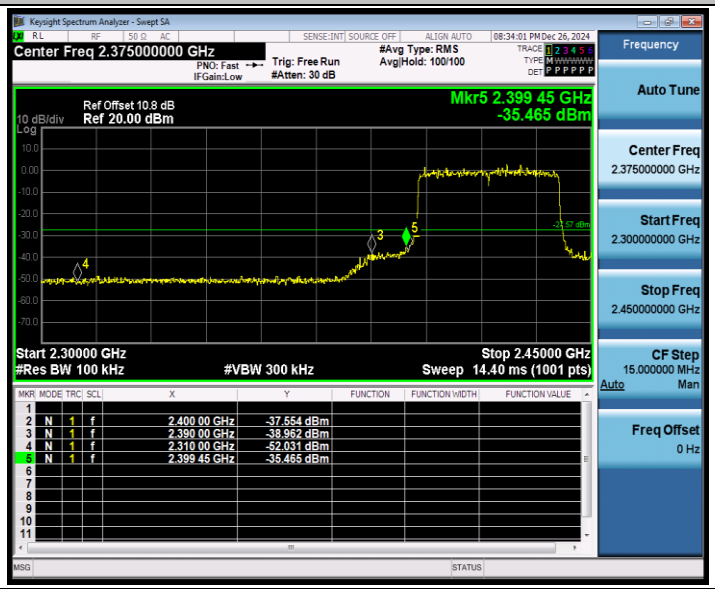
802.11ax HE20_Low_2412



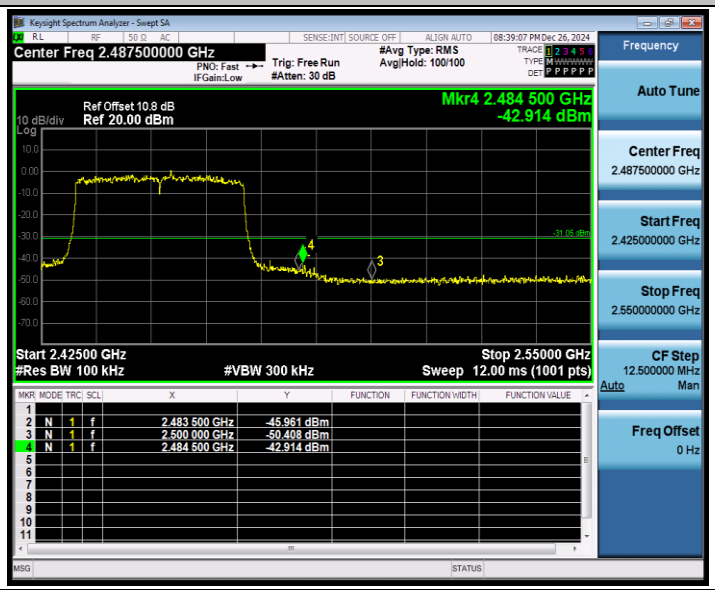
802.11ax HE20_High_2462



802.11ax HE40_Low_2422

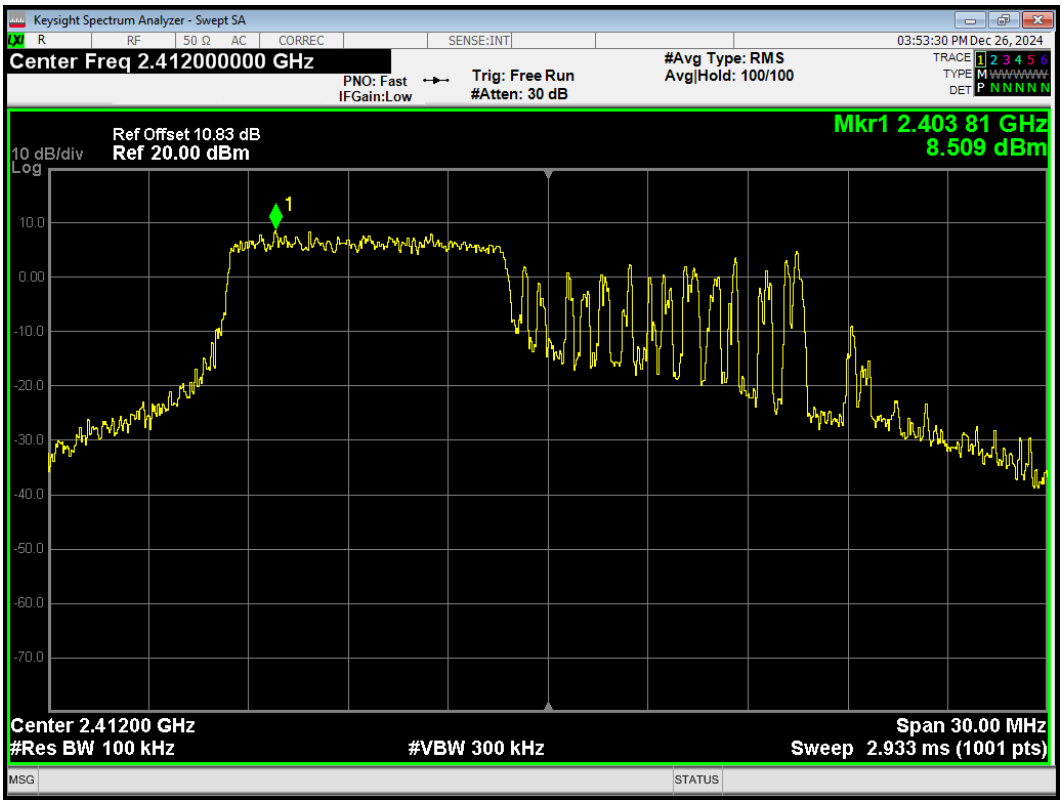


802.11ax HE40_High_2452

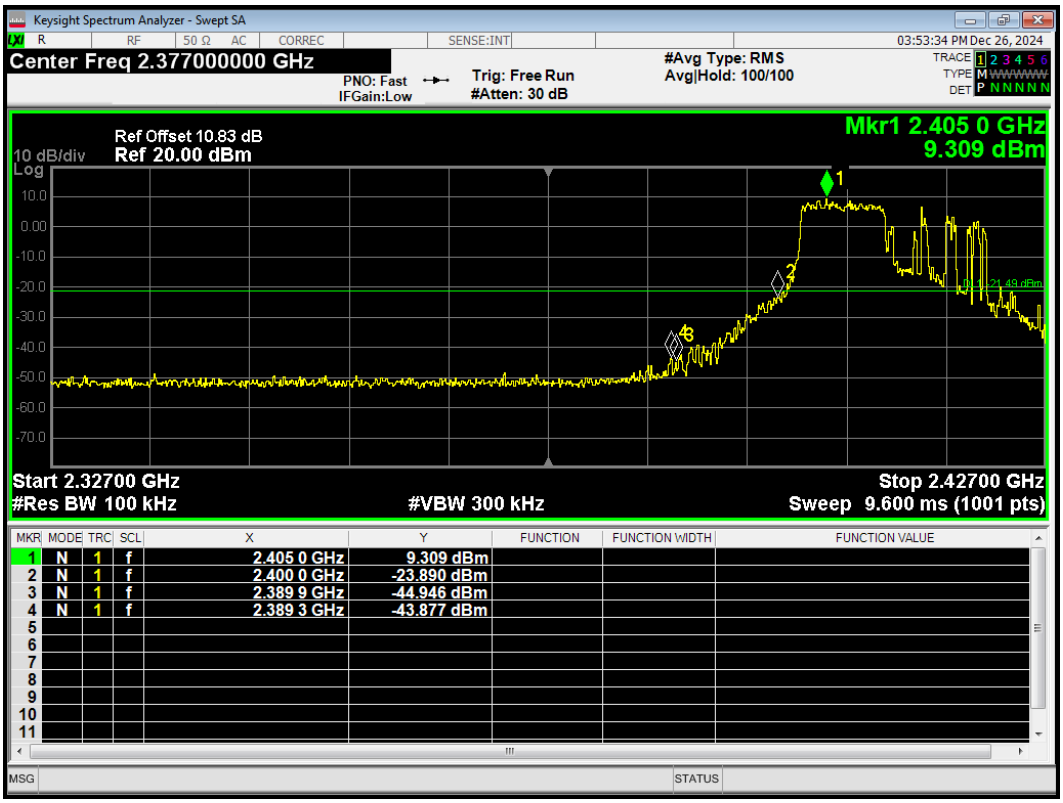


TB Mode

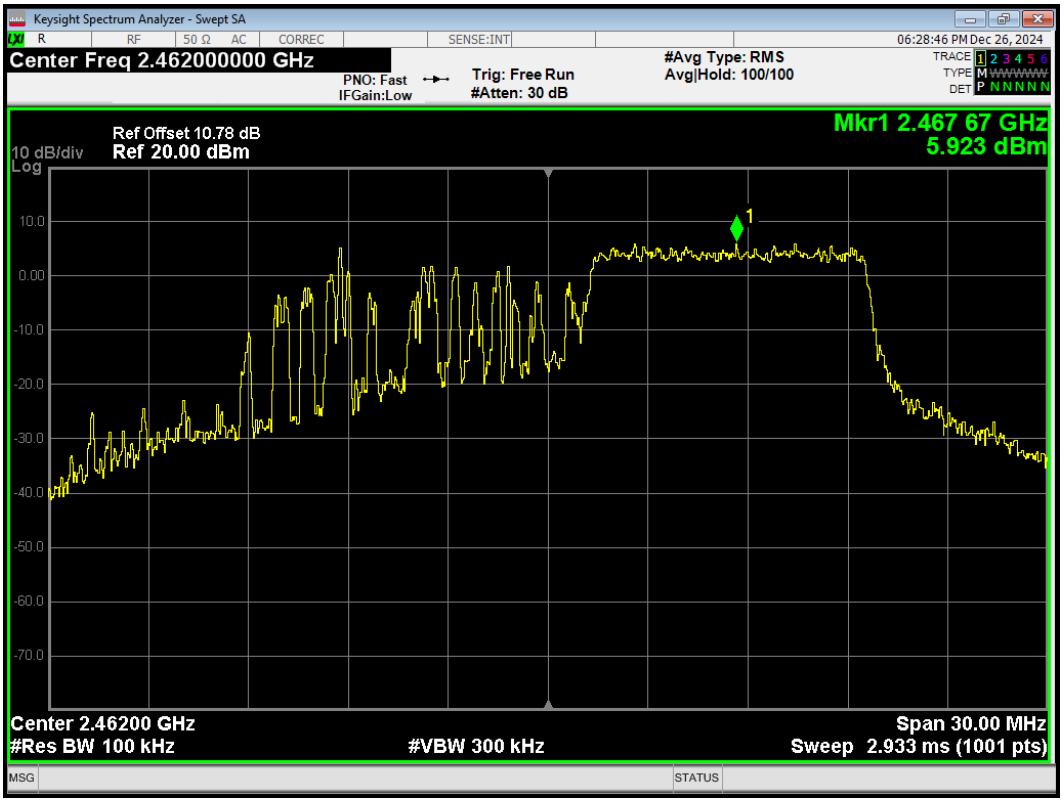
Band Edge 802.11ax(HE20) 106T 2412MHz Ref



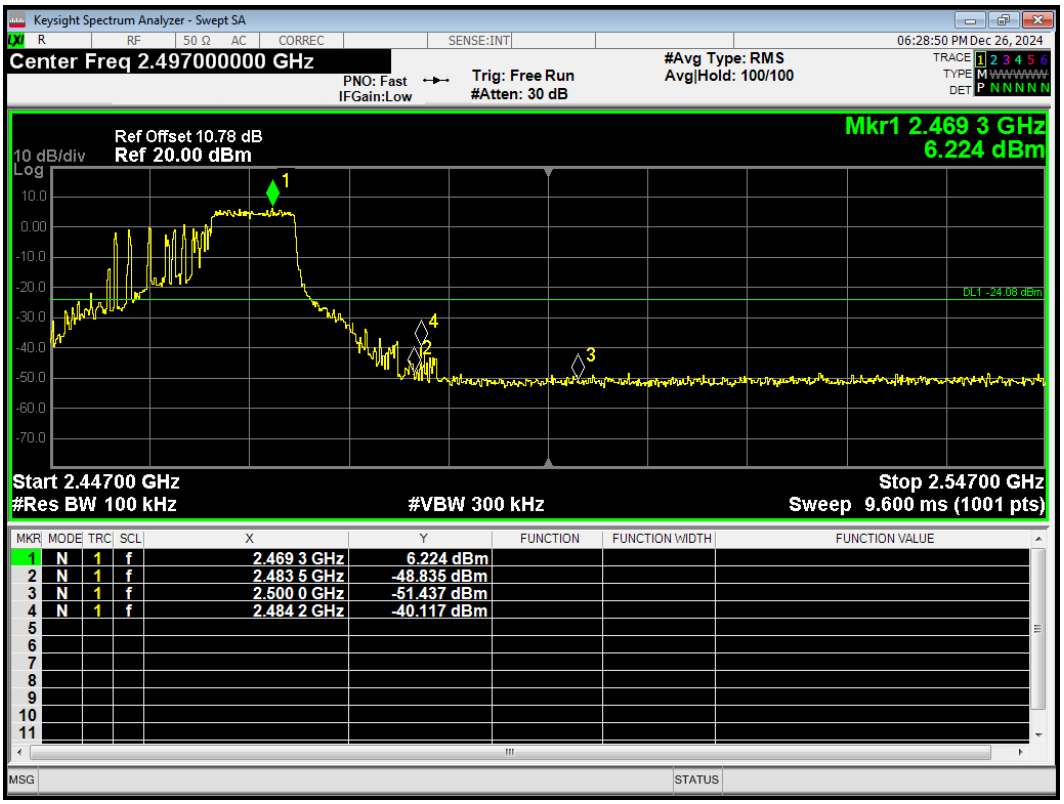
Band Edge 802.11ax(HE20) 106T 2412MHz Emission



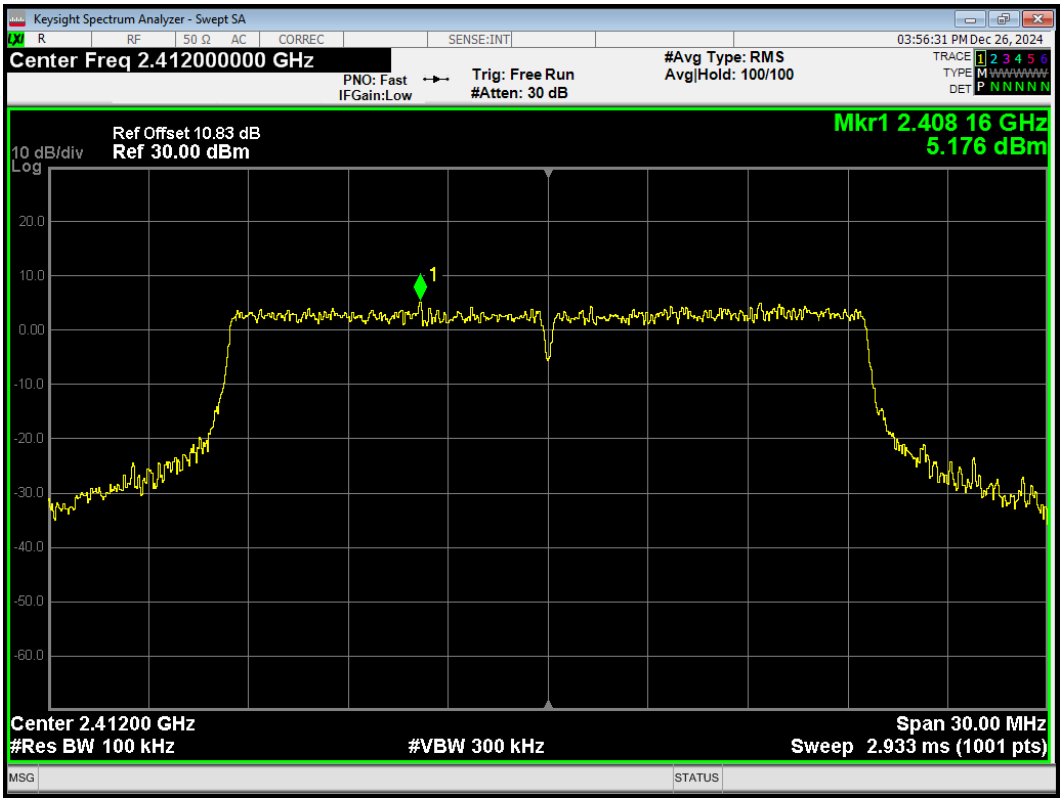
Band Edge 802.11ax(HE20) 106T 2462MHz Ref



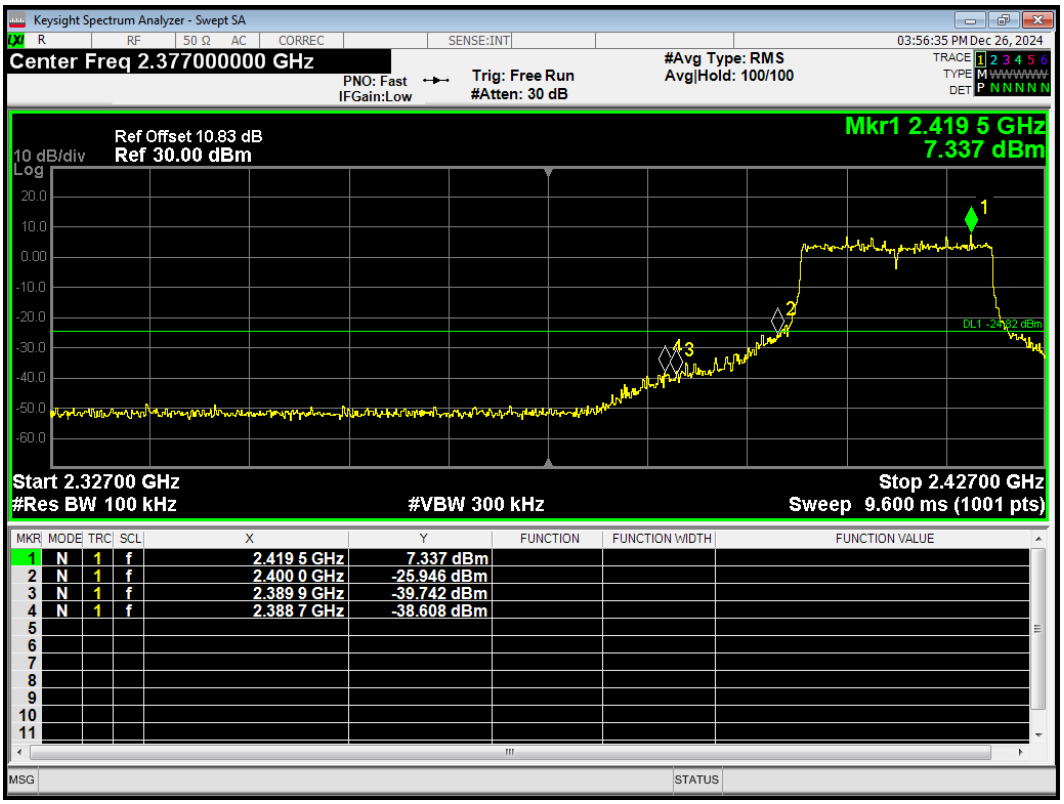
Band Edge 802.11ax(HE20) 106T 2462MHz Emission



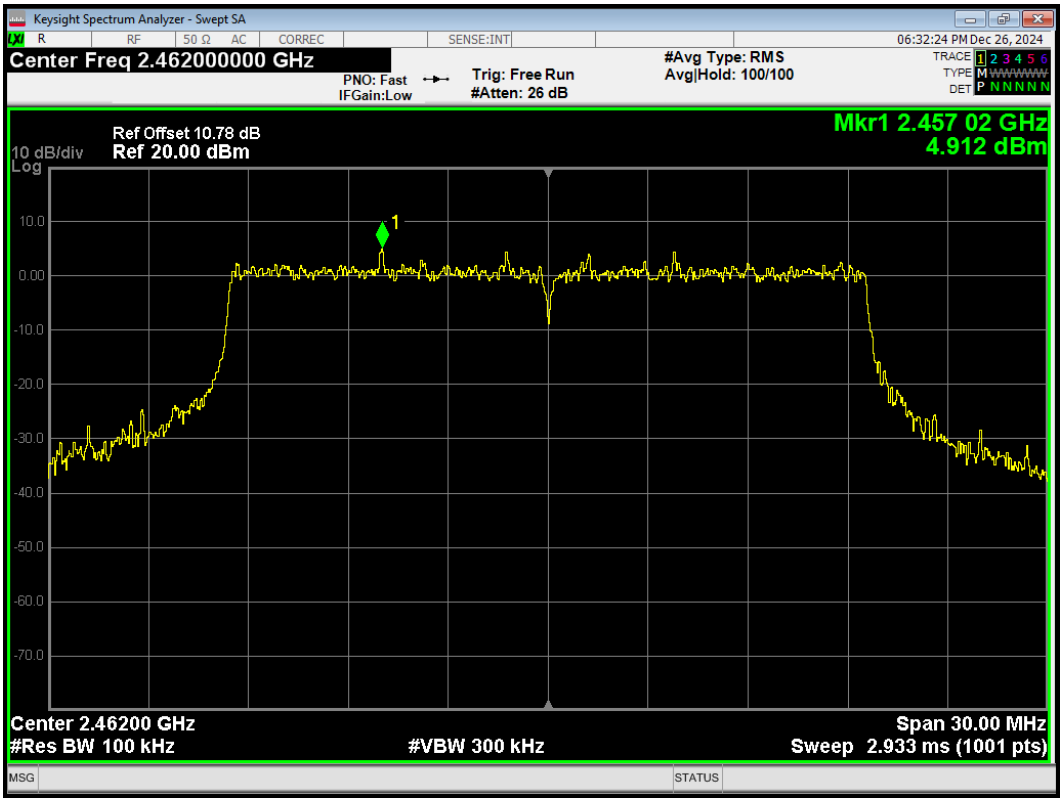
Band Edge 802.11ax(HE20) 242T 2412MHz Ref



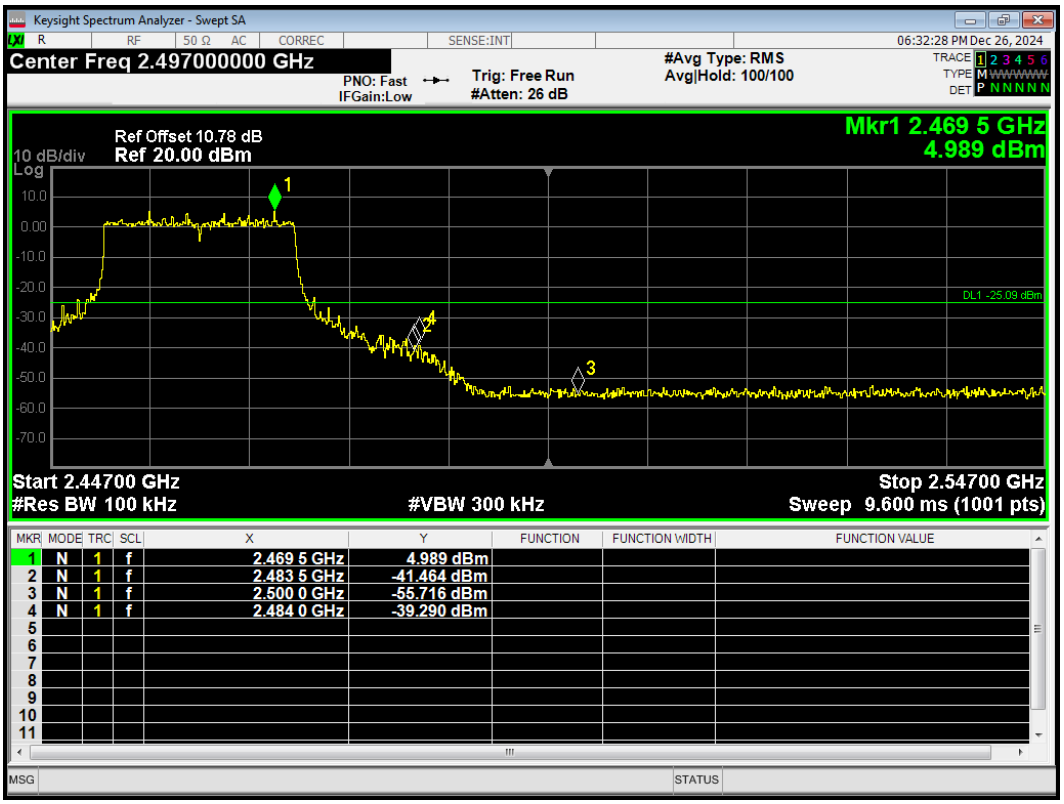
Band Edge 802.11ax(HE20) 242T 2412MHz Emission



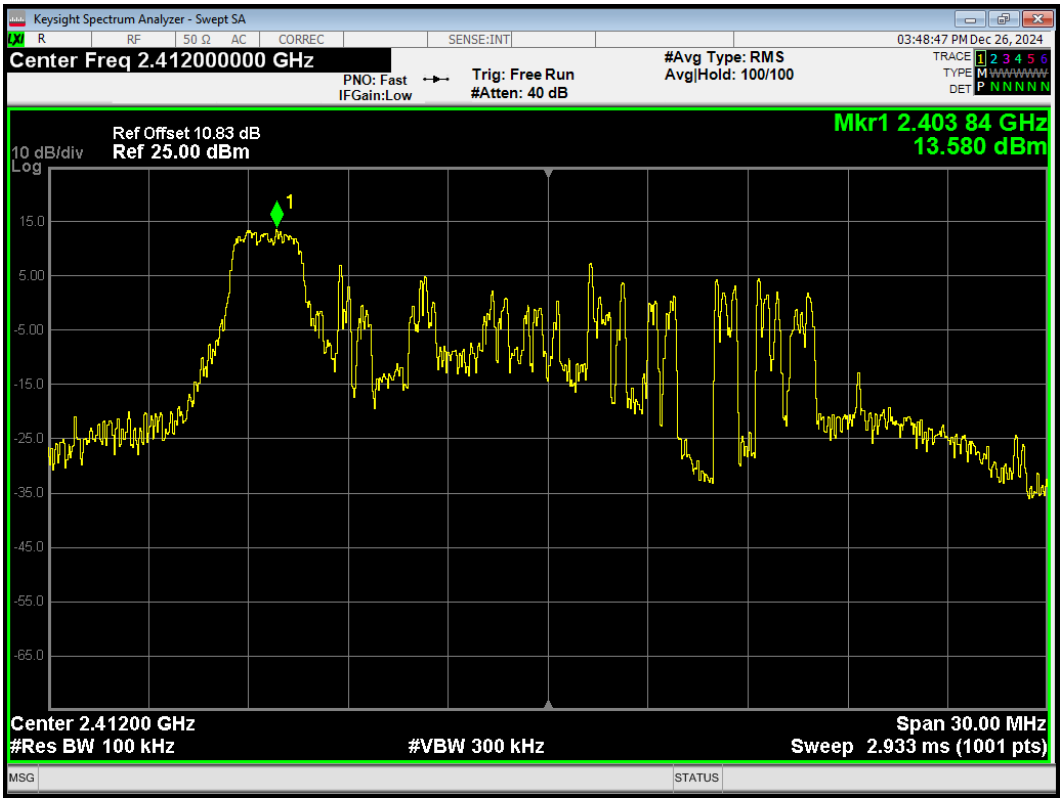
Band Edge 802.11ax(HE20) 242T 2462MHz Ref



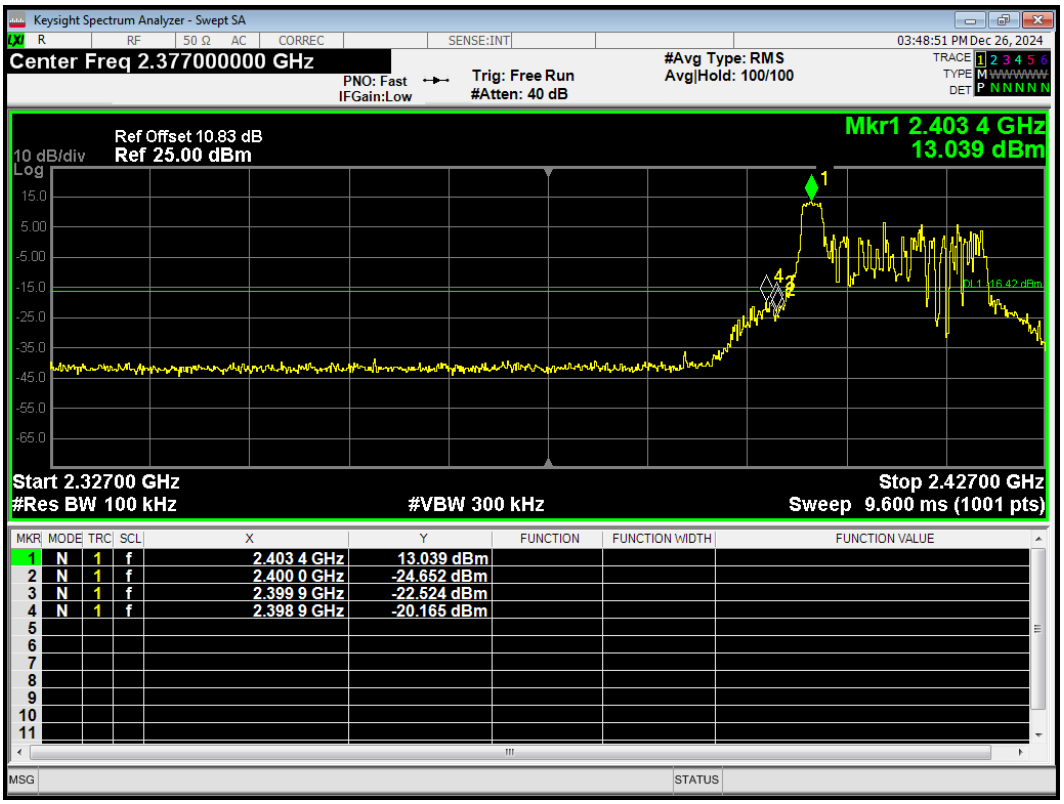
Band Edge 802.11ax(HE20) 242T 2462MHz Emission



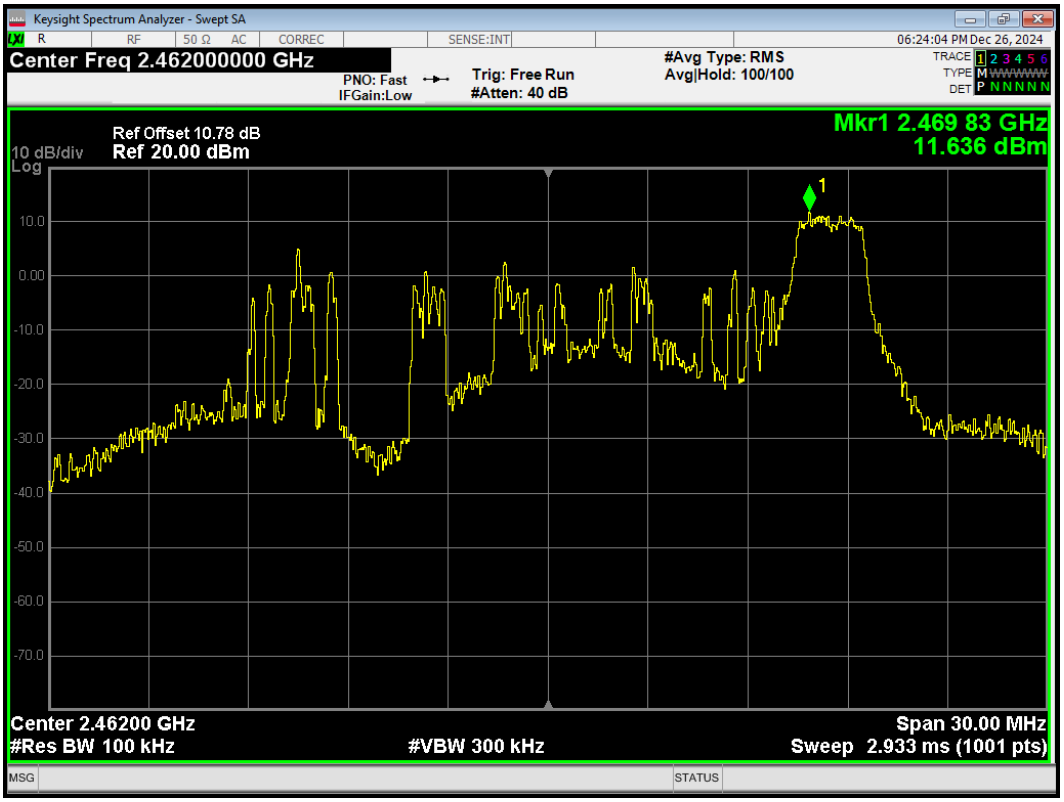
Band Edge 802.11ax(HE20) 26T 2412MHz Ref



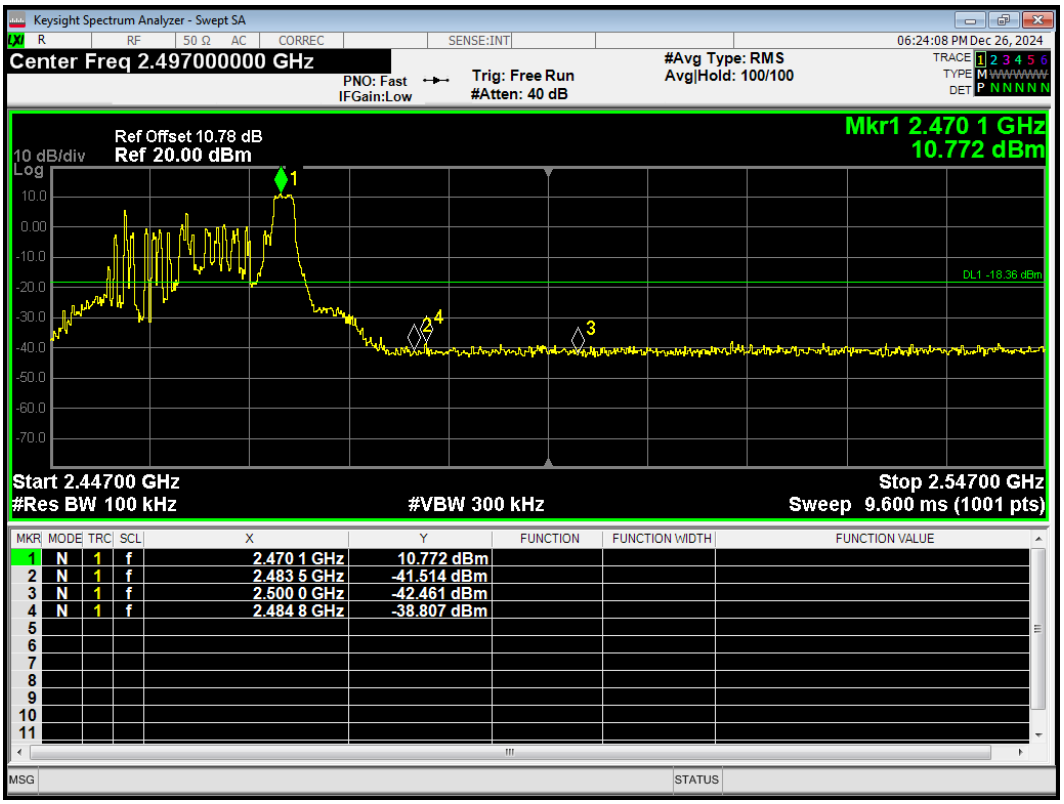
Band Edge 802.11ax(HE20) 26T 2412MHz Emission



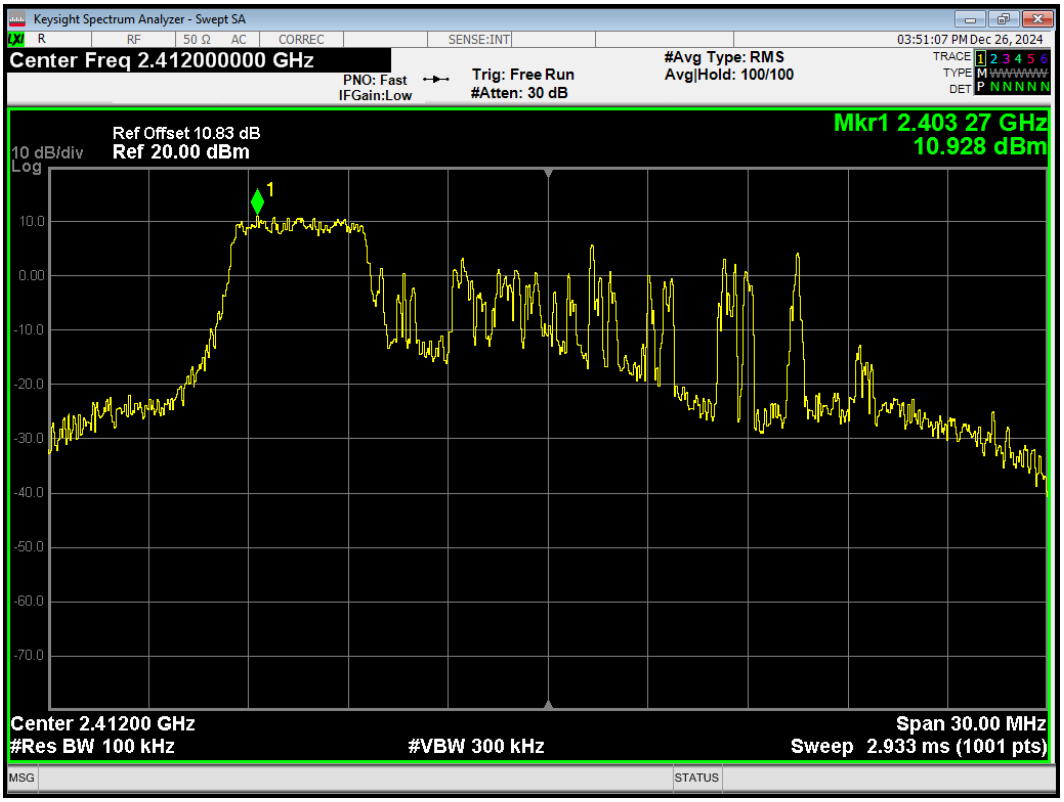
Band Edge 802.11ax(HE20) 26T 2462MHz Ref



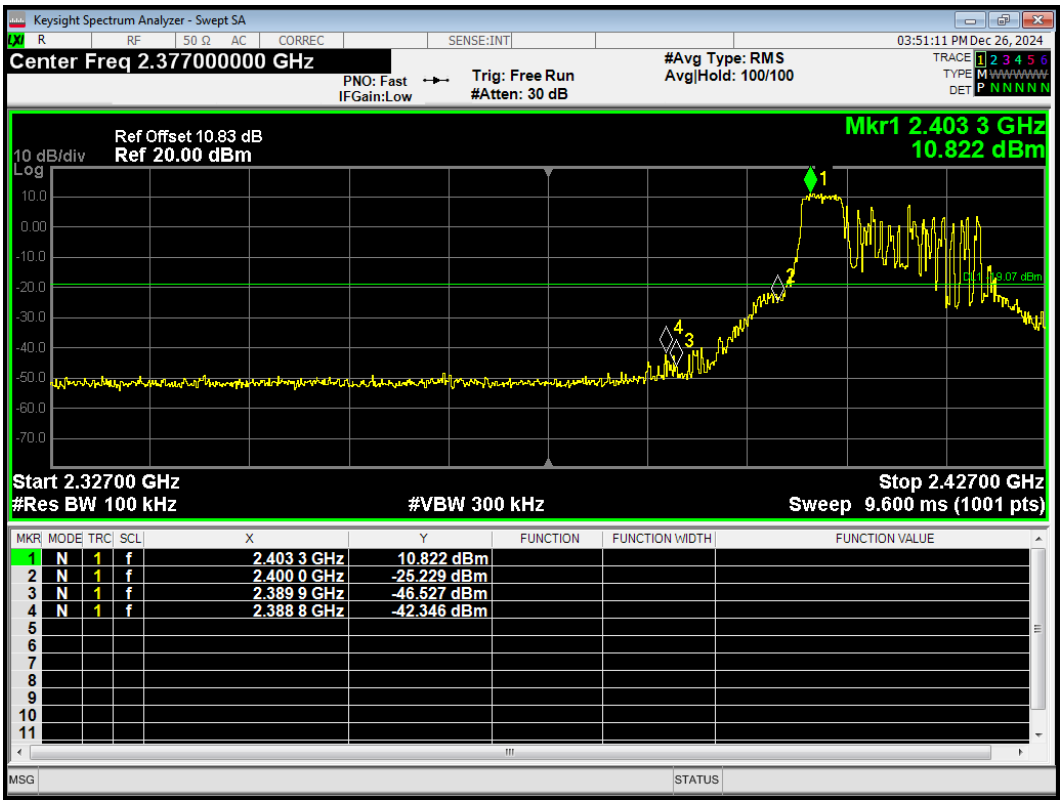
Band Edge 802.11ax(HE20) 26T 2462MHz Emission



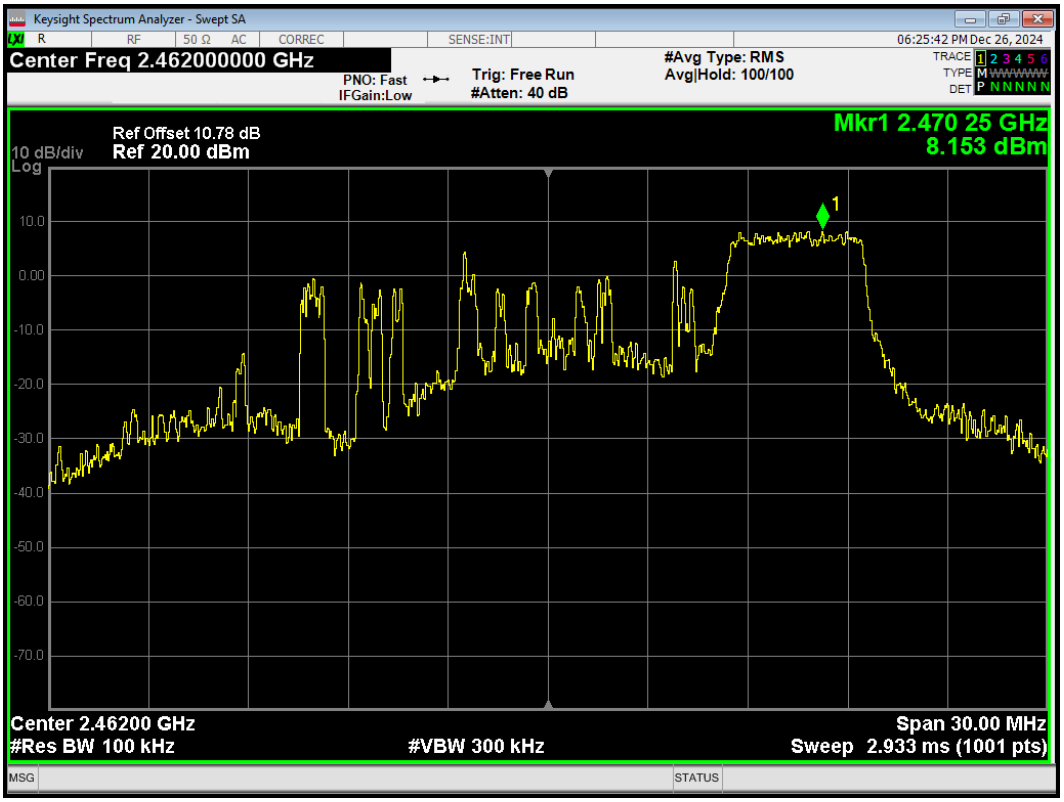
Band Edge 802.11ax(HE20) 52T 2412MHz Ref



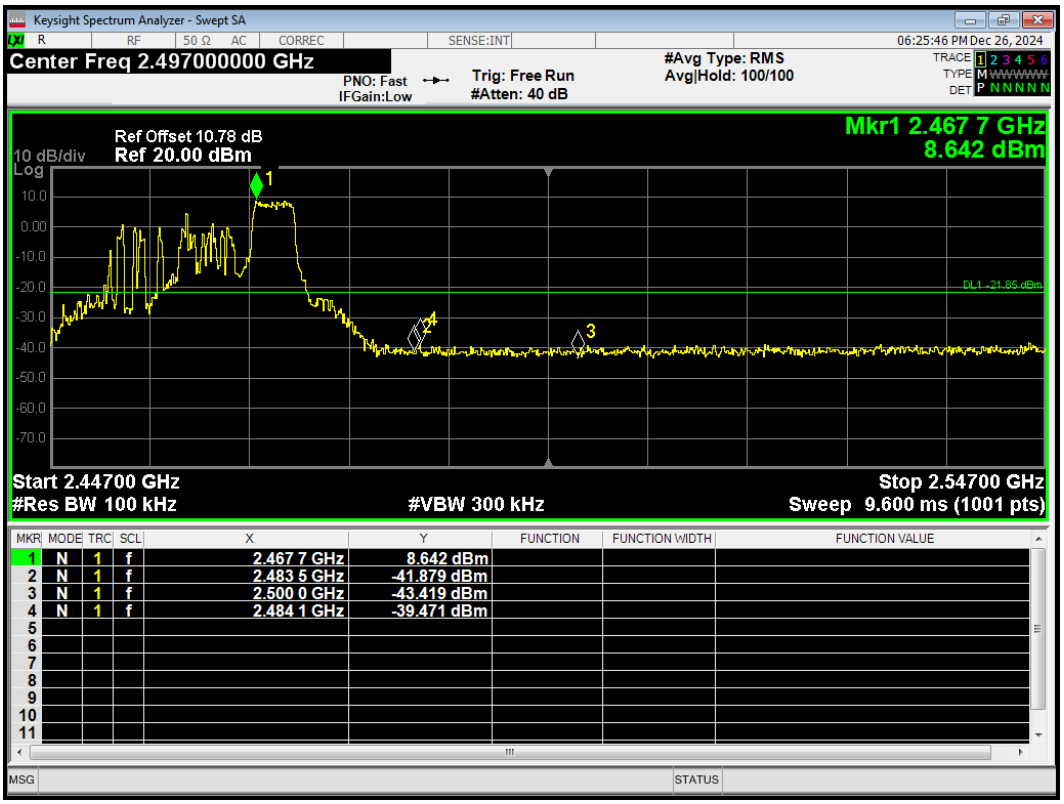
Band Edge 802.11ax(HE20) 52T 2412MHz Emission



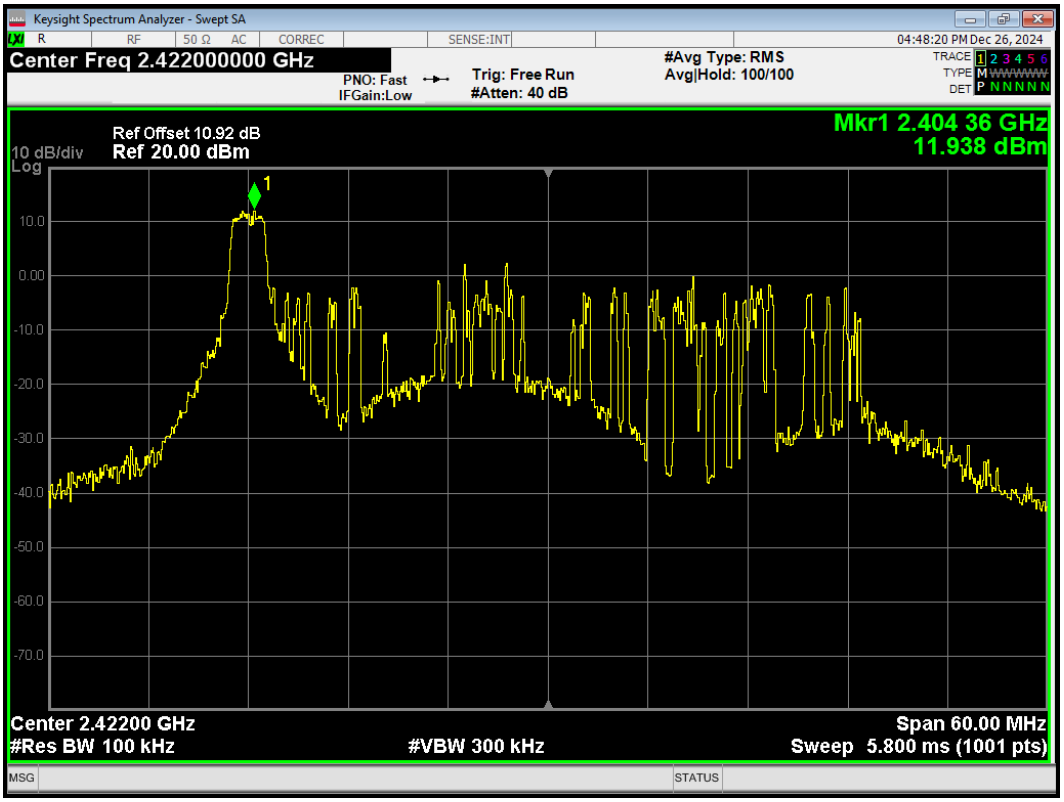
Band Edge 802.11ax(HE20) 52T 2462MHz Ref



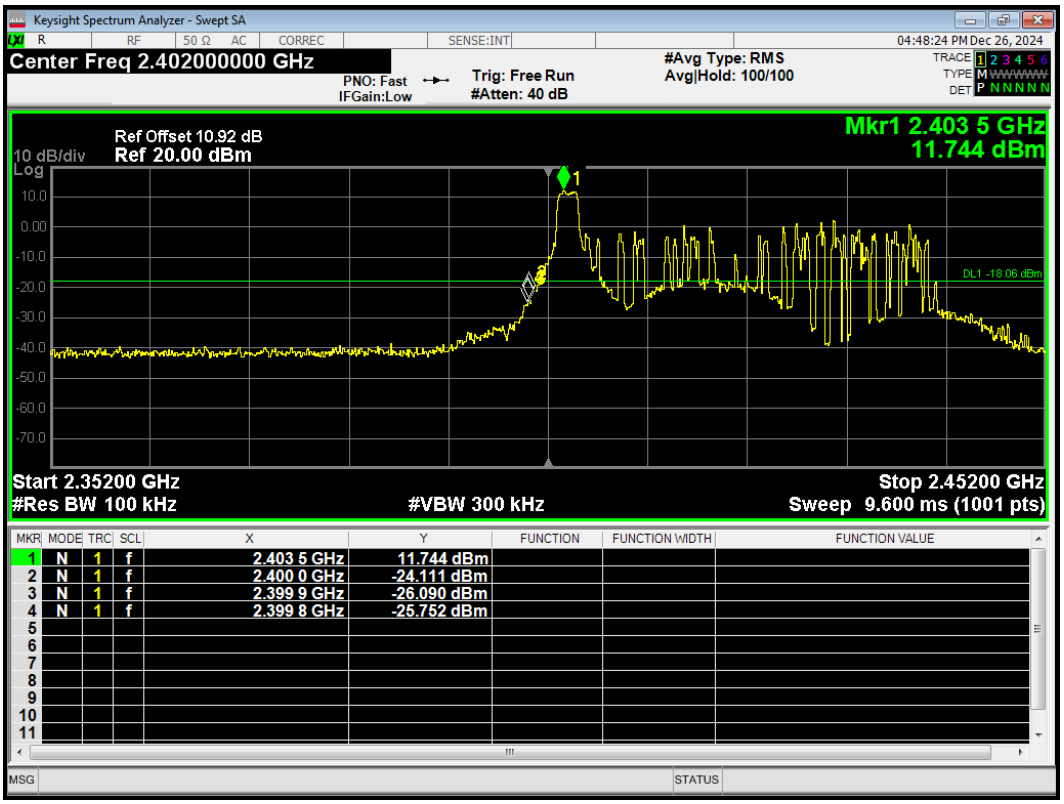
Band Edge 802.11ax(HE20) 52T 2462MHz Emission



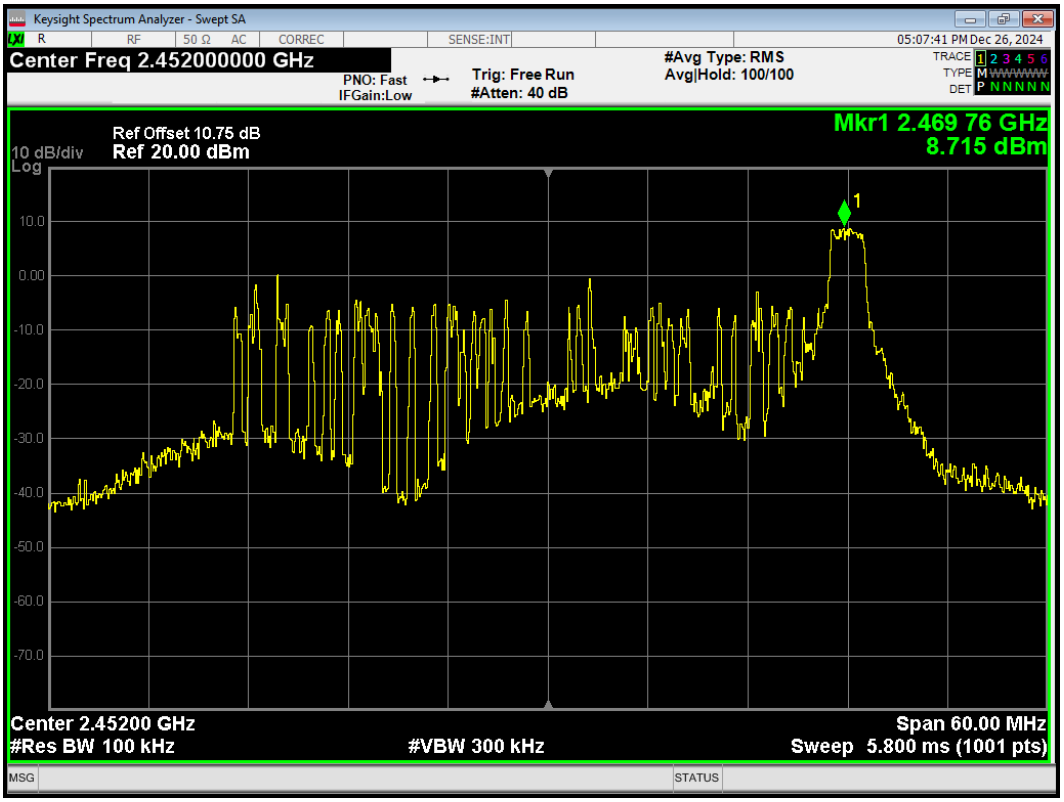
Band Edge 802.11ax(HE40) 26T 2422MHz Ref



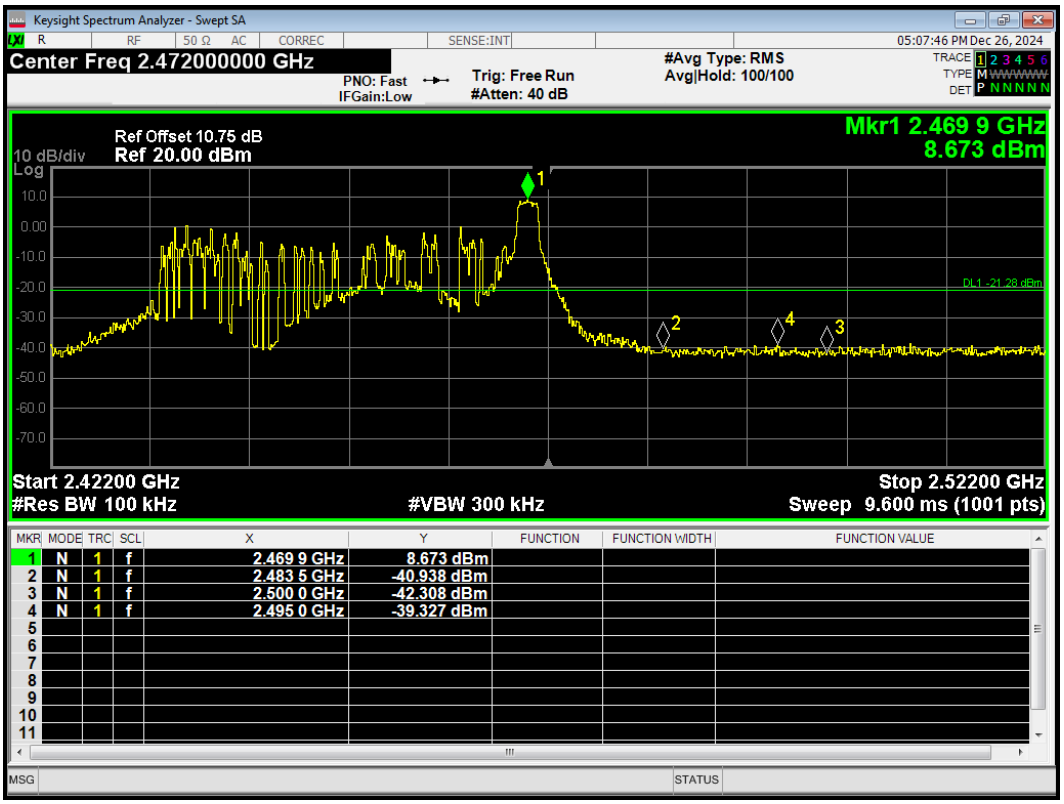
Band Edge 802.11ax(HE40) 26T 2422MHz Emission



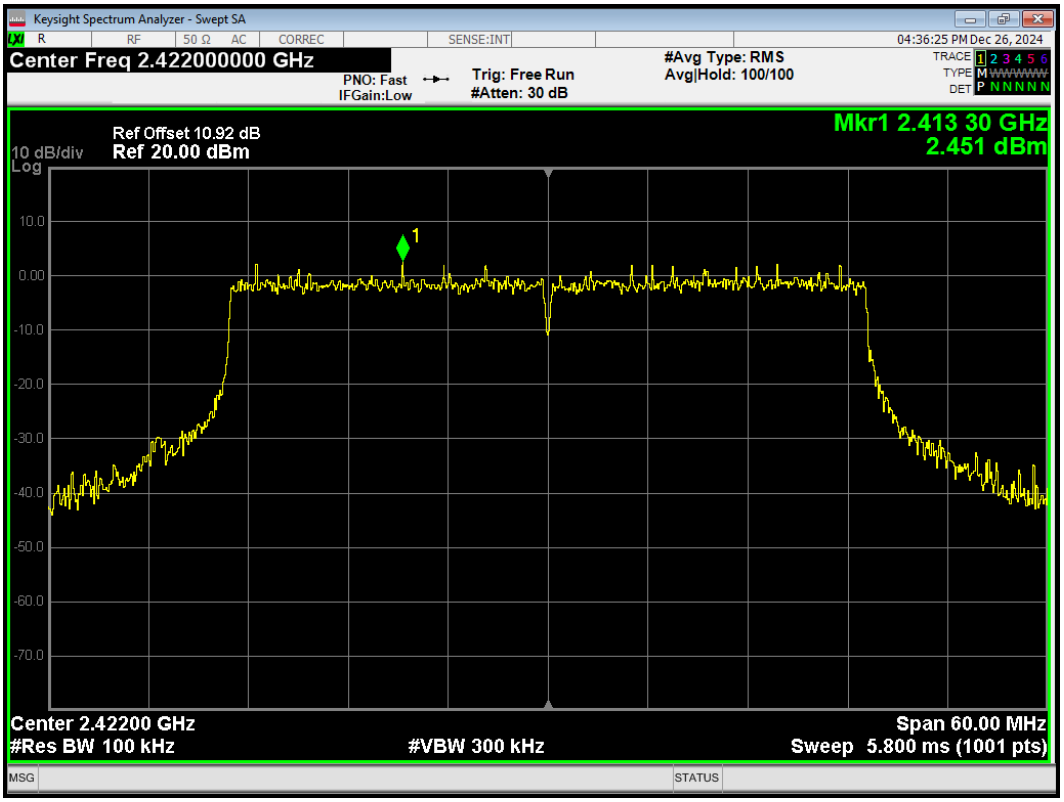
Band Edge 802.11ax(HE40) 26T 2452MHz Ref



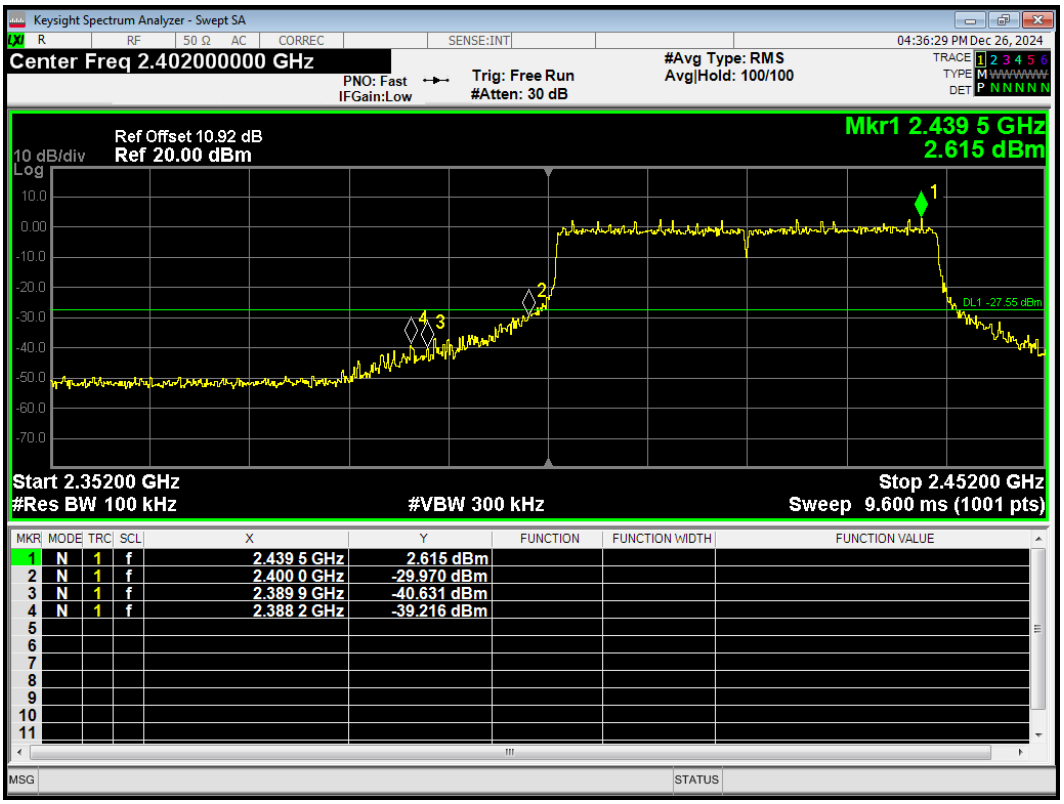
Band Edge 802.11ax(HE40) 26T 2452MHz Emission



Band Edge 802.11ax(HE40) 484T 2422MHz Ref



Band Edge 802.11ax(HE40) 484T 2422MHz Emission



5.4. Power Spectral Density

Ambient Condition

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

Method of Measurement

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

Method AVGPSD-1 was used for this test.

a) Set instrument center frequency to DTS channel center frequency

b) Set span to at least 1.5 times the OBW

c) Set RBW to:3kHz≤RBW≤100kHz

d) Set VBW≥[3x RBW]

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

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

g) Sweep time auto couple

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

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

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

Method AVGPSD-2 was used for this test.

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

b) Set instrument center frequency to DTS channel center frequency

c) Set span to at least 1.5 times the OBW

d) Set RBW to:3kHz≤RBW≤100kHz

e) Set VBW≥[3x RBW]

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

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

h) Sweep time =auto couple

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

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

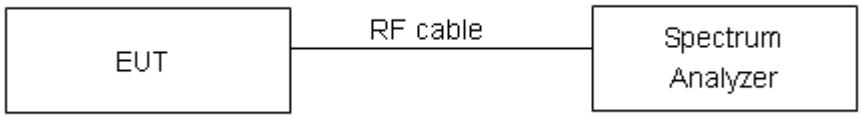
k) Use the peak marker function to determine the maximum amplitude level

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

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

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

Limits	≤ 8 dBm / 3kHz

Measurement Uncertainty

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

Test Results:

Test Mode	Carrier frequency (MHz) / Channel	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy) (1M)	2402/CH0	-12.75	-10.72	8	PASS
	2440/CH19	-10.93	-8.90	8	PASS
	2480/CH39	-11.01	-8.98	8	PASS
Bluetooth (Low Energy) (2M)	2402/CH0	-17.02	-12.20	8	PASS
	2440/CH19	-15.62	-10.80	8	PASS
	2480/CH39	-16.73	-11.91	8	PASS
Bluetooth (Low Energy) (S=2)	2402/CH0	-7.95	-5.51	8	PASS
	2440/CH19	-5.94	-3.50	8	PASS
	2480/CH39	-7.22	-4.78	8	PASS
Bluetooth (Low Energy) (S=8)	2402/CH0	-1.88	-1.06	8	PASS
	2440/CH19	-0.95	-0.13	8	PASS
	2480/CH39	-0.21	0.61	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

SISO Antenna 1

Test Mode	Carrier frequency (MHz) / Channel	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	2412/CH 1	-1.18	-11.18	8	PASS
	2437/CH 6	-1.77	-11.77	8	PASS
	2462/CH11	-2.06	-12.06	8	PASS
802.11g	2412/CH 1	-5.18	-15.18	8	PASS
	2437/CH 6	-5.98	-15.98	8	PASS
	2462/CH11	-5.49	-15.49	8	PASS
802.11n HT20	2412/CH 1	-5.84	-15.84	8	PASS
	2437/CH 6	-5.43	-15.43	8	PASS
	2462/CH11	-5.95	-15.95	8	PASS
802.11n HT40	2422/CH3	-9.81	-19.81	8	PASS
	2437/CH6	-8.61	-18.61	8	PASS
	2452/CH9	-12.21	-22.21	8	PASS
802.11ax HE20	2412/CH 1	-6.86	-16.86	8	PASS
	2437/CH 6	-7.01	-17.01	8	PASS
	2462/CH11	-8.88	-18.88	8	PASS
802.11ax HE40	2422/CH3	-11.49	-21.49	8	PASS
	2437/CH6	-9.91	-19.91	8	PASS
	2452/CH9	-13.67	-23.67	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30)					

SISO Antenna 2

Test Mode	Carrier frequency (MHz) / Channel	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	2412/CH 1	-1.17	-11.17	8	PASS
	2437/CH 6	-1.54	-11.54	8	PASS
	2462/CH11	-1.77	-11.77	8	PASS
802.11g	2412/CH 1	-5.44	-15.44	8	PASS
	2437/CH 6	-5.18	-15.18	8	PASS
	2462/CH11	-5.47	-15.47	8	PASS
802.11n HT20	2412/CH 1	-5.76	-15.76	8	PASS
	2437/CH 6	-5.73	-15.73	8	PASS
	2462/CH11	-5.85	-15.85	8	PASS
802.11n HT40	2422/CH3	-9.39	-19.39	8	PASS
	2437/CH6	-8.44	-18.44	8	PASS
	2452/CH9	-11.83	-21.83	8	PASS
802.11ax HE20	2412/CH 1	-7.19	-17.19	8	PASS
	2437/CH 6	-6.74	-16.74	8	PASS
	2462/CH11	-8.35	-18.35	8	PASS
802.11ax HE40	2422/CH3	-10.83	-20.83	8	PASS
	2437/CH6	-9.94	-19.94	8	PASS
	2452/CH9	-13.40	-23.40	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30)					

MIMO

Test Mode	Carrier frequency (MHz))/ Channel	Power Spectral Density				Total PSD	Limit (dBm / 3kHz)	Conclusion
		Antenna 1		Antenna 2				
		Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	(dBm / 3kHz)		
802.11b	2412/CH 1	-1.43	-11.43	-2.49	-12.49	-8.92	8	PASS
	2437/CH 6	-1.72	-11.72	-2.05	-12.05	-8.87	8	PASS
	2462/CH11	-1.48	-11.48	-1.62	-11.62	-8.54	8	PASS
802.11g	2412/CH 1	-4.94	-14.94	-5.10	-15.10	-12.01	8	PASS
	2437/CH 6	-5.57	-15.57	-5.32	-15.32	-12.43	8	PASS
	2462/CH11	-5.86	-15.86	-5.63	-15.63	-12.73	8	PASS
802.11n HT20	2412/CH 1	-5.77	-15.77	-5.59	-15.59	-12.67	8	PASS
	2437/CH 6	-5.42	-15.42	-5.68	-15.68	-12.53	8	PASS
	2462/CH11	-6.38	-16.38	-6.19	-16.19	-13.27	8	PASS
802.11n HT40	2422/CH3	-9.55	-19.55	-9.66	-19.66	-16.60	8	PASS
	2437/CH6	-8.40	-18.40	-8.31	-18.31	-15.34	8	PASS
	2452/CH9	-11.78	-21.78	-11.94	-21.94	-18.85	8	PASS
802.11ax HE20	2412/CH 1	-7.03	-17.03	-6.73	-16.73	-13.87	8	PASS
	2437/CH 6	-6.97	-16.97	-7.01	-17.01	-13.98	8	PASS
	2462/CH11	-8.71	-18.71	-8.28	-18.28	-15.48	8	PASS
802.11ax HE40	2422/CH3	-11.34	-21.34	-11.32	-21.32	-18.31	8	PASS
	2437/CH6	-9.75	-19.75	-9.78	-19.78	-16.75	8	PASS
	2452/CH9	-13.53	-23.53	-13.43	-23.43	-20.47	8	PASS

Note: 1.Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*LOG10(3 / 30)

2. For Total PSD, according to KDB 662911 D01 Multiple Transmitter Output v02r01 2)a),the power spectral density=10log($10^{(\text{PSD antenna1 in dBm/10})}$+$10^{(\text{PSD antenna2 in dBm/10})}$)

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 PSD measurements on all devices, Array Gain=10log(Nant/Nss)dB, so directional gain=$G_{ANT\ MAX}$+Array Gain=2.80+10log(3/1)=5.81 >6dBi.

So the PSD limit is 8+6-MAX(6, directional gain) dBm=6.23 dBm

TB Mode

SISO Antenna 1

Test Mode	Carrier frequency (MHz) / Channel	RU Index	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11ax HE20 26-Tones	2412/CH 1	0	2.43	-7.57	8	PASS
	2437/CH 6	4	1.77	-8.23	8	PASS
	2462/CH11	8	-0.05	-10.05	8	PASS
802.11ax HE20 52-Tones	2412/CH 1	37	-0.96	-10.96	8	PASS
	2437/CH 6	38	-1.22	-11.22	8	PASS
	2462/CH11	40	-3.00	-13.00	8	PASS
802.11ax HE20 106-Tones	2412/CH 1	53	-3.94	-13.94	8	PASS
	2437/CH 6	53	-3.55	-13.55	8	PASS
	2462/CH11	54	-6.21	-16.21	8	PASS
802.11ax HE20 242-Tones	2412/CH 1	61	-6.45	-16.45	8	PASS
	2437/CH 6	61	-7.06	-17.06	8	PASS
	2462/CH11	61	-8.64	-18.64	8	PASS
802.11ax HE40 26-Tones	2422/CH3	0	0.72	-9.28	8	PASS
	2452/CH9	17	-2.30	-12.30	8	PASS
802.11ax HE40 484-Tones	2422/CH3	65	-11.21	-21.21	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30)						

SISO Antenna 2

Test Mode	Carrier frequency (MHz) / Channel	RU Index	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11ax HE20 26-Tones	2412/CH 1	0	1.37	-8.63	8	PASS
	2437/CH 6	4	1.19	-8.81	8	PASS
	2462/CH11	8	-0.48	-10.48	8	PASS
802.11ax HE20 52-Tones	2412/CH 1	37	-1.51	-11.51	8	PASS
	2437/CH 6	38	-1.59	-11.59	8	PASS
	2462/CH11	40	-3.60	-13.60	8	PASS
802.11ax HE20 106-Tones	2412/CH 1	53	-4.72	-14.72	8	PASS
	2437/CH 6	53	-4.42	-14.42	8	PASS
	2462/CH11	54	-6.57	-16.57	8	PASS
802.11ax HE20 242-Tones	2412/CH 1	61	-6.94	-16.94	8	PASS
	2437/CH 6	61	-7.50	-17.50	8	PASS
	2462/CH11	61	-8.84	-18.84	8	PASS
802.11ax HE40 26-Tones	2422/CH3	0	0.06	-9.94	8	PASS
	2452/CH9	17	-2.26	-12.26	8	PASS
802.11ax HE40 484-Tones	2422/CH3	65	-10.98	-20.98	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30)						

MIMO Mode

Test Mode	Carrier frequency (MHz)	RU Index	Power Spectral Density				Total PSD	Limit (dBm / 3kHz)	Conclusion
			Antenna 1		Antenna 2				
			Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	(dBm / 3kHz)		
802.11ax HE20 26-Tones	2412	0	1.76	-8.24	1.08	-8.92	-5.56	8	PASS
	2437	4	1.40	-8.60	1.02	-8.98	-5.78	8	PASS
	2462	8	-0.39	-10.39	-1.00	-11.00	-7.67	8	PASS
802.11ax HE20 52-Tones	2412	37	-1.09	-11.09	-1.86	-11.86	-8.45	8	PASS
	2437	39	-1.31	-11.31	-1.52	-11.52	-8.40	8	PASS
	2462	40	-3.21	-13.21	-3.52	-13.52	-10.35	8	PASS
802.11ax HE20 106-Tones	2412	53	-3.87	-13.87	-4.74	-14.74	-11.27	8	PASS
	2437	53	-3.78	-13.78	-4.15	-14.15	-10.95	8	PASS
	2462	54	-5.70	-15.70	-6.56	-16.56	-13.10	8	PASS
802.11ax HE20 242-Tones	2412	61	-6.89	-16.89	-7.35	-17.35	-14.10	8	PASS
	2437	61	-7.35	-17.35	-6.78	-16.78	-14.05	8	PASS
	2462	61	-9.19	-19.19	-9.46	-19.46	-16.31	8	PASS
802.11ax HE40 26-Tones	2422	0	0.19	-9.81	-0.40	-10.40	-7.08	8	PASS
	2452	17	-2.73	-12.73	-2.32	-12.32	-9.51	8	PASS
802.11ax HE40 484-Tones	2422	65	-11.28	-21.28	-11.31	-21.31	-18.28	8	PASS

Note: 1. Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*LOG10(3 / 30)

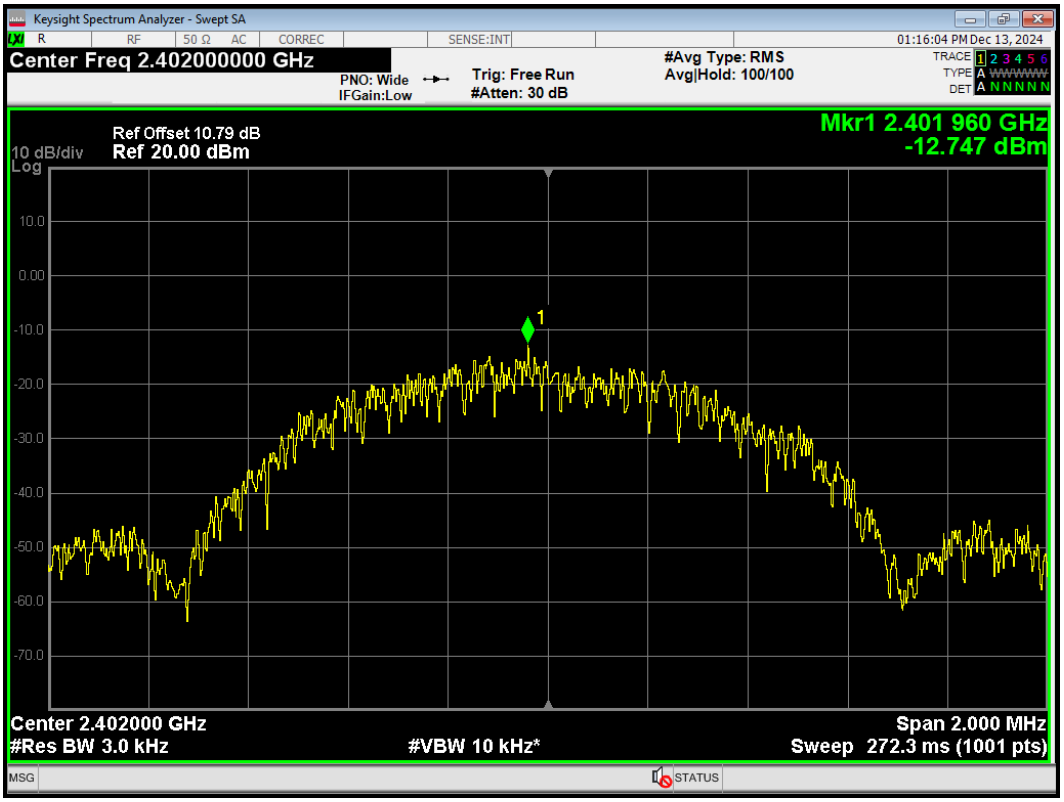
2. For Total PSD, according to KDB 662911 D01 Multiple Transmitter Output v02r01 2)a),the power spectral density=$10\log(10^{(\text{PSD antenna1 in dBm/10})}+10^{(\text{PSD antenna2 in dBm/10})}$.

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.

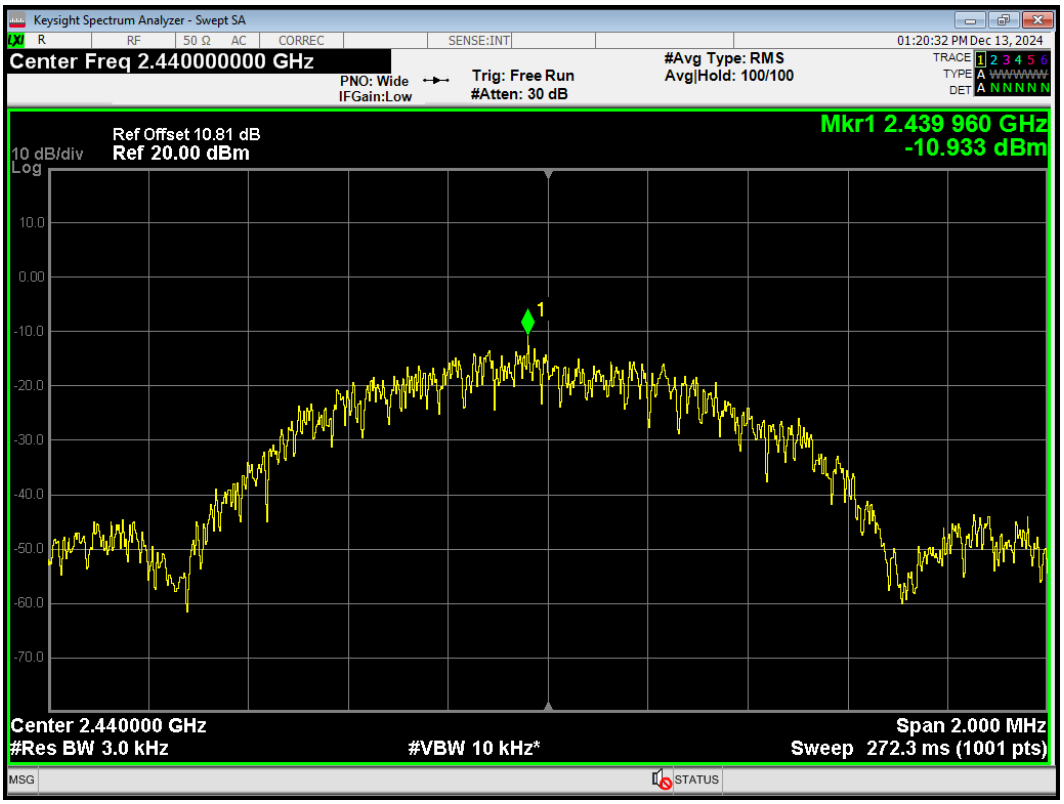
Directional gain = $G_{ANT\ MAX}$ + Array Gain. For PSD measurements on all devices, Array Gain=10log(Nant/Nss)dB, so directional gain=$G_{ANT\ MAX}$+Array Gain=2.80+10log(2/1)=5.81 <6dBi.

So the PSD limit is 8+6-MAX(6, directional gain) dBm=8 dBm / 3kHz

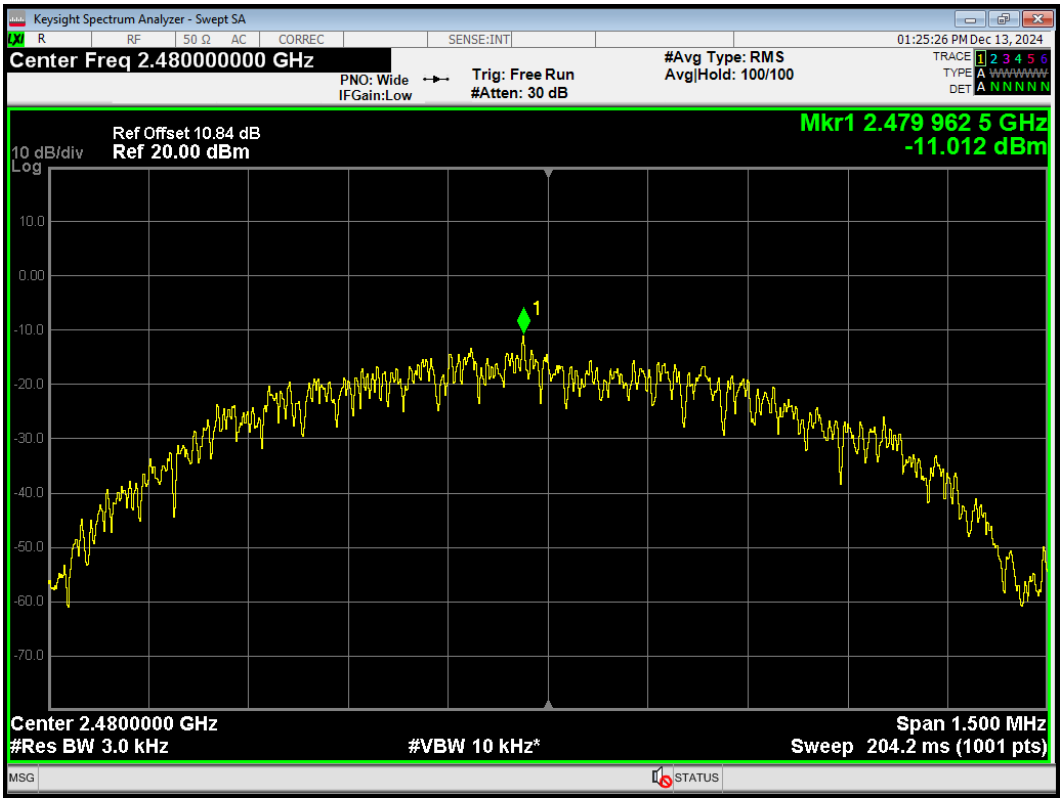
PSD Bluetooth LE (1M) 2402MHz



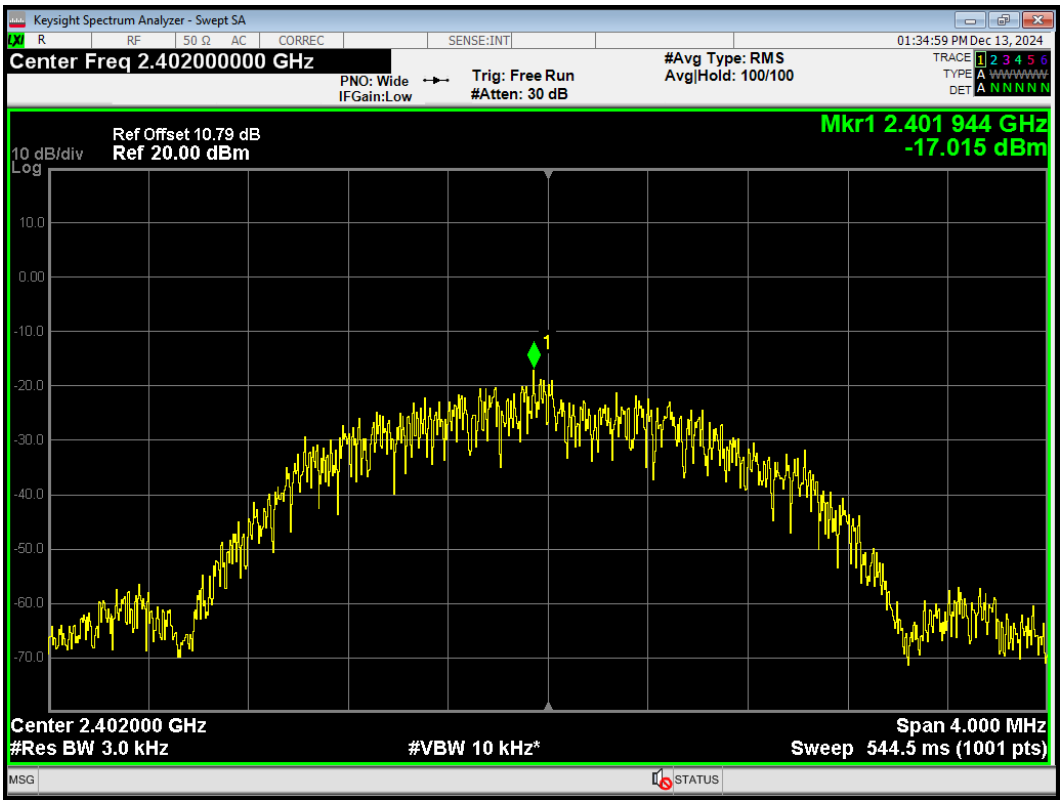
PSD Bluetooth LE (1M) 2440MHz



PSD Bluetooth LE (1M) 2480MHz



PSD Bluetooth LE (2M) 2402MHz



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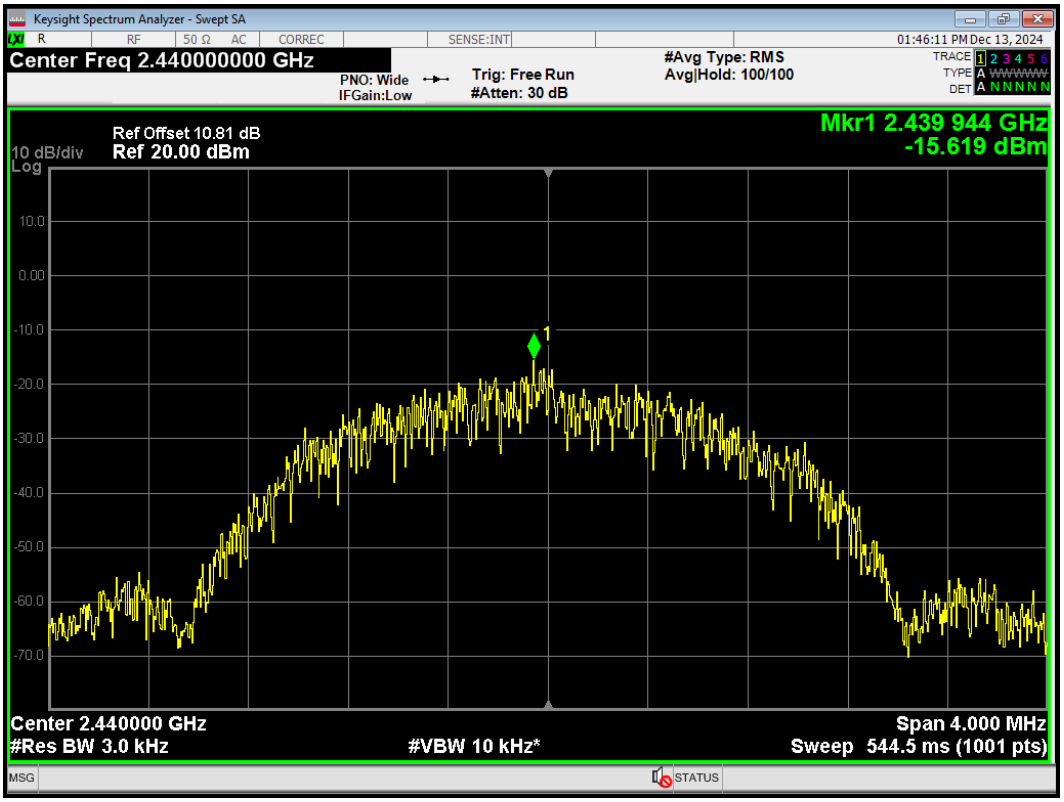

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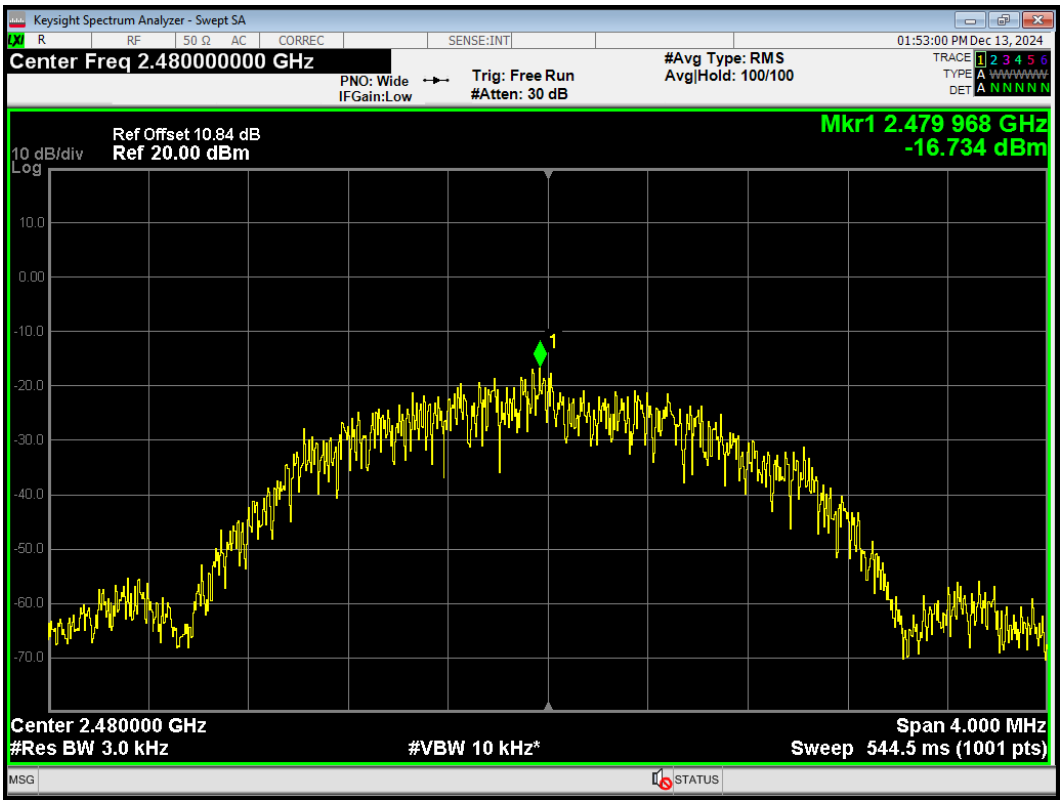
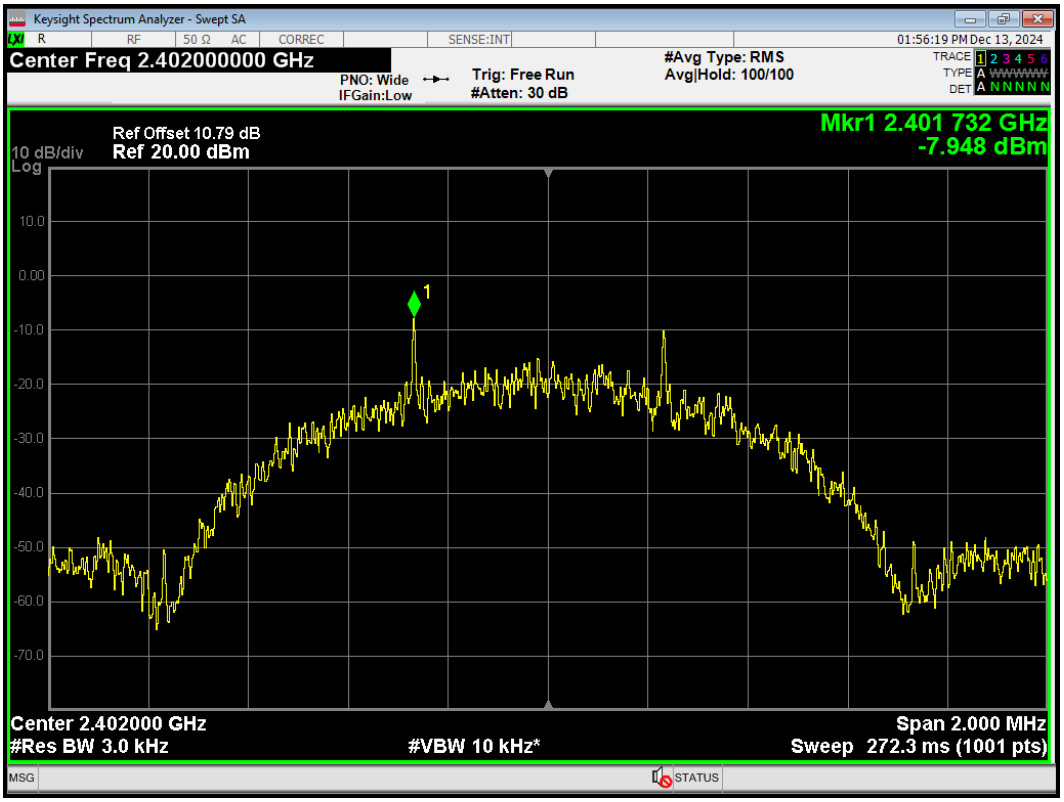


PSD Bluetooth LE (S=2) 2402MHz



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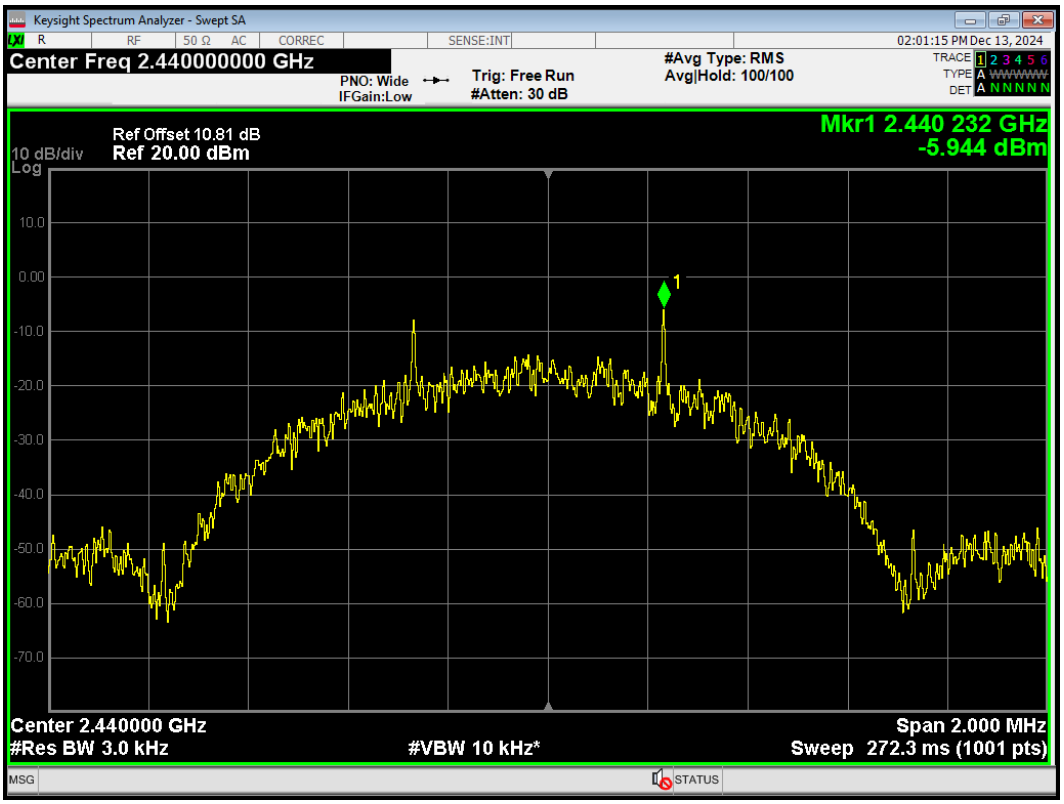

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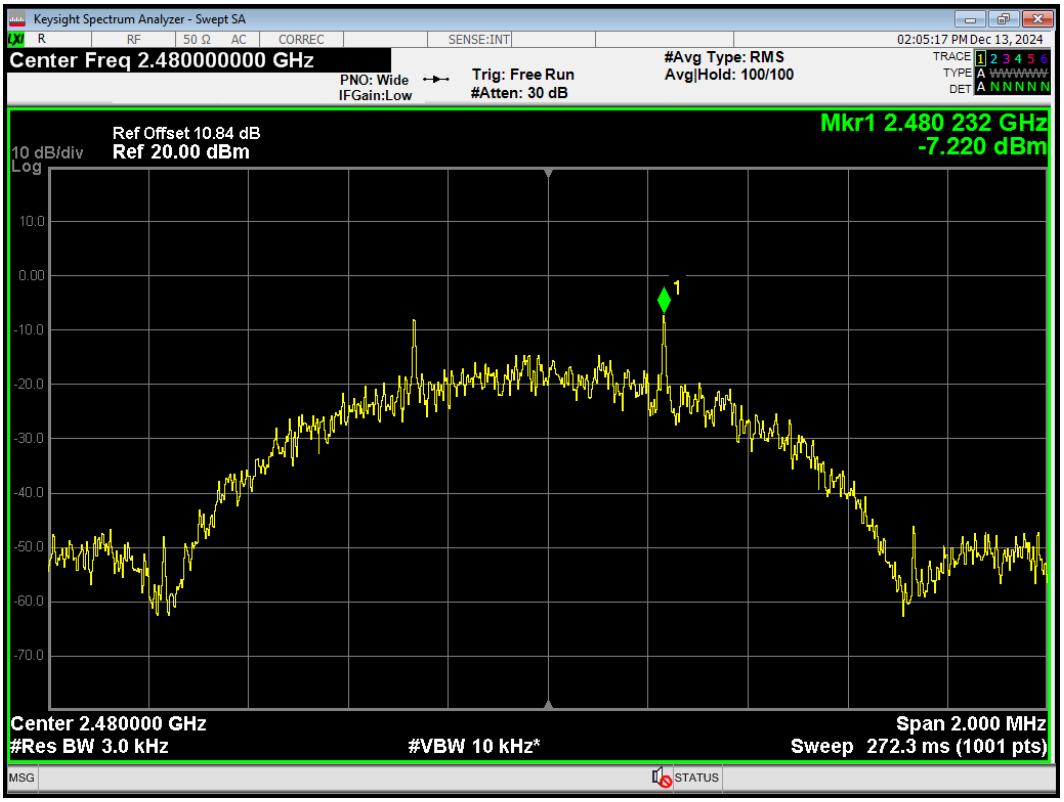
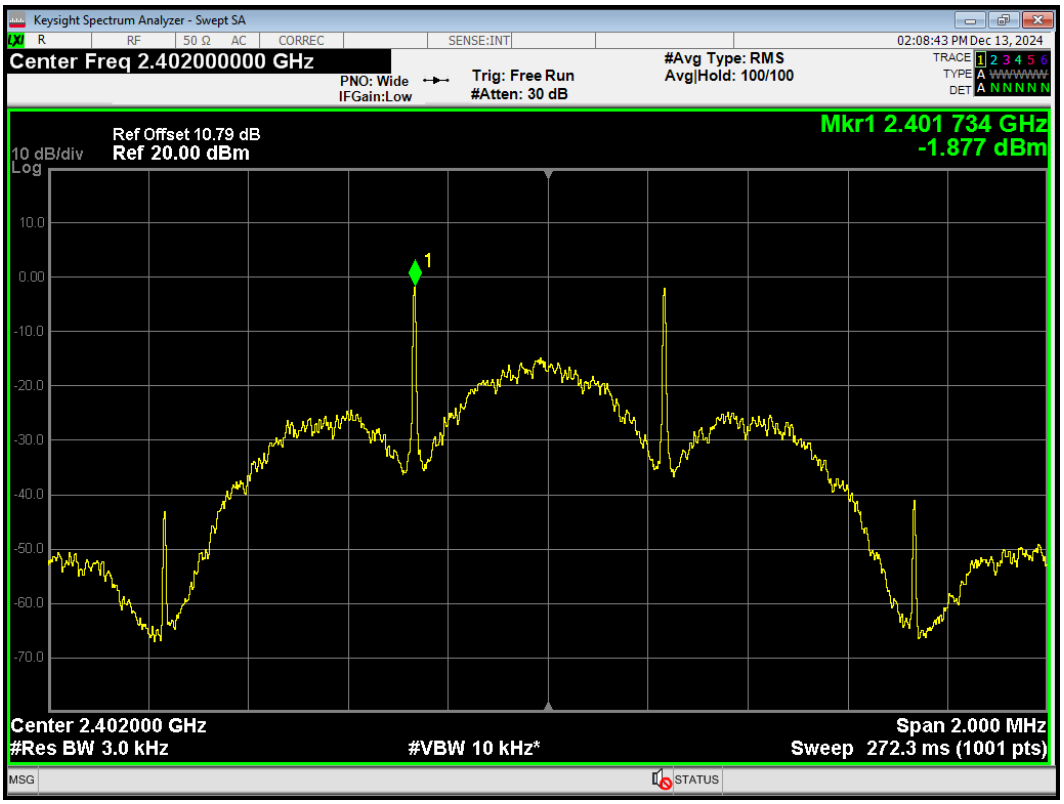


PSD Bluetooth LE (S=8) 2402MHz



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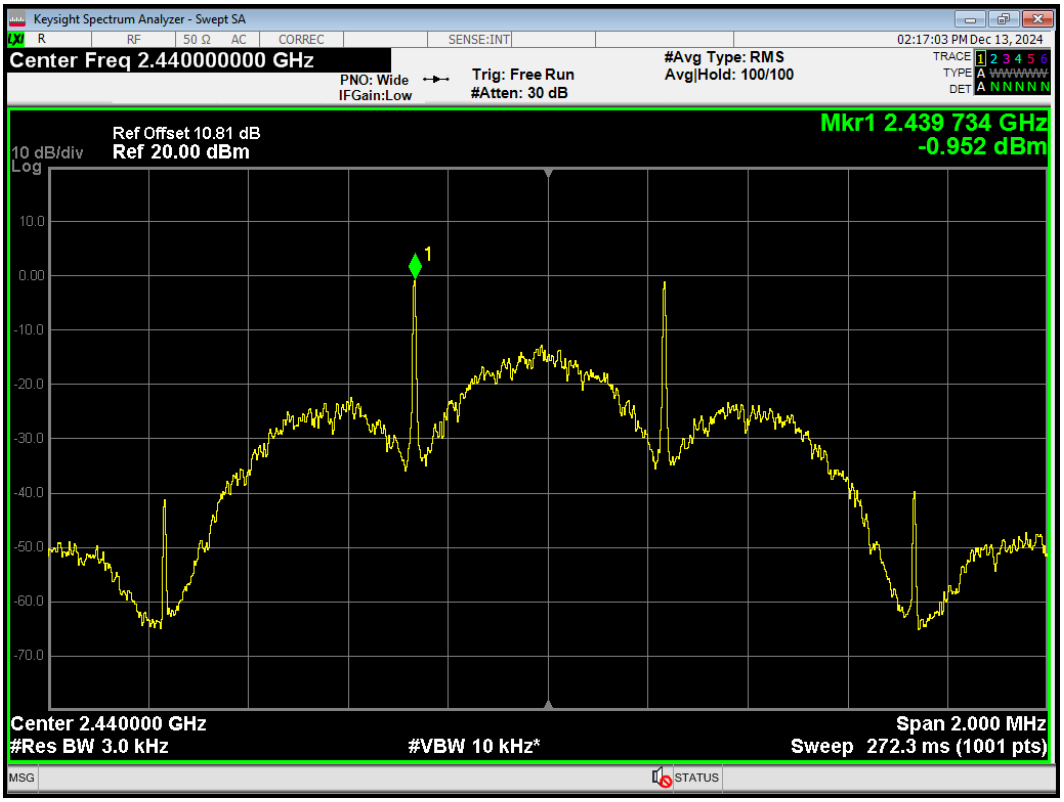
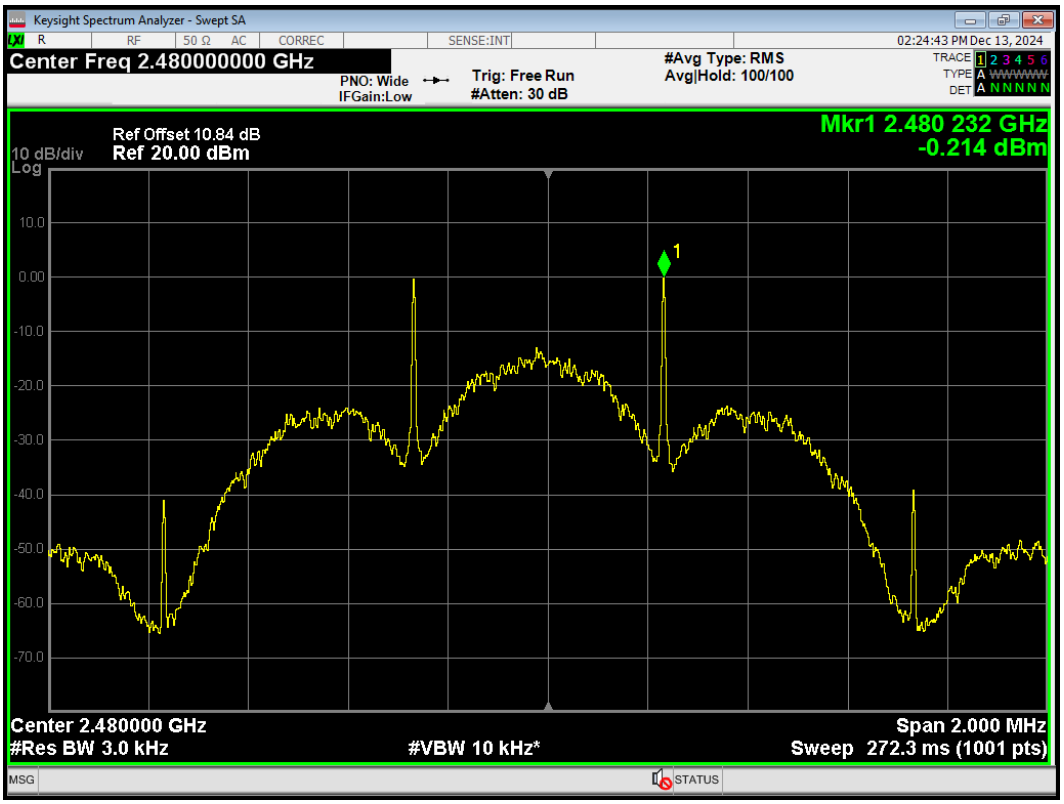
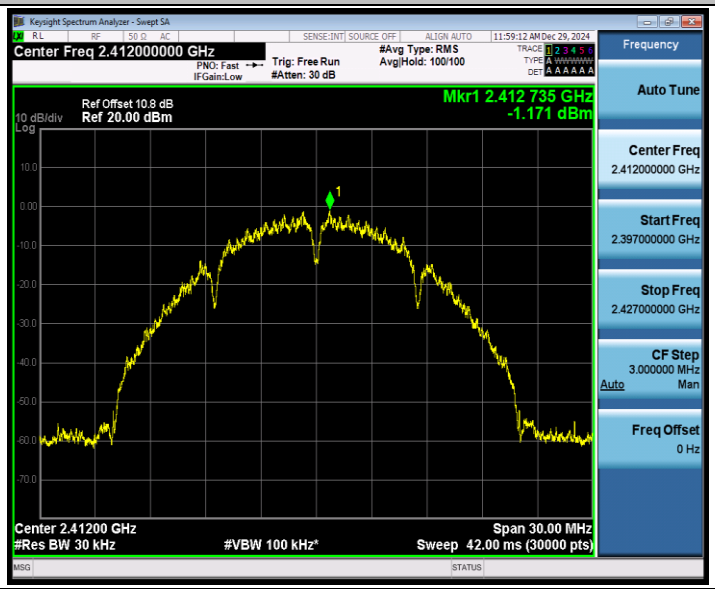


PSD Bluetooth LE (S=8) 2480MHz



802.11b _Ant1_2412

802.11b _Ant2_2412



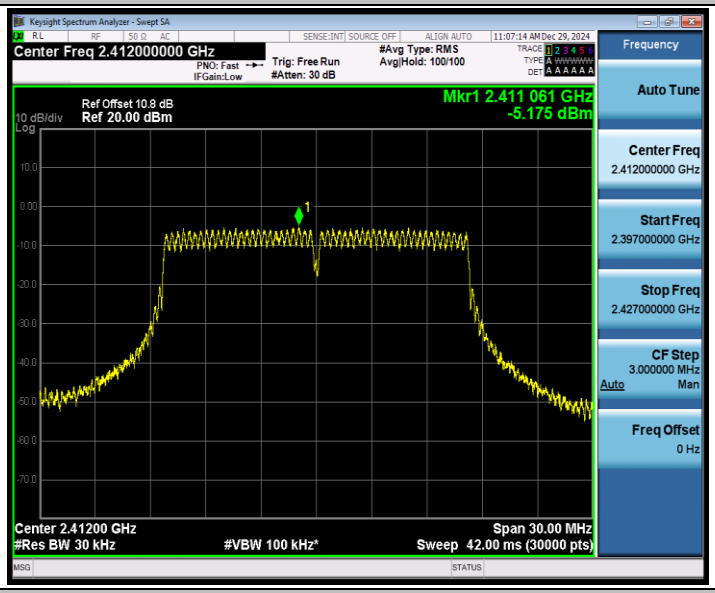
802.11b _Ant1_2437

802.11b _Ant2_2437

802.11b _Ant1_2462

802.11b _Ant2_2462

802.11g _Ant1_2412



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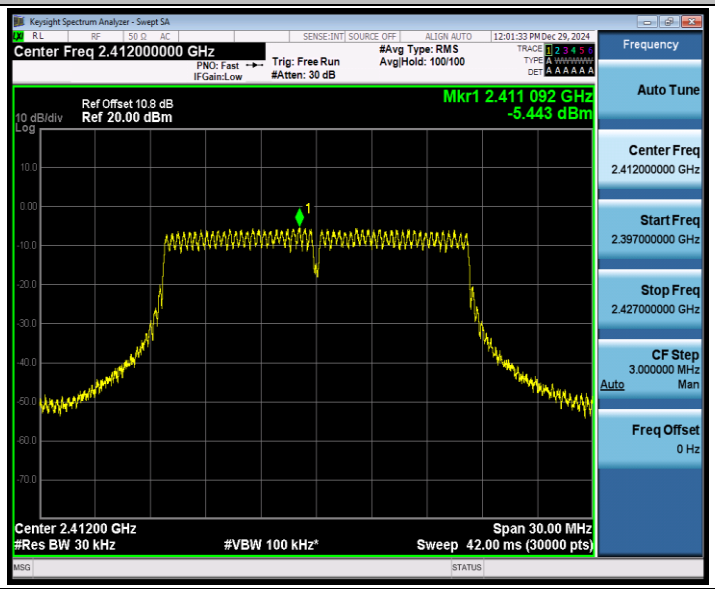

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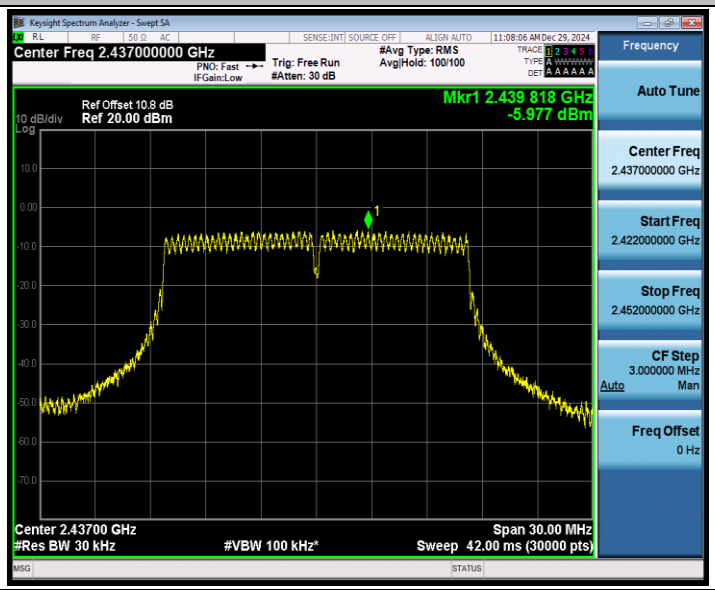

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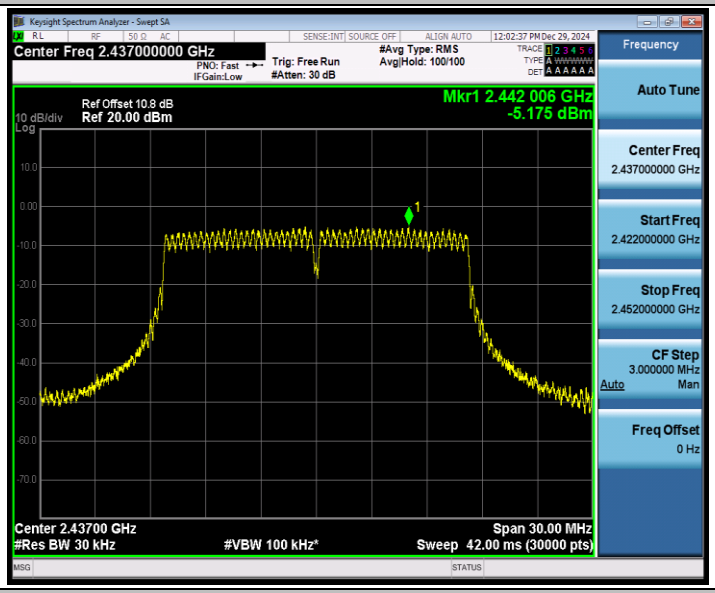

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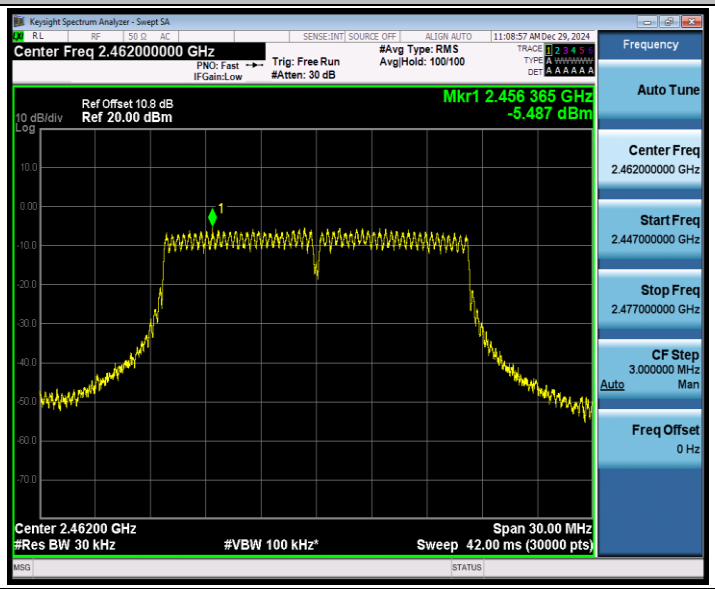
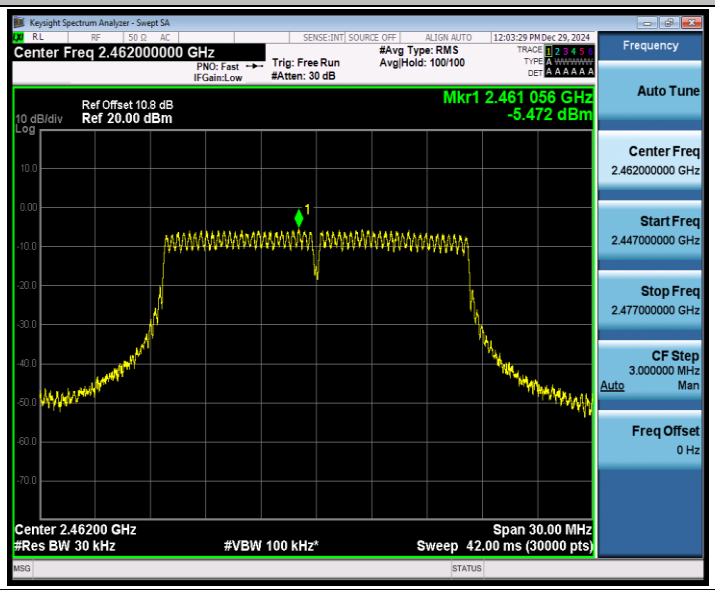
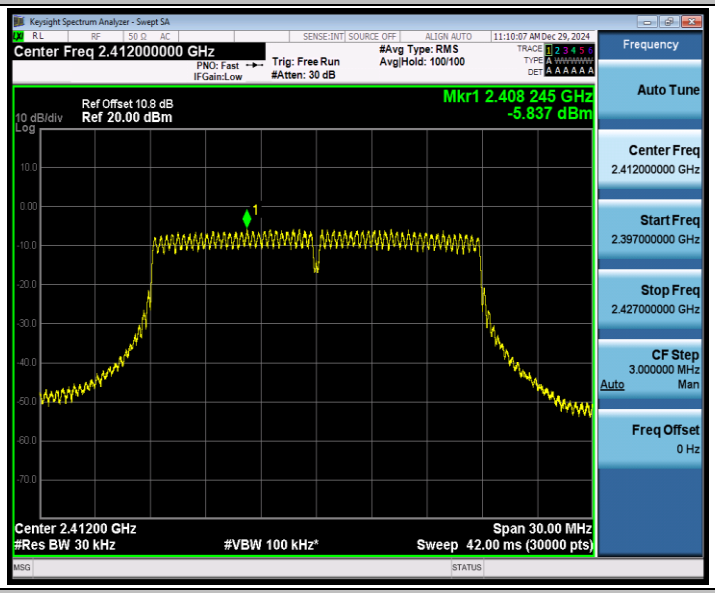


802.11g _Ant2_2462



802.11n HT20 SISO_Ant1_2412



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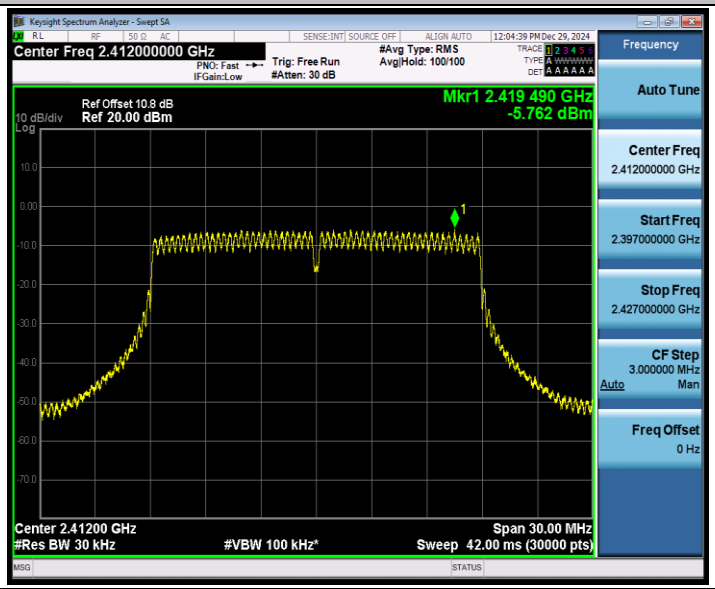

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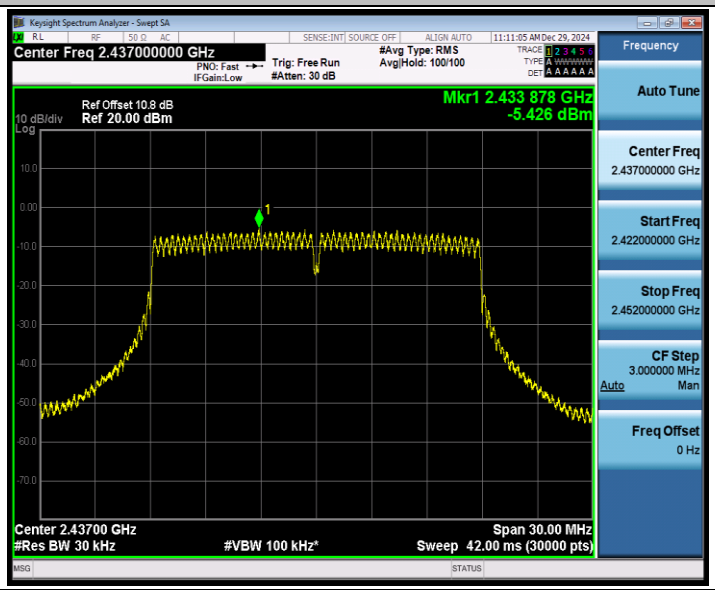

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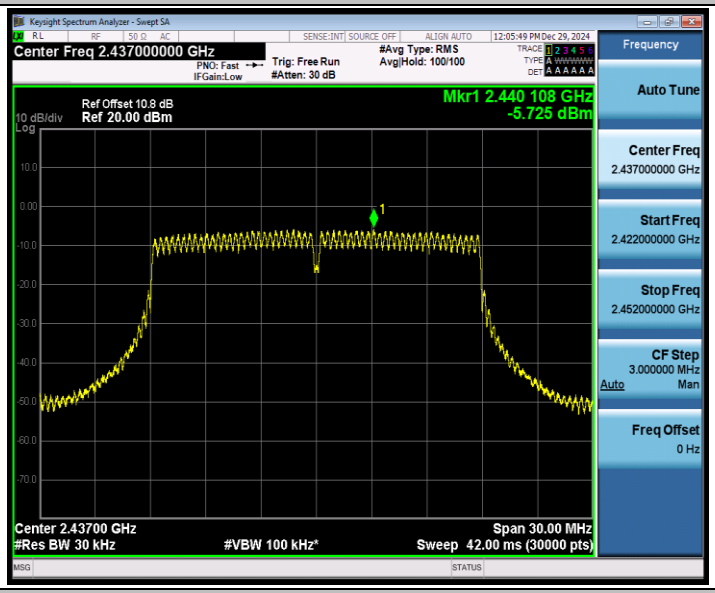

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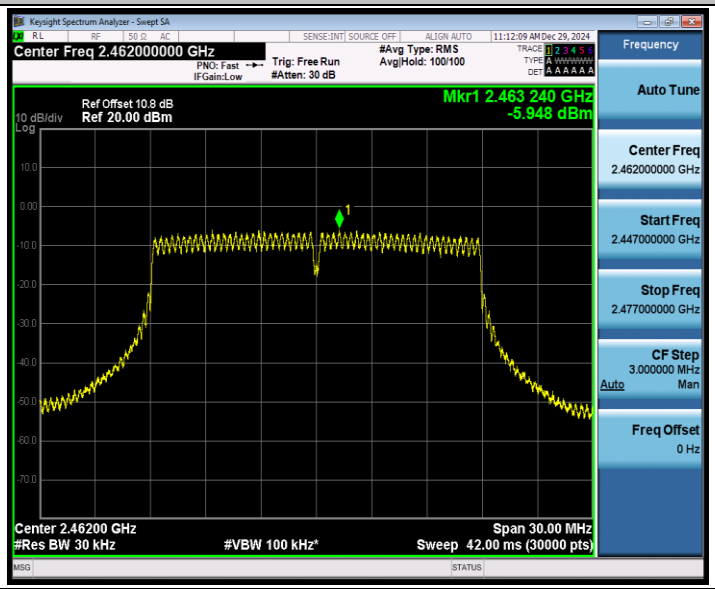

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