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

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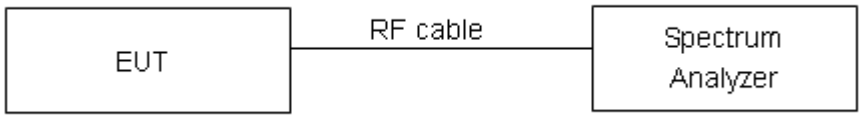
l) Add [10 log(1/ D)], where D is the duty cycle measured in step a), to the measured PSD to compute the average PSD during the actual transmission time

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.

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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/CH 0	-3.78	-3.08	8	PASS
	2440/CH 19	-4.14	-3.44	8	PASS
	2480/CH 39	-3.97	-3.27	8	PASS
Bluetooth (Low Energy) (2M)	2402/CH 0	-8.49	-6.07	8	PASS
	2440/CH 19	-7.94	-5.52	8	PASS
	2480/CH 39	-8.39	-5.97	8	PASS
Bluetooth (Low Energy) (S=2)	2402/CH 0	-0.09	2.13	8	PASS
	2440/CH 19	0.43	2.65	8	PASS
	2480/CH 39	-1.07	1.15	8	PASS
Bluetooth (Low Energy) (S=8)	2402/CH 0	7.61	7.80	8	PASS
	2440/CH 19	7.47	7.66	8	PASS
	2480/CH 39	7.34	7.53	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

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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	-3.11	-13.11	8	PASS
	2437/CH 6	-2.41	-12.41	8	PASS
	2462/CH 11	-3.68	-13.68	8	PASS
802.11g	2412/CH 1	-6.87	-16.66	8	PASS
	2437/CH 6	-5.18	-14.97	8	PASS
	2462/CH 11	-5.69	-15.48	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30)					

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	-2.40	-12.40	8	PASS
	2437/CH 6	-3.57	-13.57	8	PASS
	2462/CH 11	-4.11	-14.11	8	PASS
802.11g	2412/CH 1	-6.67	-16.46	8	PASS
	2437/CH 6	-4.66	-14.45	8	PASS
	2462/CH 11	-5.16	-14.95	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30)					

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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)		
802.11n HT20	2412/CH 1	-8.24	-17.40	-8.34	-17.50	-14.44	6.55	PASS
	2437/CH 6	-8.45	-17.61	-8.36	-17.52	-14.55	6.55	PASS
	2457/CH 10	-8.24	-17.40	-8.91	-18.07	-14.71	6.55	PASS
	2462/CH 11	-10.20	-19.36	-10.51	-19.67	-16.50	6.55	PASS
802.11n HT40	2422/CH 3	-13.18	-22.63	-13.04	-22.49	-19.55	6.55	PASS
	2437/CH 6	-12.95	-22.40	-12.64	-22.09	-19.23	6.55	PASS
	2447/CH 8	-13.09	-22.54	-13.86	-23.31	-19.90	6.55	PASS
	2452/CH 9	-17.48	-26.93	-17.24	-26.69	-23.80	6.55	PASS
802.11ax HE20	2412/CH 1	-11.17	-20.82	-10.58	-20.23	-17.50	6.55	PASS
	2437/CH 6	-11.22	-20.87	-10.65	-20.30	-17.57	6.55	PASS
	2457/CH 10	-11.46	-21.11	-12.04	-21.69	-18.38	6.55	PASS
	2462/CH 11	-15.73	-25.38	-15.57	-25.22	-22.29	6.55	PASS
802.11ax HE40	2422/CH 3	-13.13	-21.99	-13.12	-21.98	-18.97	6.55	PASS
	2437/CH 6	-12.92	-21.78	-12.77	-21.63	-18.69	6.55	PASS
	2452/CH 9	-13.42	-22.28	-12.65	-21.51	-18.87	6.55	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)(i): If all antennas have the same gain, Directional gain = G_{ANT} + Array Gain. For PSD measurements on all devices, Array Gain=10log(Nant/Nss)dB, so directional gain=G_{ANT}+Array Gain=4.44og(3/1)=7.45Bi.

So the PSD limit is 8+6-MAX(6, directional gain) dBm=6.55

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ERSU Mode

Antenna 1

Test Mode	Carrier frequency (MHz)/ Channel	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11ax HE20 242-Tones: RU Index 61	2412/CH 1	-8.24	-16.63	8	PASS
	2437/CH 6	-8.84	-17.23	8	PASS
	2462/CH11	-7.13	-15.52	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30)					

Antenna 2

Test Mode	Carrier frequency (MHz)/ Channel	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11ax HE20 242-Tones: RU Index 61	2412/CH 1	-7.62	-16.01	8	PASS
	2437/CH 6	-8.37	-16.76	8	PASS
	2462/CH11	-8.67	-17.06	8	PASS
Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*log10(3/30)					

Test Mode	Carrier frequency (MHz) / Channel	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 242-Tones: RU Index 61	2412/CH 1	61	-4.47	-12.86	-5.00	-13.39	-10.11	6.55	PASS
	2437/CH 6	61	-5.07	-13.46	-5.23	-13.62	-10.53	6.55	PASS
	2462/CH11	61	-5.81	-14.20	-6.32	-14.71	-11.44	6.55	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)(i): If all antennas have the same gain, Directional gain = G_{ANT} + Array Gain. For PSD measurements on all devices, Array Gain=10log(Nant/Nss)dB, so directional gain=G_{ANT}+Array Gain=4.44og(3/1)=7.45Bi.

So the PSD limit is 8+6-MAX(6, directional gain) dBm=6.55

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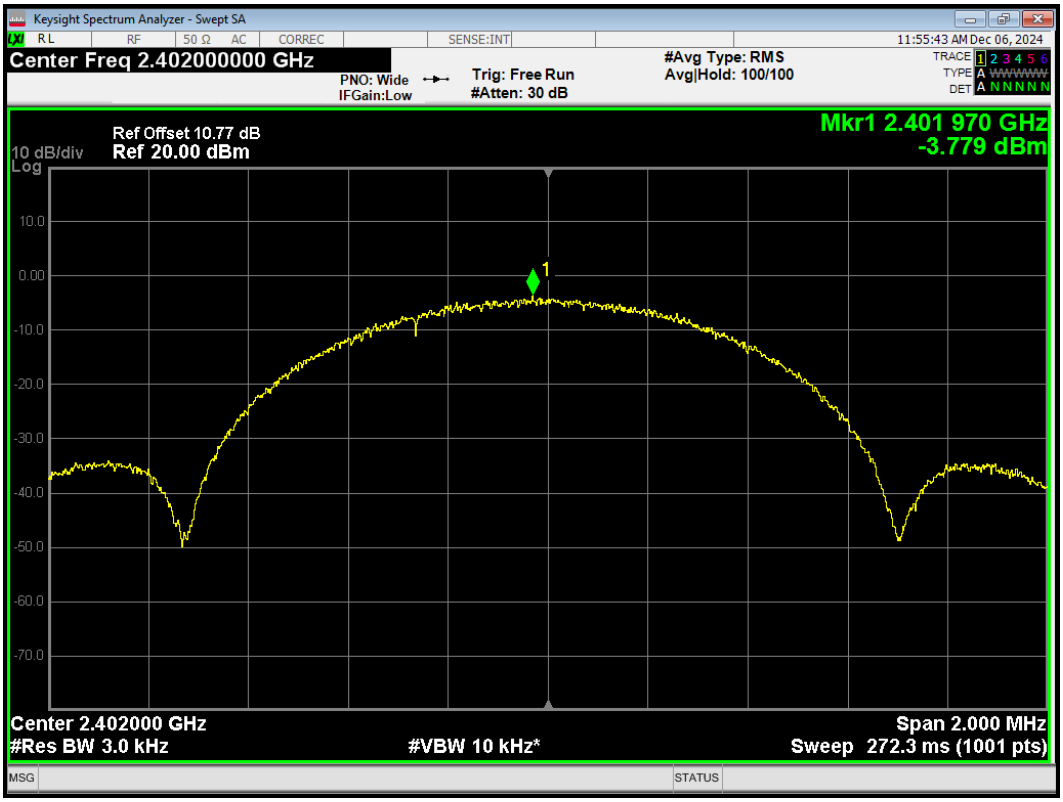
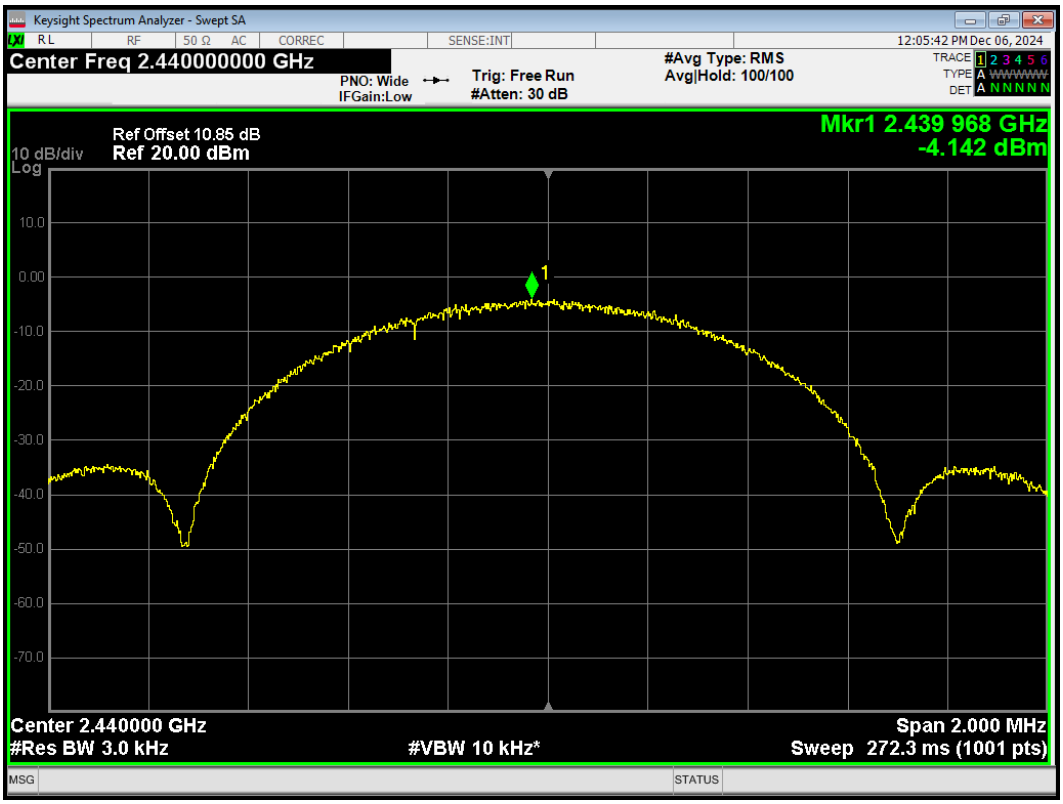
PSD Bluetooth LE (1M) 2402MHz



PSD Bluetooth LE (1M) 2440MHz



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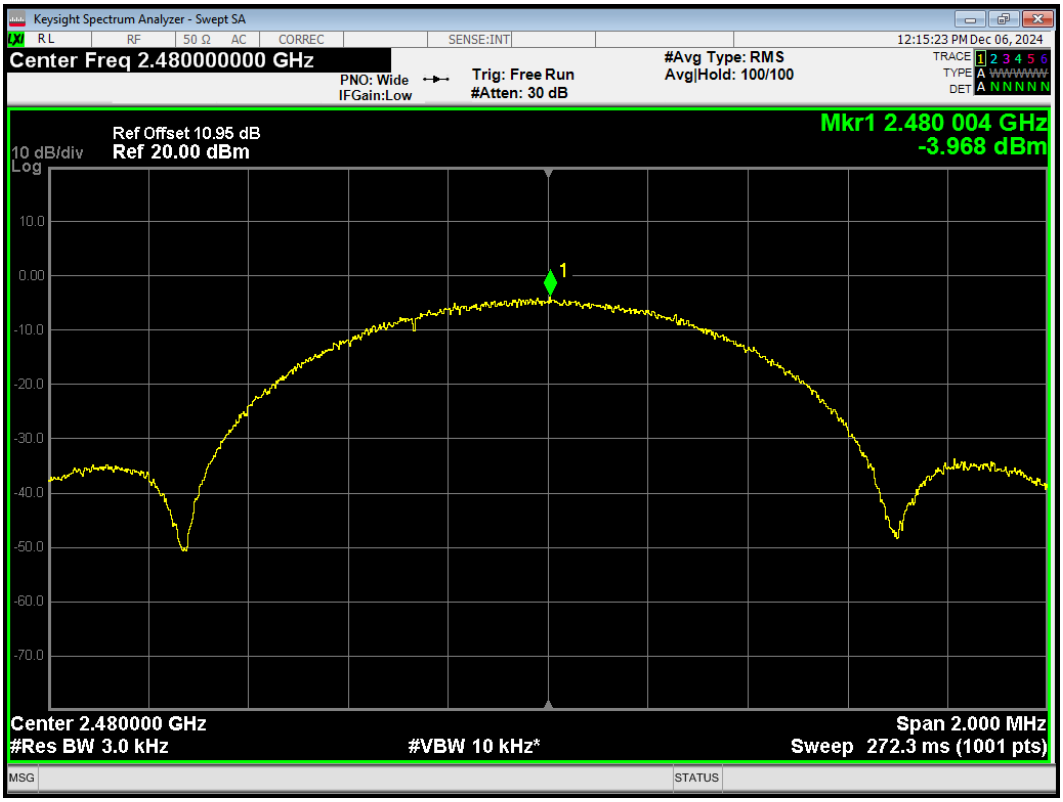
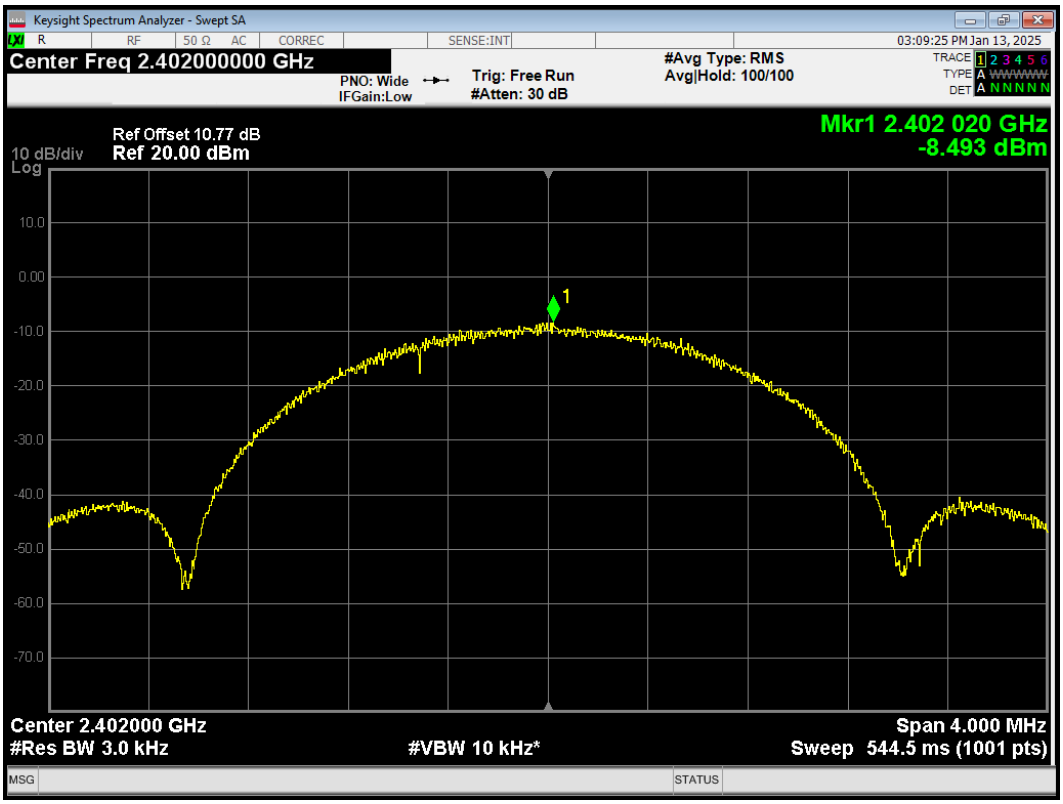
PSD Bluetooth LE (1M) 2480MHz



PSD Bluetooth LE (2M) 2402MHz



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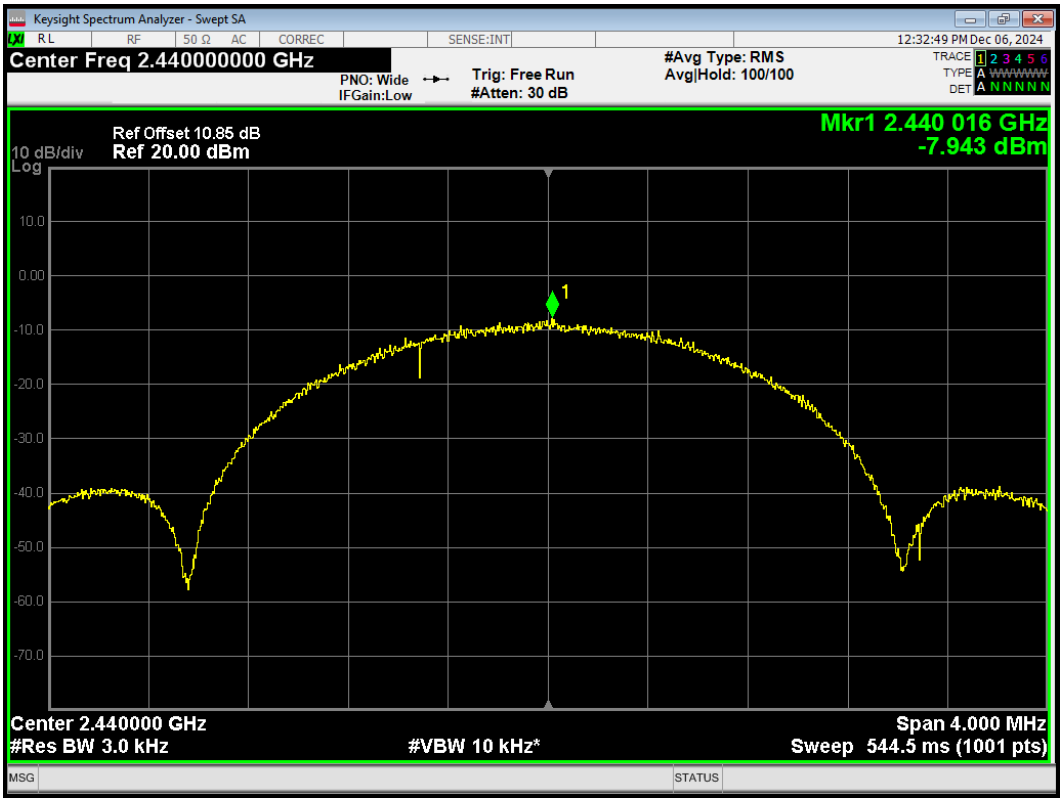
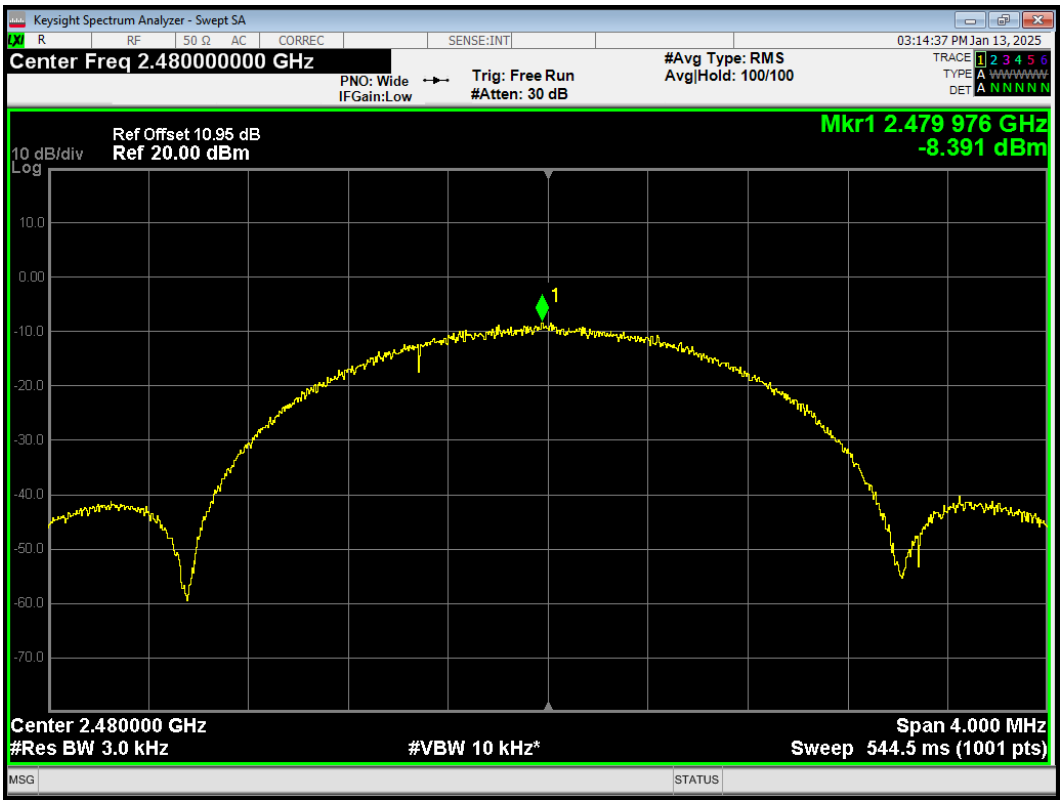
PSD Bluetooth LE (2M) 2440MHz



PSD Bluetooth LE (2M) 2480MHz



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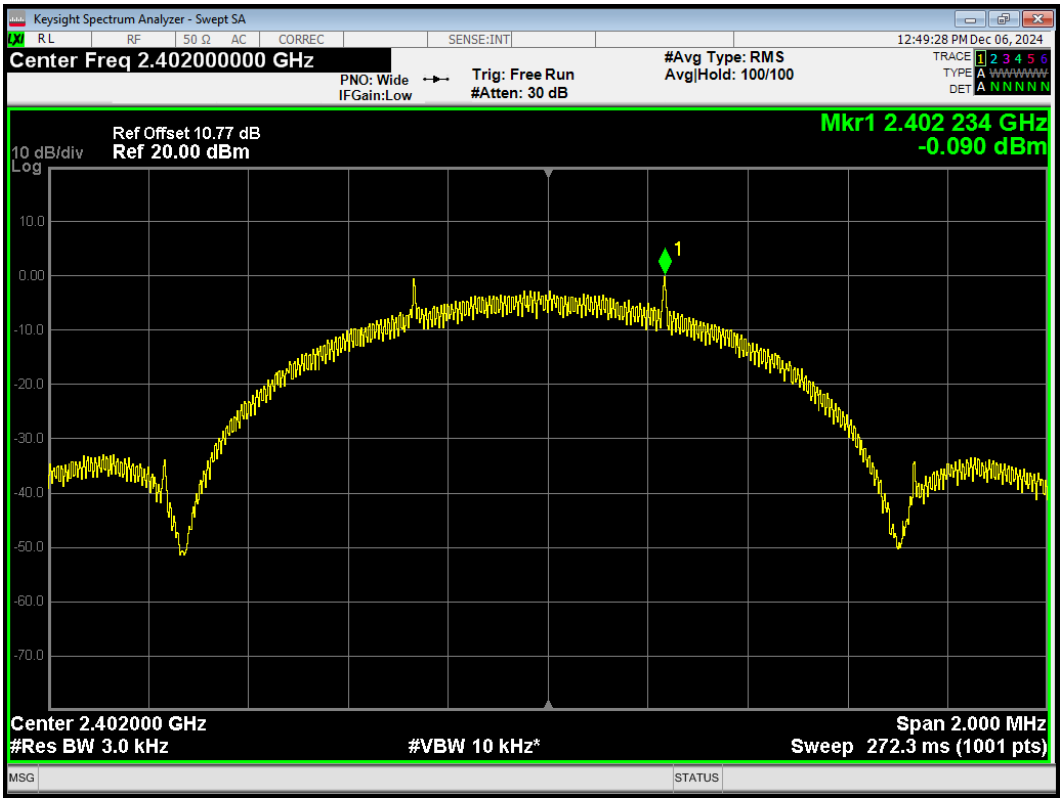
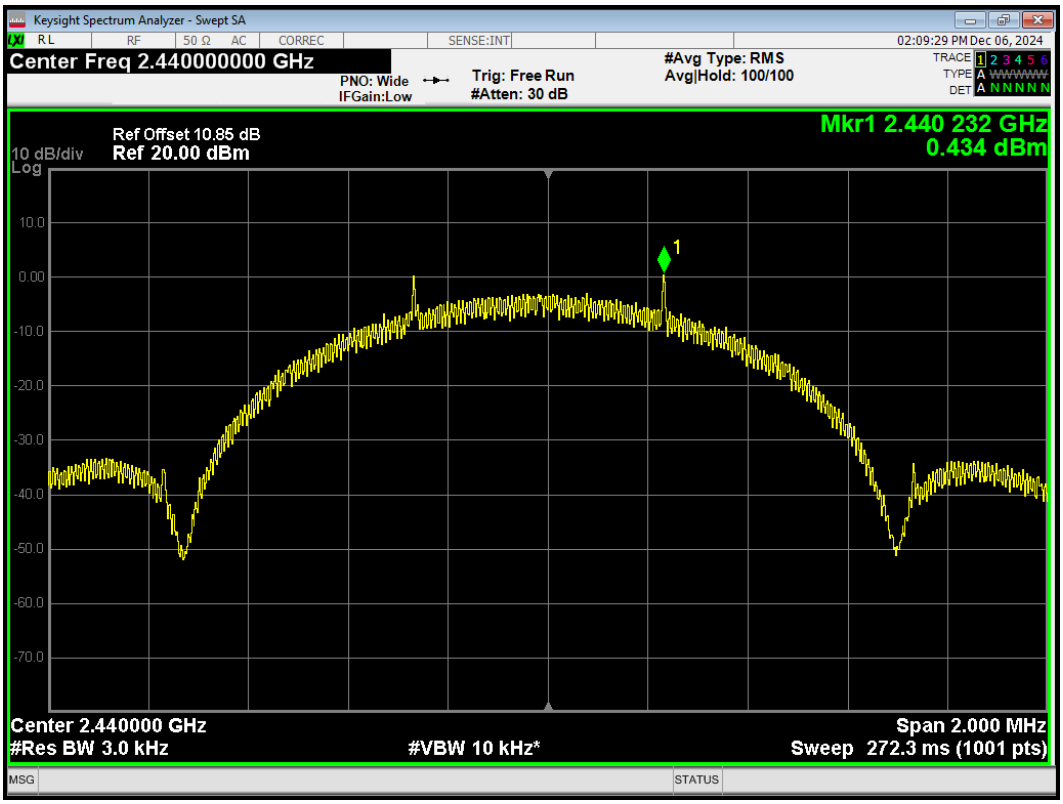
PSD Bluetooth LE (S=2) 2402MHz



PSD Bluetooth LE (S=2) 2440MHz



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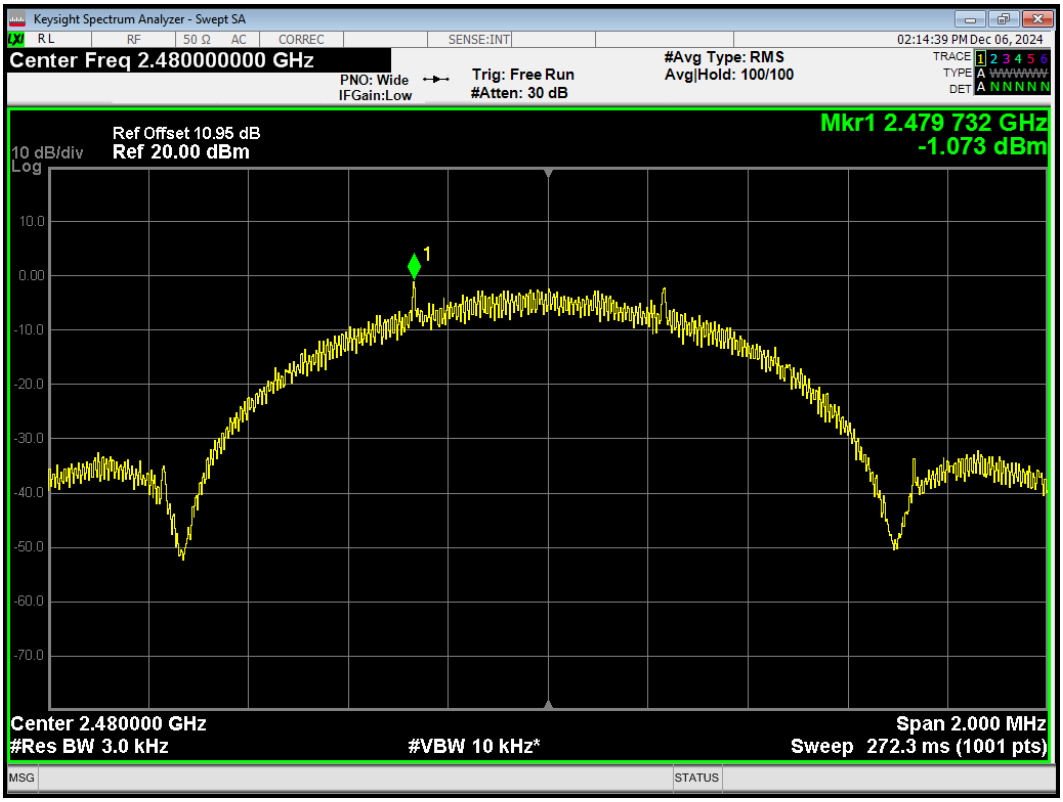
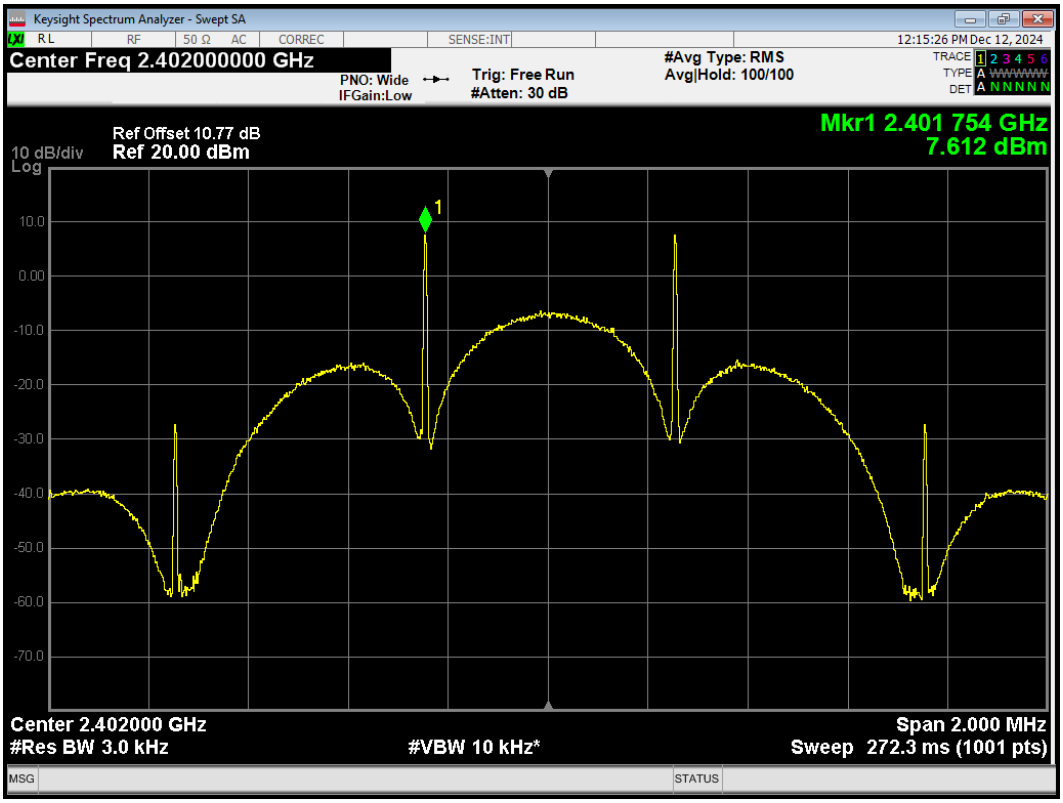
PSD Bluetooth LE (S=2) 2480MHz



PSD Bluetooth LE (S=8) 2402MHz



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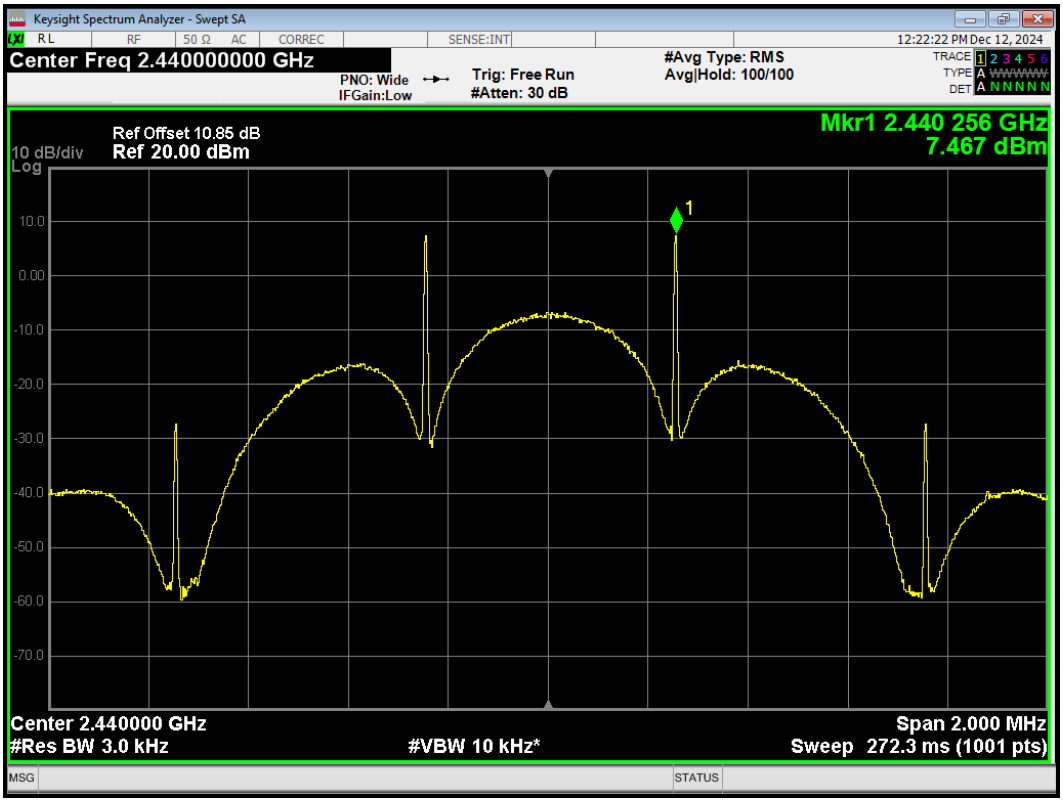
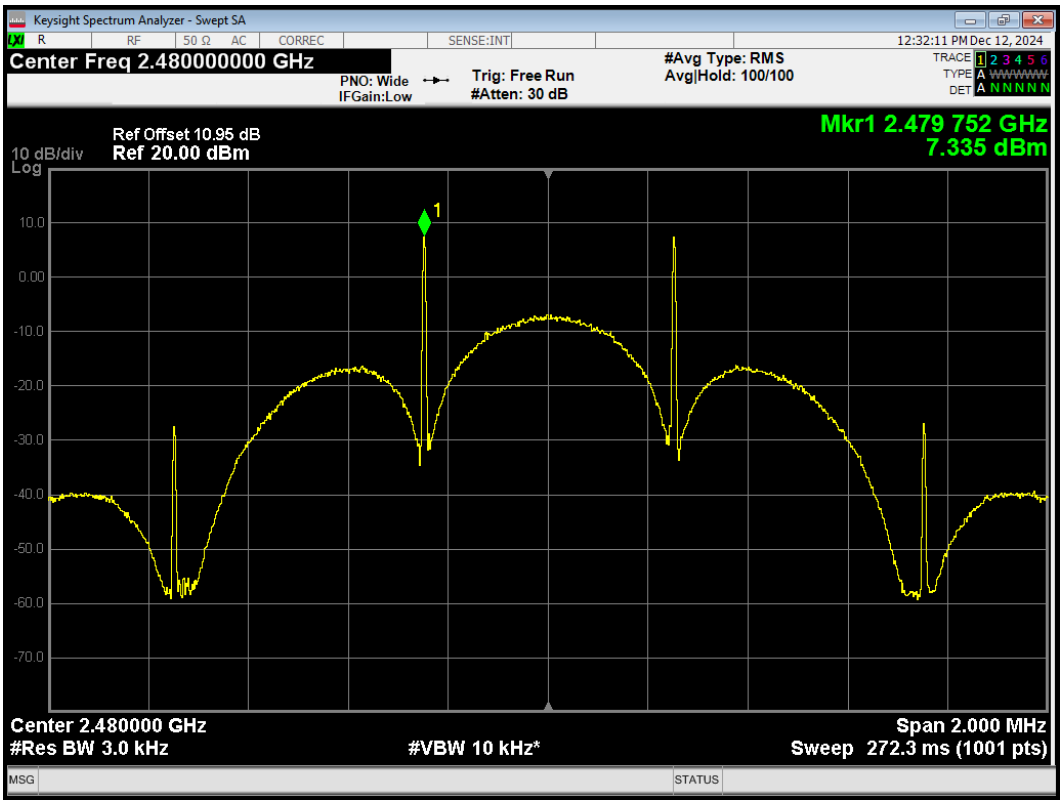
PSD Bluetooth LE (S=8) 2440MHz



PSD Bluetooth LE (S=8) 2480MHz



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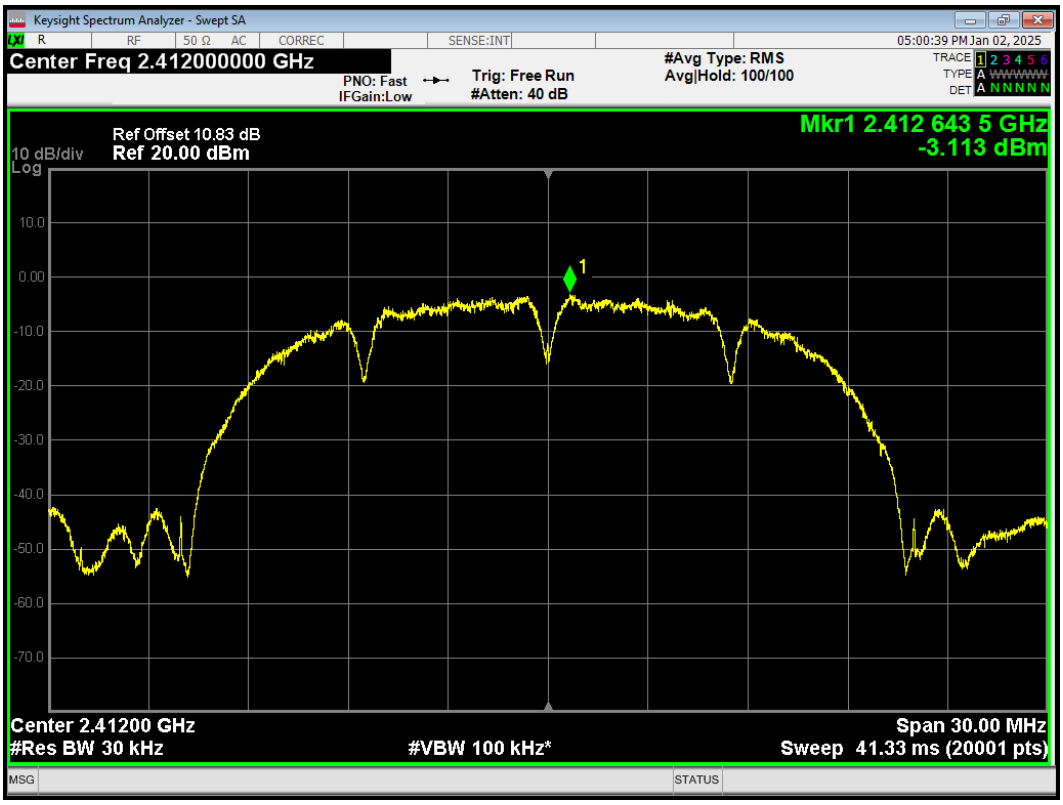
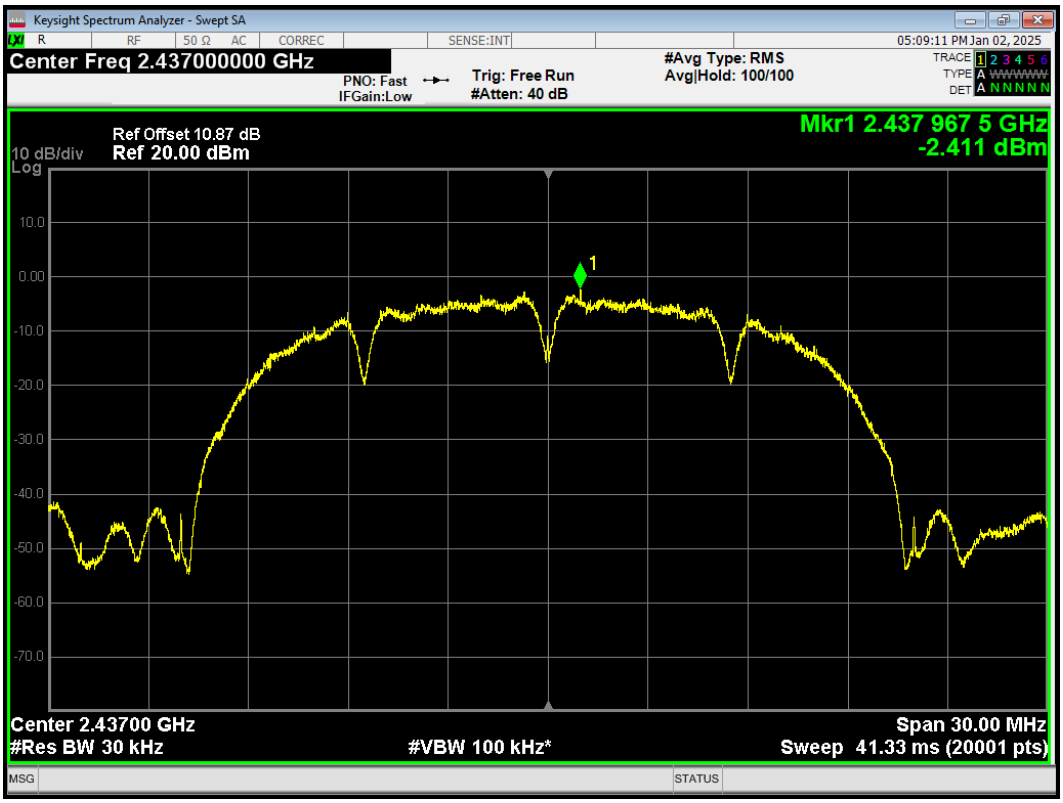
Antenna 1

PSD 802.11b 2412MHz



PSD 802.11b 2437MHz



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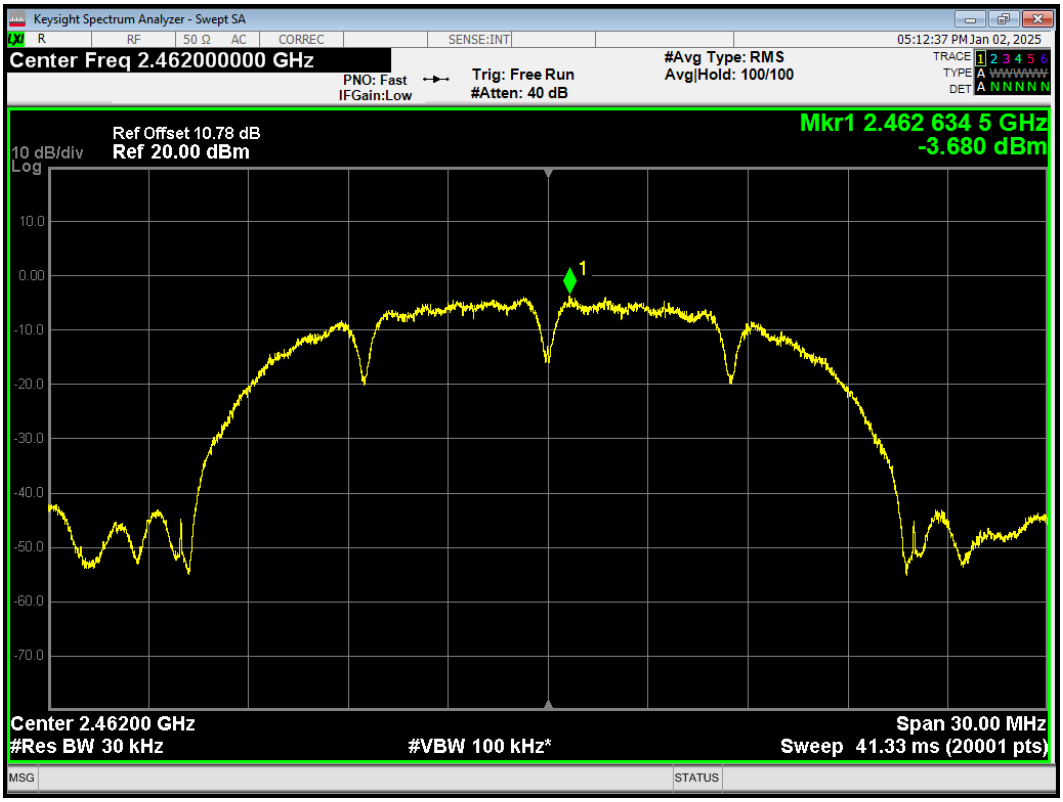
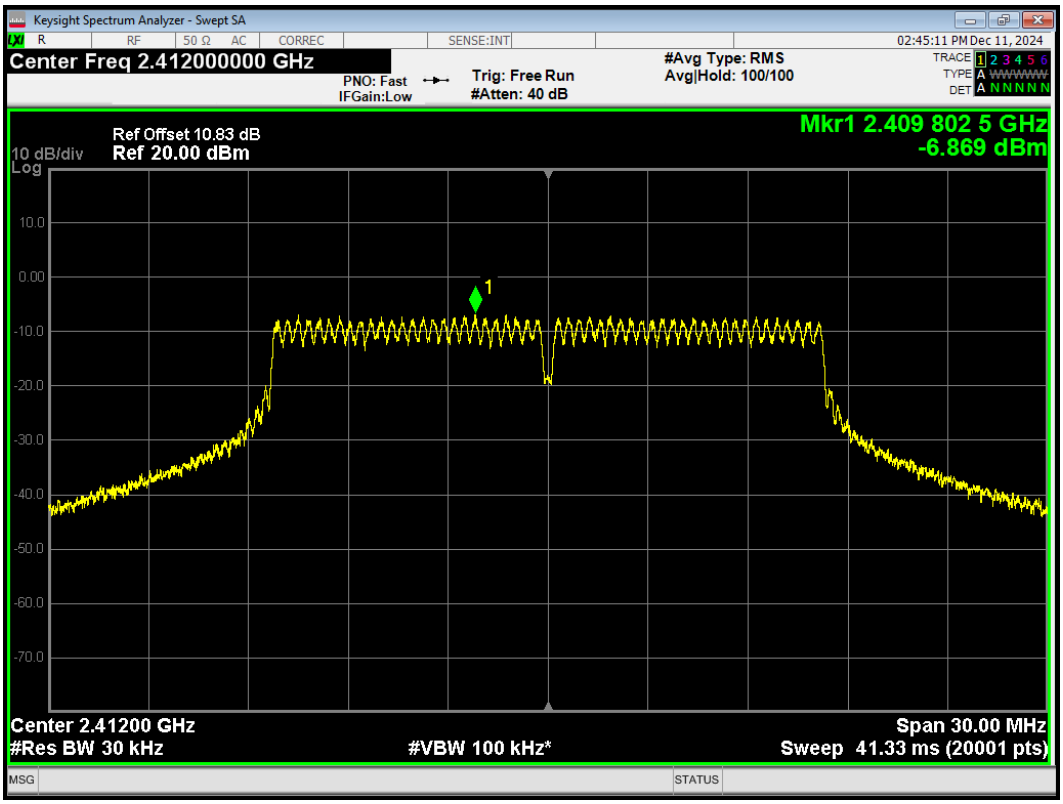
PSD 802.11b 2462MHz



PSD 802.11g 2412MHz



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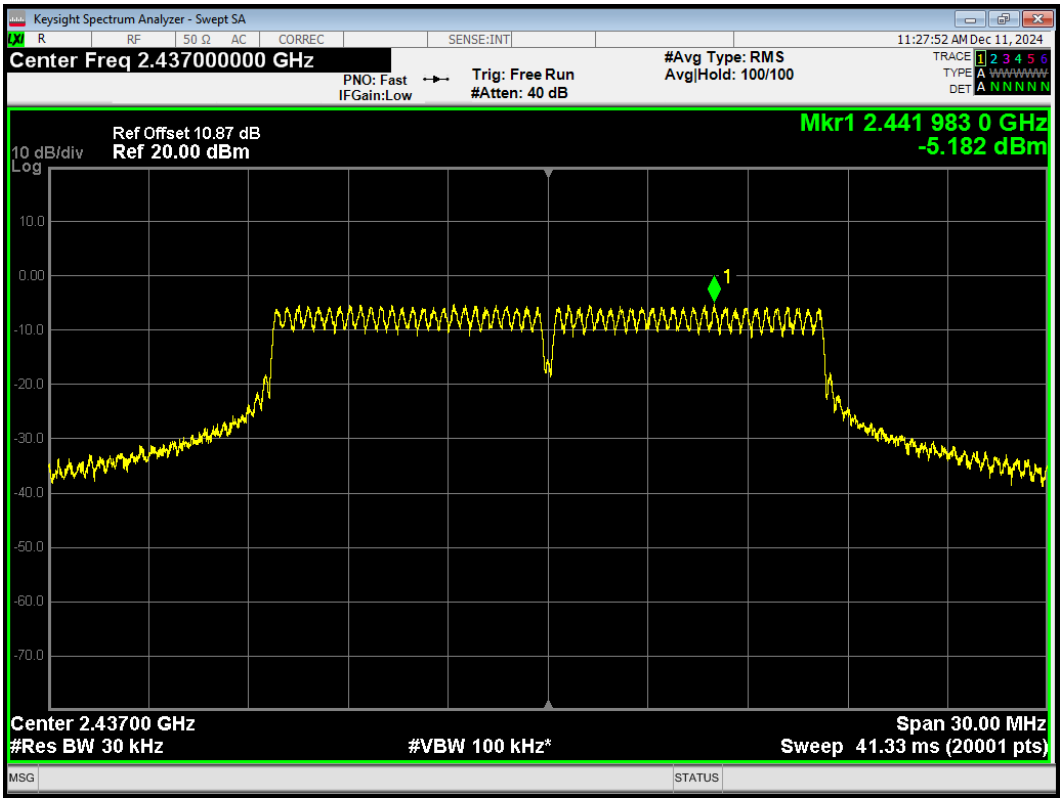
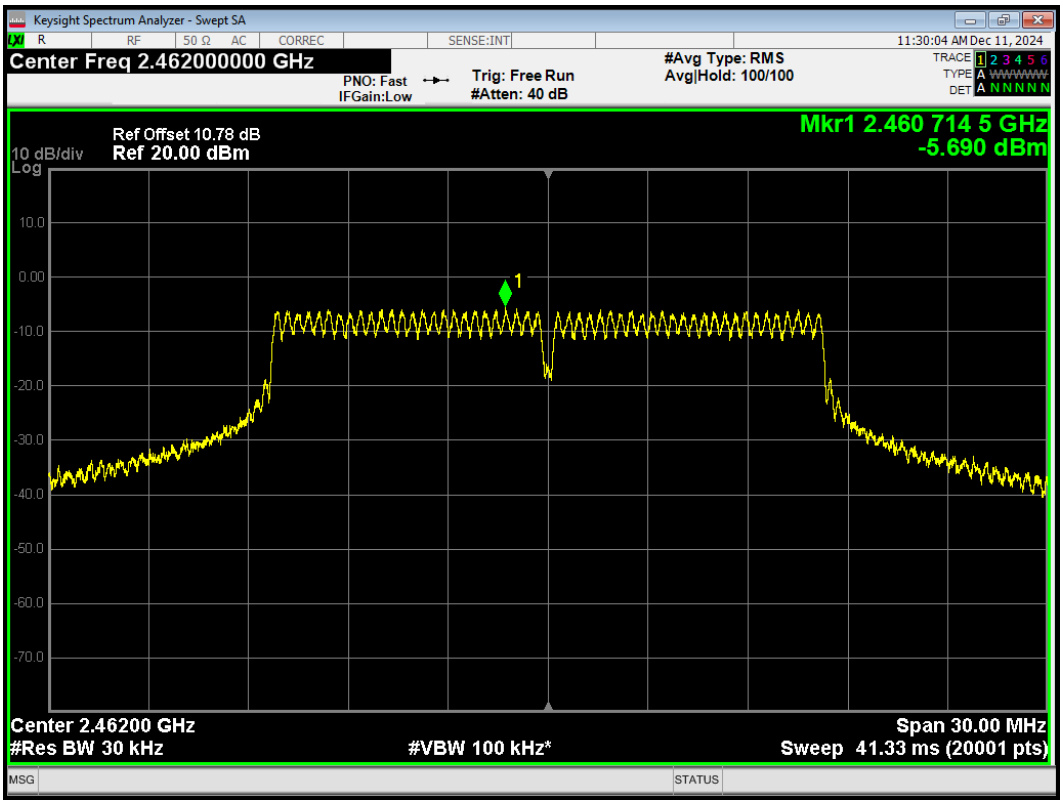
PSD 802.11g 2437MHz



PSD 802.11g 2462MHz



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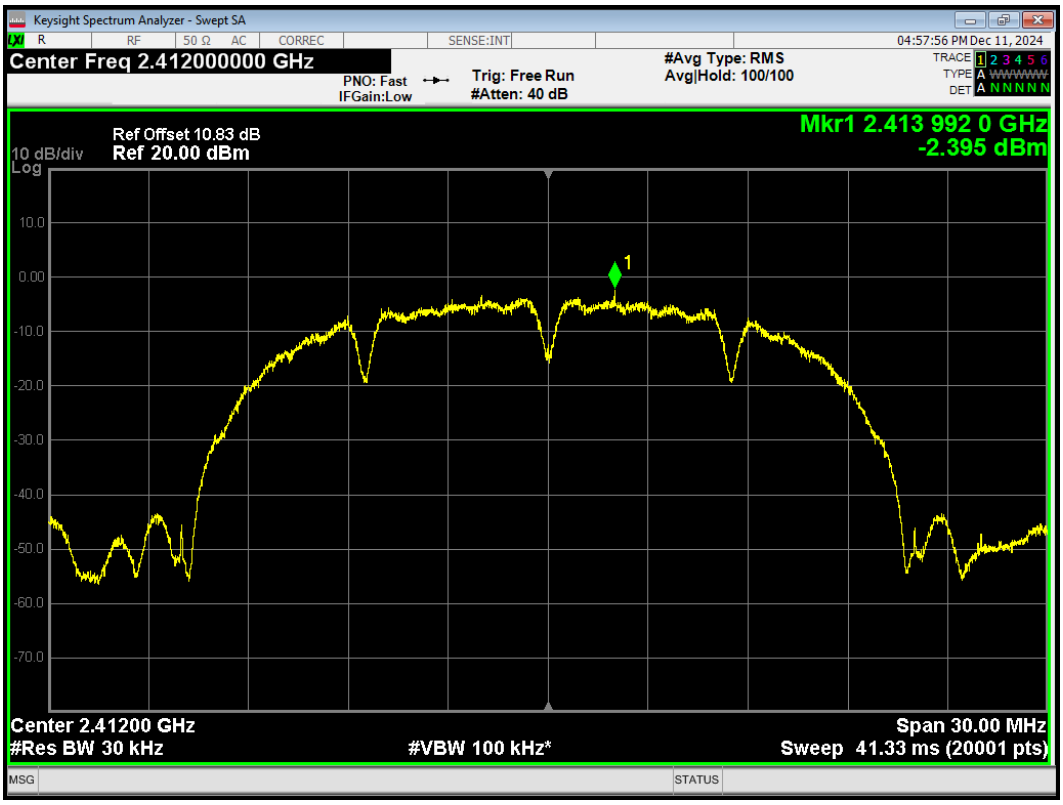
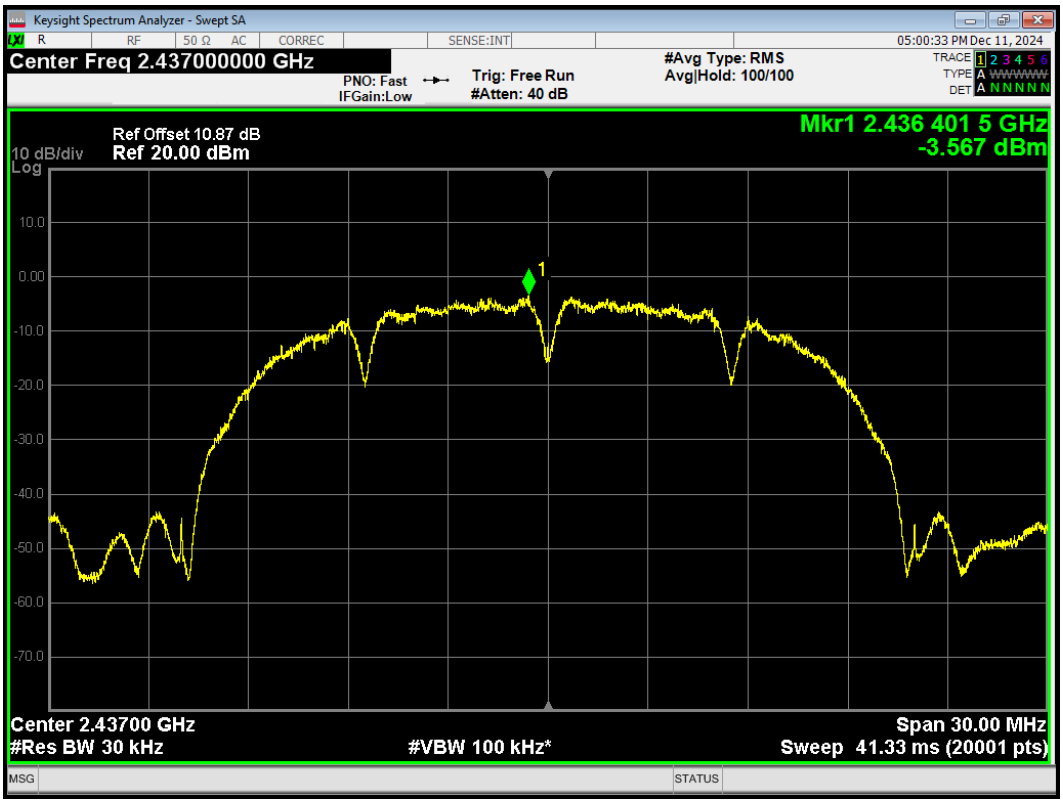
Antenna 2

PSD 802.11b 2412MHz



PSD 802.11b 2437MHz



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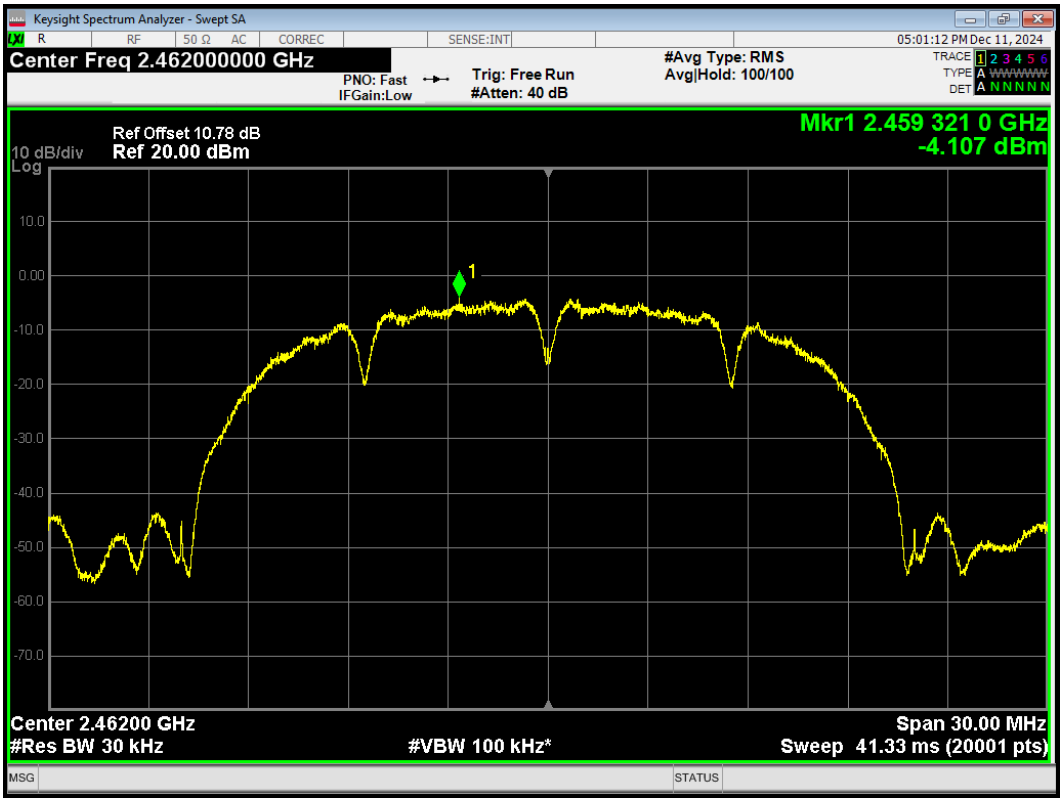
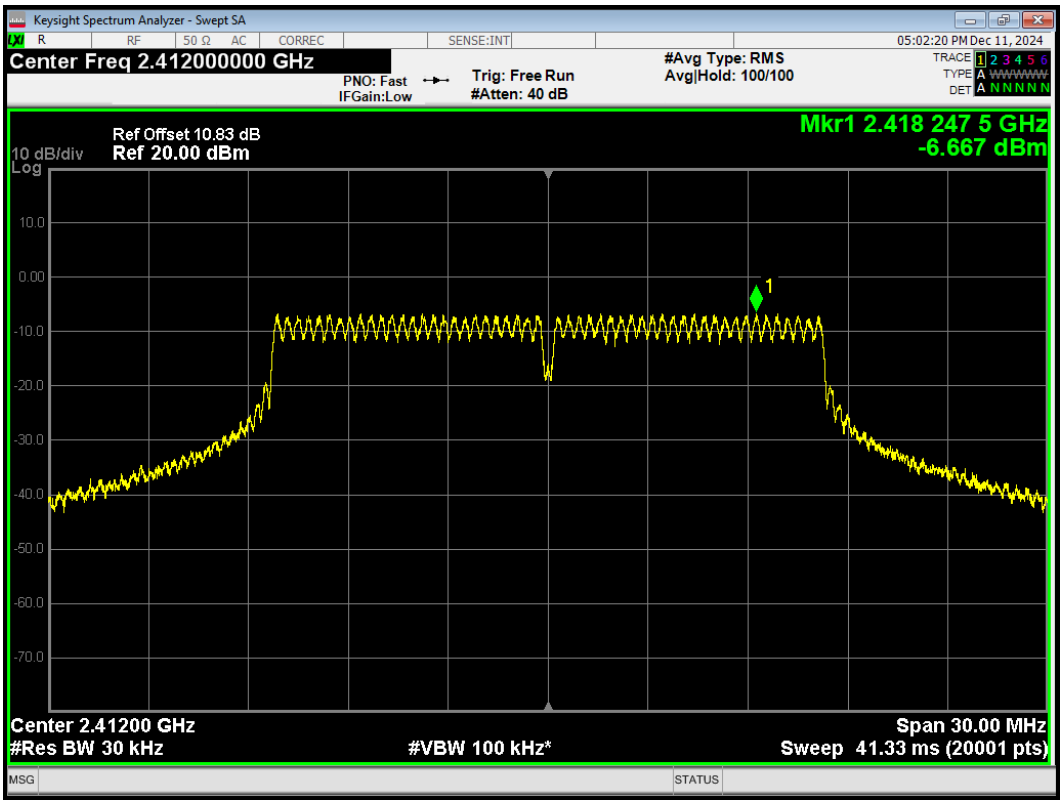
PSD 802.11b 2462MHz



PSD 802.11g 2412MHz



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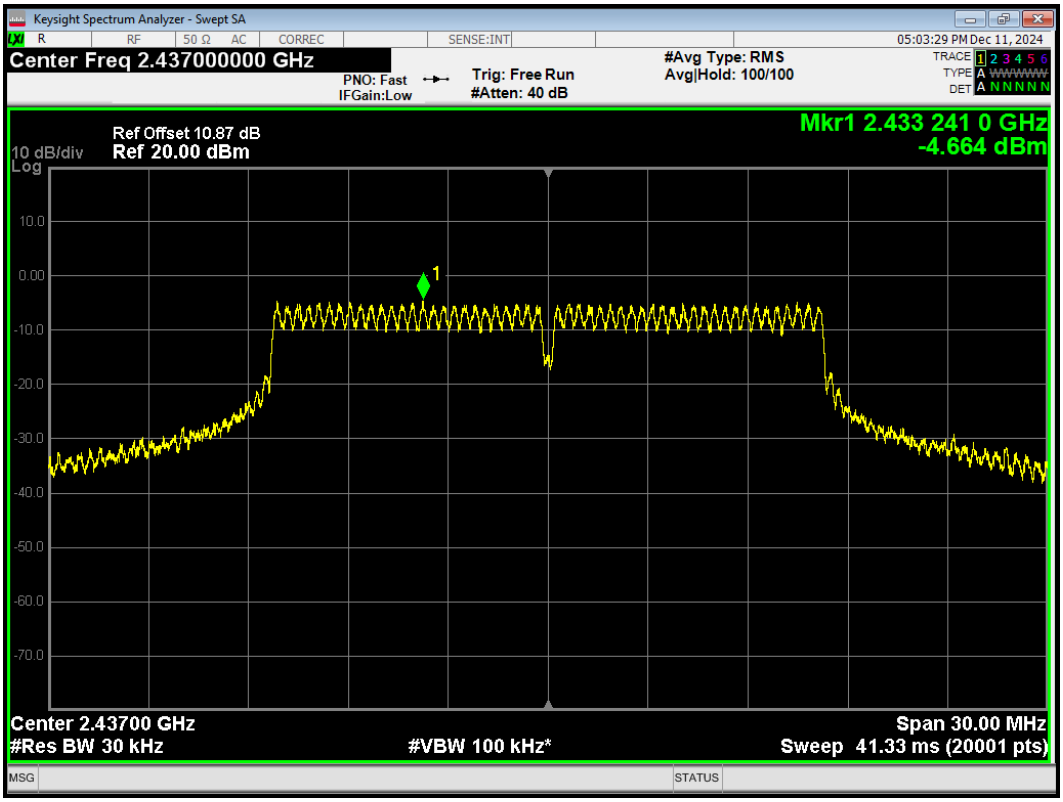
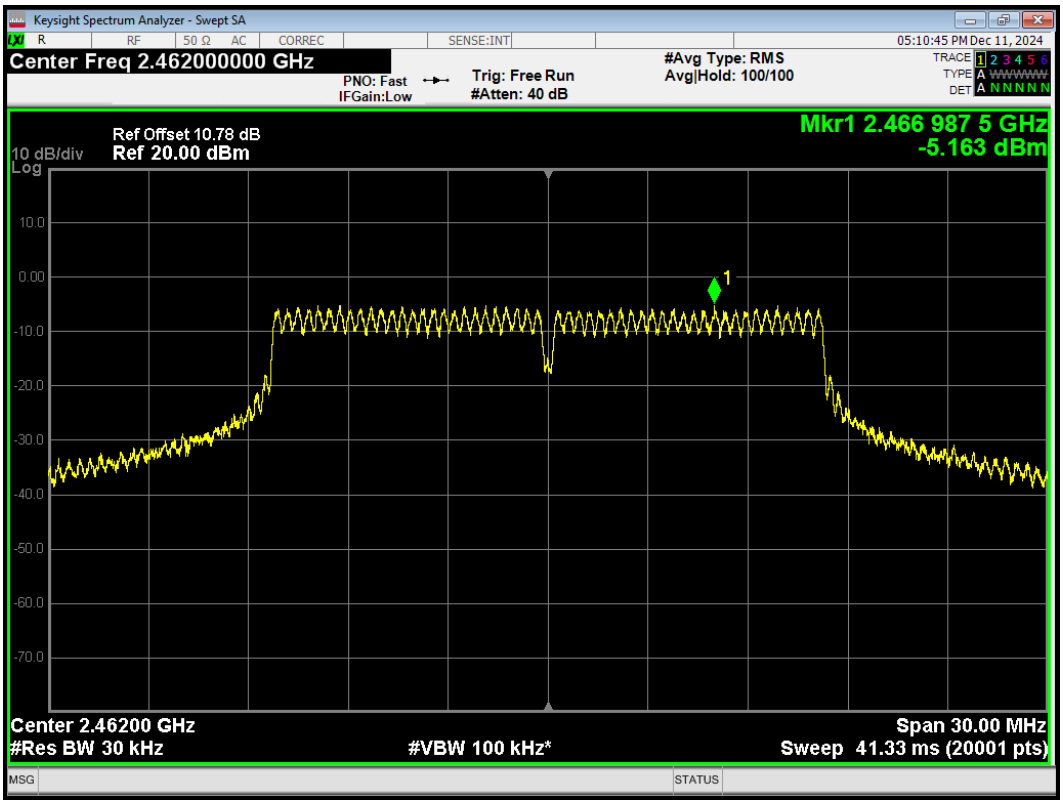
PSD 802.11g 2437MHz



PSD 802.11g 2462MHz



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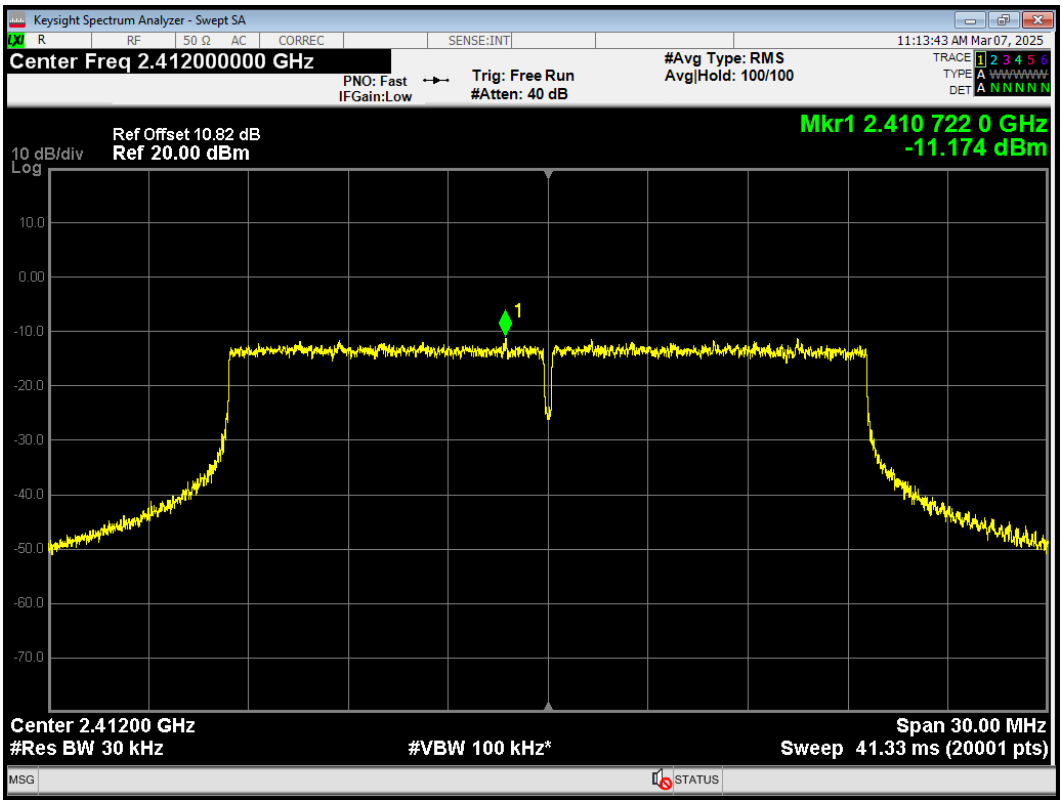
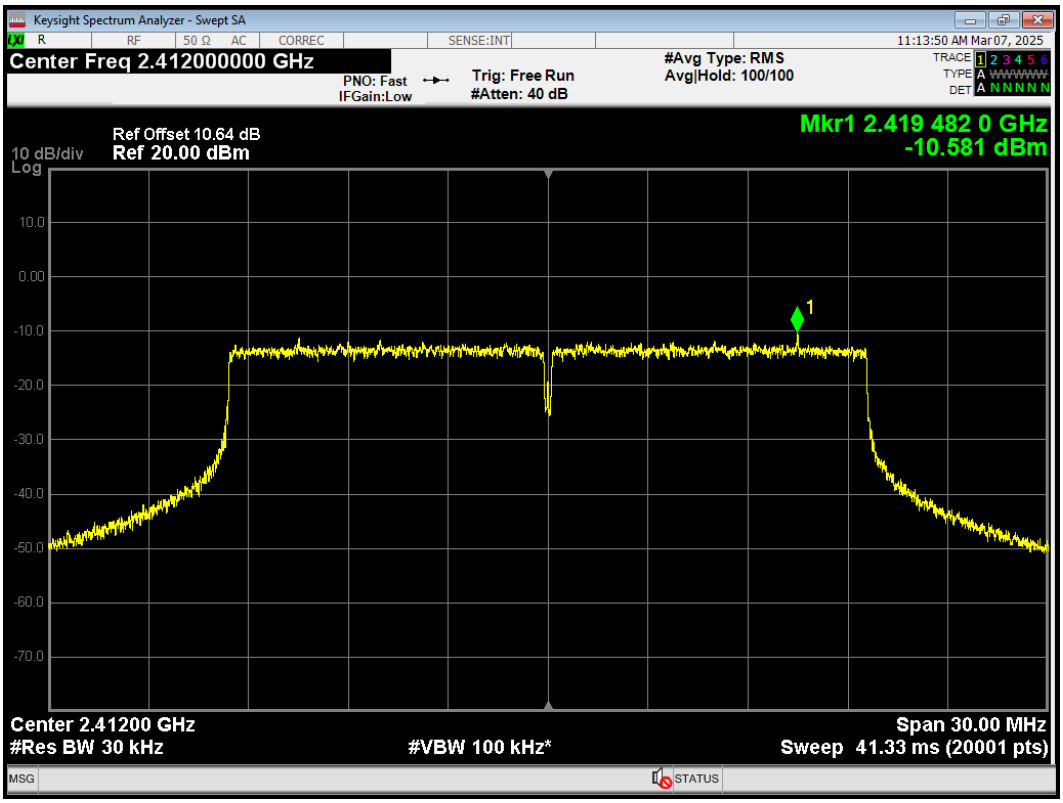
MIMO

PSD 802.11ax(HE20) 2412MHz Ant1



PSD 802.11ax(HE20) 2412MHz Ant2



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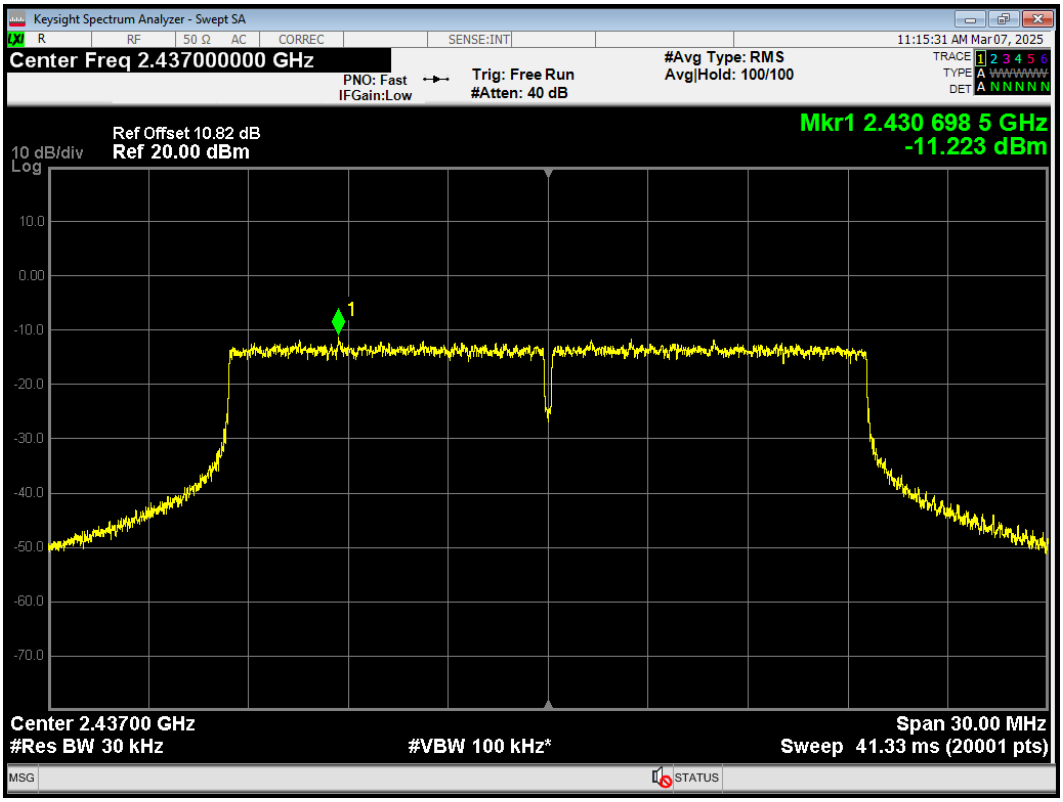
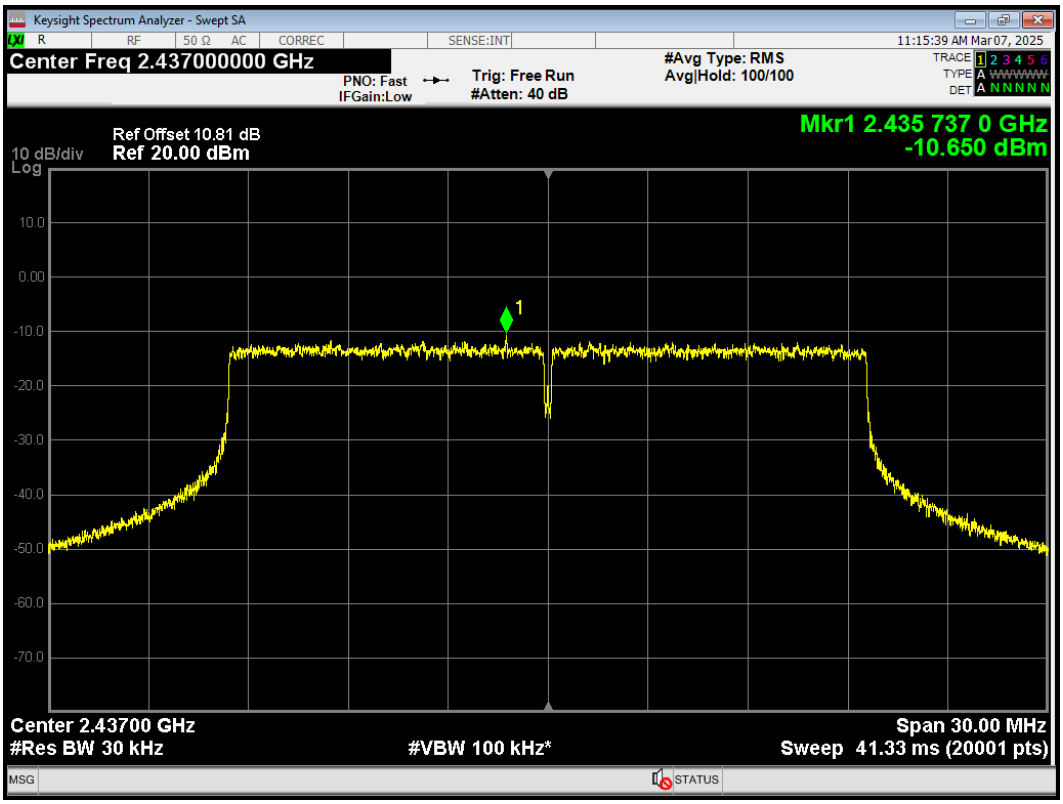
PSD 802.11ax(HE20) 2437MHz Ant1



PSD 802.11ax(HE20) 2437MHz Ant2



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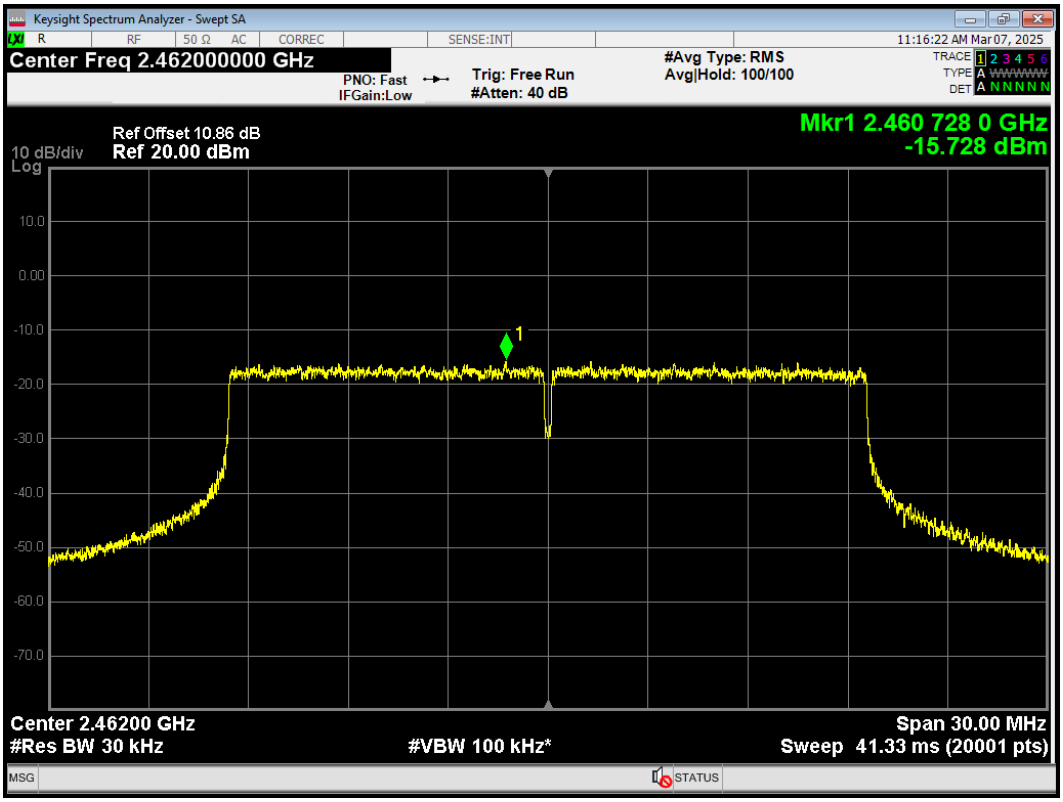
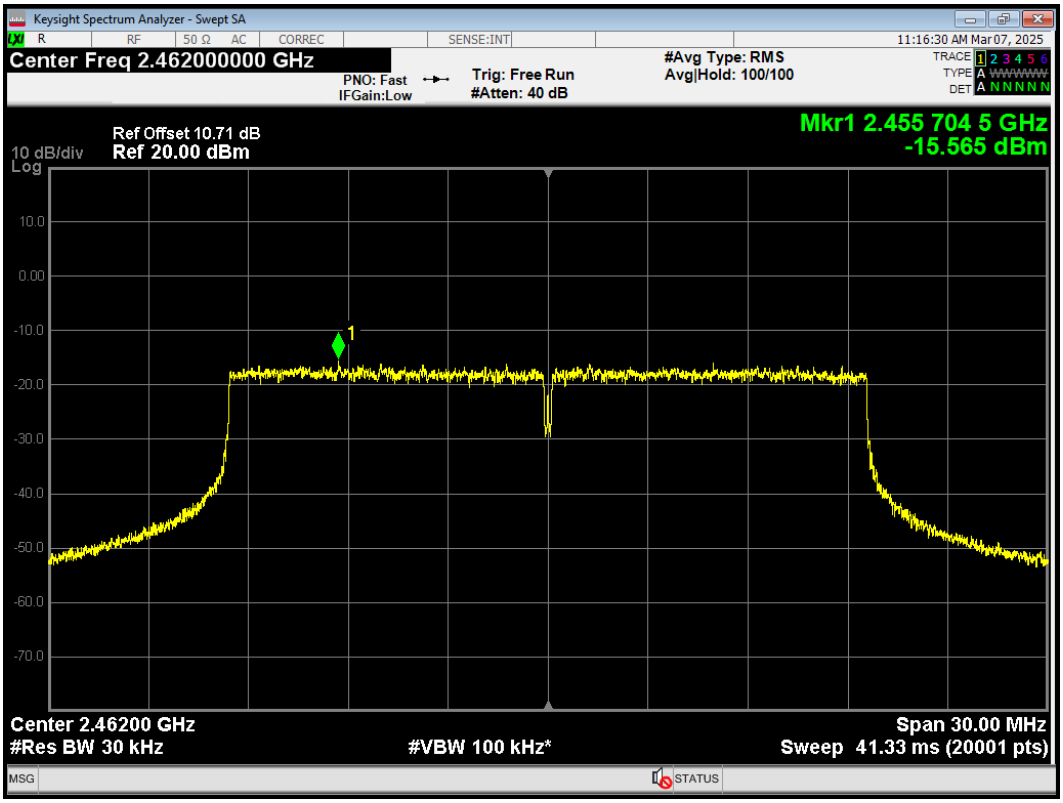
PSD 802.11ax(HE20) 2462MHz Ant1



PSD 802.11ax(HE20) 2462MHz Ant2



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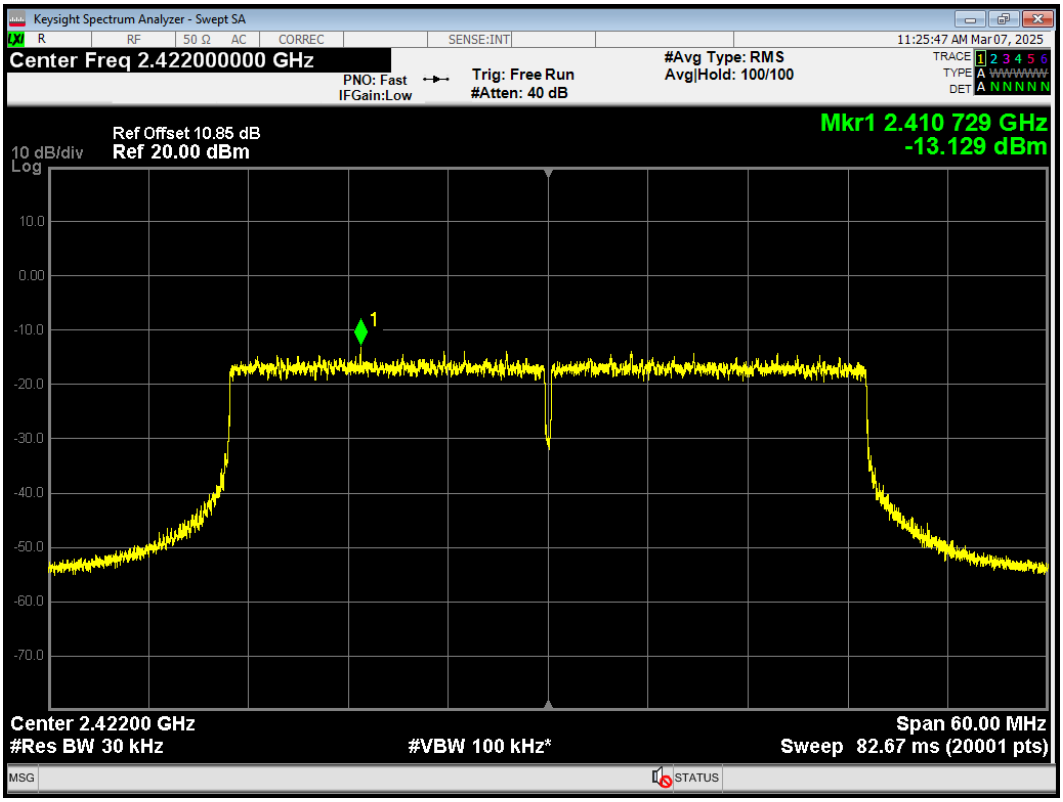
PSD 802.11ax(HE40) 2422MHz Ant1



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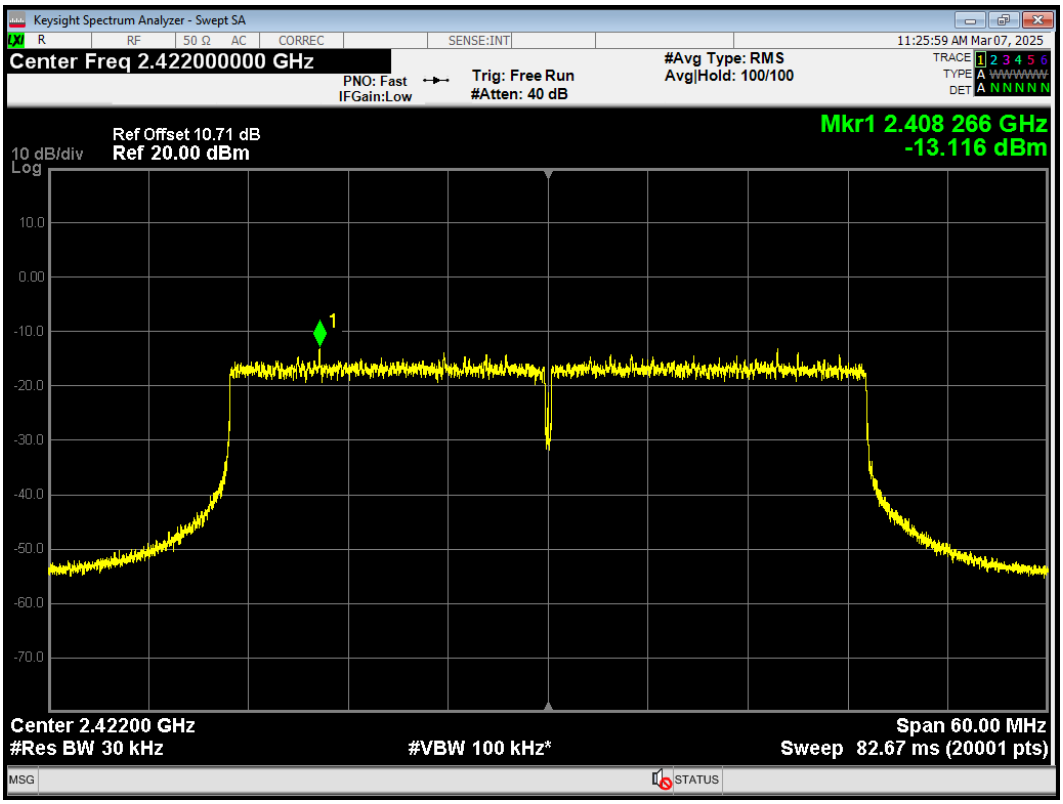

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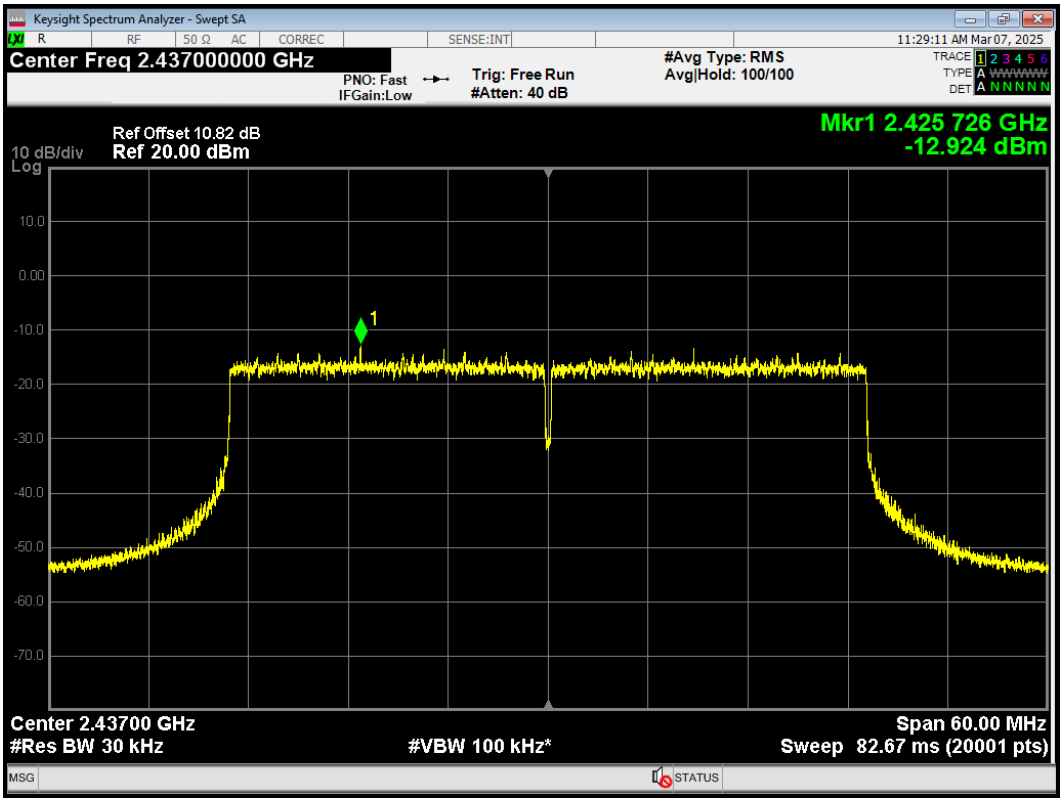
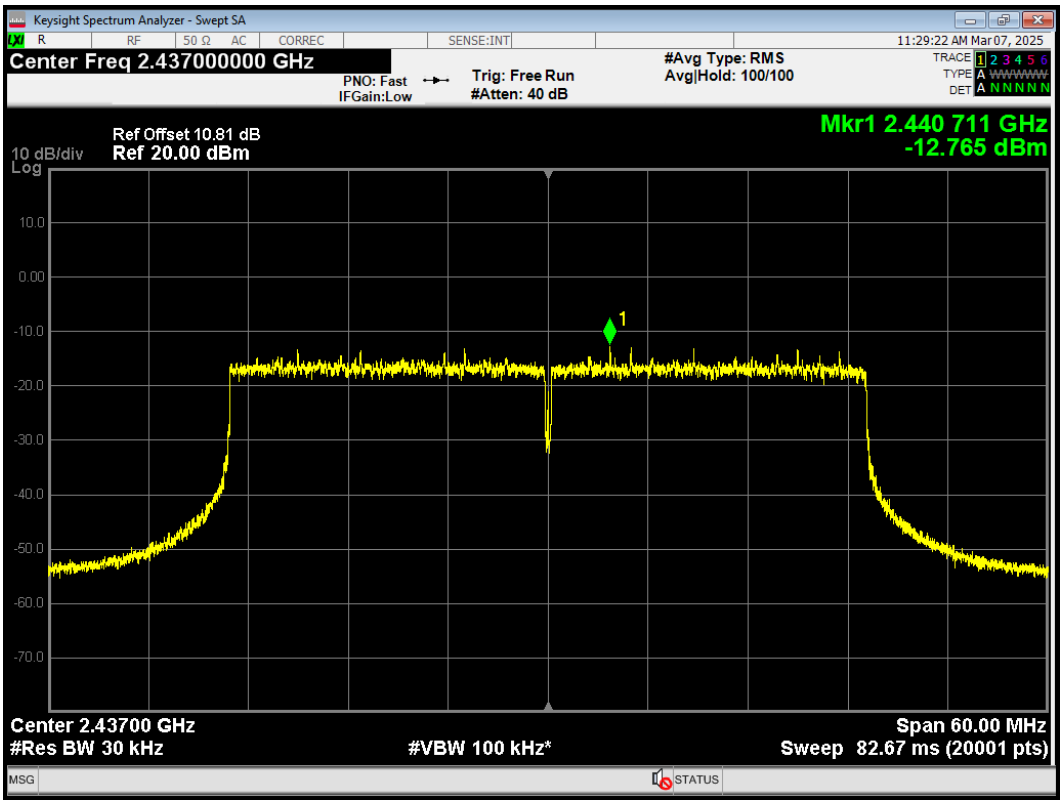


PSD 802.11ax(HE40) 2437MHz Ant2



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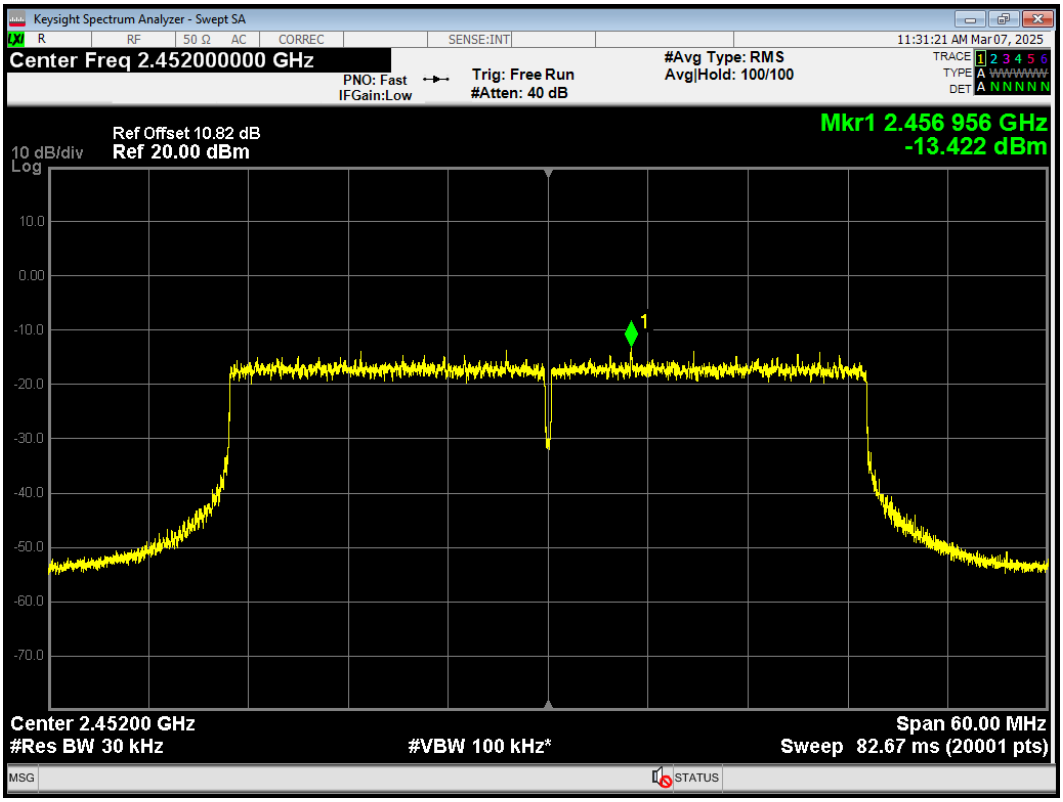
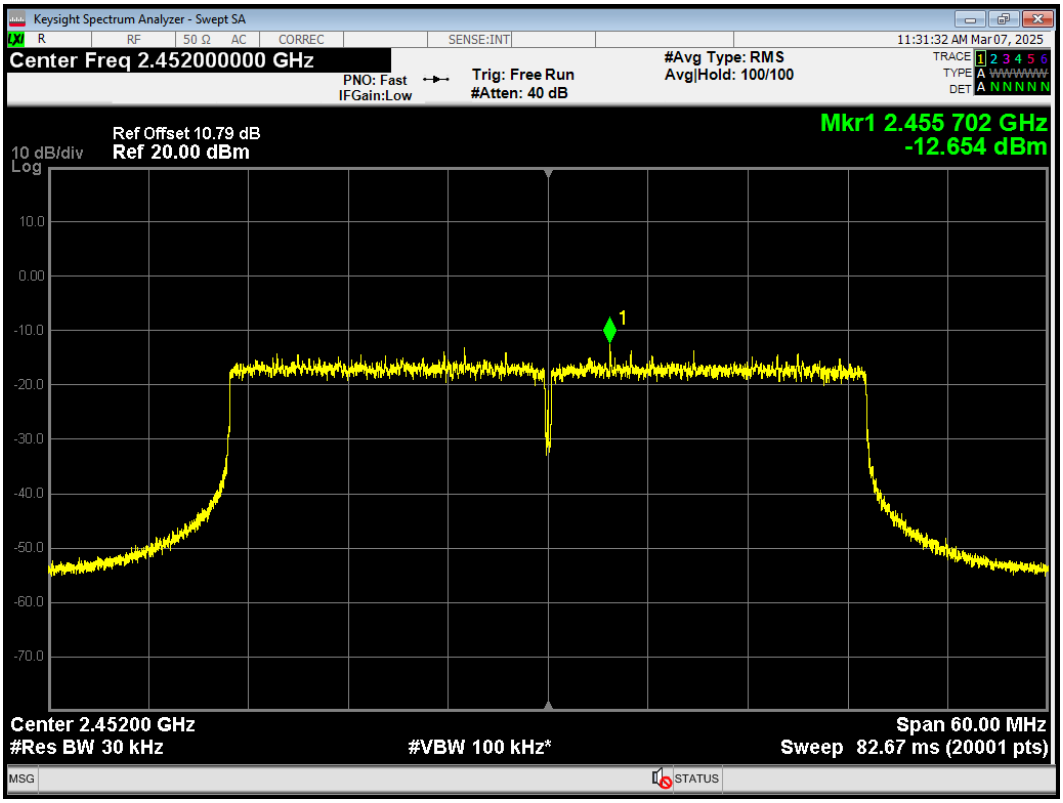
PSD 802.11ax(HE40) 2452MHz Ant1



PSD 802.11ax(HE40) 2452MHz Ant2



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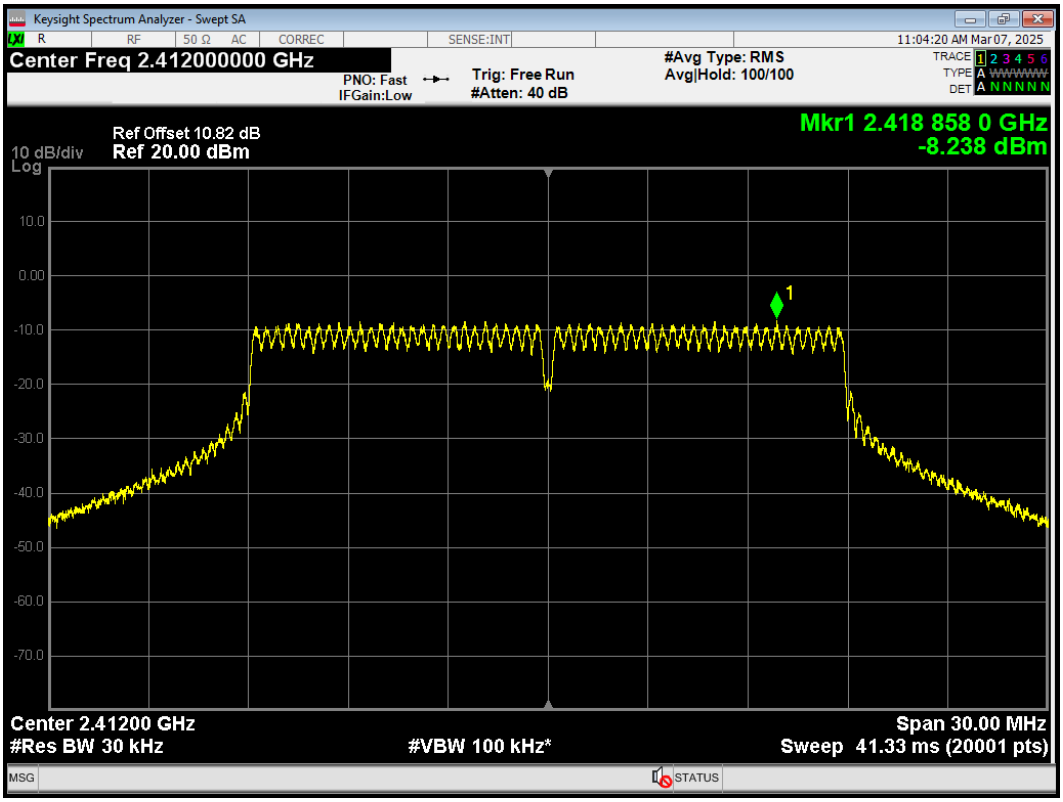
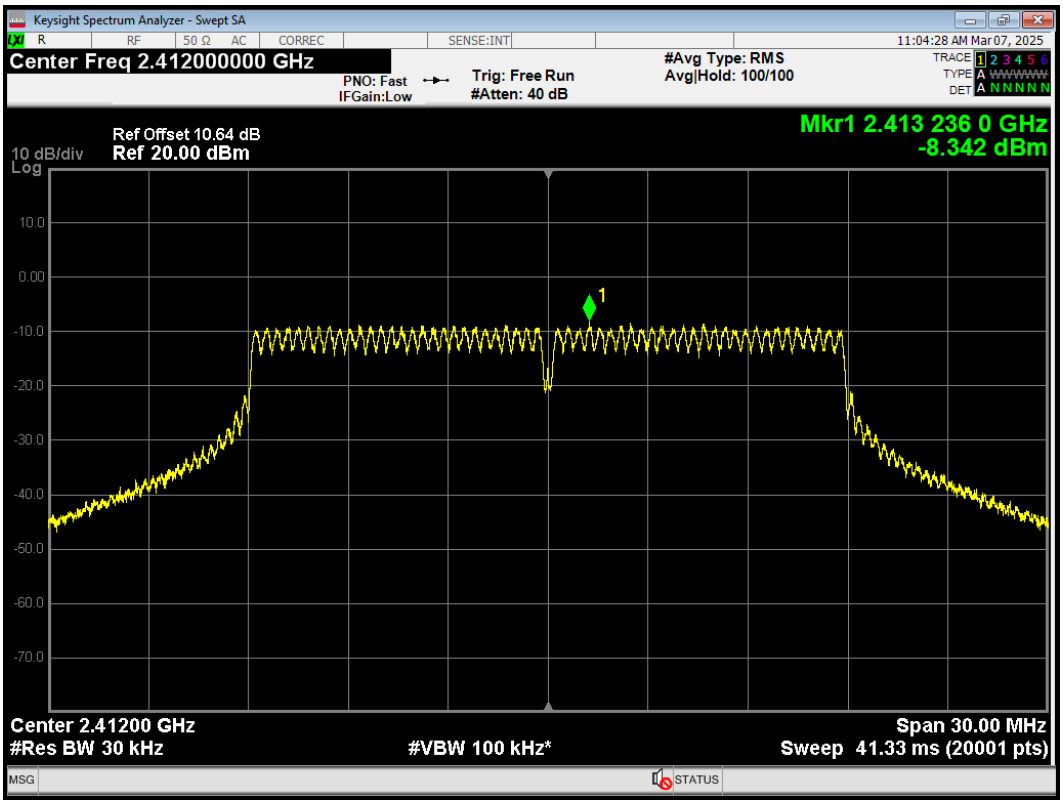
PSD 802.11n(HT20) 2412MHz Ant1



PSD 802.11n(HT20) 2412MHz Ant2



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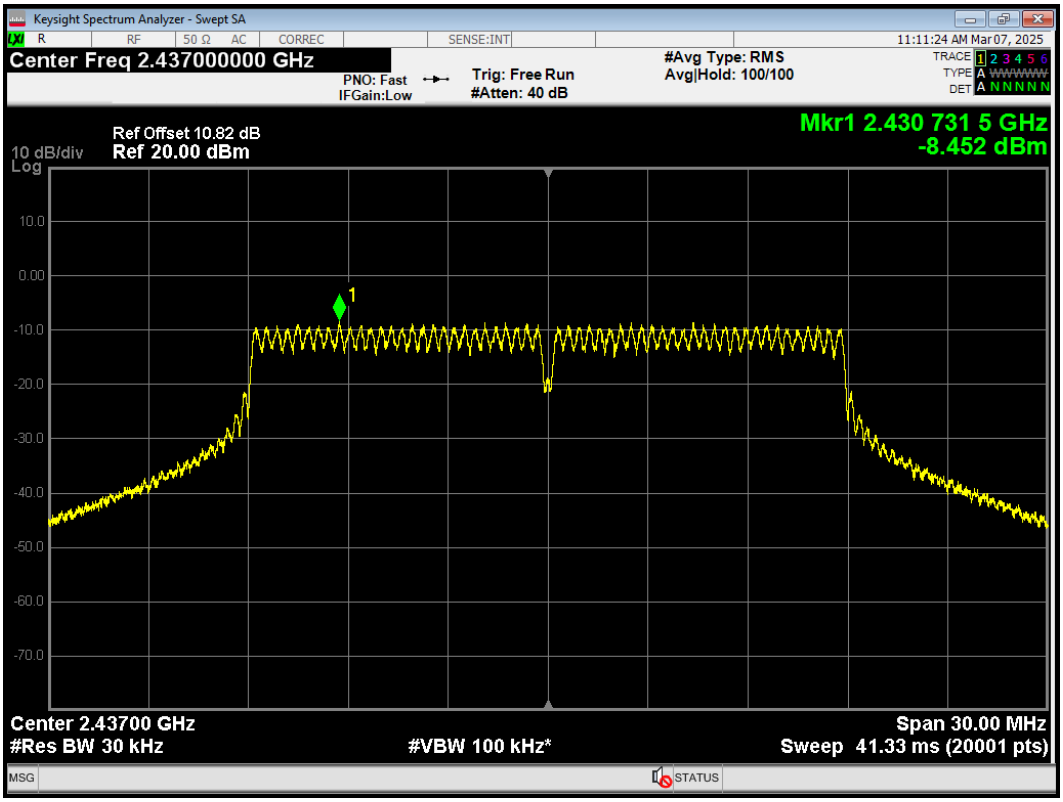
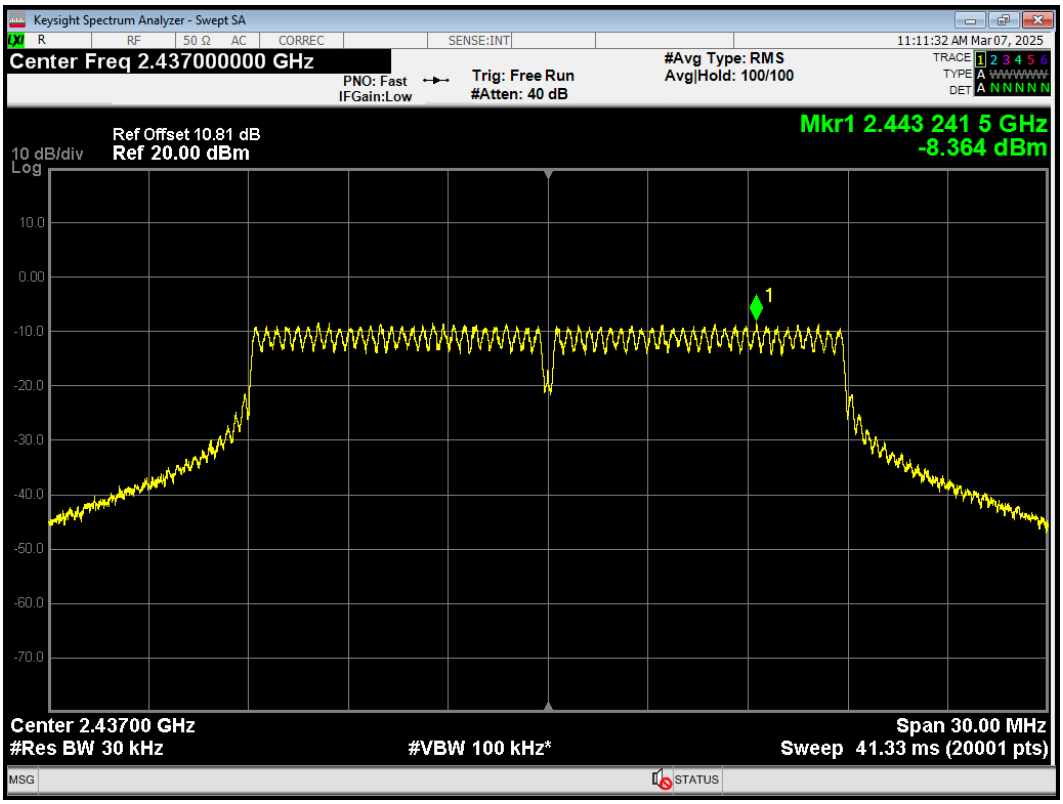
PSD 802.11n(HT20) 2437MHz Ant1



PSD 802.11n(HT20) 2437MHz Ant2



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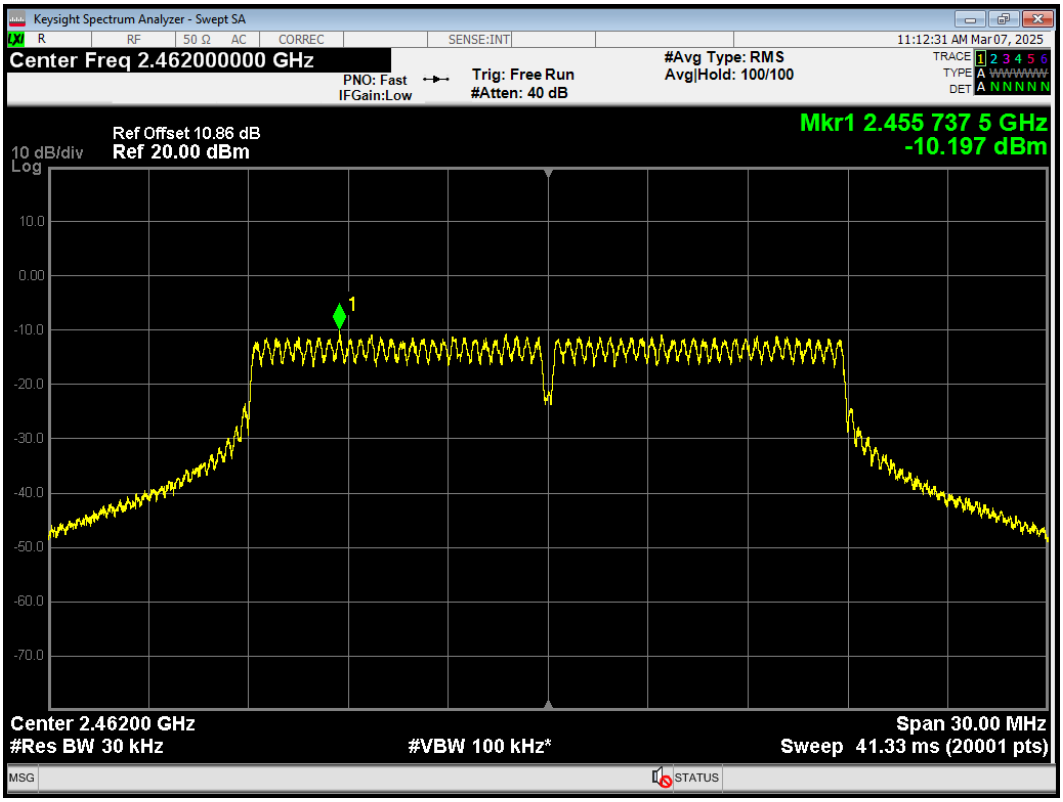
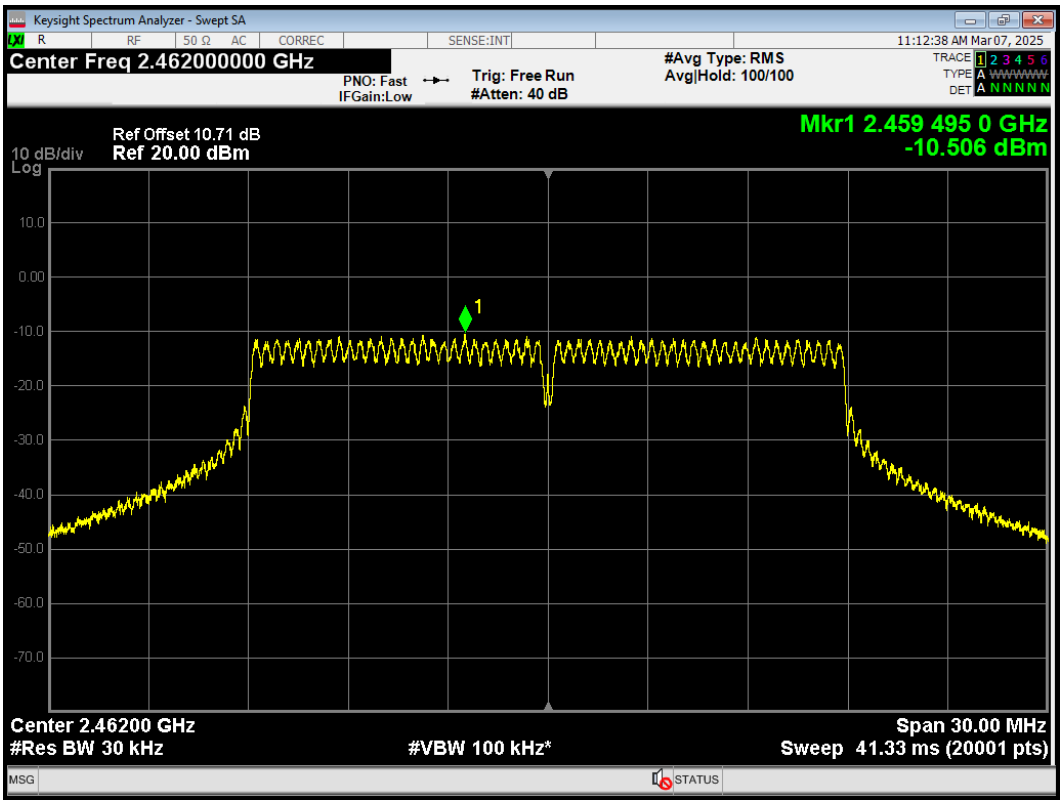
PSD 802.11n(HT20) 2462MHz Ant1



PSD 802.11n(HT20) 2462MHz Ant2



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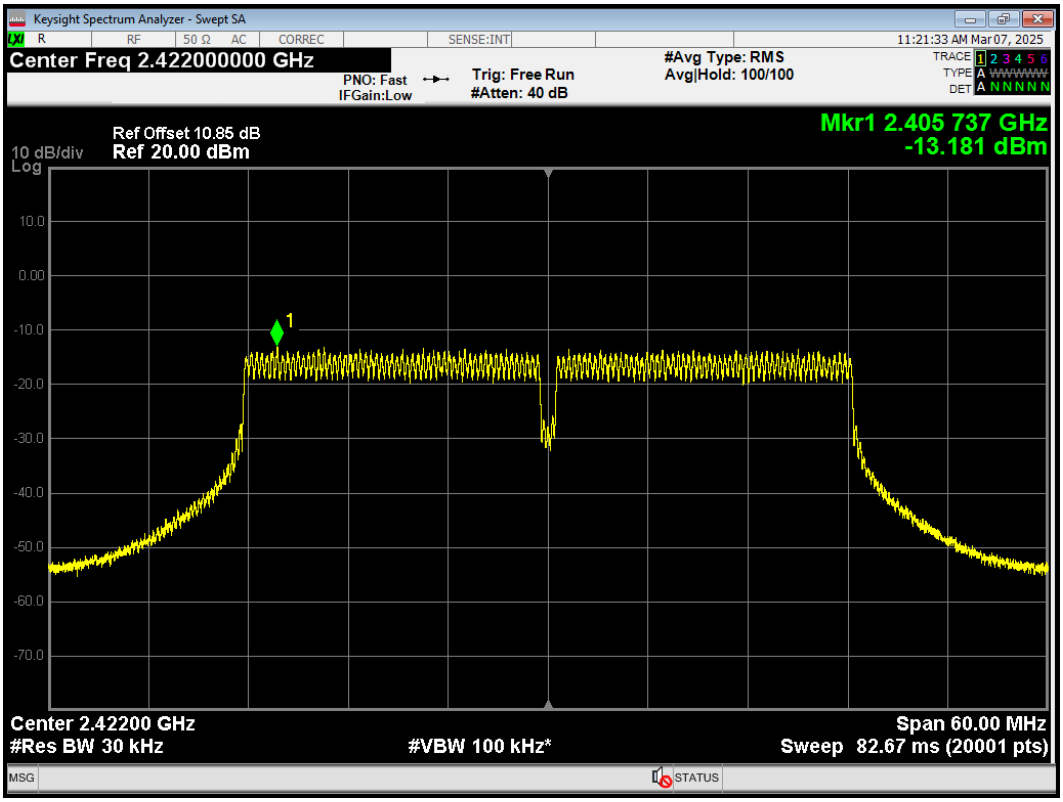
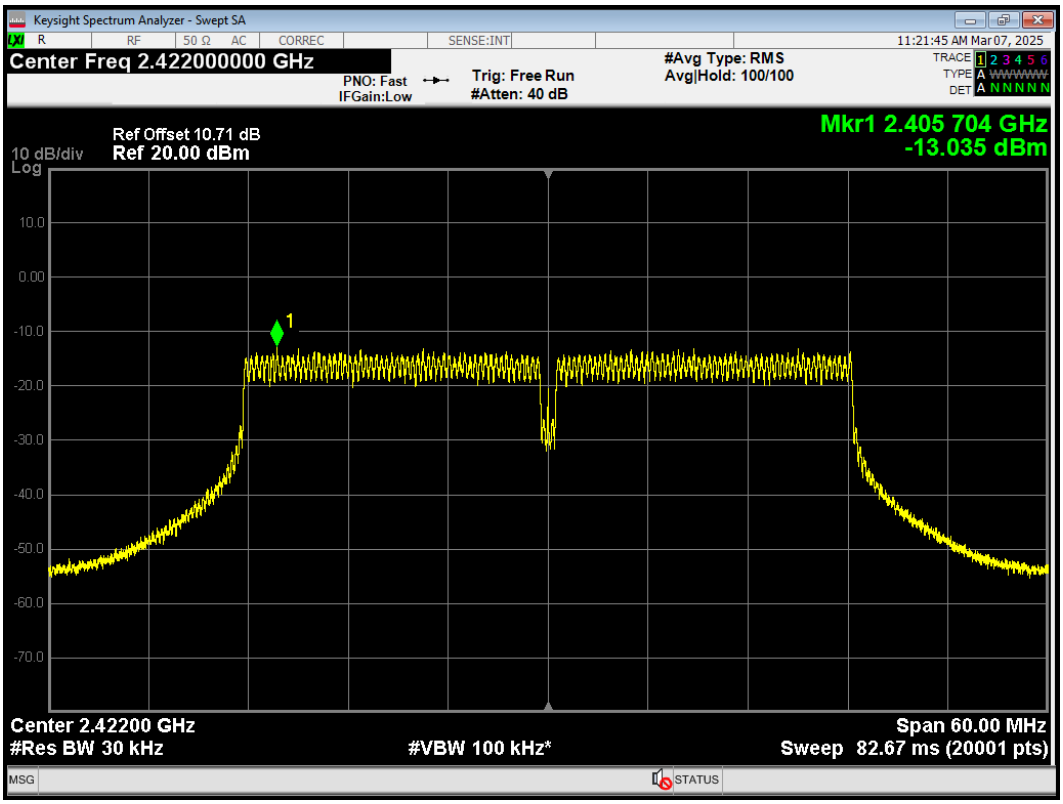
PSD 802.11n(HT40) 2422MHz Ant1



PSD 802.11n(HT40) 2422MHz Ant2



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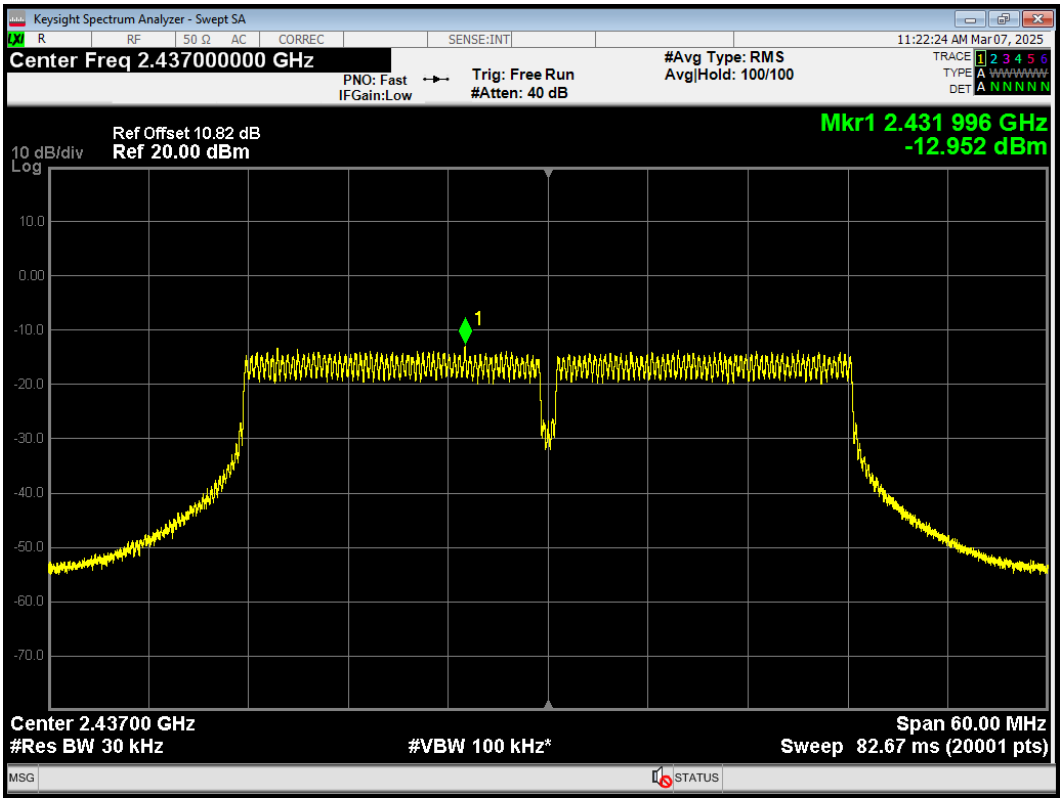
PSD 802.11n(HT40) 2437MHz Ant1



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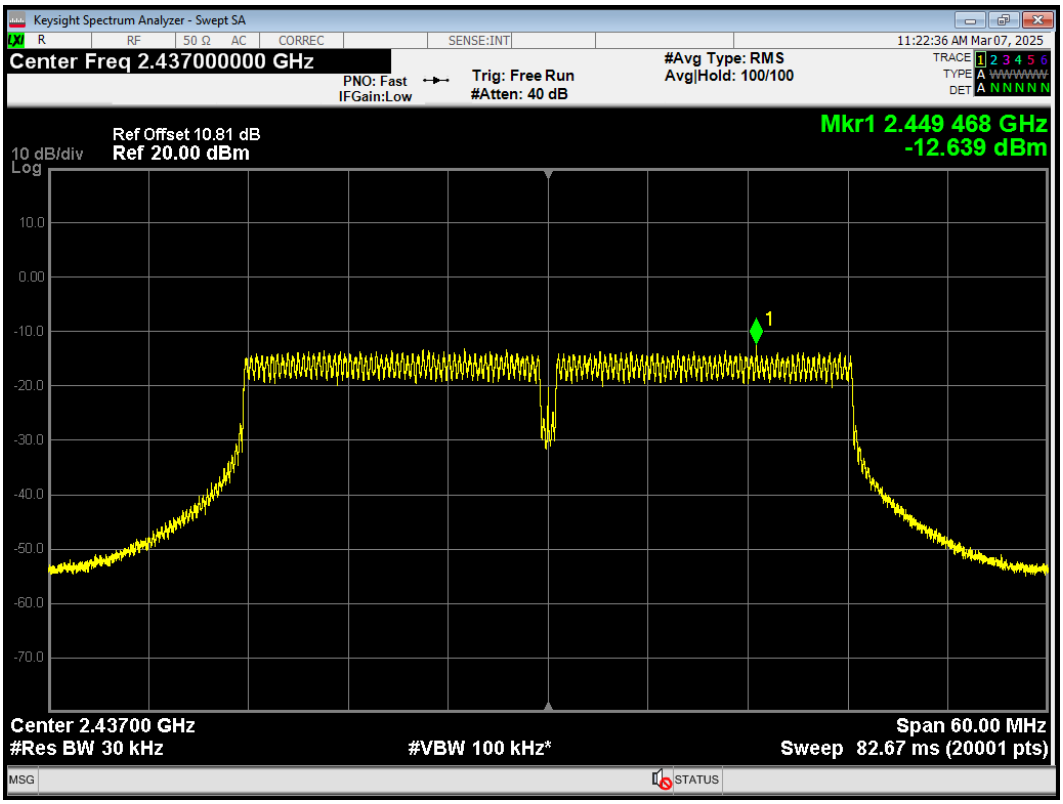

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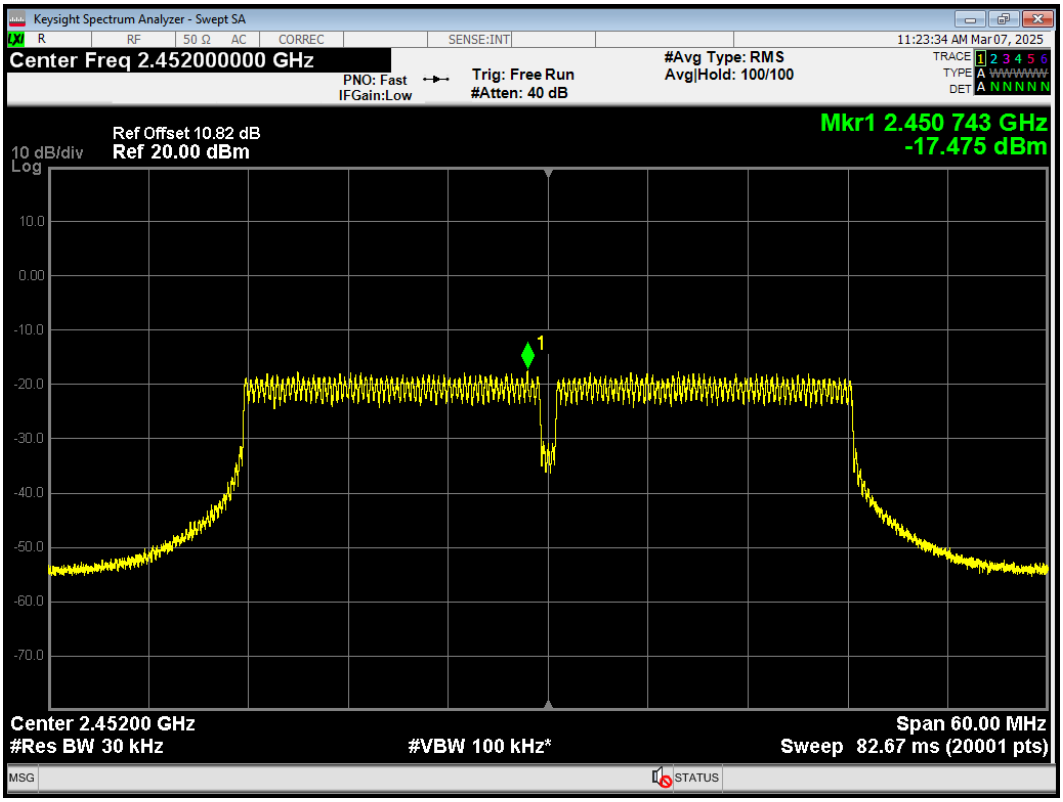
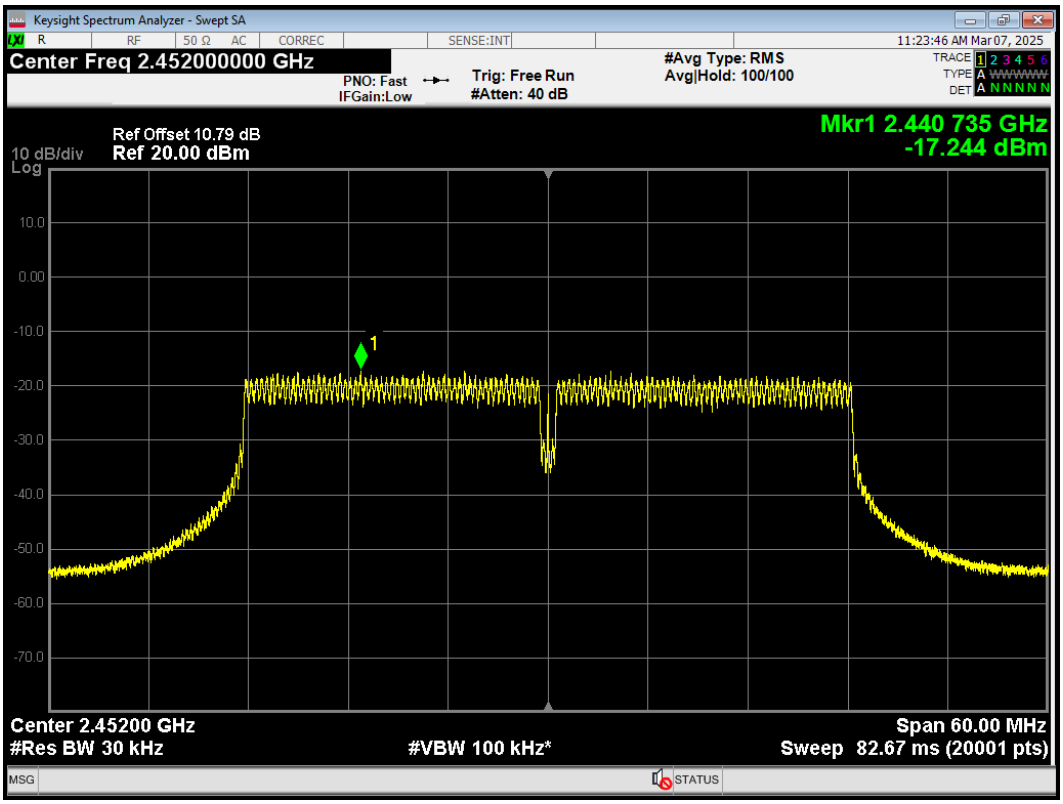
PSD 802.11n(HT40) 2452MHz Ant1



PSD 802.11n(HT40) 2452MHz Ant2



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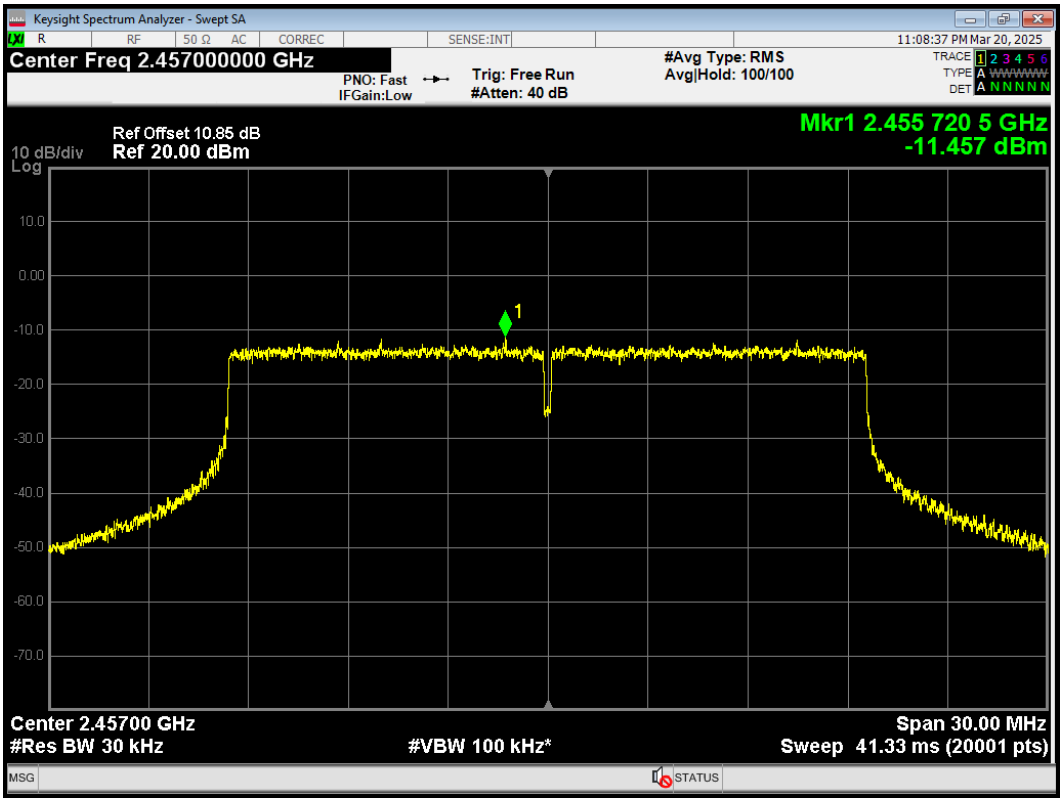
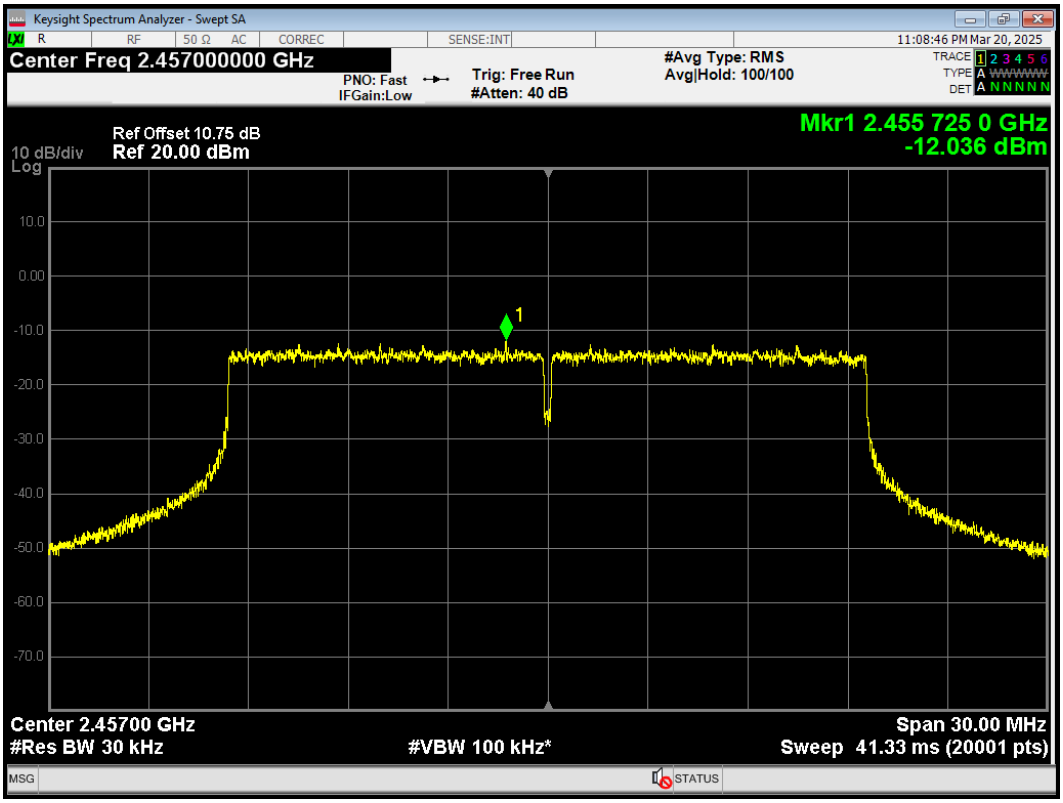
PSD 802.11ax(HE20) 2457MHz Ant1



PSD 802.11ax(HE20) 2457MHz Ant2



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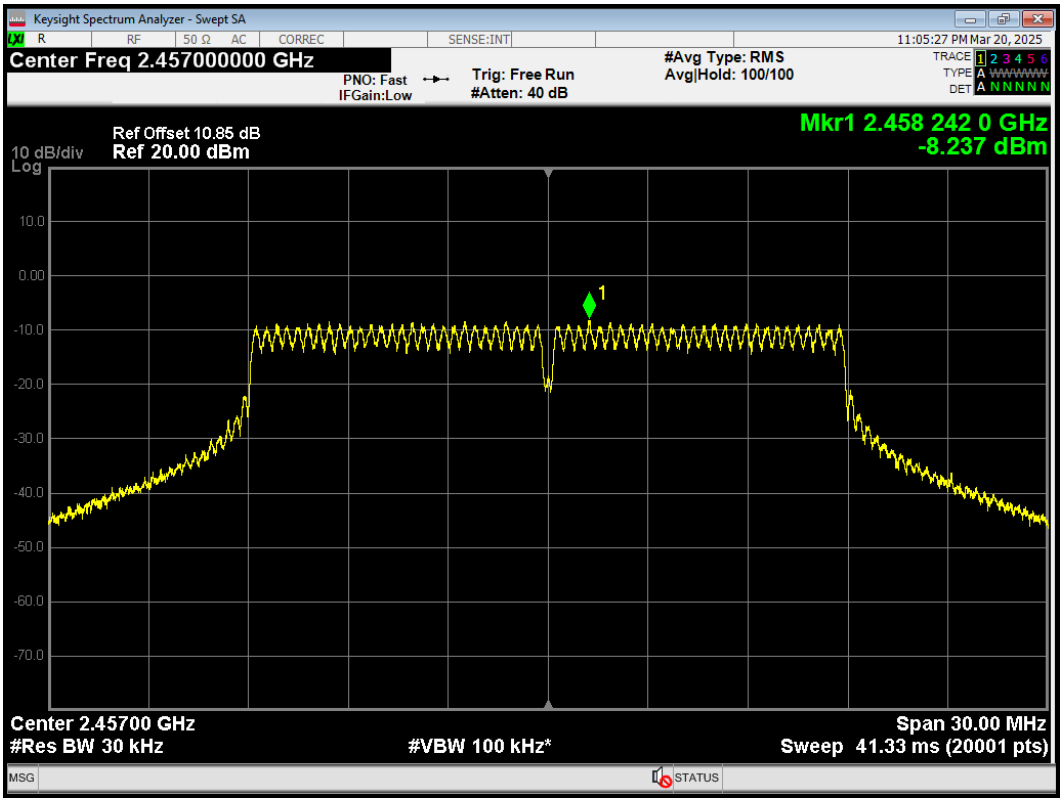
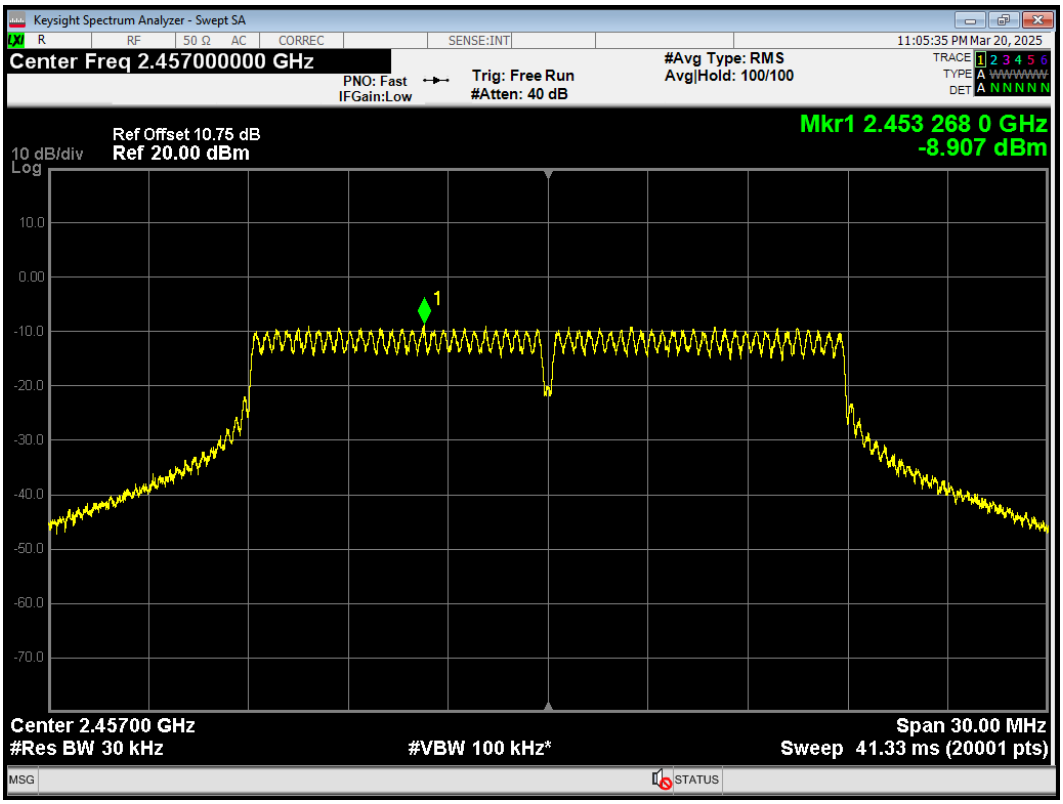
PSD 802.11n(HT20) 2457MHz Ant1



PSD 802.11n(HT20) 2457MHz Ant2



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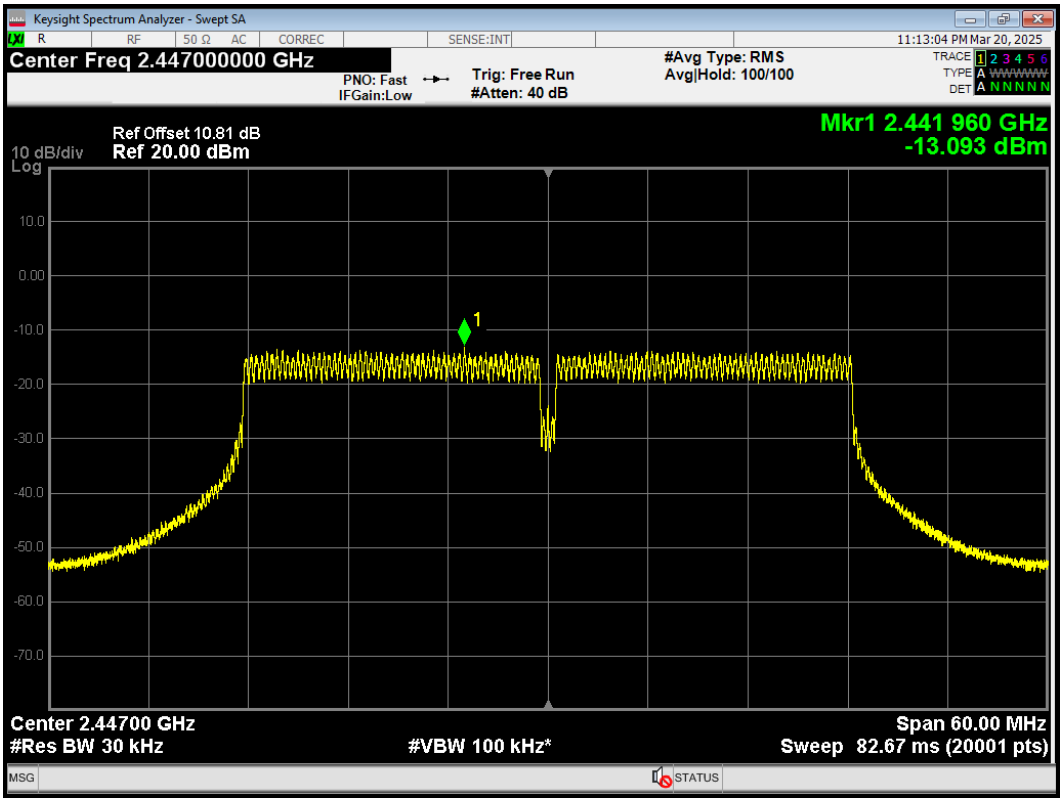
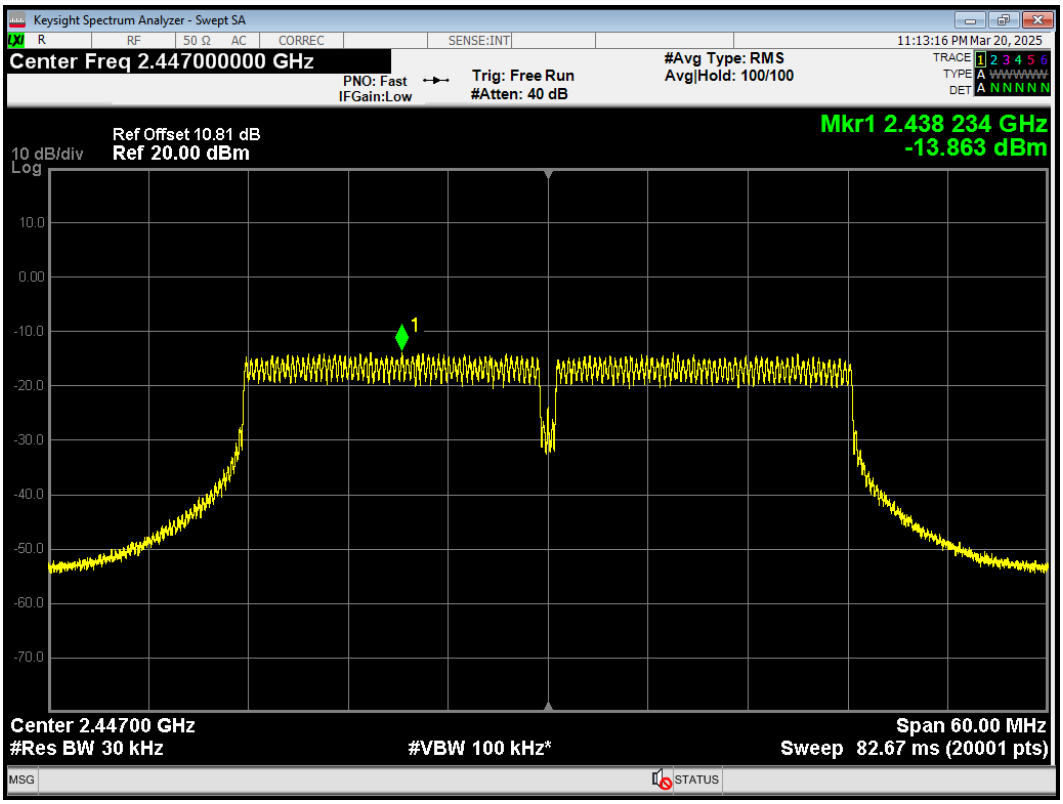
PSD 802.11n(HT40) 2447MHz Ant1



PSD 802.11n(HT40) 2447MHz Ant2



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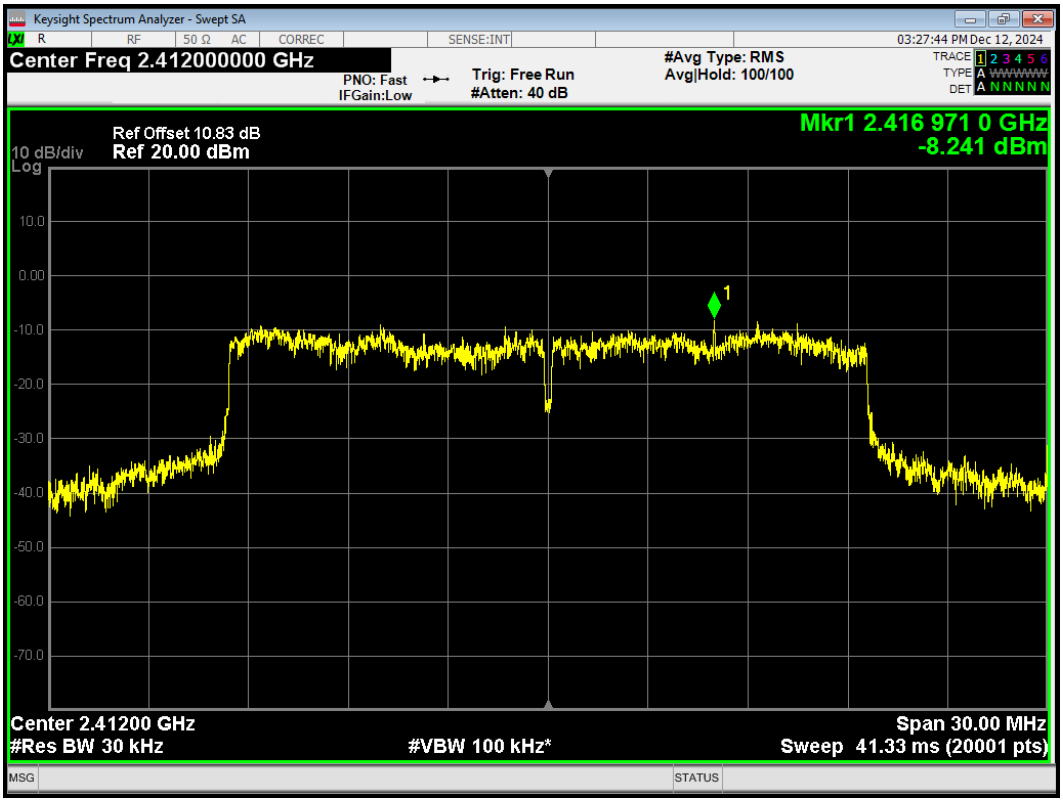
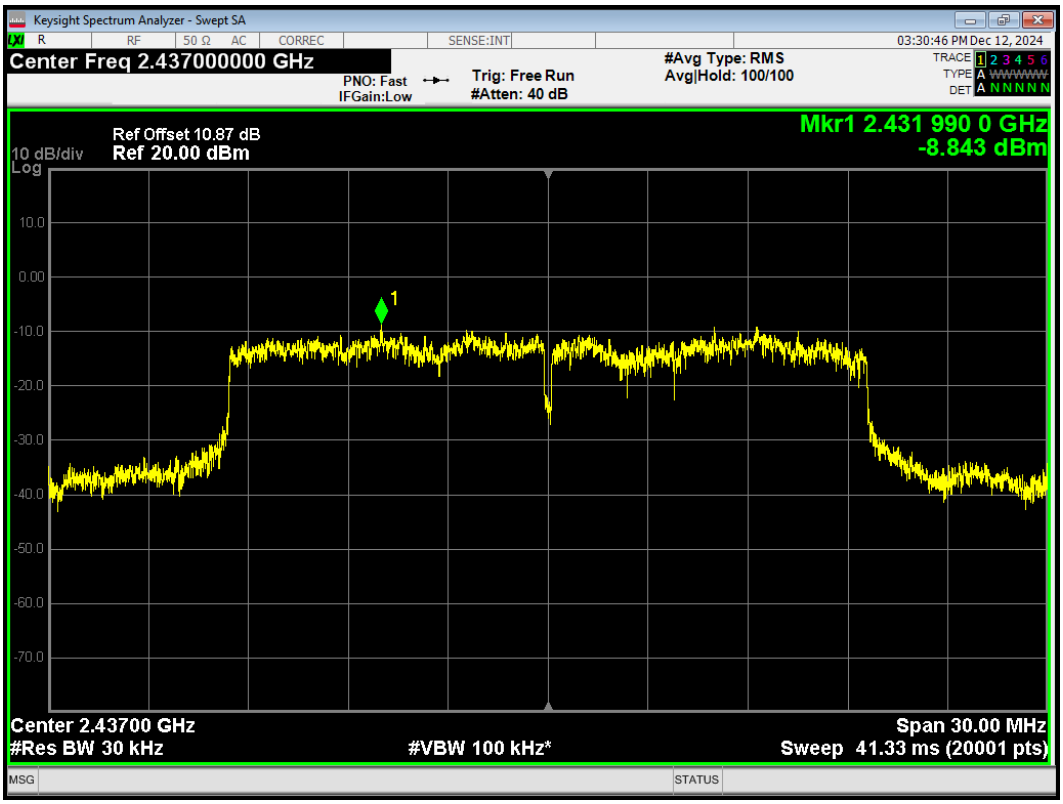
ERSU Mode

Antenna 1

PSD 802.11ax(HE20) 242-Tones 2412MHz



PSD 802.11ax(HE20) 242-Tones 2437MHz



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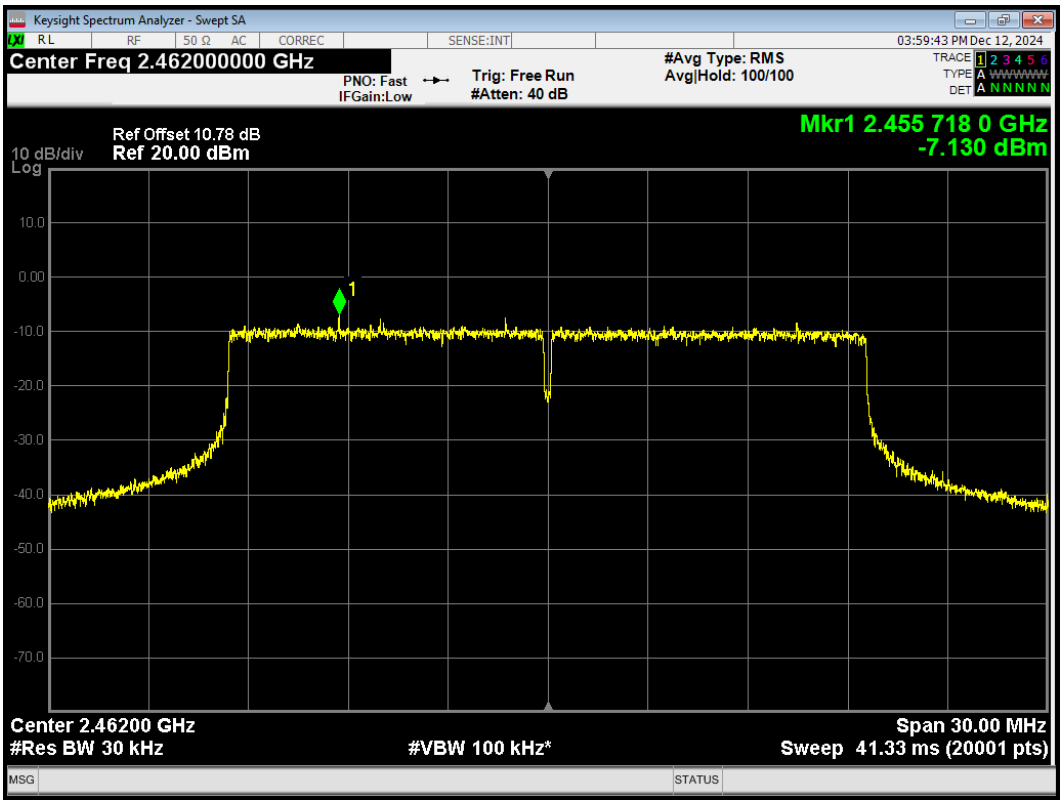
PSD 802.11ax(HE20) 242-Tones 2462MHz



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Antenna 2

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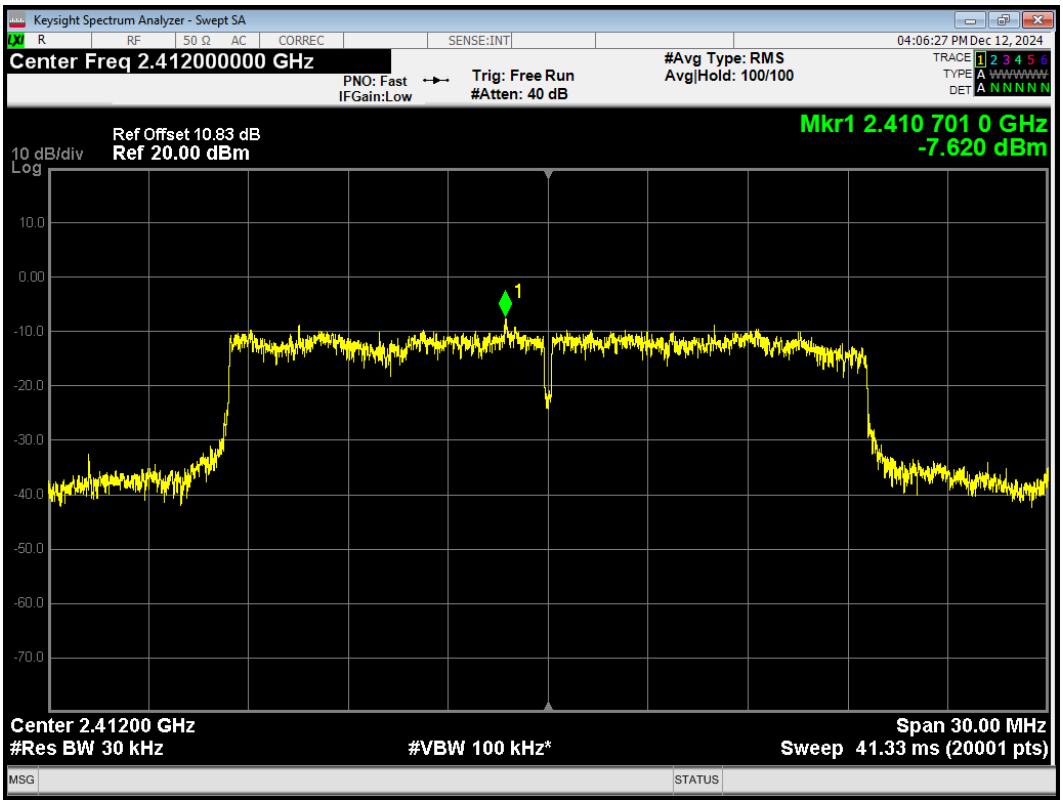
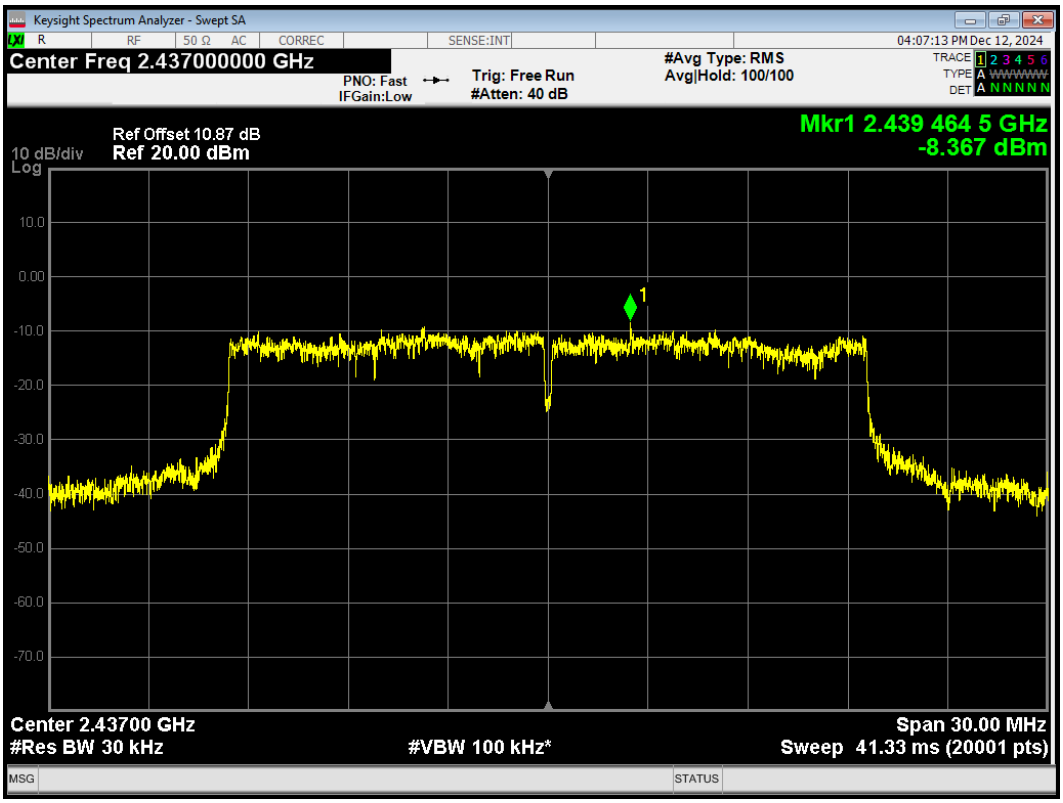


PSD 802.11ax(HE20) 242-Tones 2437MHz



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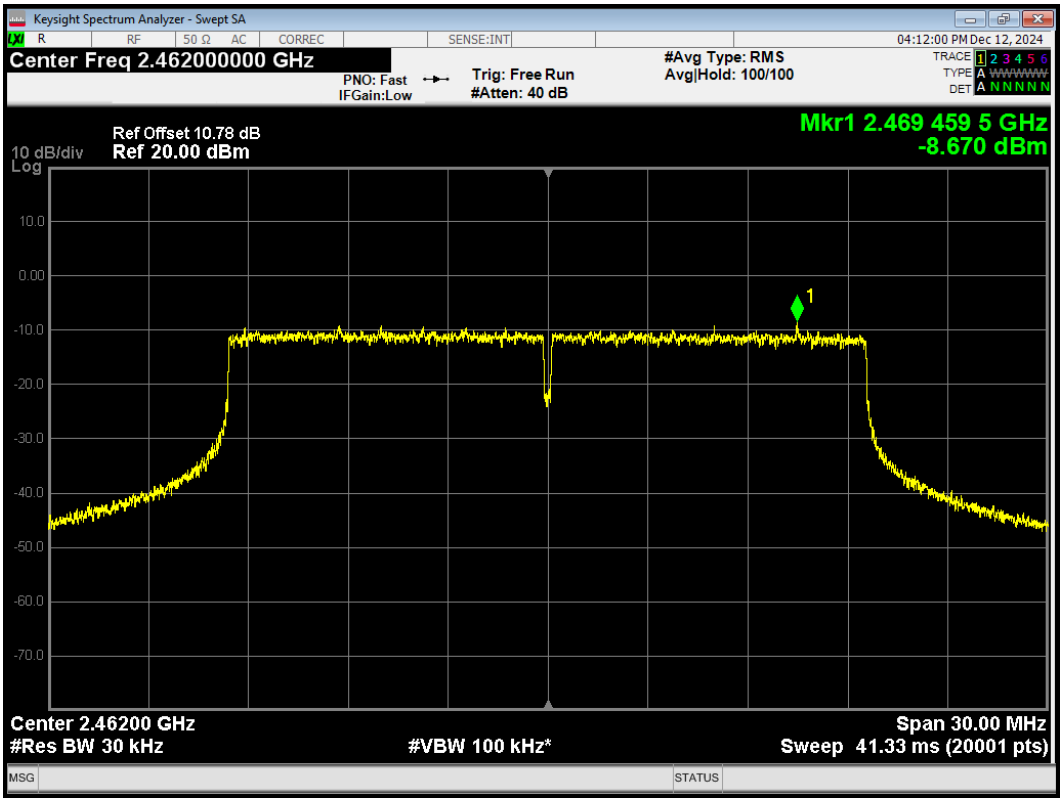
PSD 802.11ax(HE20) 242-Tones 2462MHz



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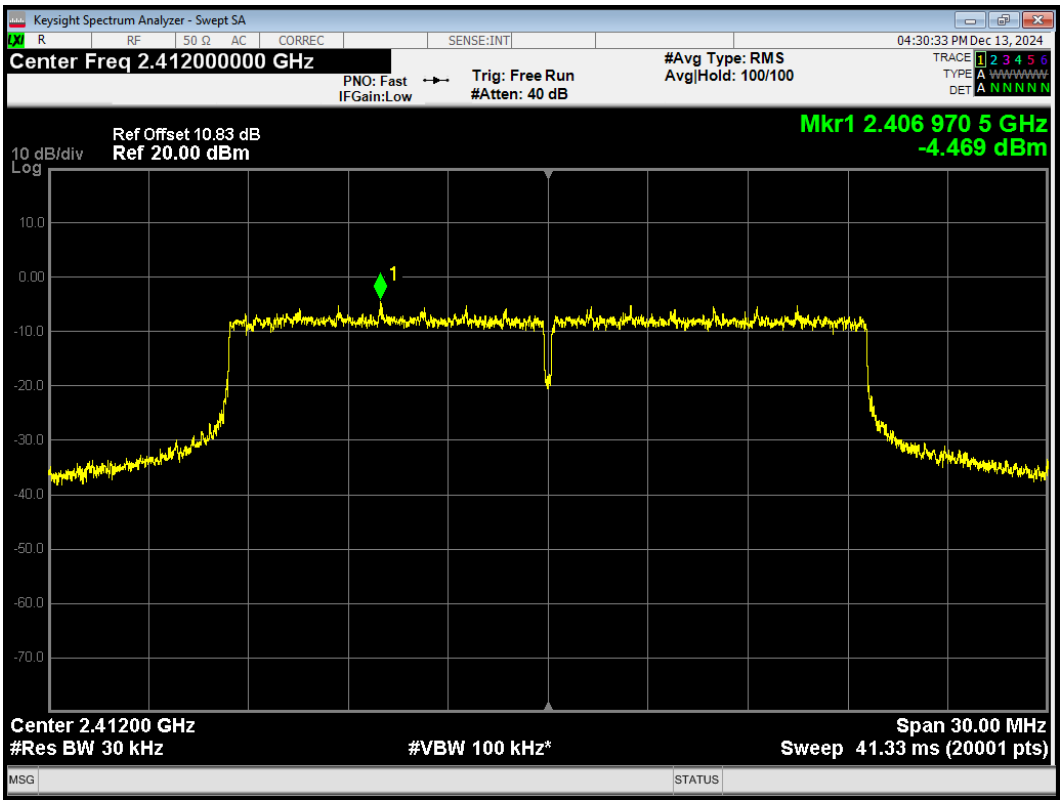
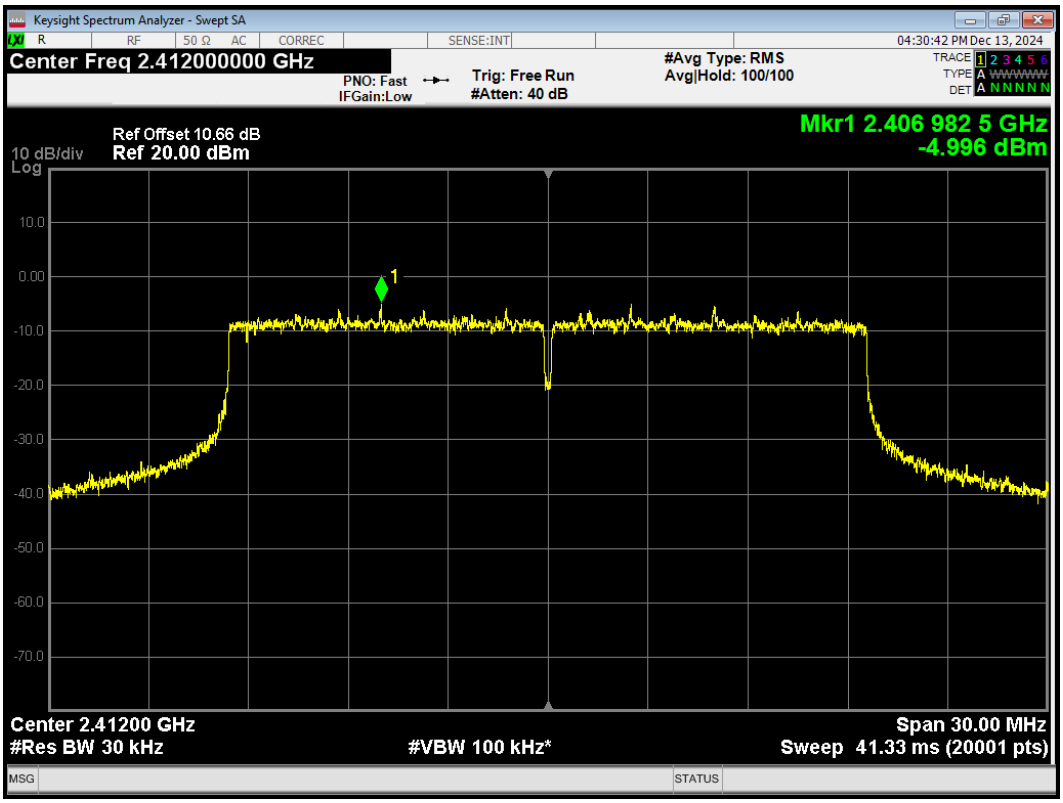
MIMO

PSD 802.11ax(HE20) 242-Tones 2412MHz Ant1



PSD 802.11ax(HE20) 242-Tones 2412MHz Ant2



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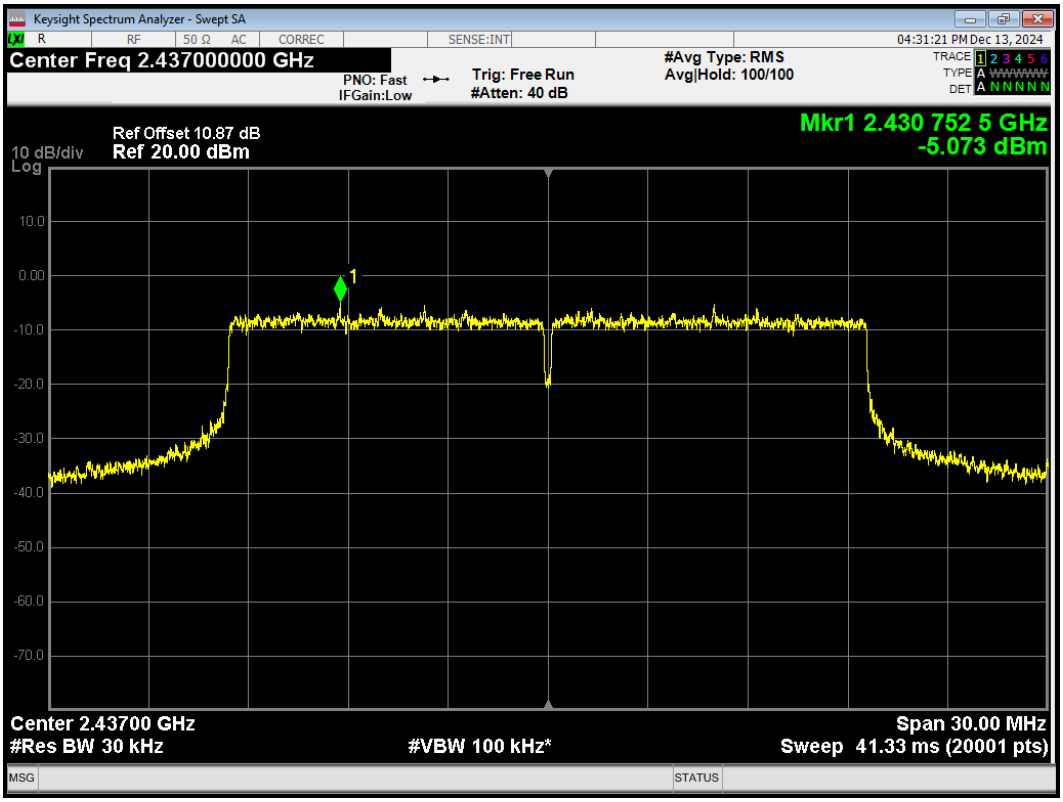
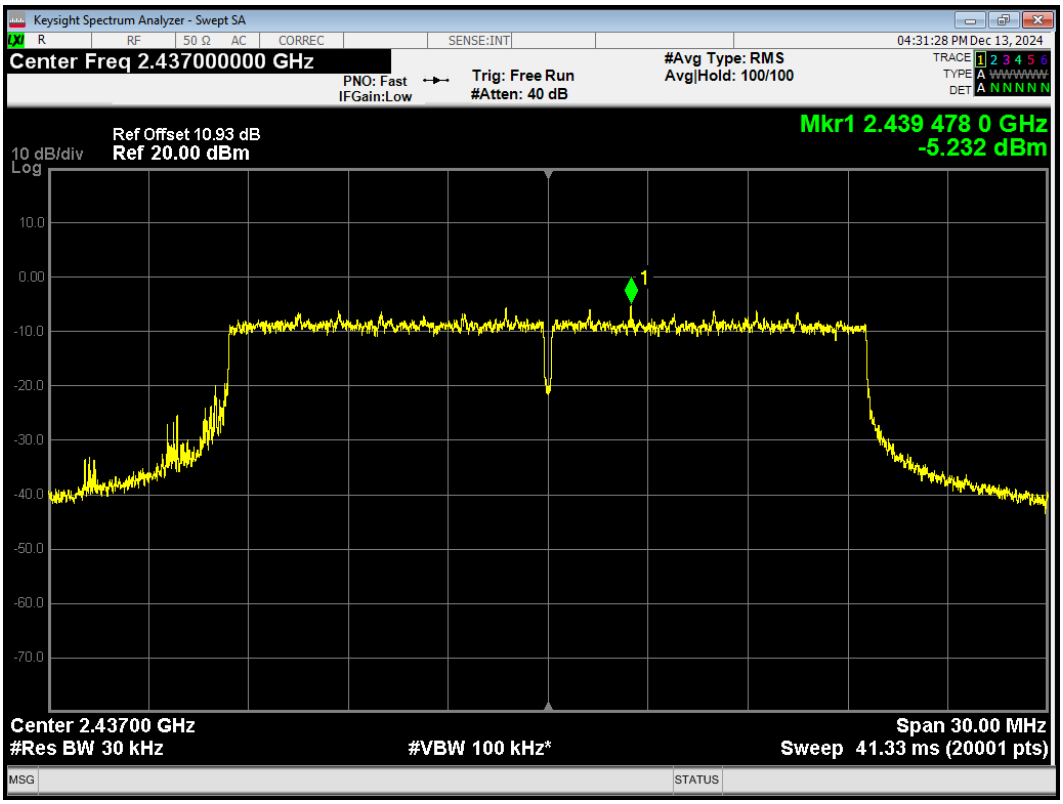
PSD 802.11ax(HE20) 242-Tones 2437MHz Ant1



PSD 802.11ax(HE20) 242-Tones 2437MHz Ant2



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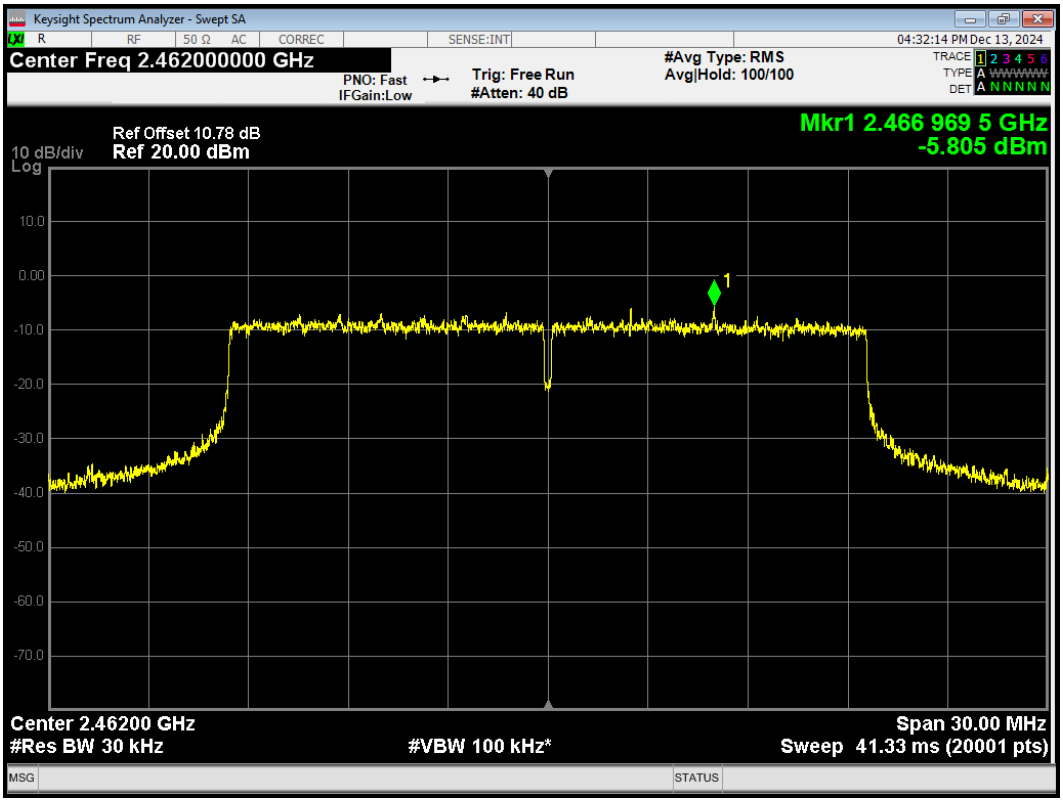
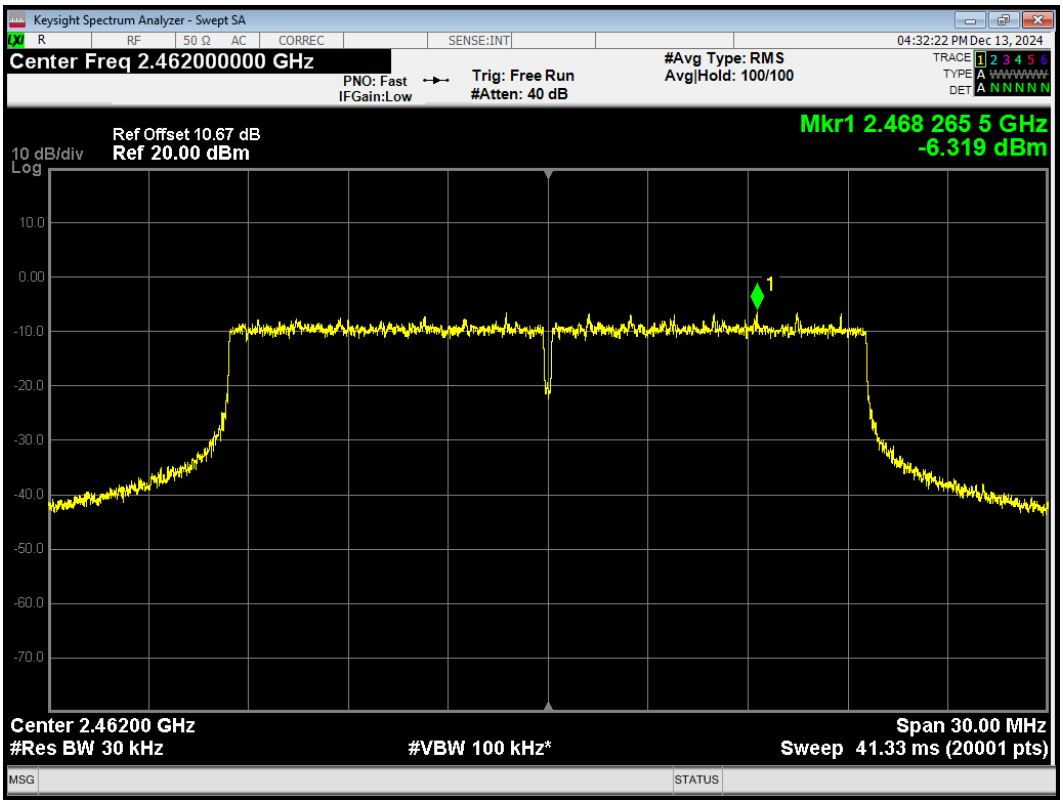
PSD 802.11ax(HE20) 242-Tones 2462MHz Ant1



PSD 802.11ax(HE20) 242-Tones 2462MHz Ant2



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5.5. Spurious RF Conducted Emissions

Ambient Condition

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

Method of Measurement

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

Test Setup

Limits

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

Test Mode	Carrier frequency (MHz)	Reference value (dBm)	Limit
Bluetooth (Low Energy) (1M)	2402	18.05	-11.95
	2440	17.61	-12.39
	2480	17.58	-12.42
Bluetooth (Low Energy) (2M)	2402	16.73	-13.27
	2440	17.47	-12.53
	2480	17.26	-12.74
Bluetooth (Low Energy) (S=2)	2402	17.67	-12.33
	2440	17.4	-12.6
	2480	17.94	-12.06
Bluetooth (Low Energy) (S=8)	2402	12.31	-17.69
	2440	13.61	-16.39
	2480	11.63	-18.37

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Test Mode	Carrier frequency (MHz)	Reference value (dBm)	Limit
802.11b	2412	8.68	-21.32
	2437	10.06	-19.94
	2462	9.42	-20.58
802.11g	2412	6.58	-23.42
	2437	8.42	-21.58
	2462	7.71	-22.29
802.11n HT20	2412	1.59	-28.41
	2437	5.59	-24.41
	2457	5.32	-24.68
	2462	3.20	-26.80
802.11n HT40	2422	-1.08	-31.08
	2437	0.43	-29.57
	2447	0.26	-29.74
	2452	-3.85	-33.85
802.11ax HE20	2412	2.29	-27.71
	2437	3.62	-26.38
	2457	3.36	-26.64
	2462	-0.54	-30.54
802.11ax HE40	2422	-0.68	-30.68
	2437	-4.00	-34.00
	2452	-0.19	-30.19

ERSU Mode

Test Mode	Carrier frequency (MHz)	Reference value (dBm)	Limit
802.11ax HE20 242-Tones: RU Index 61	2412	12.76	-17.24
	2437	12.81	-17.19
	2462	8.74	-21.26

Measurement Uncertainty

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

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

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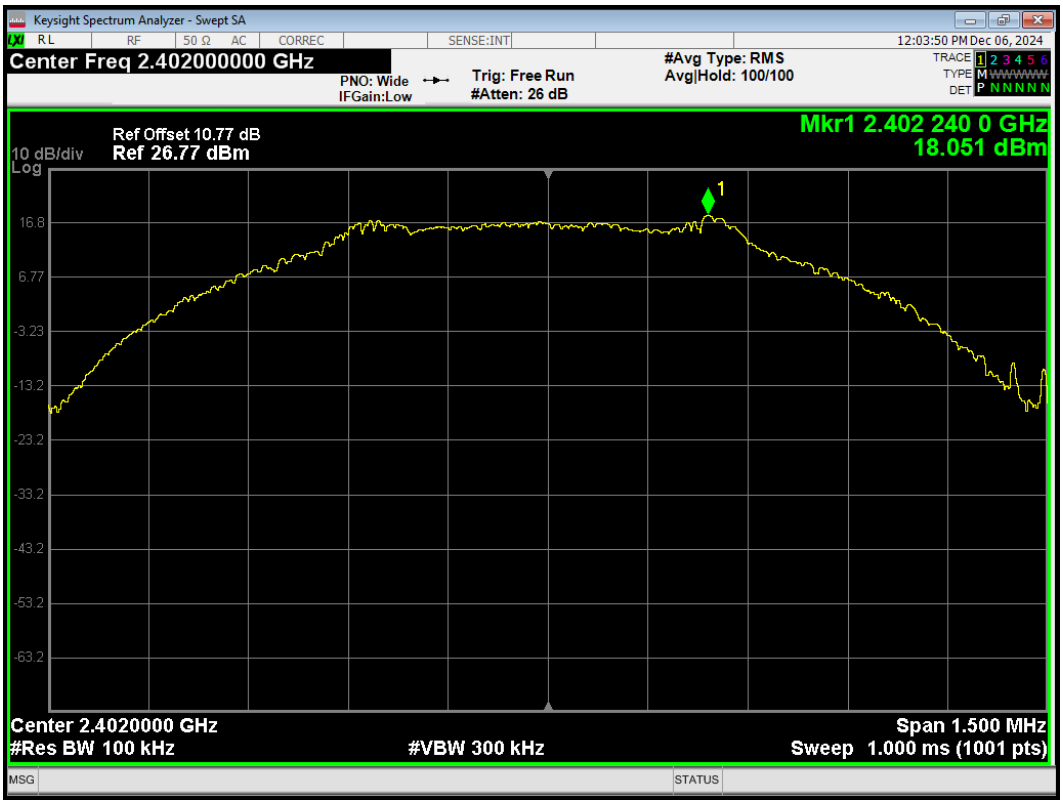
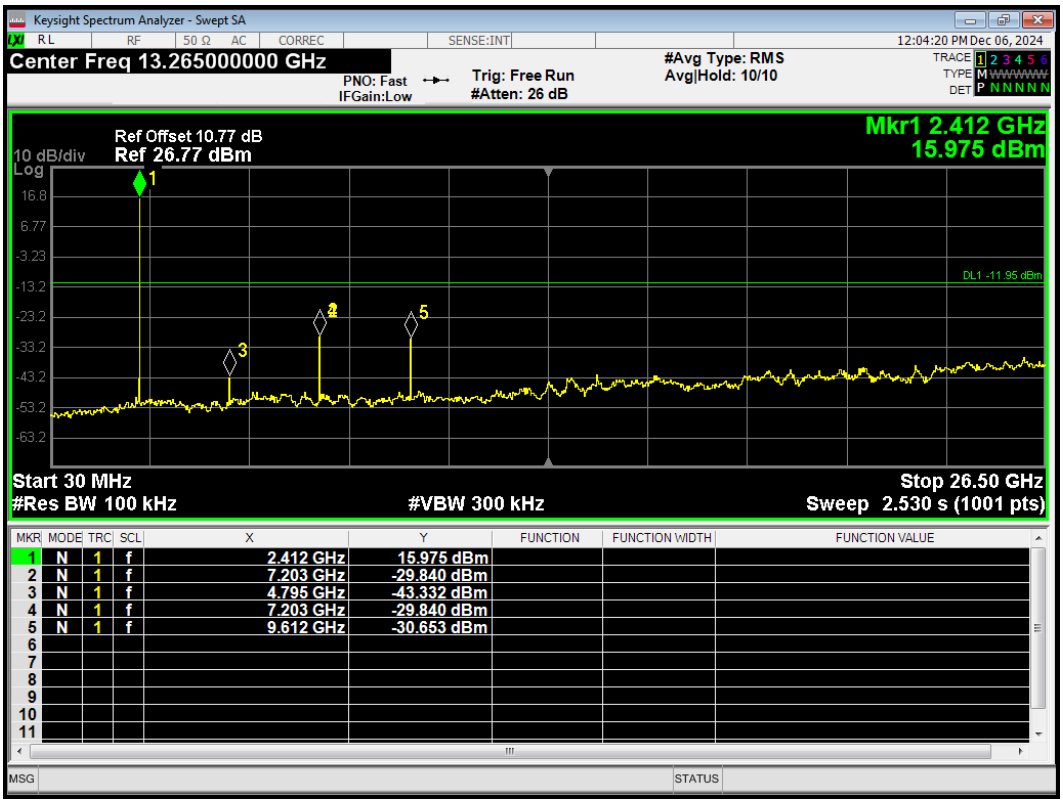
Test Results:

Tx. Spurious Bluetooth LE (1M) 2402MHz Ref



Tx. Spurious Bluetooth LE (1M) 2402MHz Emission



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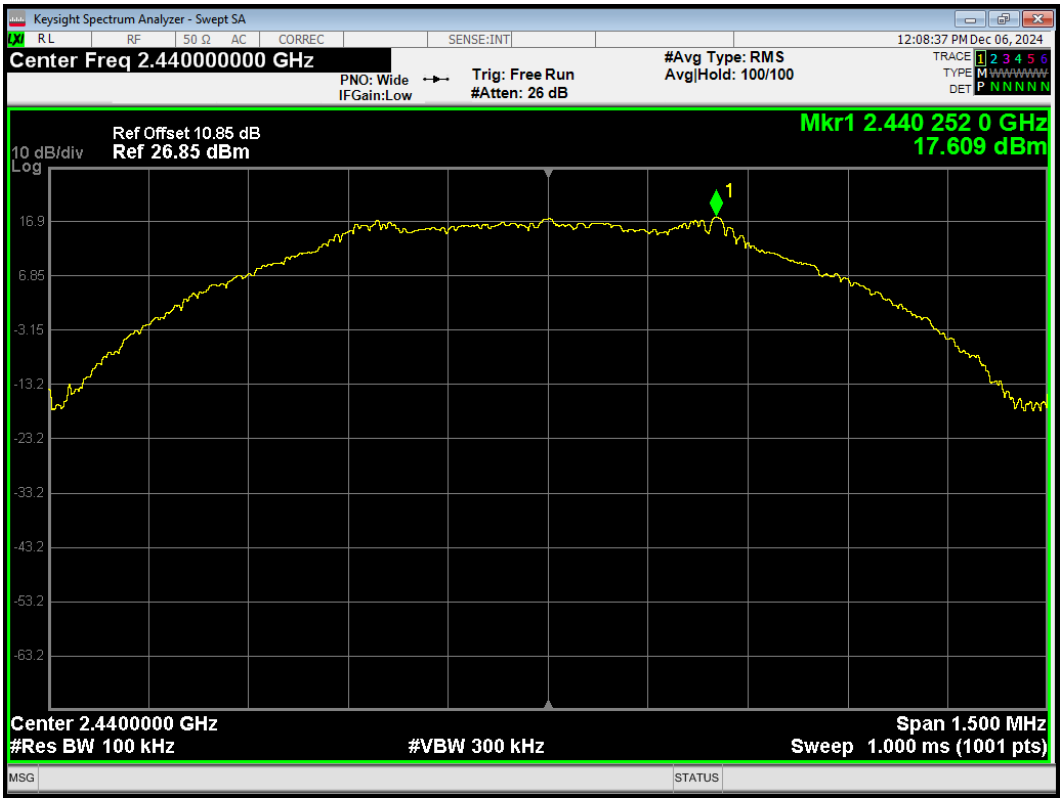
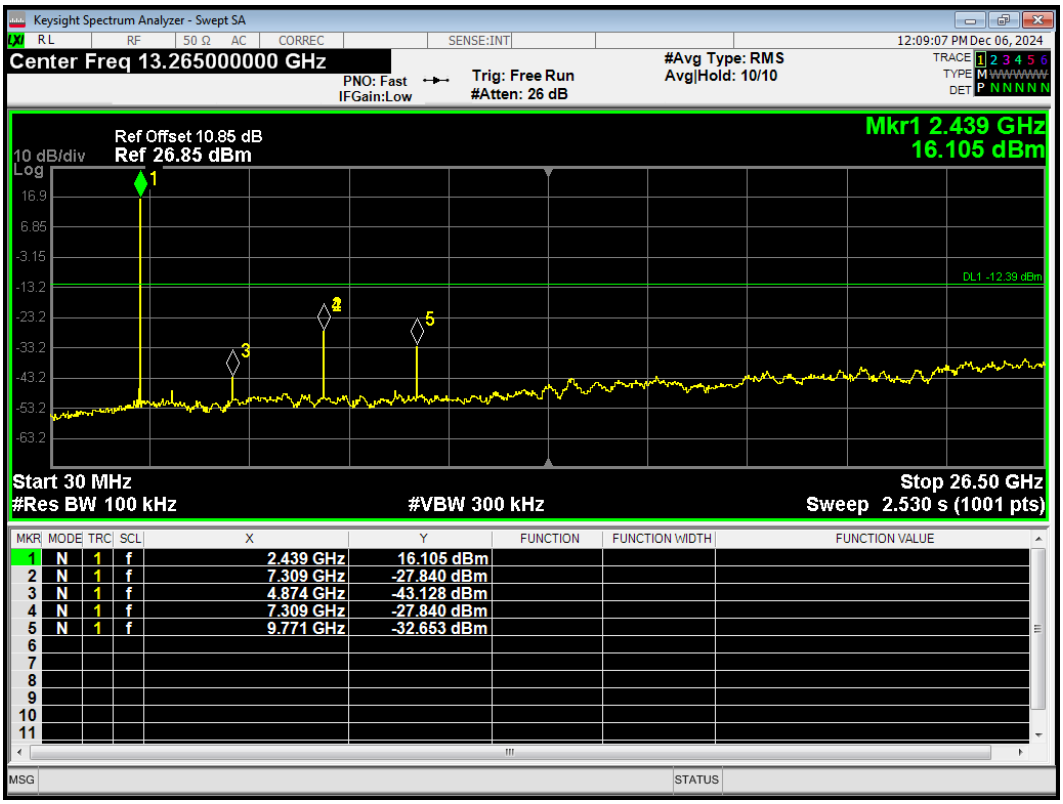
Tx. Spurious Bluetooth LE (1M) 2440MHz Ref



Tx. Spurious Bluetooth LE (1M) 2440MHz Emission



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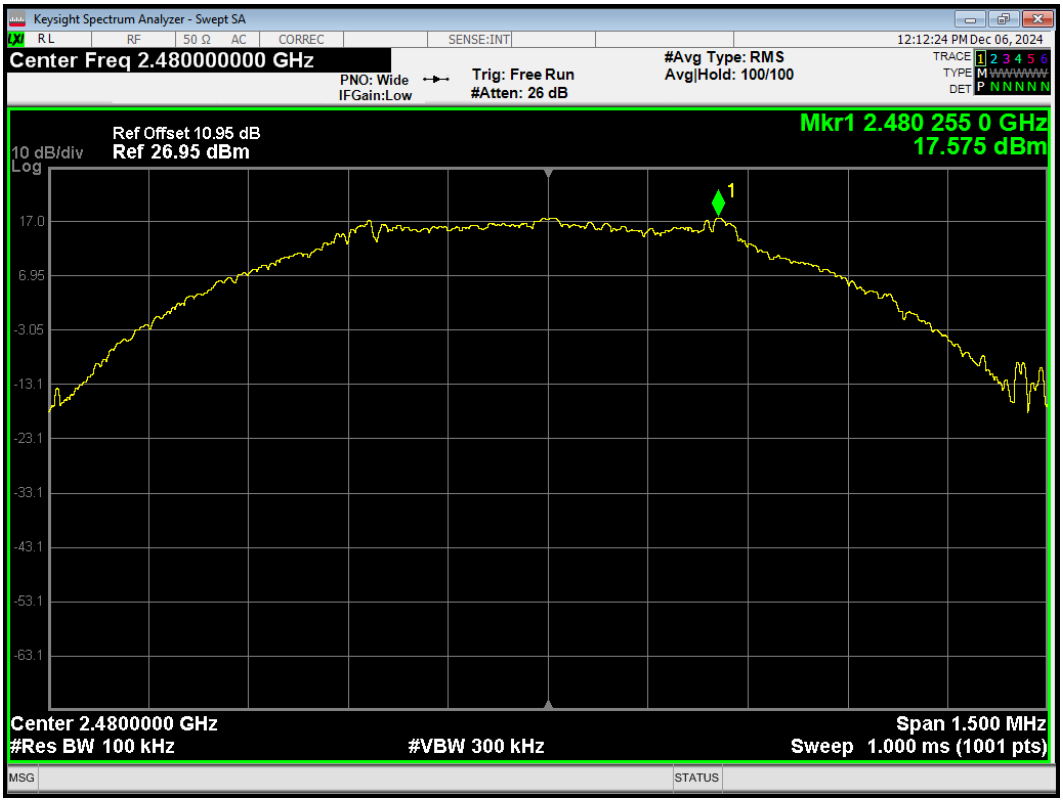
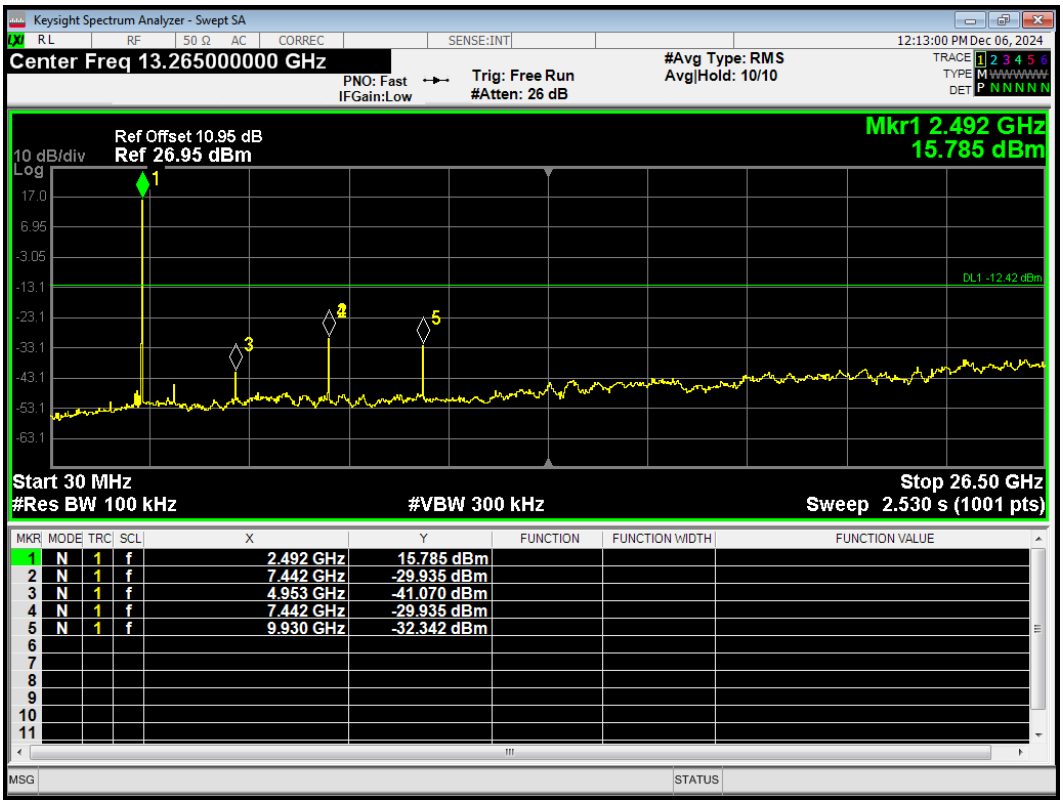
Tx. Spurious Bluetooth LE (1M) 2480MHz Ref



Tx. Spurious Bluetooth LE (1M) 2480MHz Emission



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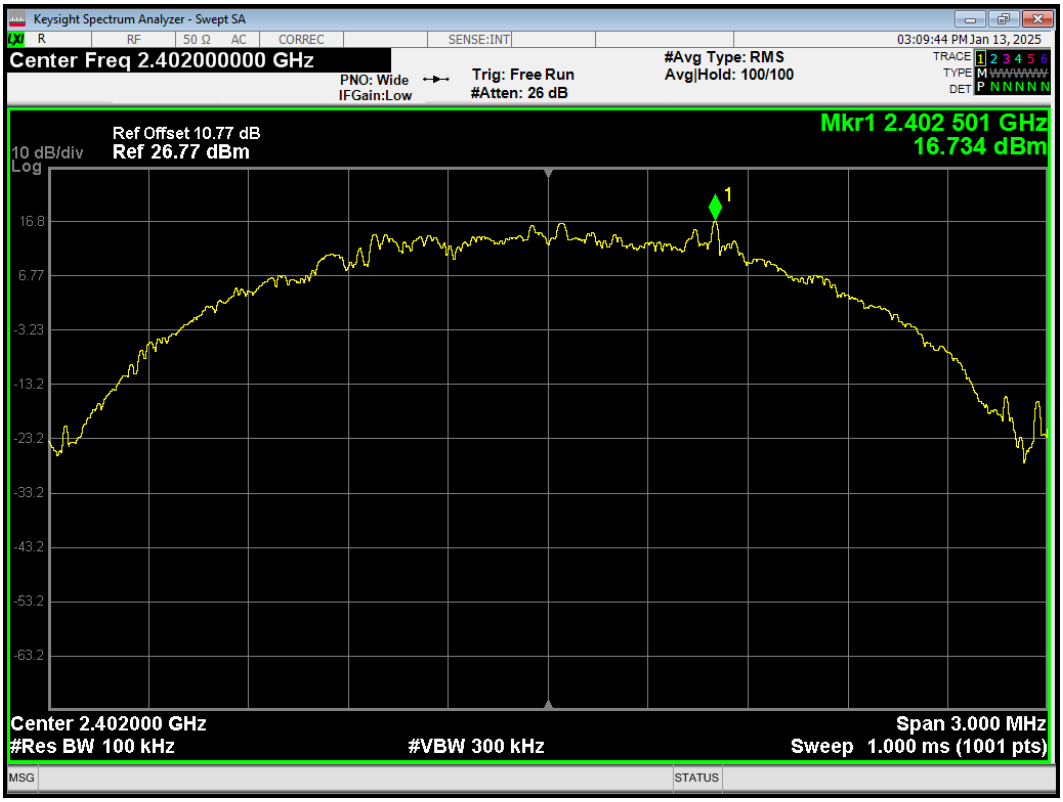
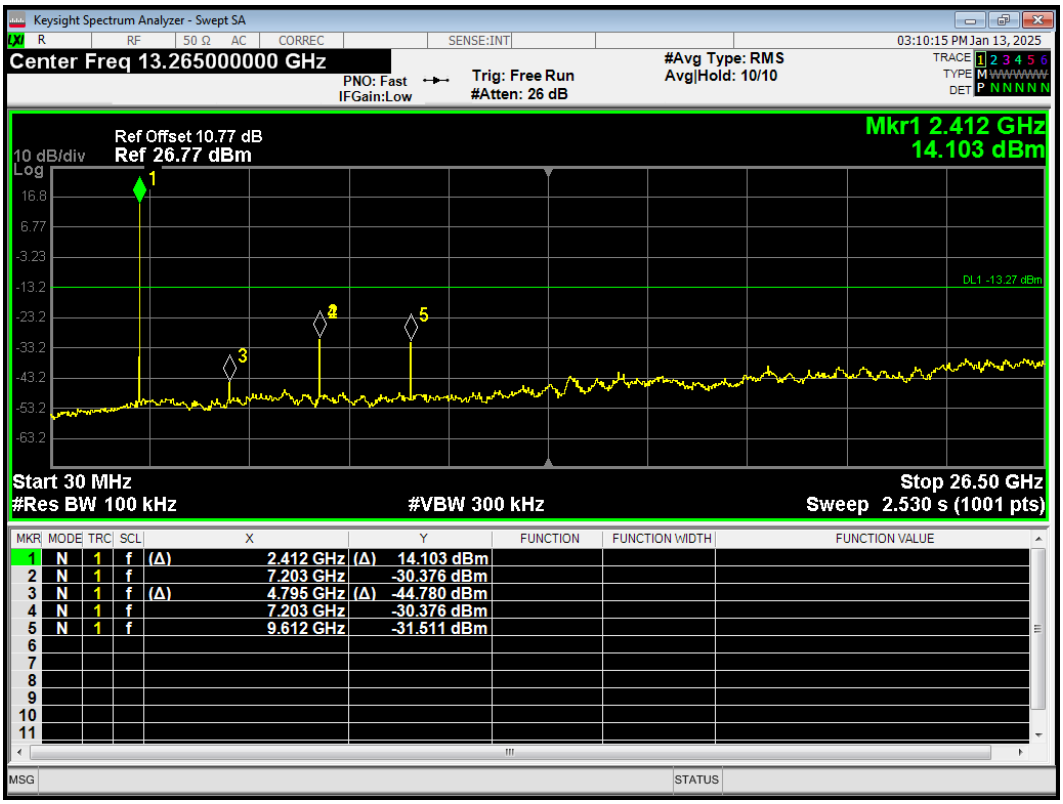
Tx. Spurious Bluetooth LE (2M) 2402MHz Ref



Tx. Spurious Bluetooth LE (2M) 2402MHz Emission



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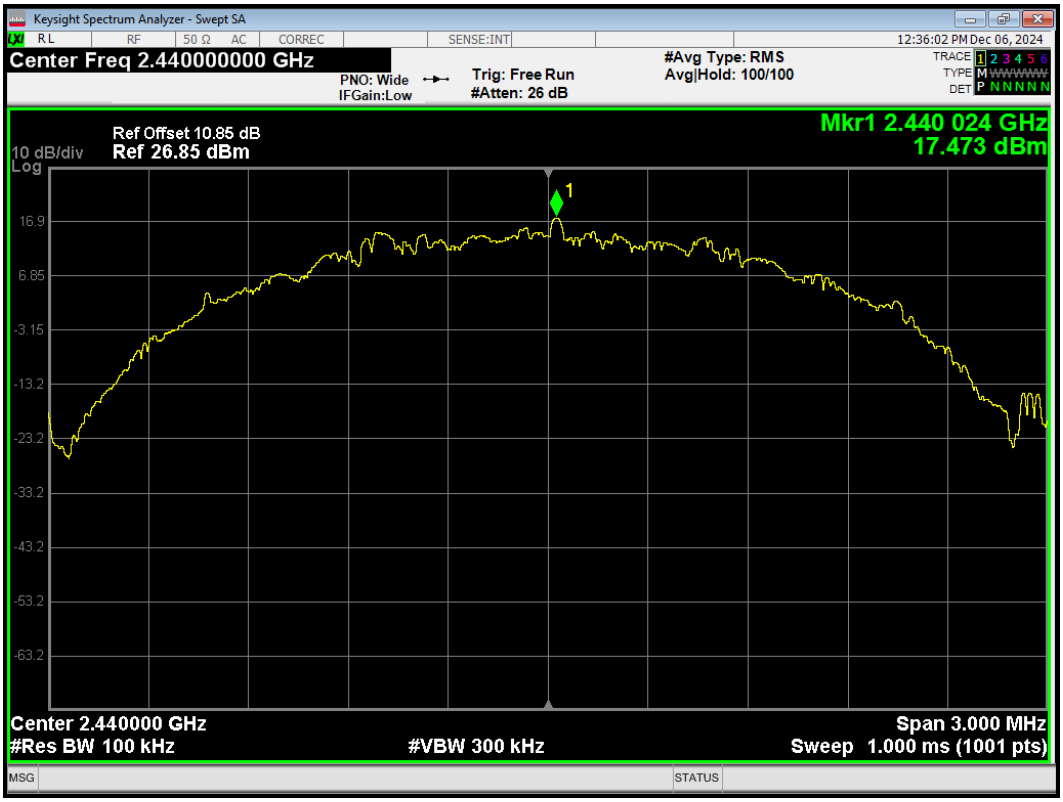
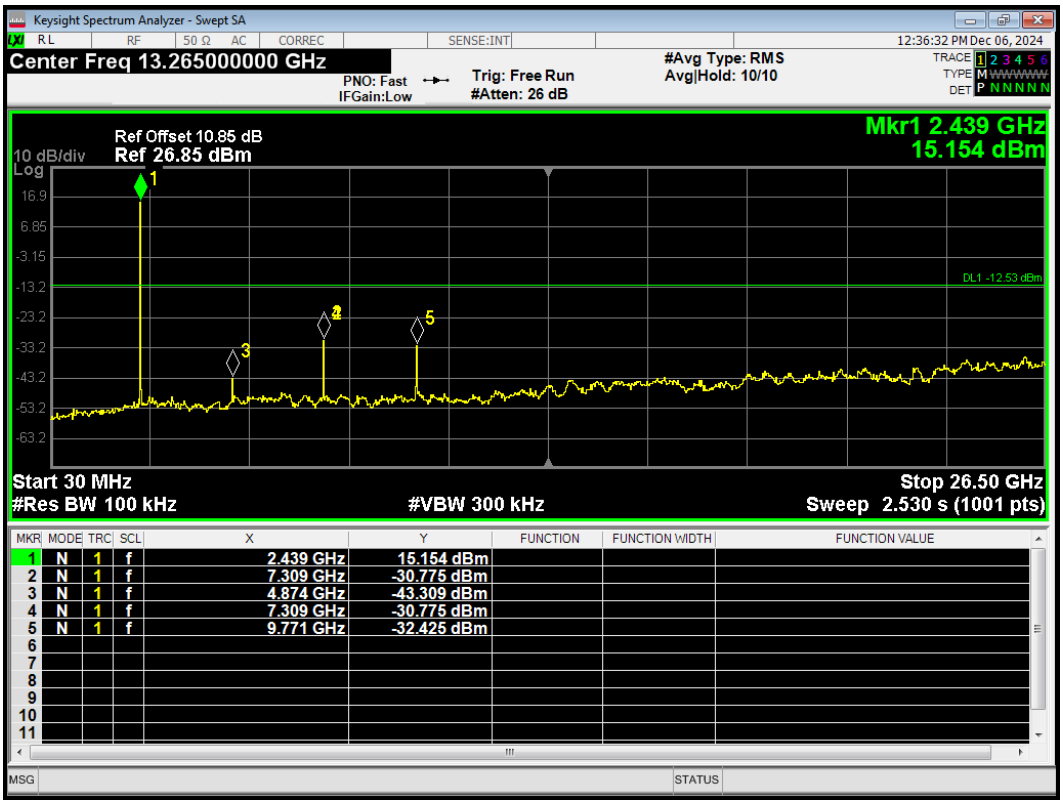
Tx. Spurious Bluetooth LE (2M) 2440MHz Ref



Tx. Spurious Bluetooth LE (2M) 2440MHz Emission



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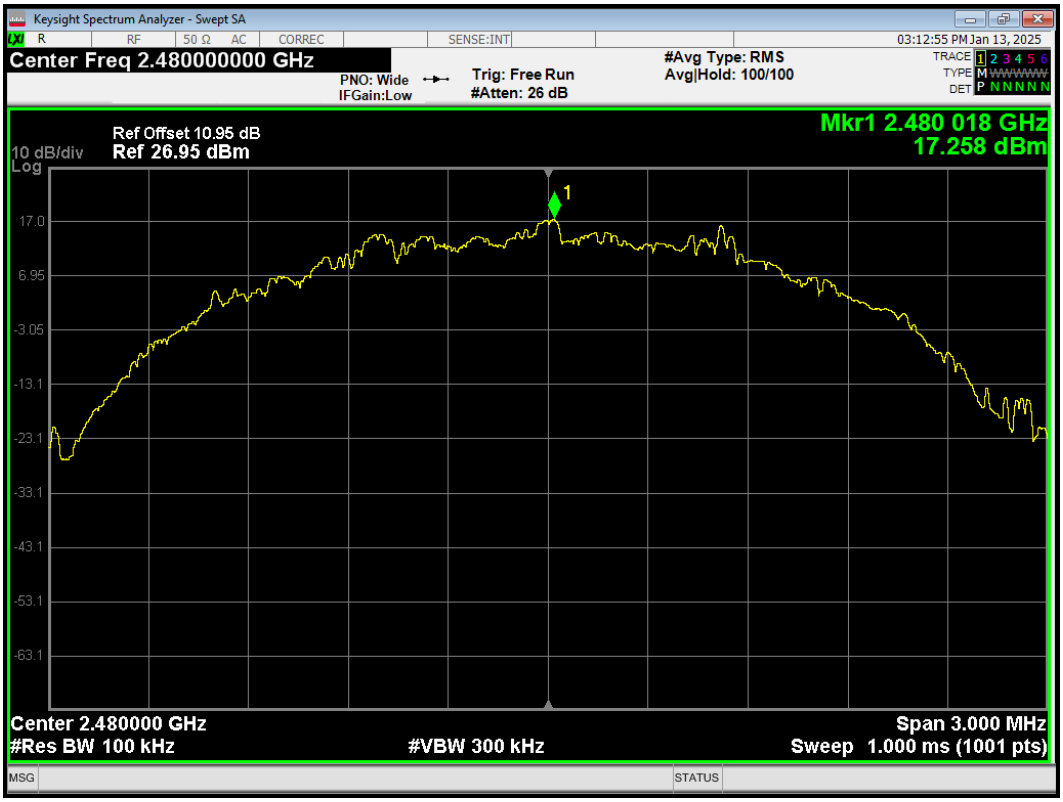
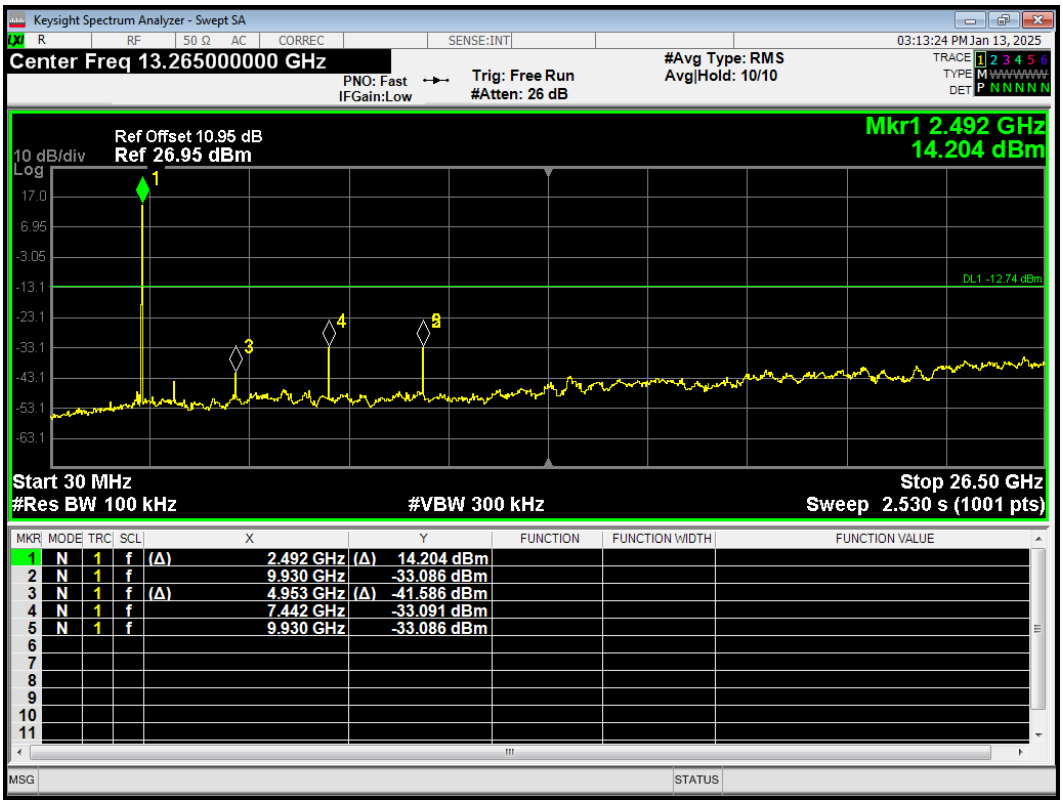
Tx. Spurious Bluetooth LE (2M) 2480MHz Ref



Tx. Spurious Bluetooth LE (2M) 2480MHz Emission



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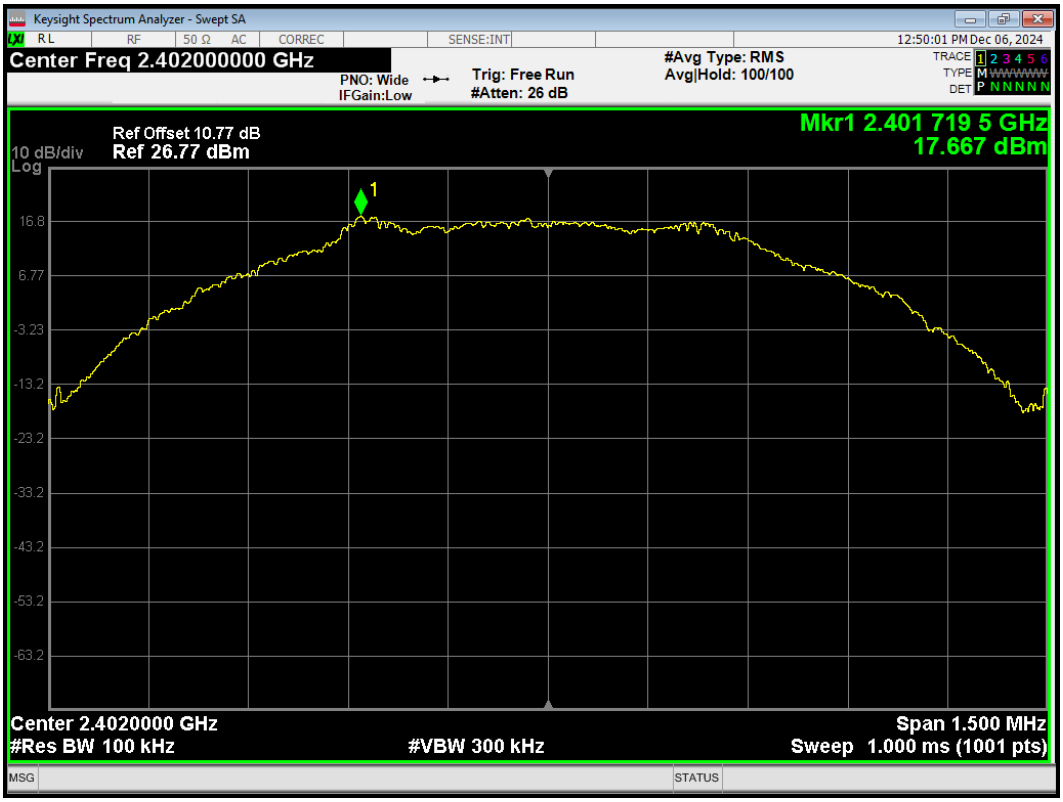
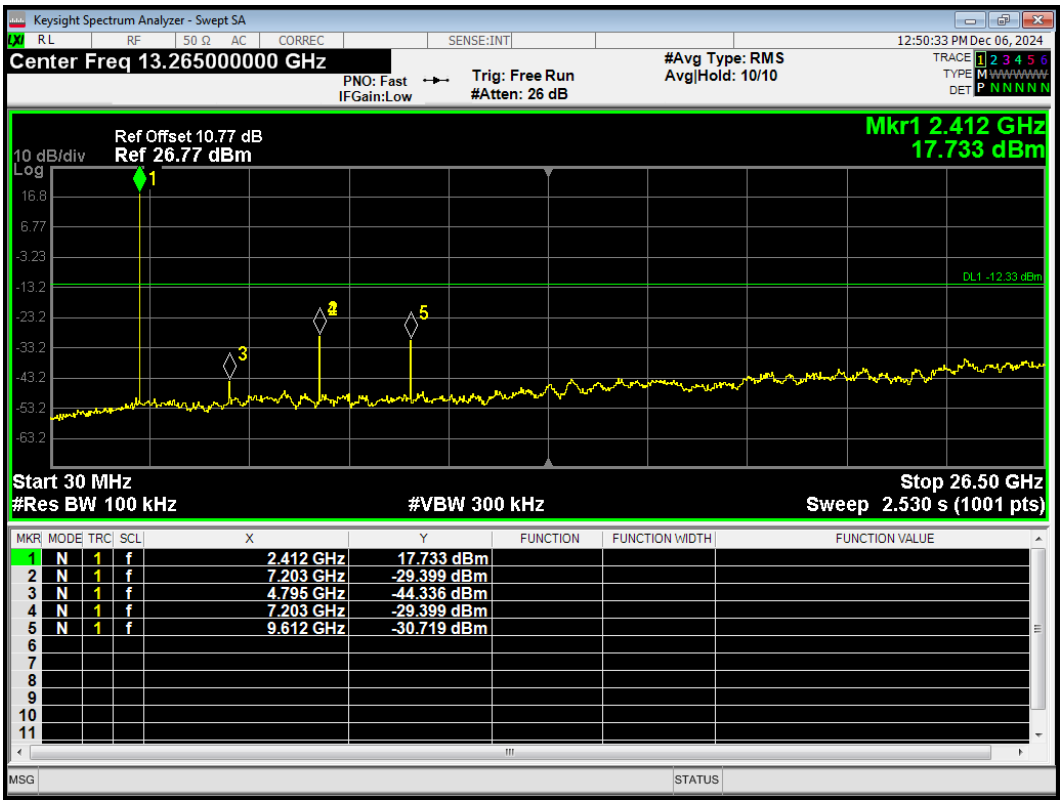
Tx. Spurious Bluetooth LE (S=2) 2402MHz Ref



Tx. Spurious Bluetooth LE (S=2) 2402MHz Emission



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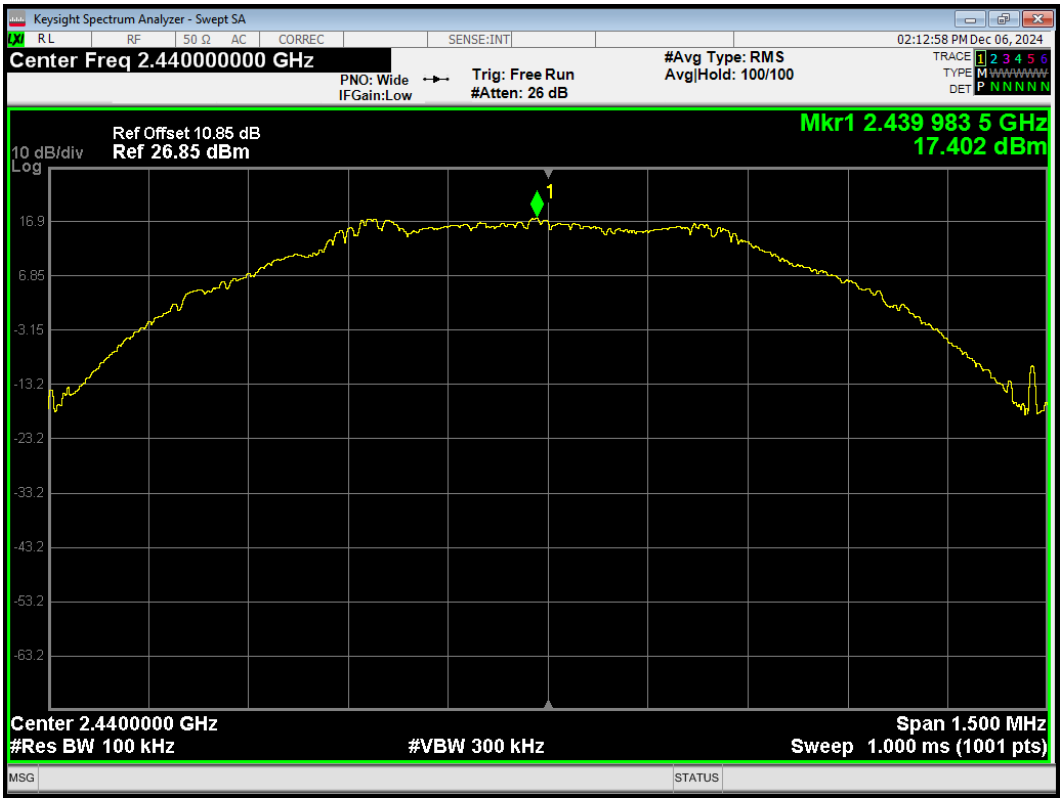
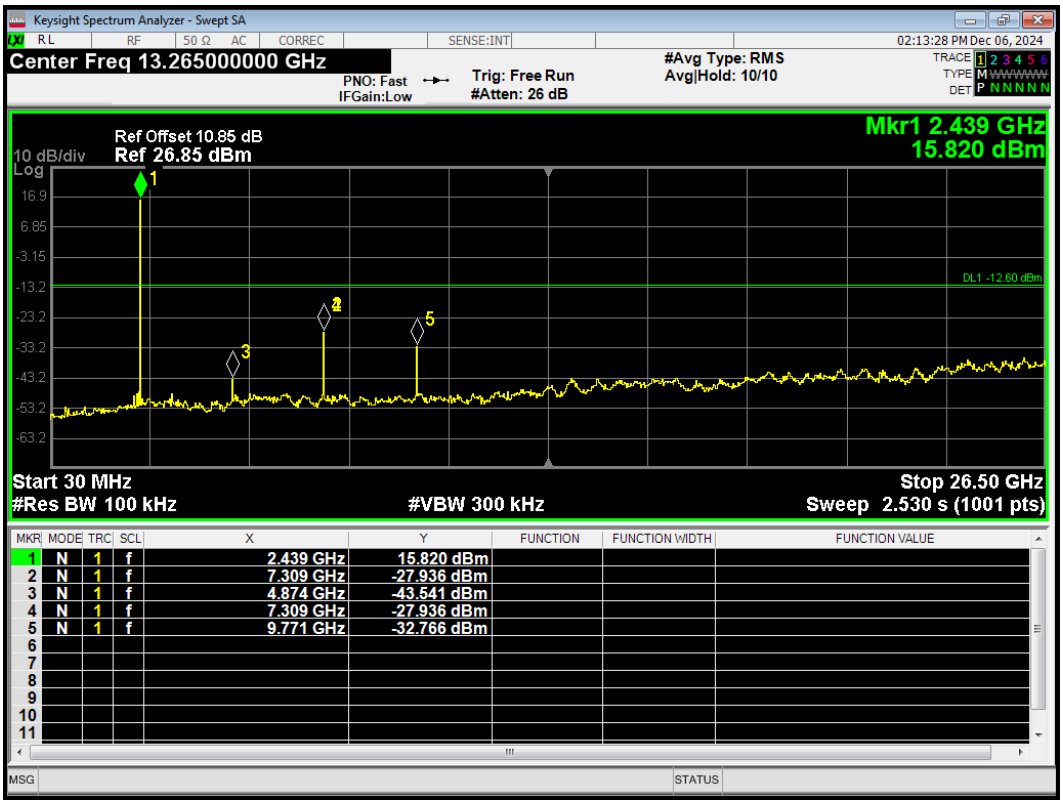
Tx. Spurious Bluetooth LE (S=2) 2440MHz Ref



Tx. Spurious Bluetooth LE (S=2) 2440MHz Emission



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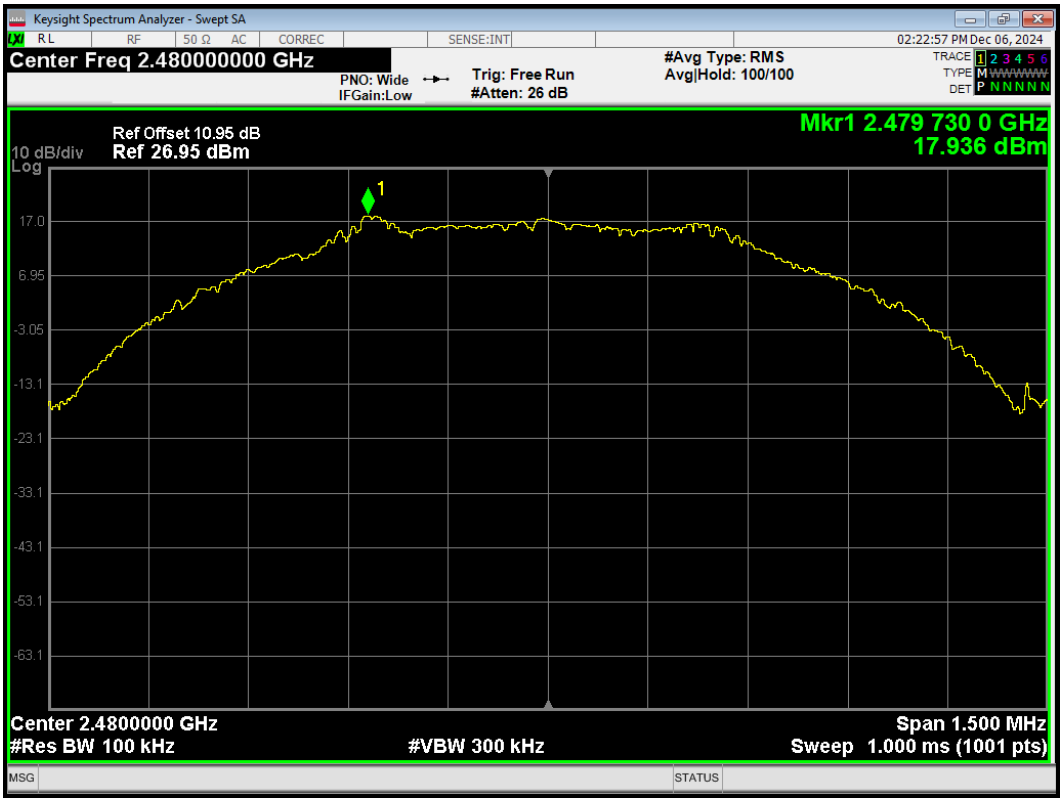
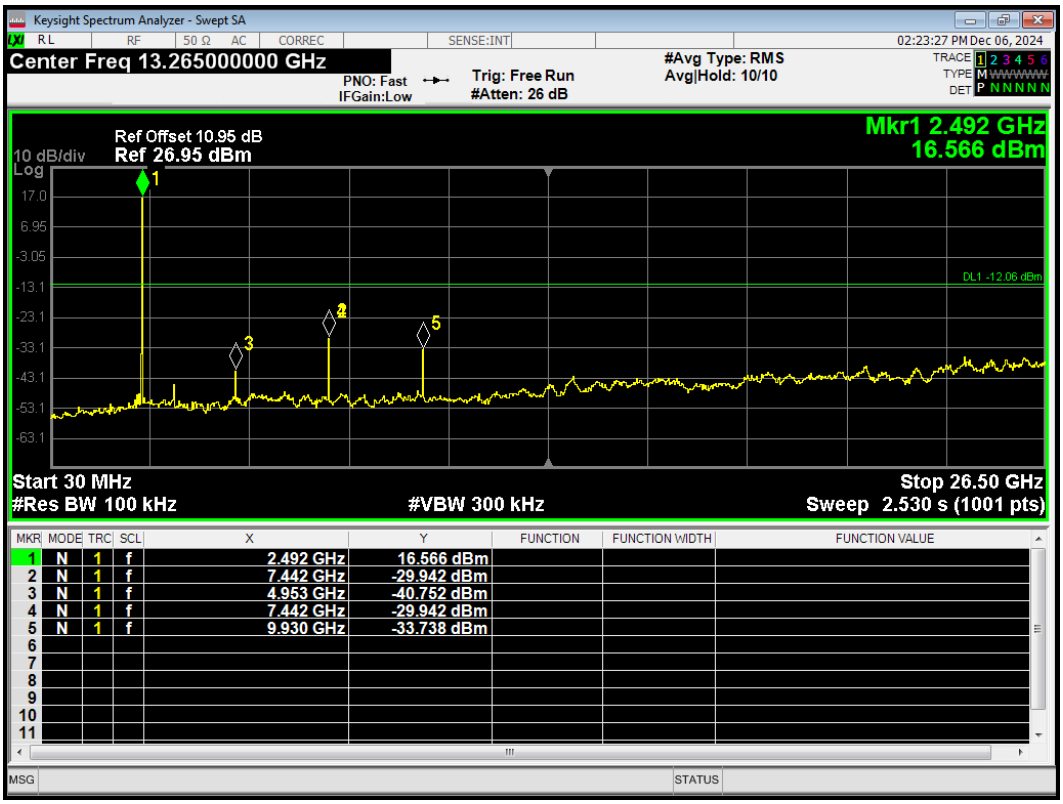
Tx. Spurious Bluetooth LE (S=2) 2480MHz Ref



Tx. Spurious Bluetooth LE (S=2) 2480MHz Emission



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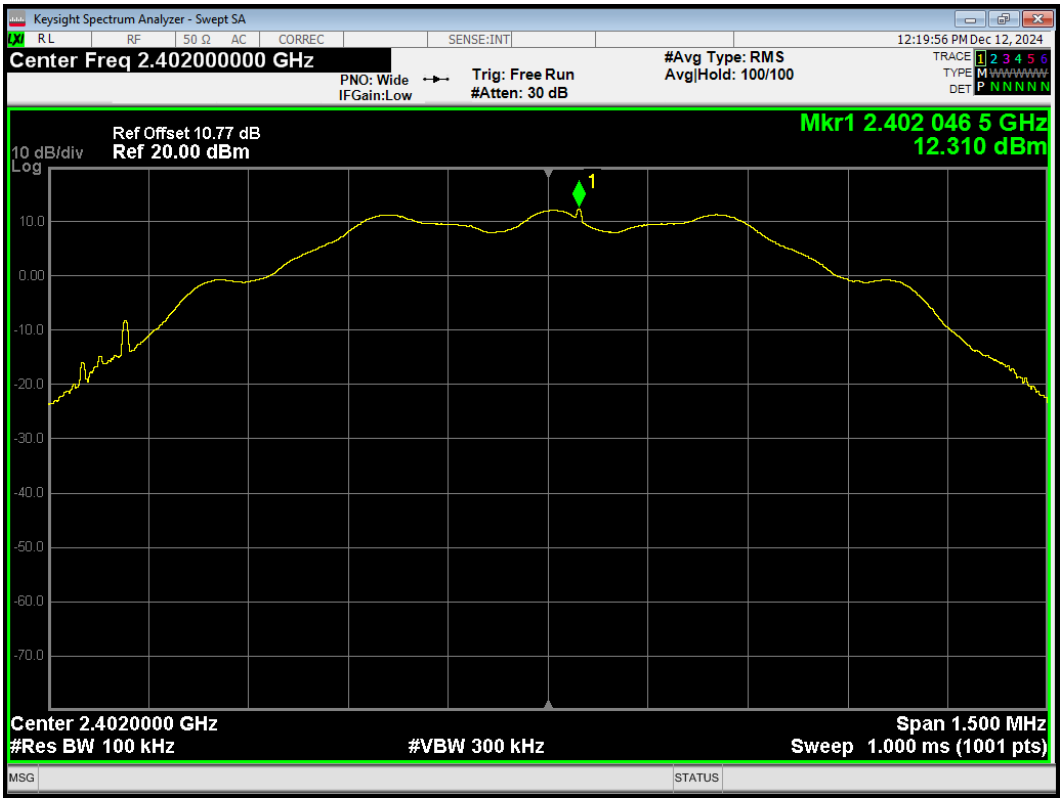
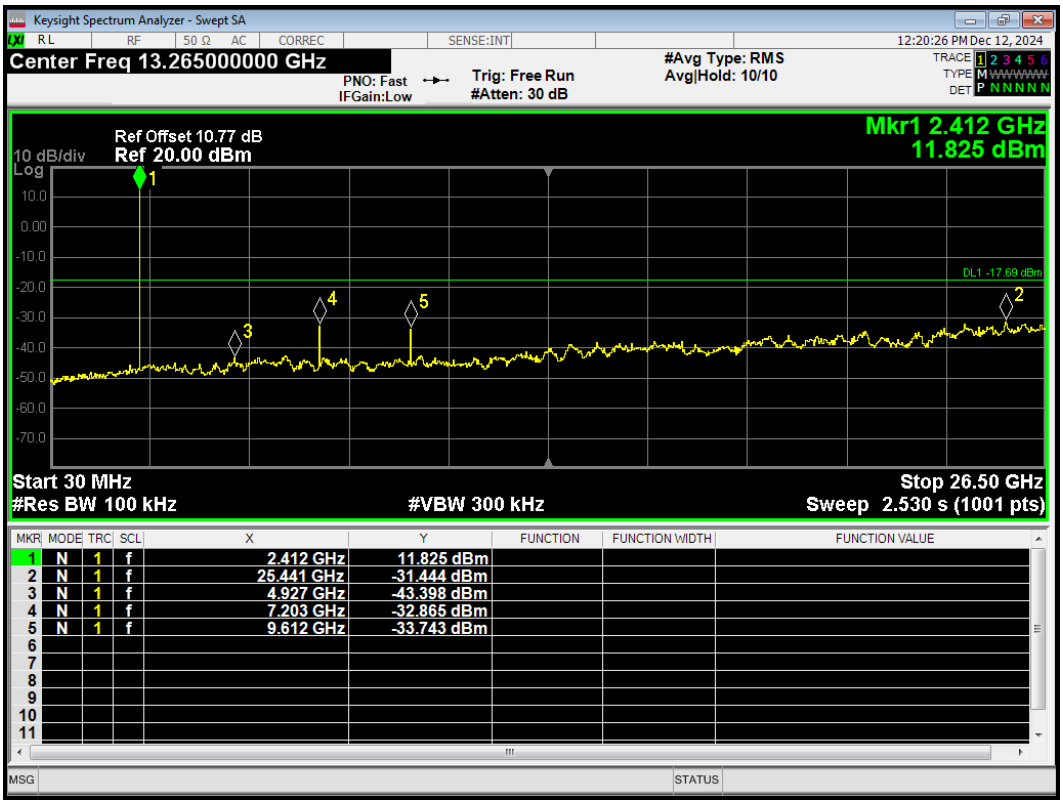
Tx. Spurious Bluetooth LE (S=8) 2402MHz Ref



Tx. Spurious Bluetooth LE (S=8) 2402MHz Emission



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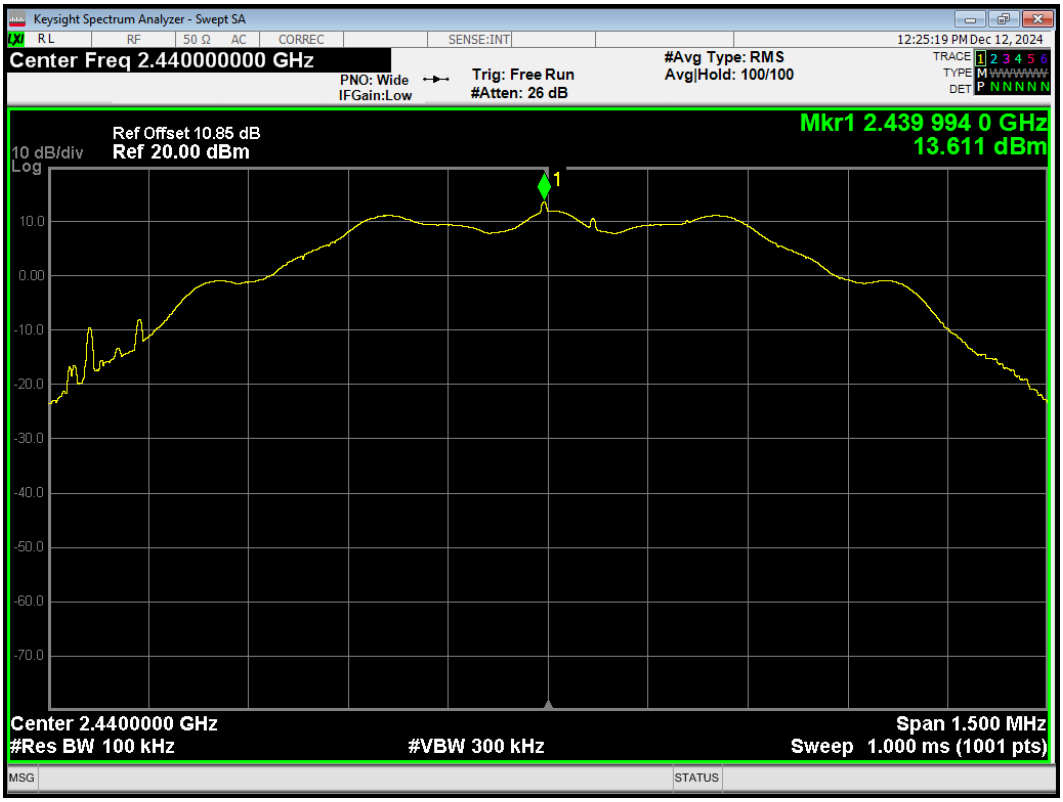
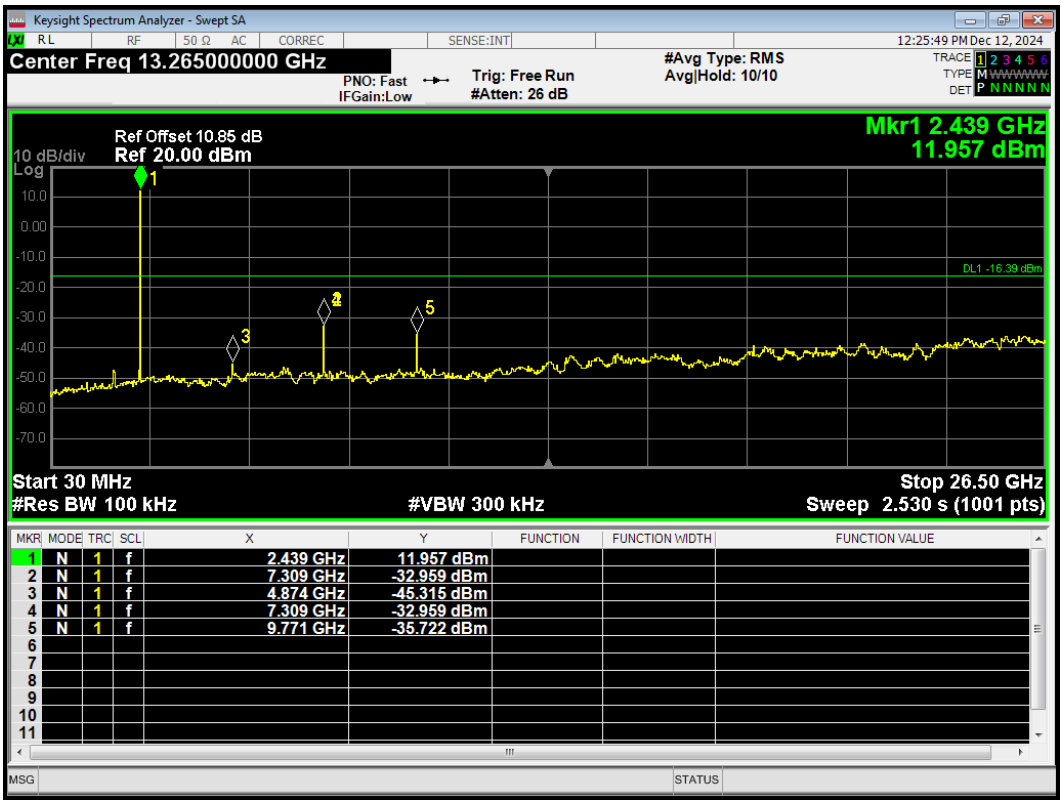
Tx. Spurious Bluetooth LE (S=8) 2440MHz Ref



Tx. Spurious Bluetooth LE (S=8) 2440MHz Emission



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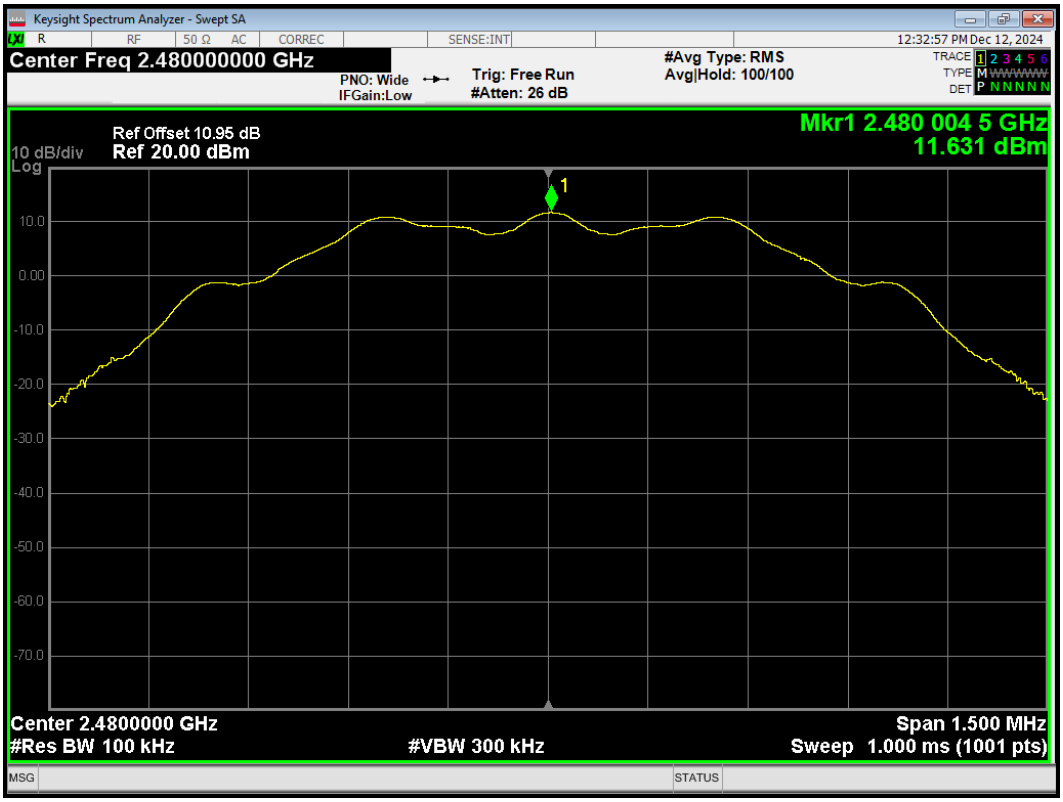
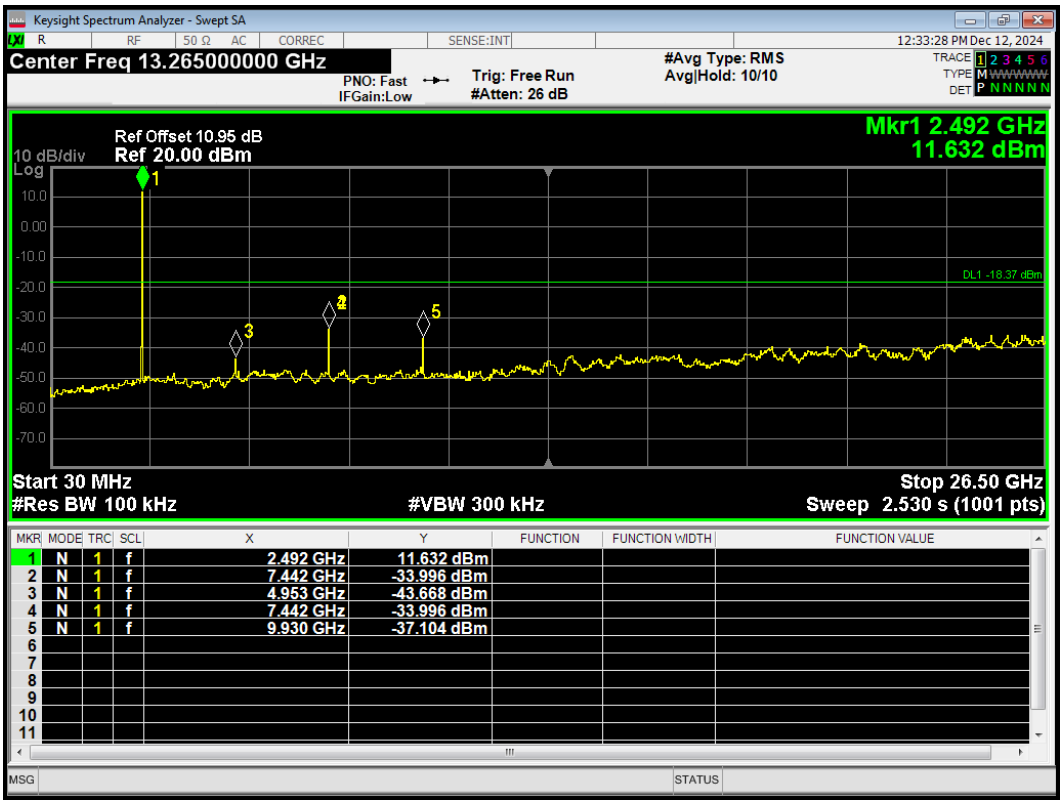
Tx. Spurious Bluetooth LE (S=8) 2480MHz Ref



Tx. Spurious Bluetooth LE (S=8) 2480MHz Emission



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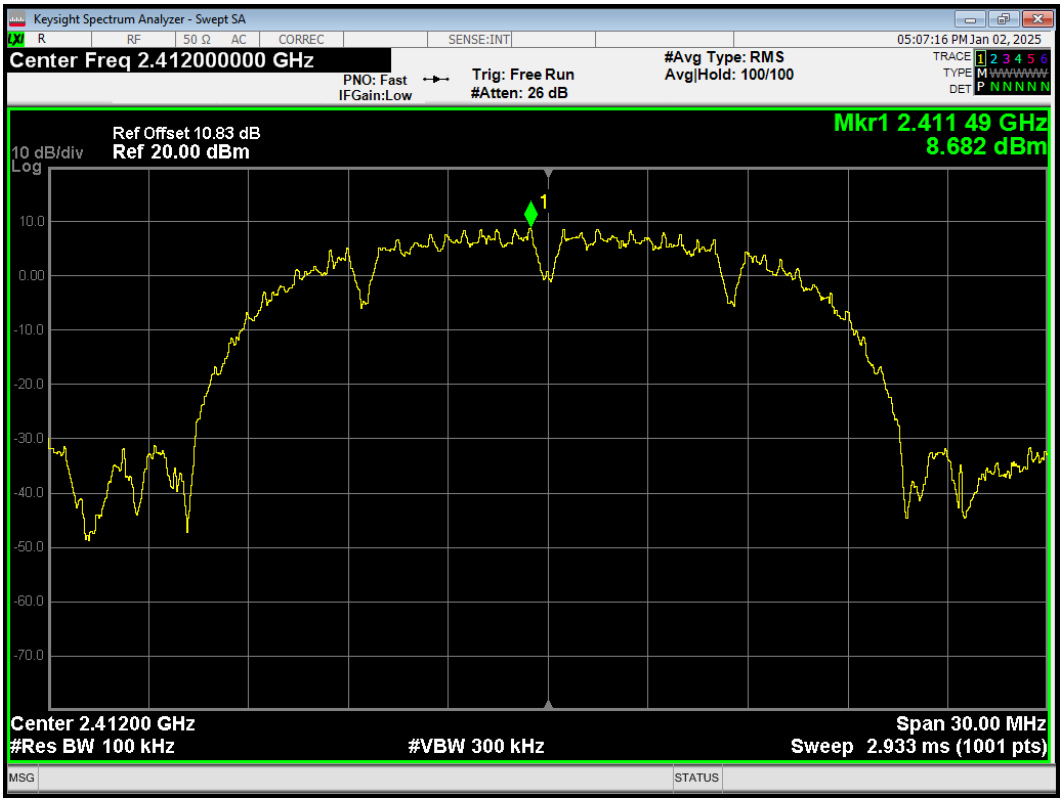
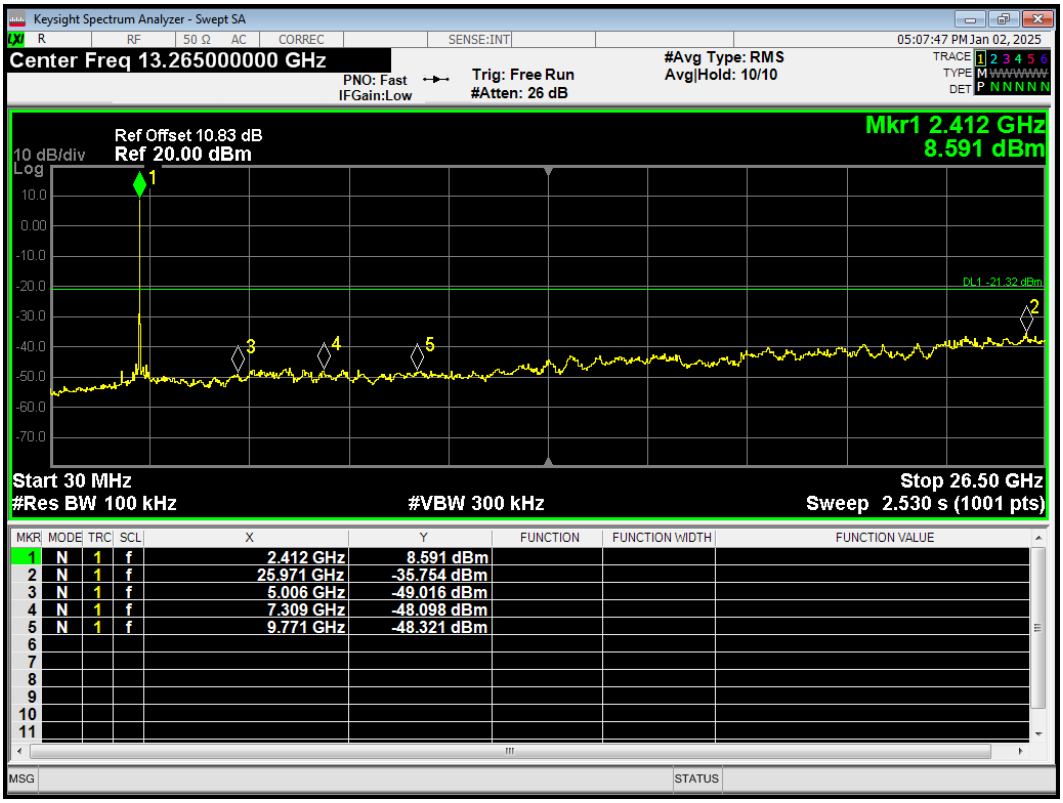
Tx. Spurious 802.11b 2412MHz Ref



Tx. Spurious 802.11b 2412MHz Emission



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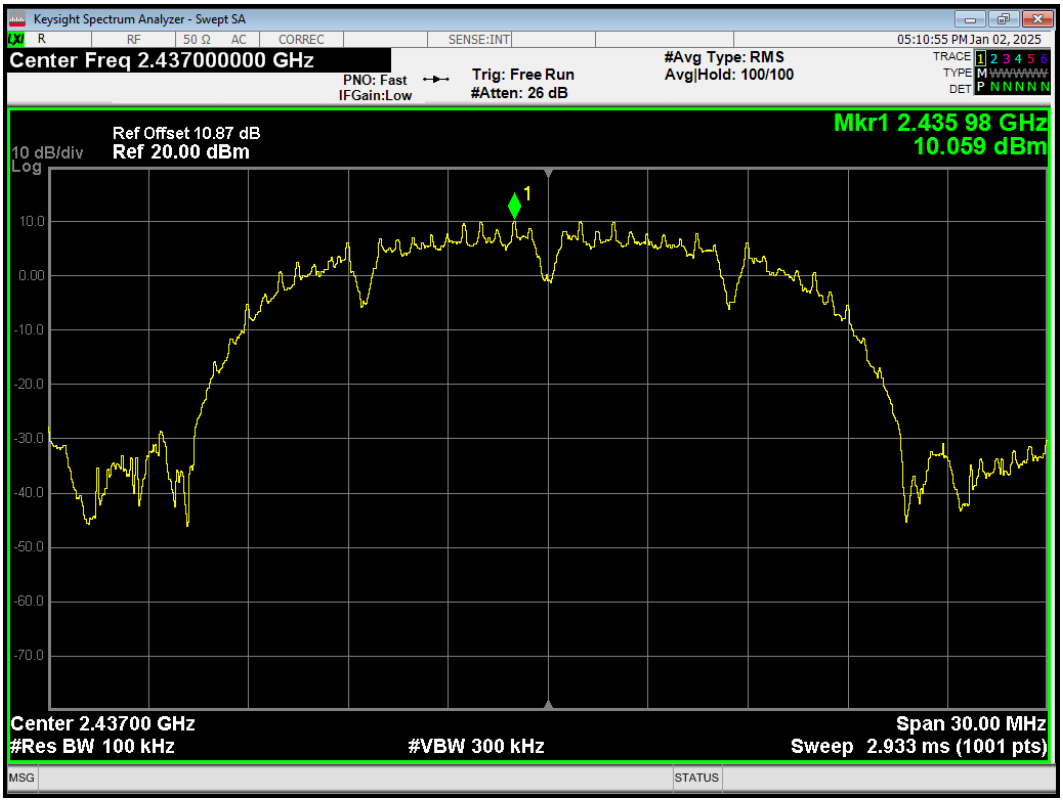
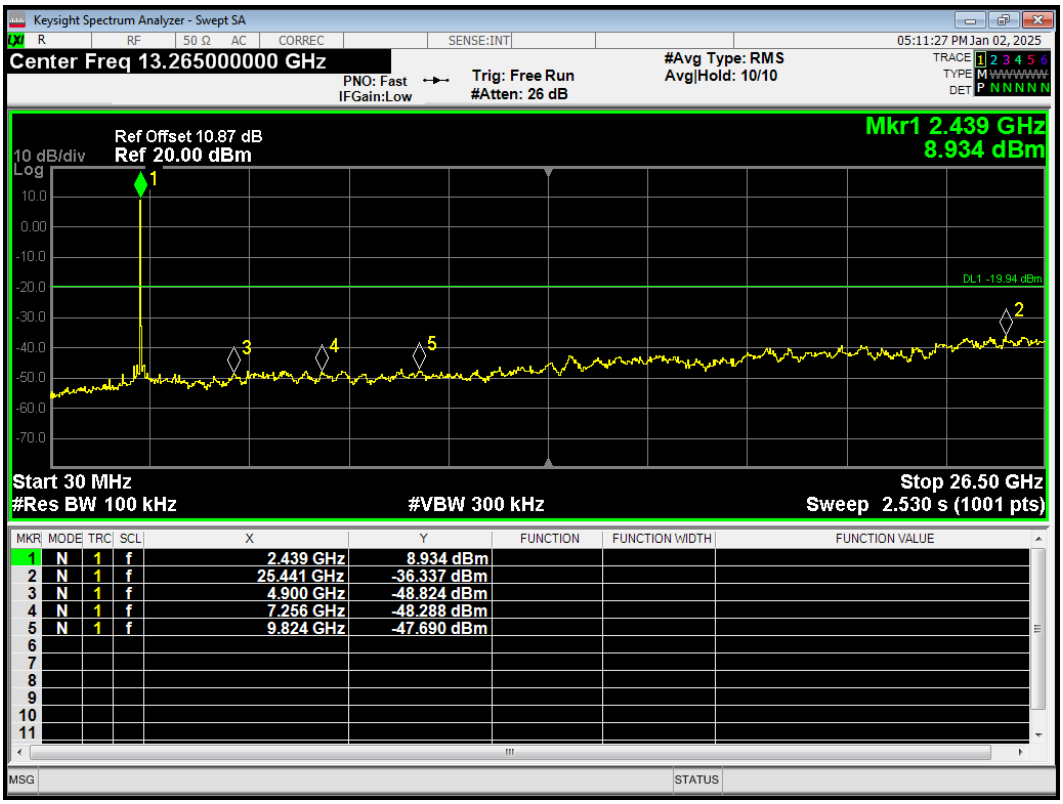
Tx. Spurious 802.11b 2437MHz Ref



Tx. Spurious 802.11b 2437MHz Emission



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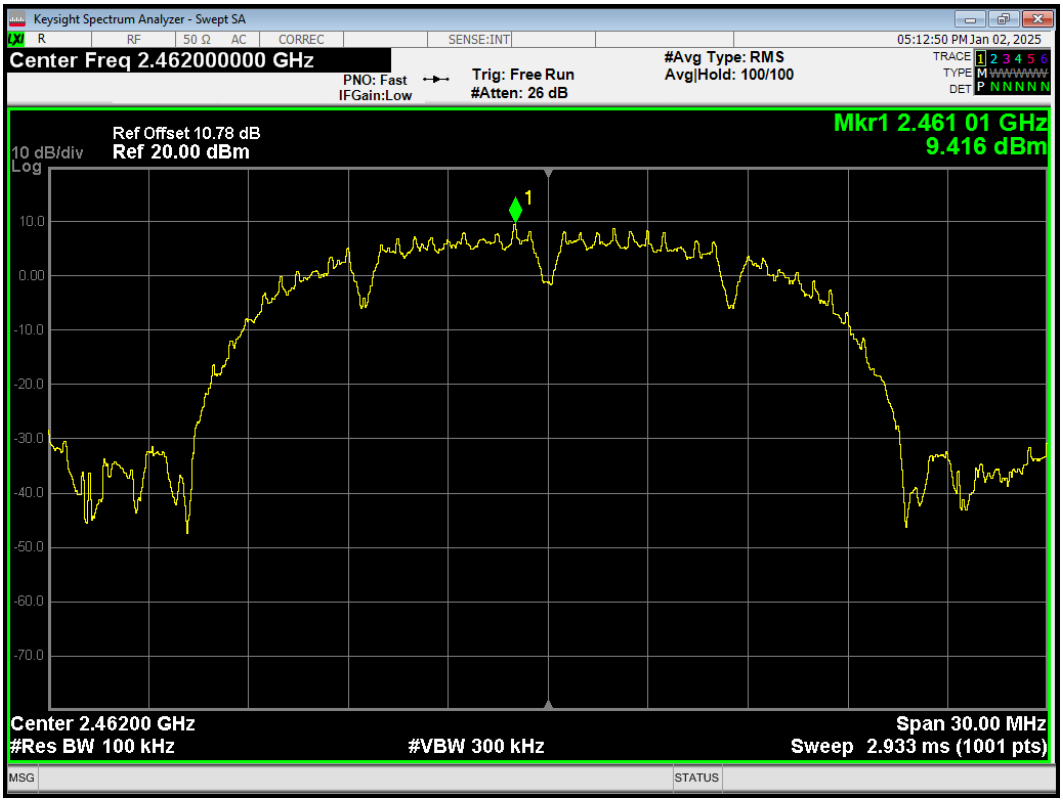
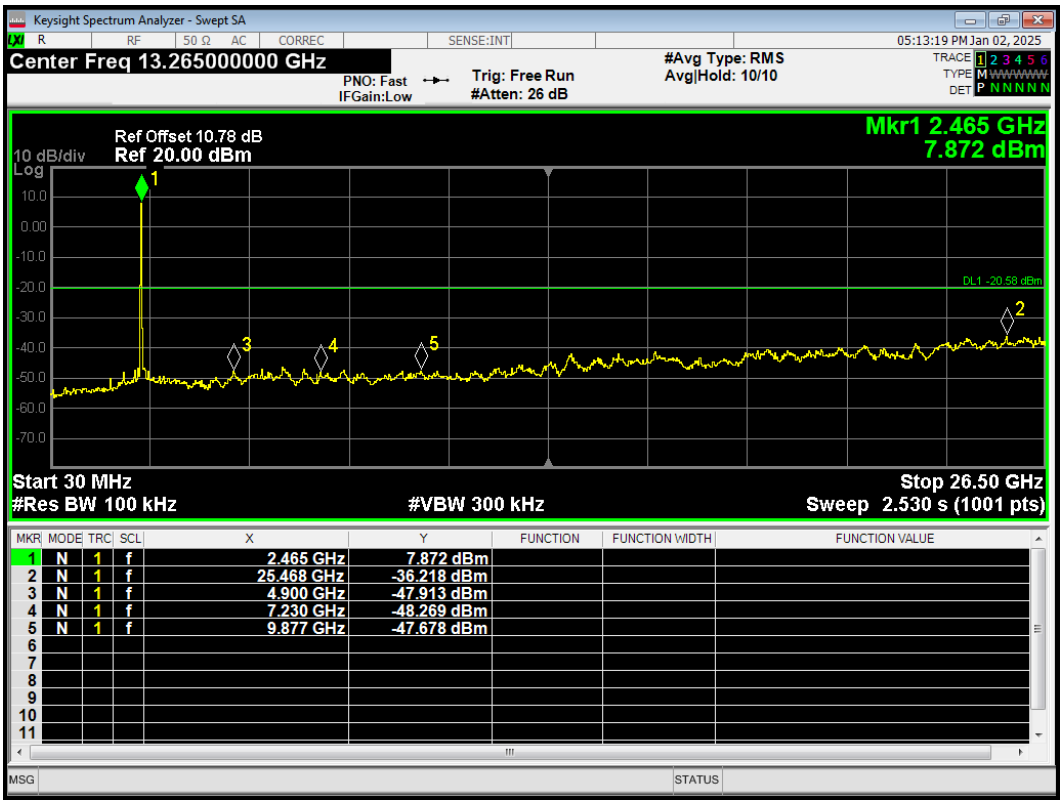
Tx. Spurious 802.11b 2462MHz Ref



Tx. Spurious 802.11b 2462MHz Emission



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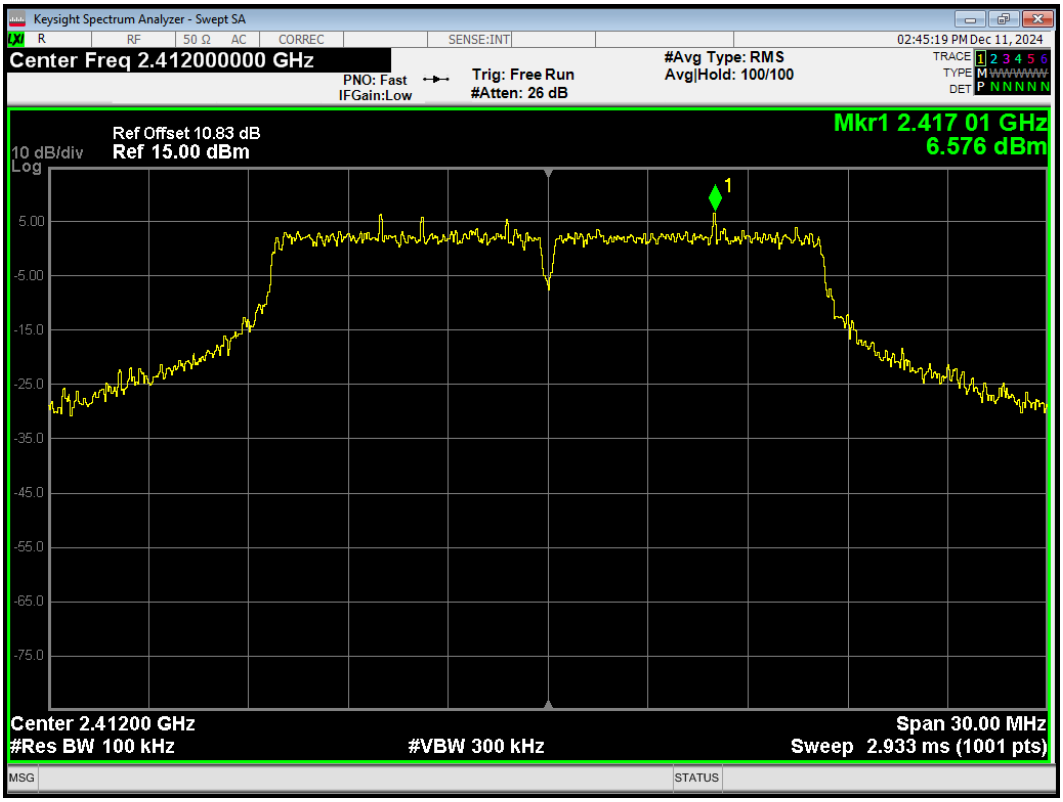
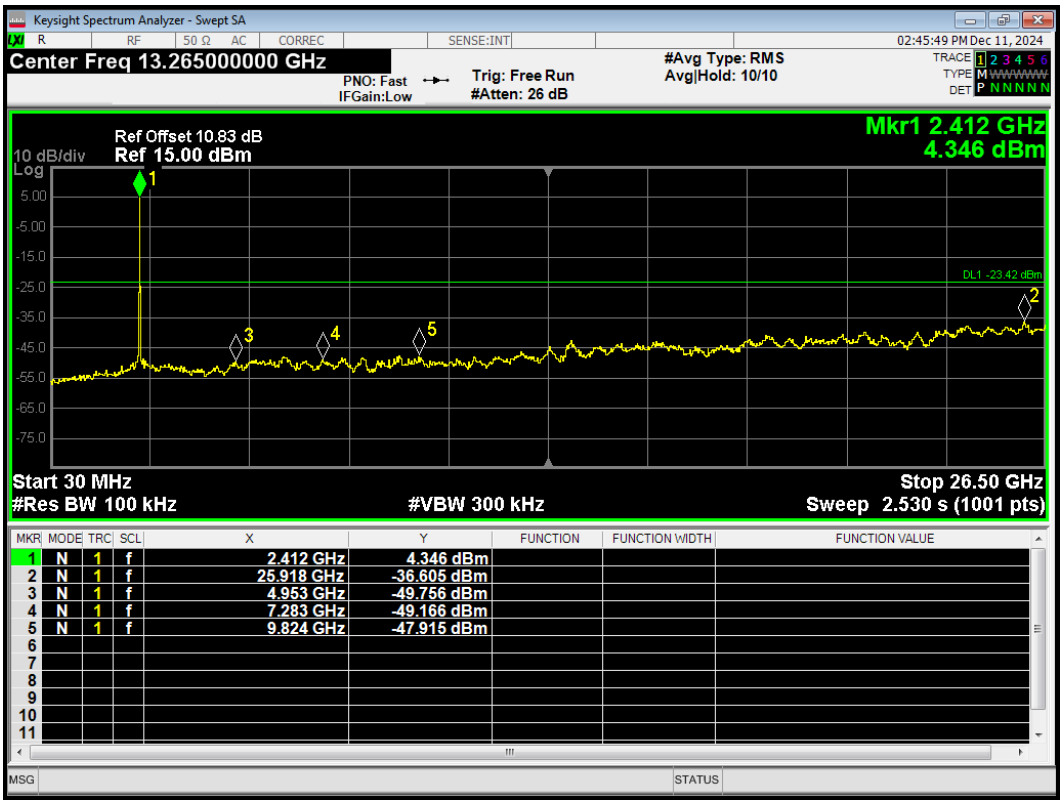
Tx. Spurious 802.11g 2412MHz Ref



Tx. Spurious 802.11g 2412MHz Emission



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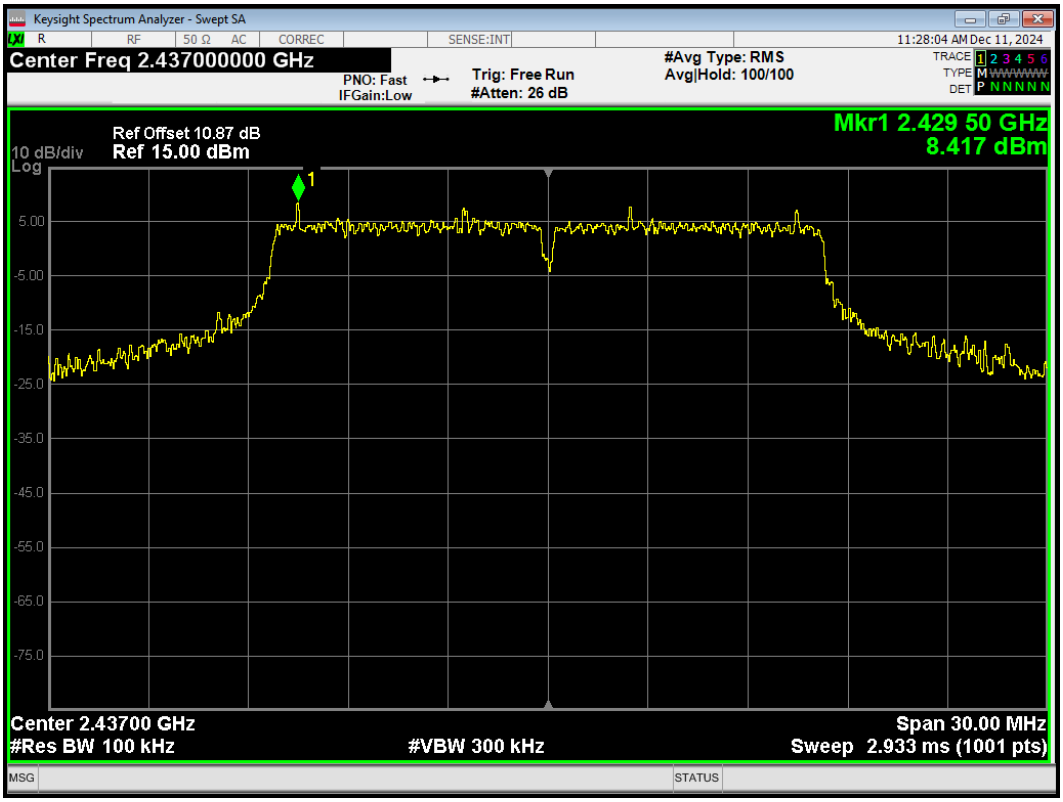
Tx. Spurious 802.11g 2437MHz Ref



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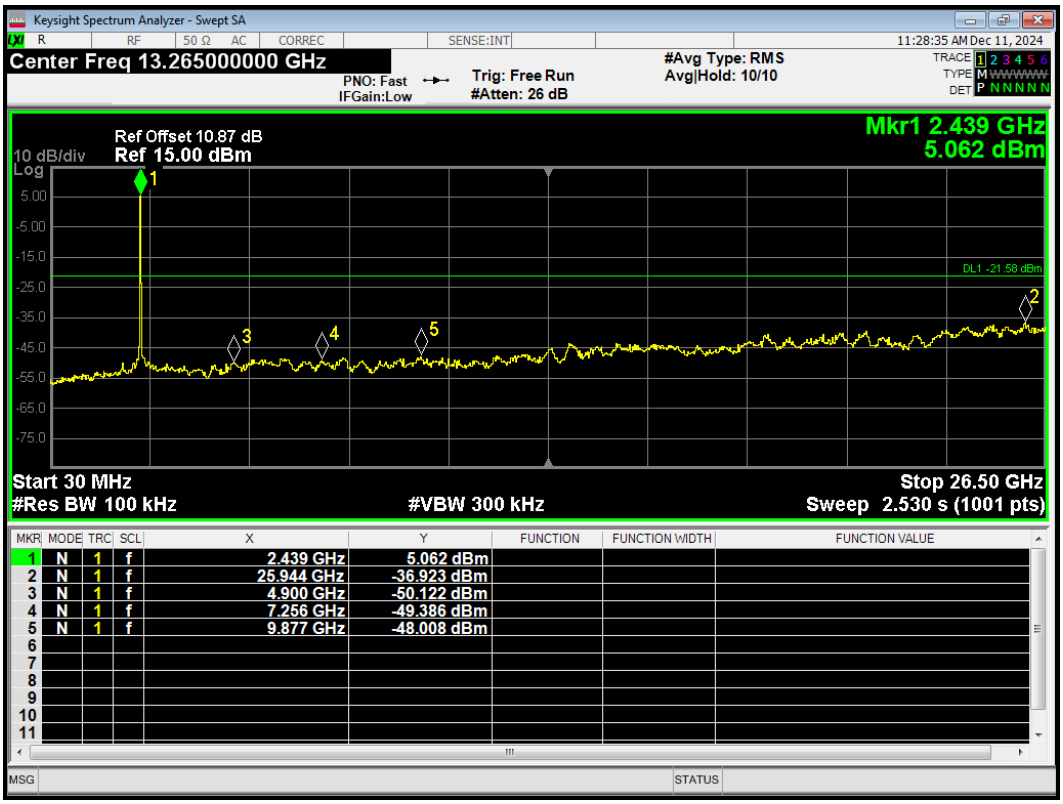

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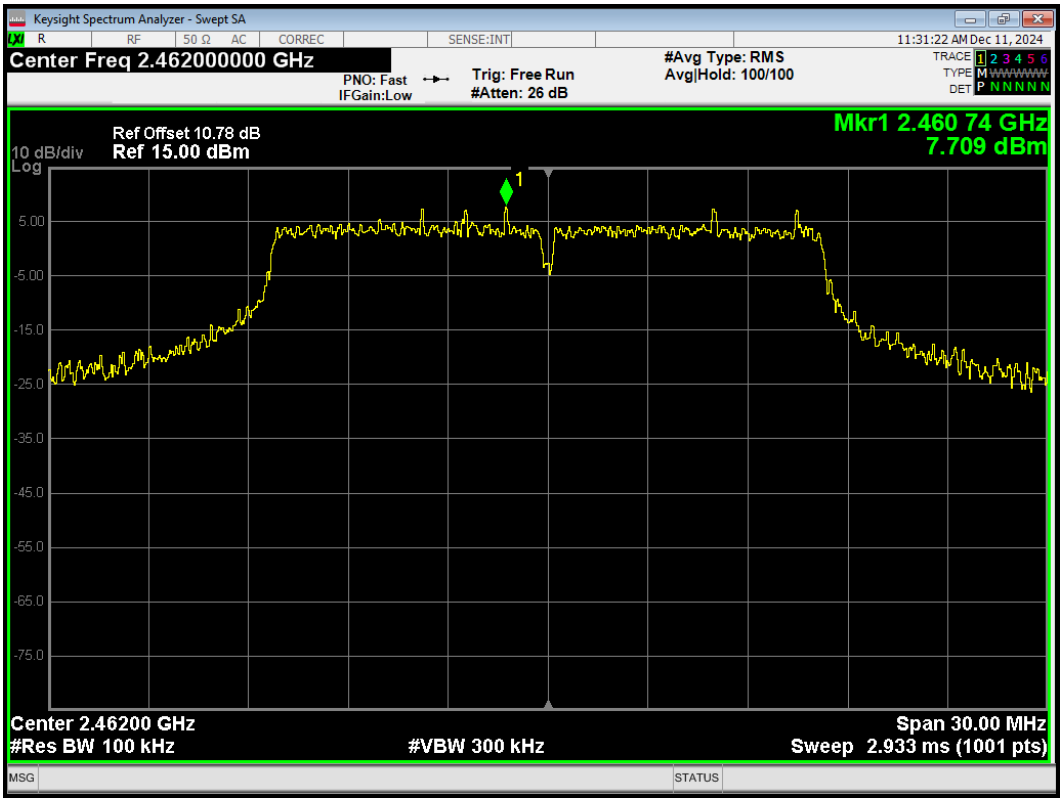
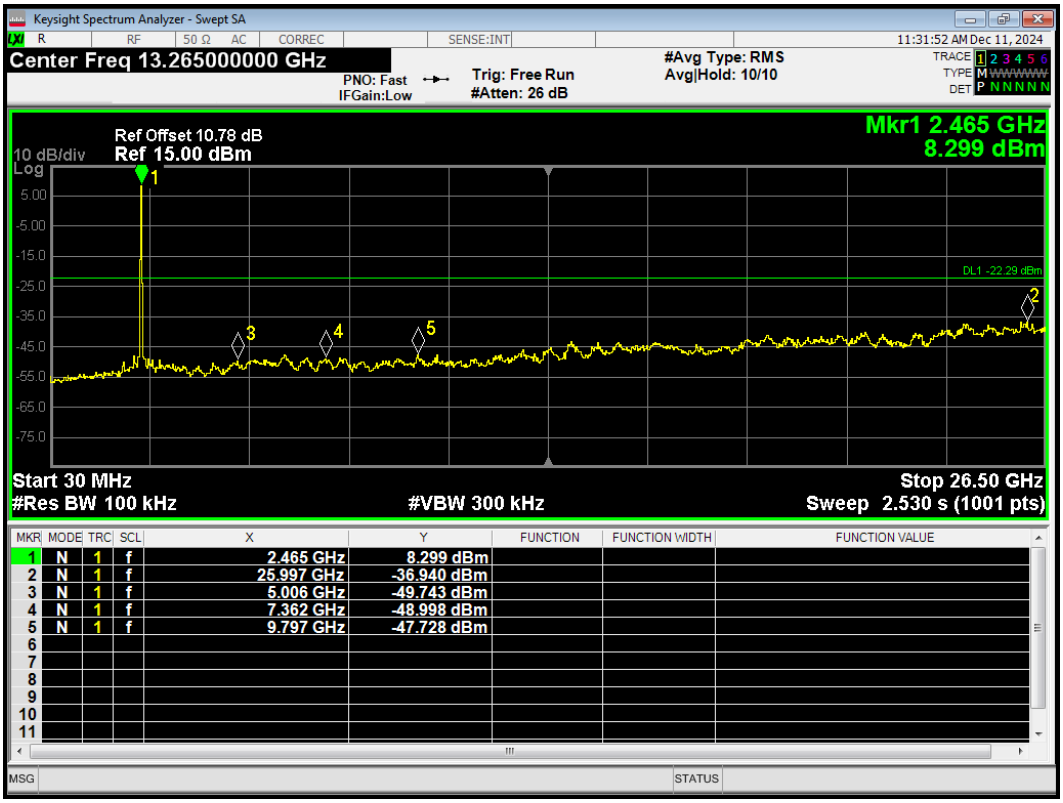
Tx. Spurious 802.11g 2462MHz Ref



Tx. Spurious 802.11g 2462MHz Emission



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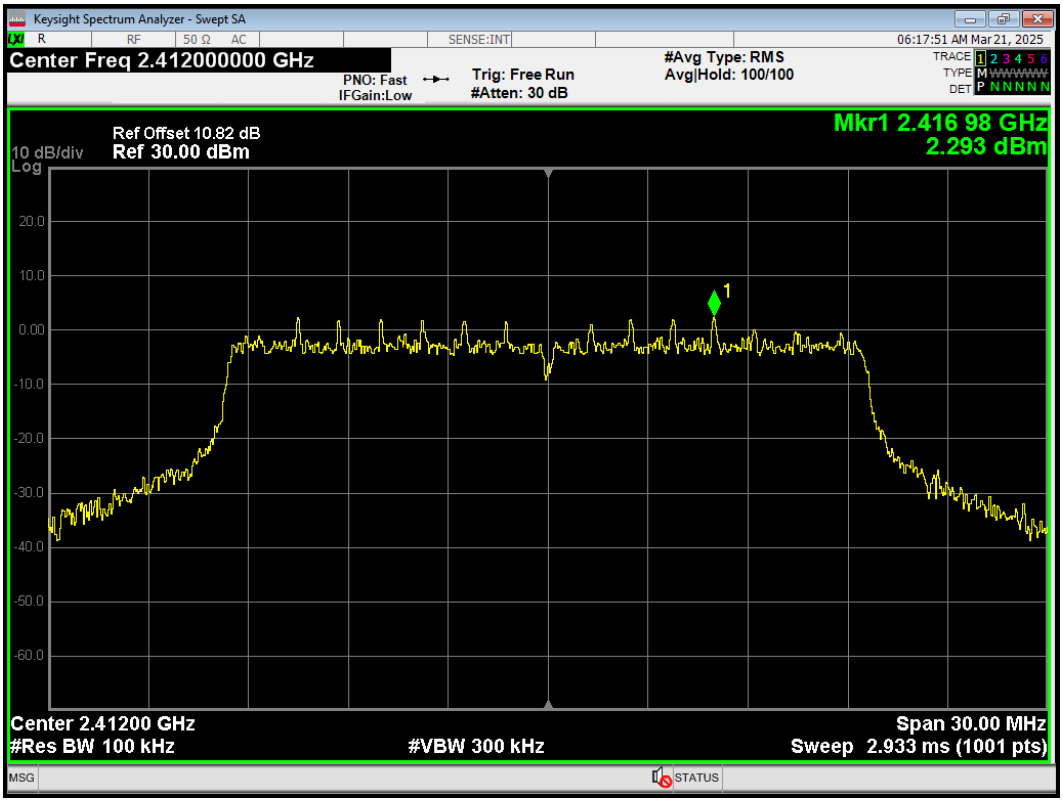
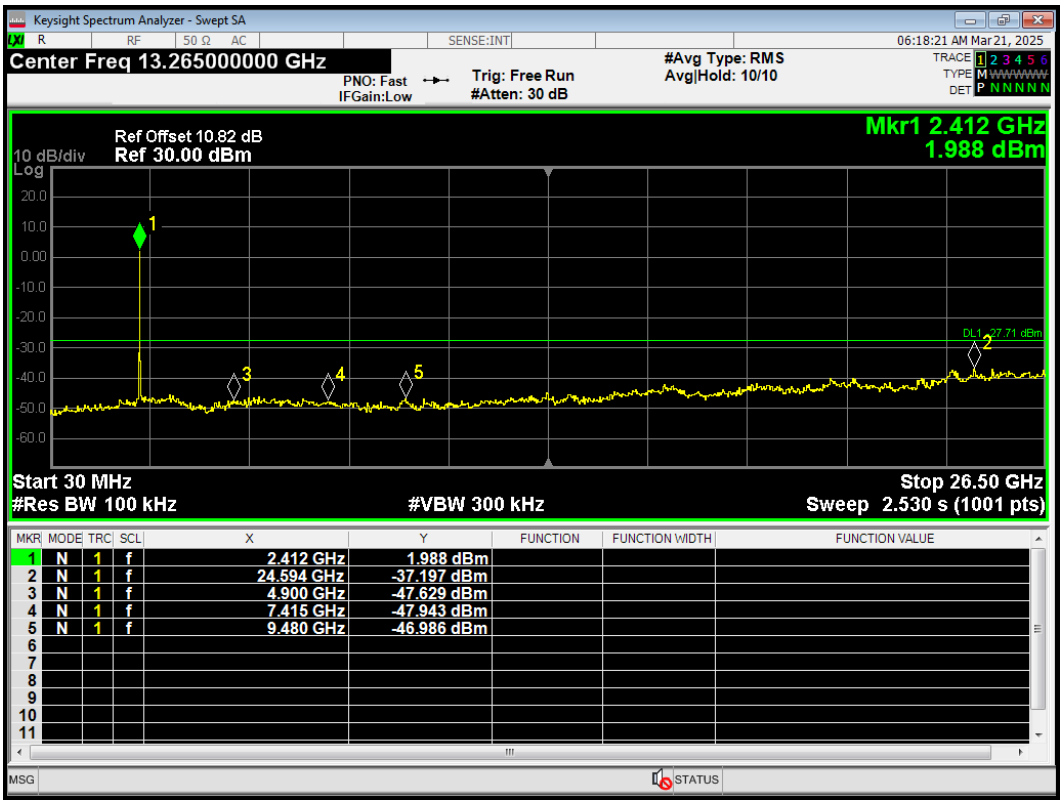
Tx. Spurious 802.11ax(HE20) 2412MHz Ref



Tx. Spurious 802.11ax(HE20) 2412MHz Emission



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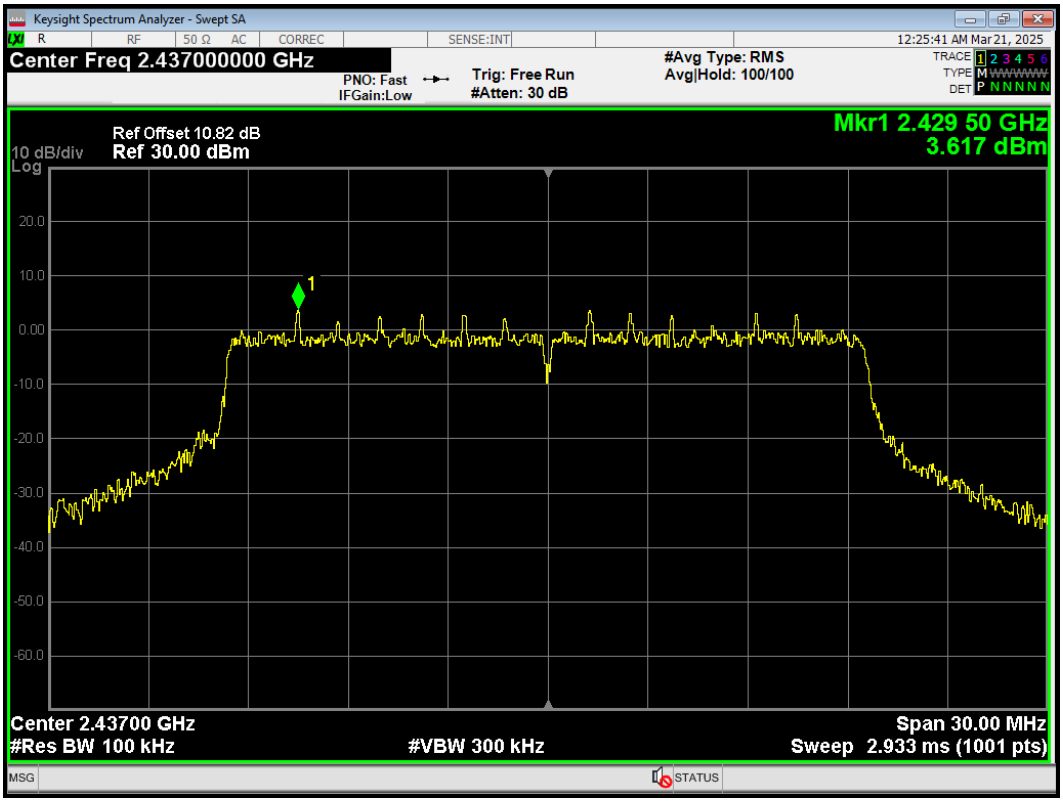
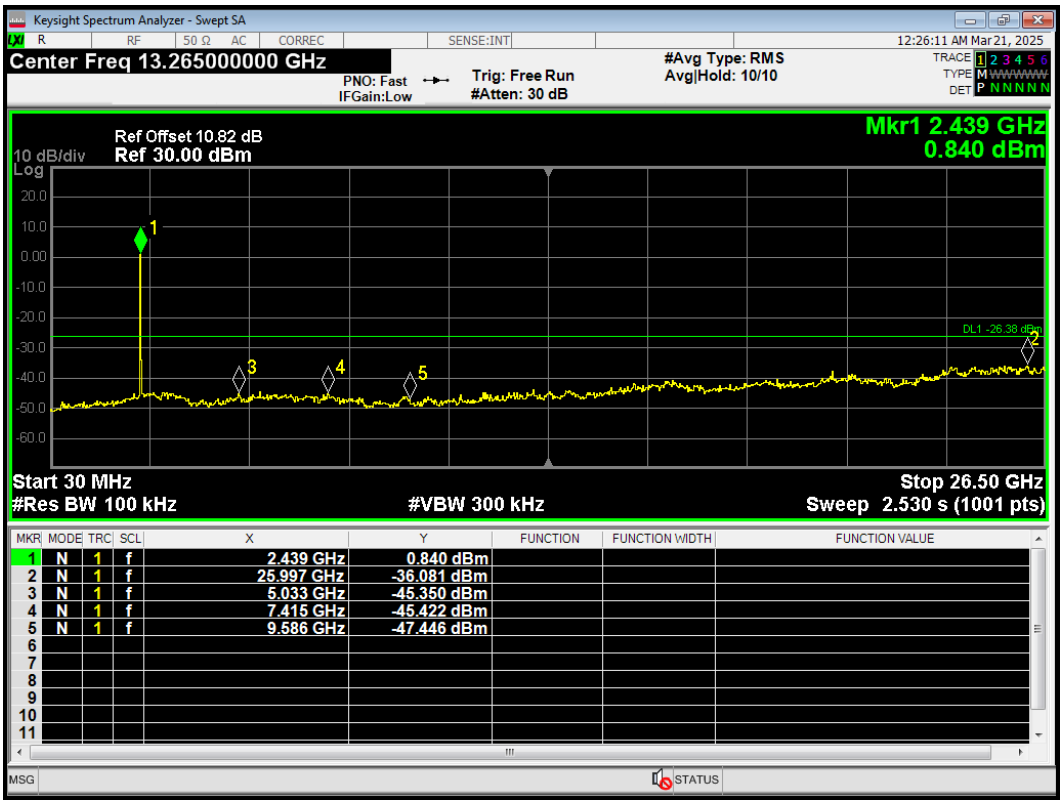
Tx. Spurious 802.11ax(HE20) 2437MHz Ref



Tx. Spurious 802.11ax(HE20) 2437MHz Emission



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.439 GHz	0.840 dBm			
2	N	1	f	25.997 GHz	-36.081 dBm			
3	N	1	f	5.033 GHz	-45.350 dBm			
4	N	1	f	7.415 GHz	-45.422 dBm			
5	N	1	f	9.586 GHz	-47.446 dBm			
6								
7								
8								
9								
10								
11								

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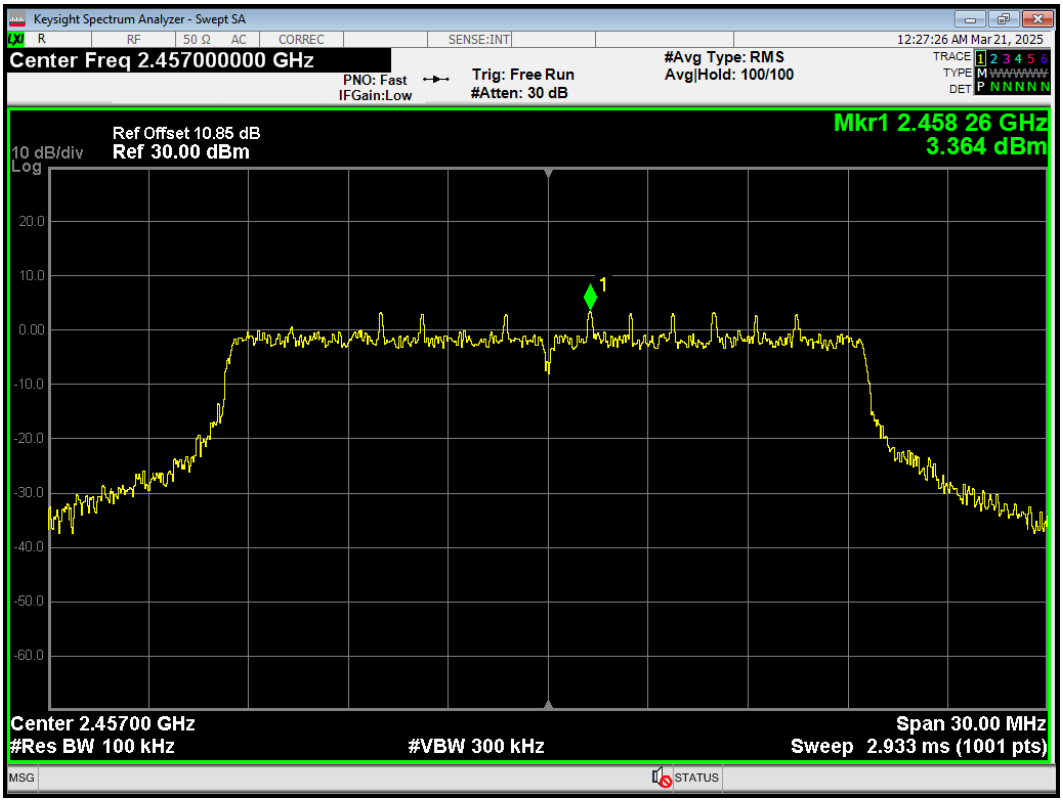
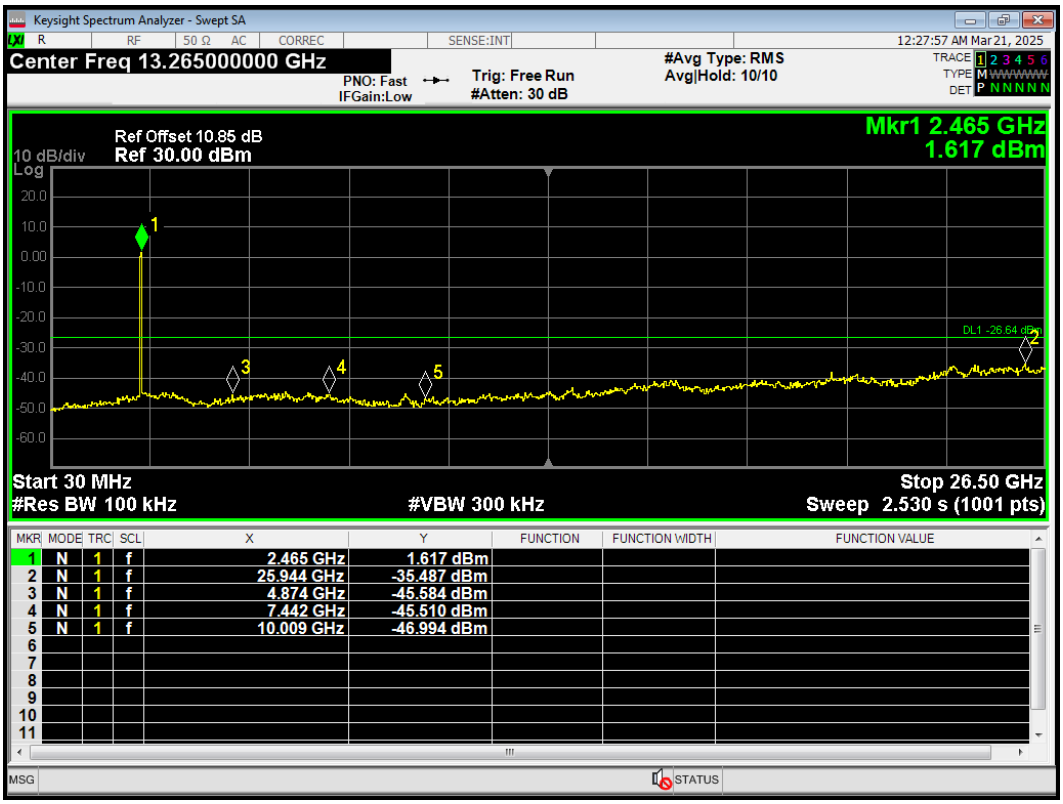
Tx. Spurious 802.11ax(HE20) 2457MHz Ref



Tx. Spurious 802.11ax(HE20) 2457MHz Emission



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.465 GHz	1.617 dBm			
2	N	1	f	25.944 GHz	-35.487 dBm			
3	N	1	f	4.874 GHz	-45.584 dBm			
4	N	1	f	7.442 GHz	-45.510 dBm			
5	N	1	f	10.009 GHz	-46.994 dBm			
6								
7								
8								
9								
10								
11								

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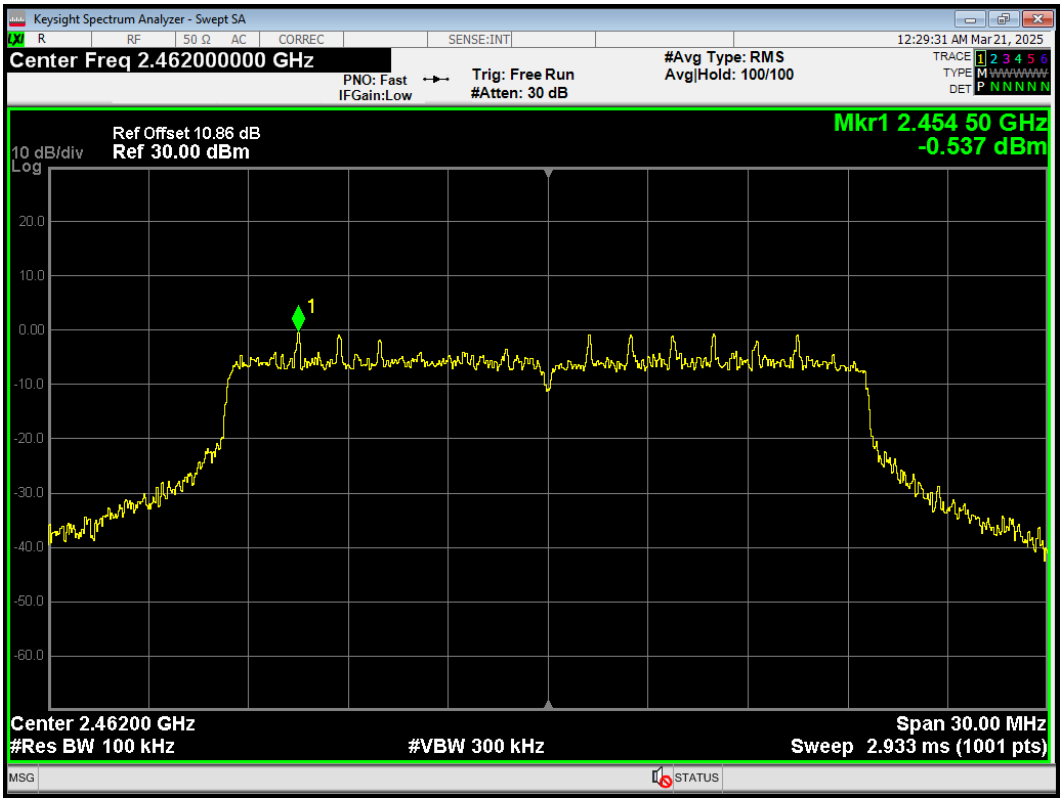
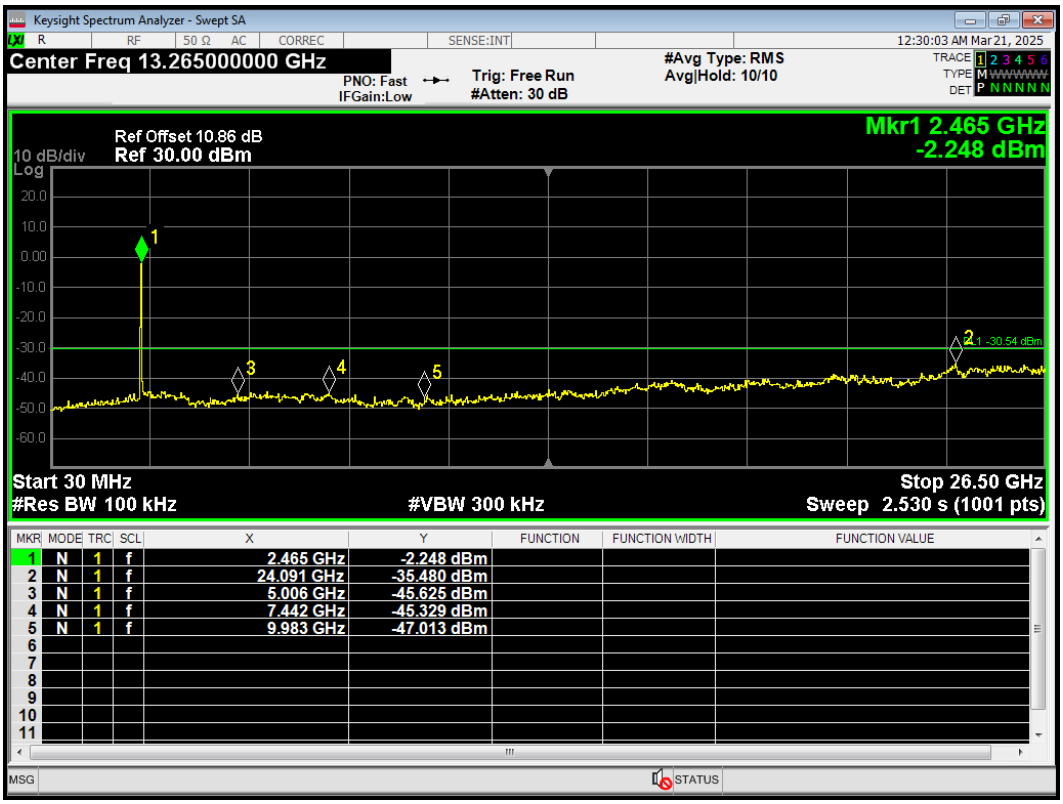
Tx. Spurious 802.11ax(HE20) 2462MHz Ref



Tx. Spurious 802.11ax(HE20) 2462MHz Emission



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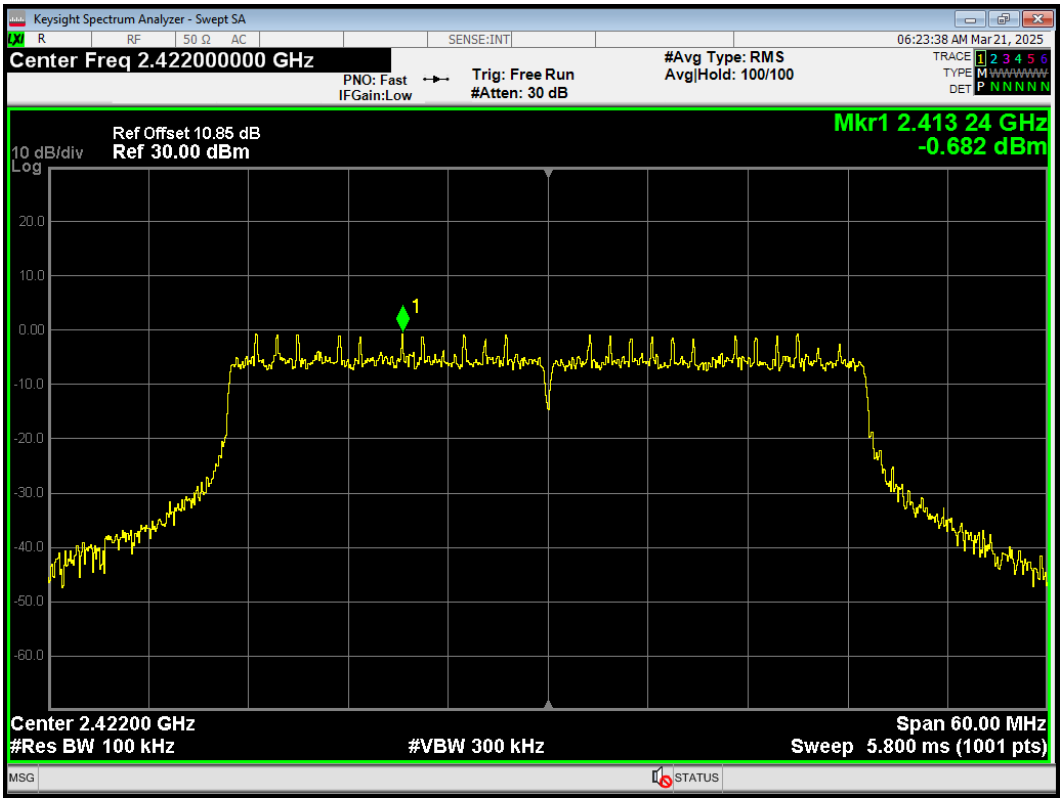
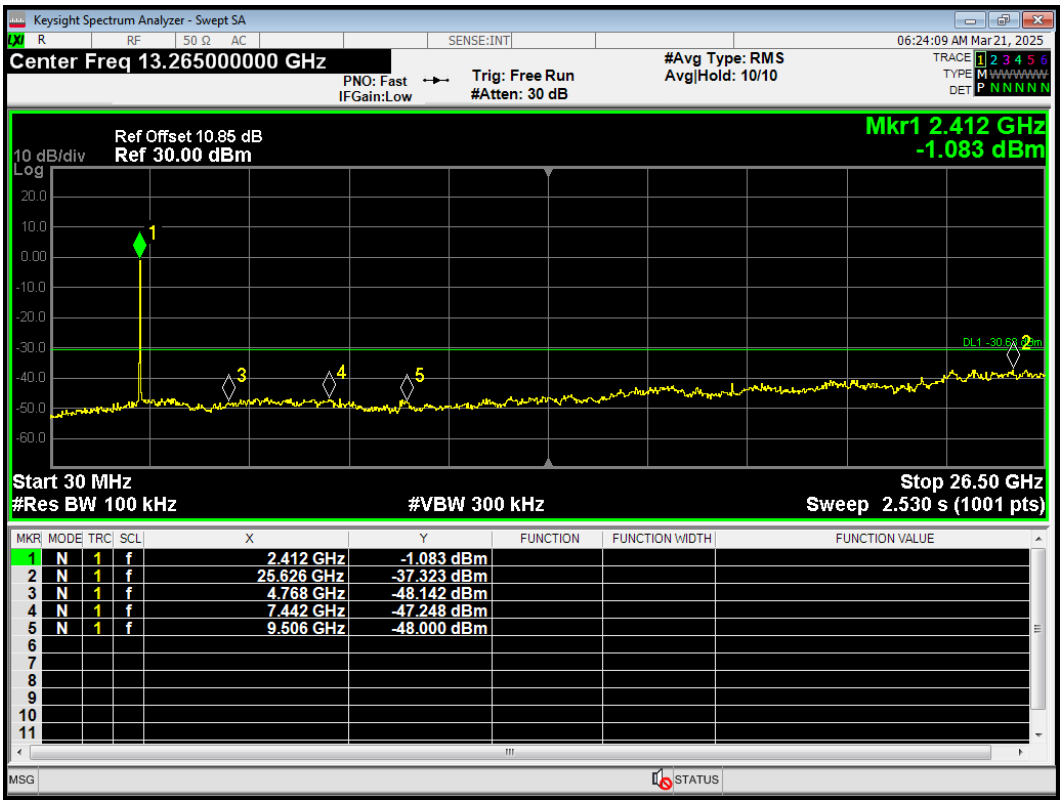
Tx. Spurious 802.11ax(HE40) 2422MHz Ref



Tx. Spurious 802.11ax(HE40) 2422MHz Emission



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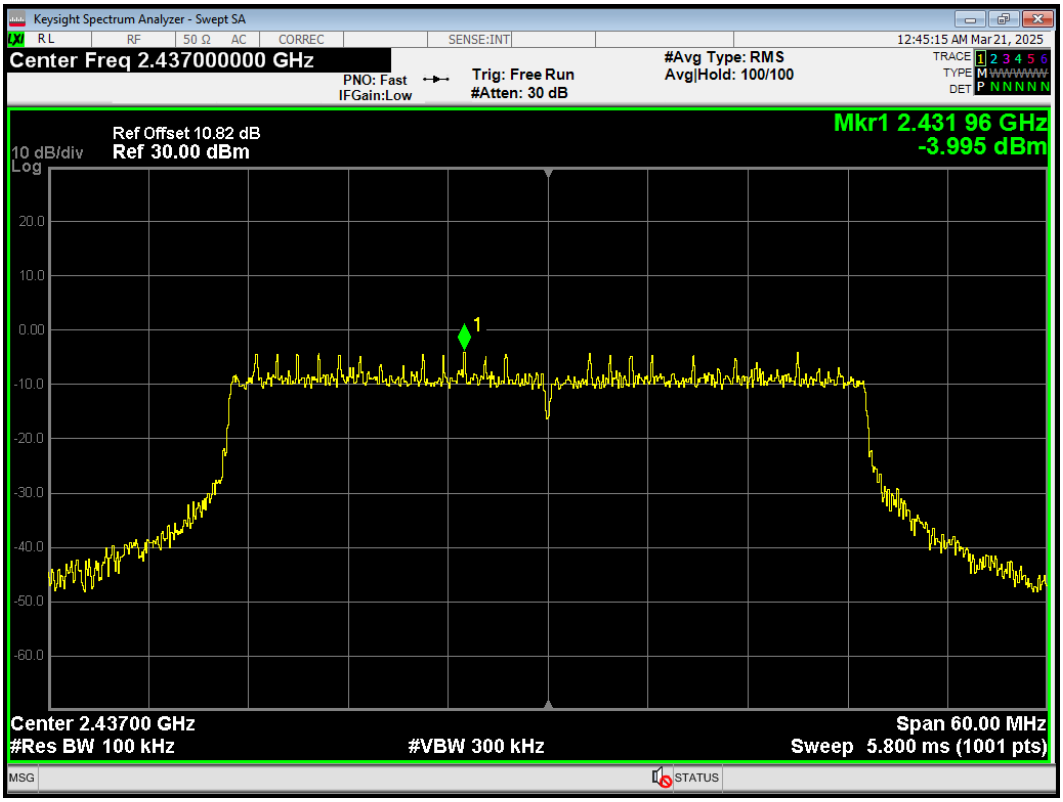
Tx. Spurious 802.11ax(HE40) 2437MHz Ref



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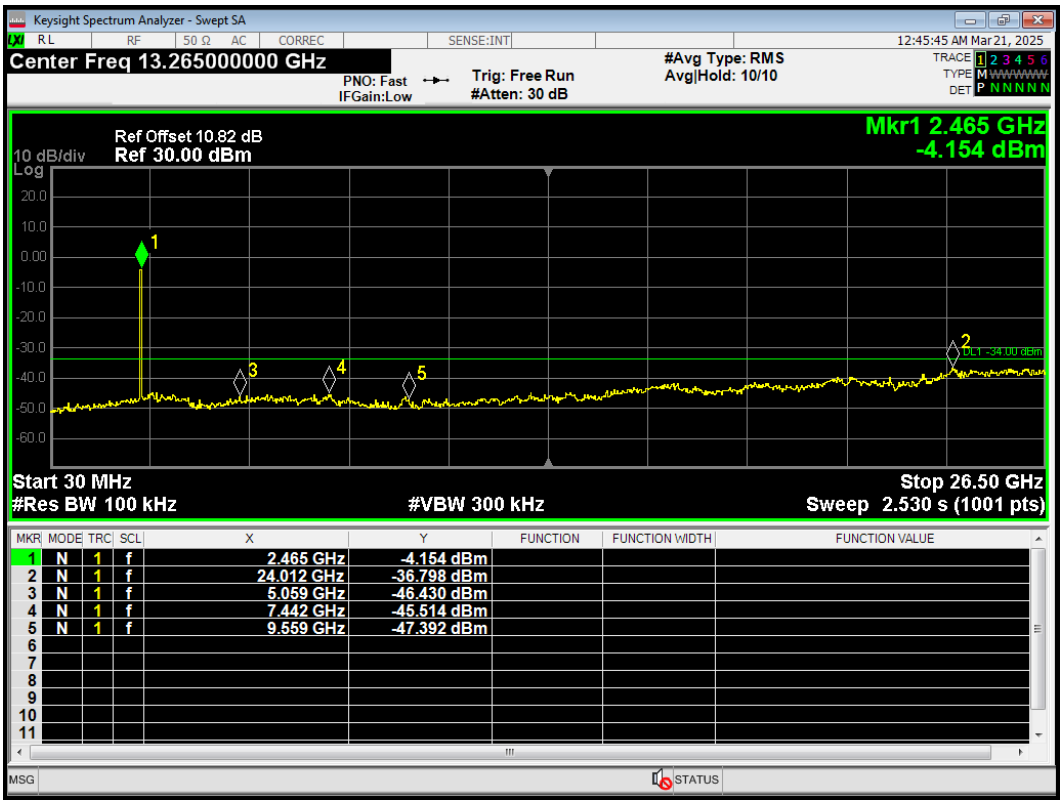

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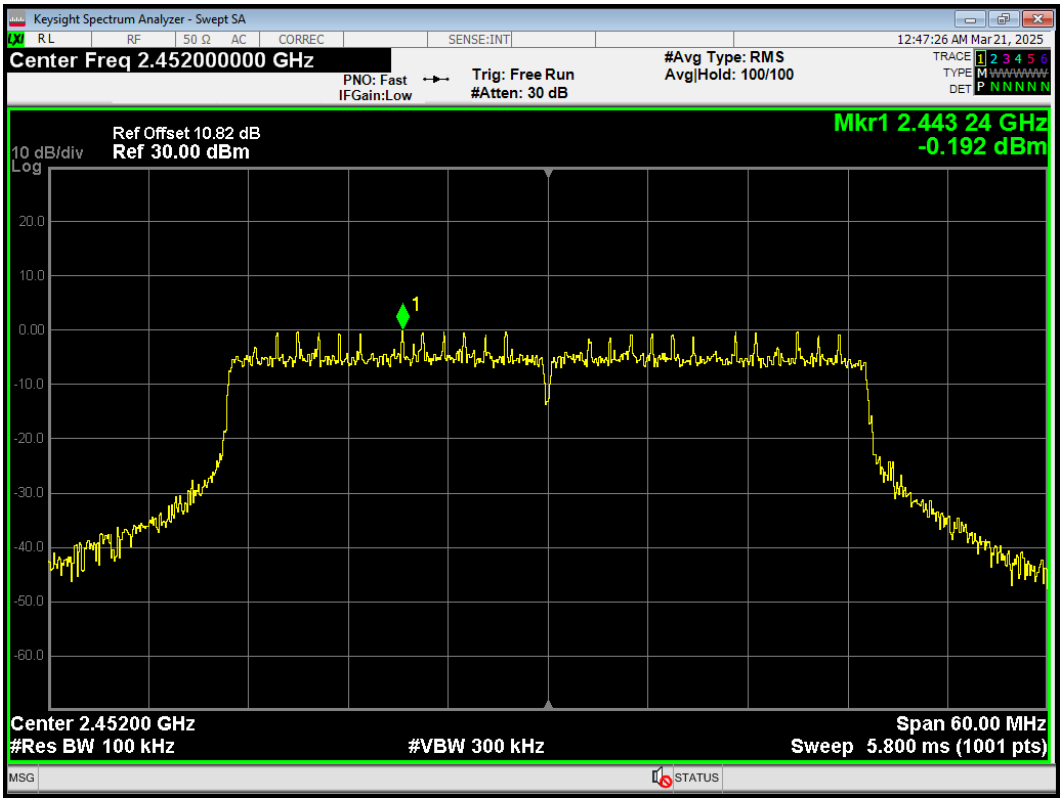
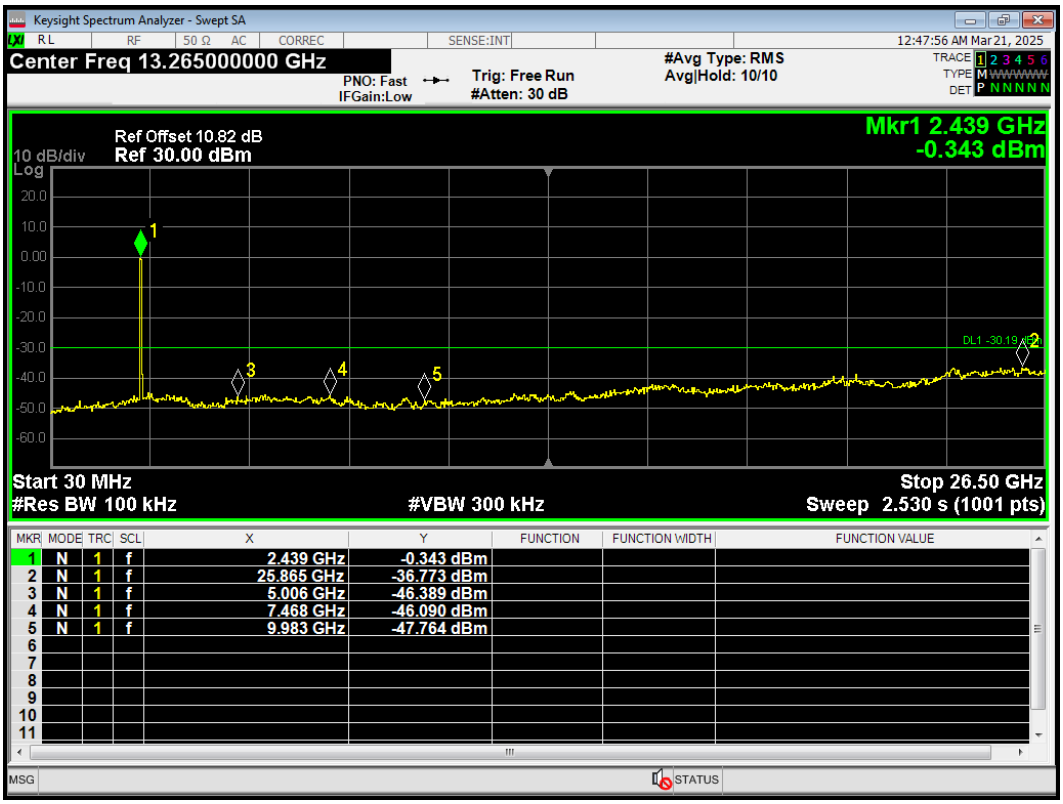
Tx. Spurious 802.11ax(HE40) 2452MHz Ref



Tx. Spurious 802.11ax(HE40) 2452MHz Emission



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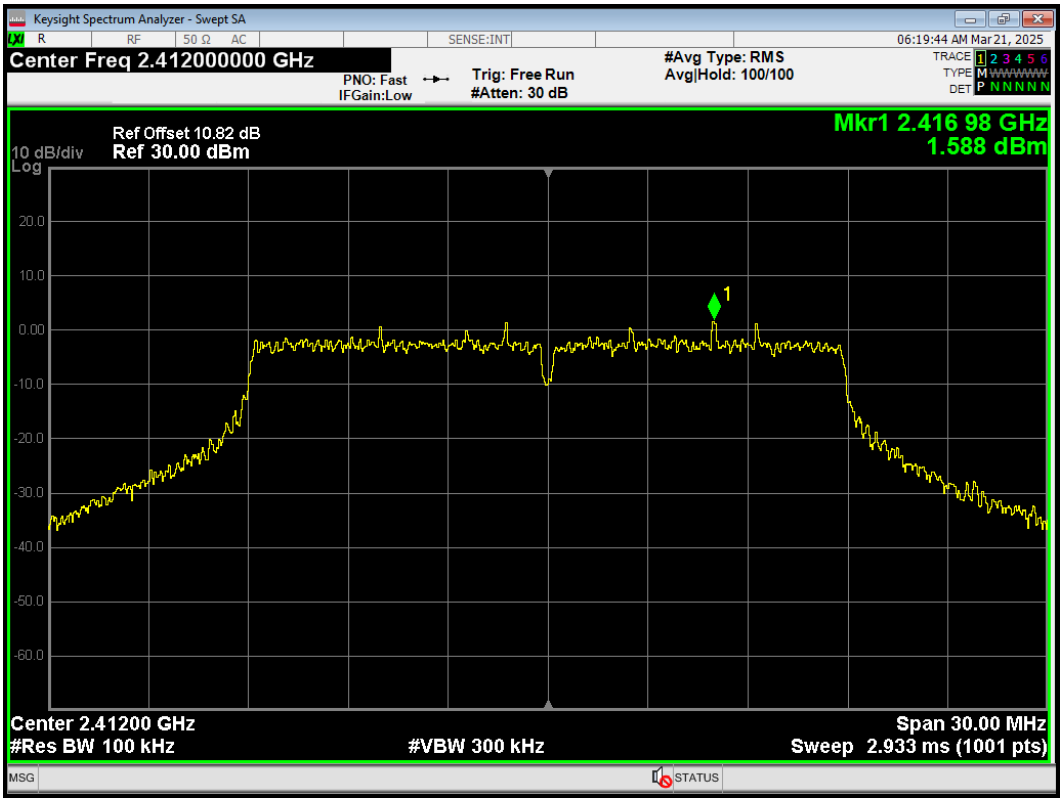
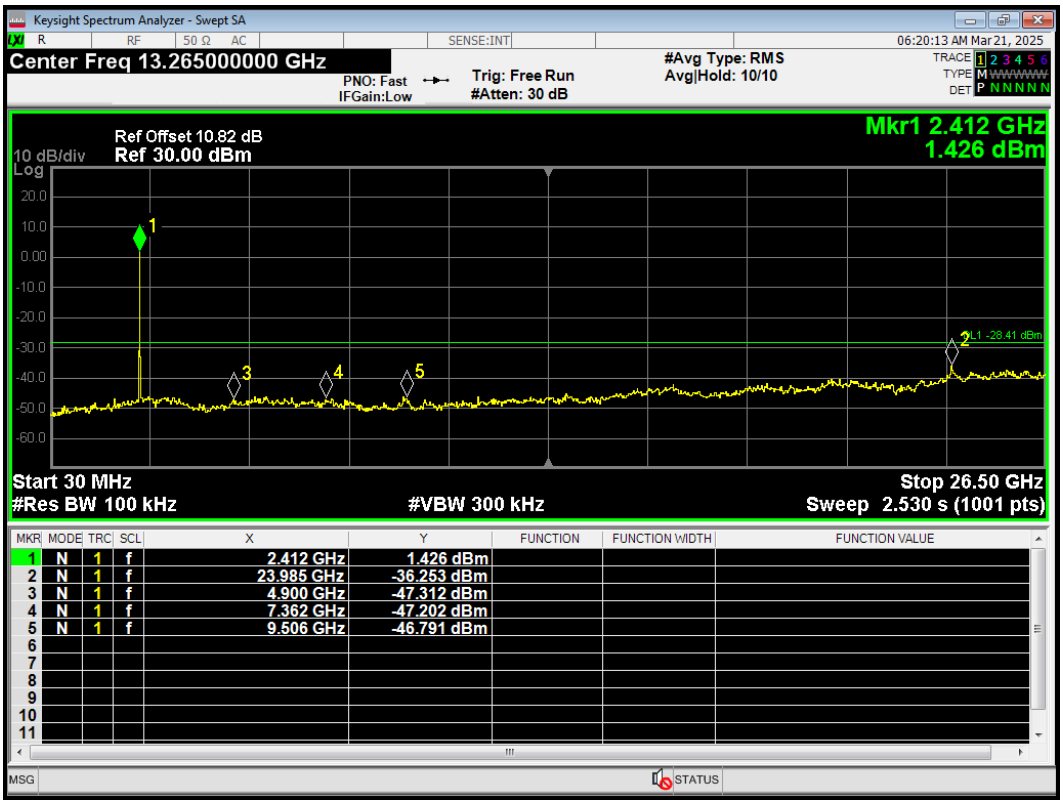
Tx. Spurious 802.11n(HT20) 2412MHz Ref



Tx. Spurious 802.11n(HT20) 2412MHz Emission



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.412 GHz	1.426 dBm			
2	N	1	f	23.985 GHz	-36.253 dBm			
3	N	1	f	4.900 GHz	-47.312 dBm			
4	N	1	f	7.362 GHz	-47.202 dBm			
5	N	1	f	9.506 GHz	-46.791 dBm			
6								
7								
8								
9								
10								
11								

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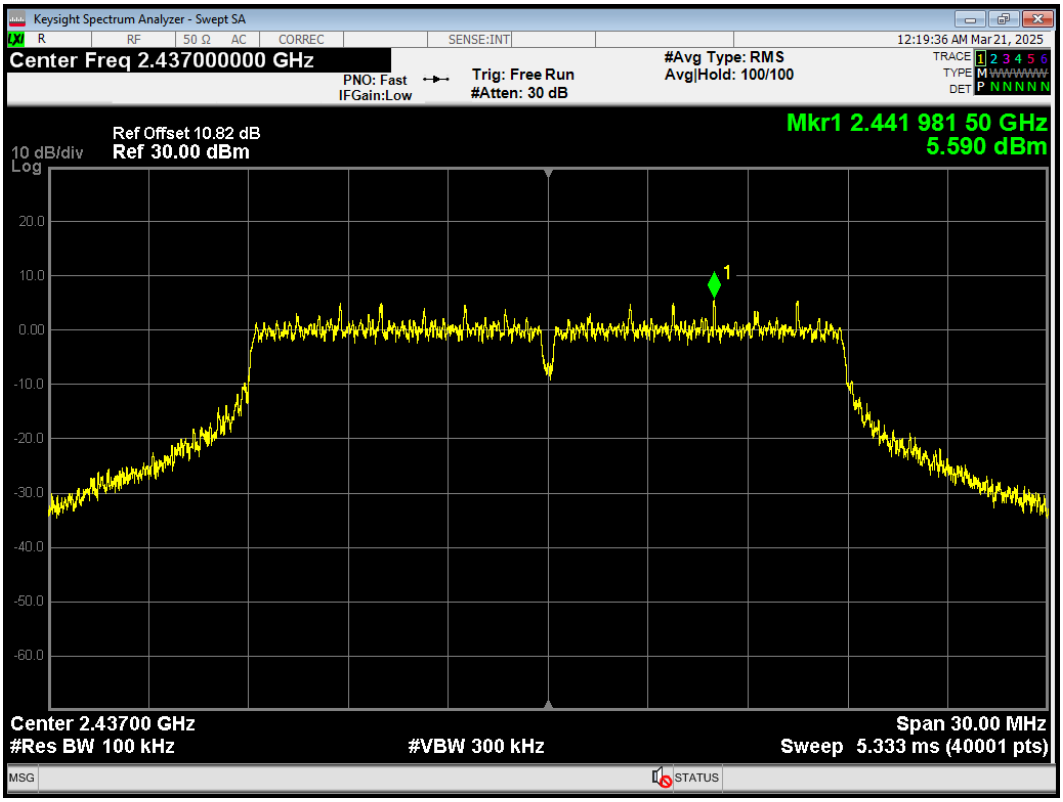
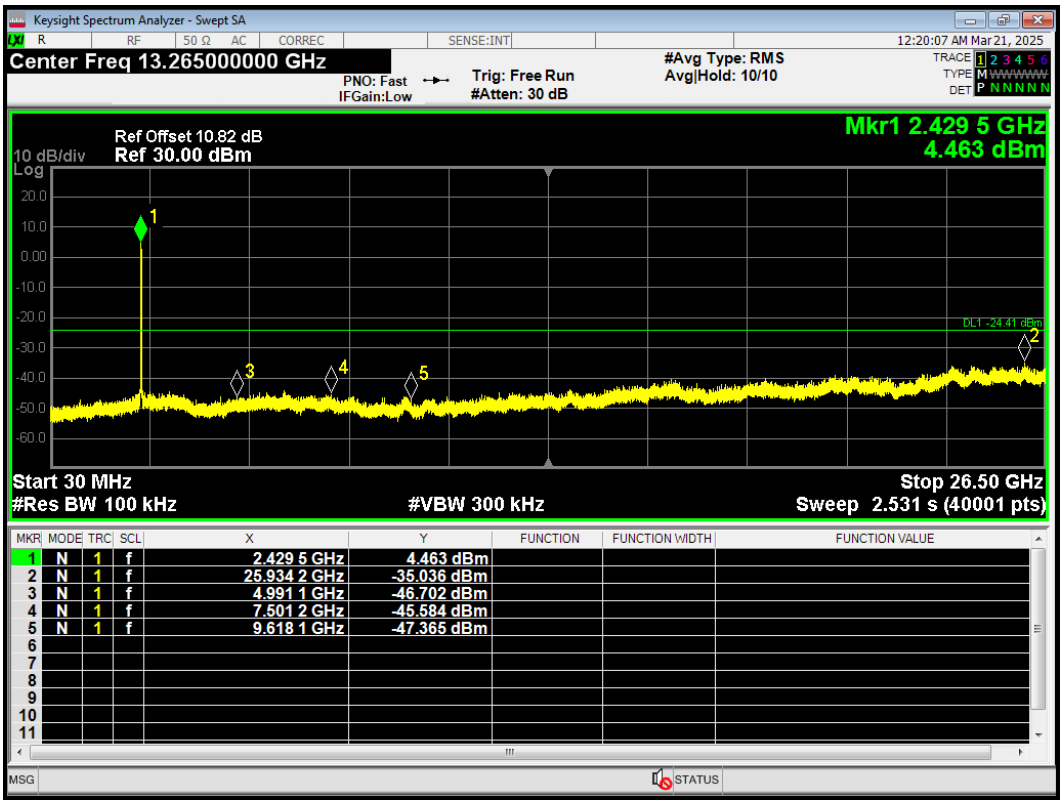
Tx. Spurious 802.11n(HT20) 2437MHz Ref



Tx. Spurious 802.11n(HT20) 2437MHz Emission



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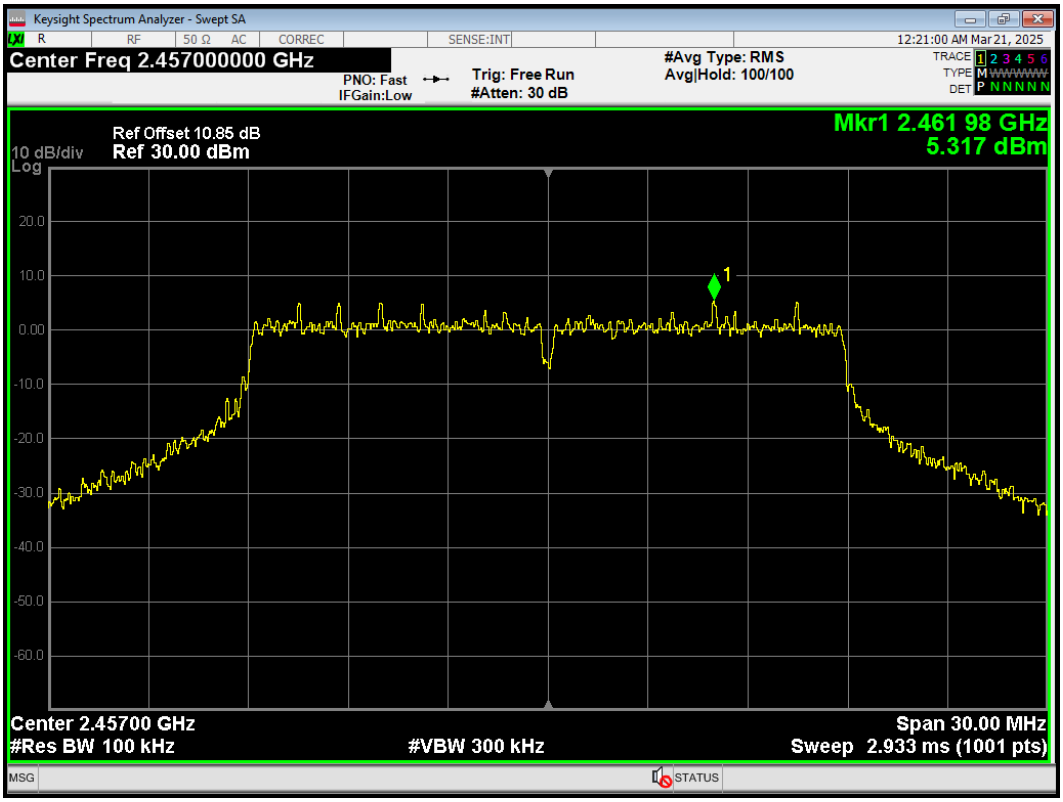
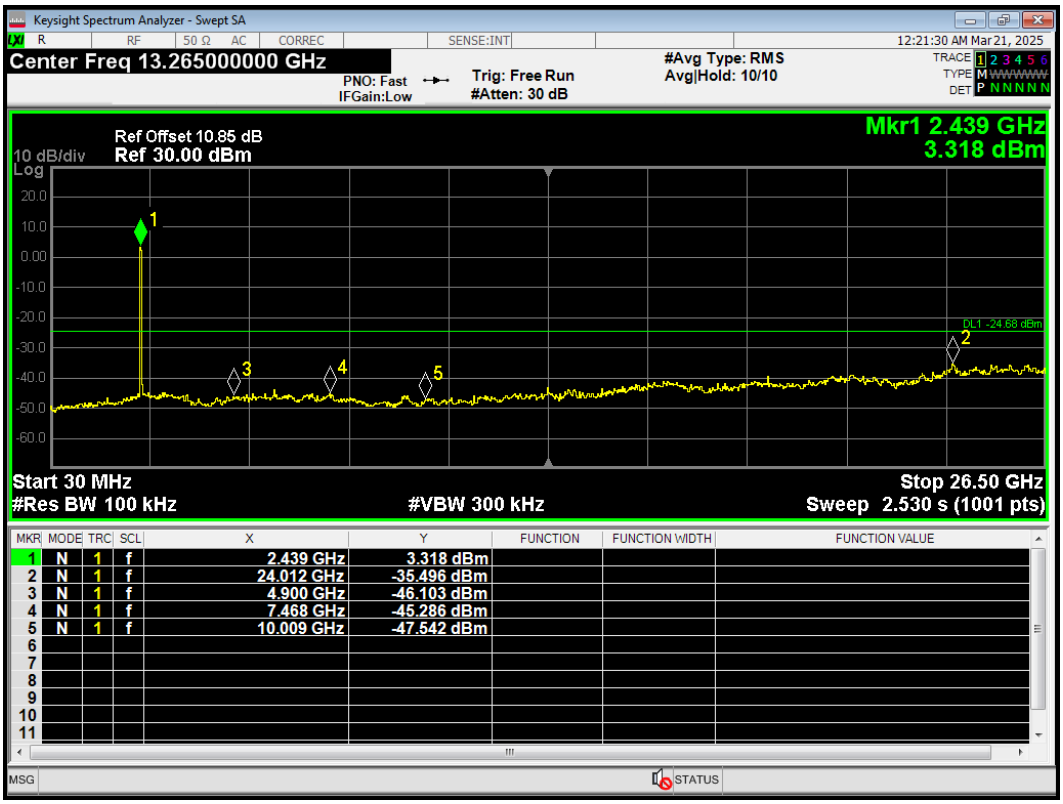
Tx. Spurious 802.11n(HT20) 2457MHz Ref



Tx. Spurious 802.11n(HT20) 2457MHz Emission



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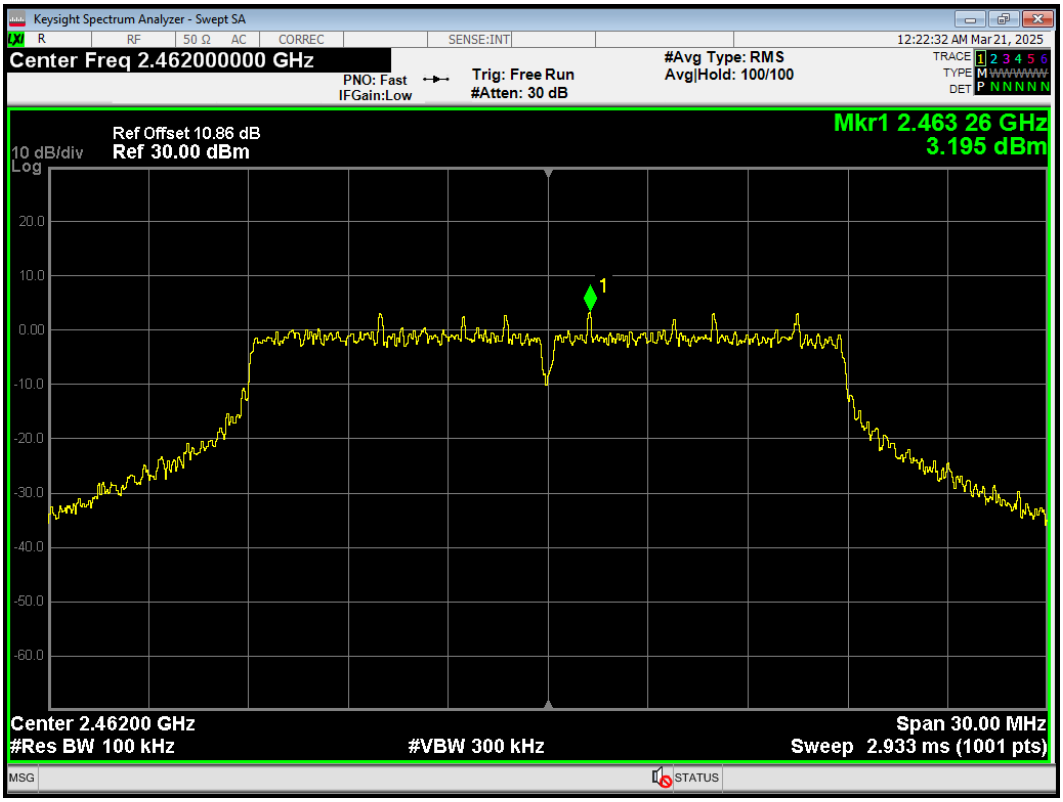
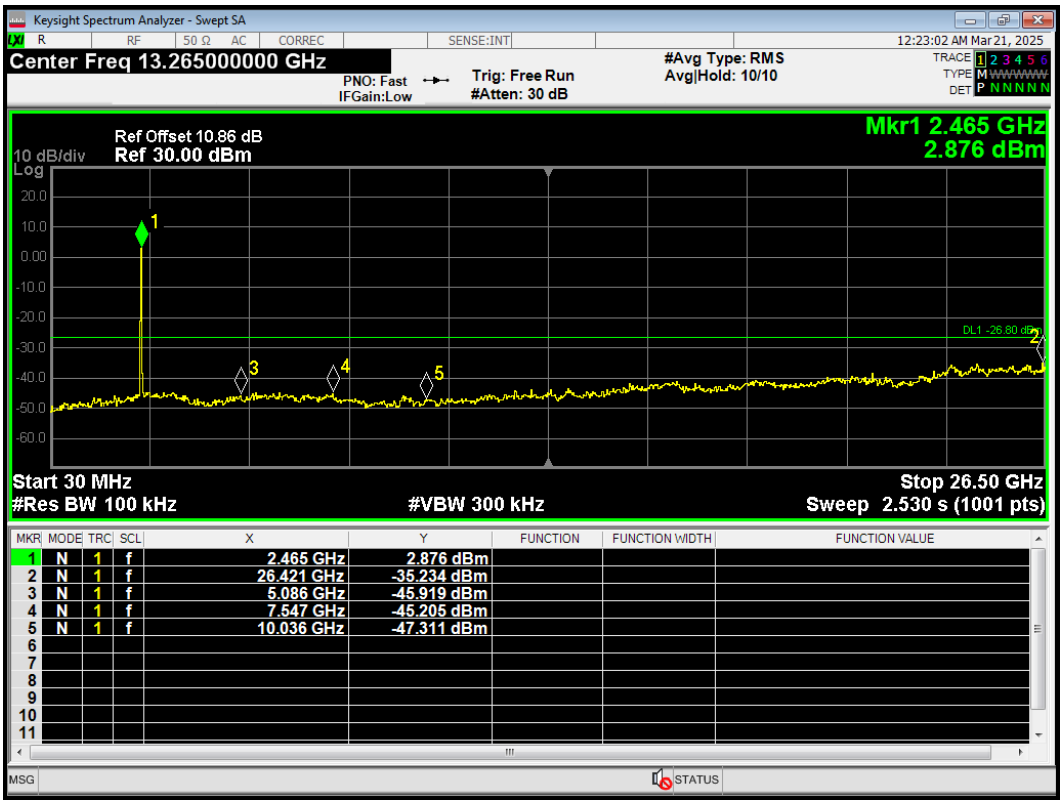
Tx. Spurious 802.11n(HT20) 2462MHz Ref



Tx. Spurious 802.11n(HT20) 2462MHz Emission



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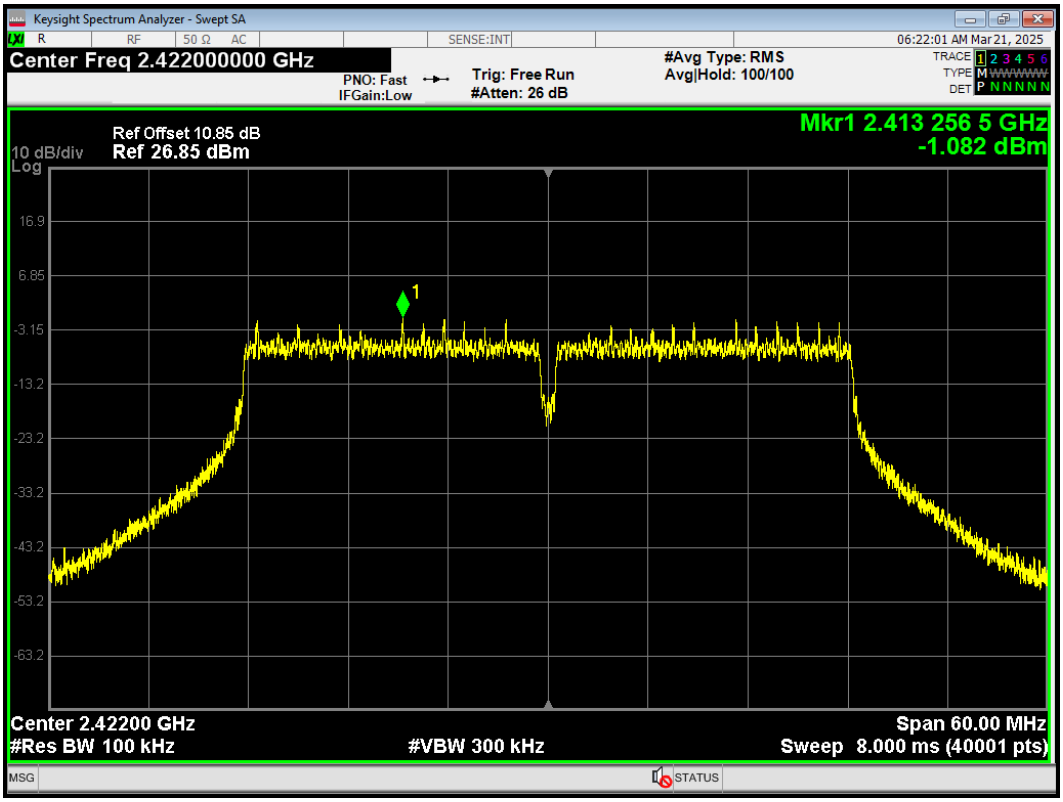
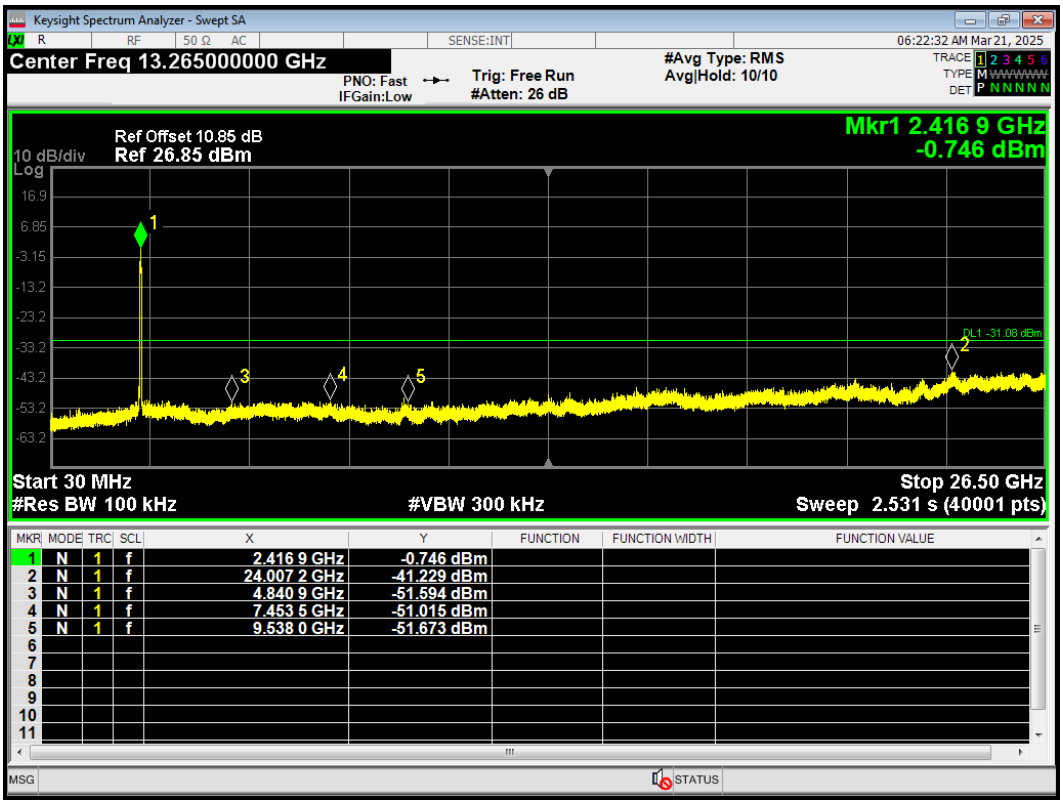
Tx. Spurious 802.11n(HT40) 2422MHz Ref



Tx. Spurious 802.11n(HT40) 2422MHz Emission



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.416 9 GHz	-0.746 dBm			
2	N	1	f	24.007 2 GHz	-41.229 dBm			
3	N	1	f	4.840 9 GHz	-51.594 dBm			
4	N	1	f	7.453 5 GHz	-51.015 dBm			
5	N	1	f	9.538 0 GHz	-51.673 dBm			
6								
7								
8								
9								
10								
11								

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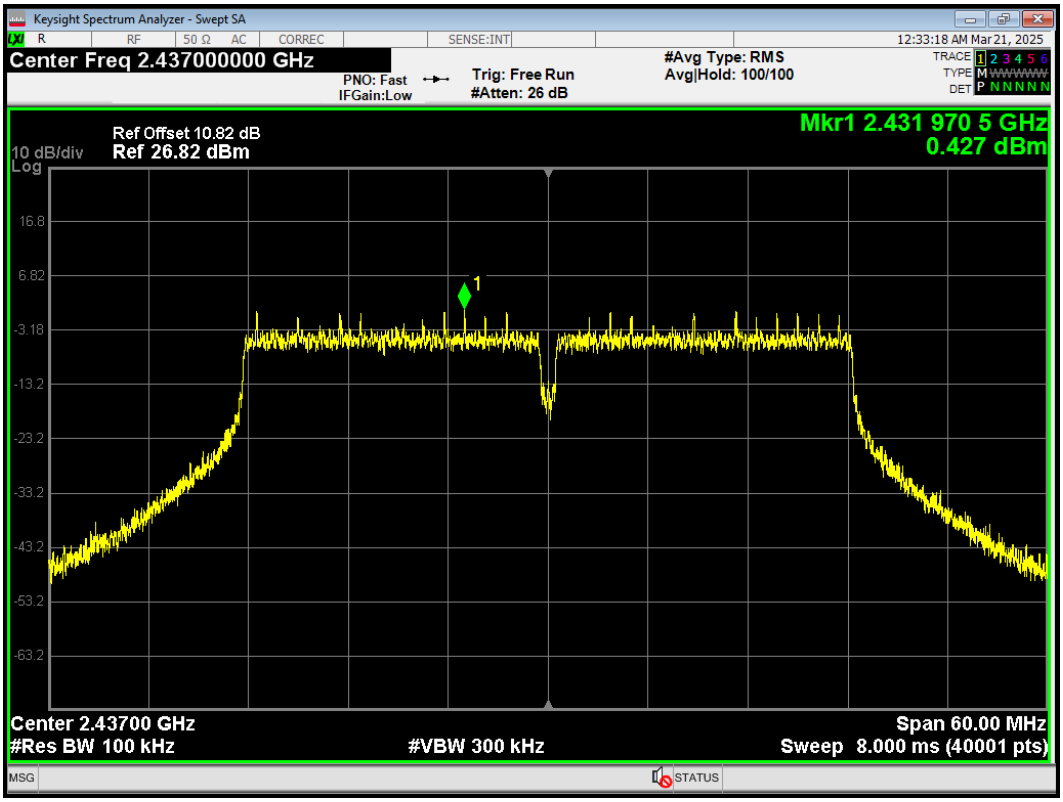
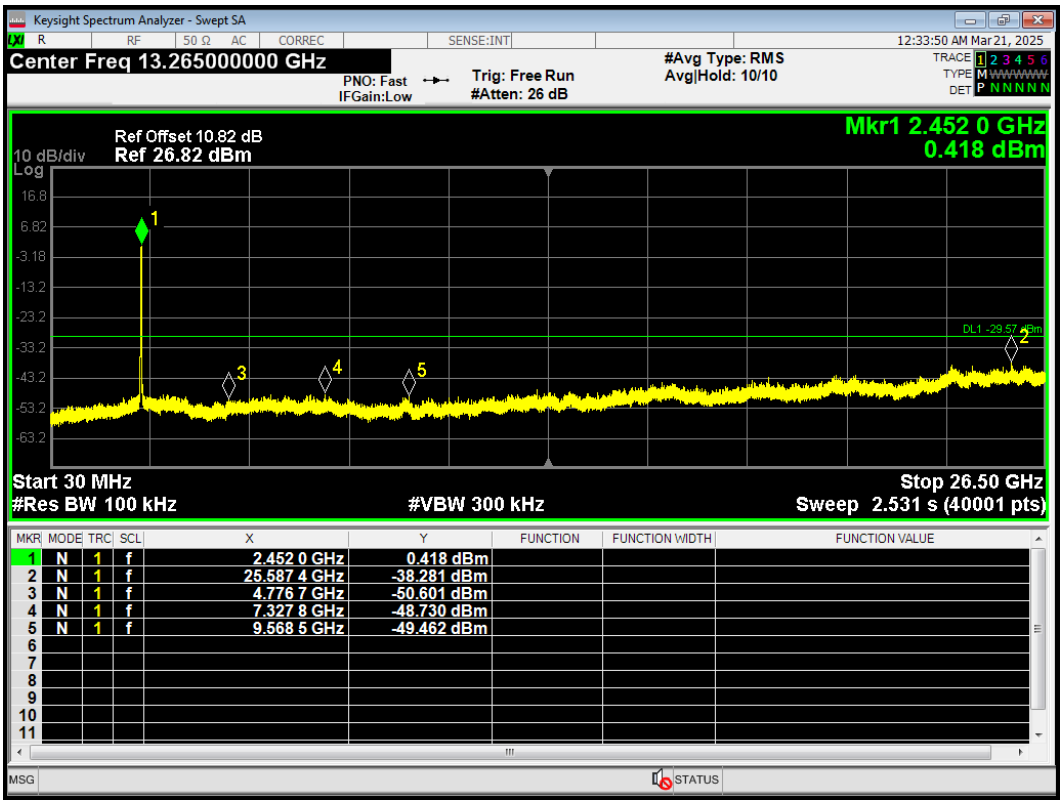
Tx. Spurious 802.11n(HT40) 2437MHz Ref



Tx. Spurious 802.11n(HT40) 2437MHz Emission



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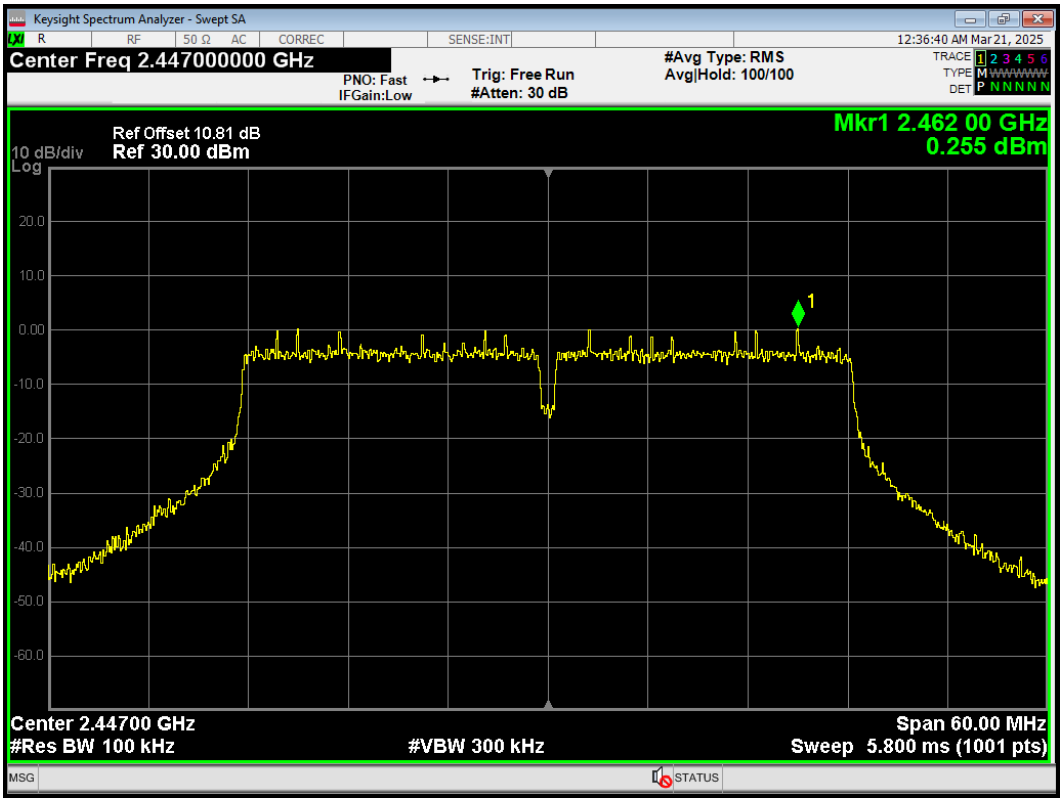
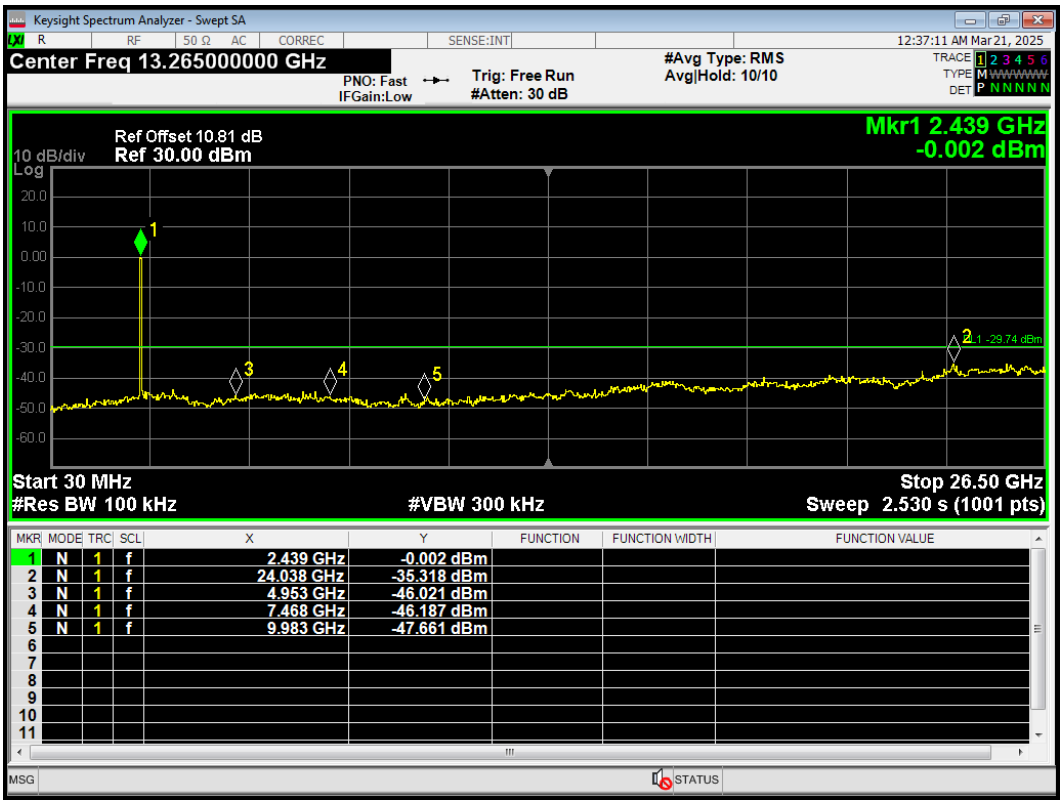
Tx. Spurious 802.11n(HT40) 2447MHz Ref



Tx. Spurious 802.11n(HT40) 2447MHz Emission



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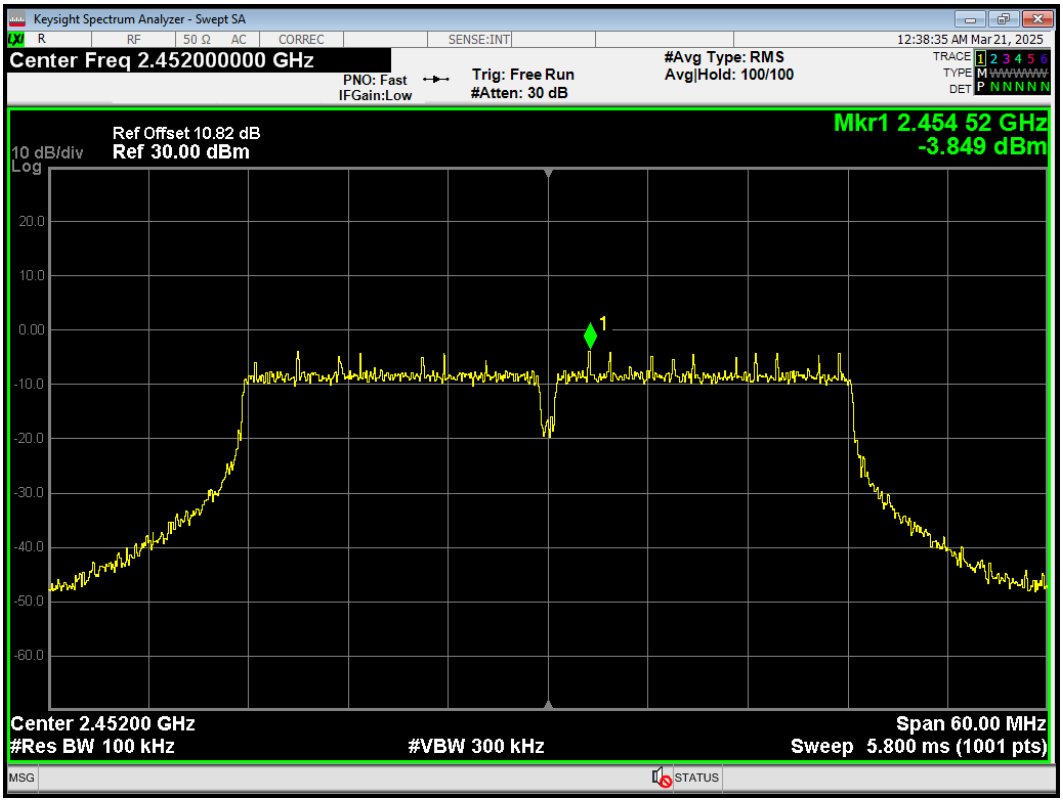
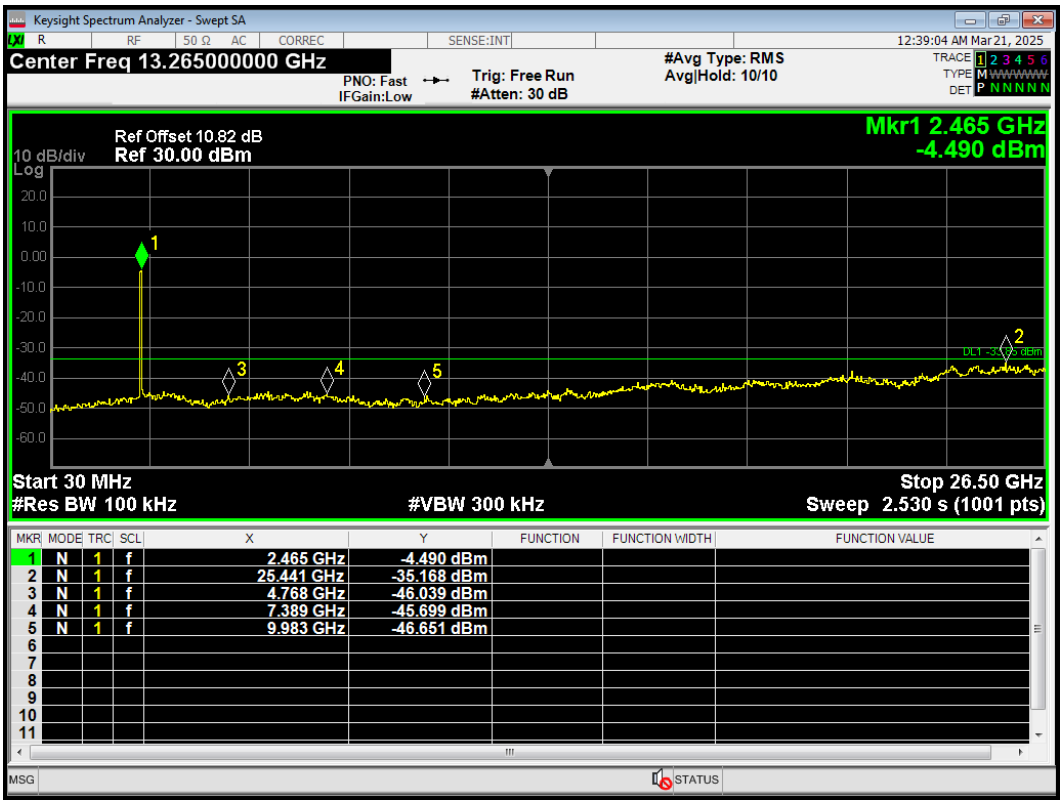
Tx. Spurious 802.11n(HT40) 2452MHz Ref



Tx. Spurious 802.11n(HT40) 2452MHz Emission



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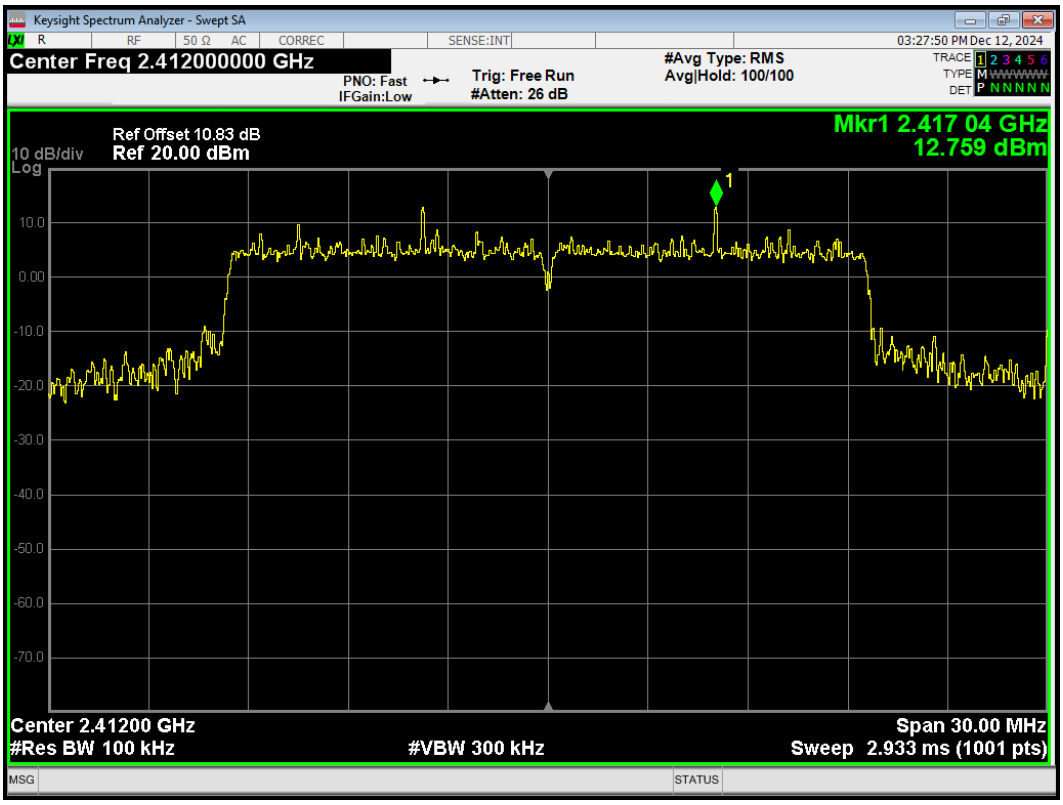
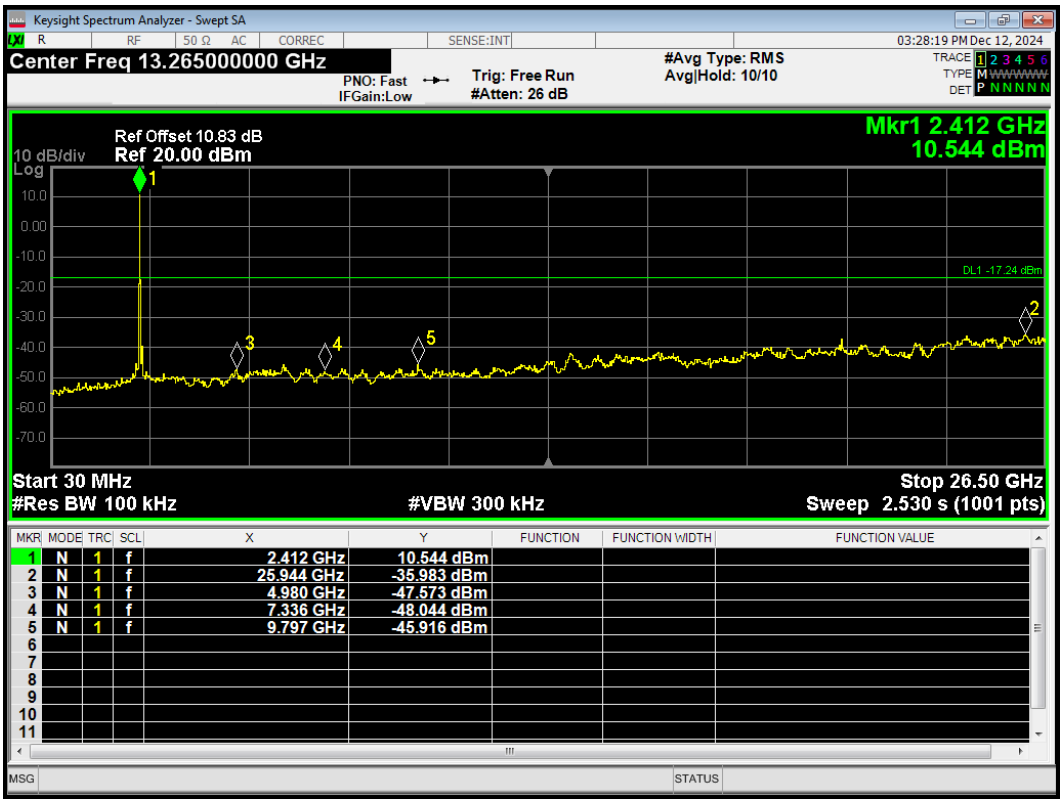
ERSU Mode

Tx. Spurious 802.11ax(HE20) 242-Tones 2412MHz Ref



Tx. Spurious 802.11ax(HE20) 242-Tones 2412MHz Emission



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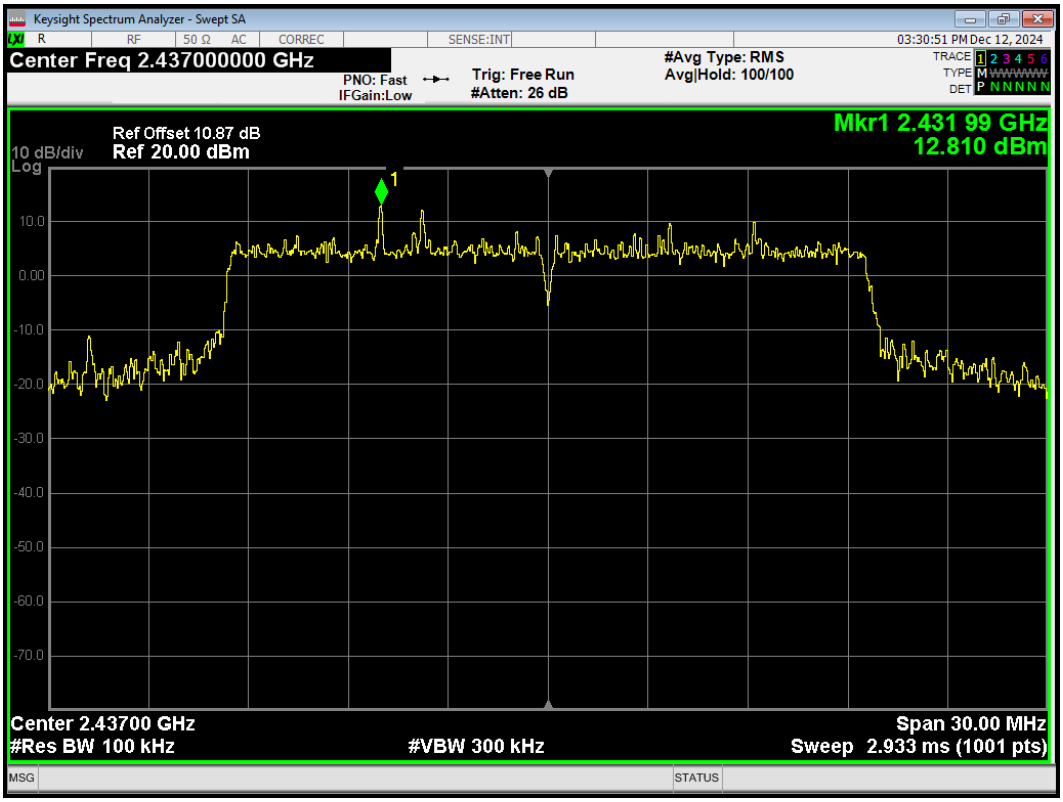
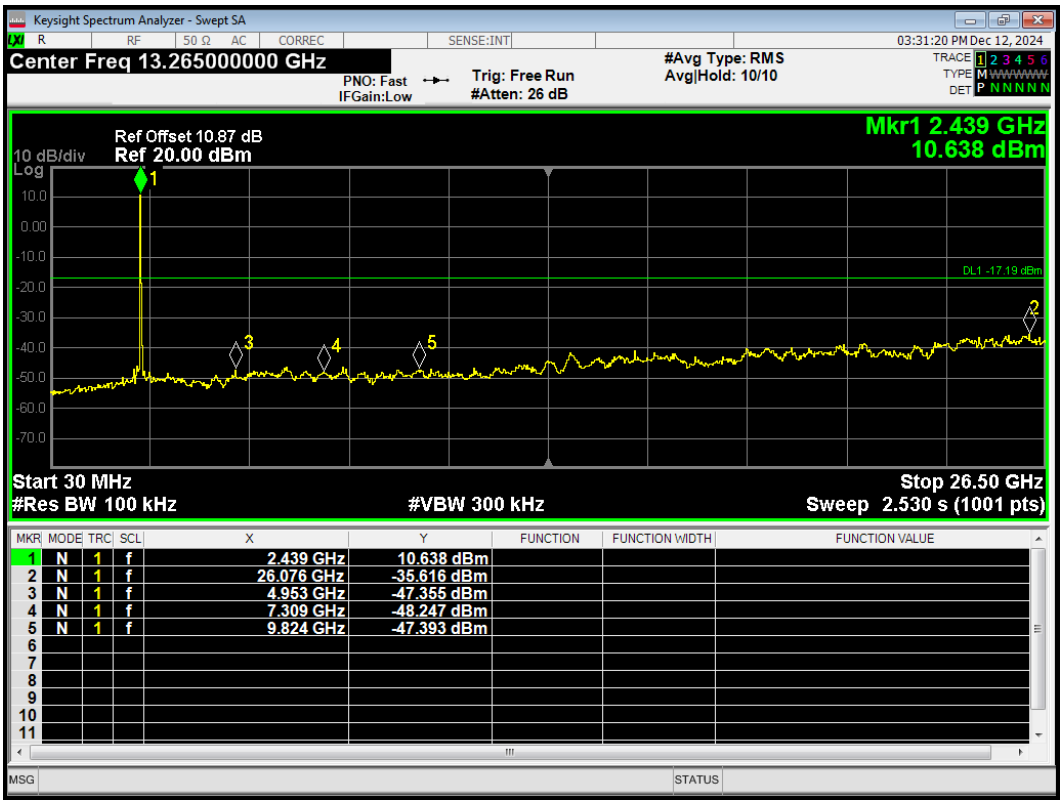
Tx. Spurious 802.11ax(HE20) 242-Tones 2437MHz Ref



Tx. Spurious 802.11ax(HE20) 242-Tones 2437MHz Emission



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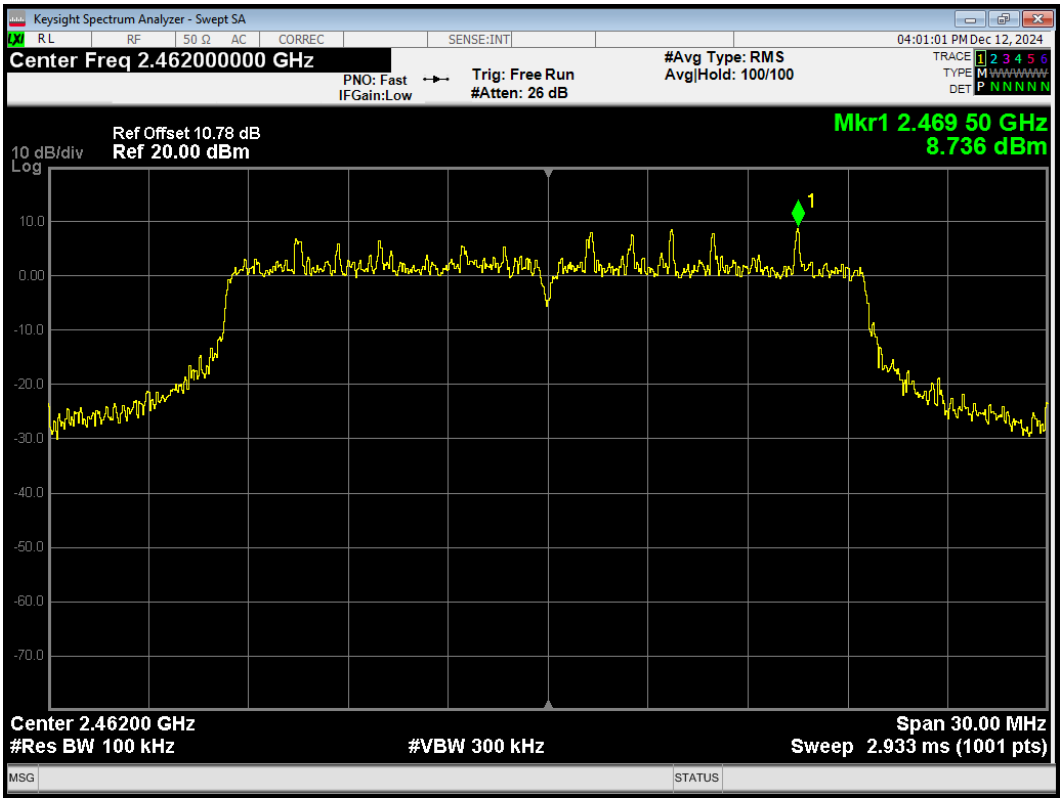
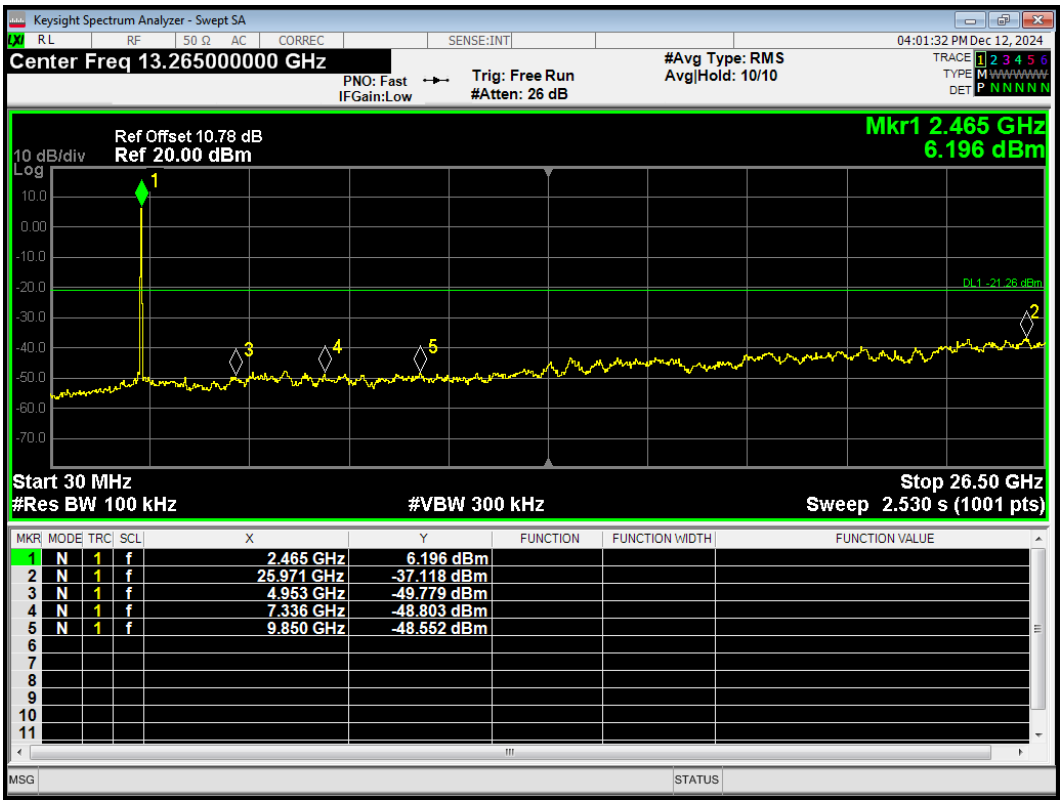
Tx. Spurious 802.11ax(HE20) 242-Tones 2462MHz Ref



Tx. Spurious 802.11ax(HE20) 242-Tones 2462MHz Emission



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6. Main Test Instruments

Name	Manufacturer	Type	Serial Number	Calibration Date	Expiration Date
Signal Analyzer	KEYSIGHT	N9020A	MY51330870	2024-05-07	2025-05-06
Power Sensor	R&S	NRP18S	101954	2024-05-07	2025-05-06
Attenuator	HASCO	HA18A-10	0003	/	/

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ANNEX A: The EUT Appearance

The EUT Appearance are submitted separately.

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ANNEX B: Test Setup Photos

The Test Setup Photos are submitted separately.

******** END OF REPORT ********

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