RF TEST REPORT

Applicant	Shanghai Smawave Technology Co. ,Ltd
FCC ID	2AU8HSC421
Product	Cat12 Indoor CPE
Brand	Smawave
Model	SC421
Report No.	R2404A0415-R4
Issue Date	May 23, 2024

Eurofins TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2023)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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Summary of Measurement Results

Number	Test Case	Clause in FCC rules	Verdict
1	Maximum output power	15.247(b)(3)	PASS
2	99% Bandwidth and 6dB Bandwidth	15.247(a)(2) C63.10 6.9	PASS
3	Power spectral density	15.247(e)	PASS
4	Band Edge	15.247(d)	PASS
5	Spurious RF Conducted Emissions	15.247(d)	PASS
6	Unwanted Emissions	15.247(d), 15.205, 15.209	PASS
7	Conducted Emissions	15.207	PASS
Date of Testing: April 25, 2024 ~ May 10, 2024 Date of Sample Received: April 15, 2024			
Note: All indications of Pass/Fail in this report are opinions expressed by Eurofins TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.			

1. Test Laboratory

1.1. Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **Eurofins TA Technology (Shanghai) Co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Test Facility

FCC (Designation number: CN1179, Test Firm Registration Number: 446626)

Eurofins TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

A2LA (Certificate Number: 3857.01)

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

1.3. Testing Location

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

2. General Description of Equipment Under Test

2.1. Applicant and Manufacturer Information

Applicant	Shanghai Smawave Technology Co. ,Ltd
Applicant address	3/F, Building 8, 1001 North Qinzhou Road，Xuhui District, Shanghai, China
Manufacturer	Shanghai Smawave Technology Co. ,Ltd
Manufacturer address	3/F, Building 8, 1001 North Qinzhou Road，Xuhui District, Shanghai, China

2.2. General Information

EUT Description	
Model	SC421
SN	Conducted: FG1JQE0001 Radiated: SC421X00241500011
Hardware Version	/
Software Version	/
Power Supply	AC adapter
Antenna Type	PCB Antenna
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)
Antenna Gain	Antenna 1: 3.12dBi Antenna 2: 2.59 dBi
Beamforming Directional Gain	2.80 dBi
MIMO Directional Gain	Power: 3.12 dBi PSD: 6.13 dBi
Operating Frequency Range(s)	802.11b/g/n(HT20): 2412 ~ 2462 MHz 802.11n(HT40): 2422 ~ 2452 MHz
Modulation Type	802.11b: DSSS 802.11g/n: OFDM
Max. Output Power	21.85 dBm
EUT Accessory	
Adapter	Manufacturer: SHENZHEN TOPOW Model: TPA259-18120-US
Auxiliary test equipment	
PC	Manufacturer: LENOVO Model: ThinkPad TP00067A (SN: PF-099YFU 15/06)
Note: 1. The EUT is sent from the applicant to Eurofins TA and the information of the EUT is declared by the applicant. 2.The manufacturer declared the Beamforming gain is 2.80dBi, data sharing between Beamforming and MIMO.	

3. Applied Standards

According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

Test standards:

FCC CFR47 Part 15C (2023) Radio Frequency Devices

ANSI C63.10-2013

Reference standard:

KDB 558074 D01 15.247 Meas Guidance v05r02

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.

Worst-case data rates are shown as following table.

Test Mode	Data Rate		
	Antenna 1	Antenna 2	MIMO/ Beamforming
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

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

Test Cases	Antenna 1	Antenna 2	MIMO/ Beamforming
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	--	--	802.11n HT40
Note: “O”: test all bands			

5. Test Case Results

5.1. Maximum output power

Ambient Condition

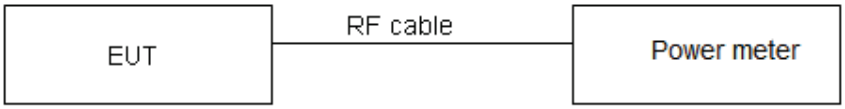
Temperature	Relative humidity
15°C ~ 35°C	20% ~ 80%

Methods of Measurement

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

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

Antenna	Channel	802.11b	802.11g	802.11n HT20	Channel	802.11n HT40
SISO Antenna 1	CH1	16.0	17.0	17.0	CH3	17.5
	CH6	16.0	17.0	17.5	CH6	17.5
	CH11	16.0	17.5	17.5	CH9	17.5
SISO Antenna 2	CH1	15.5	16.5	17.0	CH3	17.0
	CH6	15.5	16.5	17.0	CH6	17.0
	CH11	15.5	17.0	17.0	CH9	17.0
Antenna	**Channel**	**802.11b**	**802.11g**	**802.11n HT20**	**Channel**	**802.11n HT40**
MIMO/ Beamforming	CH1	15.5	12.5	11.5	CH3	10.5
	CH2	-	15.5	15.5	CH4	11.5
	CH3	-	16.5	16.5	CH5	13.0
	CH6	15.5	16.5	16.5	CH6	14.5
	CH9	-	16.5	16.5	CH7	13.5
	CH10	--	14.5	14.5	CH8	11.5
	CH11	15.5	12.0	11.5	CH9	10.5

Test Mode	Duty cycle	Duty cycle correction Factor (dB)
802.11b	0.981	0.000
802.11g	0.930	0.320
802.11n HT20	0.925	0.340
802.11n HT40	0.892	0.500
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	18.95	18.95	30	PASS
	2437/CH 6	18.67	18.67	30	PASS
	2462/CH11	18.55	18.55	30	PASS
802.11g	2412/CH 1	18.61	18.93	30	PASS
	2437/CH 6	18.50	18.82	30	PASS
	2462/CH11	18.62	18.94	30	PASS
802.11n HT20	2412/CH 1	18.40	18.74	30	PASS
	2437/CH 6	18.58	18.92	30	PASS
	2462/CH11	18.47	18.81	30	PASS
802.11n HT40	2422/CH3	18.49	18.99	30	PASS
	2437/CH6	18.24	18.74	30	PASS
	2452/CH9	18.44	18.94	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	18.76	18.76	30	PASS
	2437/CH 6	18.92	18.92	30	PASS
	2462/CH11	18.68	18.68	30	PASS
802.11g	2412/CH 1	18.49	18.81	30	PASS
	2437/CH 6	18.55	18.87	30	PASS
	2462/CH11	18.58	18.90	30	PASS
802.11n HT20	2412/CH 1	18.56	18.90	30	PASS
	2437/CH 6	18.64	18.98	30	PASS
	2462/CH11	18.38	18.72	30	PASS
802.11n HT40	2422/CH3	18.47	18.97	30	PASS
	2437/CH6	18.48	18.98	30	PASS
	2452/CH9	18.31	18.81	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	18.61	18.61	18.70	18.70	21.67	30	PASS
	2437/CH 6	18.34	18.34	19.13	19.13	21.77	30	PASS
	2462/CH11	18.11	18.11	18.43	18.43	21.28	30	PASS
802.11g	2412/CH 1	14.31	14.63	14.61	14.93	17.79	30	PASS
	2417/CH 2	17.22	17.54	17.61	17.93	20.75	30	PASS
	2422/ CH 3	18.39	18.71	18.64	18.96	21.85	30	PASS
	2437/CH 6	18.09	18.41	18.65	18.97	21.71	30	PASS
	2452/CH 9	17.85	18.17	18.42	18.74	21.48	30	PASS
	2457/CH 10	15.57	15.89	16.41	16.73	19.34	30	PASS
	2462/CH11	13.58	13.90	13.94	14.26	17.10	30	PASS
802.11n HT20	2412/CH 1	13.30	13.64	13.79	14.13	16.90	30	PASS
	2417/CH 2	17.10	17.44	17.65	17.99	20.74	30	PASS
	2422/ CH 3	18.09	18.43	18.65	18.99	21.73	30	PASS
	2437/CH 6	17.99	18.33	18.66	19.00	21.69	30	PASS
	2452/CH 9	17.65	17.99	18.41	18.75	21.40	30	PASS
	2457/CH 10	15.52	15.86	16.49	16.83	19.38	30	PASS
	2462/CH11	12.95	13.29	13.56	13.90	16.62	30	PASS
802.11n HT40	2422/CH3	11.91	12.41	12.32	12.82	15.63	30	PASS
	2427/CH4	12.76	13.26	13.48	13.98	16.65	30	PASS
	2432/CH5	14.54	15.04	14.88	15.38	18.23	30	PASS
	2437/CH6	15.48	15.98	16.20	16.70	19.37	30	PASS
	2442/CH7	14.41	14.91	15.12	15.62	18.29	30	PASS
	2447/CH8	12.45	12.95	13.27	13.77	16.39	30	PASS
	2452/CH9	11.20	11.70	12.22	12.72	15.25	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 =3.12+0=3.12 dBi<6dBi. So the power limit is 30dBm.

Beamforming

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	18.61	18.61	18.70	18.70	21.67	30	PASS
	2437/CH 6	18.34	18.34	19.13	19.13	21.77	30	PASS
	2462/CH11	18.11	18.11	18.43	18.43	21.28	30	PASS
802.11g	2412/CH 1	14.31	14.63	14.61	14.93	17.79	30	PASS
	2417/CH 2	17.22	17.54	17.61	17.93	20.75	30	PASS
	2422/ CH 3	18.39	18.71	18.64	18.96	21.85	30	PASS
	2437/CH 6	18.09	18.41	18.65	18.97	21.71	30	PASS
	2452/CH 9	17.85	18.17	18.42	18.74	21.48	30	PASS
	2457/CH 10	15.57	15.89	16.41	16.73	19.34	30	PASS
	2462/CH11	13.58	13.90	13.94	14.26	17.10	30	PASS
802.11n HT20	2412/CH 1	13.30	13.64	13.79	14.13	16.90	30	PASS
	2417/CH 2	17.10	17.44	17.65	17.99	20.74	30	PASS
	2422/ CH 3	18.09	18.43	18.65	18.99	21.73	30	PASS
	2437/CH 6	17.99	18.33	18.66	19.00	21.69	30	PASS
	2452/CH 9	17.65	17.99	18.41	18.75	21.40	30	PASS
	2457/CH 10	15.52	15.86	16.49	16.83	19.38	30	PASS
	2462/CH11	12.95	13.29	13.56	13.90	16.62	30	PASS
802.11n HT40	2422/CH3	11.91	12.41	12.32	12.82	15.63	30	PASS
	2427/CH4	12.76	13.26	13.48	13.98	16.65	30	PASS
	2432/CH5	14.54	15.04	14.88	15.38	18.23	30	PASS
	2437/CH6	15.48	15.98	16.20	16.70	19.37	30	PASS
	2442/CH7	14.41	14.91	15.12	15.62	18.29	30	PASS
	2447/CH8	12.45	12.95	13.27	13.77	16.39	30	PASS
	2452/CH9	11.20	11.70	12.22	12.72	15.25	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. The manufacturer declared the directional gain is 2.80dBi. And directional gain = 2.80dBi <6dBi.

So the limit is 30 dBm. Data sharing between Beamforming and MIMO.

5.2. 99% Bandwidth and 6dB Bandwidth

Ambient Condition

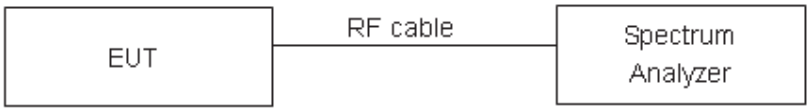
Temperature	Relative humidity
15°C ~ 35°C	20% ~ 80%

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable. RBW is set to 100 kHz; VBW is set to 300 kHz on spectrum analyzer.
Dector=Peak, Trace mode=max hold.

The EUT was connected to the spectrum analyzer through a known loss cable. The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value.

Test Setup



Limits

Rule Part 15.247 (a) (2) specifies that “Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.”

minimum 6 dB bandwidth	≥ 500 kHz

Measurement Uncertainty

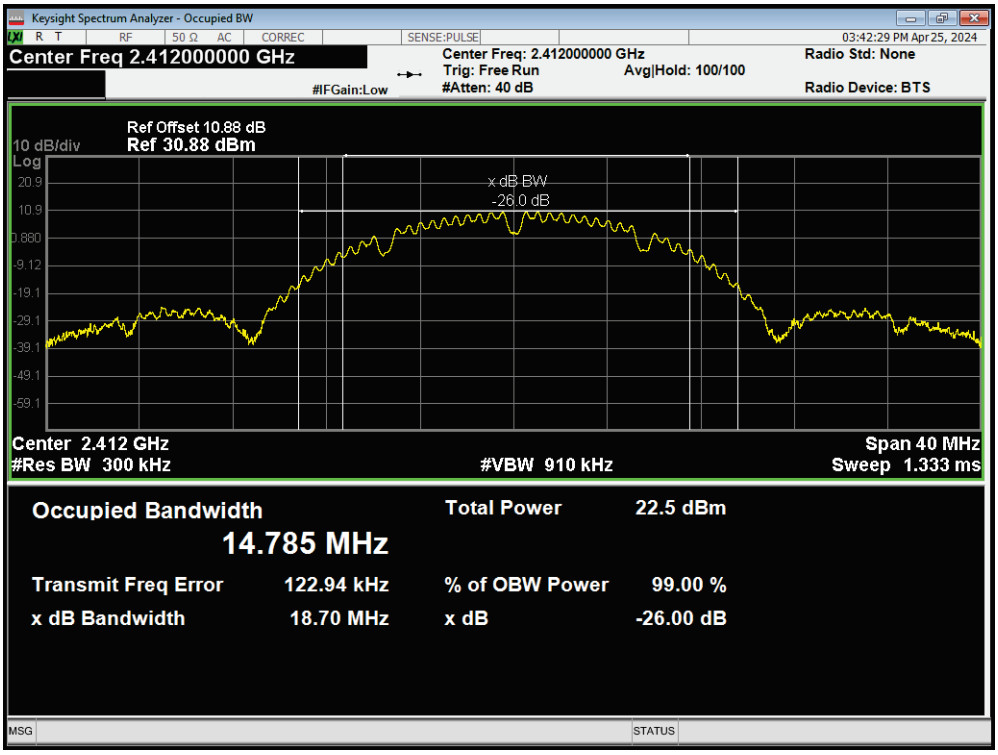
The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 936 Hz.

Test Results:

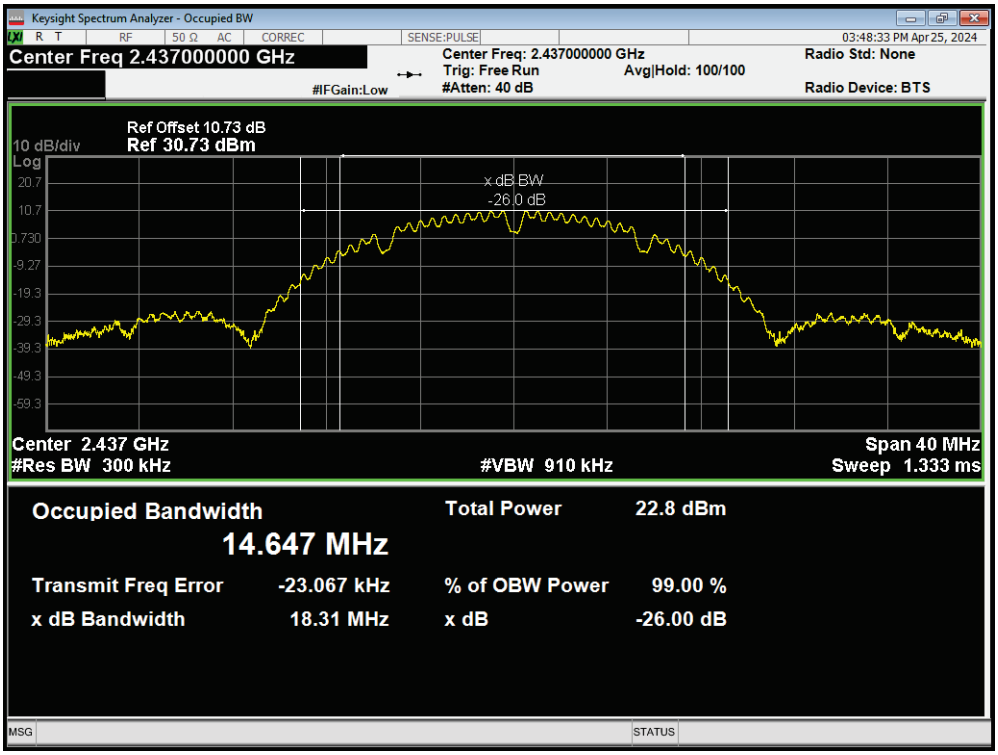
Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11b	2412	14.785	9.593	500	PASS
	2437	14.647	9.970	500	PASS
	2462	14.670	10.049	500	PASS
802.11g	2412	16.677	14.012	500	PASS
	2417	16.730	10.741	500	PASS
	2422	16.400	13.794	500	PASS
	2437	16.526	13.745	500	PASS
	2452	16.429	13.148	500	PASS
	2457	16.718	15.039	500	PASS
	2462	16.594	13.830	500	PASS
802.11n HT20	2412	17.717	14.216	500	PASS
	2417	17.789	13.831	500	PASS
	2422	17.519	15.050	500	PASS
	2437	17.601	15.105	500	PASS
	2452	17.538	15.912	500	PASS
	2457	17.755	13.958	500	PASS
	2462	17.658	12.952	500	PASS
802.11n HT40	2422	35.883	32.508	500	PASS
	2427	35.813	33.827	500	PASS
	2432	35.895	28.846	500	PASS
	2437	35.866	35.076	500	PASS
	2442	36.004	33.737	500	PASS
	2447	35.942	35.100	500	PASS
	2452	36.037	35.034	500	PASS

99%bandwidth

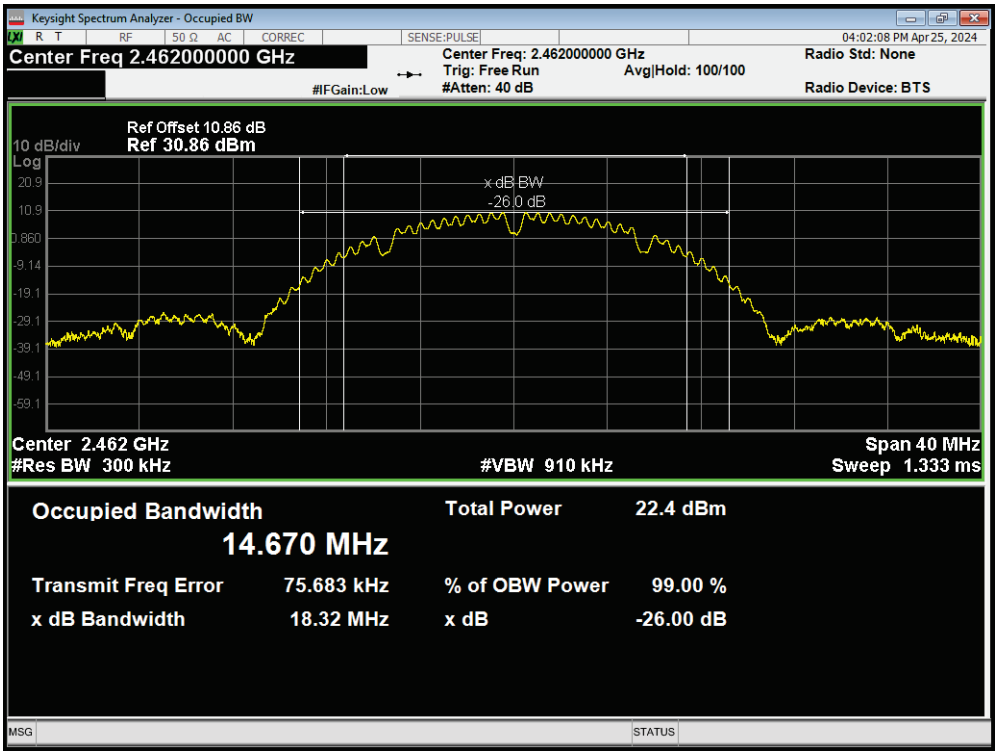
OBW 802.11b 2412MHz



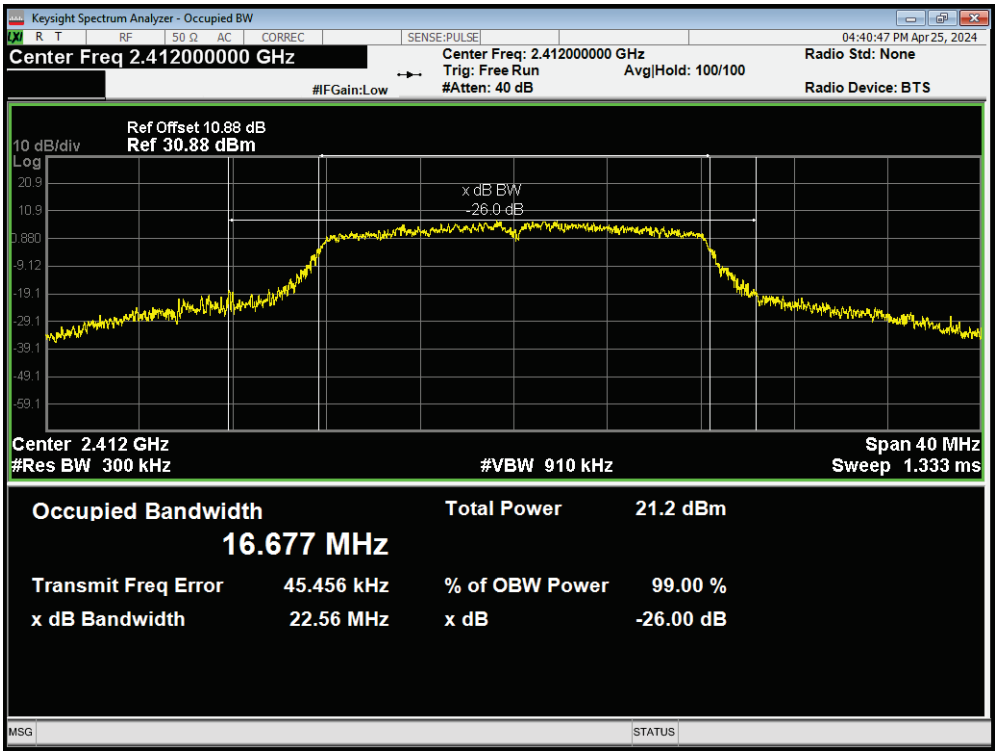
OBW 802.11b 2437MHz



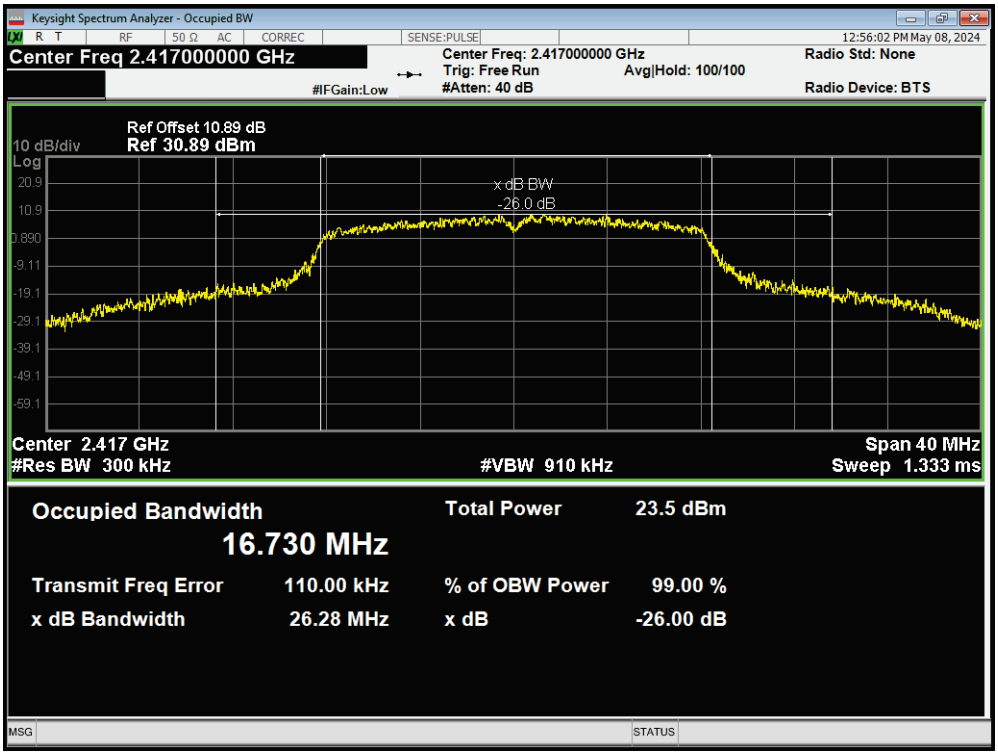
OBW 802.11b 2462MHz



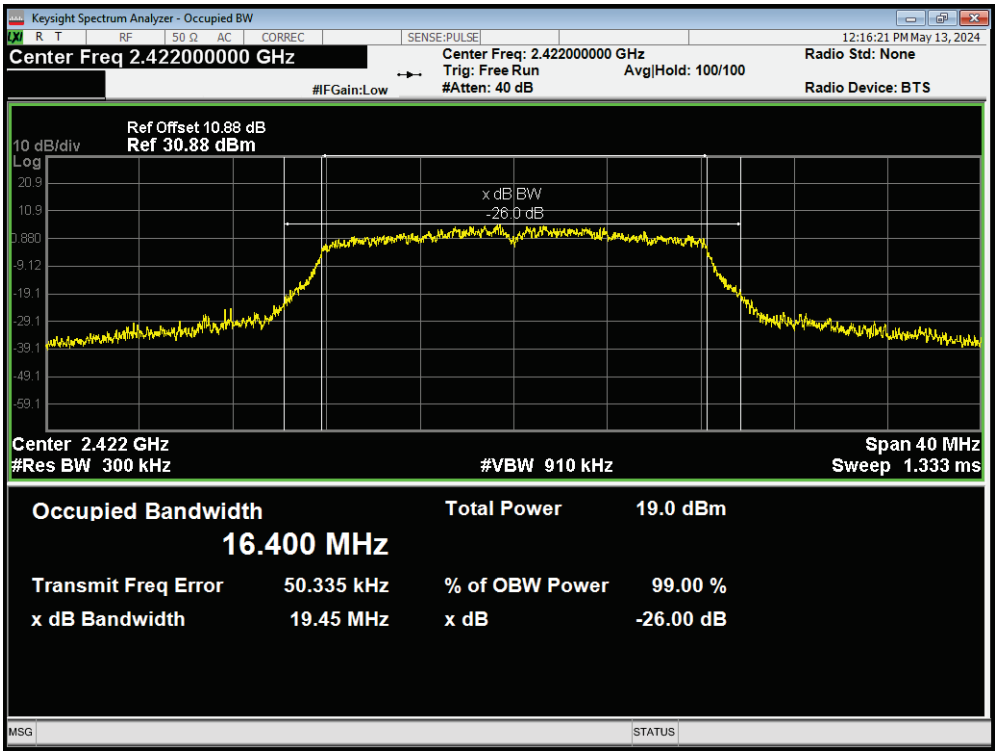
OBW 802.11g 2412MHz



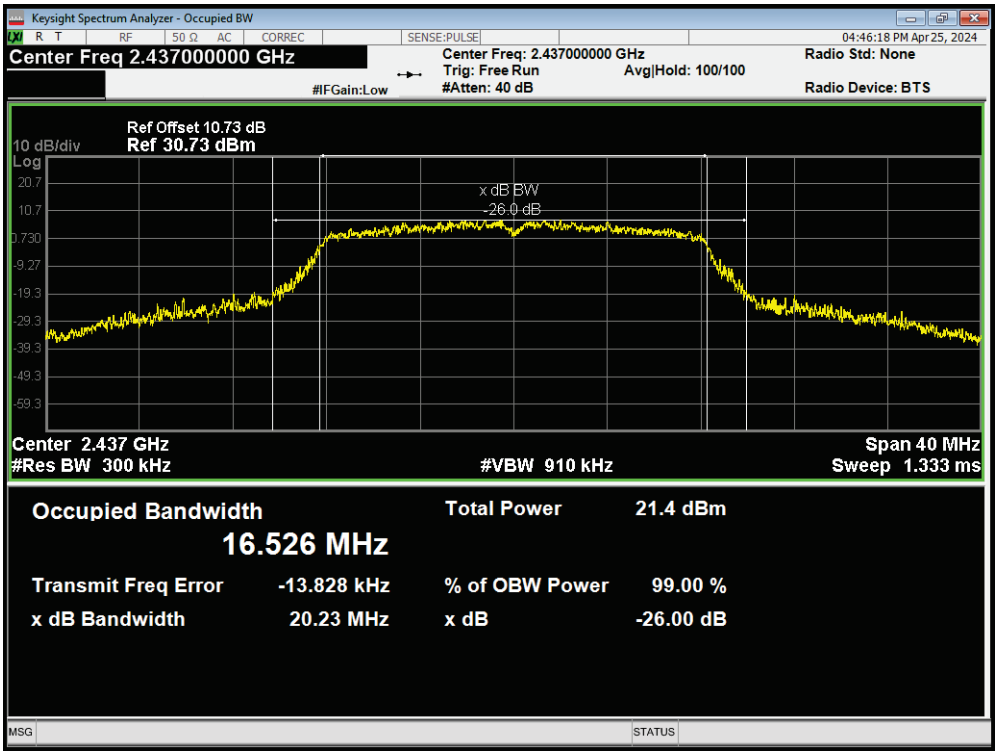
OBW 802.11g 2417MHz



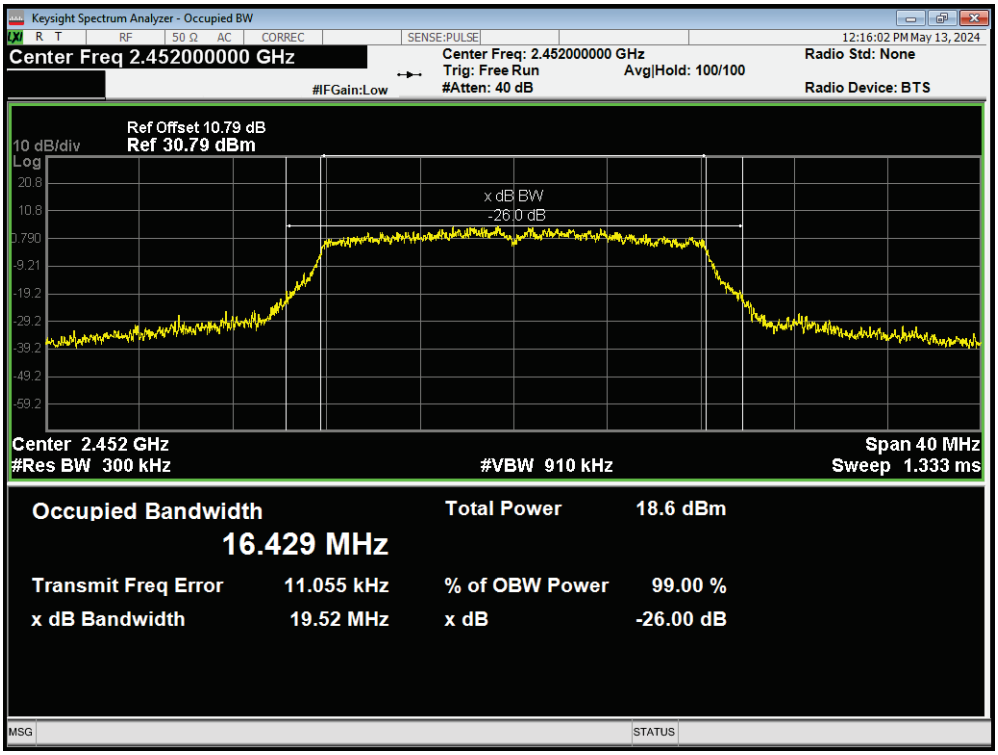
OBW 802.11g 2422MHz



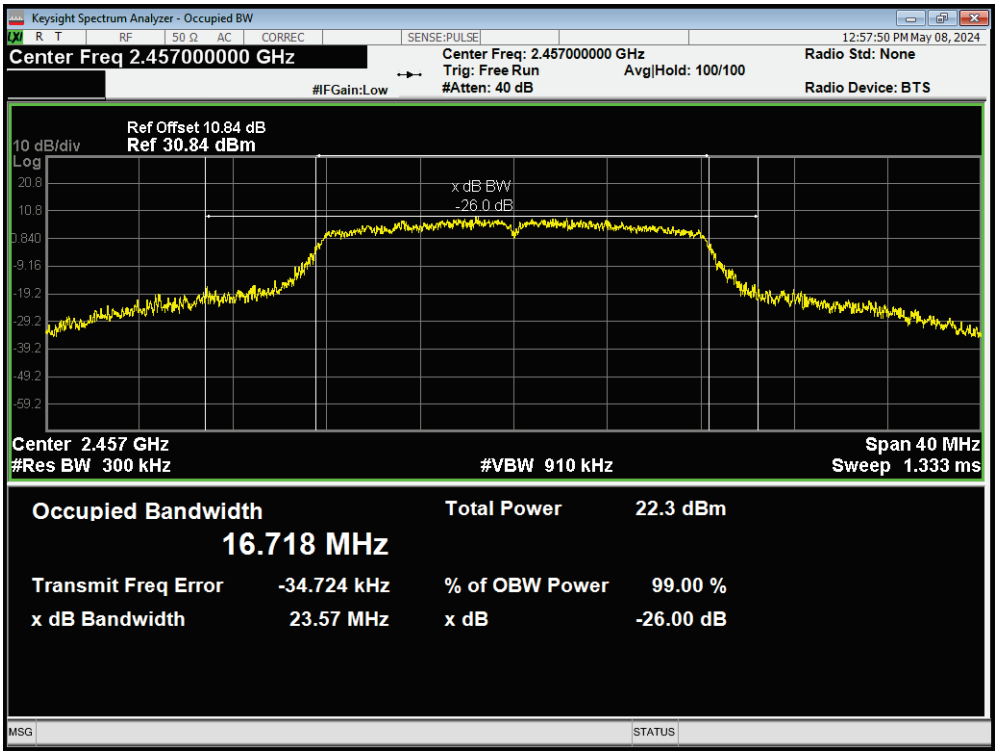
OBW 802.11g 2437MHz



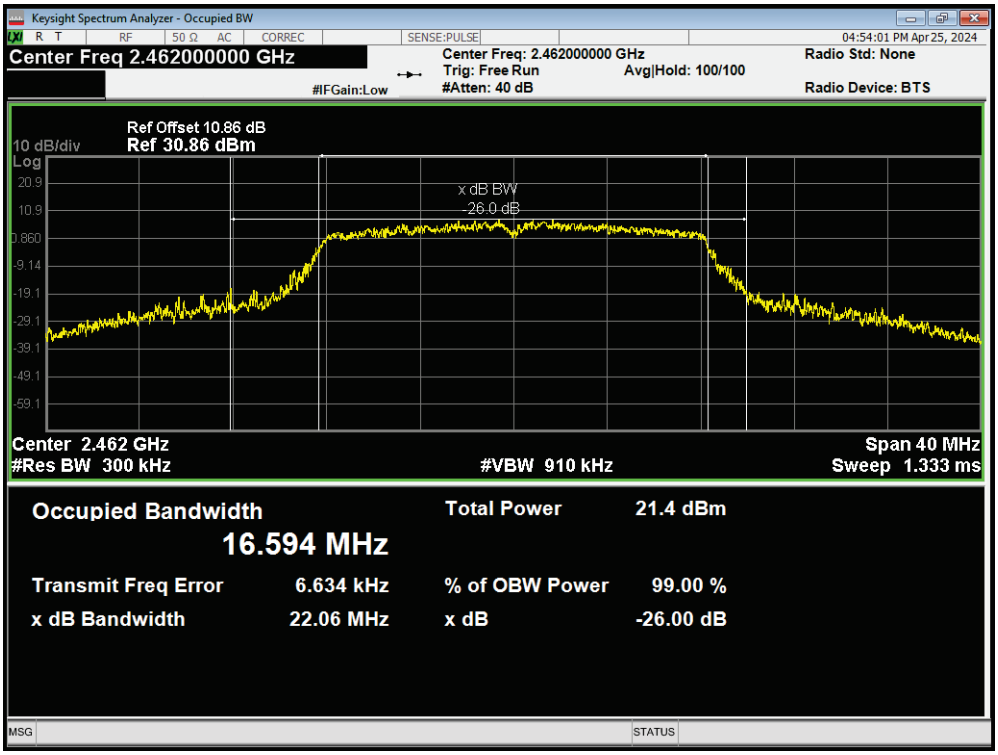
OBW 802.11g 2452MHz



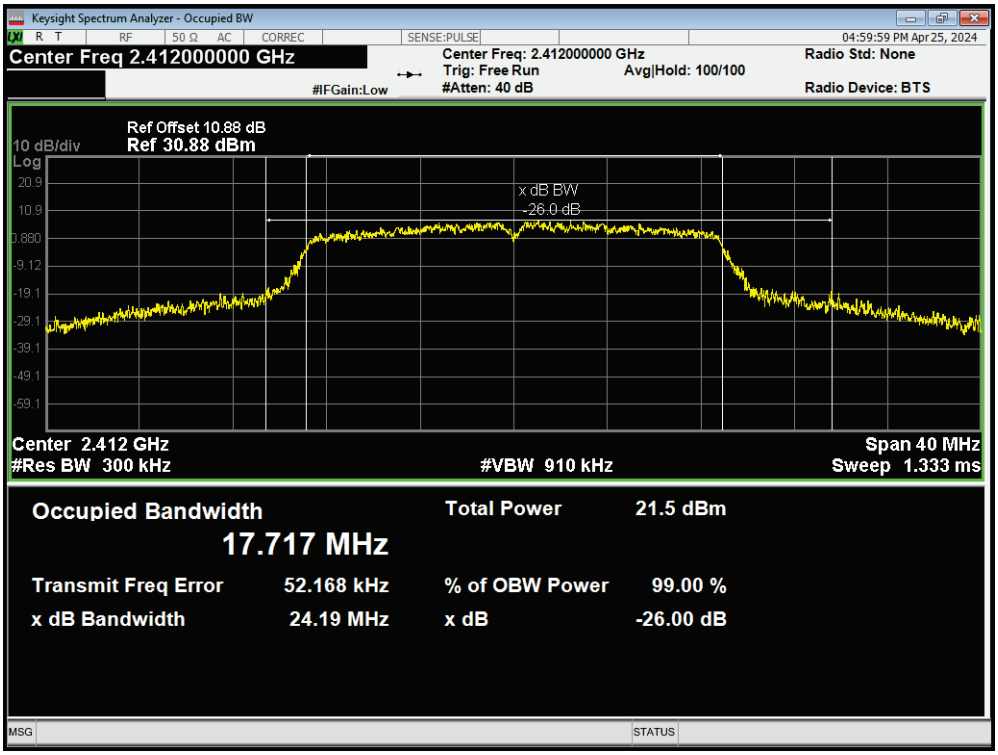
OBW 802.11g 2457MHz



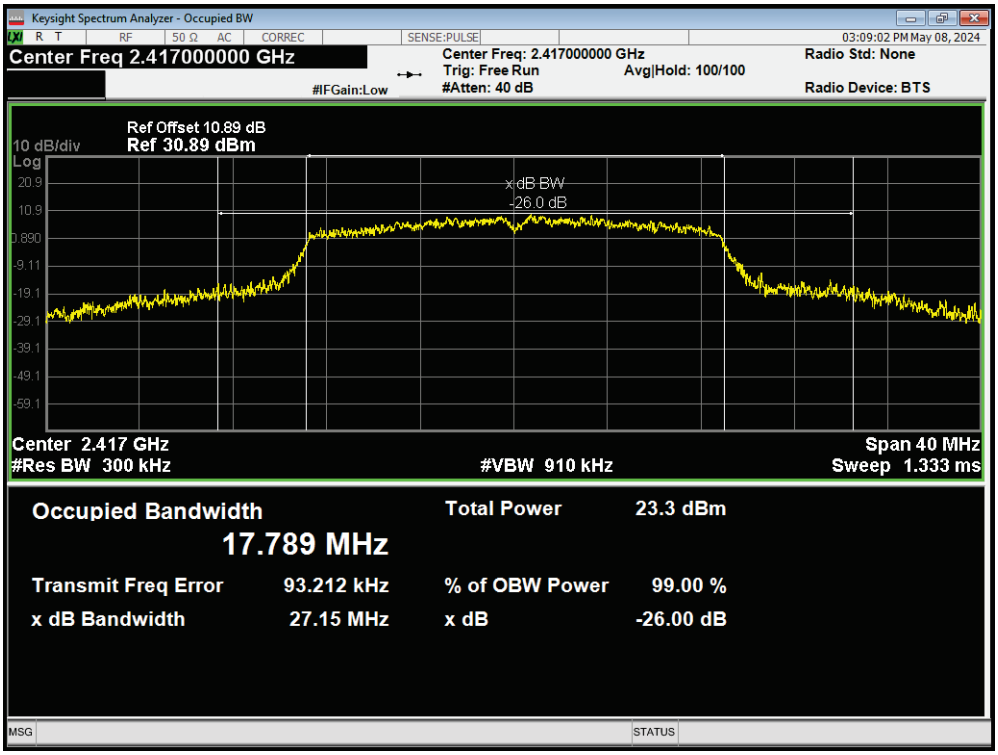
OBW 802.11g 2462MHz



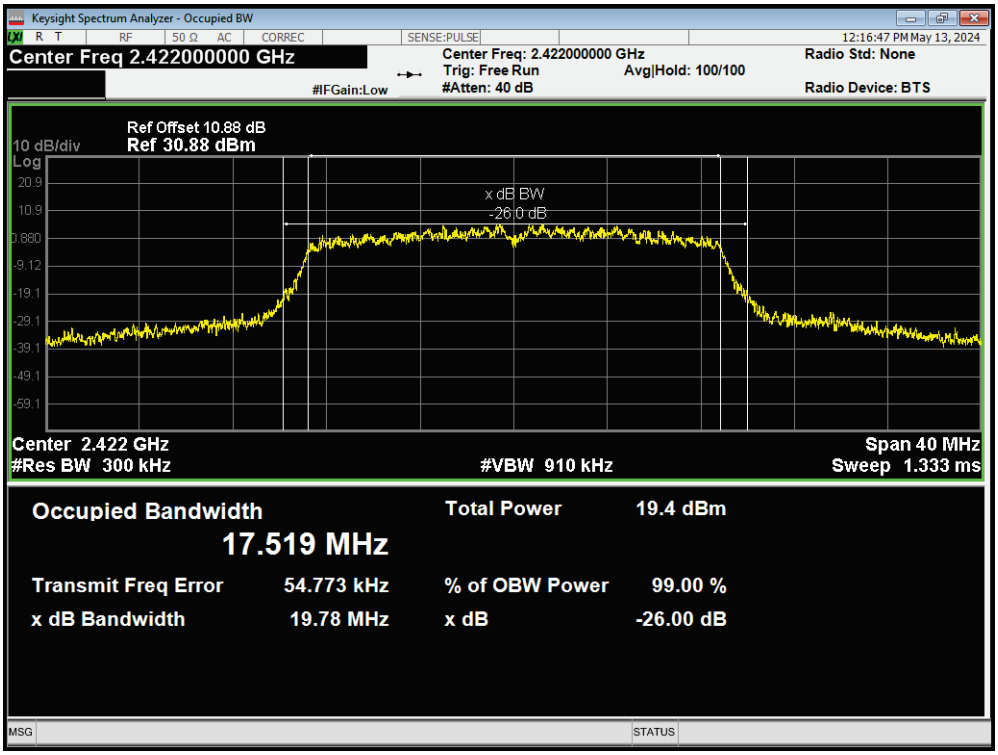
OBW 802.11n(HT20) 2412MHz



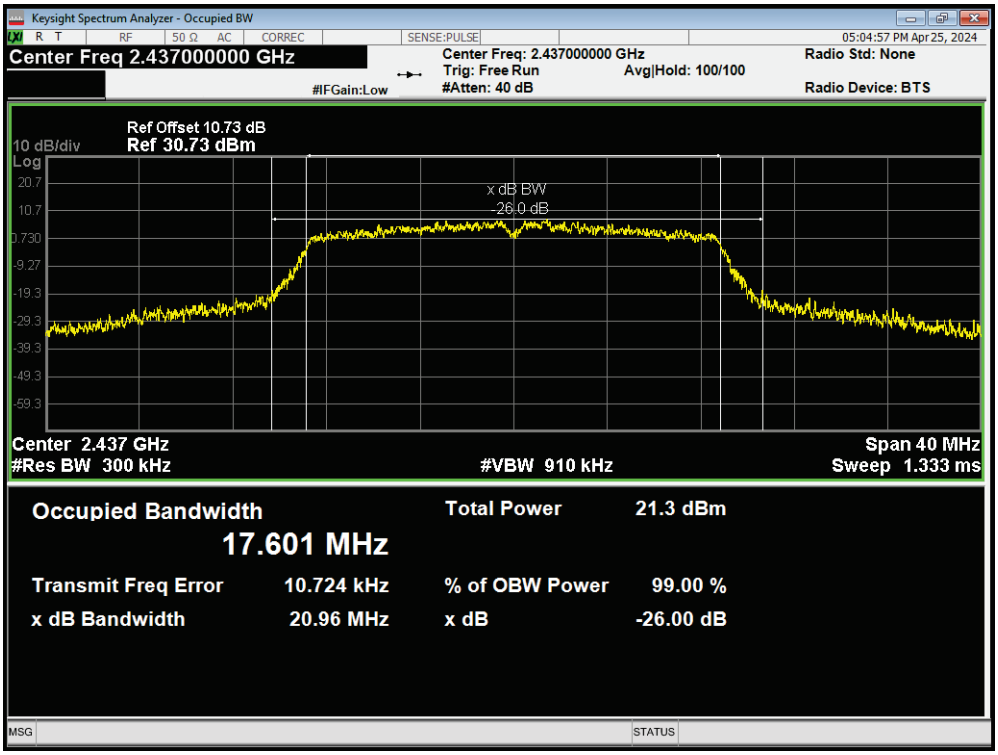
OBW 802.11n(HT20) 2417MHz



OBW 802.11n(HT20) 2422MHz



OBW 802.11n(HT20) 2437MHz



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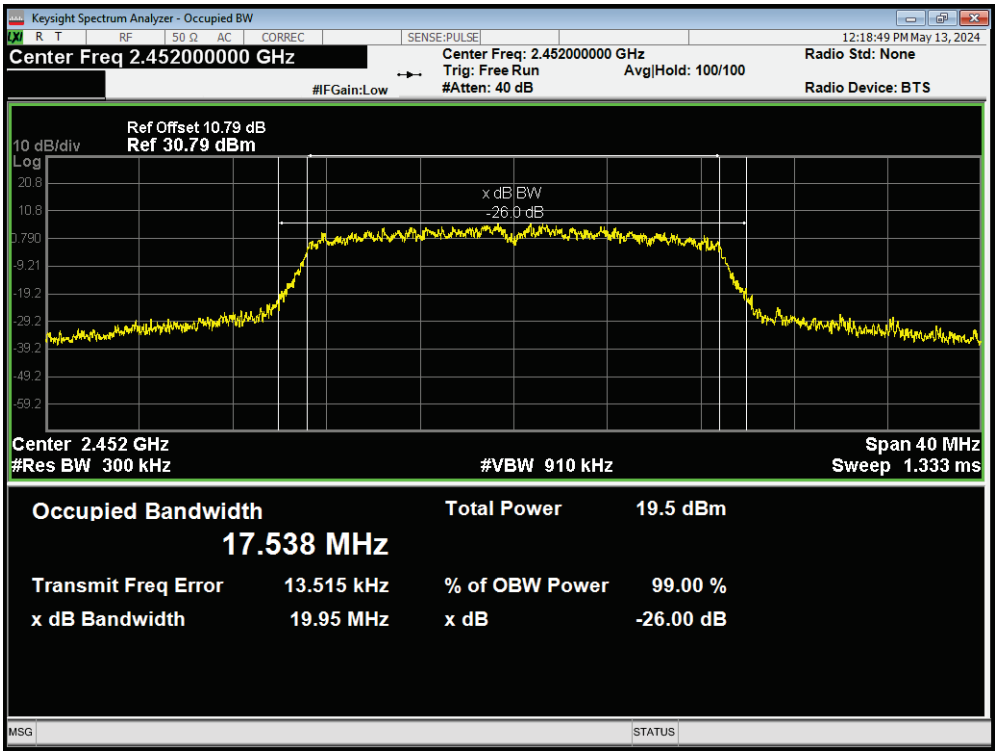
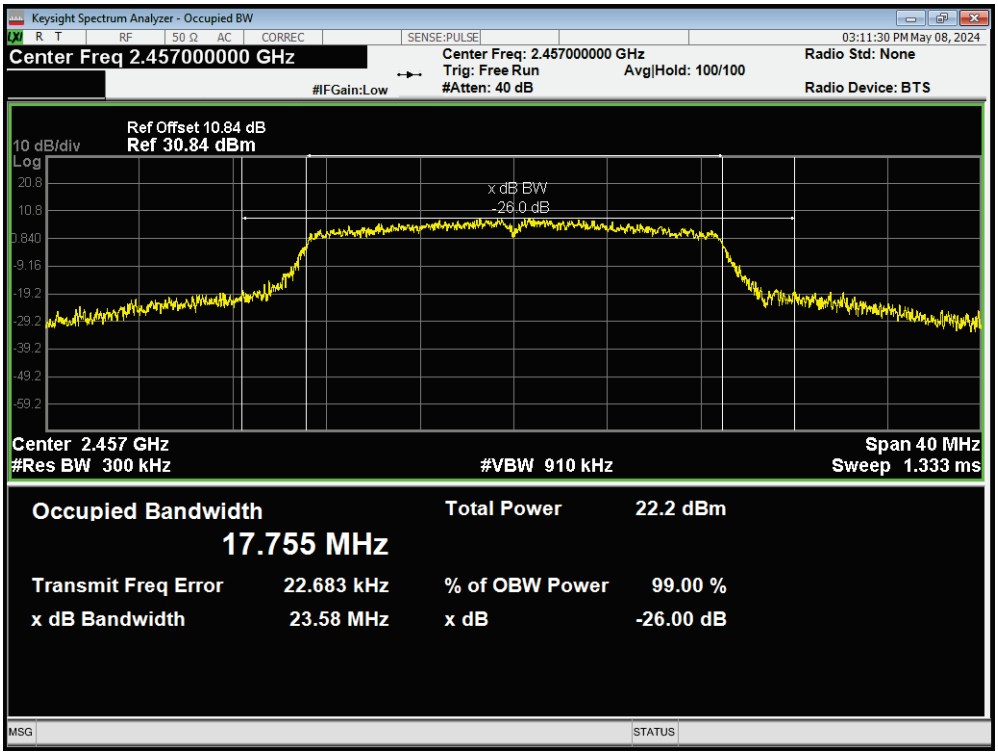
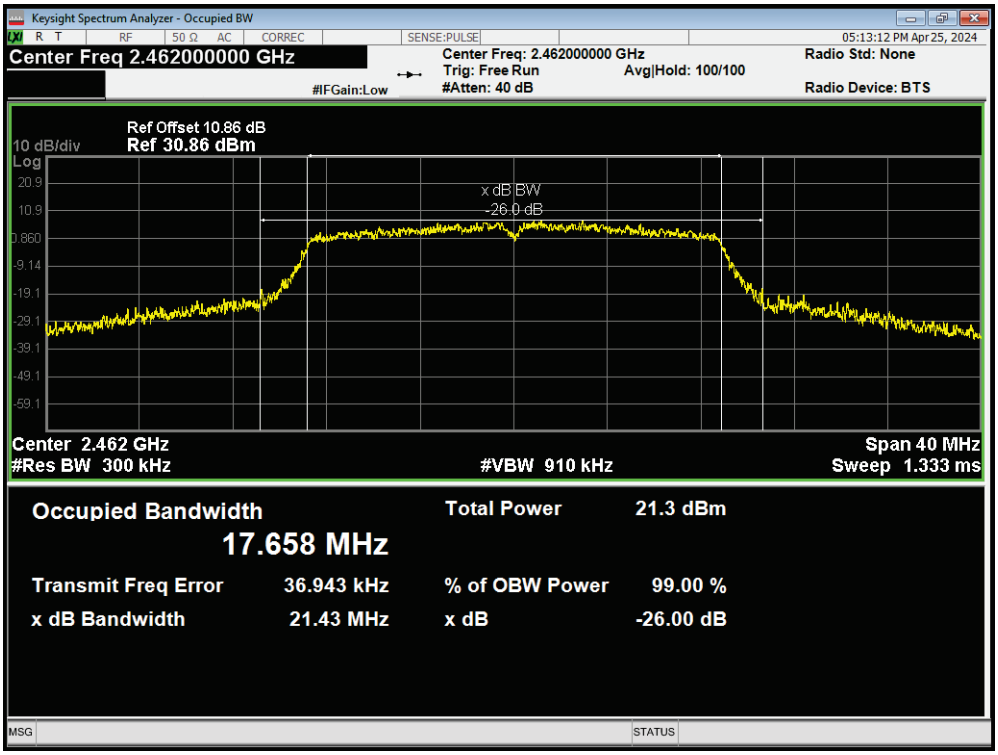


OBW 802.11n(HT20) 2457MHz



OBW 802.11n(HT20) 2462MHz



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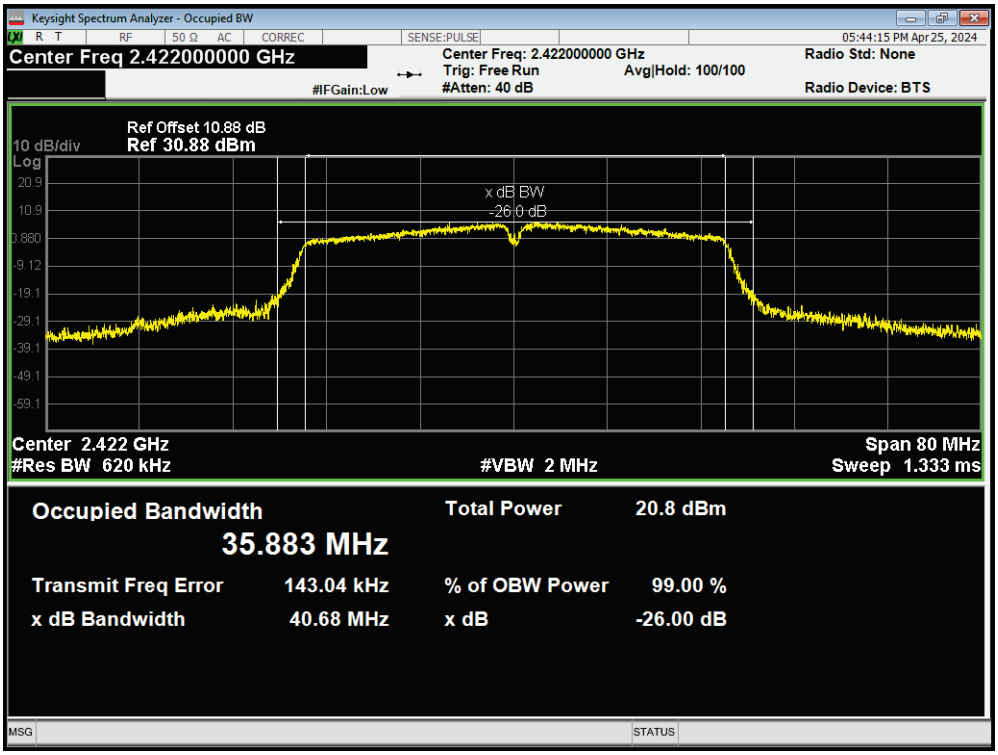

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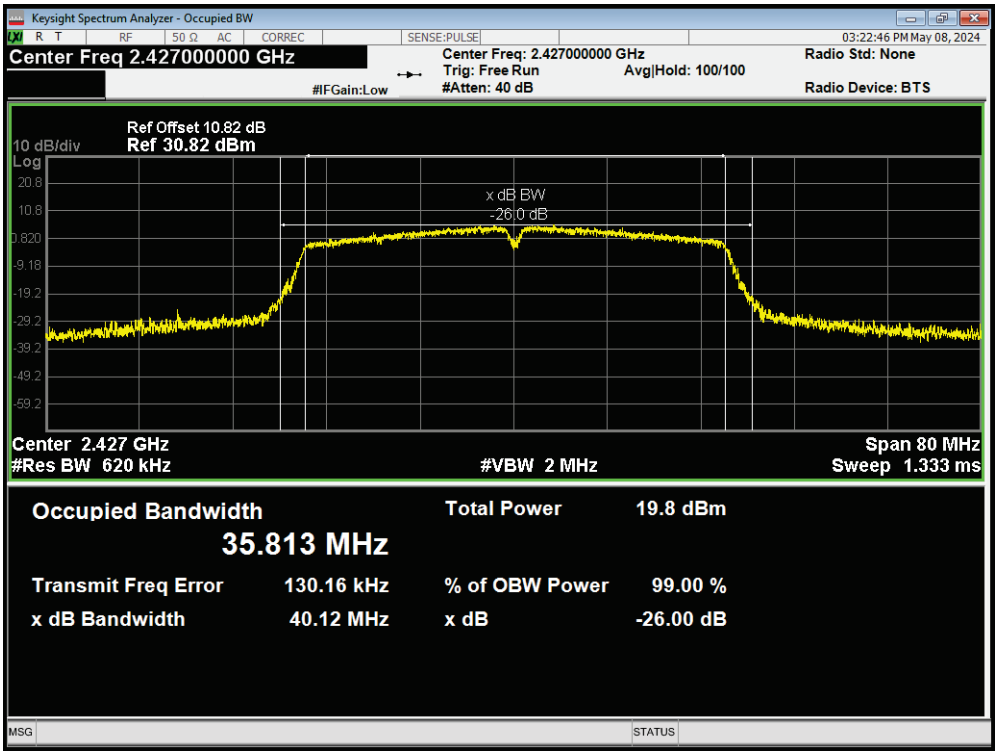

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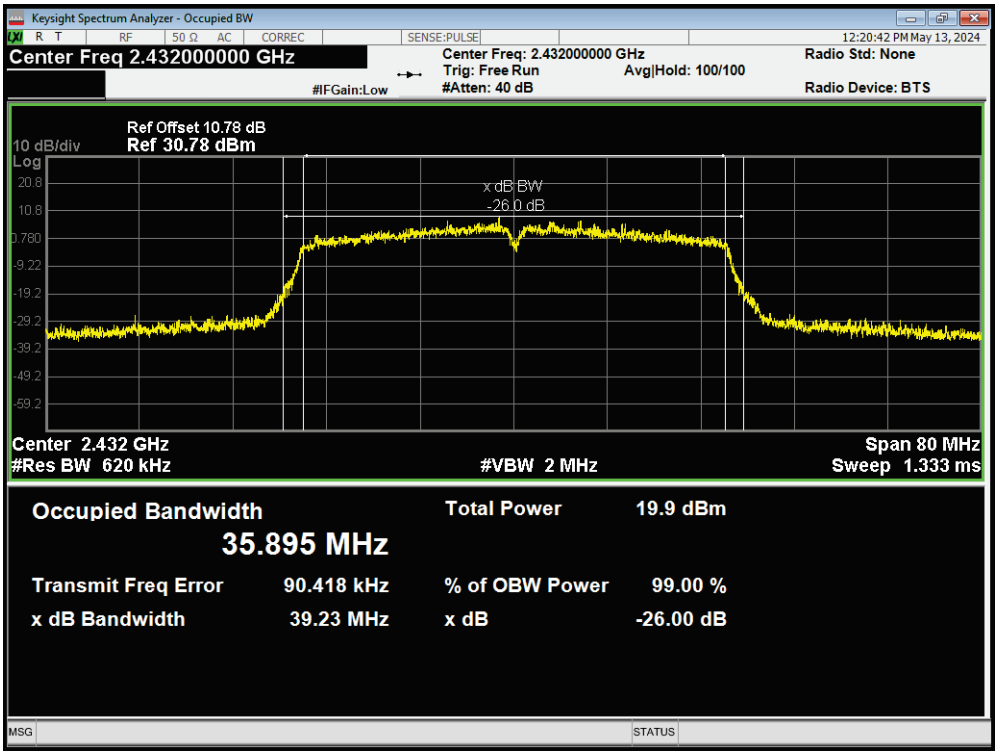

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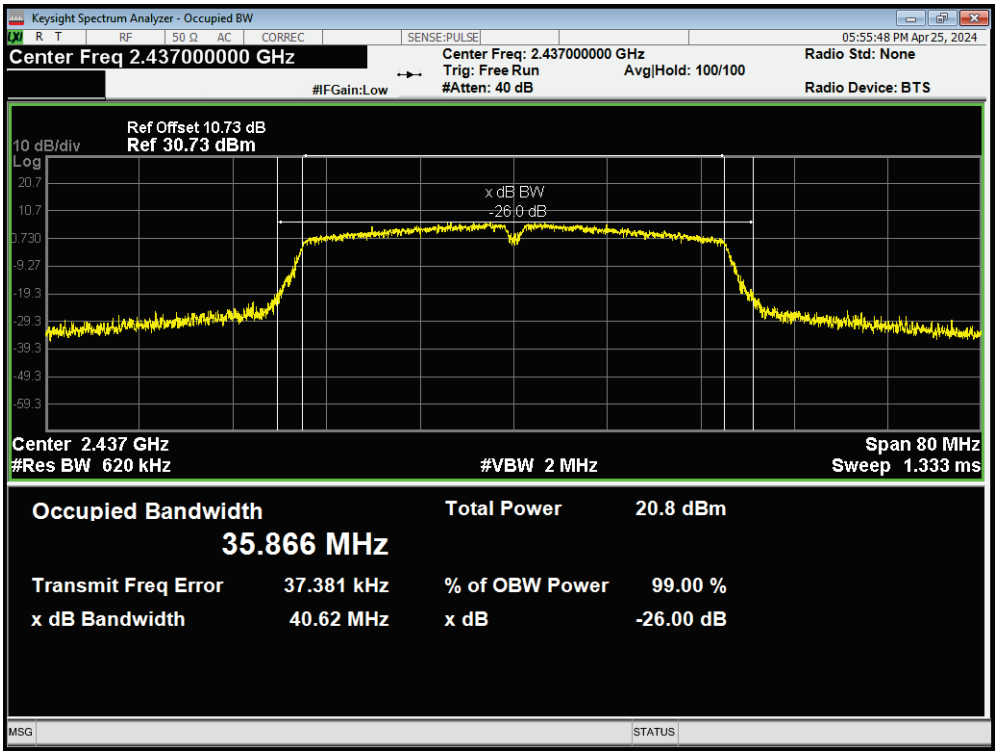

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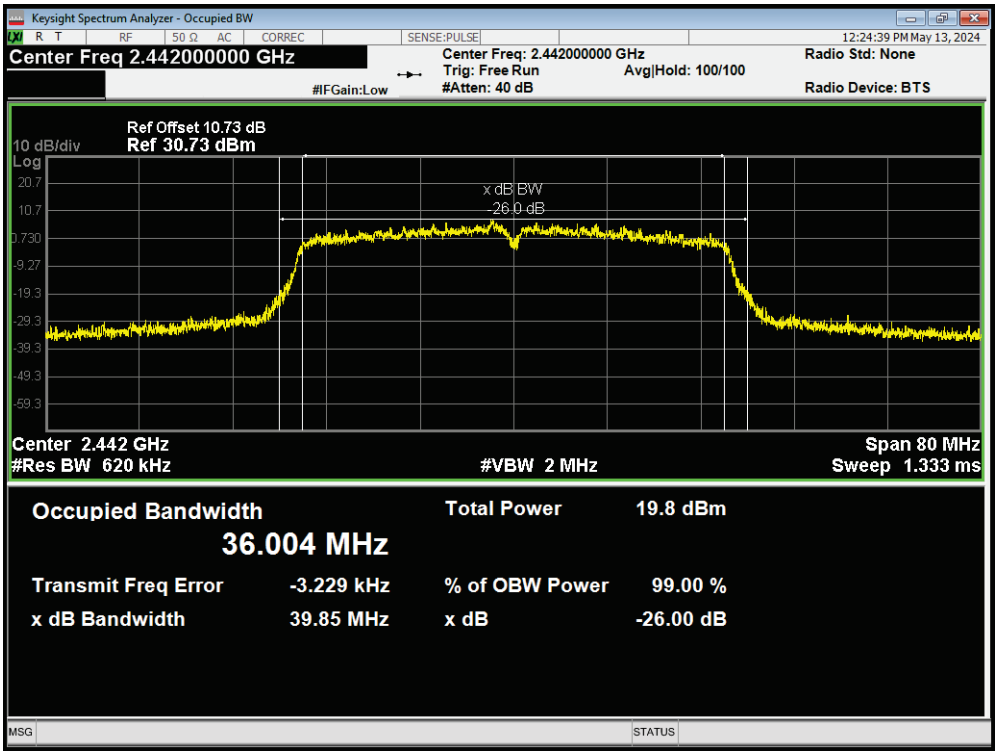

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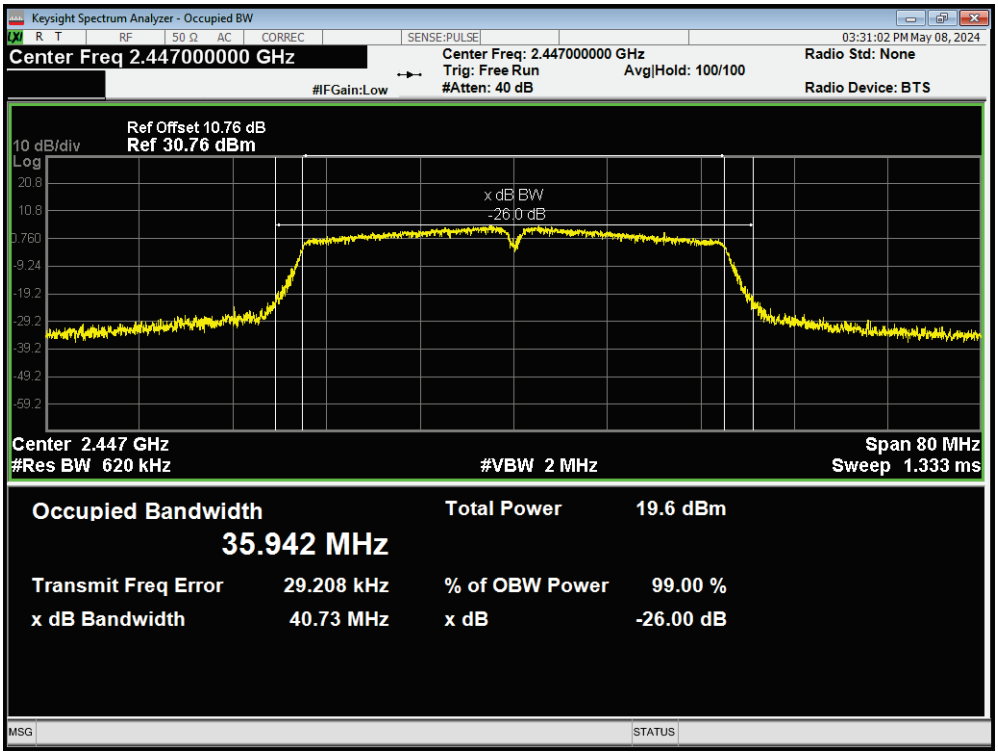
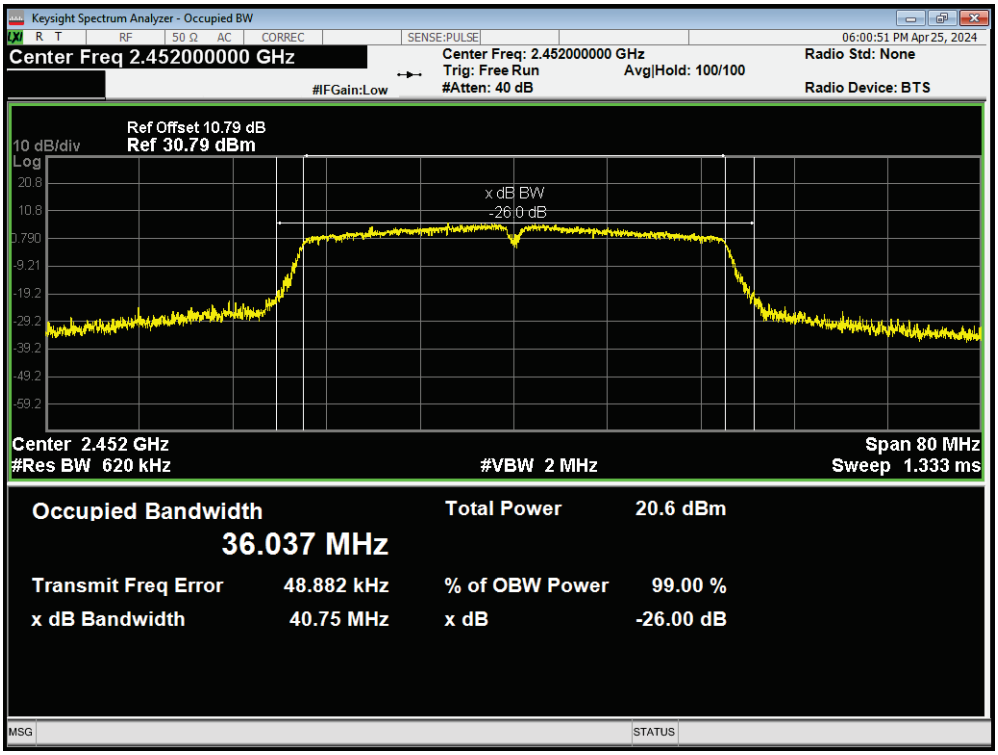
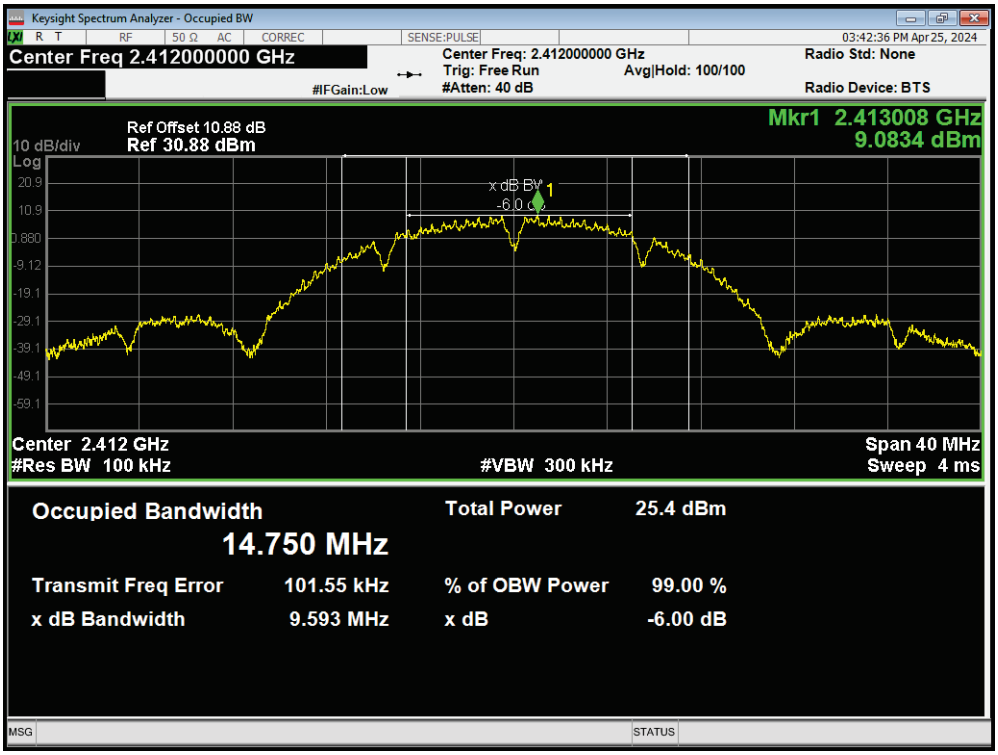


OBW 802.11n(HT40) 2452MHz

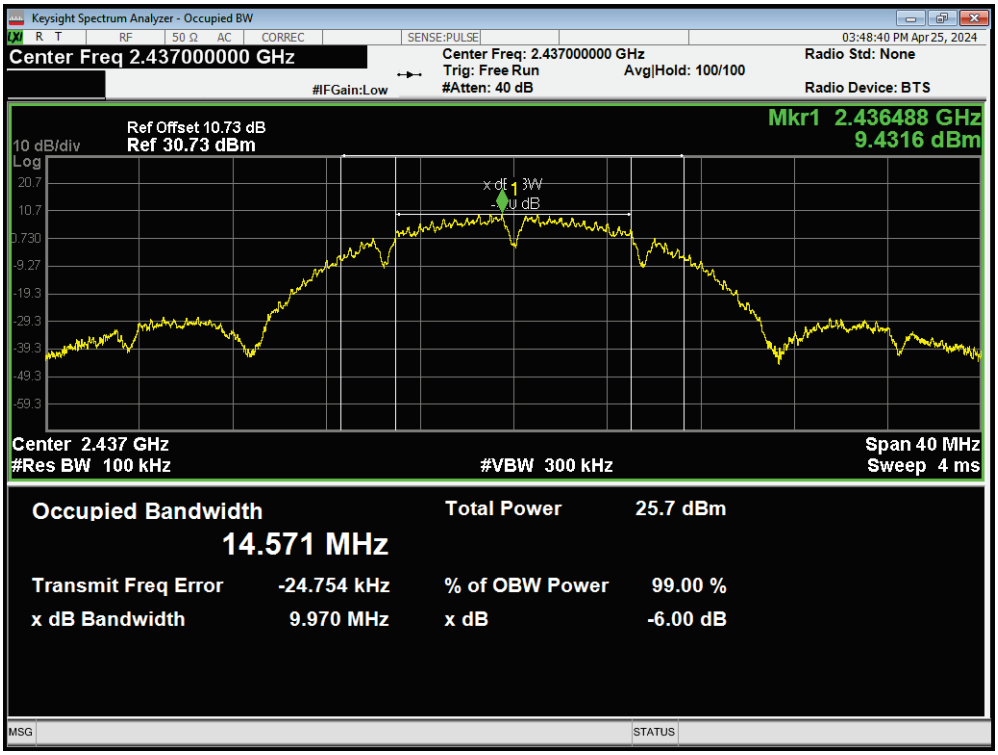


6 dB bandwidth

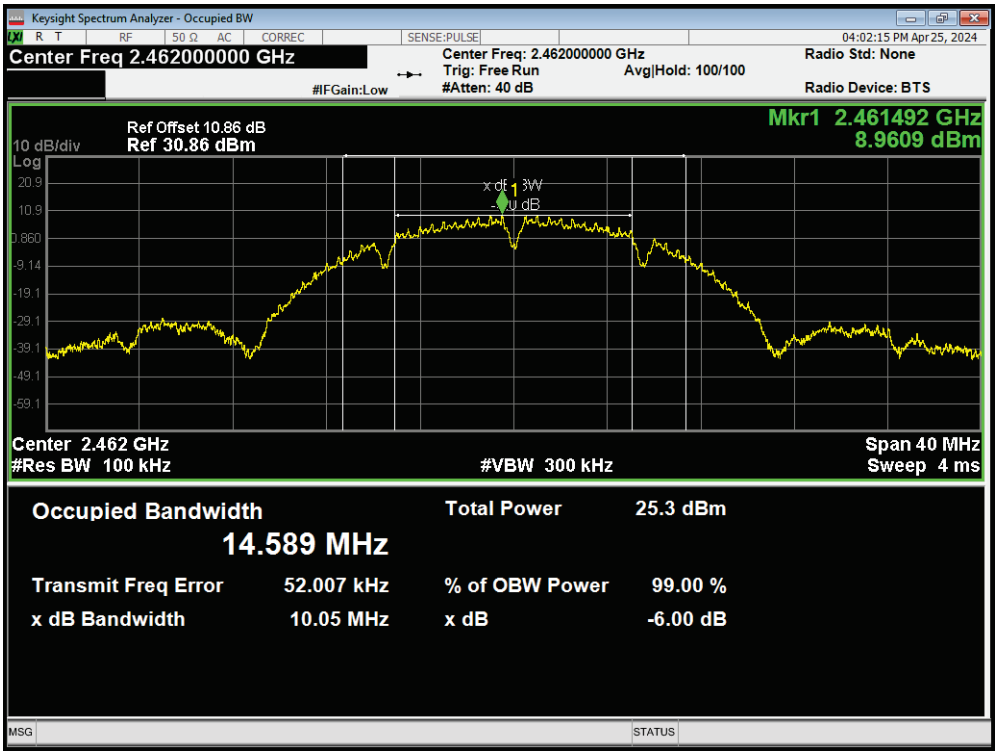
-6dB Bandwidth 802.11b 2412MHz



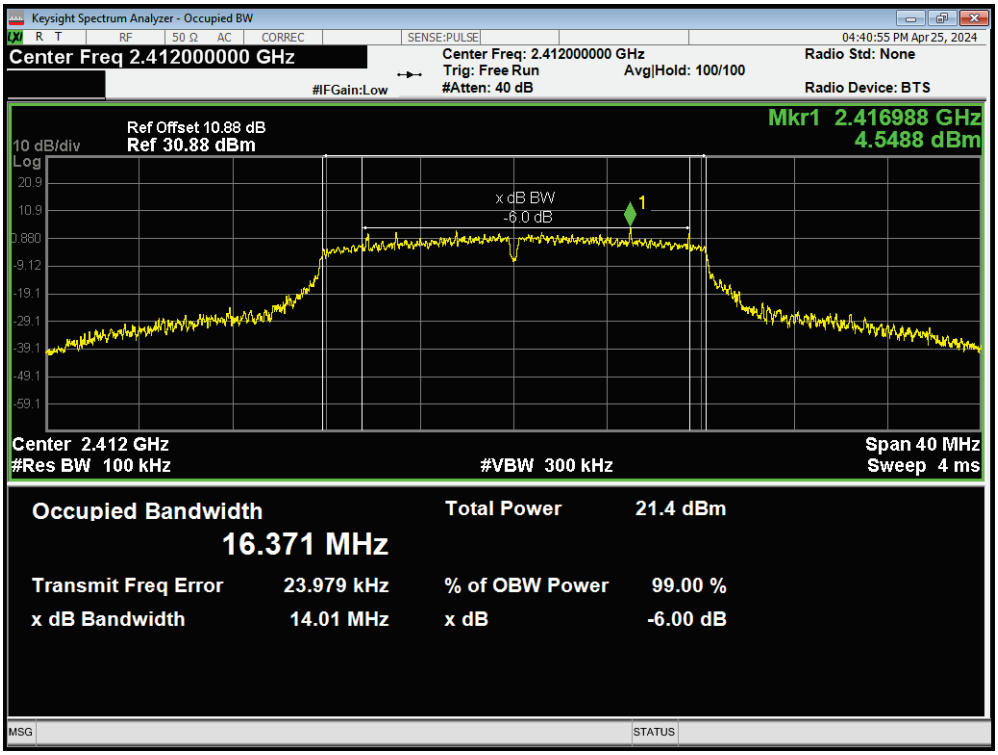
-6dB Bandwidth 802.11b 2437MHz



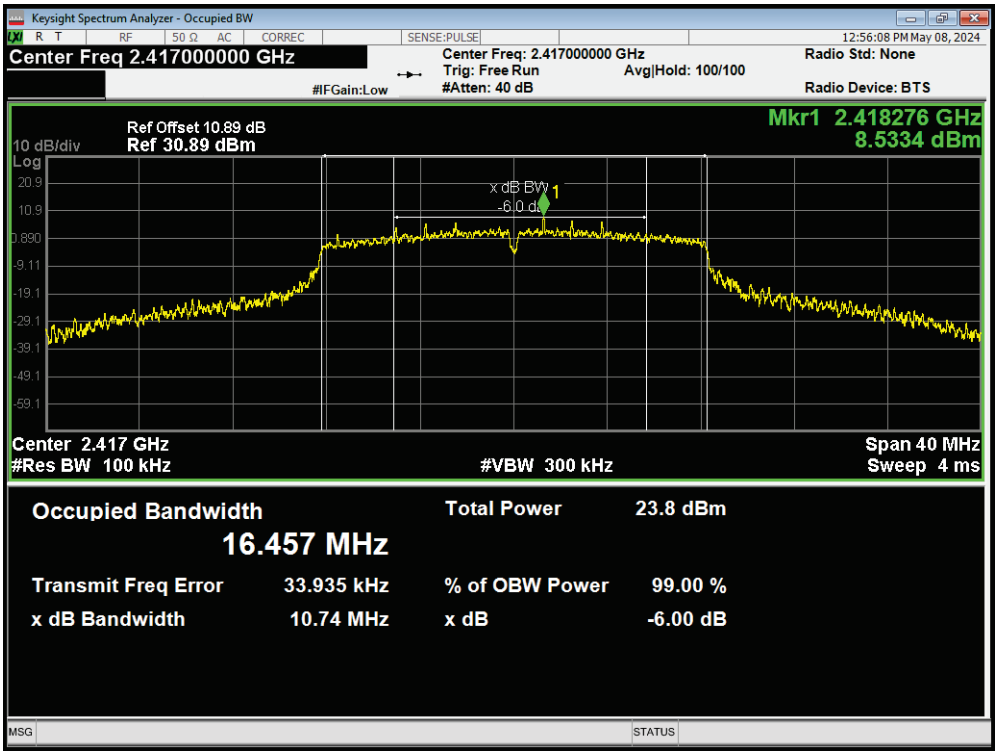
-6dB Bandwidth 802.11b 2462MHz



-6dB Bandwidth 802.11g 2412MHz



-6dB Bandwidth 802.11g 2417MHz



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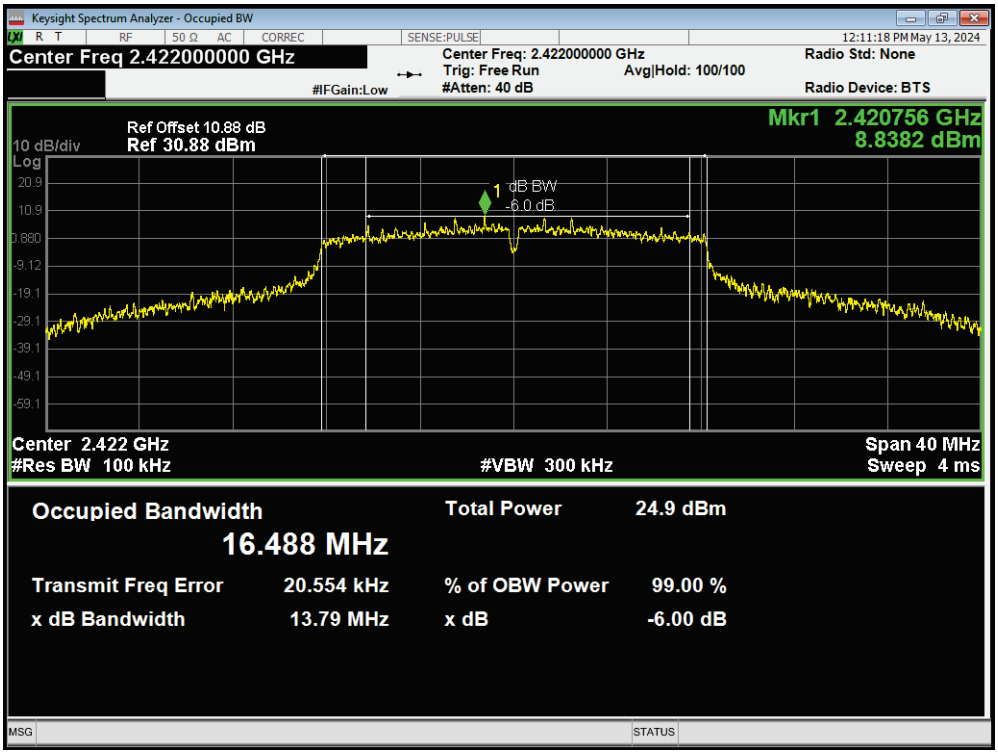

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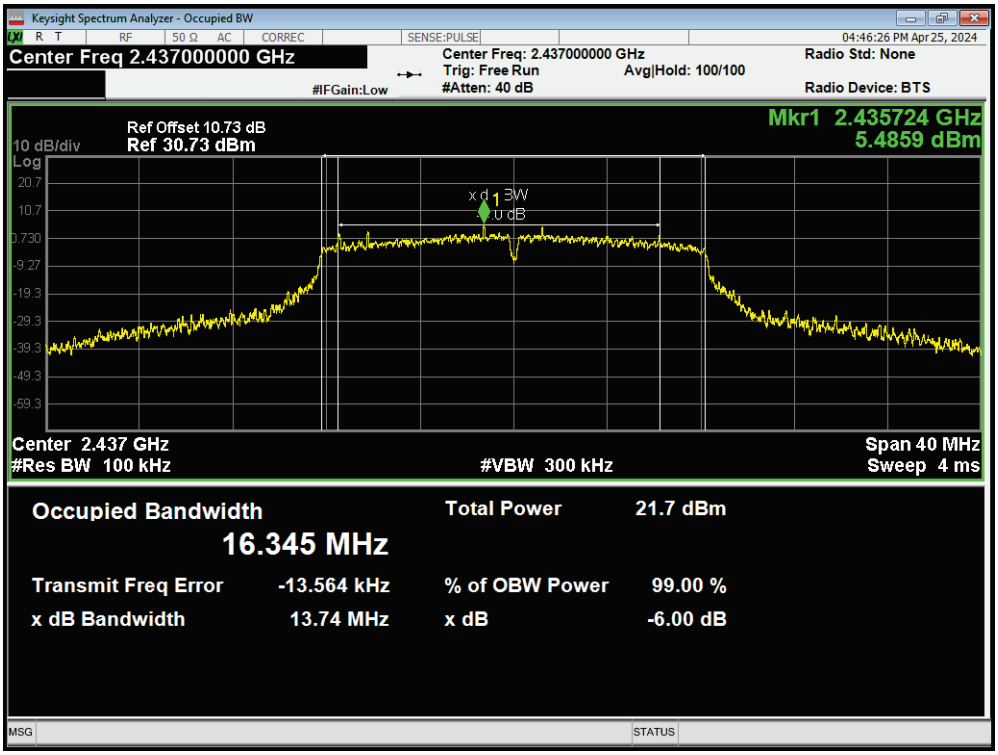
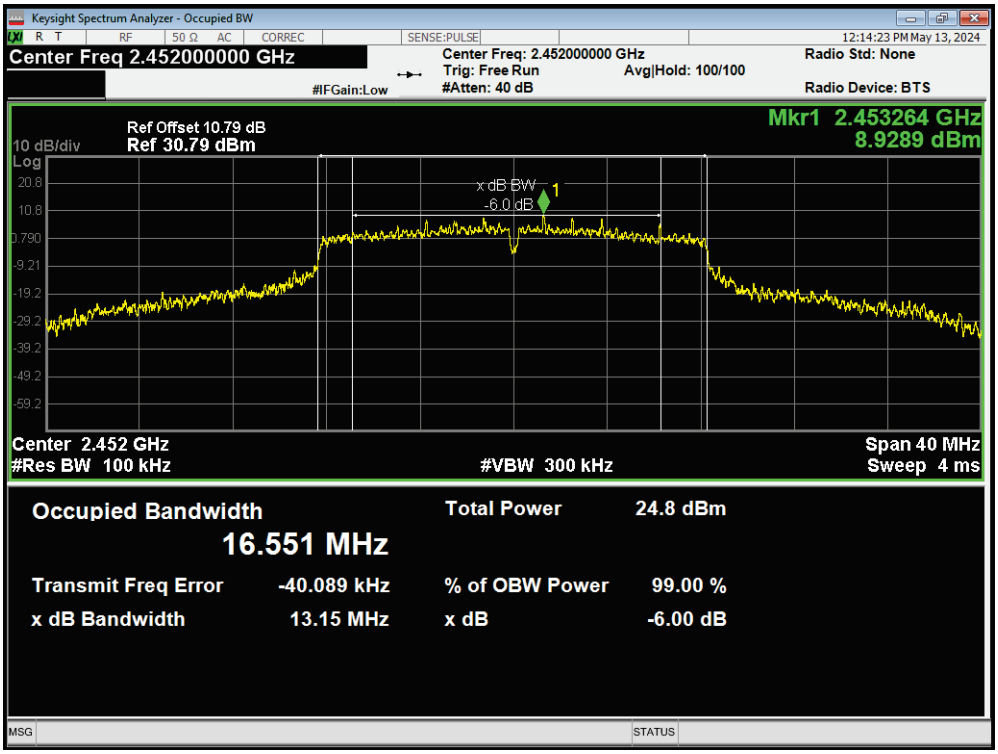
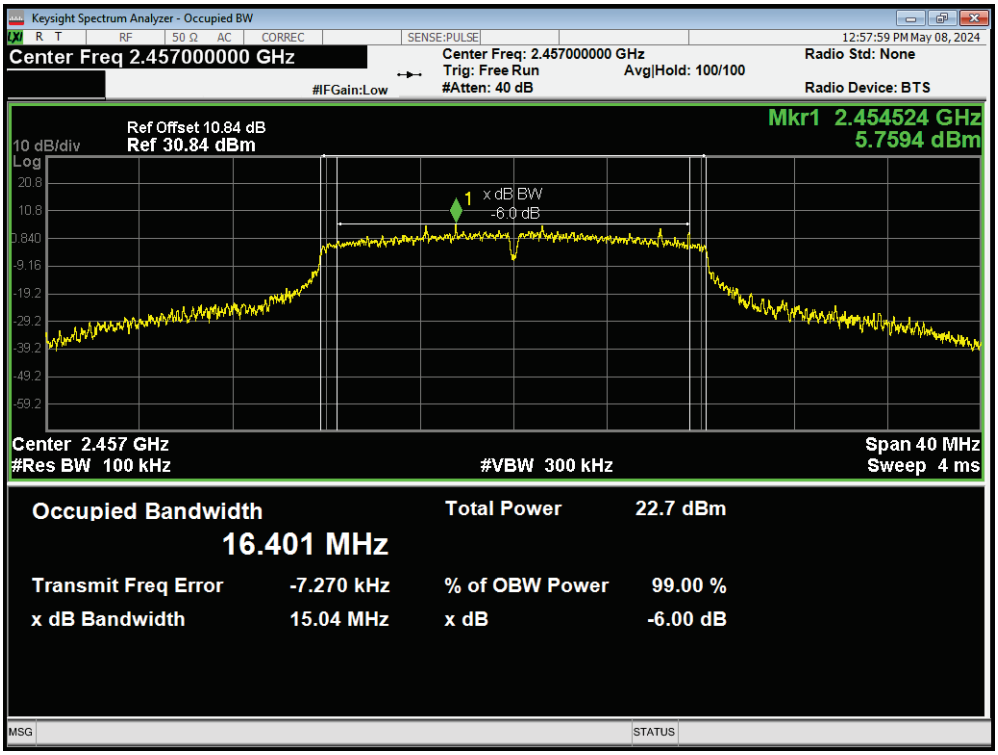


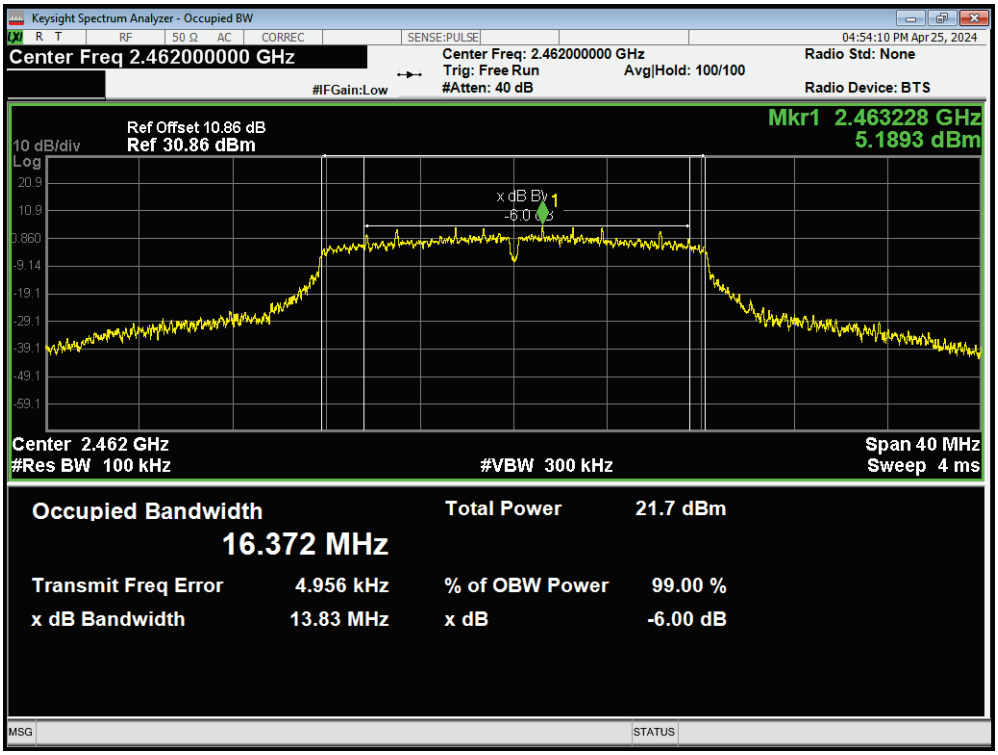
-6dB Bandwidth 802.11g 2452MHz



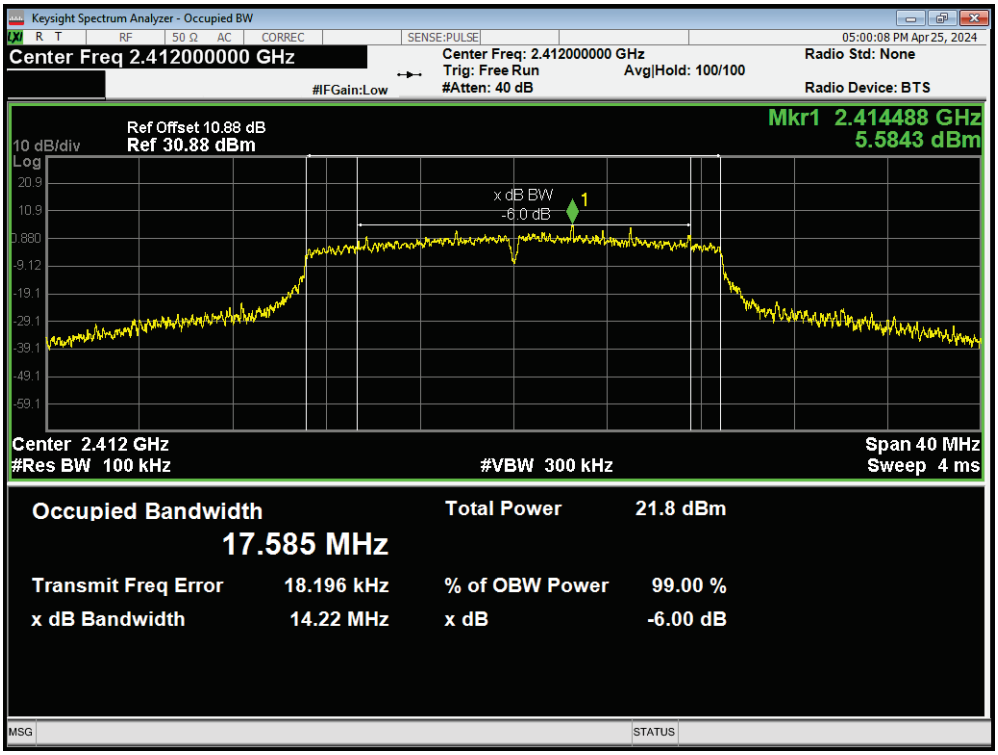
-6dB Bandwidth 802.11g 2457MHz



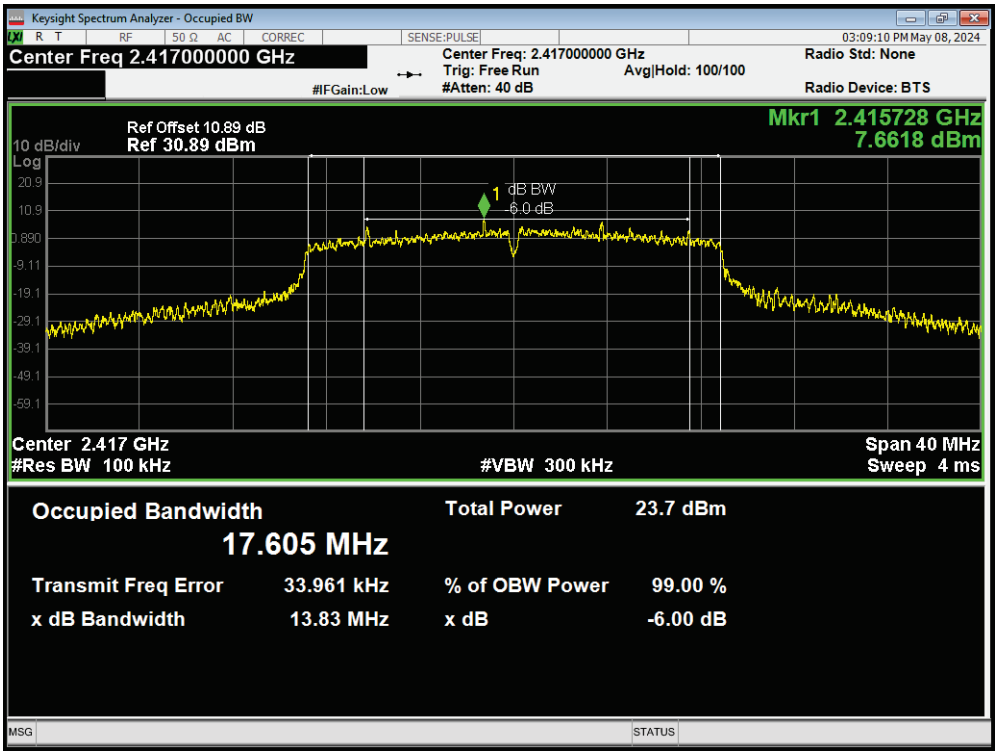
-6dB Bandwidth 802.11g 2462MHz



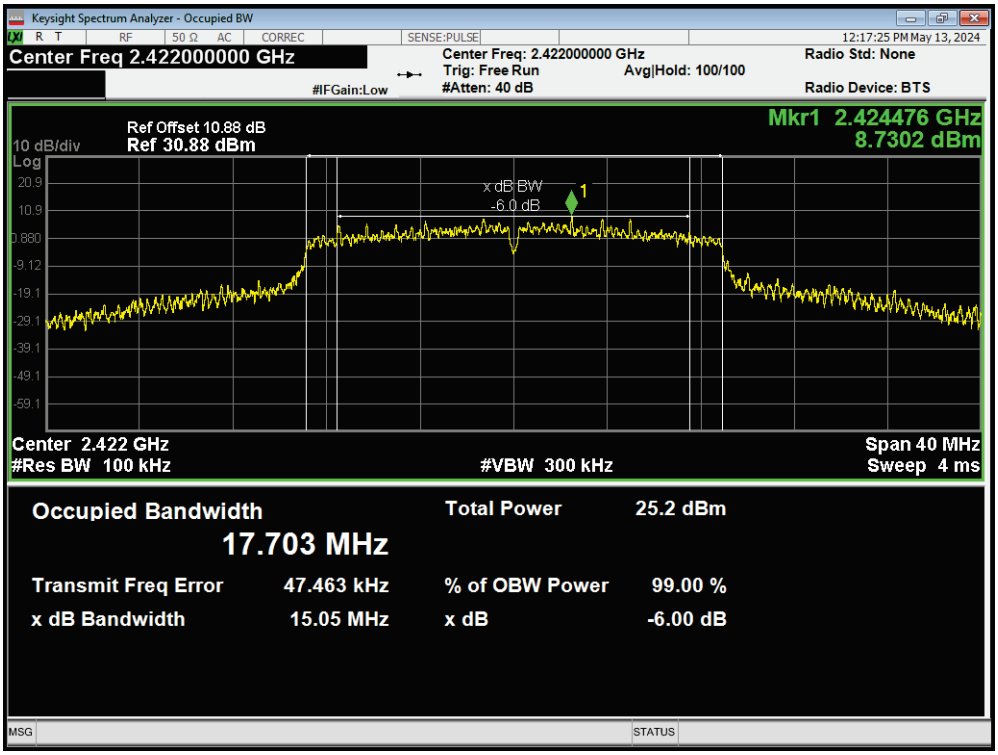
-6dB Bandwidth 802.11n(HT20) 2412MHz



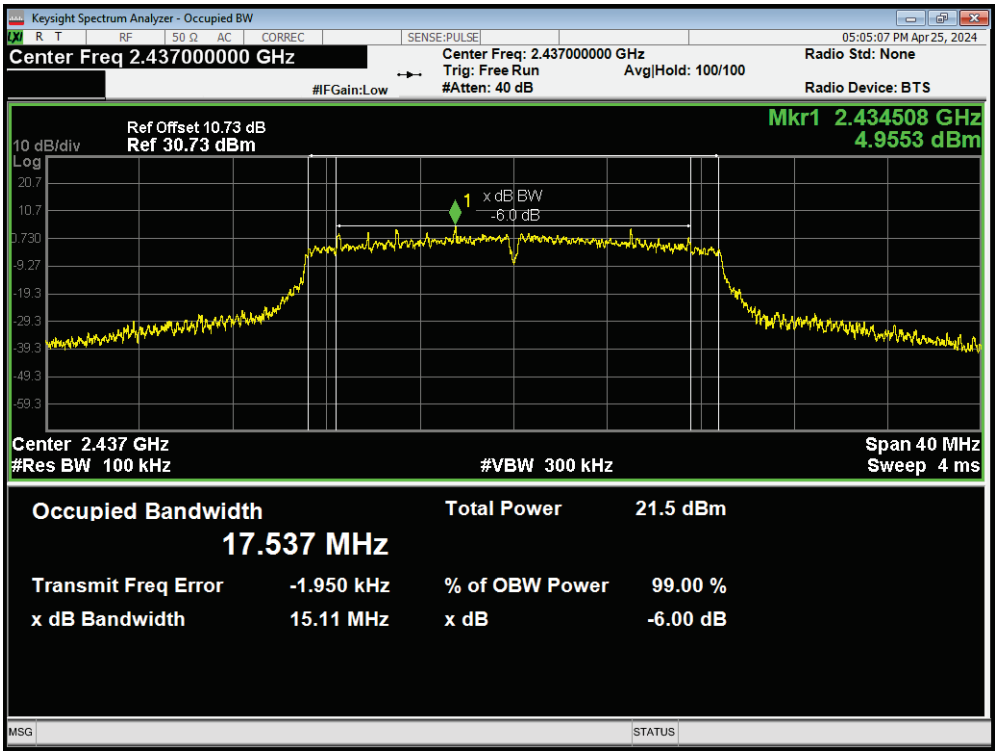
-6dB Bandwidth 802.11n(HT20) 2417MHz



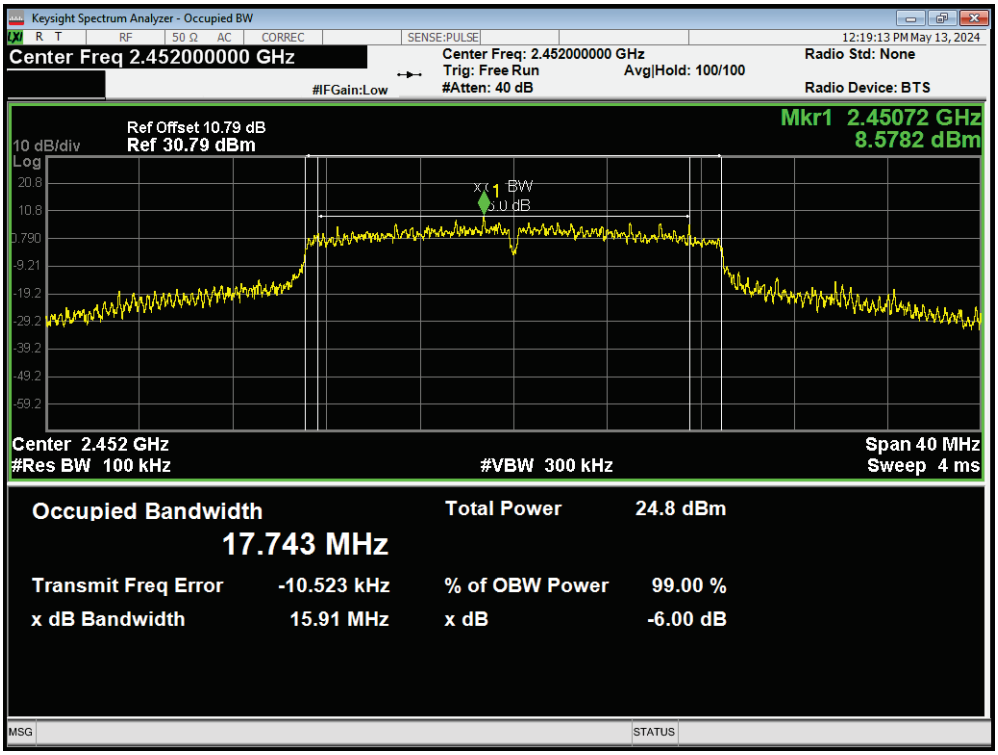
-6dB Bandwidth 802.11n(HT20) 2422MHz



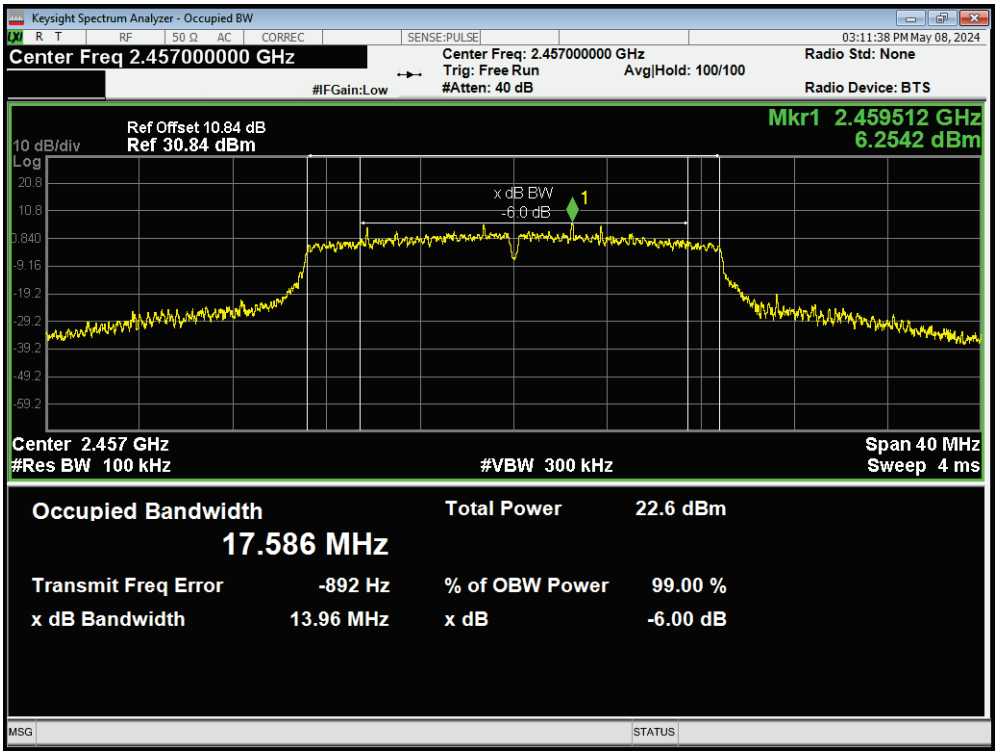
-6dB Bandwidth 802.11n(HT20) 2437MHz



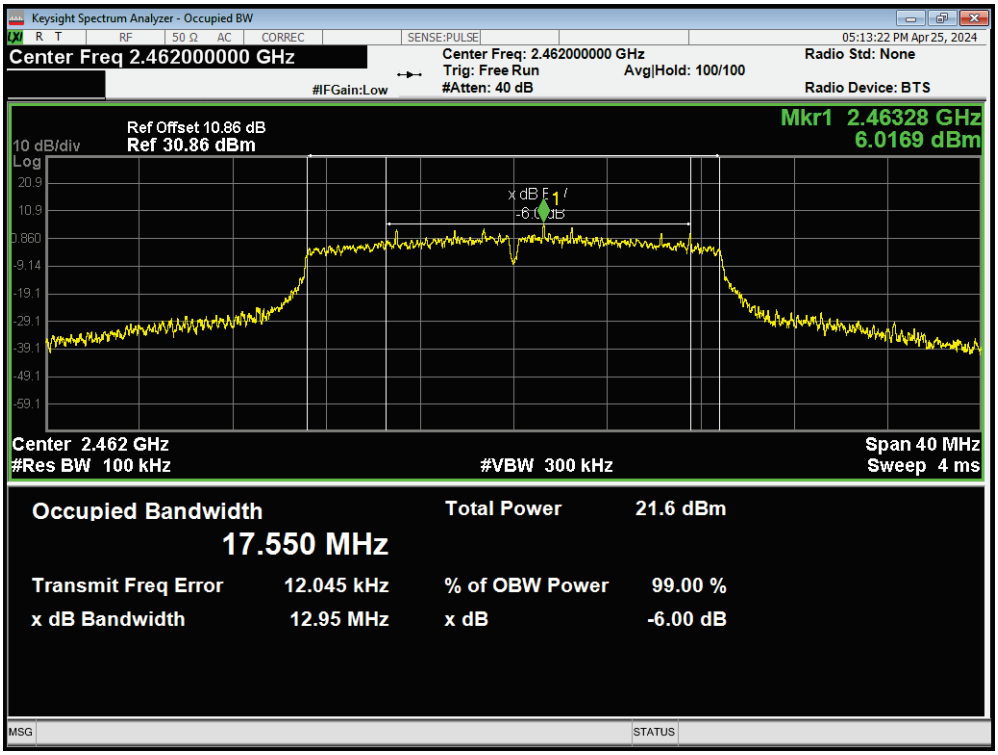
-6dB Bandwidth 802.11n(HT20) 2452MHz



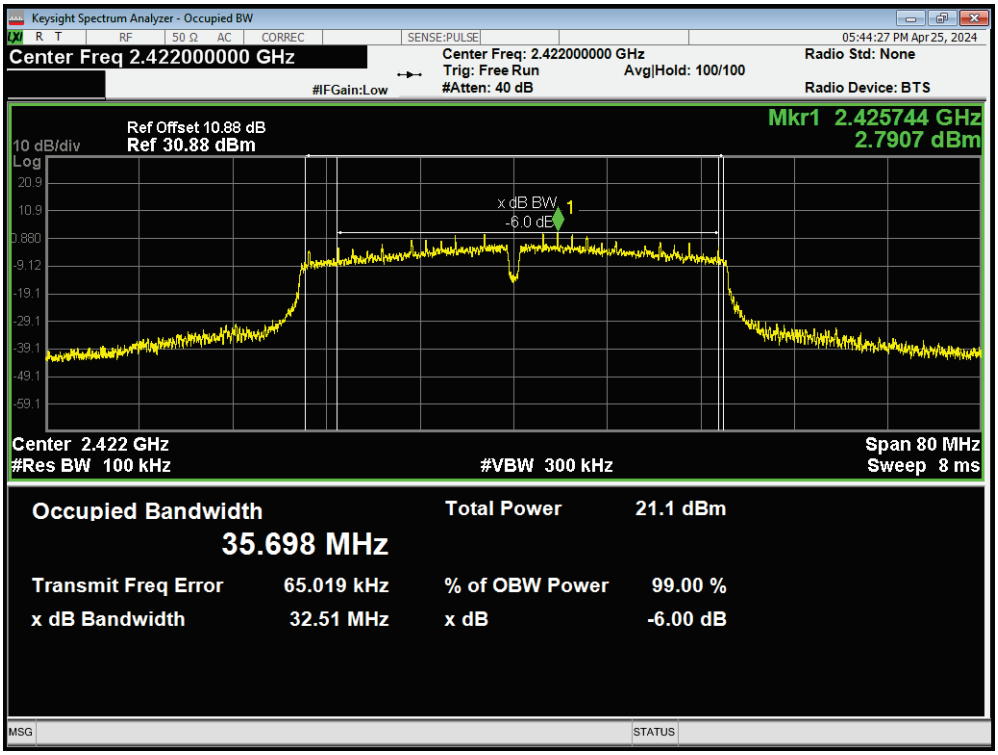
-6dB Bandwidth 802.11n(HT20) 2457MHz



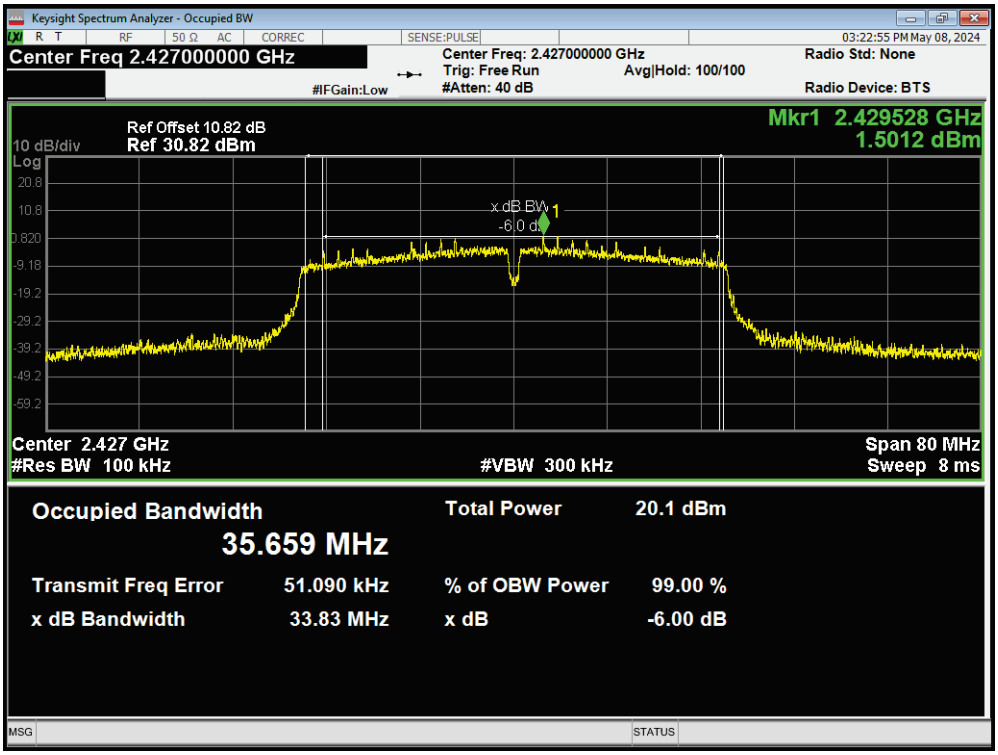
-6dB Bandwidth 802.11n(HT20) 2462MHz



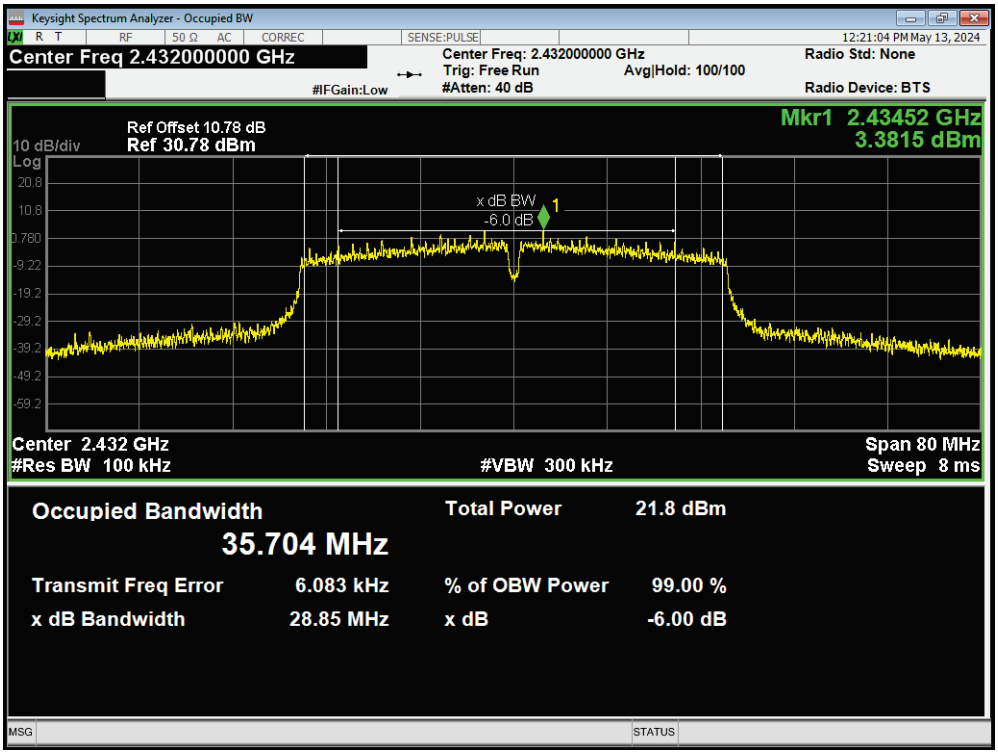
-6dB Bandwidth 802.11n(HT40) 2422MHz



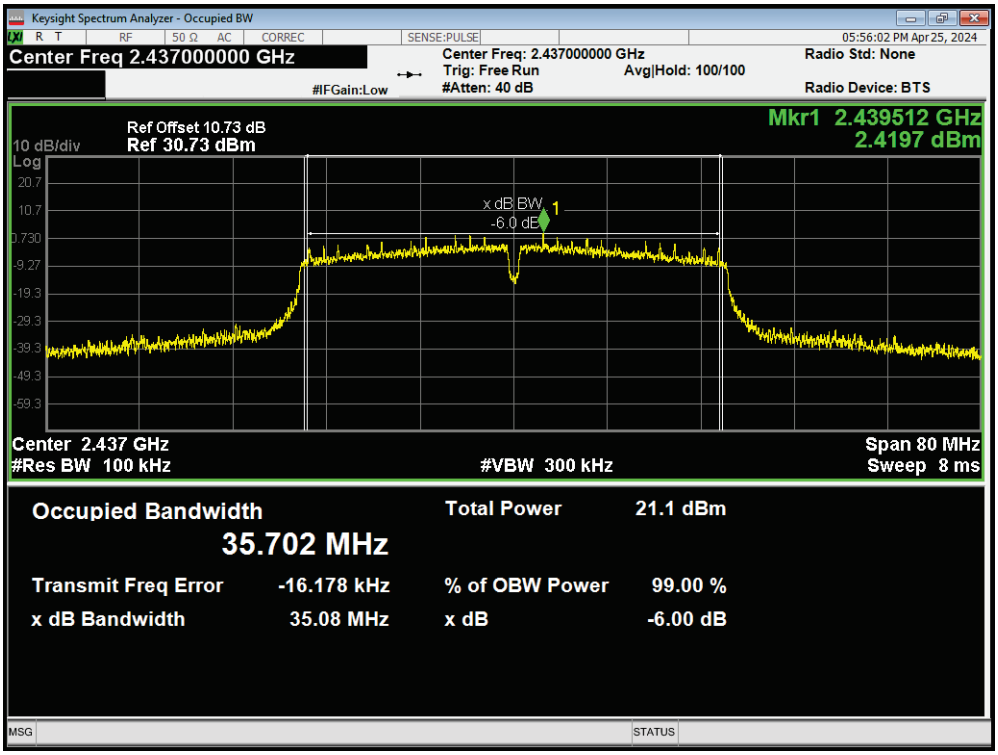
-6dB Bandwidth 802.11n(HT40) 2427MHz



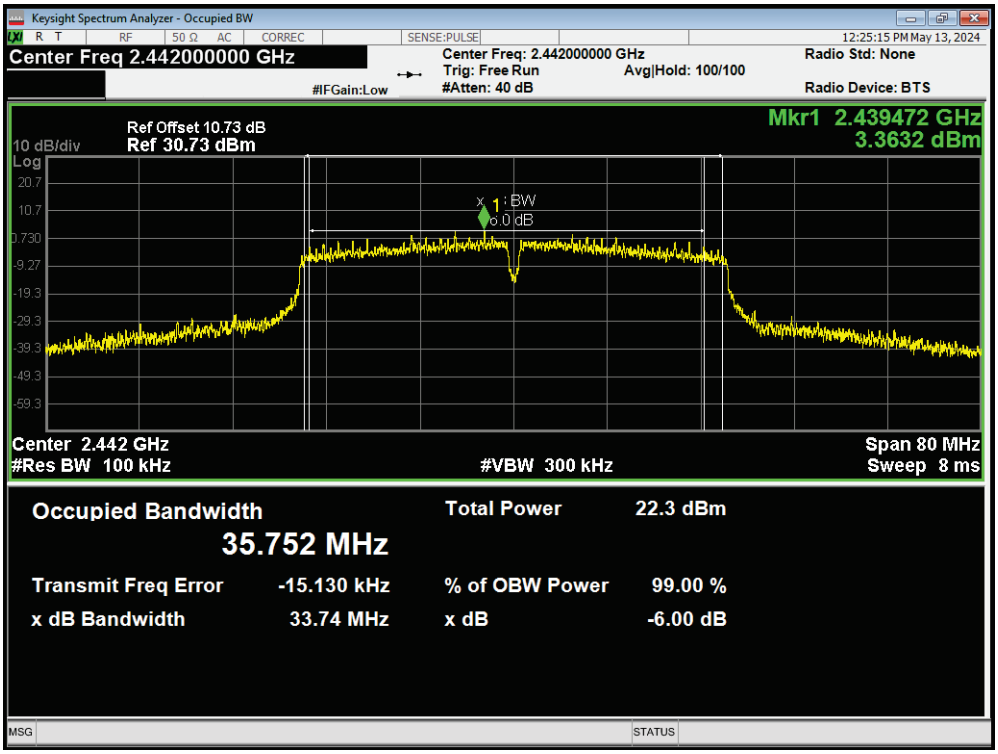
-6dB Bandwidth 802.11n(HT40) 2432MHz



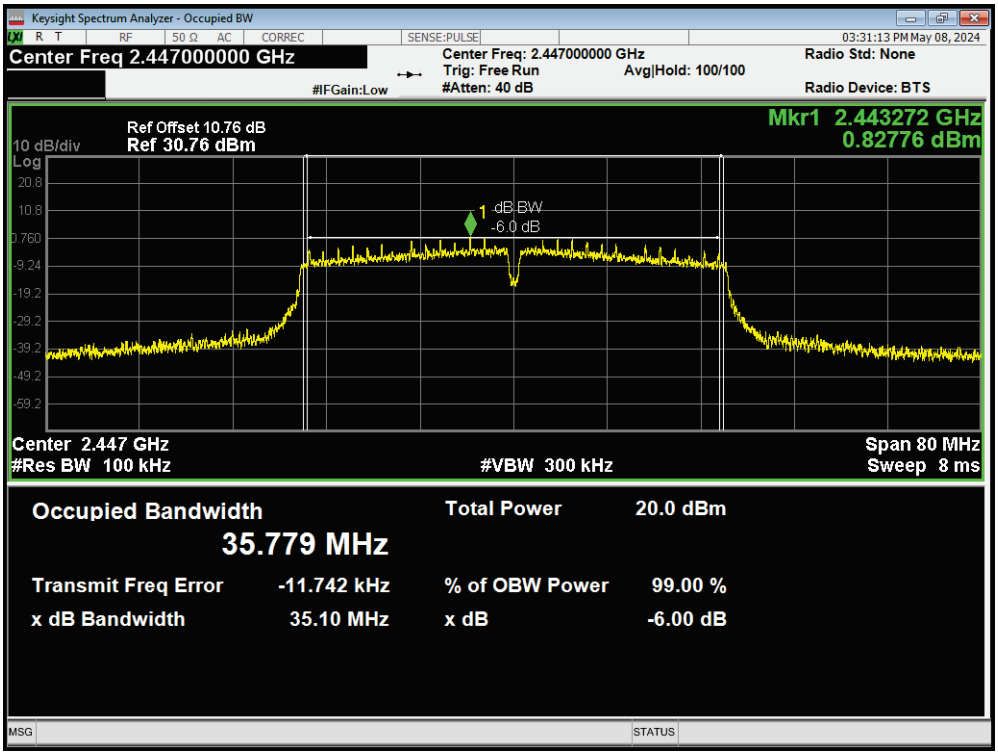
-6dB Bandwidth 802.11n(HT40) 2437MHz



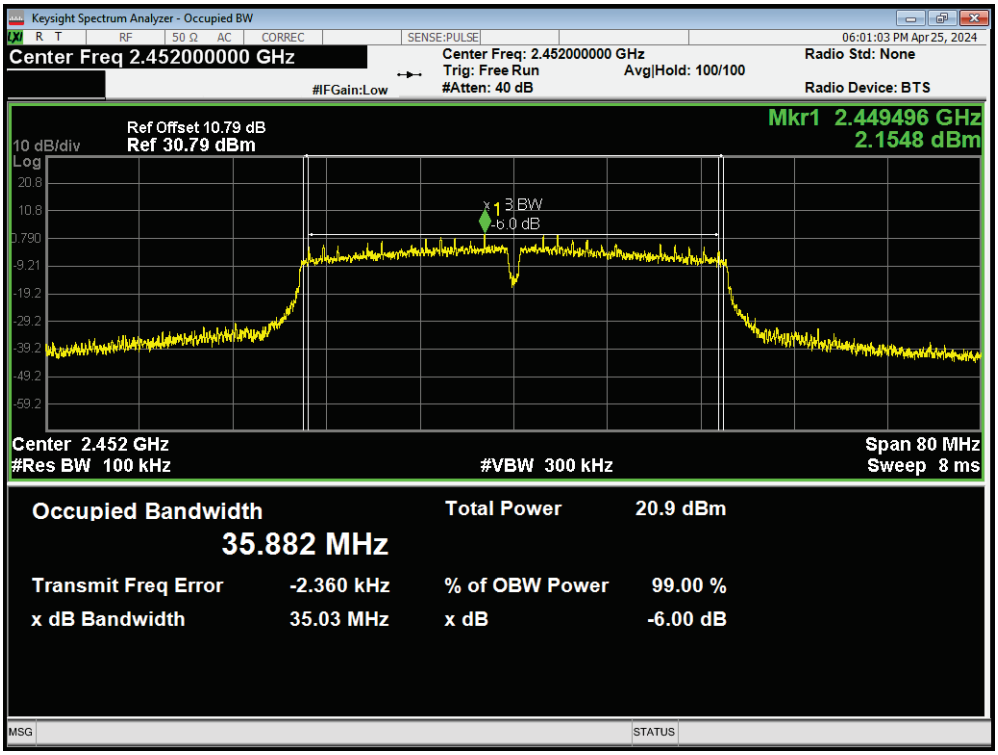
-6dB Bandwidth 802.11n(HT40) 2442MHz



-6dB Bandwidth 802.11n(HT40) 2447MHz



-6dB Bandwidth 802.11n(HT40) 2452MHz



5.3. Band Edge

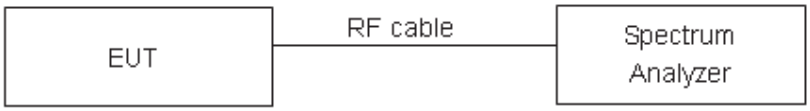
Ambient Condition

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

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable the band edge of the lowest and highest channels were measured. The peak detector is used and RBW is set to 100 kHz and VBW is set to 300 kHz on spectrum analyzer. Spectrum analyzer plots are included on the following pages.

Test Setup



Limits

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

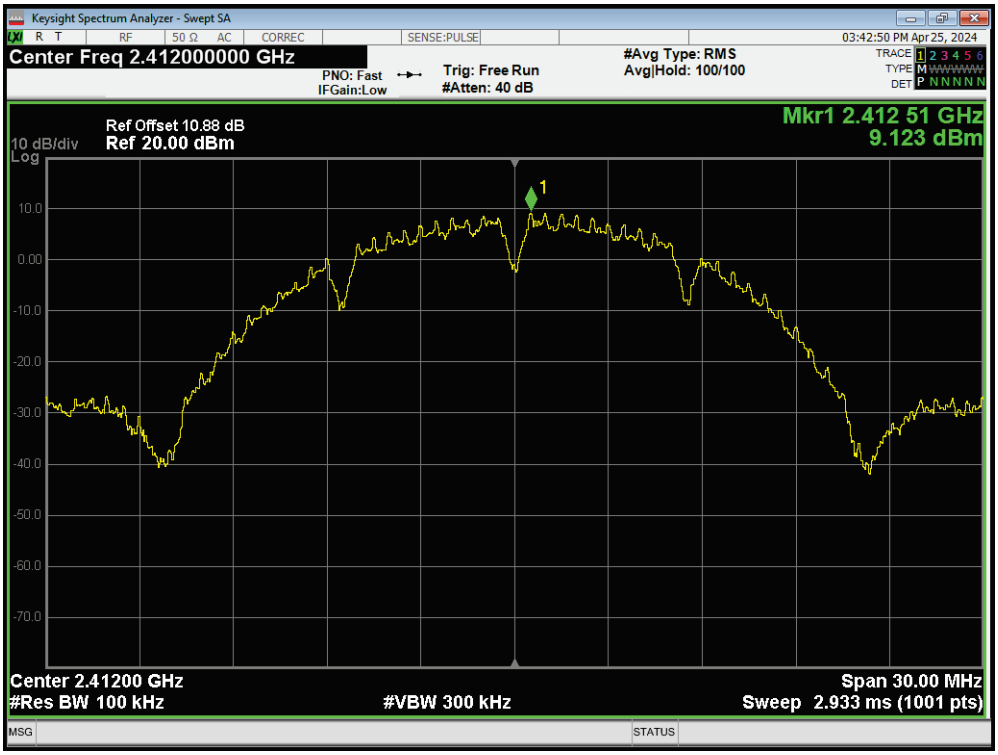
Measurement Uncertainty

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

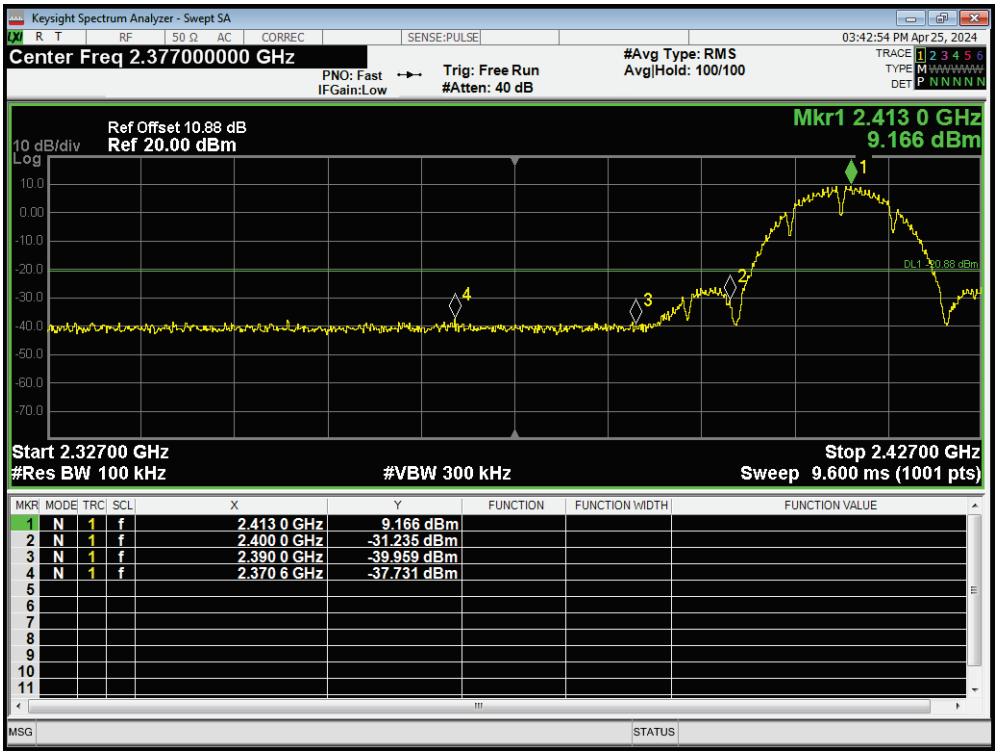
Frequency	Uncertainty
2GHz-3GHz	1.407 dB

Test Results: PASS

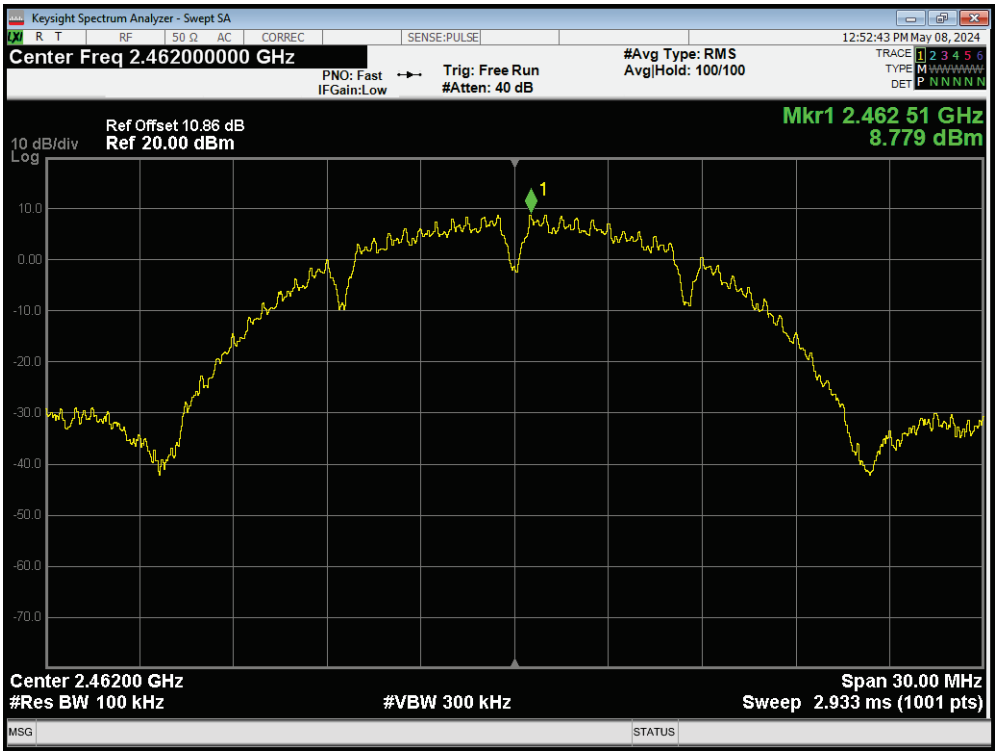
Band Edge 802.11b 2412MHz Ref



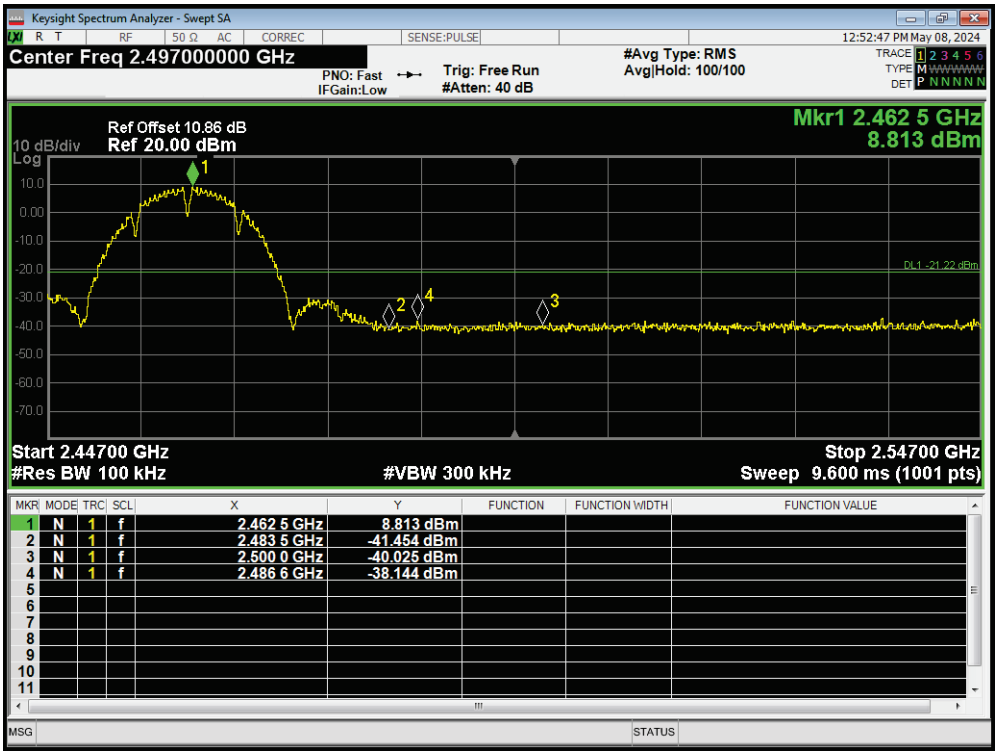
Band Edge 802.11b 2412MHz Emission



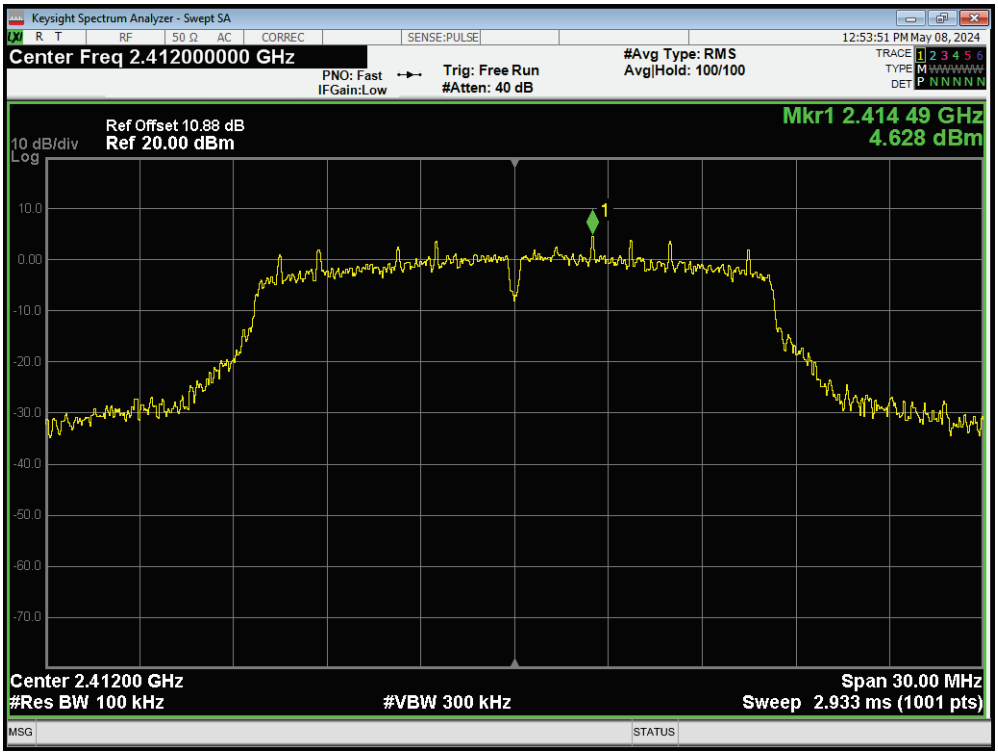
Band Edge 802.11b 2462MHz Ref



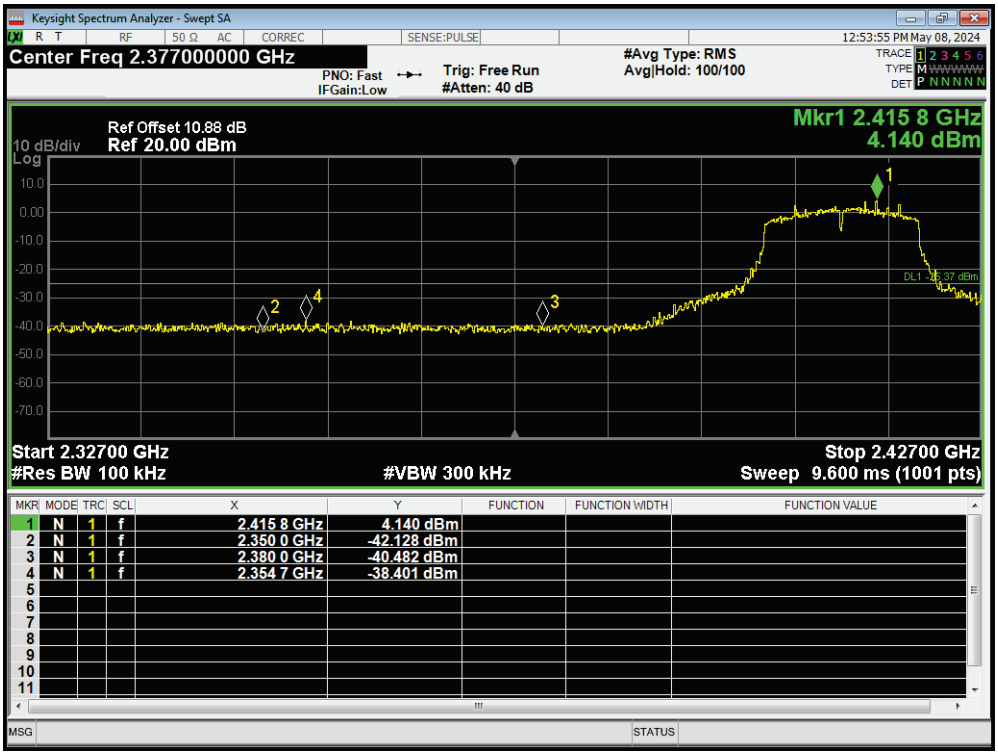
Band Edge 802.11b 2462MHz Emission



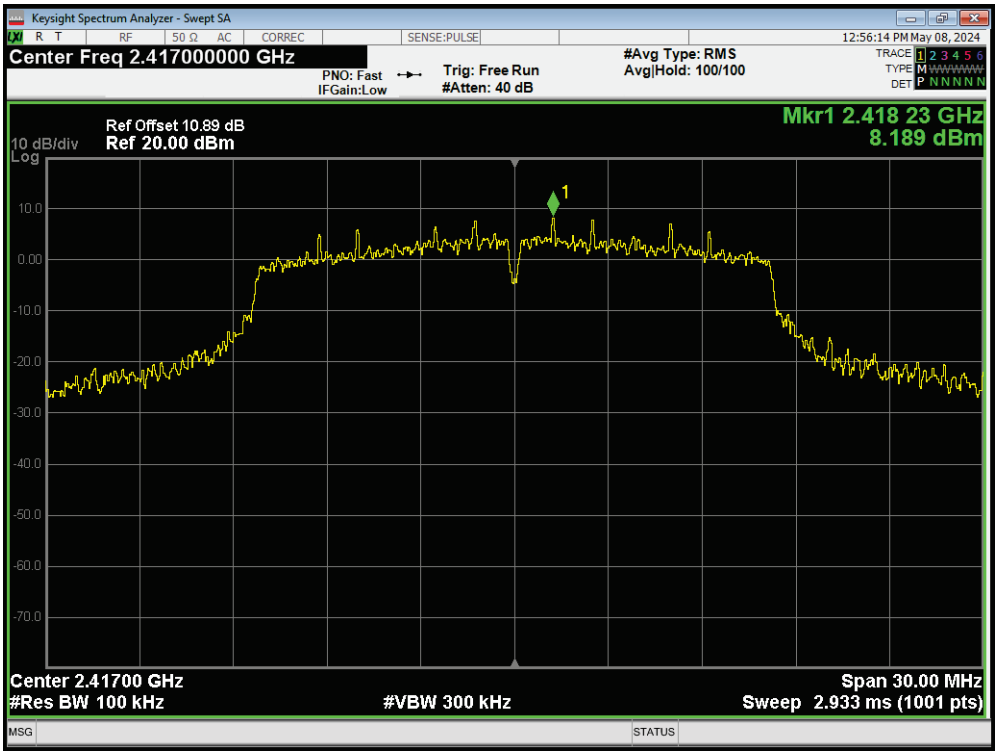
Band Edge 802.11g 2412MHz Ref



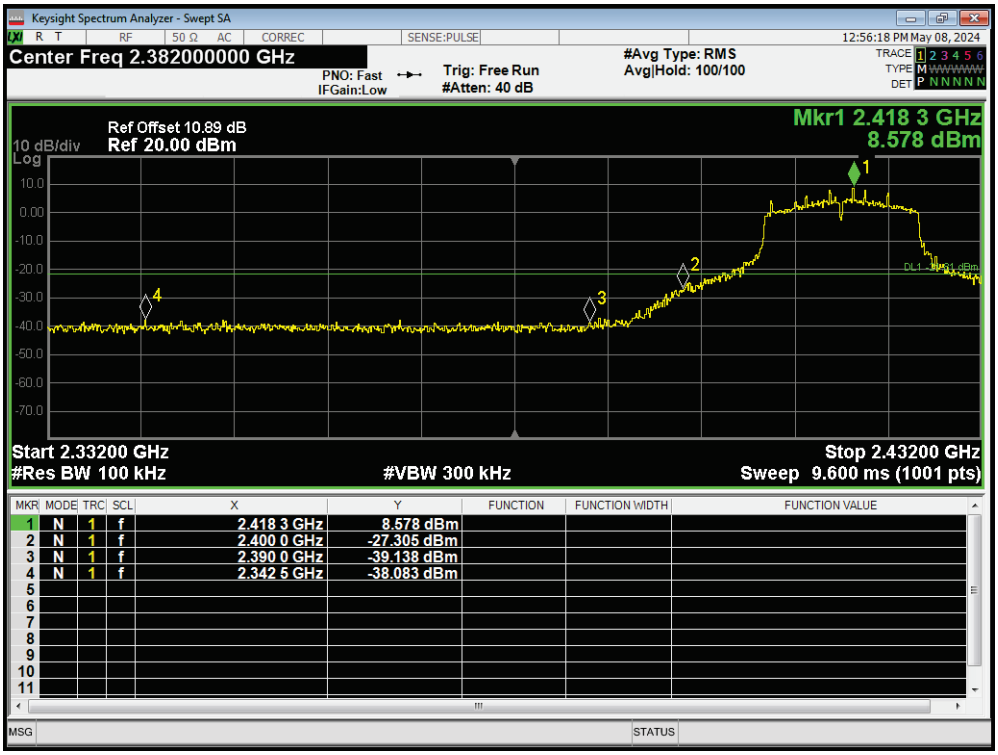
Band Edge 802.11g 2412MHz Emission



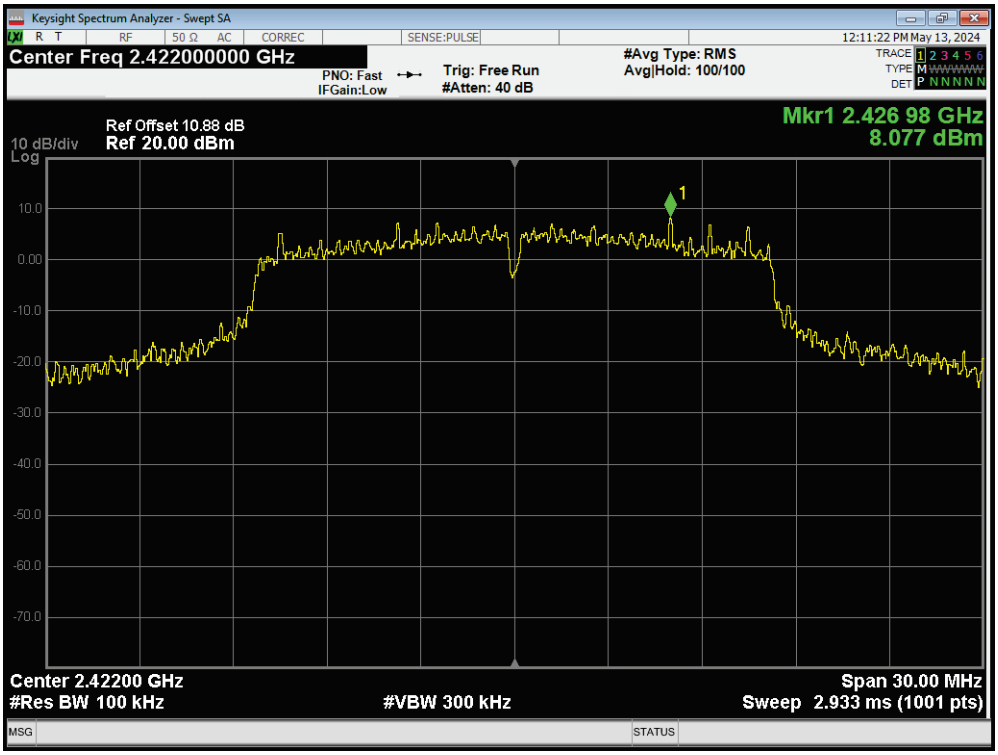
Band Edge 802.11g 2417MHz Ref



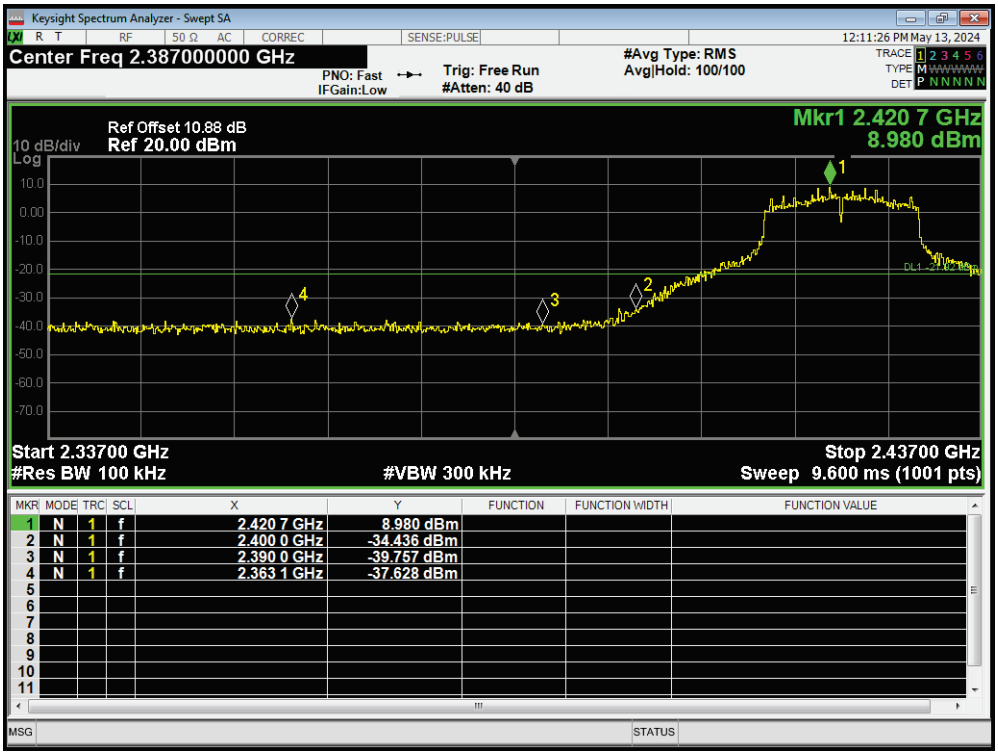
Band Edge 802.11g 2417MHz Emission



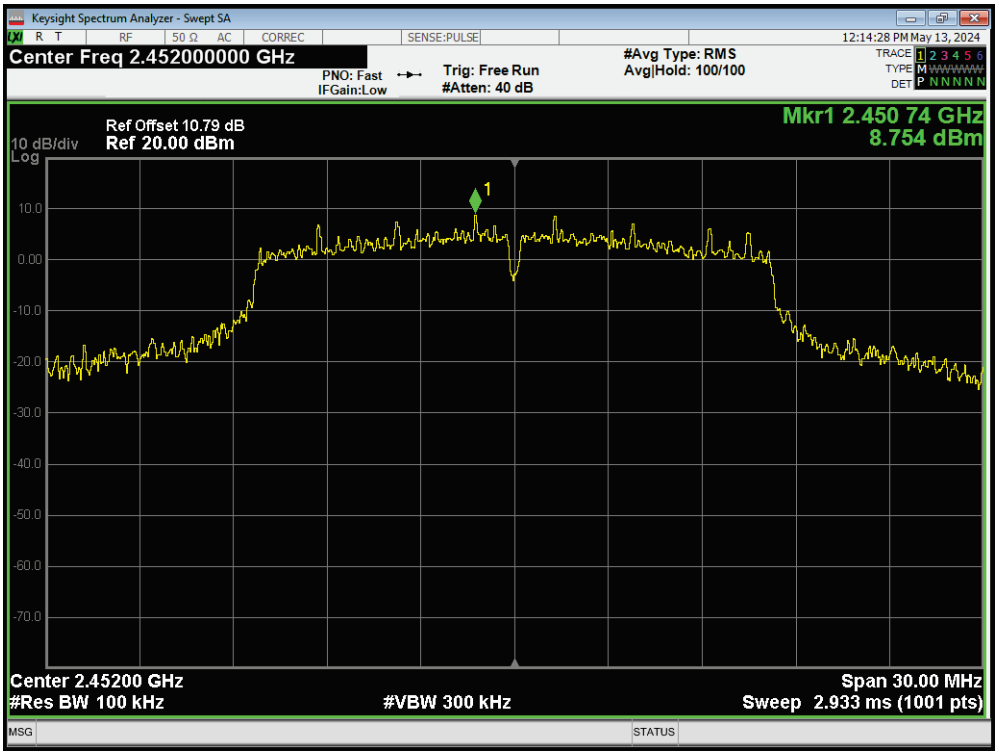
Band Edge 802.11g 2422MHz Ref



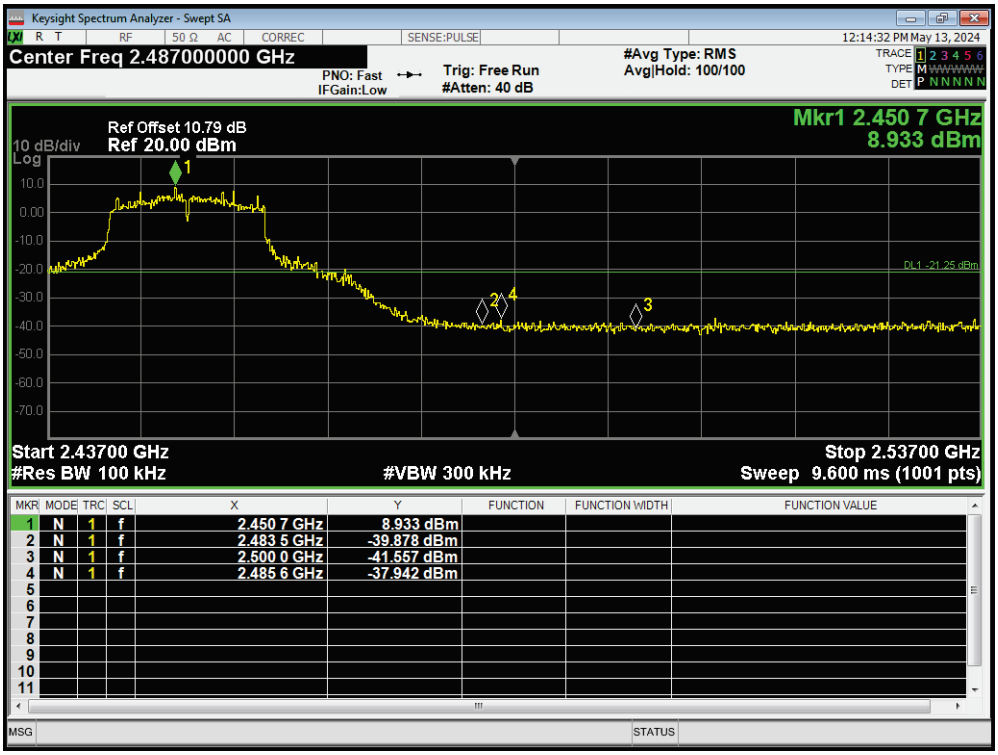
Band Edge 802.11g 2422MHz Emission



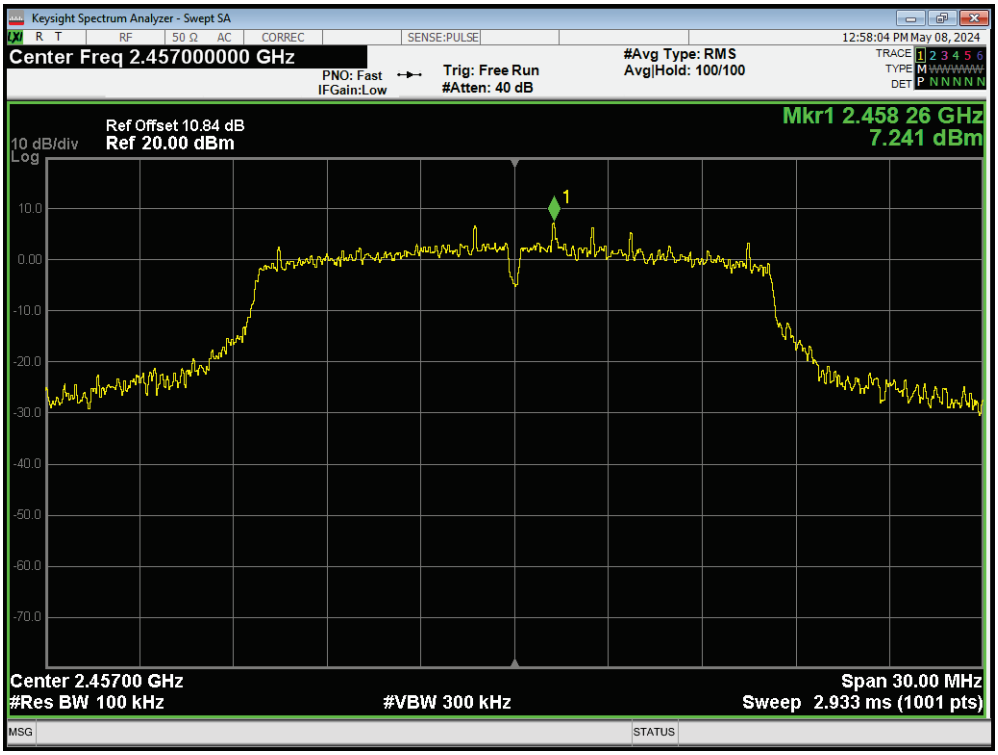
Band Edge 802.11g 2452MHz Ref



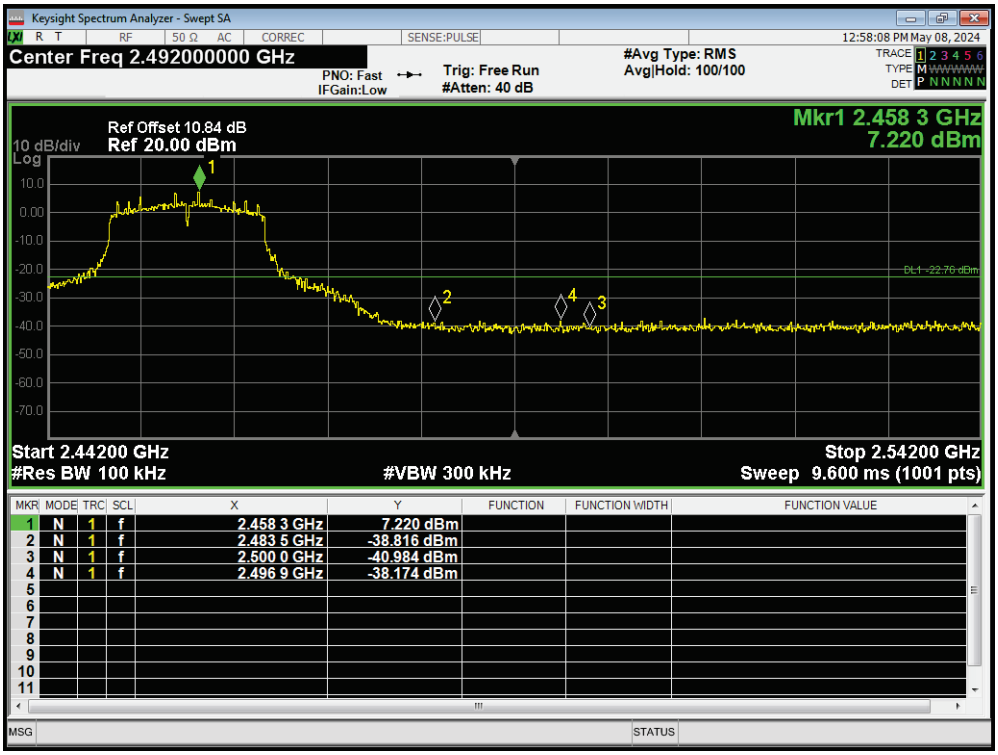
Band Edge 802.11g 2452MHz Emission



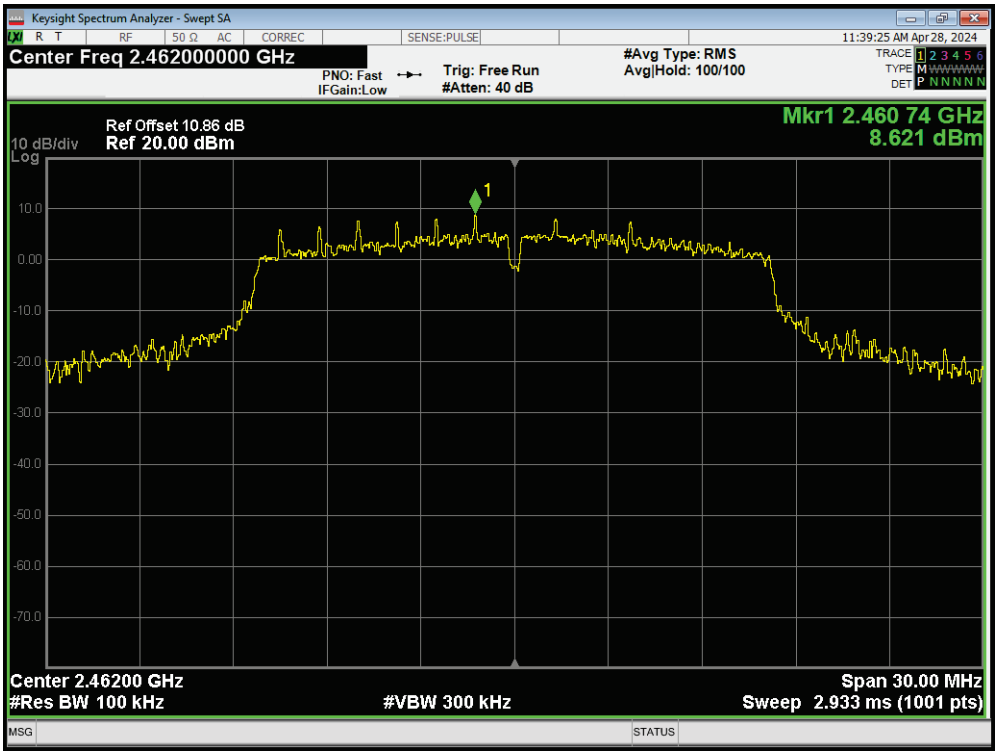
Band Edge 802.11g 2457MHz Ref



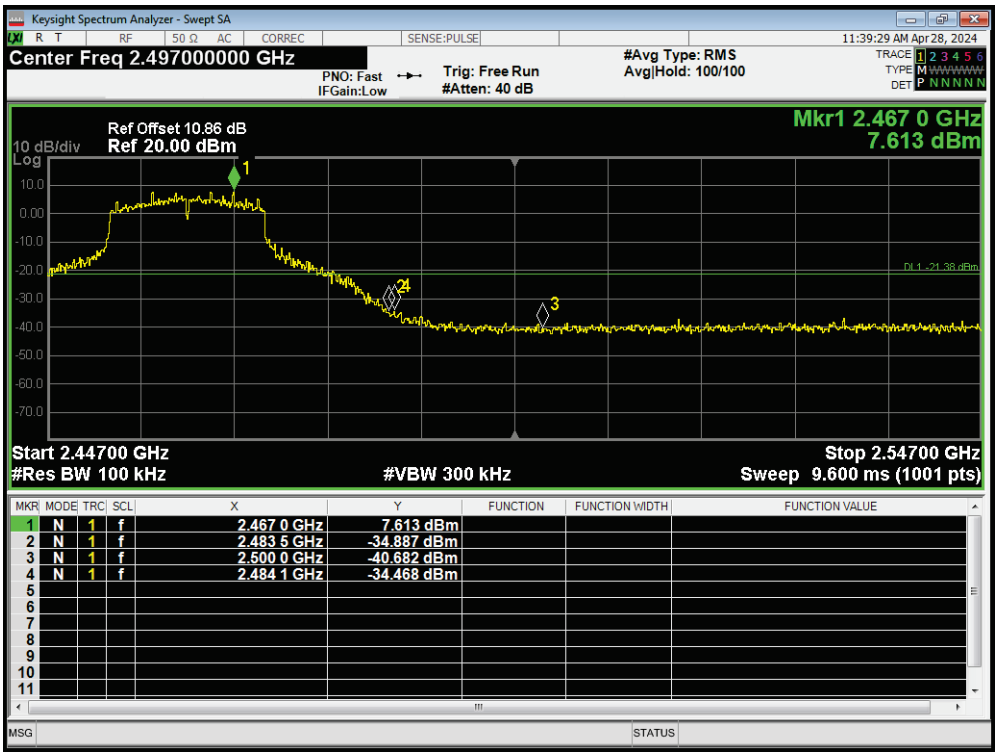
Band Edge 802.11g 2457MHz Emission



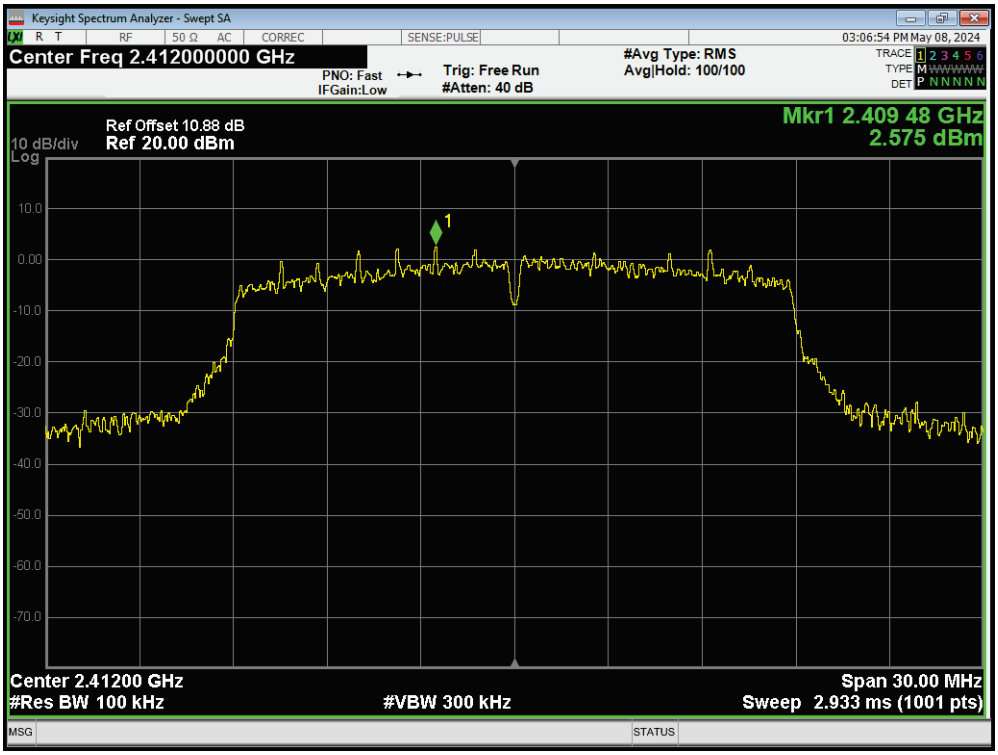
Band Edge 802.11g 2462MHz Ref



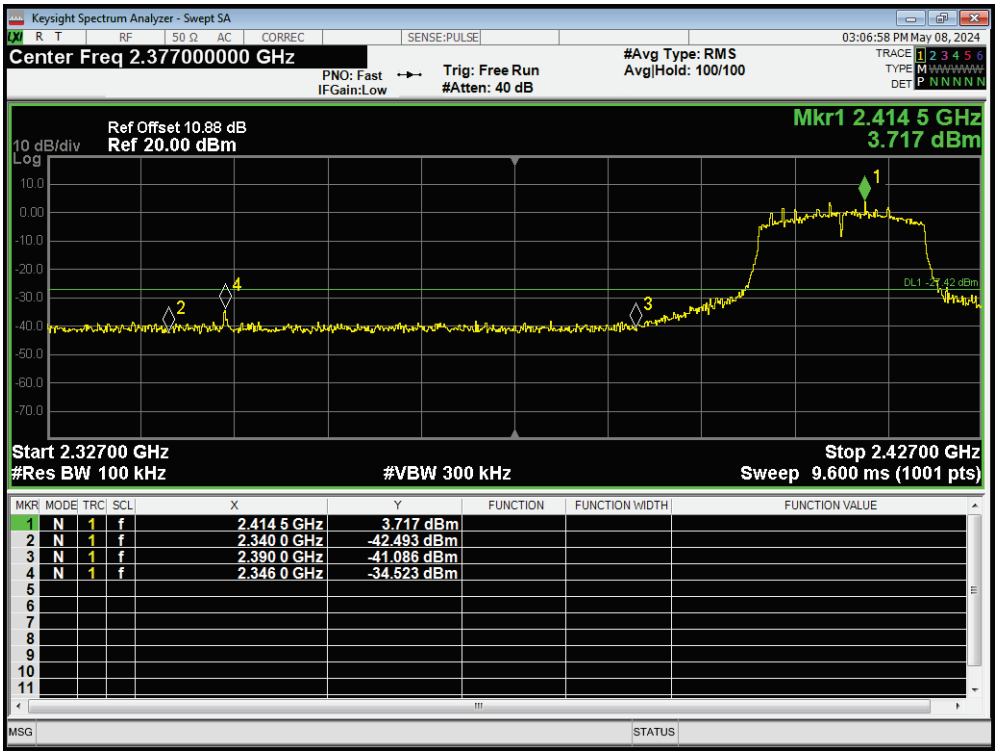
Band Edge 802.11g 2462MHz Emission



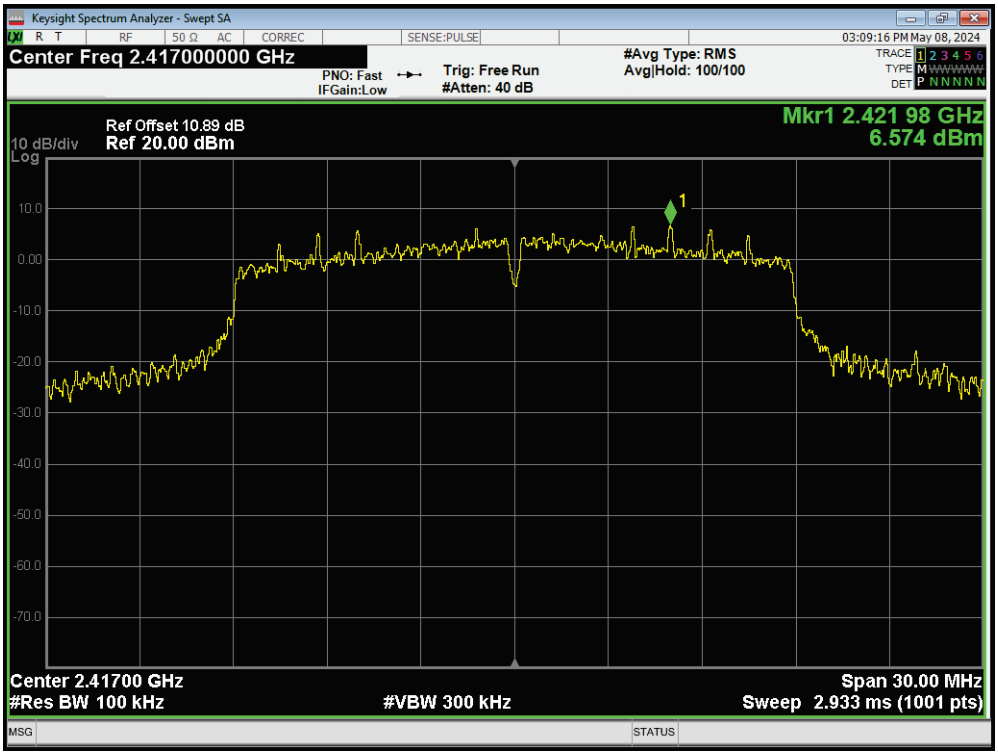
Band Edge 802.11n(HT20) 2412MHz Ref



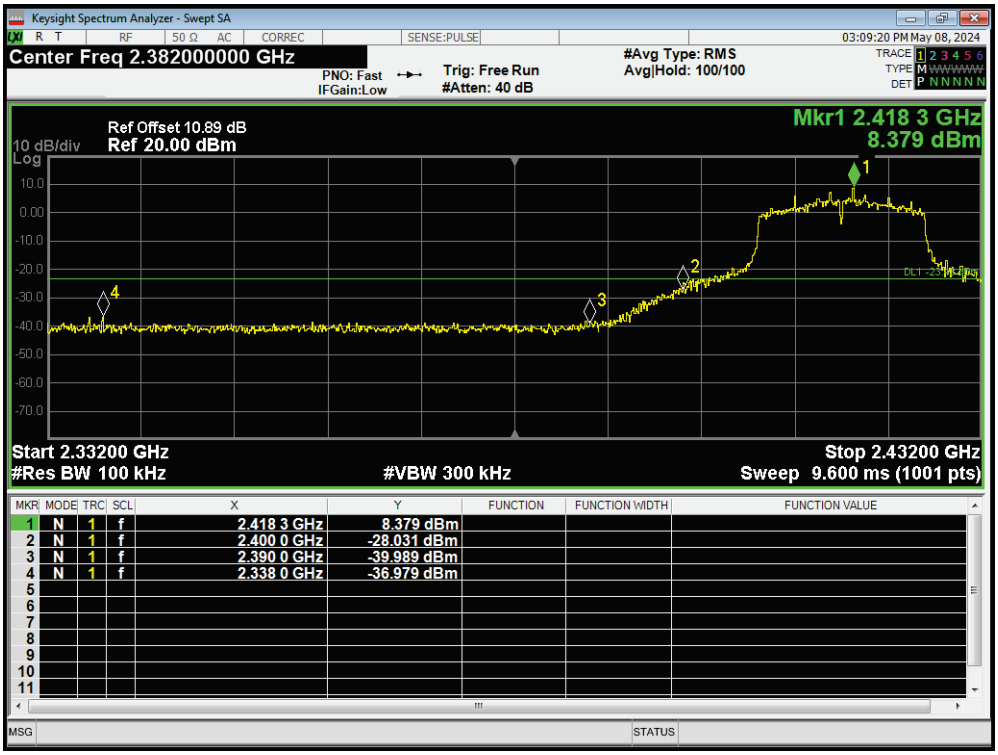
Band Edge 802.11n(HT20) 2412MHz Emission



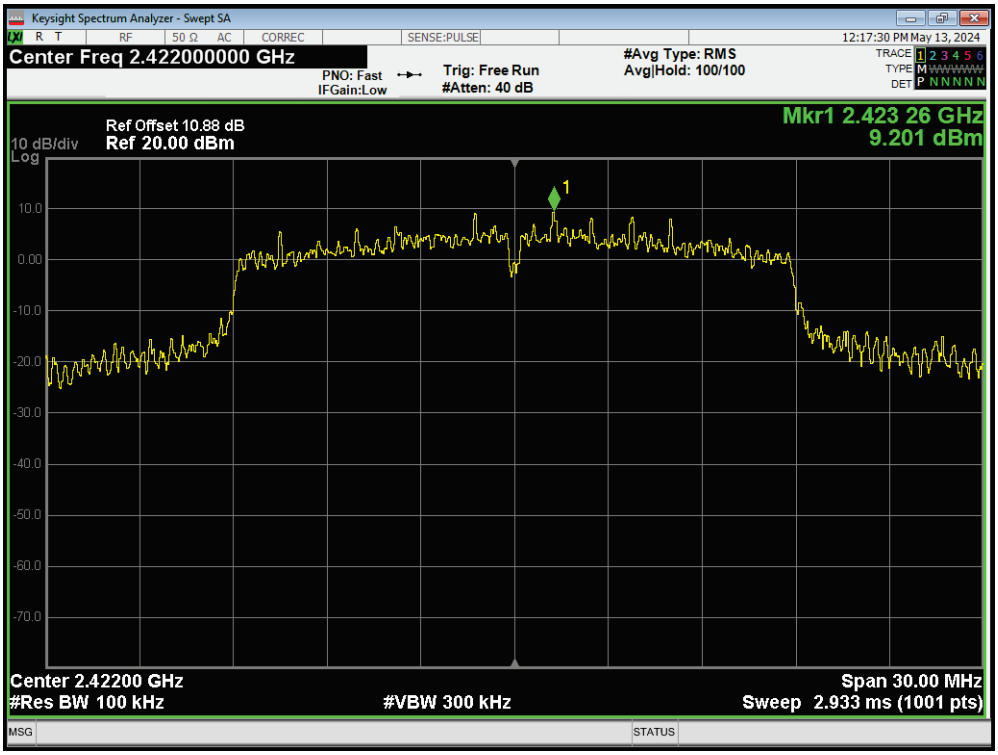
Band Edge 802.11n(HT20) 2417MHz Ref



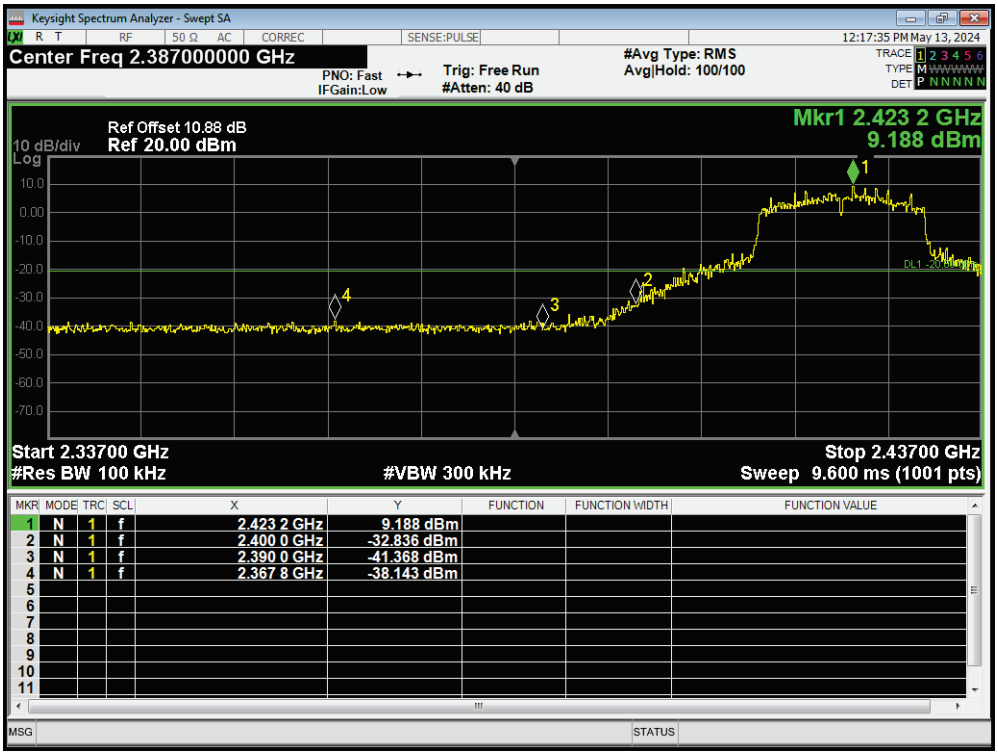
Band Edge 802.11n(HT20) 2417MHz Emission



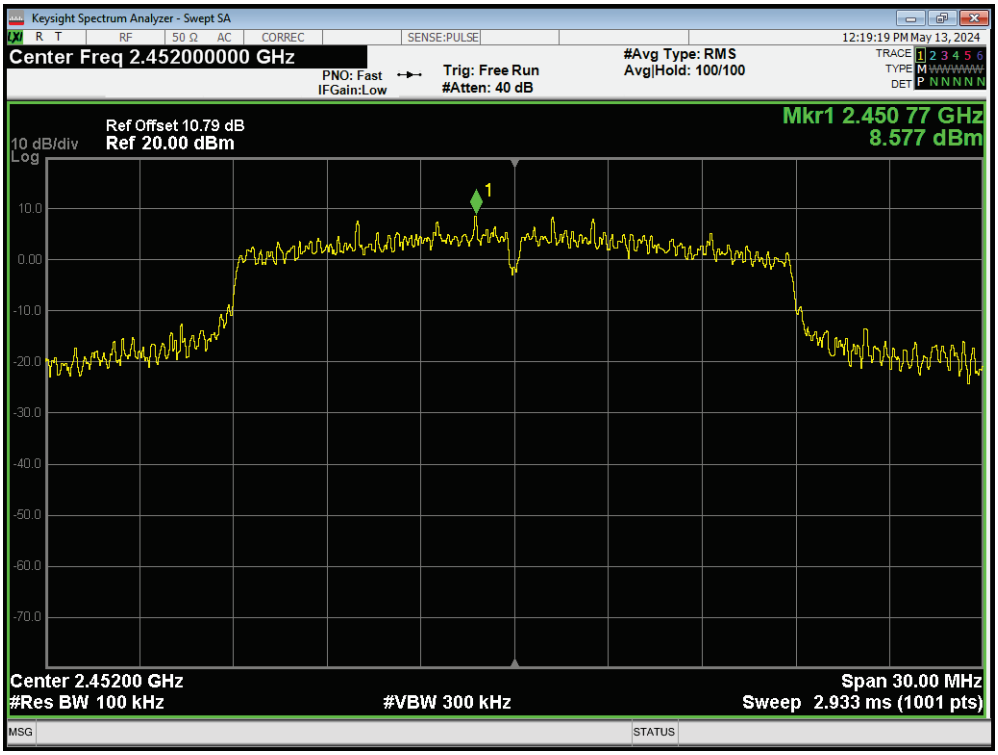
Band Edge 802.11n(HT20) 2422MHz Ref



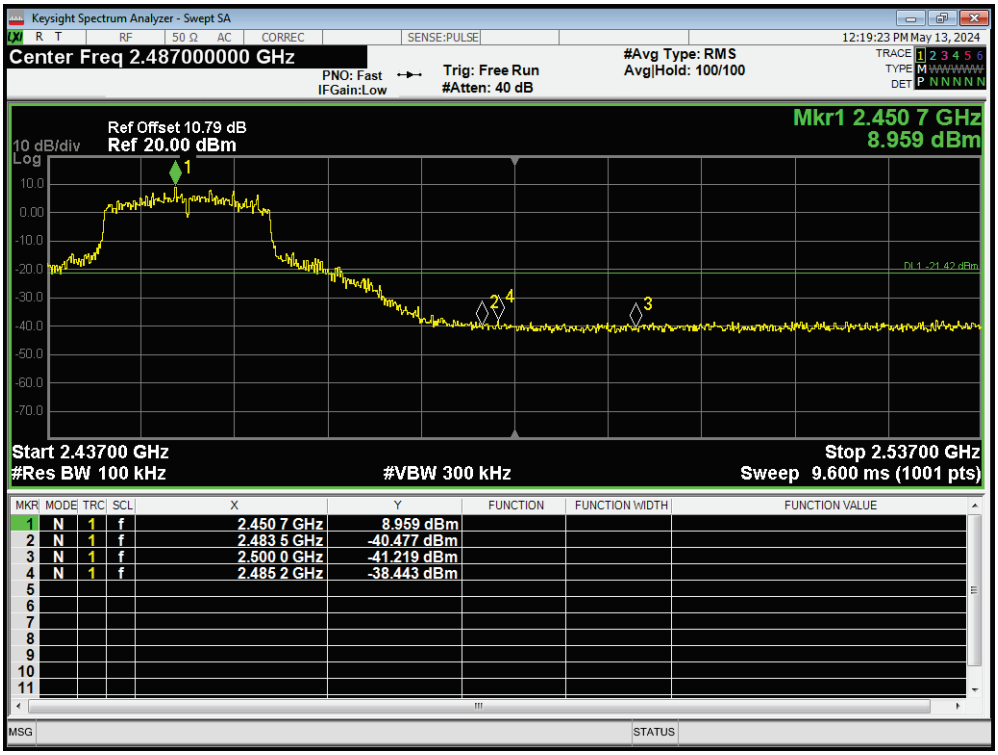
Band Edge 802.11n(HT20) 2422MHz Emission



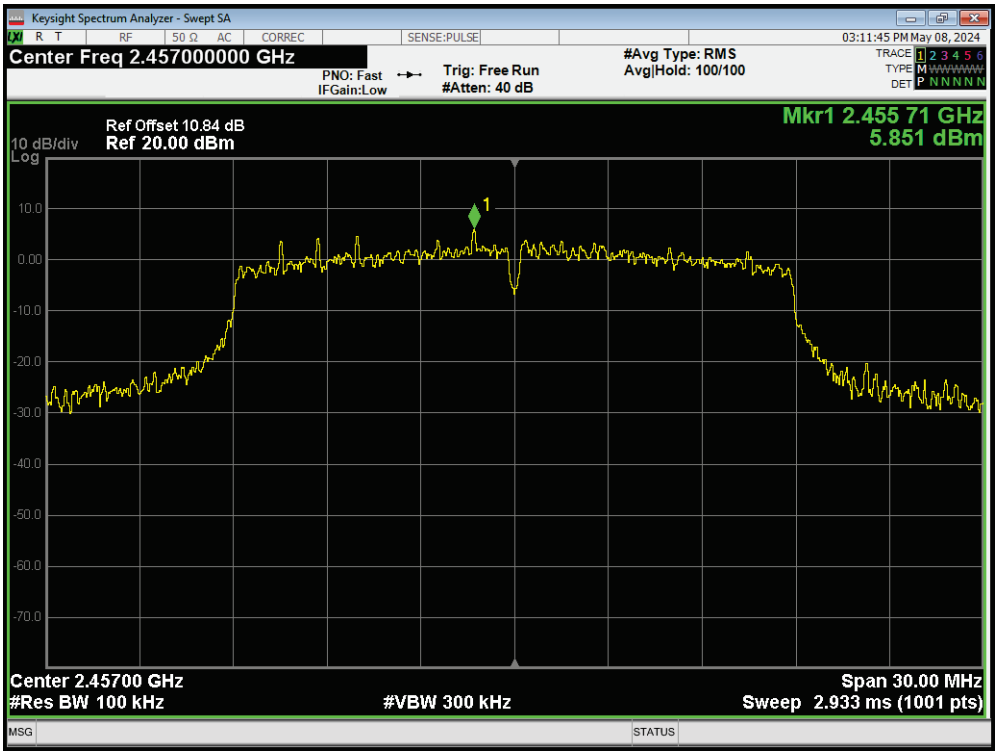
Band Edge 802.11n(HT20) 2452MHz Ref



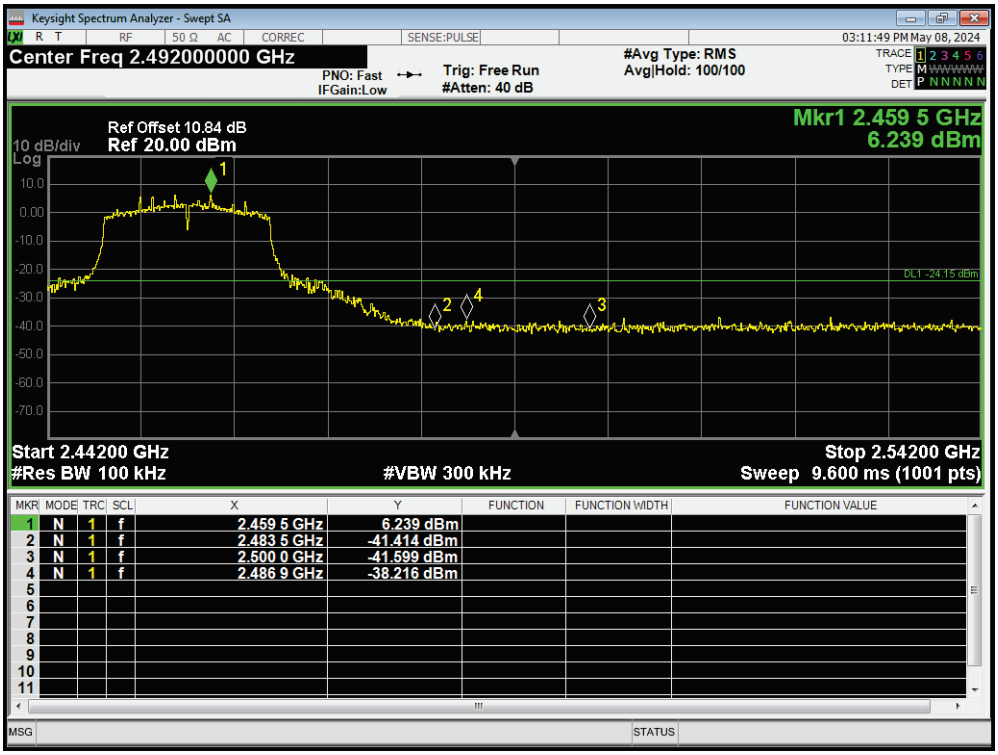
Band Edge 802.11n(HT20) 2452MHz Emission



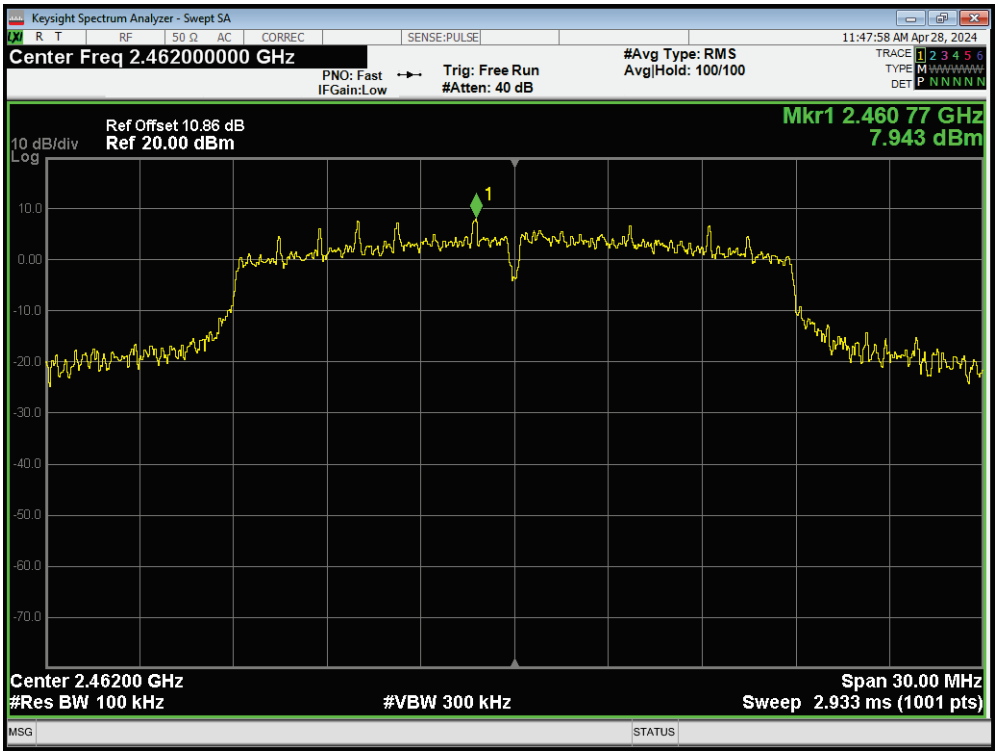
Band Edge 802.11n(HT20) 2457MHz Ref



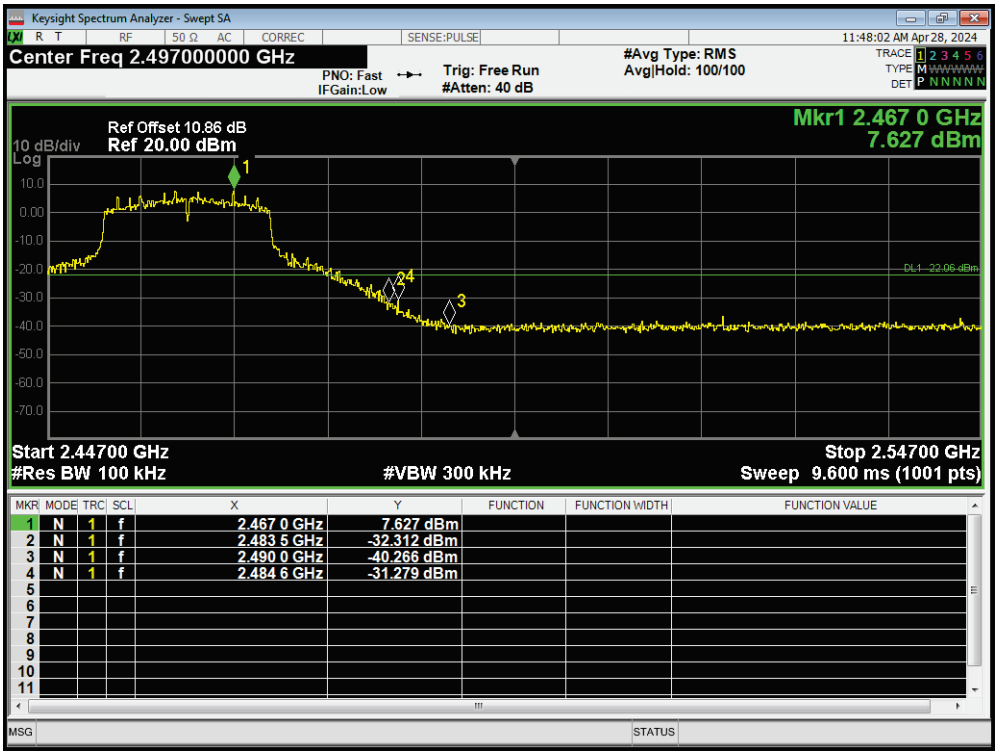
Band Edge 802.11n(HT20) 2457MHz Emission



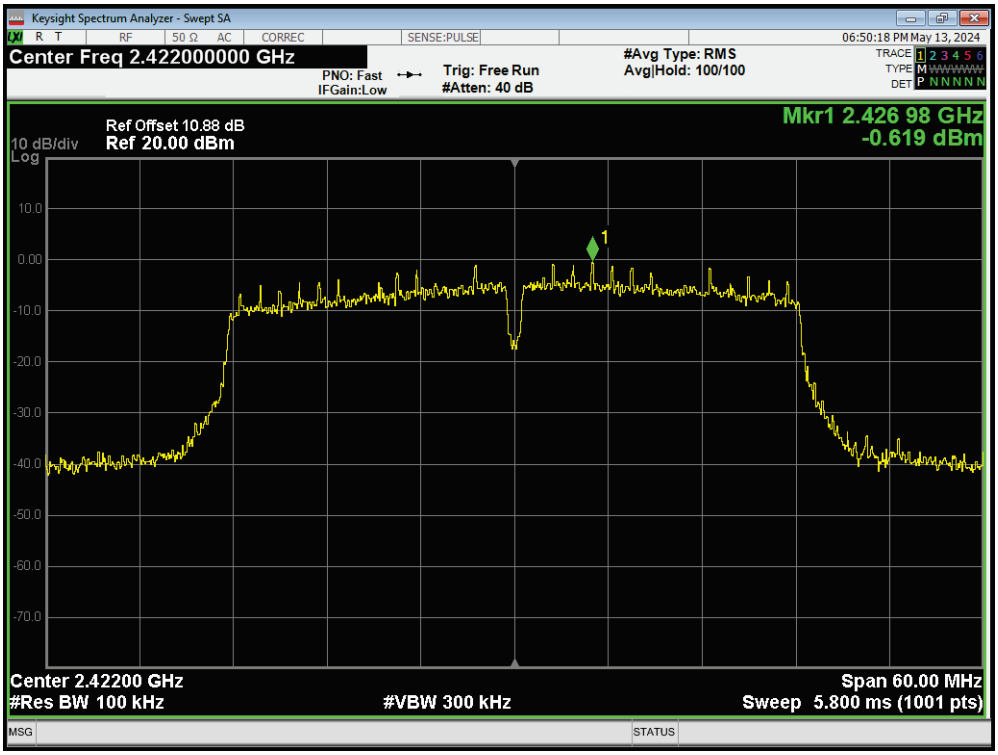
Band Edge 802.11n(HT20) 2462MHz Ref



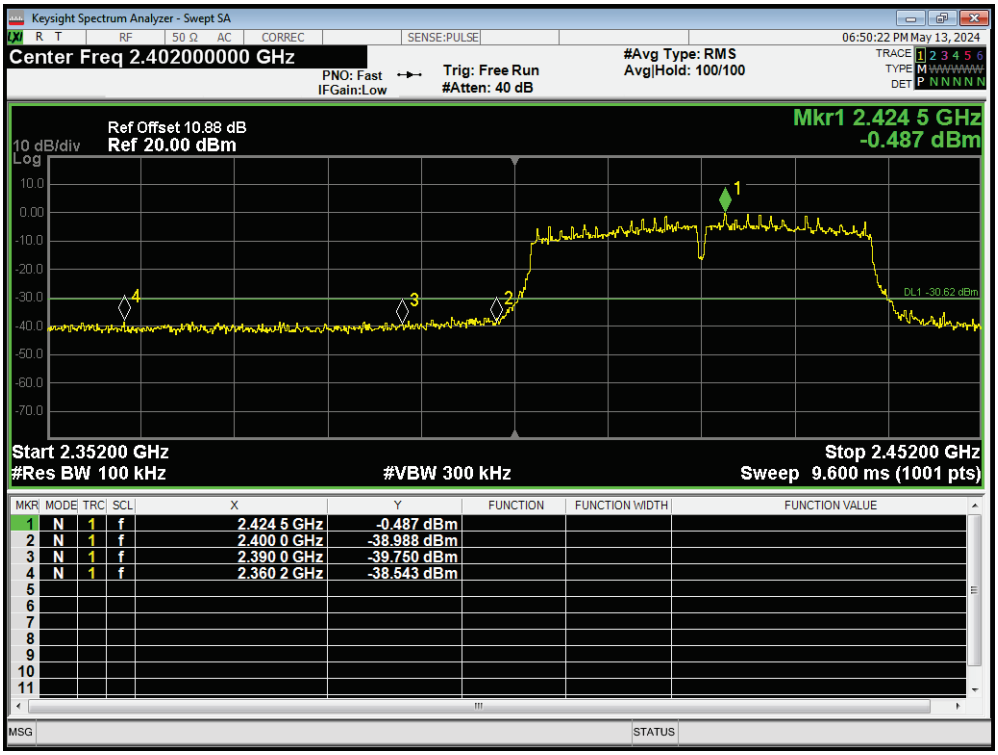
Band Edge 802.11n(HT20) 2462MHz Emission



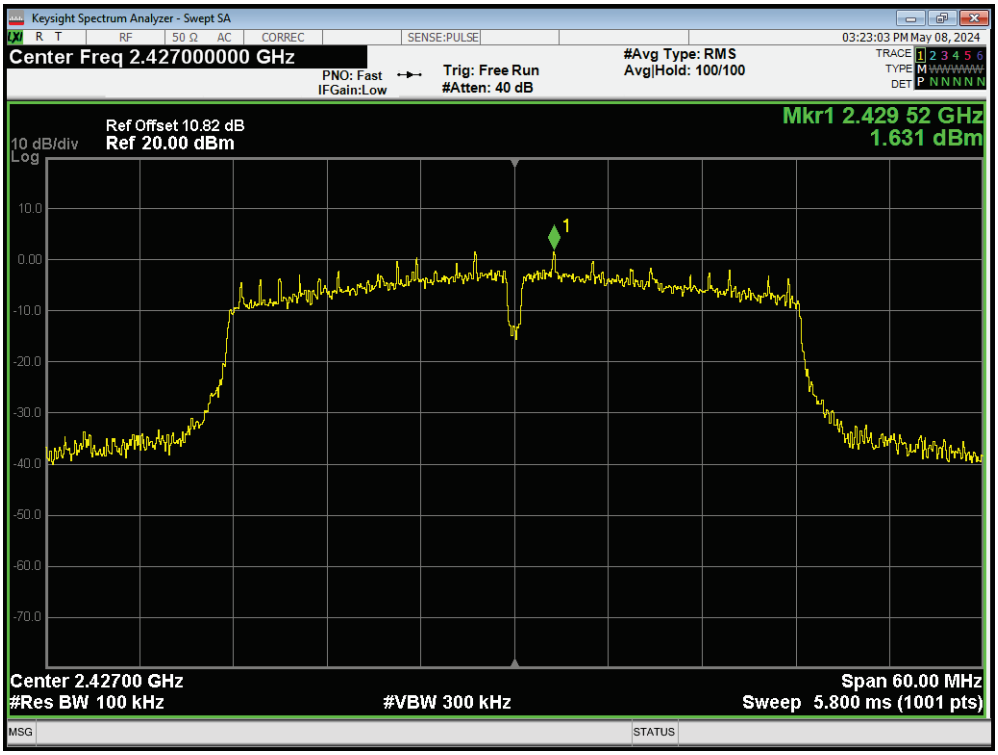
Band Edge 802.11n(HT40) 2422MHz Ref



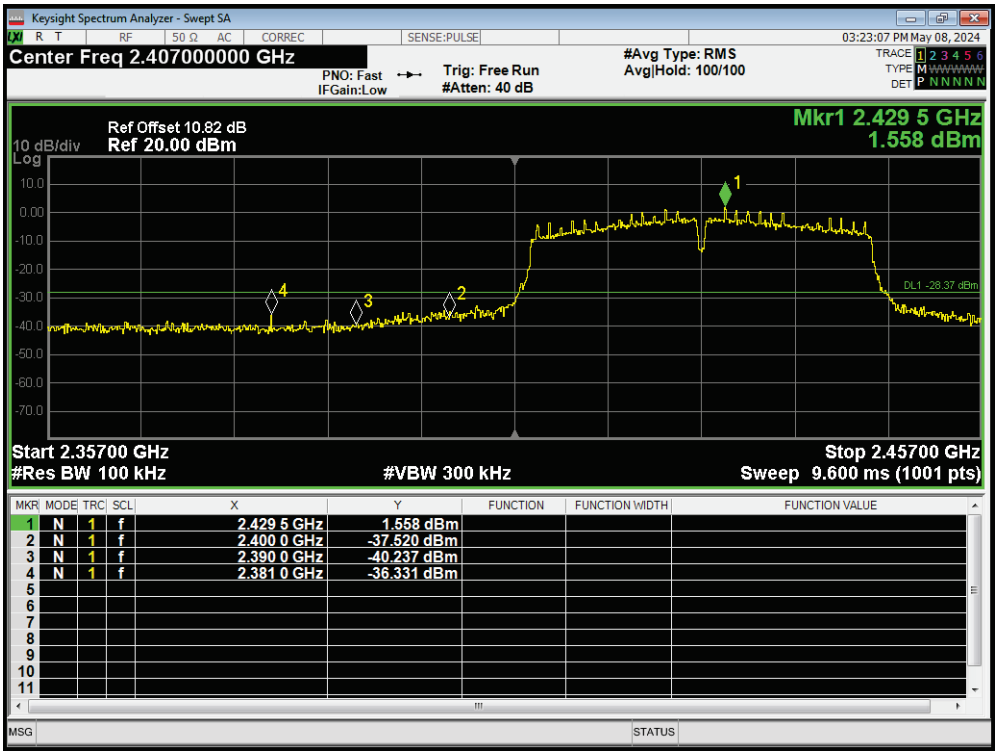
Band Edge 802.11n(HT40) 2422MHz Emission



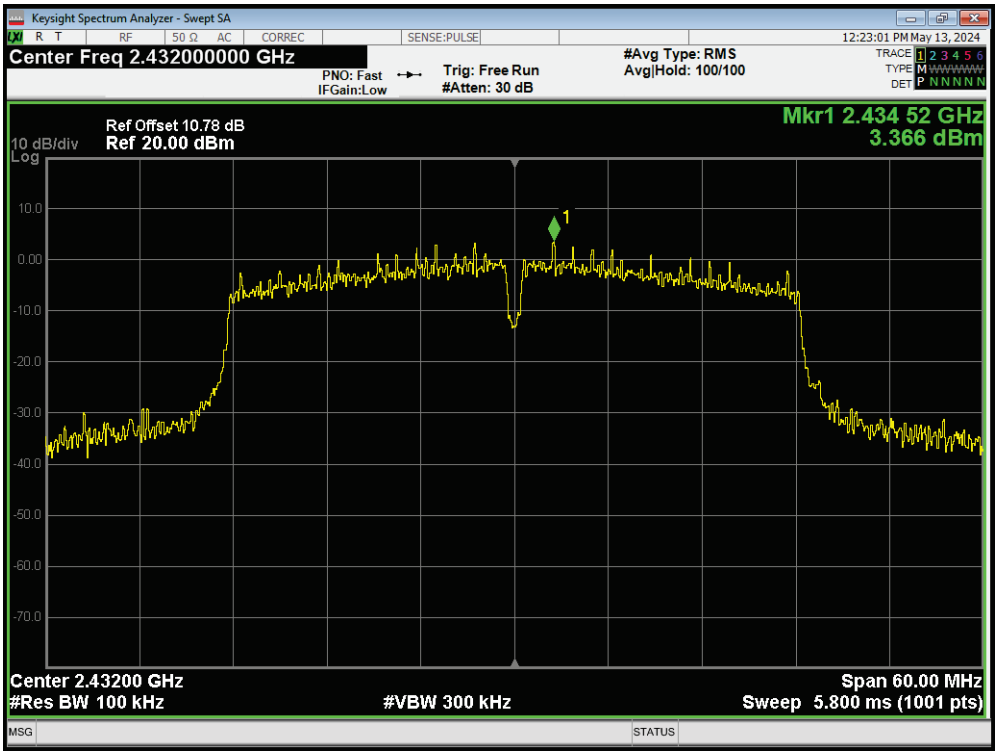
Band Edge 802.11n(HT40) 2427MHz Ref



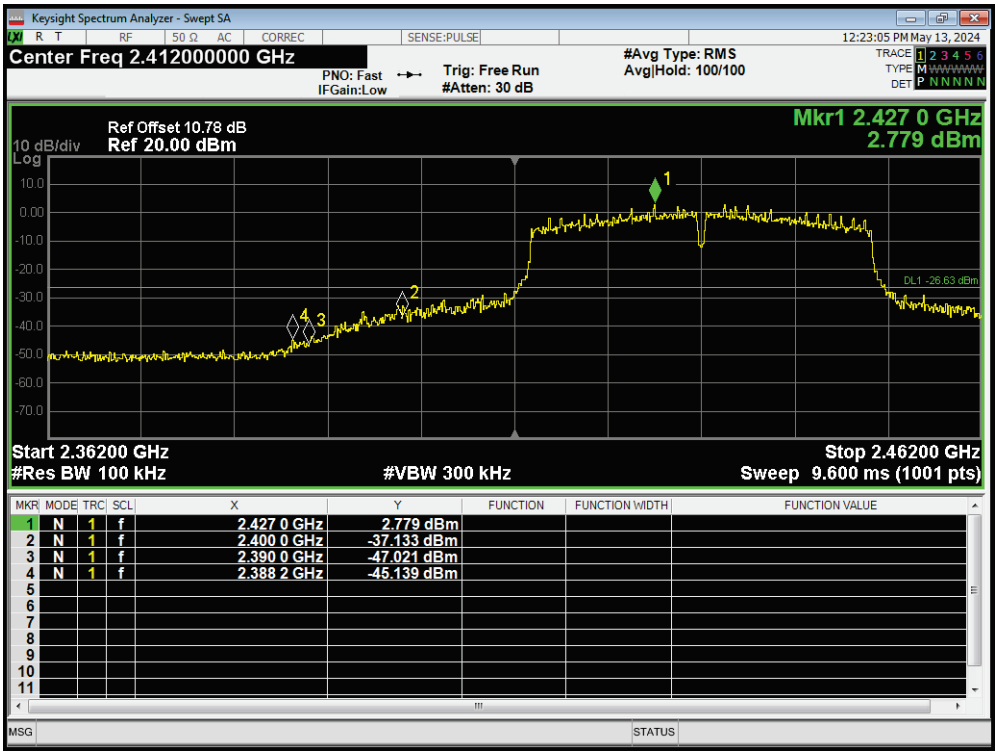
Band Edge 802.11n(HT40) 2427MHz Emission



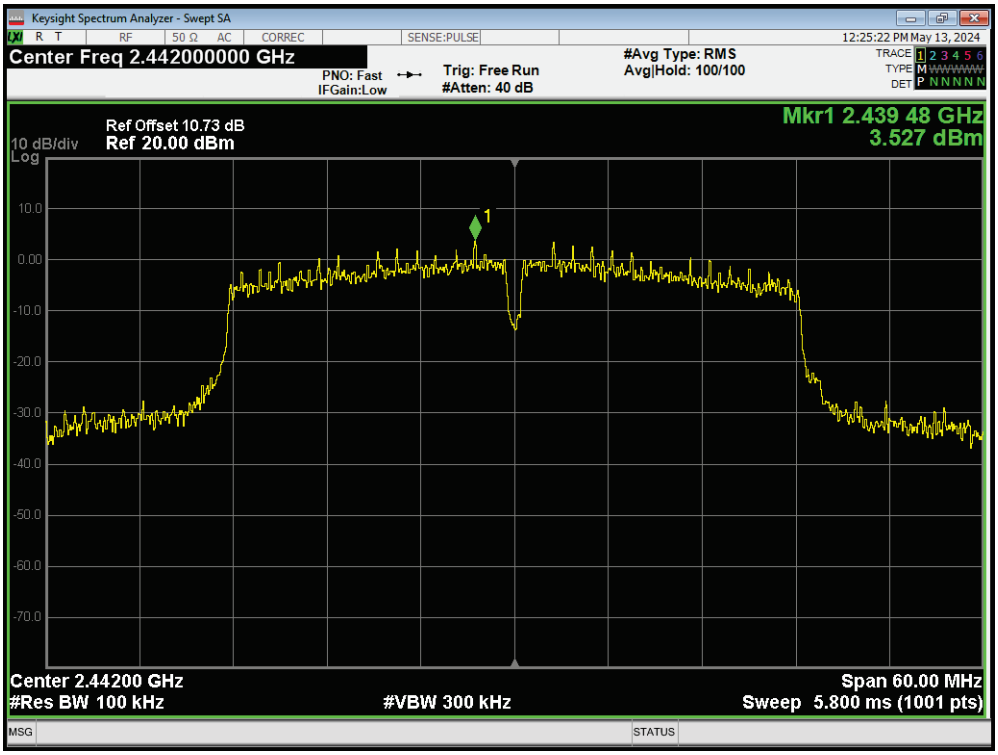
Band Edge 802.11n(HT40) 2432MHz Ref



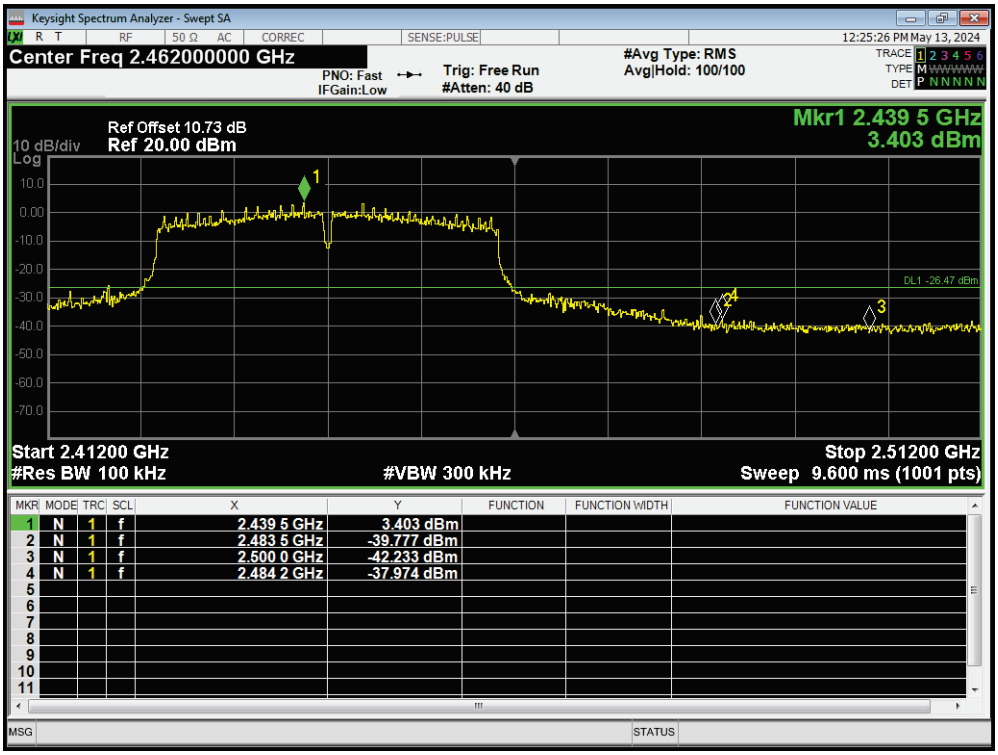
Band Edge 802.11n(HT40) 2432MHz Emission



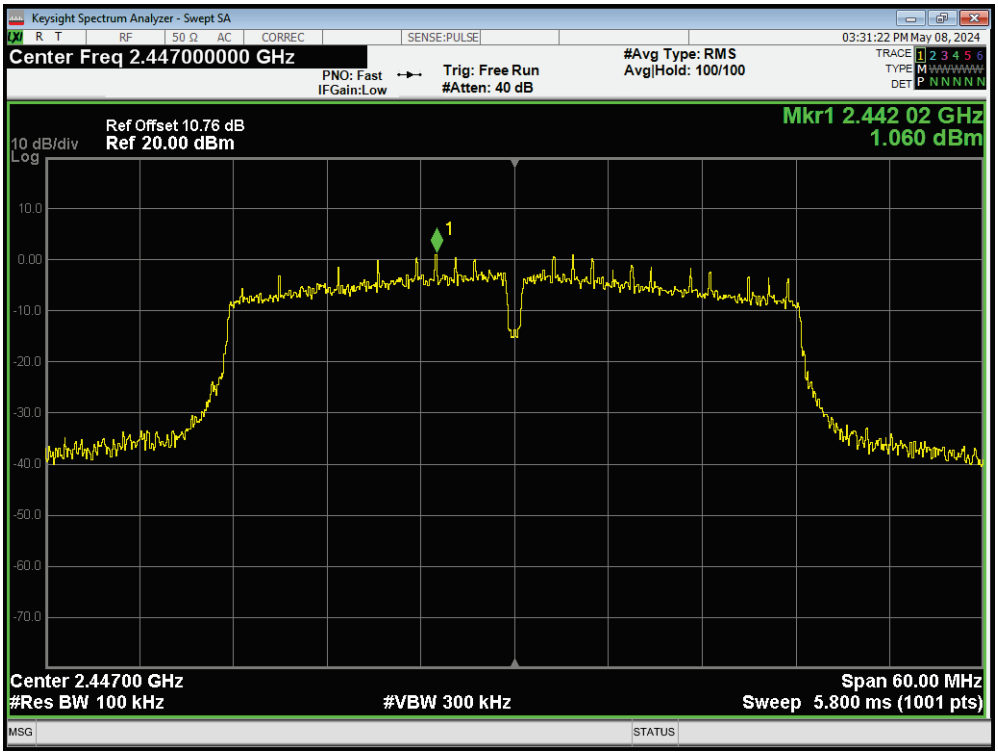
Band Edge 802.11n(HT40) 2442MHz Ref



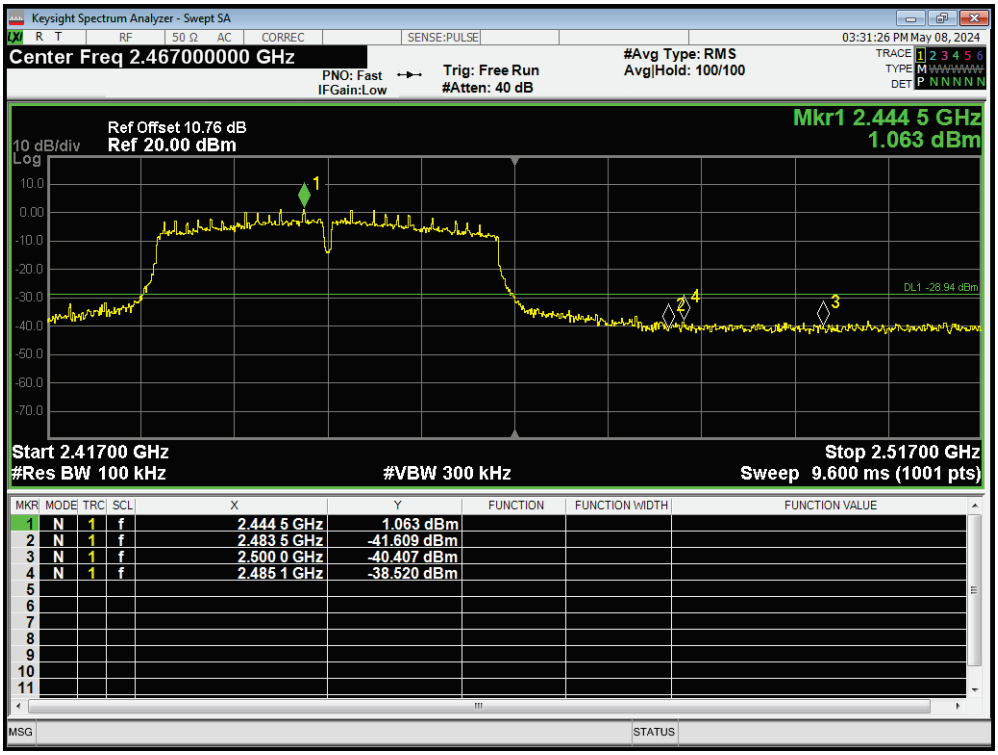
Band Edge 802.11n(HT40) 2442MHz Emission



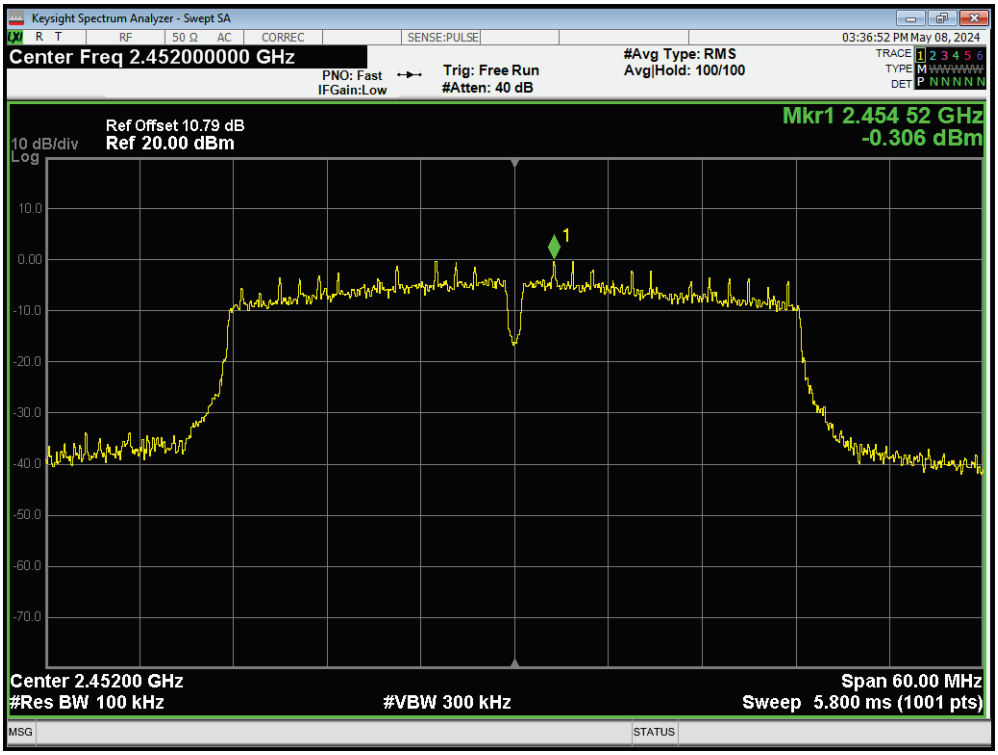
Band Edge 802.11n(HT40) 2447MHz Ref



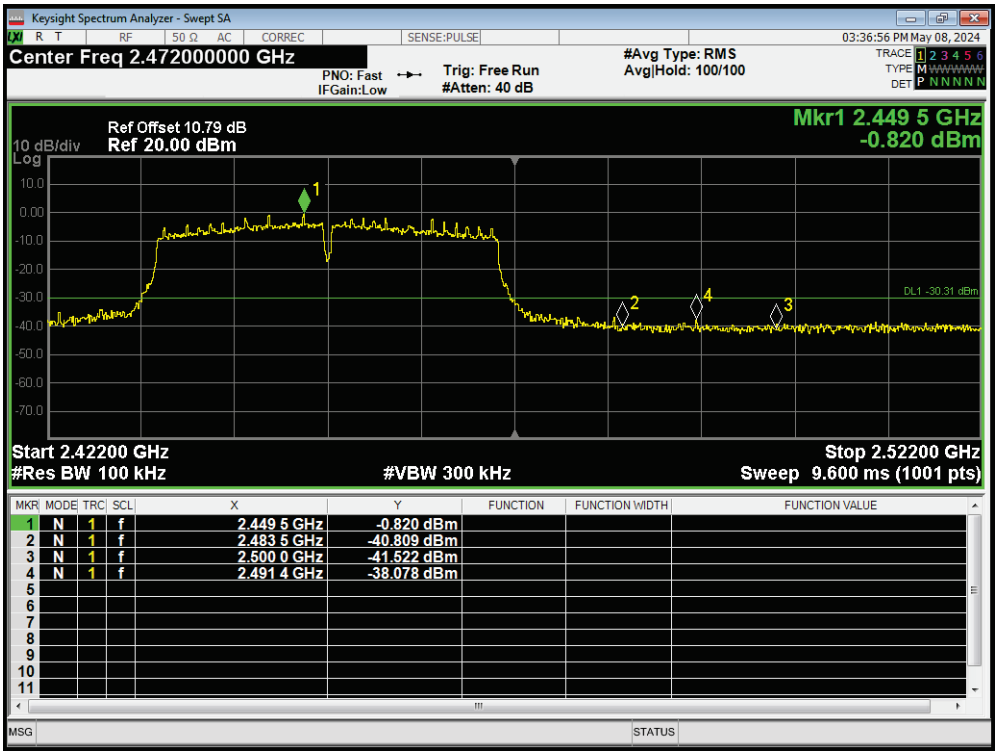
Band Edge 802.11n(HT40) 2447MHz Emission



Band Edge 802.11n(HT40) 2452MHz Ref



Band Edge 802.11n(HT40) 2452MHz 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

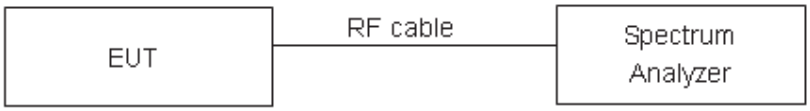
k) Use the peak marker function to determine the maximum amplitude level

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:

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	-2.72	-12.72	8	PASS
	2437/CH 6	-2.65	-12.65	8	PASS
	2462/CH11	-3.70	-13.70	8	PASS
802.11g	2412/CH 1	-4.76	-14.44	8	PASS
	2437/CH 6	-4.14	-13.82	8	PASS
	2462/CH11	-4.22	-13.90	8	PASS
802.11n HT20	2412/CH 1	-4.89	-14.55	8	PASS
	2437/CH 6	-4.71	-14.37	8	PASS
	2462/CH11	-4.97	-14.63	8	PASS
802.11n HT40	2422/CH3	-7.65	-17.15	8	PASS
	2437/CH6	-7.12	-16.62	8	PASS
	2452/CH9	-7.53	-17.03	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	-3.09	-13.09	8	PASS
	2437/CH 6	-3.12	-13.12	8	PASS
	2462/CH11	-3.01	-13.01	8	PASS
802.11g	2412/CH 1	-4.46	-14.14	8	PASS
	2437/CH 6	-4.52	-14.20	8	PASS
	2462/CH11	-4.45	-14.13	8	PASS
802.11n HT20	2412/CH 1	-4.11	-13.77	8	PASS
	2437/CH 6	-3.85	-13.51	8	PASS
	2462/CH11	-5.05	-14.71	8	PASS
802.11n HT40	2422/CH3	-7.09	-16.59	8	PASS
	2437/CH6	-7.62	-17.12	8	PASS
	2452/CH9	-7.98	-17.48	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	-3.25	-13.25	-3.00	-13.00	-10.11	7.87	PASS
	2437/CH 6	-3.09	-13.09	-2.58	-12.58	-9.82	7.87	PASS
	2462/CH11	-3.50	-13.50	-3.39	-13.39	-10.43	7.87	PASS
802.11g	2412/CH 1	-8.47	-18.15	-8.56	-18.24	-15.18	7.87	PASS
	2417/CH 2	-5.37	-15.05	-5.54	-15.22	-12.12	7.87	PASS
	2422/ CH 3	-4.92	-14.60	-4.33	-14.01	-11.28	7.87	PASS
	2437/CH 6	-4.79	-14.47	-4.49	-14.17	-11.31	7.87	PASS
	2452/CH 9	-5.10	-14.78	-4.54	-14.22	-11.48	7.87	PASS
	2457/CH 10	-7.17	-16.85	-6.32	-16.00	-13.39	7.87	PASS
	2462/CH11	-9.57	-19.25	-8.81	-18.49	-15.84	7.87	PASS
802.11n HT20	2412/CH 1	-9.82	-19.48	-9.10	-18.76	-16.09	7.87	PASS
	2417/CH 2	-6.27	-15.93	-4.73	-14.39	-12.08	7.87	PASS
	2422/ CH 3	-5.31	-14.97	-4.35	-14.01	-11.45	7.87	PASS
	2437/CH 6	-4.79	-14.45	-3.96	-13.62	-11.00	7.87	PASS
	2452/CH 9	-4.43	-14.09	-4.15	-13.81	-10.94	7.87	PASS
	2457/CH 10	-8.05	-17.71	-6.28	-15.94	-13.73	7.87	PASS
	2462/CH11	-10.36	-20.02	-9.29	-18.95	-16.44	7.87	PASS
802.11n HT40	2422/CH3	-14.34	-23.84	-13.00	-22.50	-20.11	7.87	PASS
	2427/CH4	-12.61	-22.11	-12.11	-21.61	-18.84	7.87	PASS
	2432/CH5	-10.82	-20.32	-10.72	-20.22	-17.26	7.87	PASS
	2437/CH6	-9.54	-19.04	-9.81	-19.31	-16.16	7.87	PASS
	2442/CH7	-10.64	-20.14	-10.69	-20.19	-17.16	7.87	PASS
	2447/CH8	-13.45	-22.95	-12.20	-21.70	-19.27	7.87	PASS
	2452/CH9	-14.96	-24.46	-13.92	-23.42	-20.90	7.87	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=3.12 +10log(2/1)=6.13 >6dBi.

So the PSD limit is 8+6-MAX(6, directional gain) dBm=7.87 dBm

Beamforming

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	-3.25	-13.25	-3.00	-13.00	-10.11	8	PASS
	2437/CH 6	-3.09	-13.09	-2.58	-12.58	-9.82	8	PASS
	2462/CH11	-3.50	-13.50	-3.39	-13.39	-10.43	8	PASS
802.11g	2412/CH 1	-8.47	-18.15	-8.56	-18.24	-15.18	8	PASS
	2417/CH 2	-5.37	-15.05	-5.54	-15.22	-12.12	8	PASS
	2422/ CH 3	-4.92	-14.60	-4.33	-14.01	-11.28	8	PASS
	2437/CH 6	-4.79	-14.47	-4.49	-14.17	-11.31	8	PASS
	2452/CH 9	-5.10	-14.78	-4.54	-14.22	-11.48	8	PASS
	2457/CH 10	-7.17	-16.85	-6.32	-16.00	-13.39	8	PASS
	2462/CH11	-9.57	-19.25	-8.81	-18.49	-15.84	8	PASS
802.11n HT20	2412/CH 1	-9.82	-19.48	-9.10	-18.76	-16.09	8	PASS
	2417/CH 2	-6.27	-15.93	-4.73	-14.39	-12.08	8	PASS
	2422/ CH 3	-5.31	-14.97	-4.35	-14.01	-11.45	8	PASS
	2437/CH 6	-4.79	-14.45	-3.96	-13.62	-11.00	8	PASS
	2452/CH 9	-4.43	-14.09	-4.15	-13.81	-10.94	8	PASS
	2457/CH 10	-8.05	-17.71	-6.28	-15.94	-13.73	8	PASS
	2462/CH11	-10.36	-20.02	-9.29	-18.95	-16.44	8	PASS
802.11n HT40	2422/CH3	-14.34	-23.84	-13.00	-22.50	-20.11	8	PASS
	2427/CH4	-12.61	-22.11	-12.11	-21.61	-18.84	8	PASS
	2432/CH5	-10.82	-20.32	-10.72	-20.22	-17.26	8	PASS
	2437/CH6	-9.54	-19.04	-9.81	-19.31	-16.16	8	PASS
	2442/CH7	-10.64	-20.14	-10.69	-20.19	-17.16	8	PASS
	2447/CH8	-13.45	-22.95	-12.20	-21.70	-19.27	8	PASS
	2452/CH9	-14.96	-24.46	-13.92	-23.42	-20.90	8	PASS

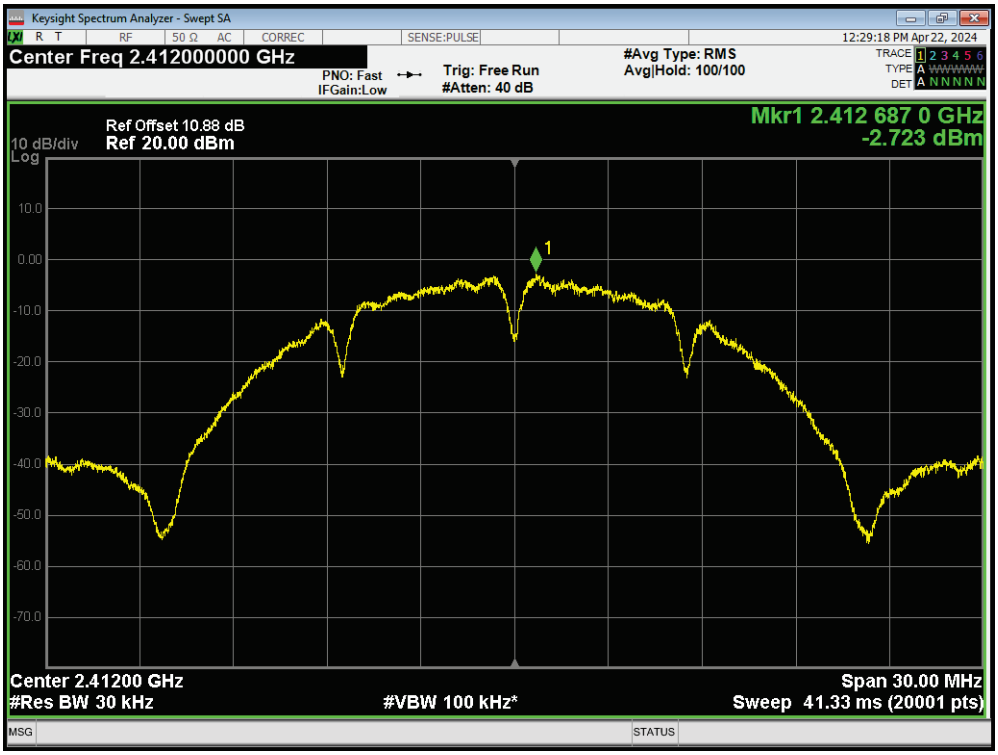
Note: 1.Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + 10*LOG10(3 / 30)

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

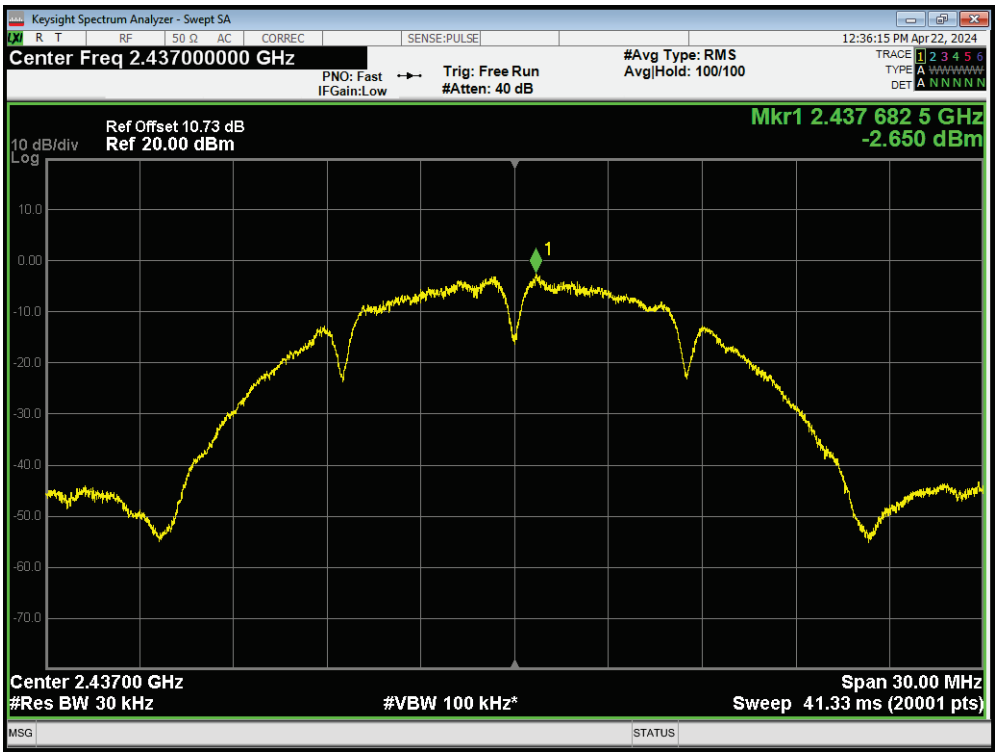
3.The manufacturer declared the directional gain is 2.80dBi. And directional gain = 2.80dBi <6dBi. So the limit is 8 dBm. Data sharing between Beamforming and MIMO.

SISO Antenna 1

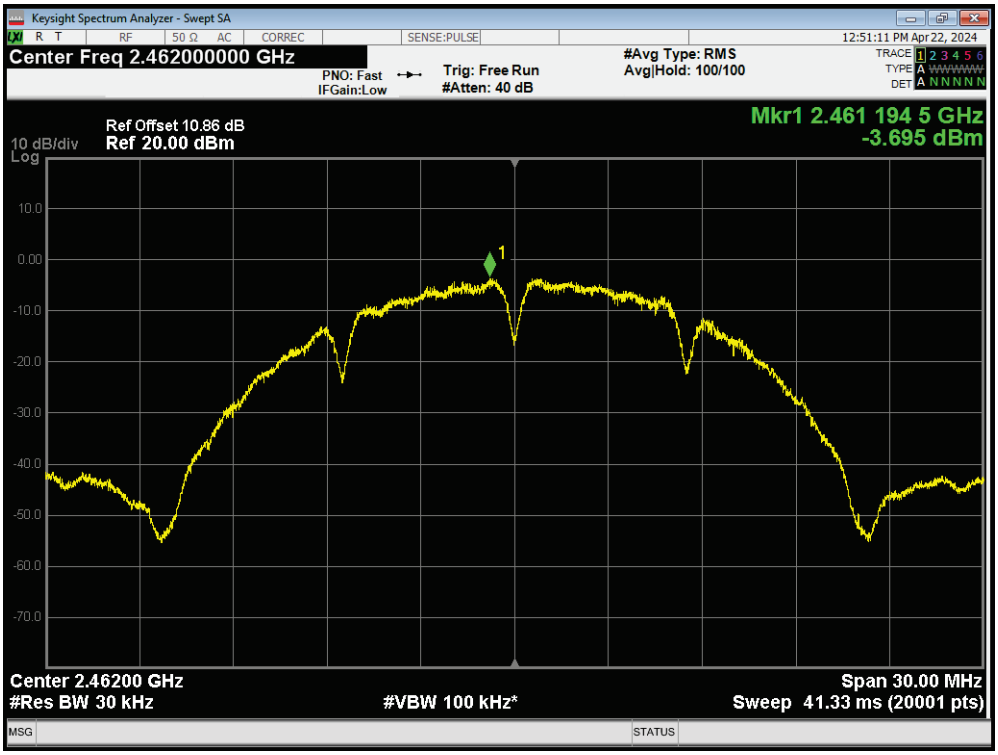
PSD 802.11b 2412MHz



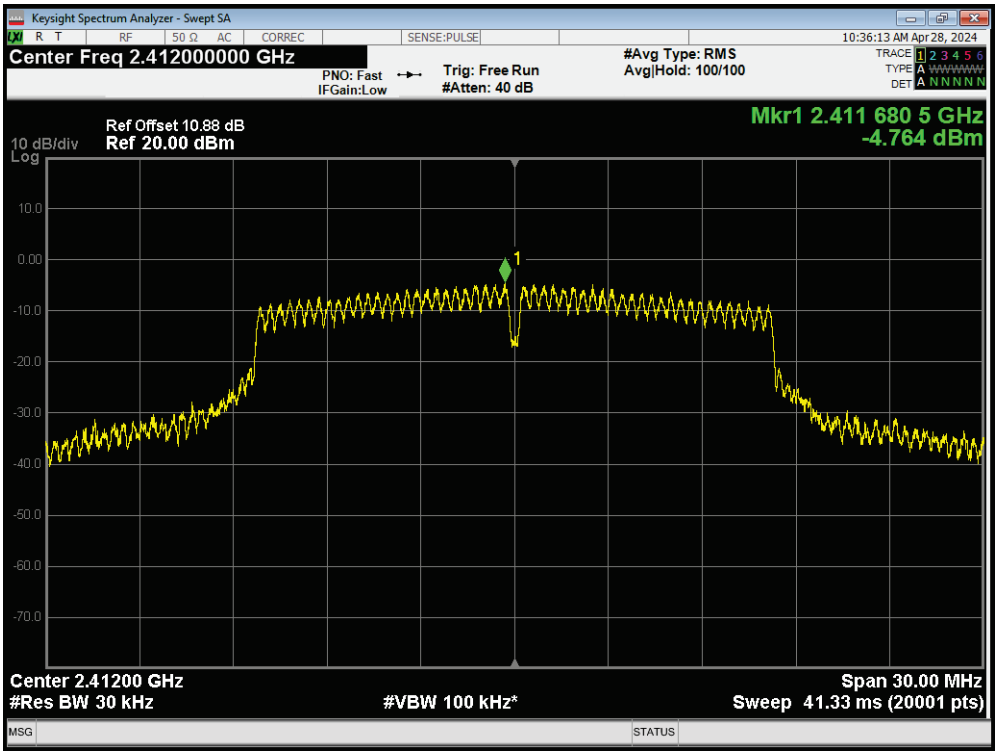
PSD 802.11b 2437MHz



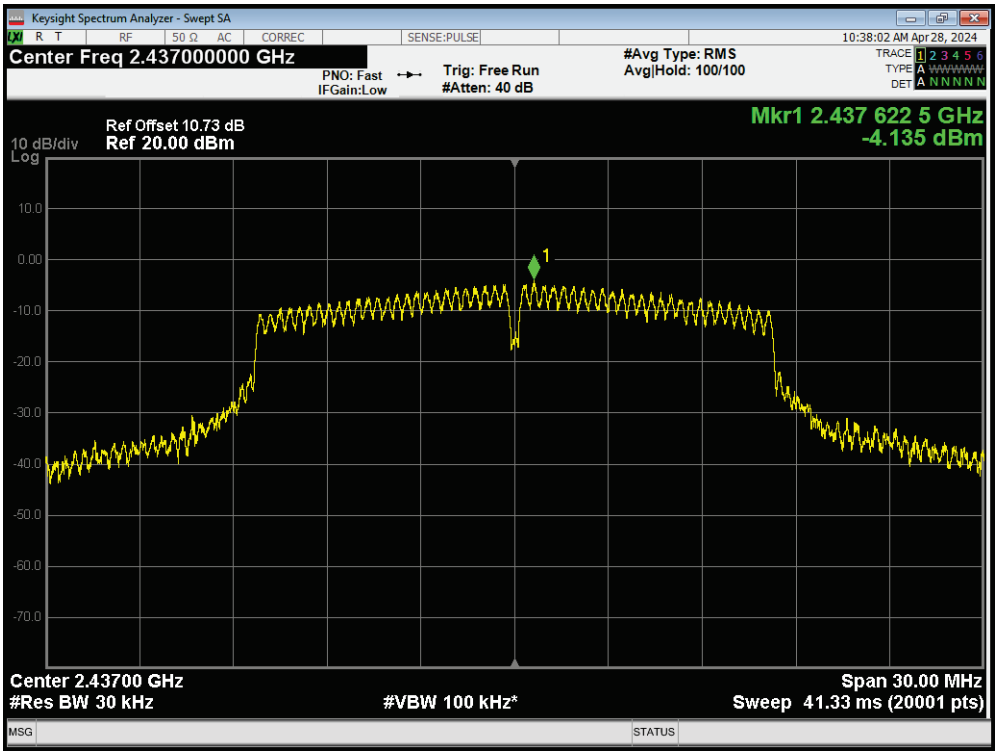
PSD 802.11b 2462MHz



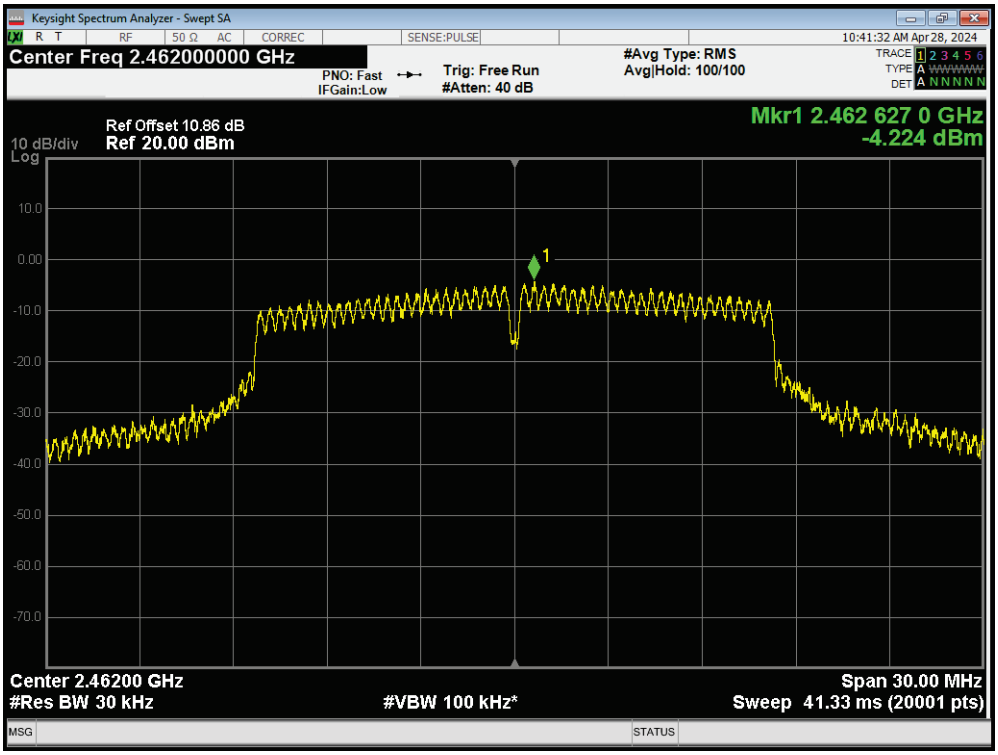
PSD 802.11g 2412MHz



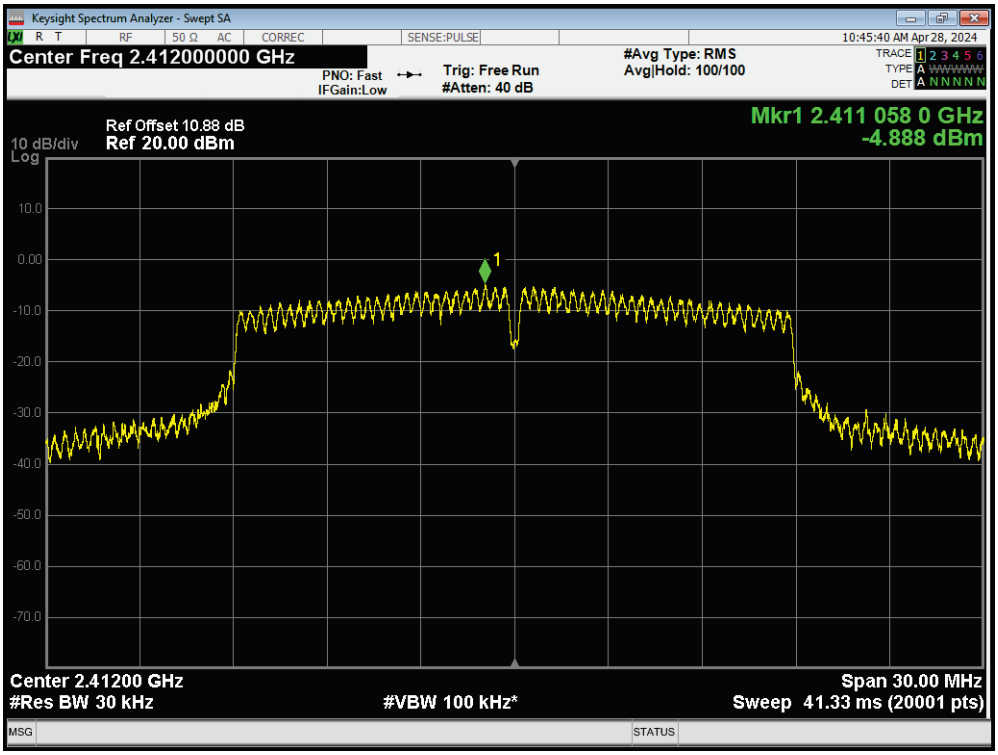
PSD 802.11g 2437MHz



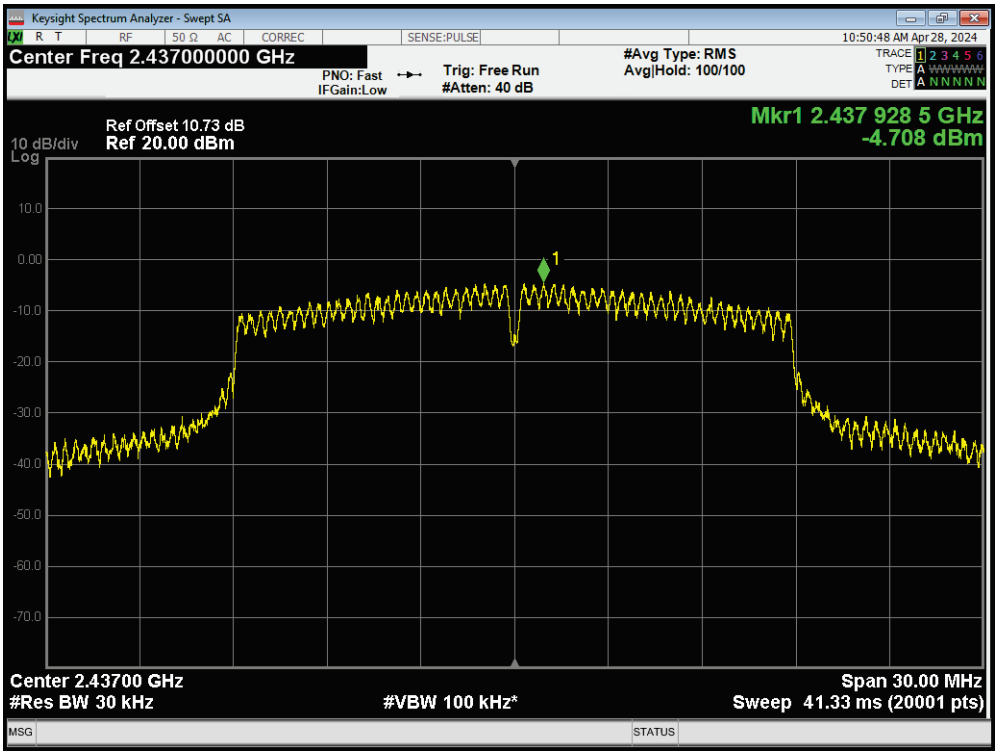
PSD 802.11g 2462MHz



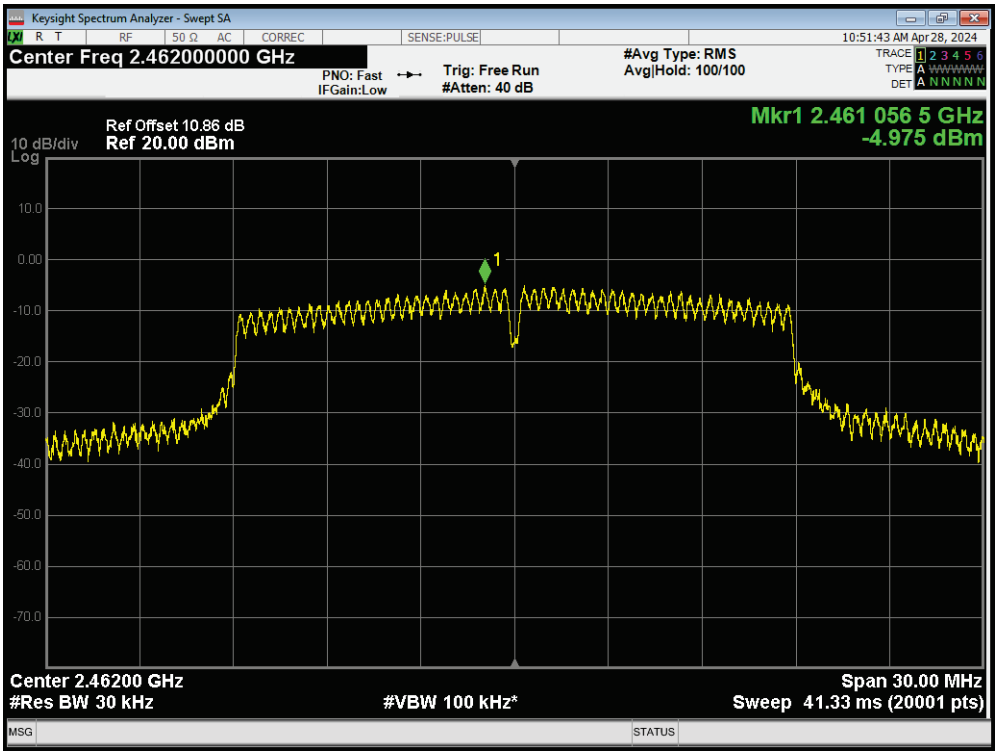
PSD 802.11n(HT20) 2412MHz



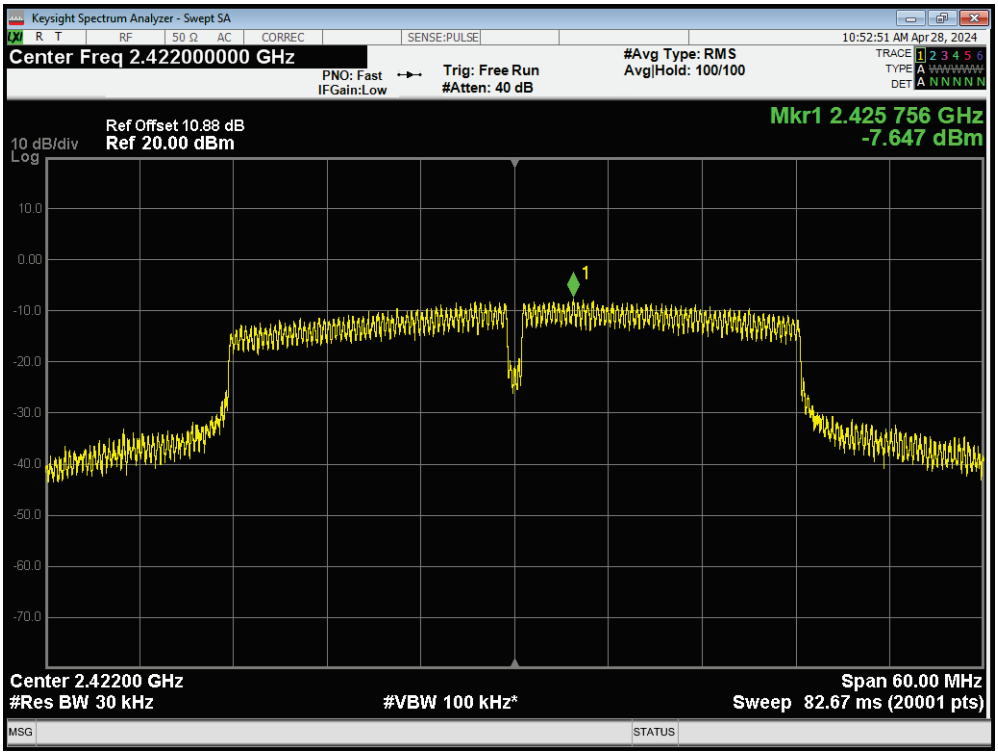
PSD 802.11n(HT20) 2437MHz



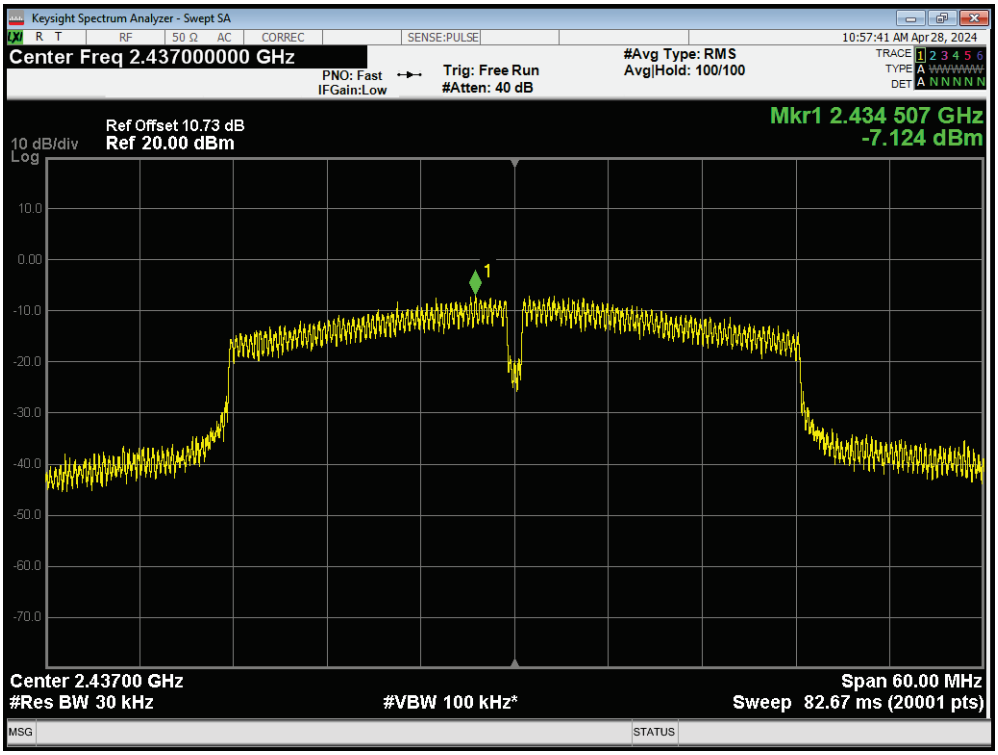
PSD 802.11n(HT20) 2462MHz



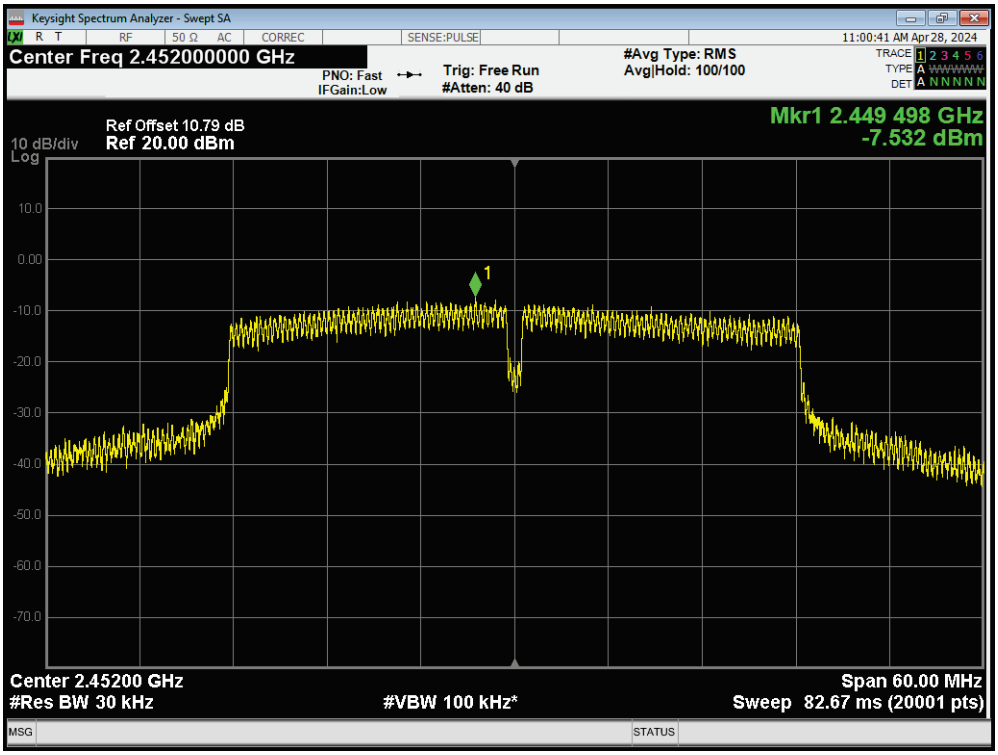
PSD 802.11n(HT40) 2422MHz



PSD 802.11n(HT40) 2437MHz

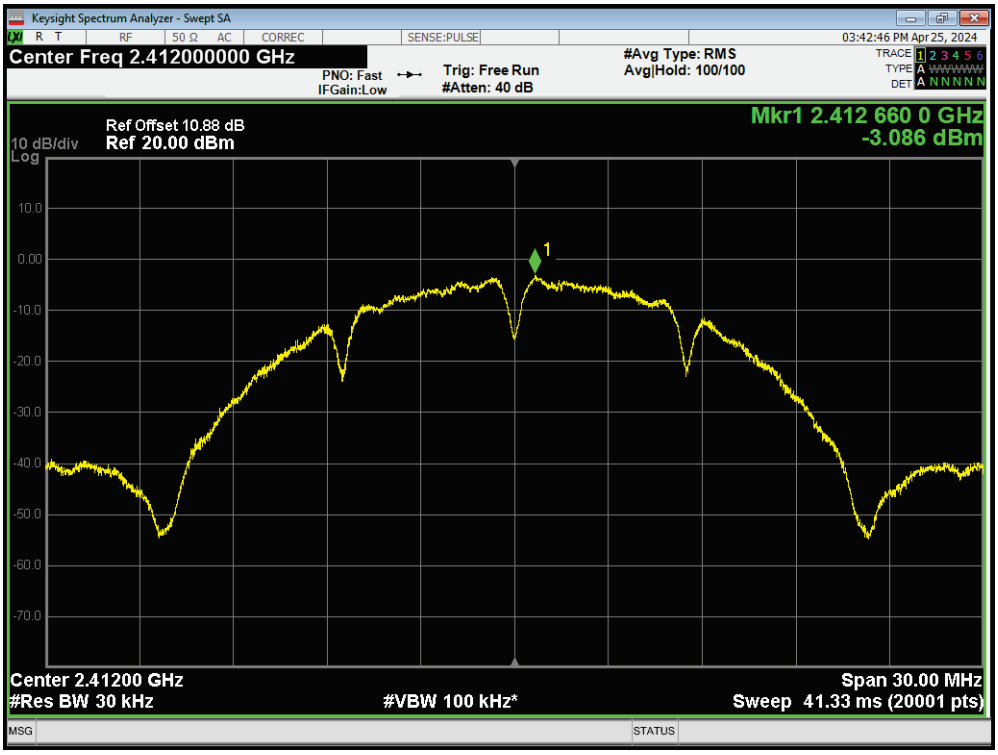


PSD 802.11n(HT40) 2452MHz

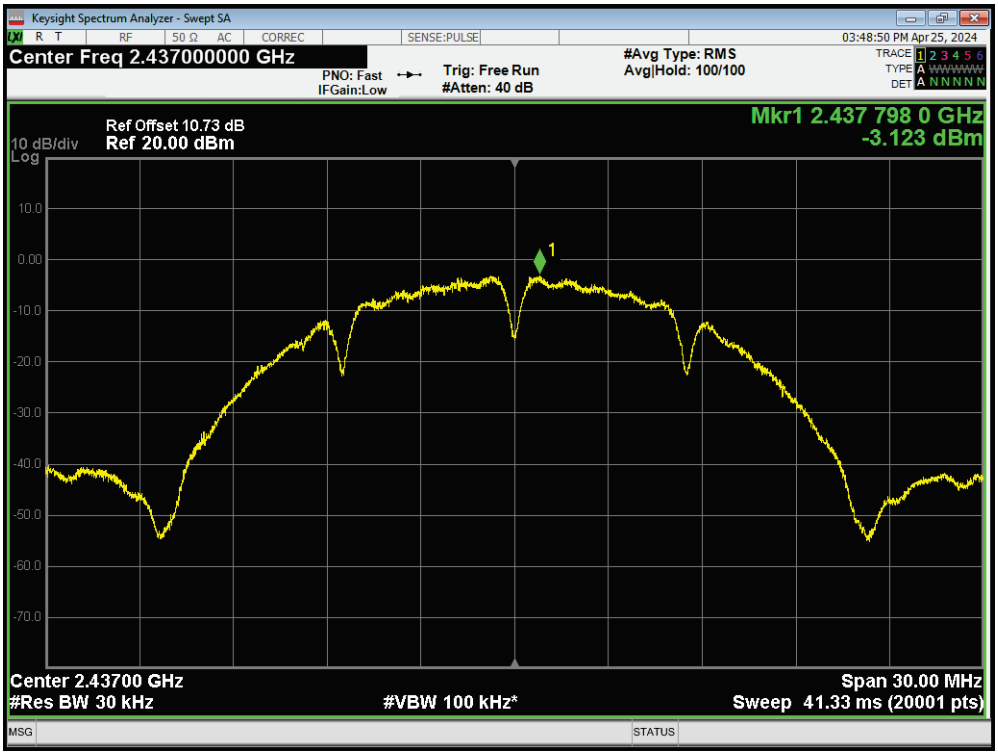


SISO Antenna 2

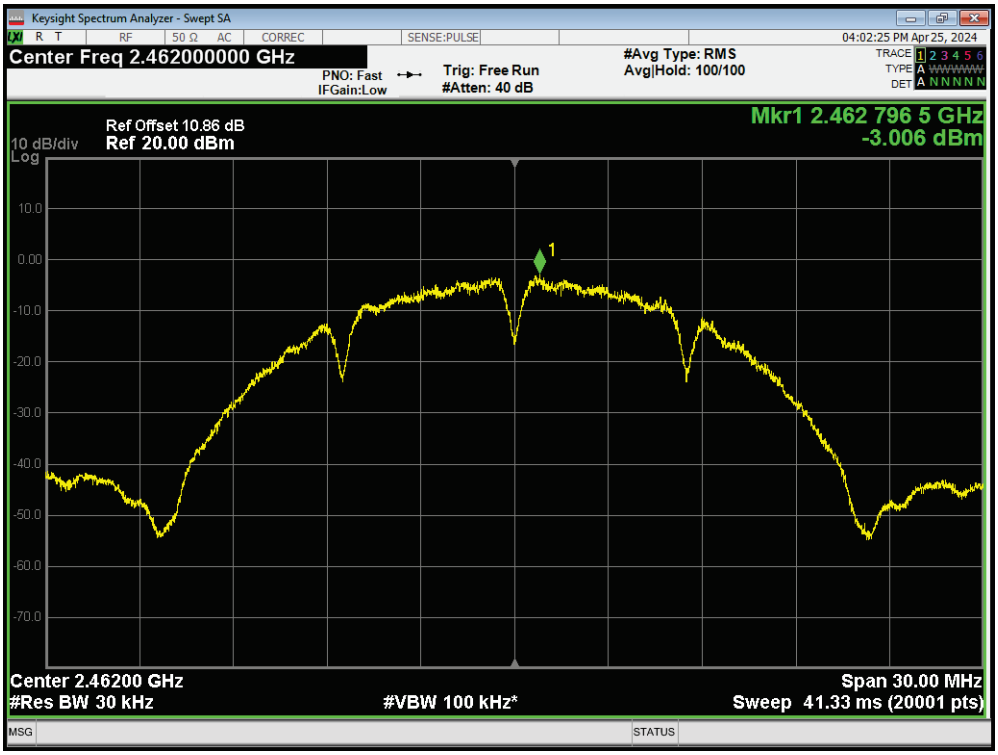
PSD 802.11b 2412MHz



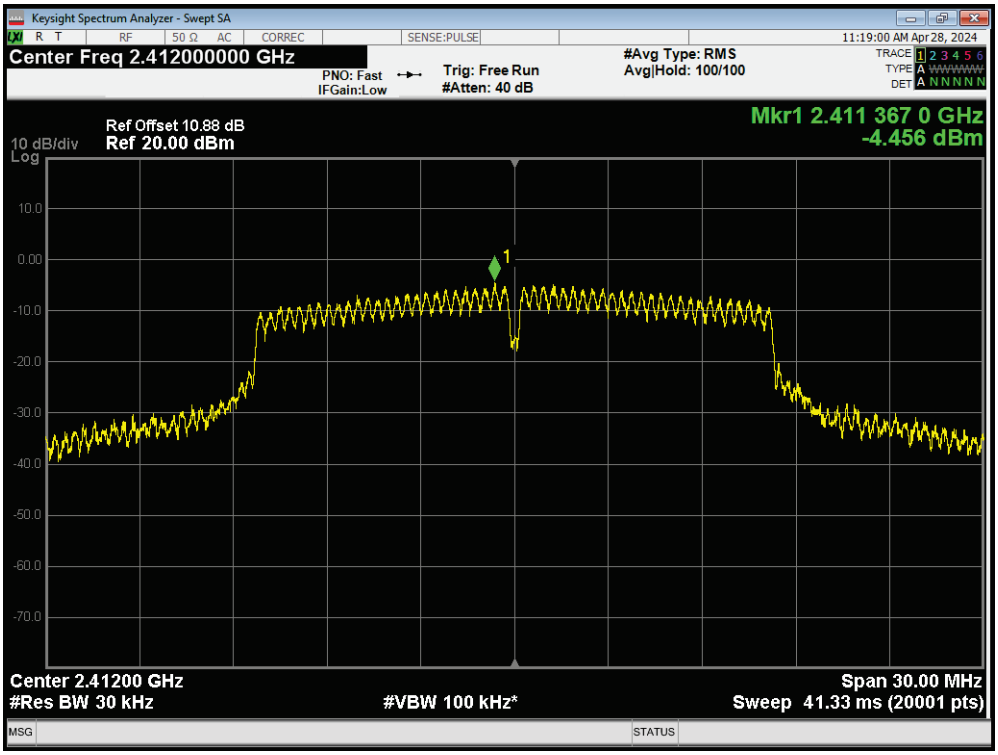
PSD 802.11b 2437MHz



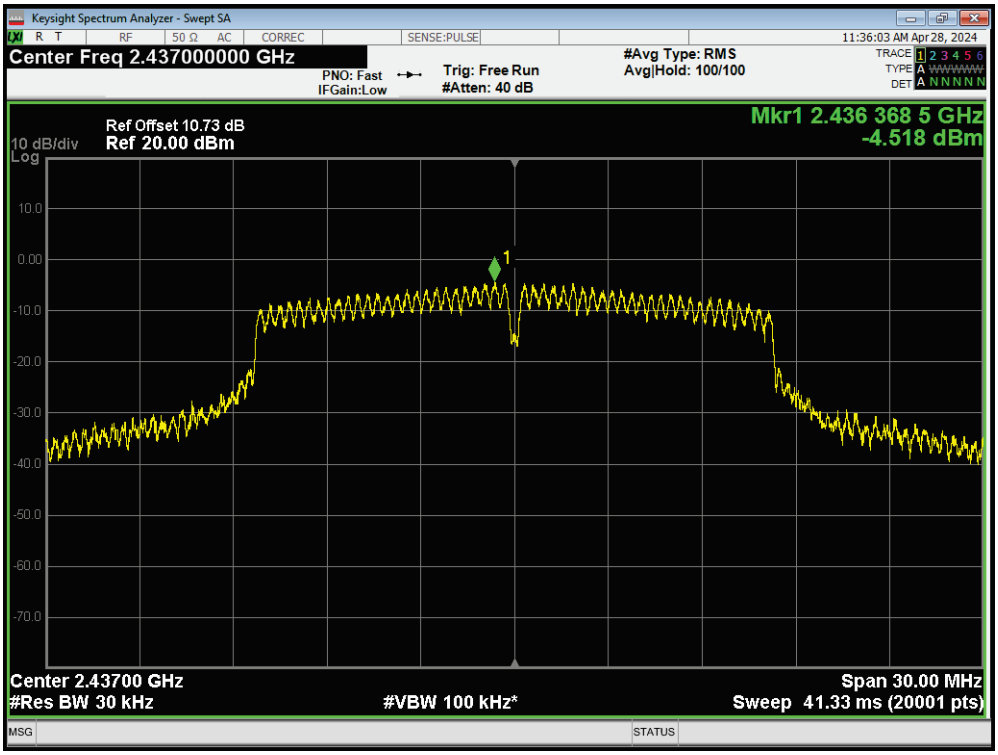
PSD 802.11b 2462MHz



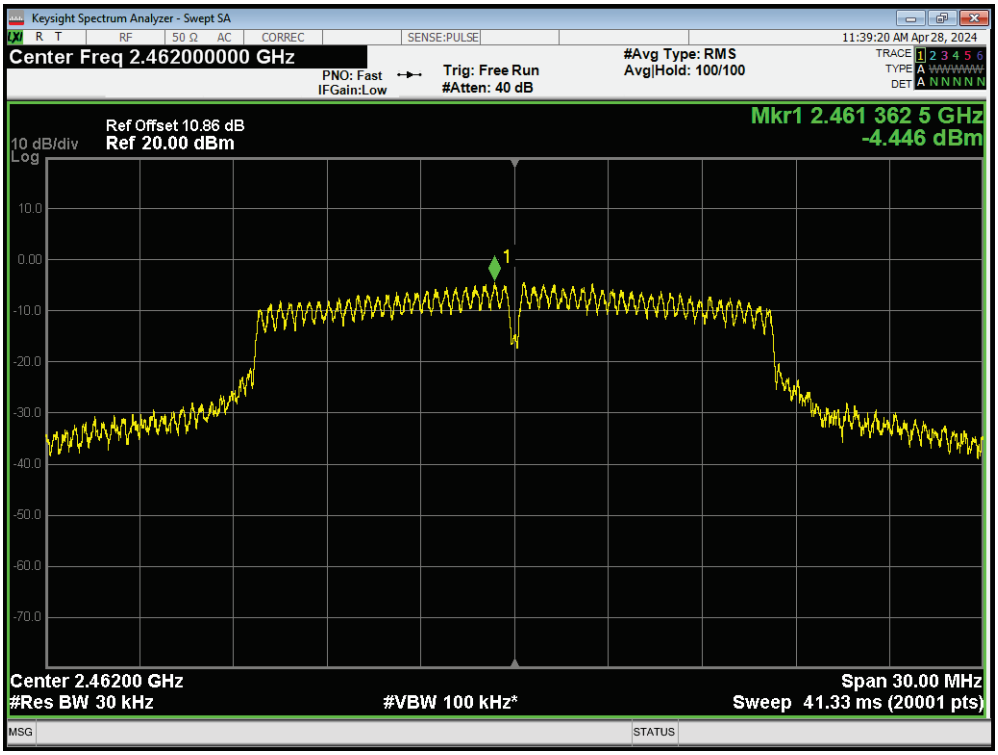
PSD 802.11g 2412MHz



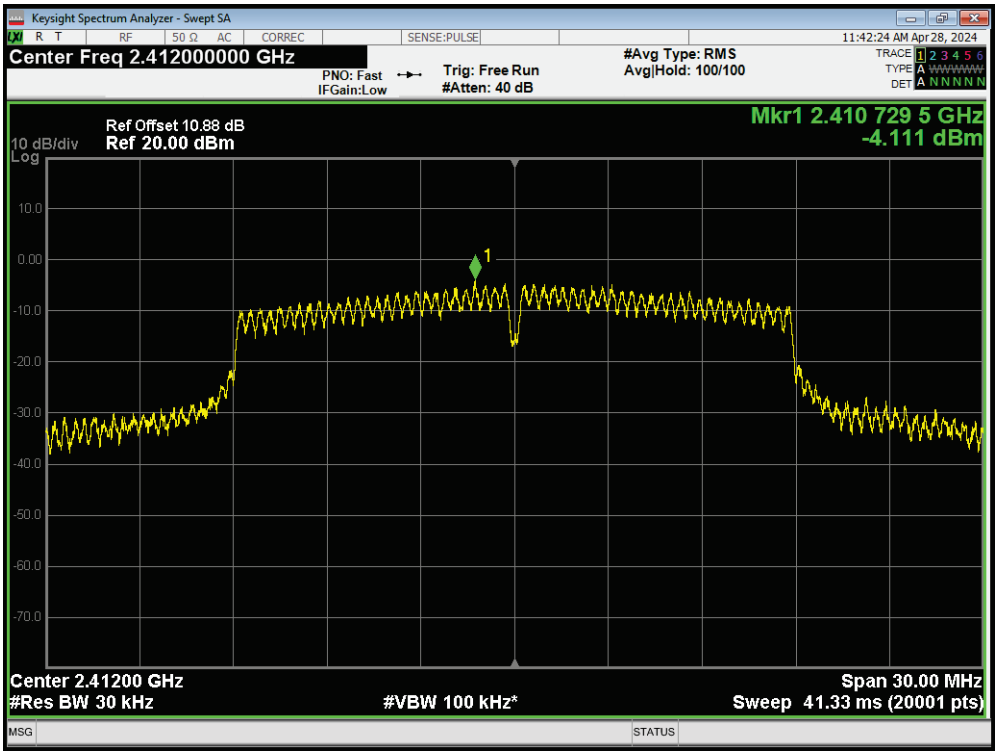
PSD 802.11g 2437MHz



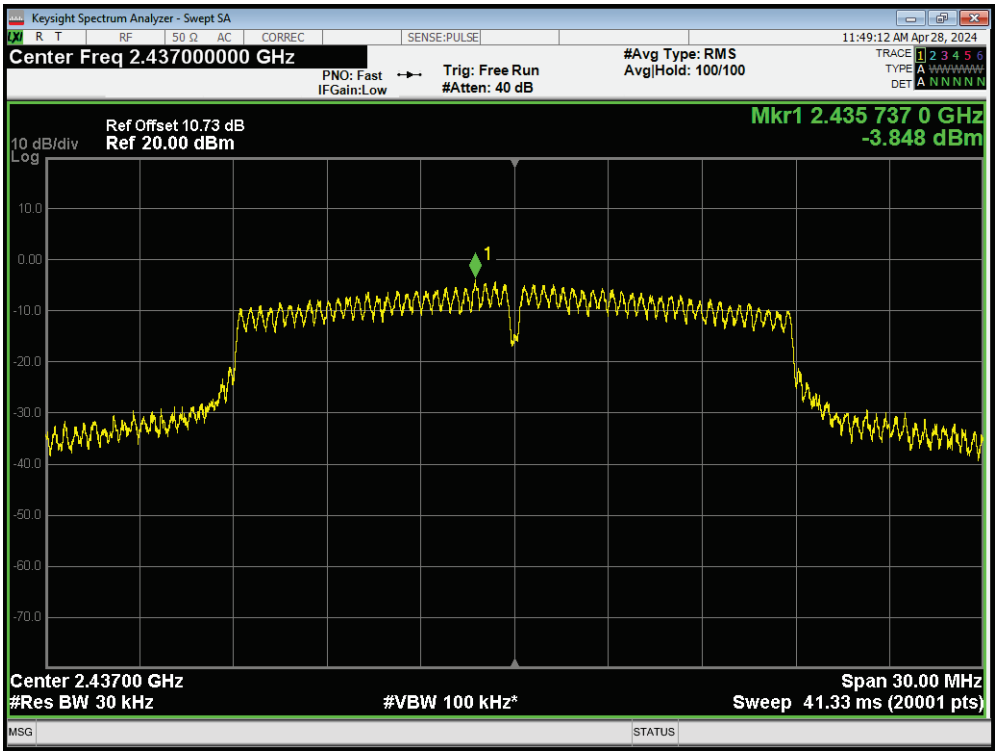
PSD 802.11g 2462MHz



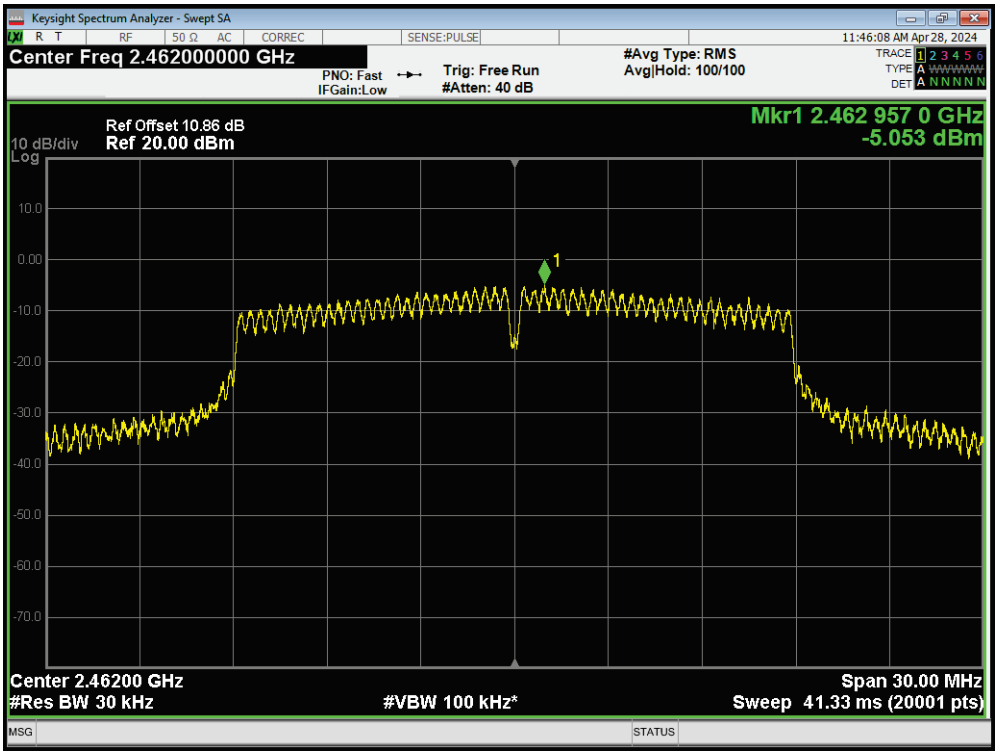
PSD 802.11n(HT20) 2412MHz



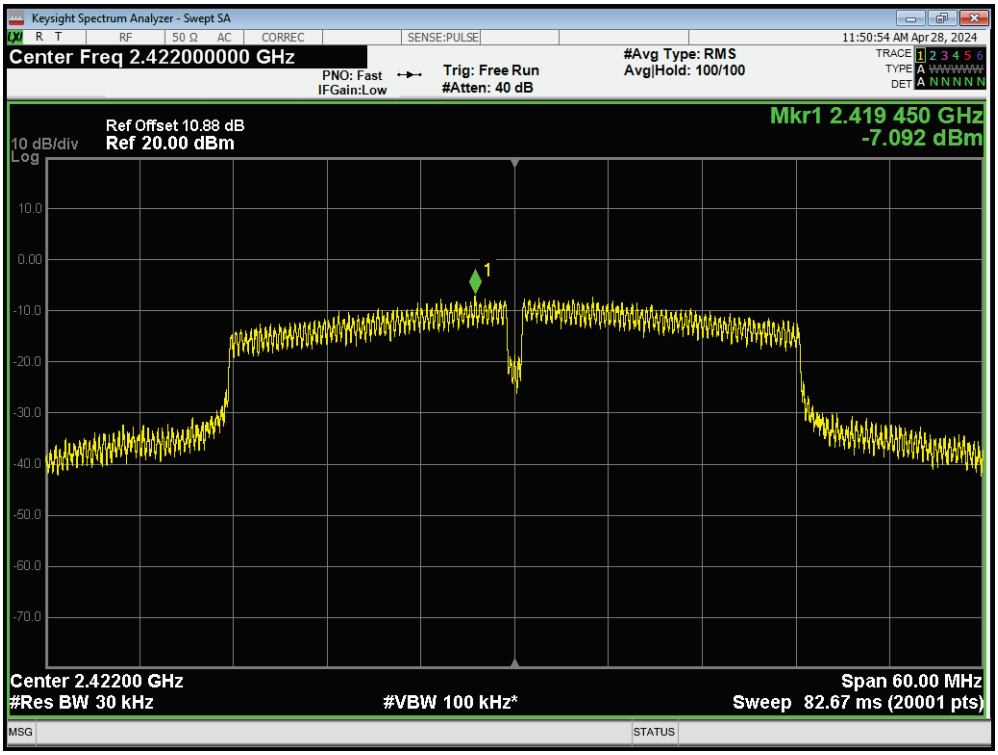
PSD 802.11n(HT20) 2437MHz



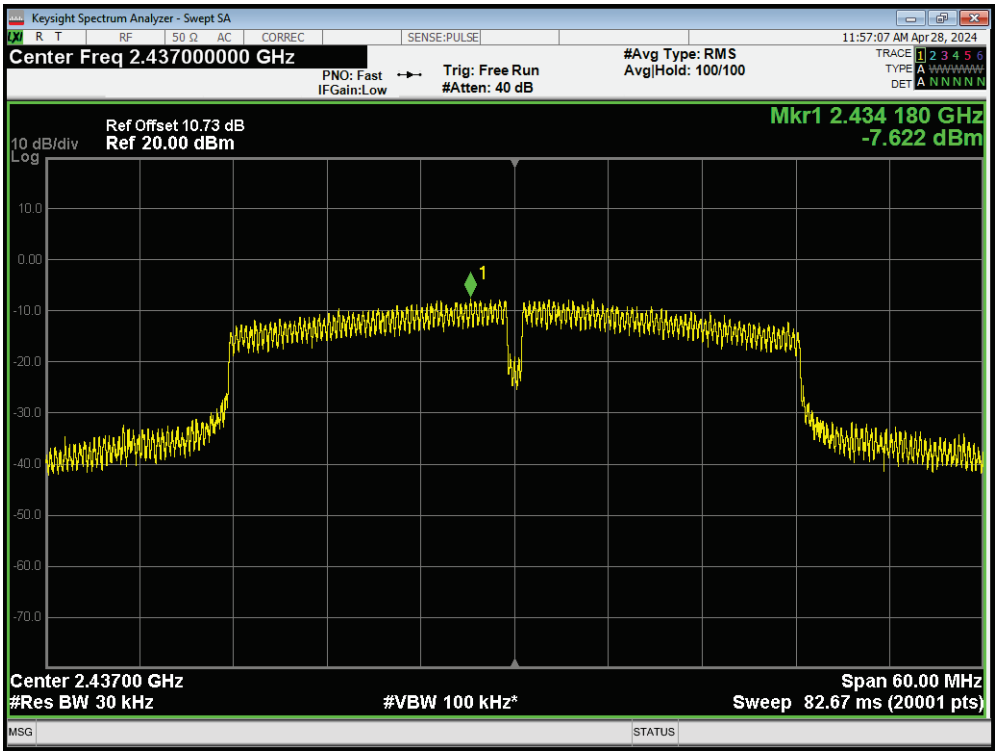
PSD 802.11n(HT20) 2462MHz



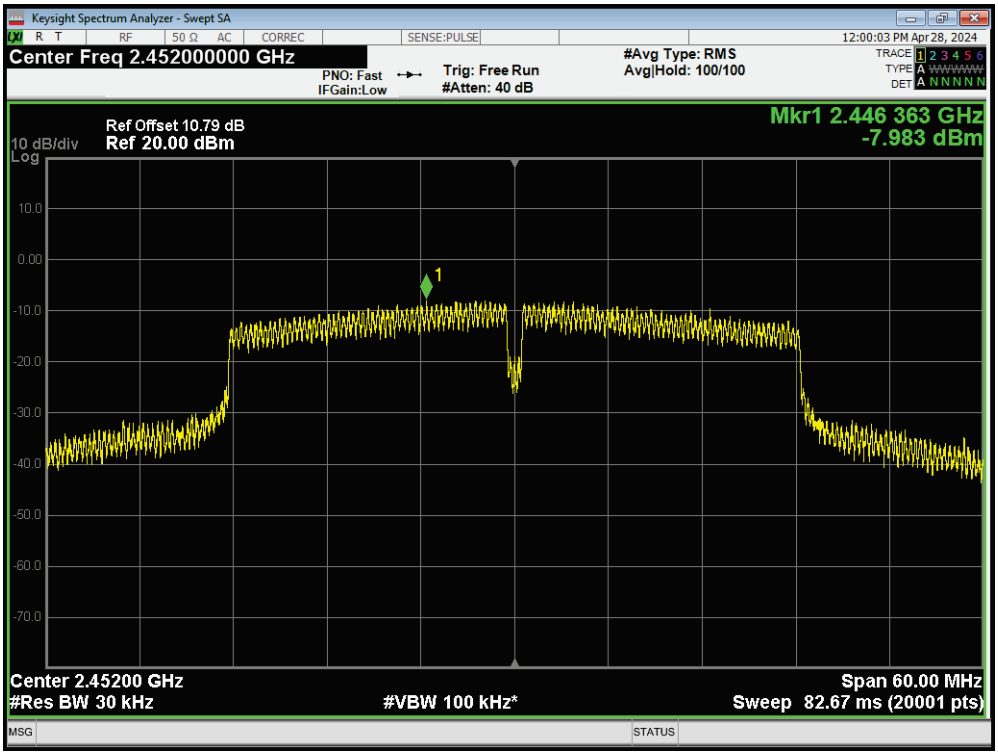
PSD 802.11n(HT40) 2422MHz



PSD 802.11n(HT40) 2437MHz

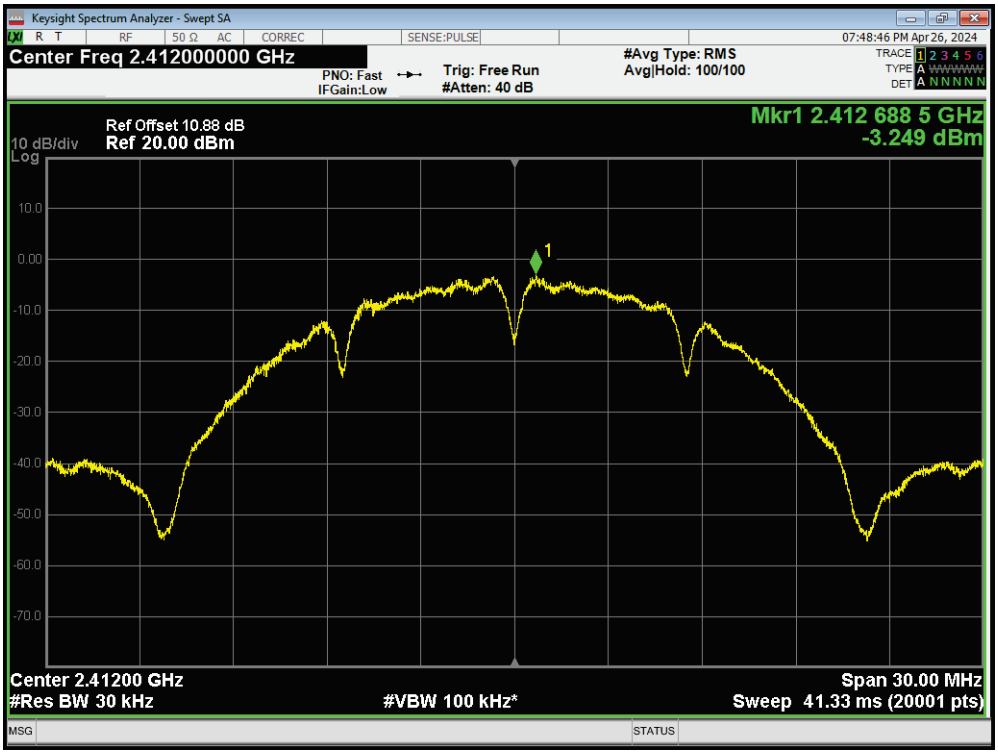


PSD 802.11n(HT40) 2452MHz

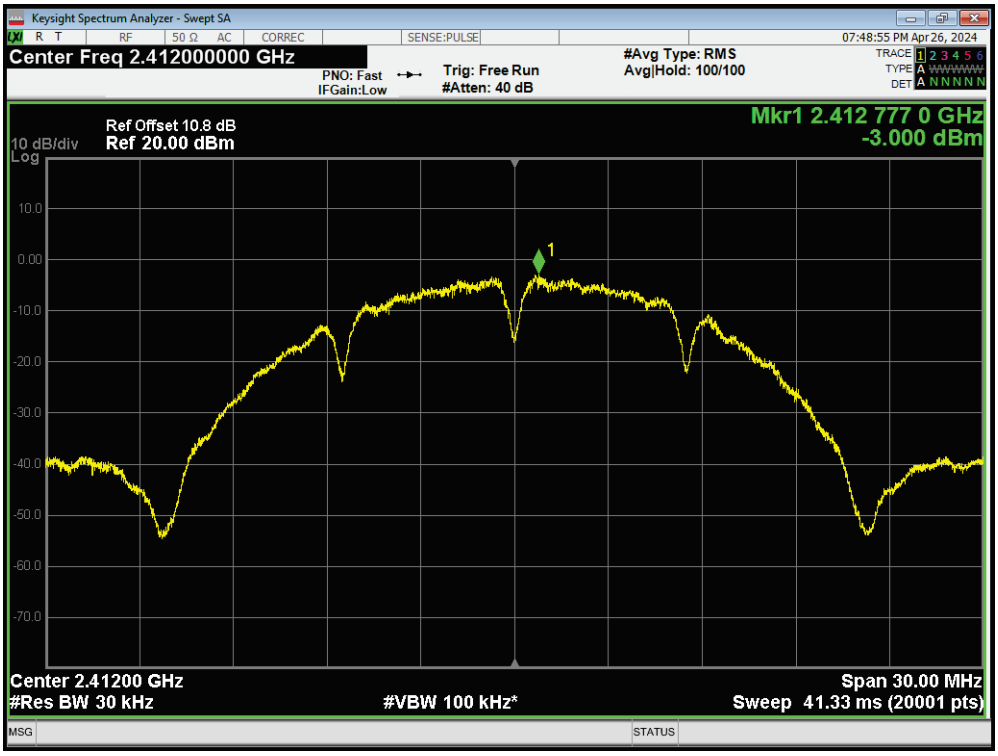


MIMO

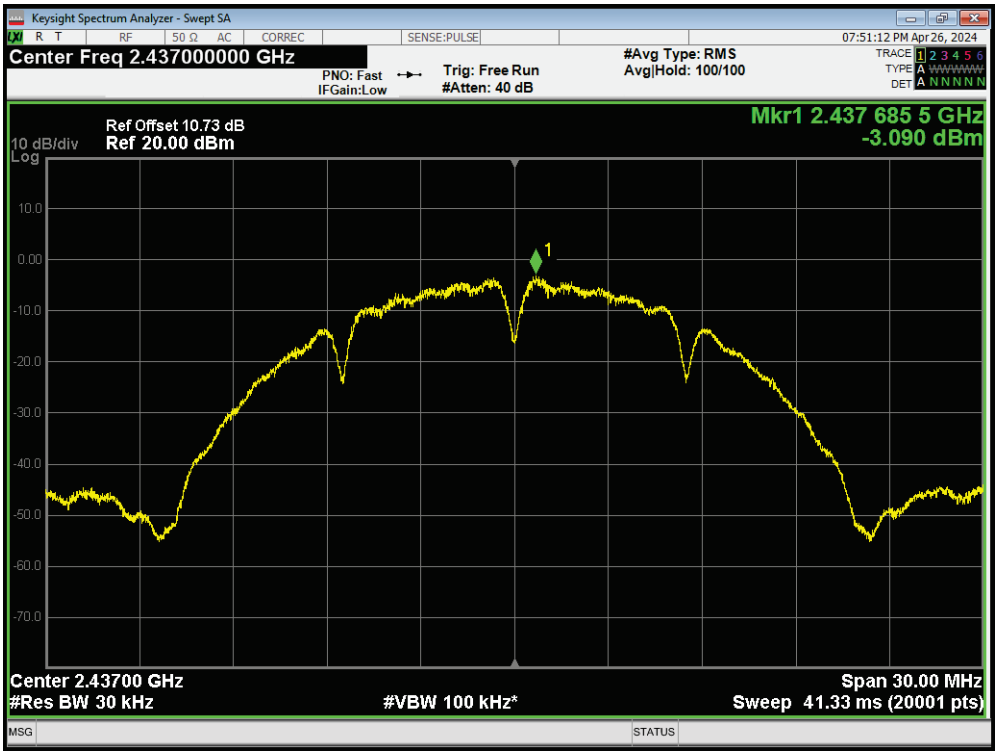
PSD 802.11b 2412MHz Ant1



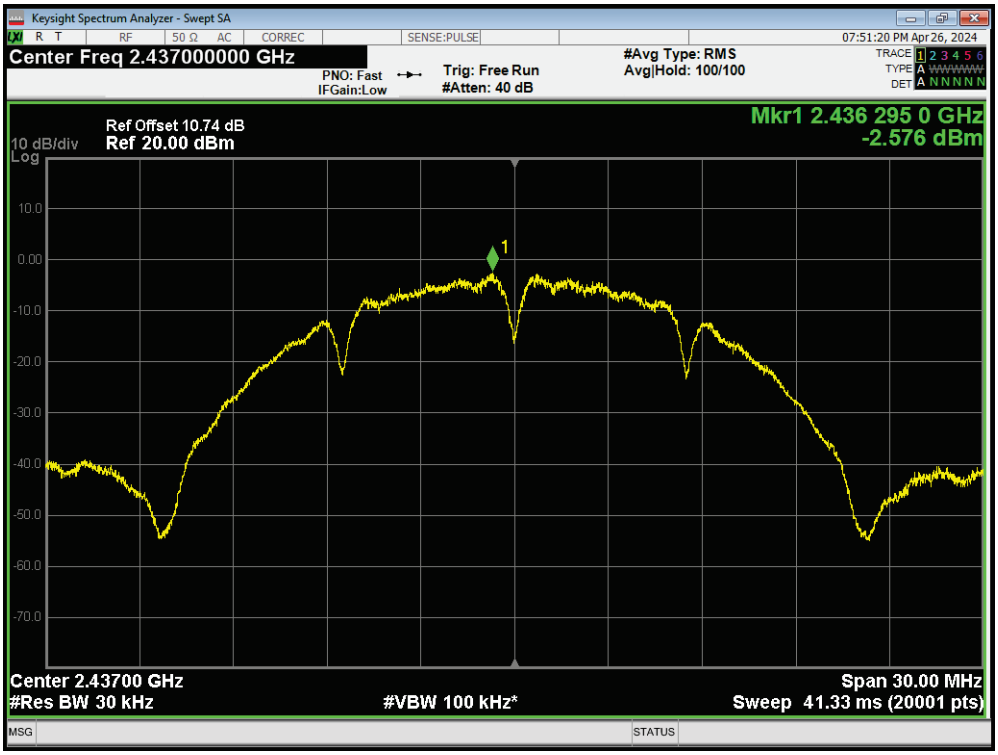
PSD 802.11b 2412MHz Ant2



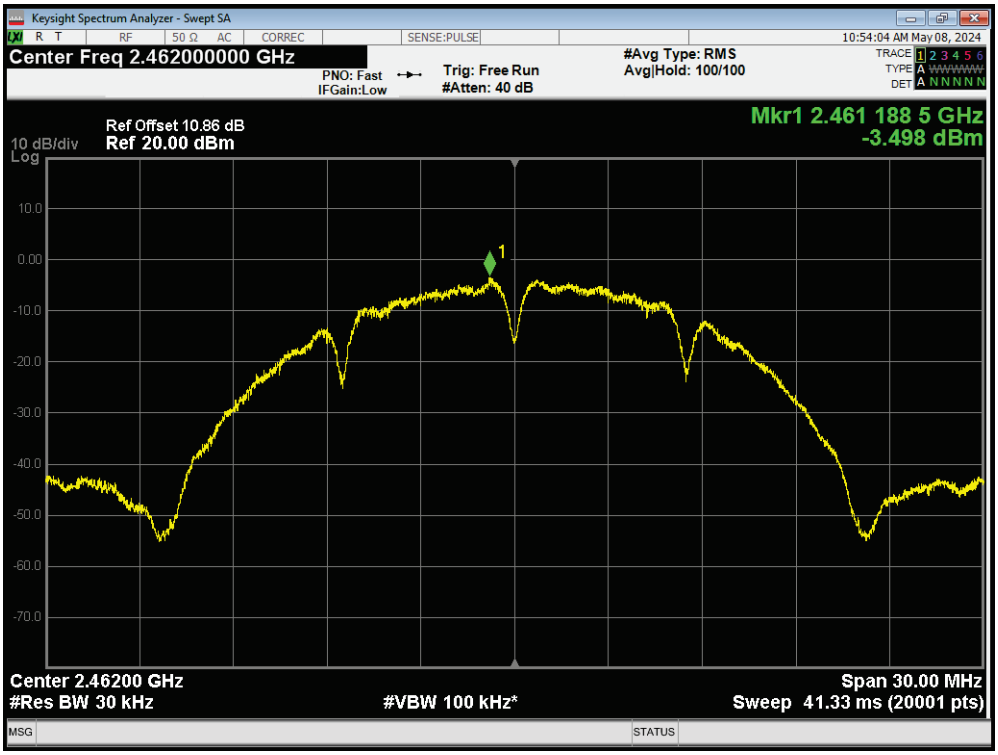
PSD 802.11b 2437MHz Ant1



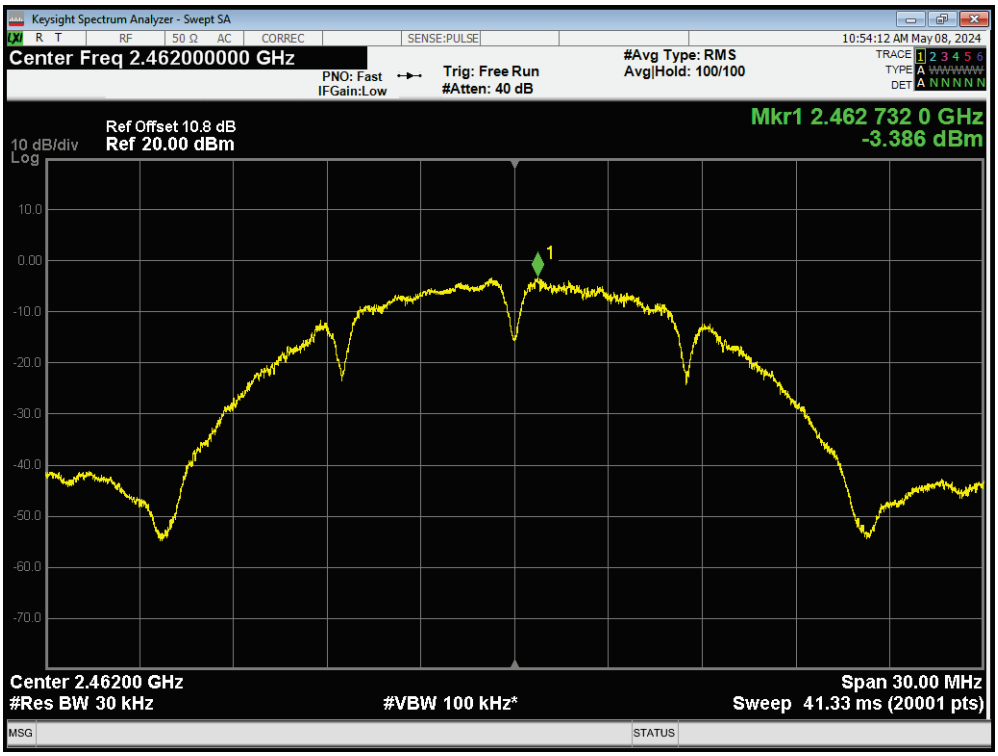
PSD 802.11b 2437MHz Ant2



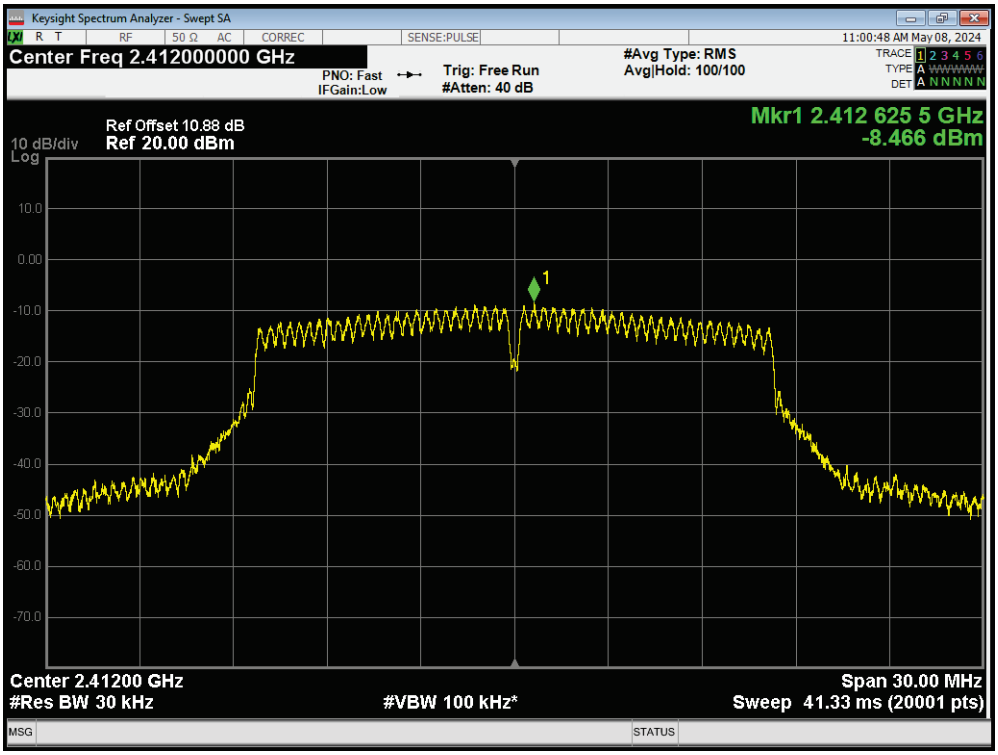
PSD 802.11b 2462MHz Ant1



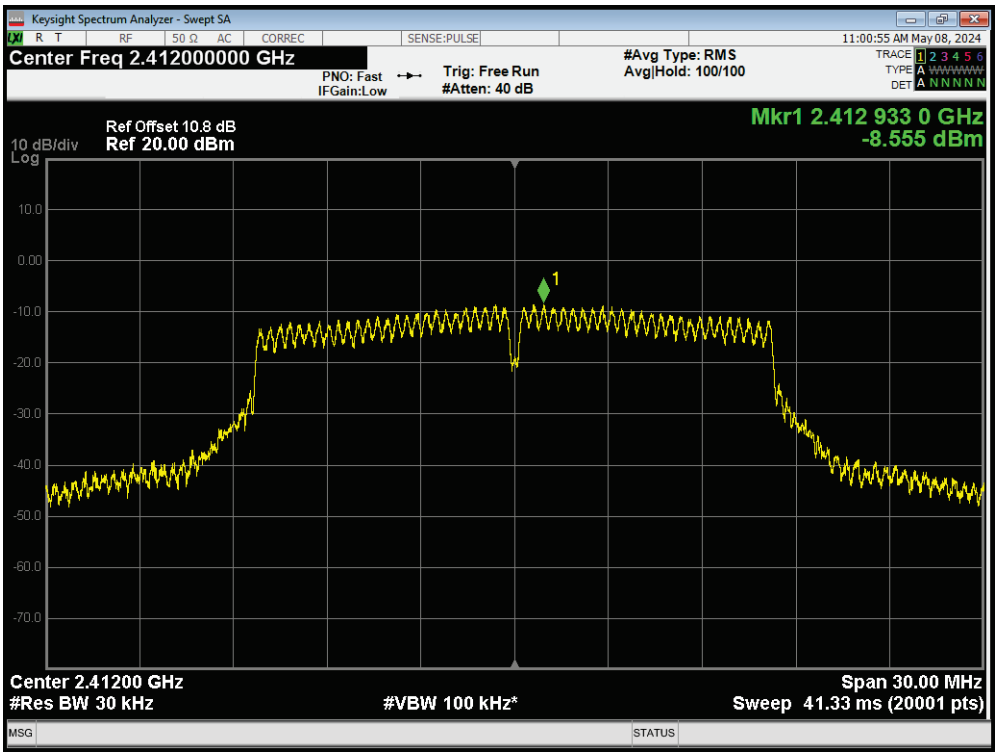
PSD 802.11b 2462MHz Ant2



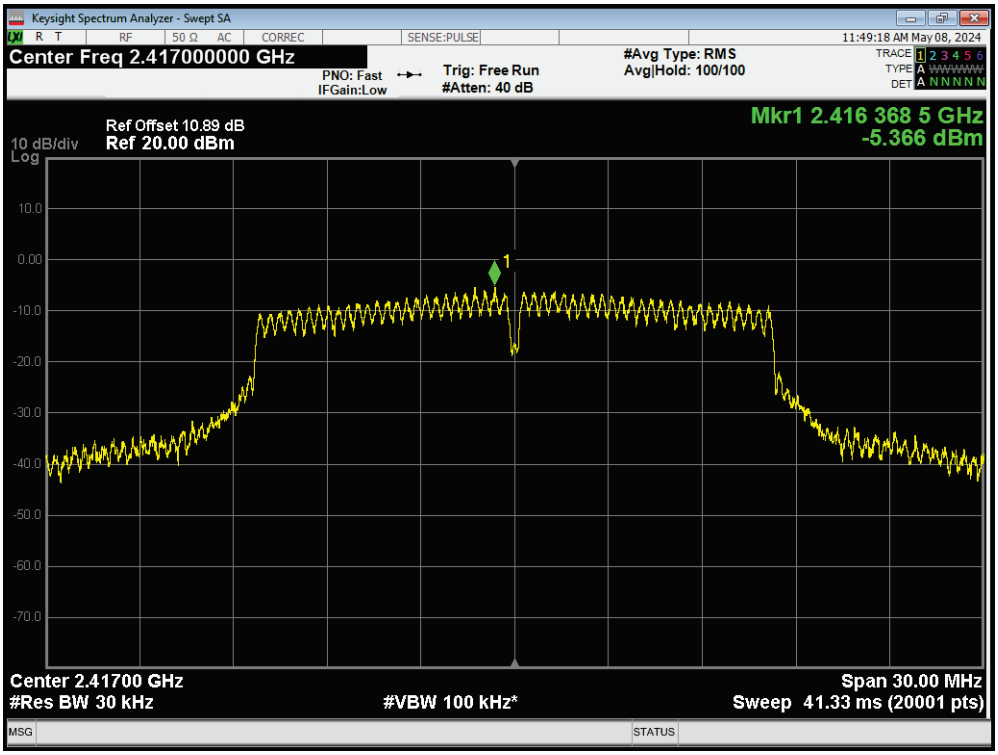
PSD 802.11g 2412MHz Ant1



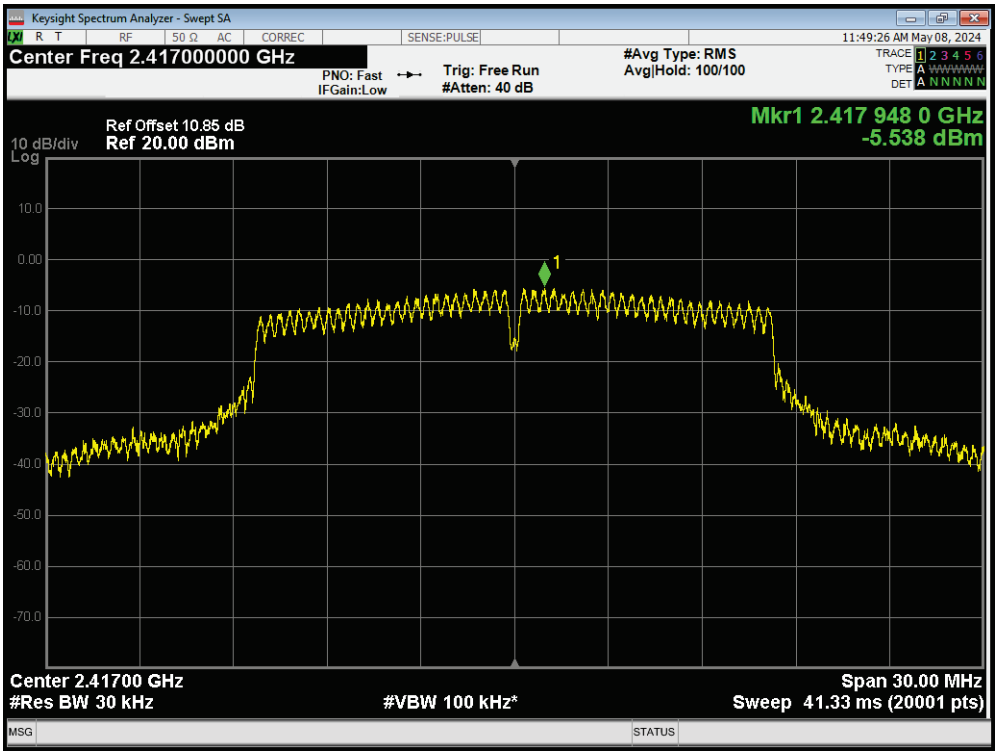
PSD 802.11g 2412MHz Ant2



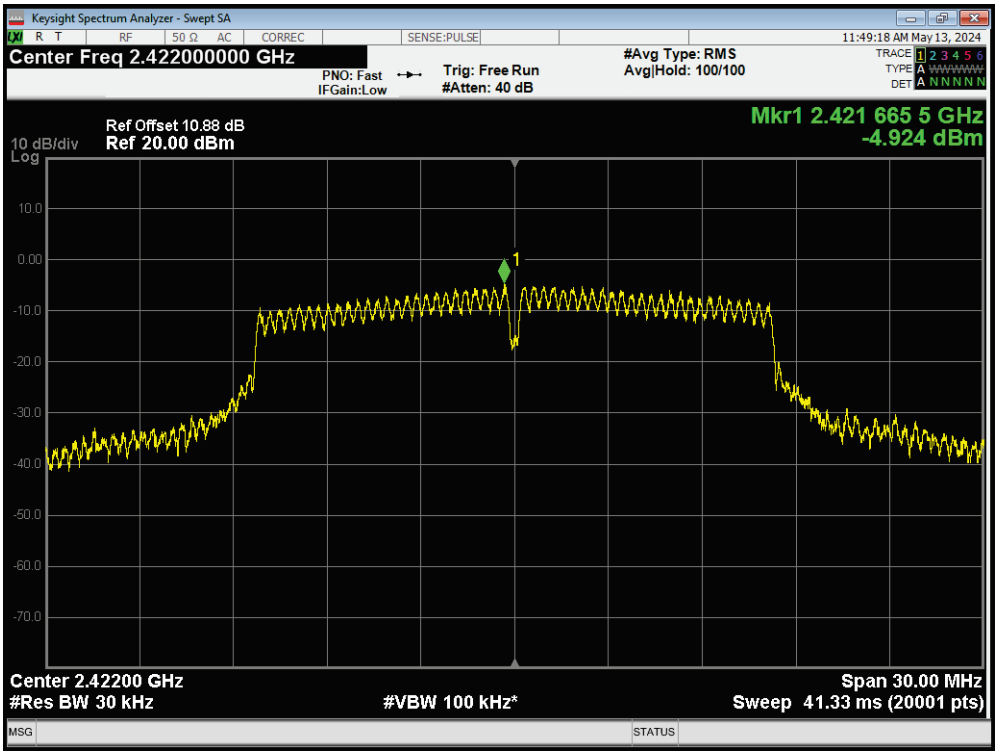
PSD 802.11g 2417MHz Ant1



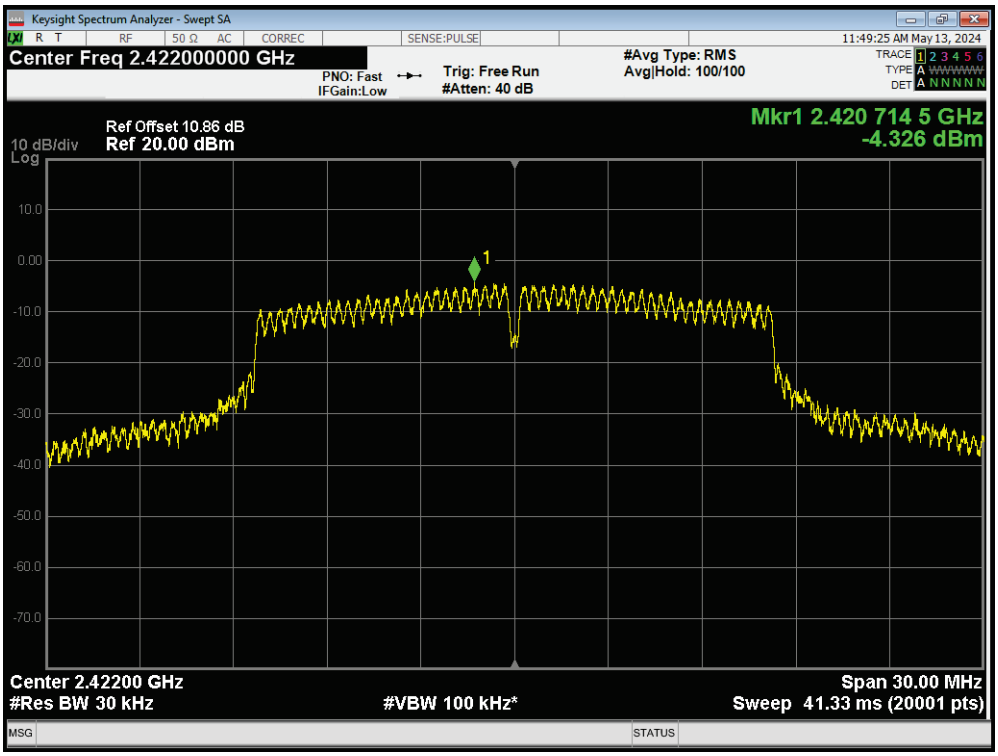
PSD 802.11g 2417MHz Ant2



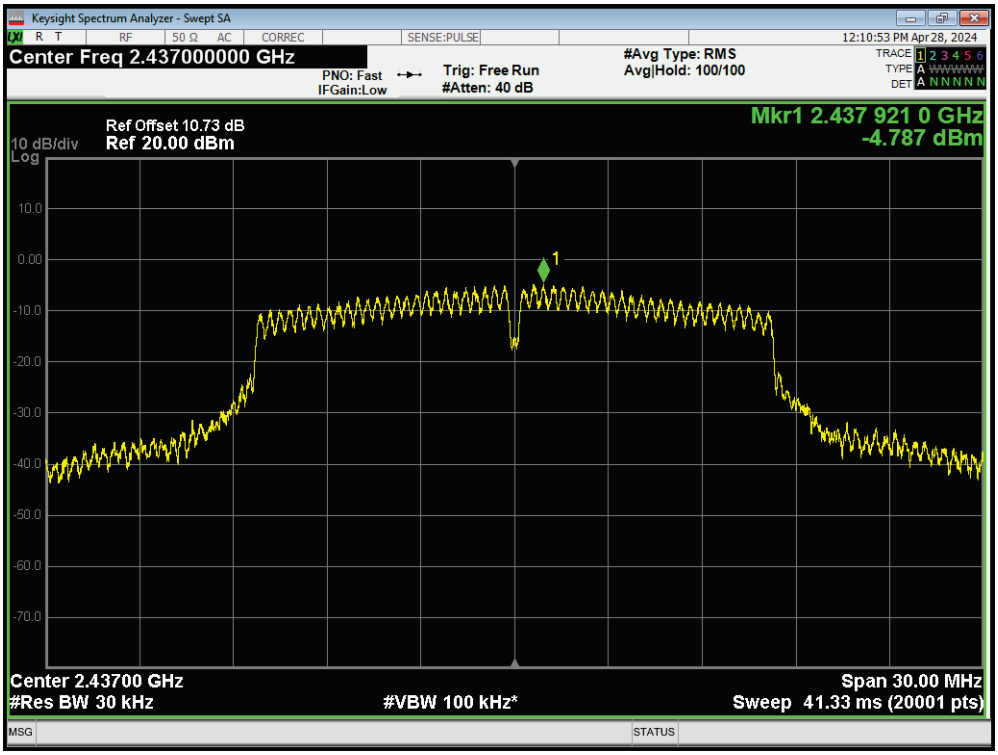
PSD 802.11g 2422MHz Ant1



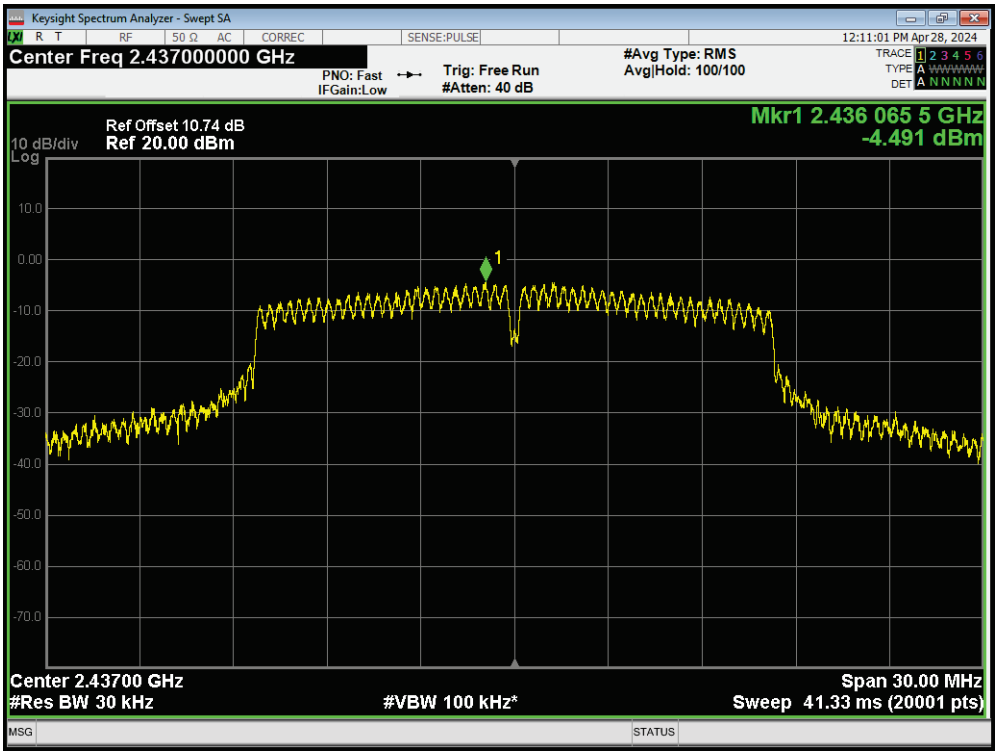
PSD 802.11g 2422MHz Ant2



PSD 802.11g 2437MHz Ant1



PSD 802.11g 2437MHz Ant2



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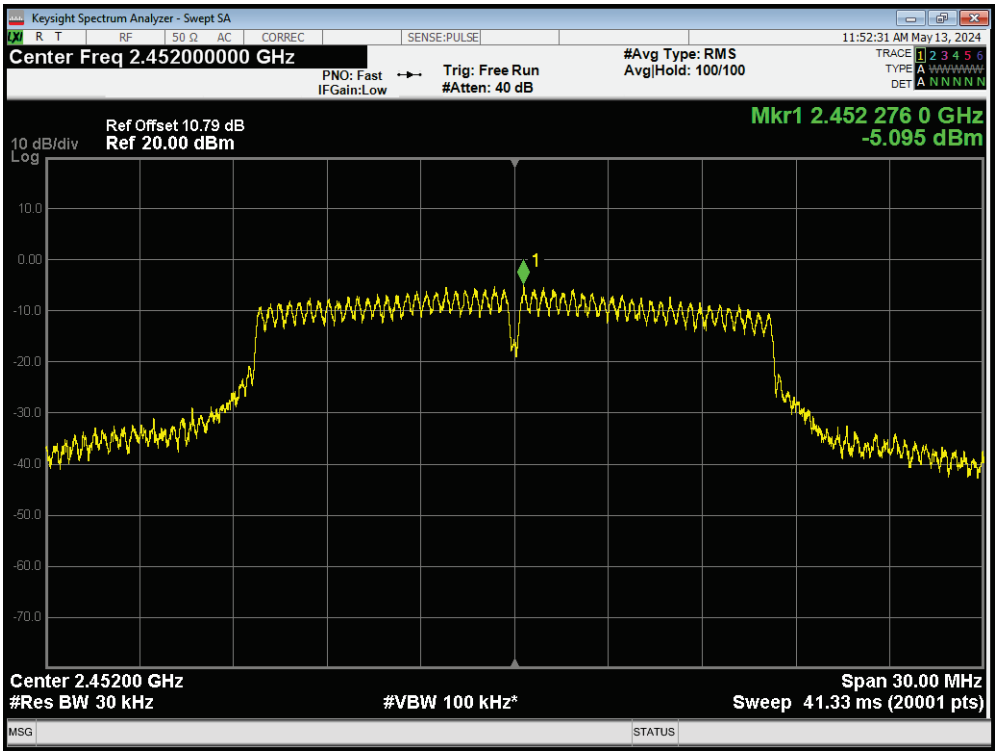
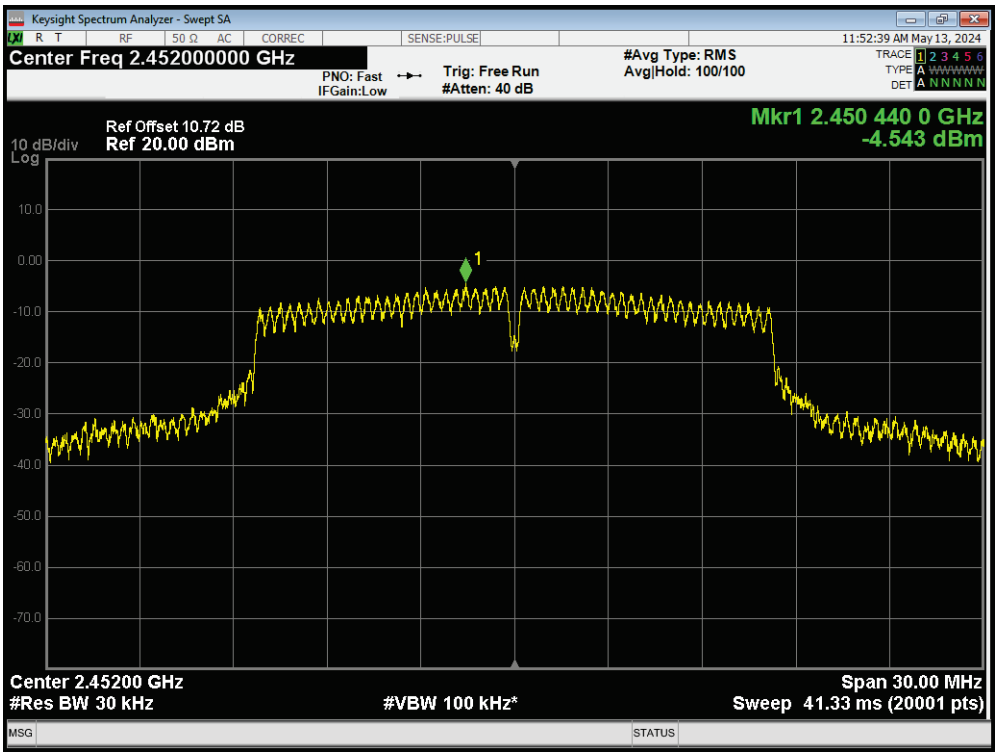
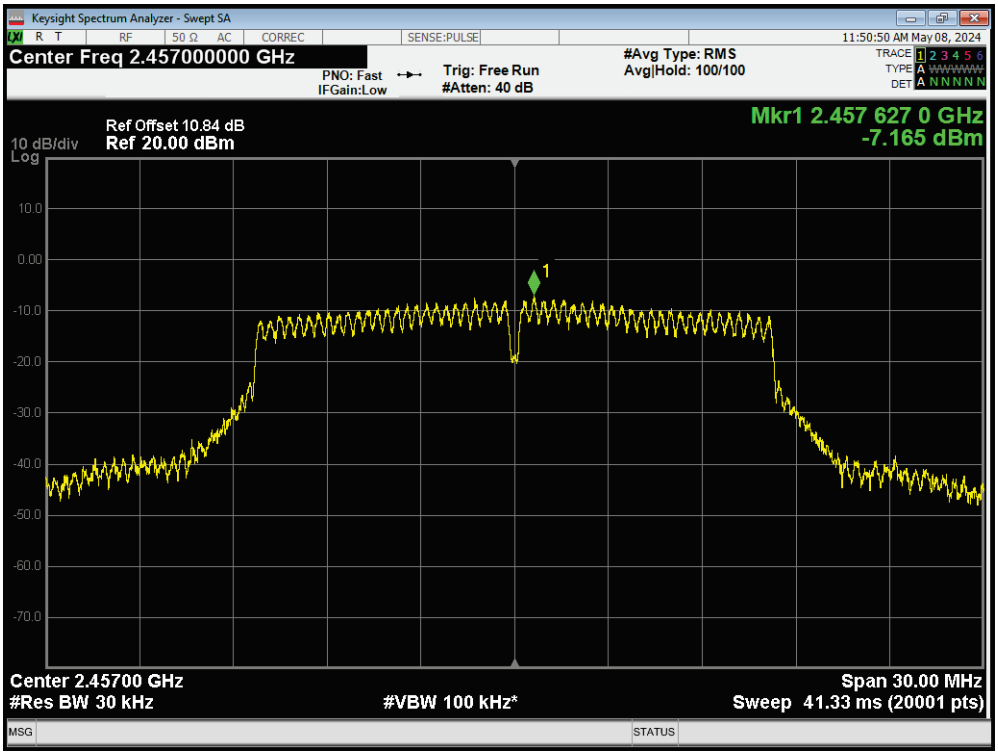


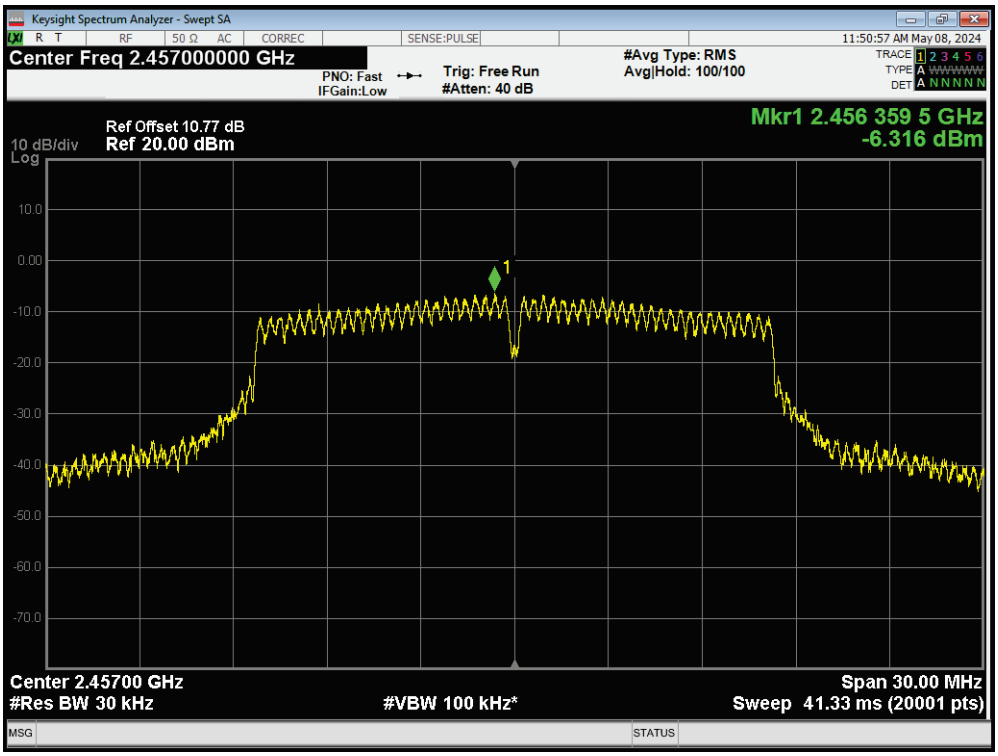
PSD 802.11g 2452MHz Ant2



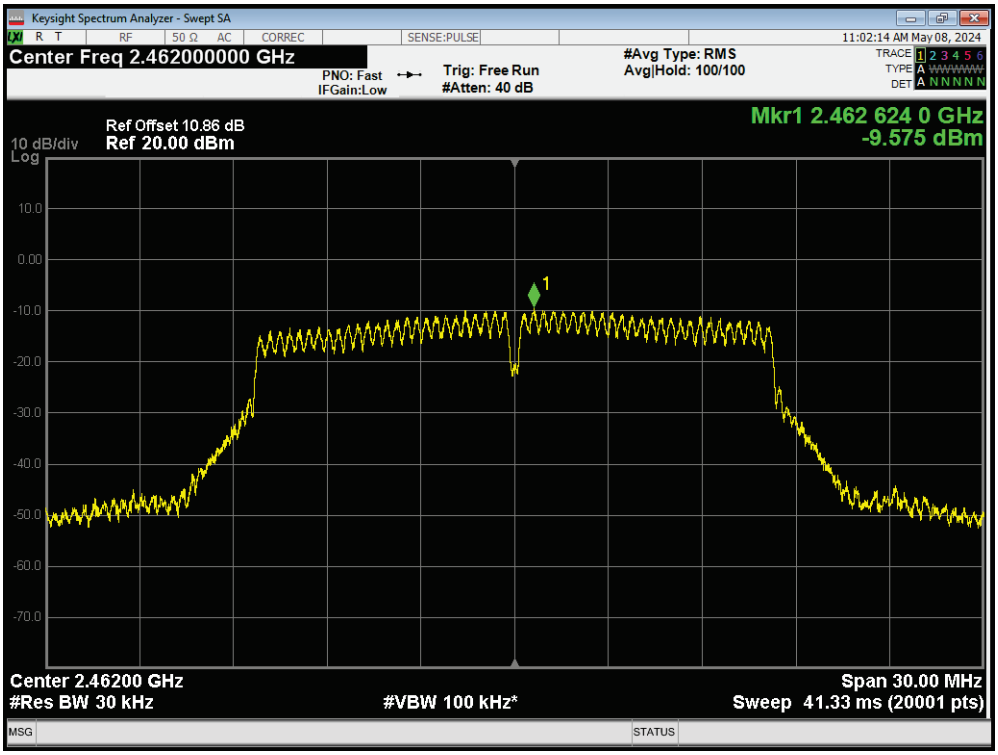
PSD 802.11g 2457MHz Ant1



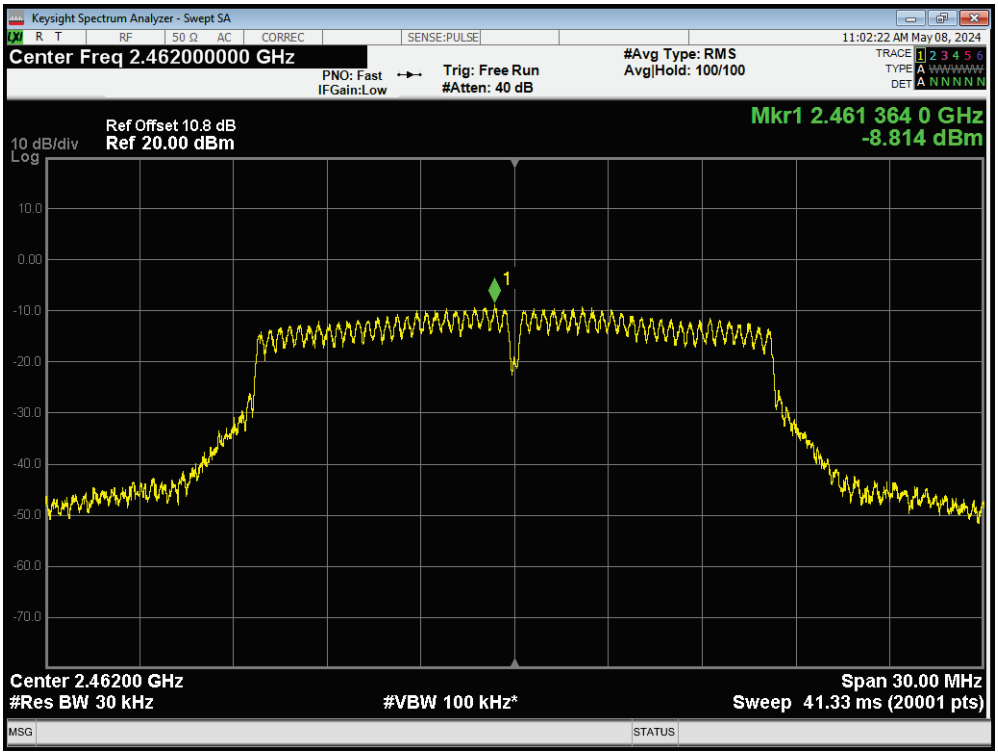
PSD 802.11g 2457MHz Ant2



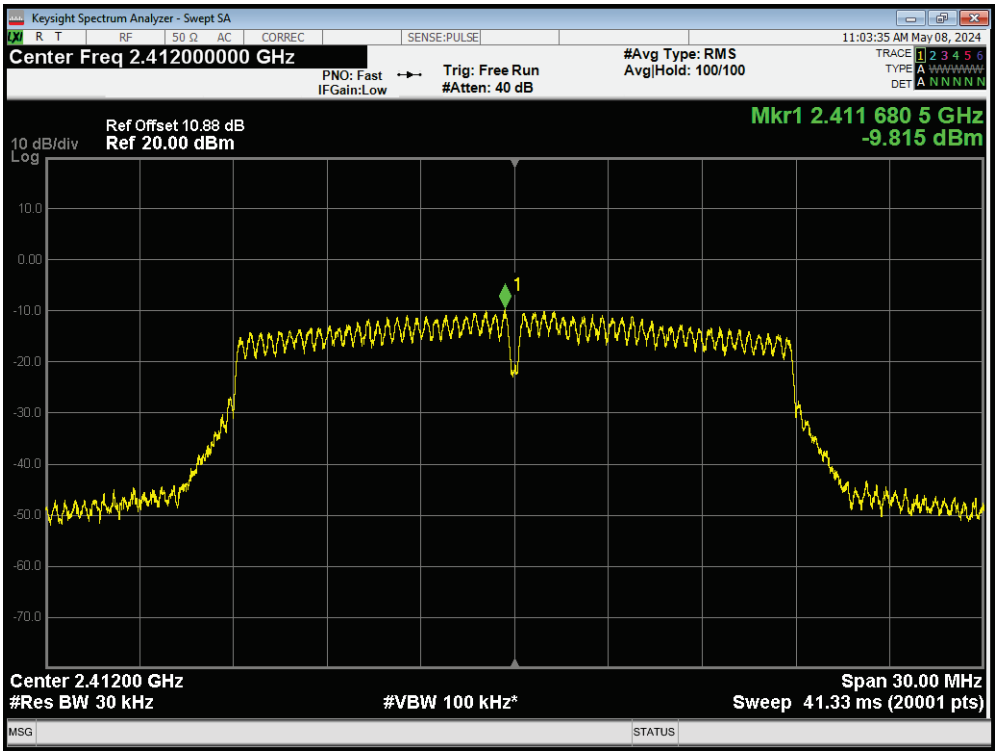
PSD 802.11g 2462MHz Ant1



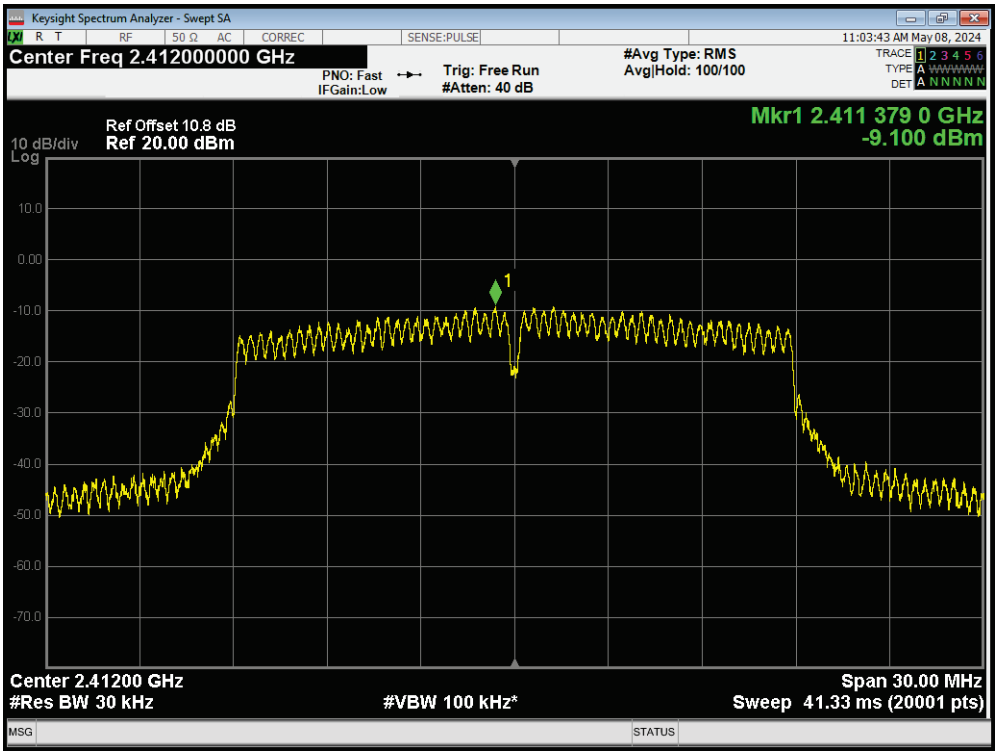
PSD 802.11g 2462MHz Ant2



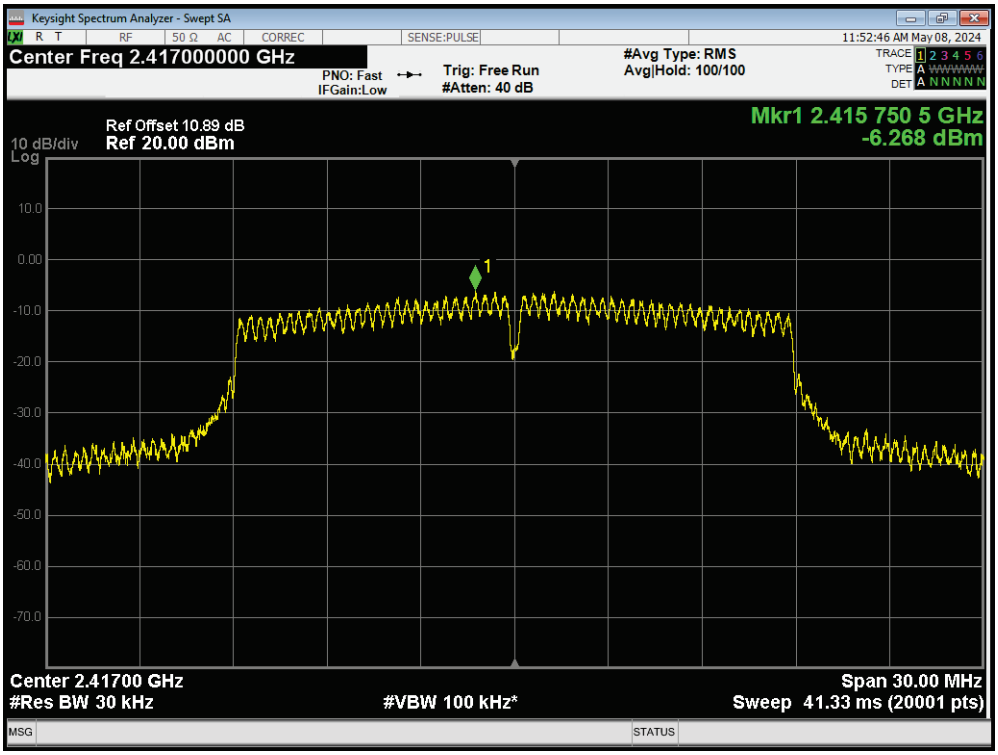
PSD 802.11n(HT20) 2412MHz Ant1



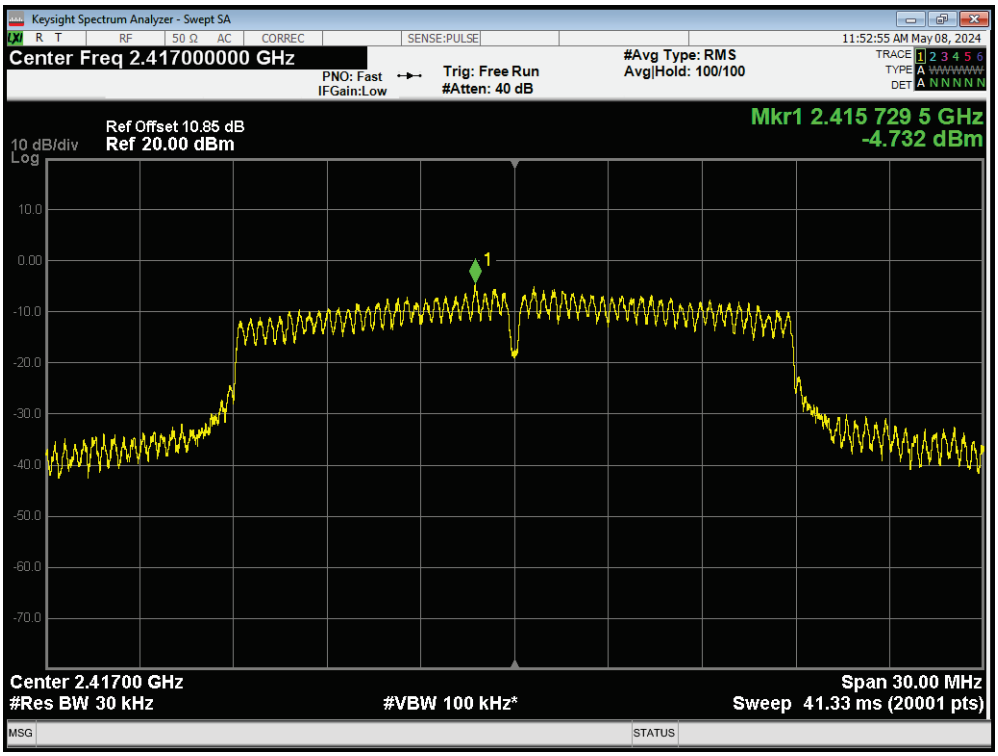
PSD 802.11n(HT20) 2412MHz Ant2



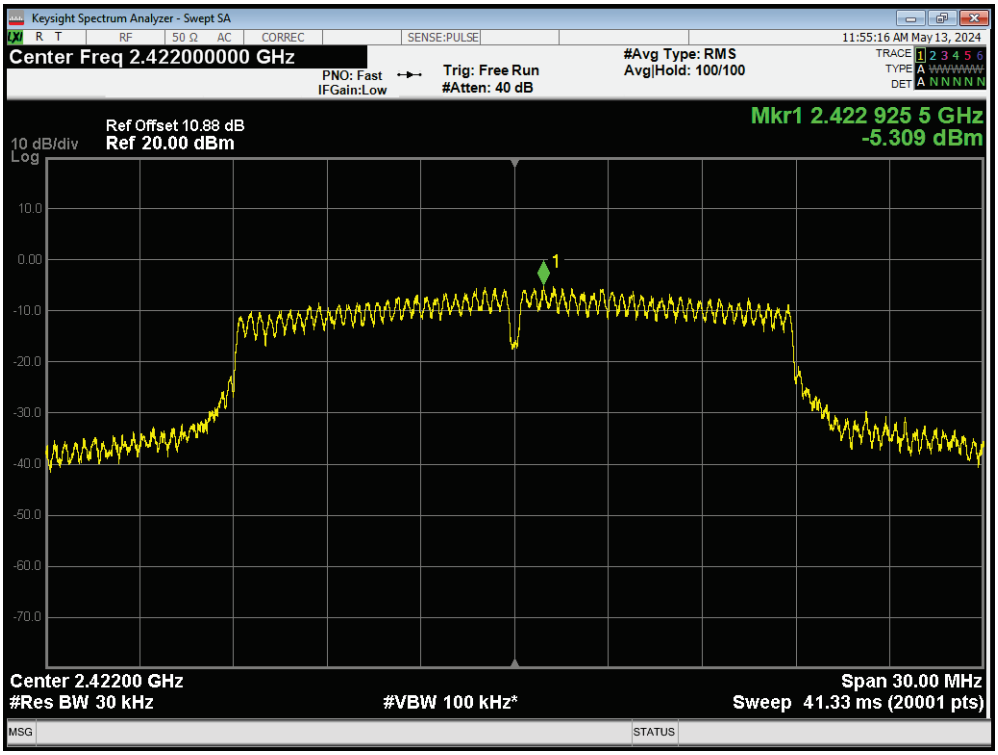
PSD 802.11n(HT20) 2417MHz Ant1



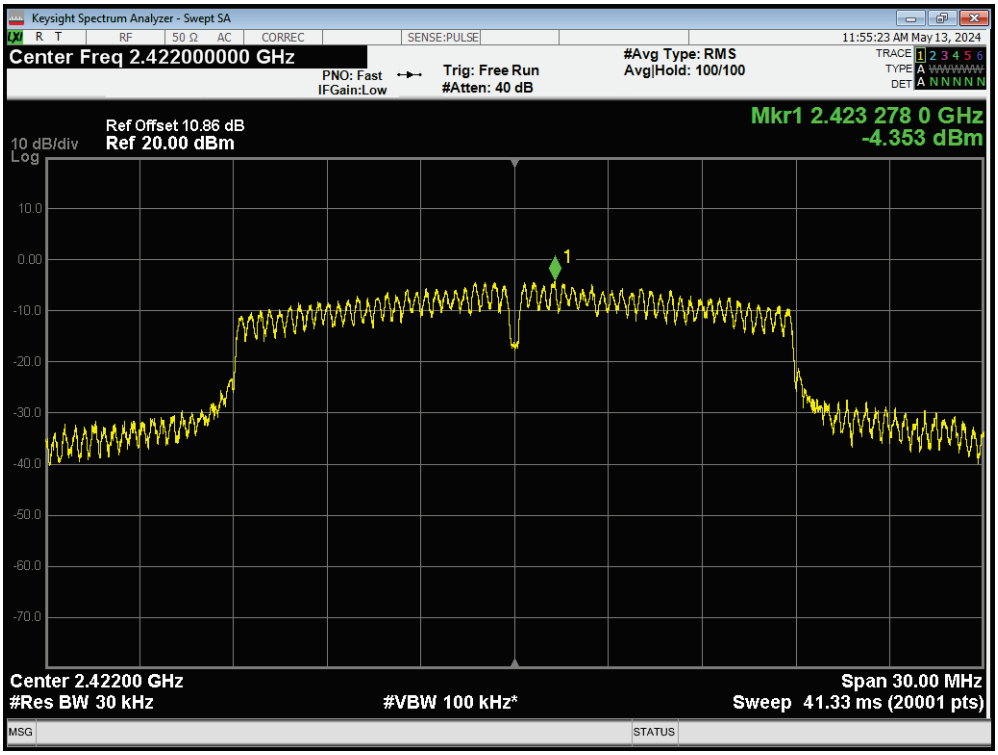
PSD 802.11n(HT20) 2417MHz Ant2



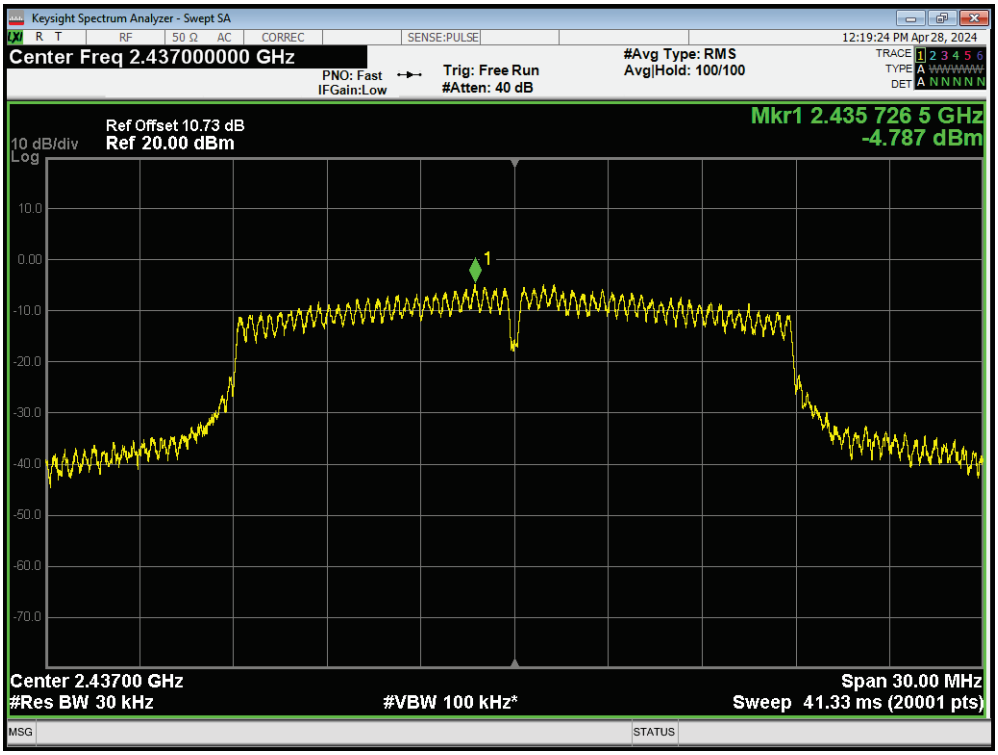
PSD 802.11n(HT20) 2422MHz Ant1



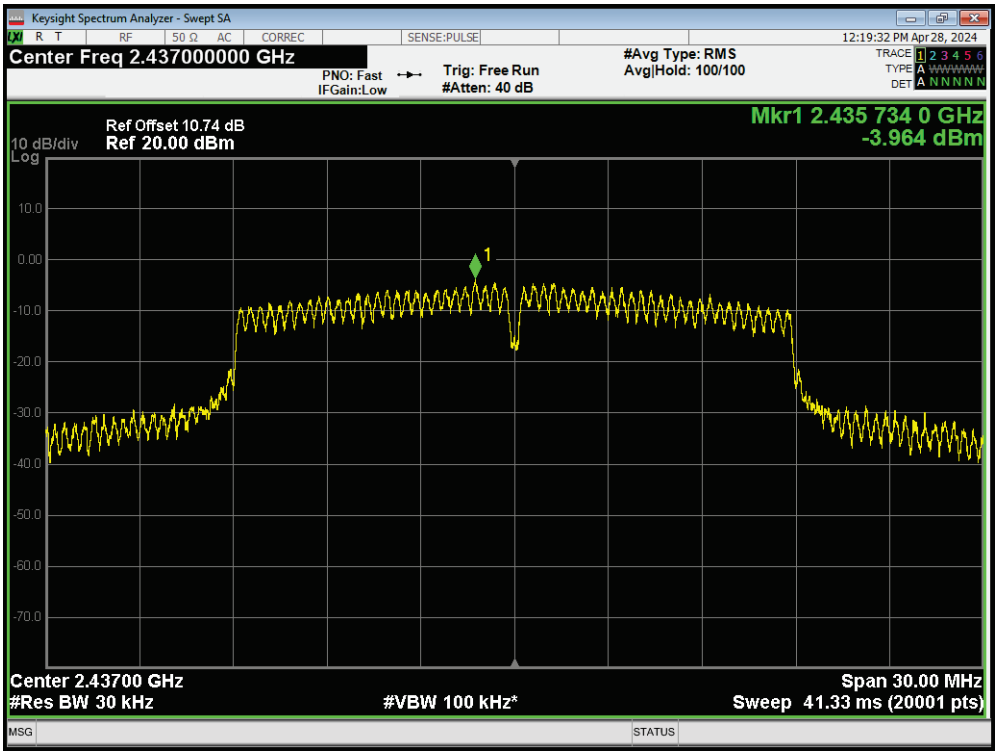
PSD 802.11n(HT20) 2422MHz Ant2



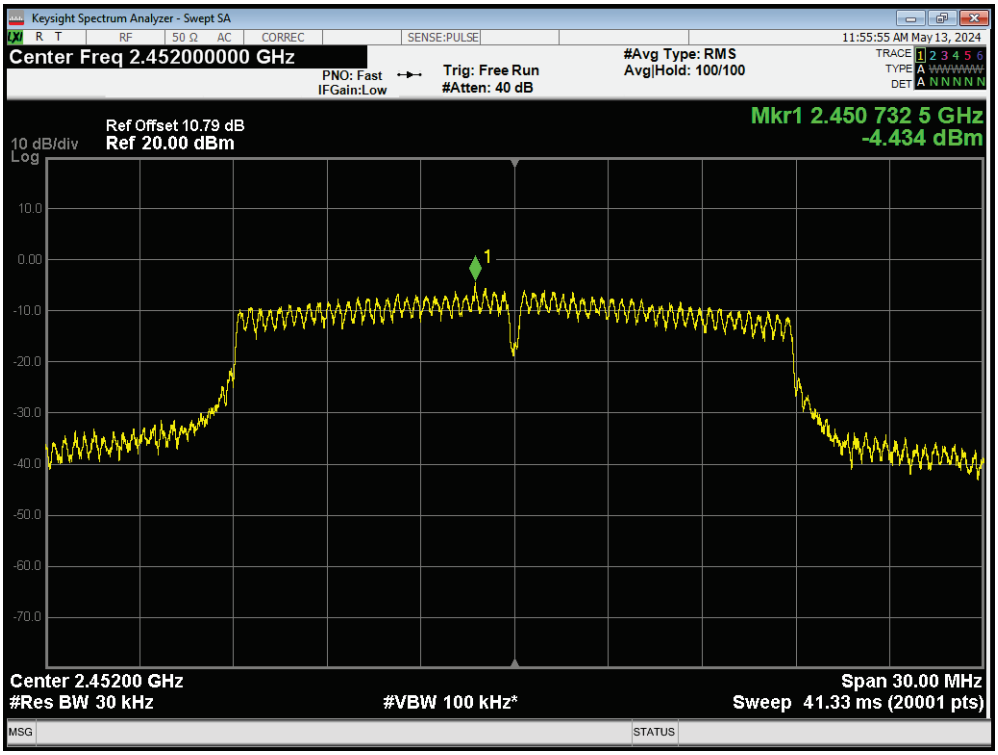
PSD 802.11n(HT20) 2437MHz Ant1



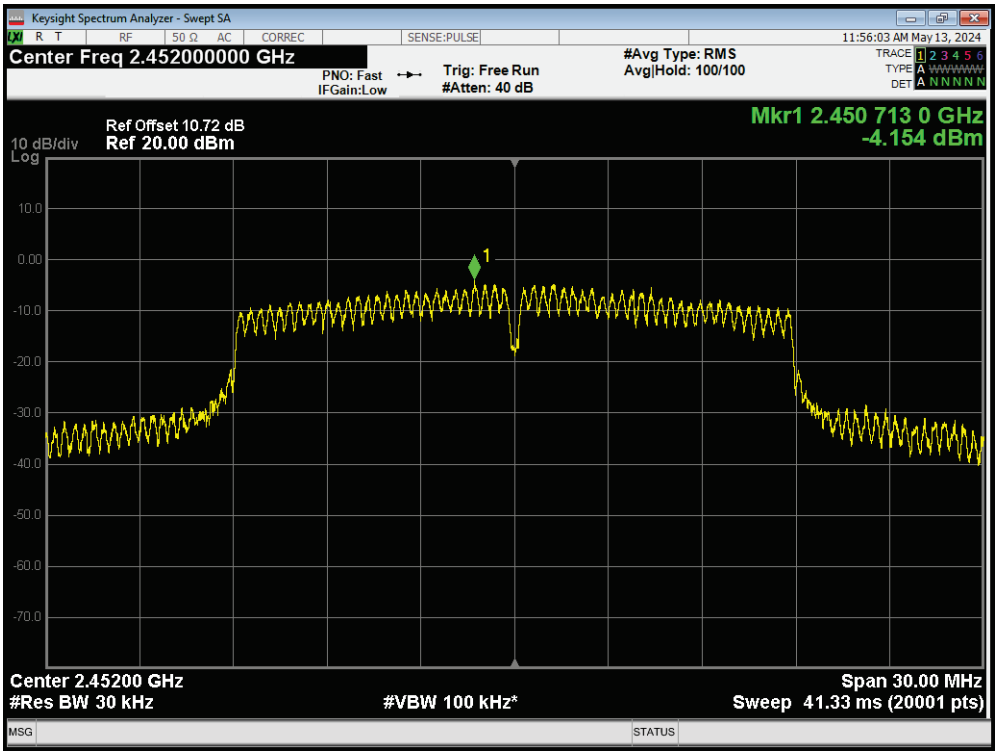
PSD 802.11n(HT20) 2437MHz Ant2



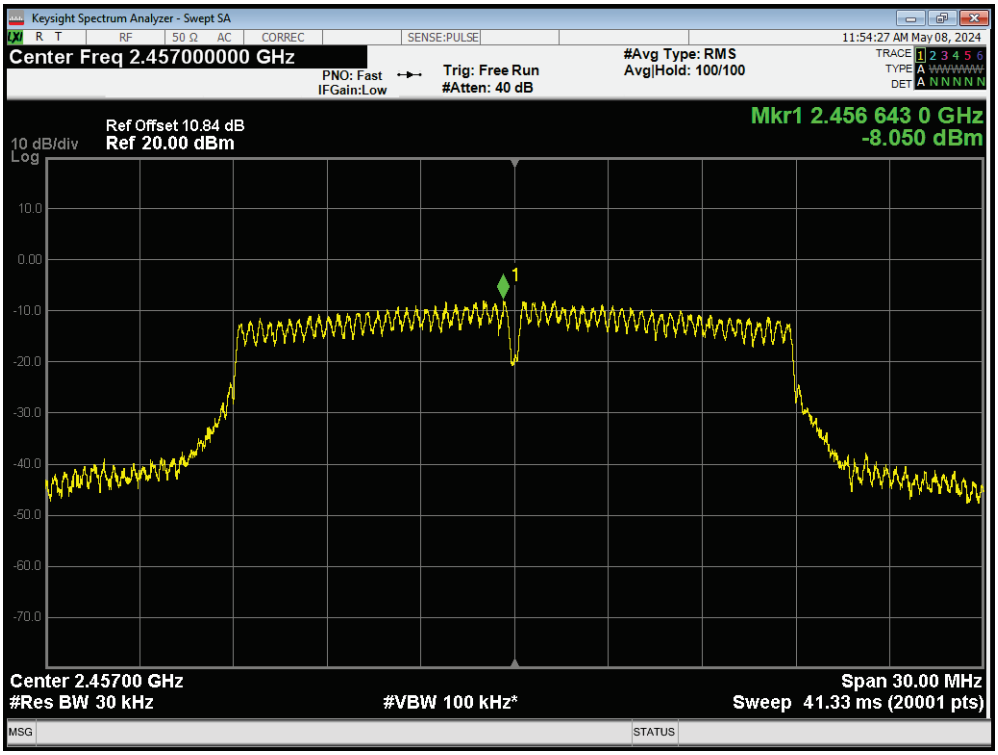
PSD 802.11n(HT20) 2452MHz Ant1



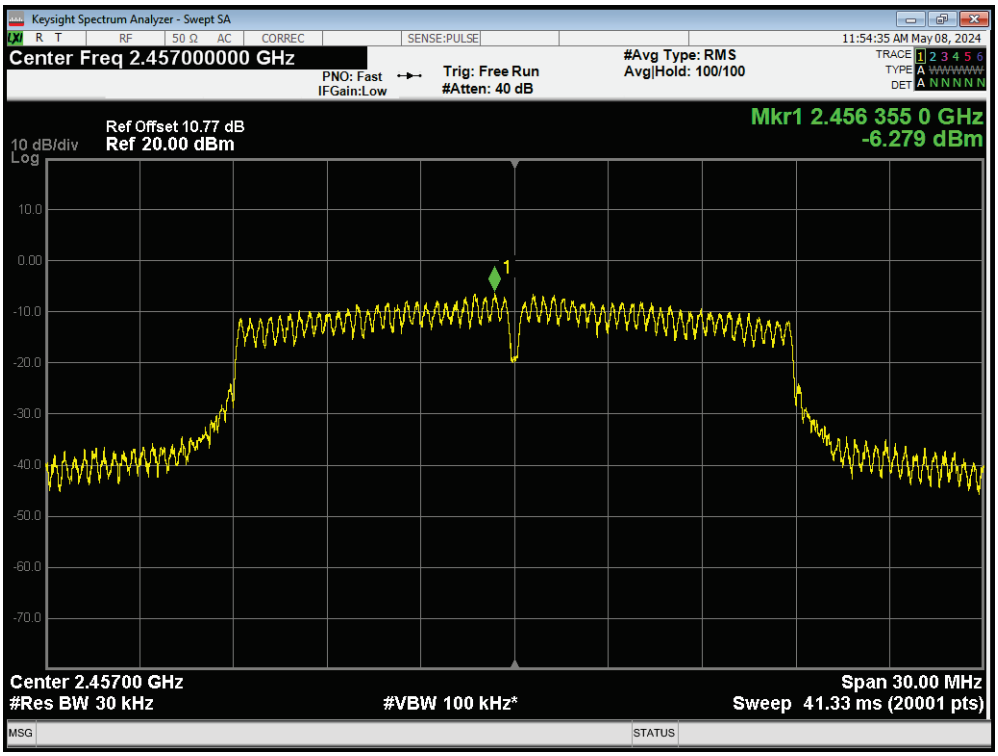
PSD 802.11n(HT20) 2452MHz Ant2



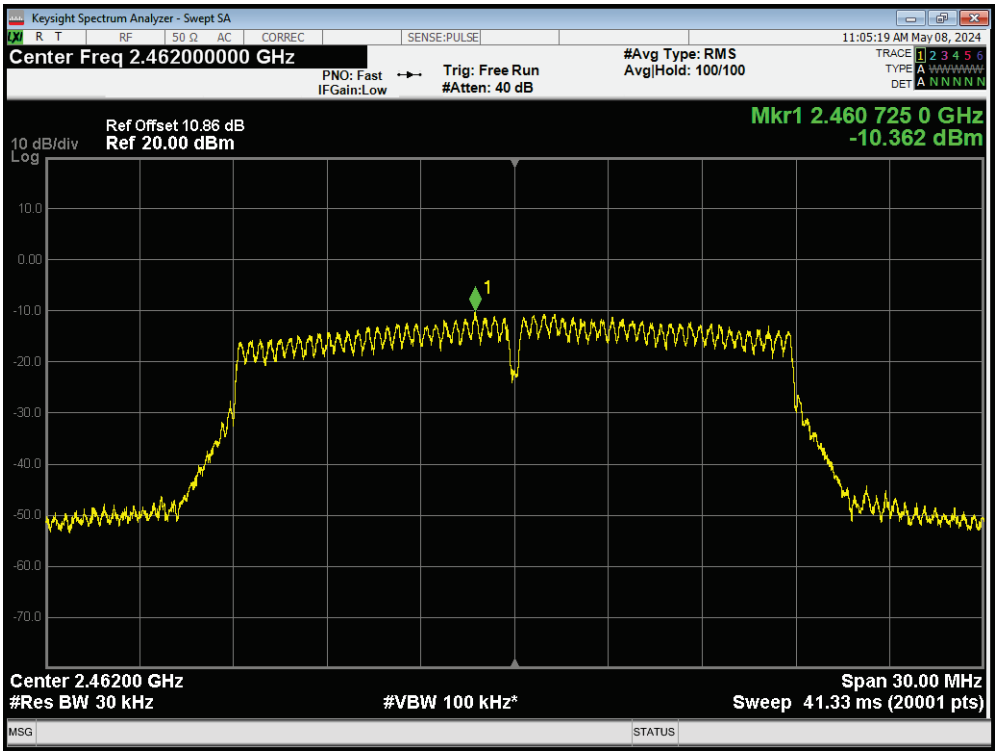
PSD 802.11n(HT20) 2457MHz Ant1



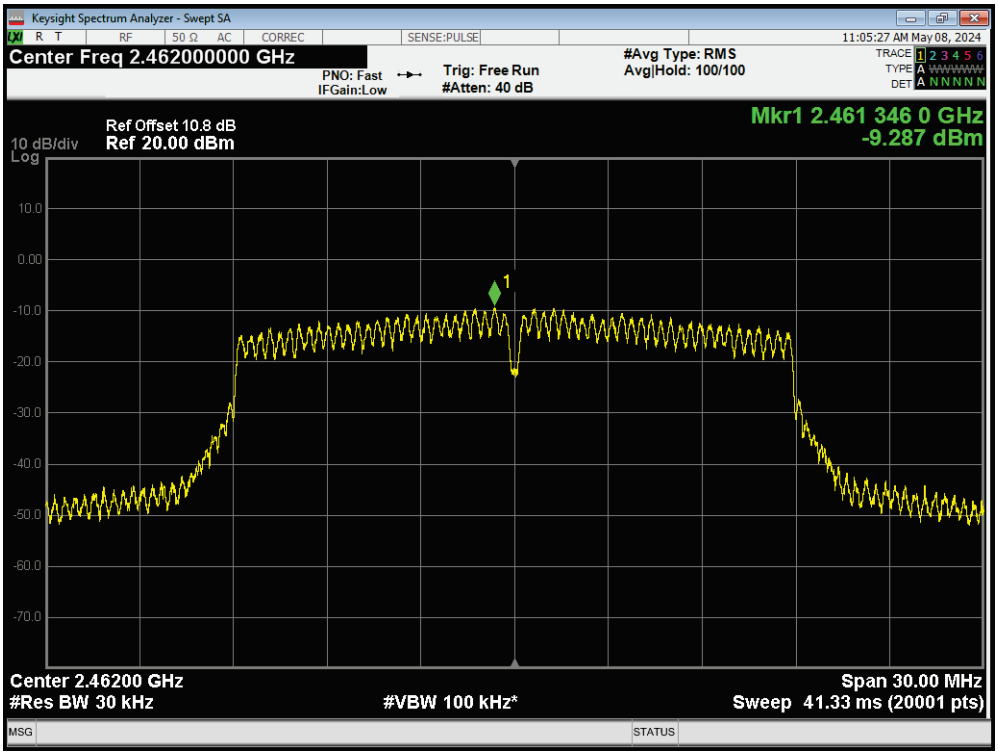
PSD 802.11n(HT20) 2457MHz Ant2



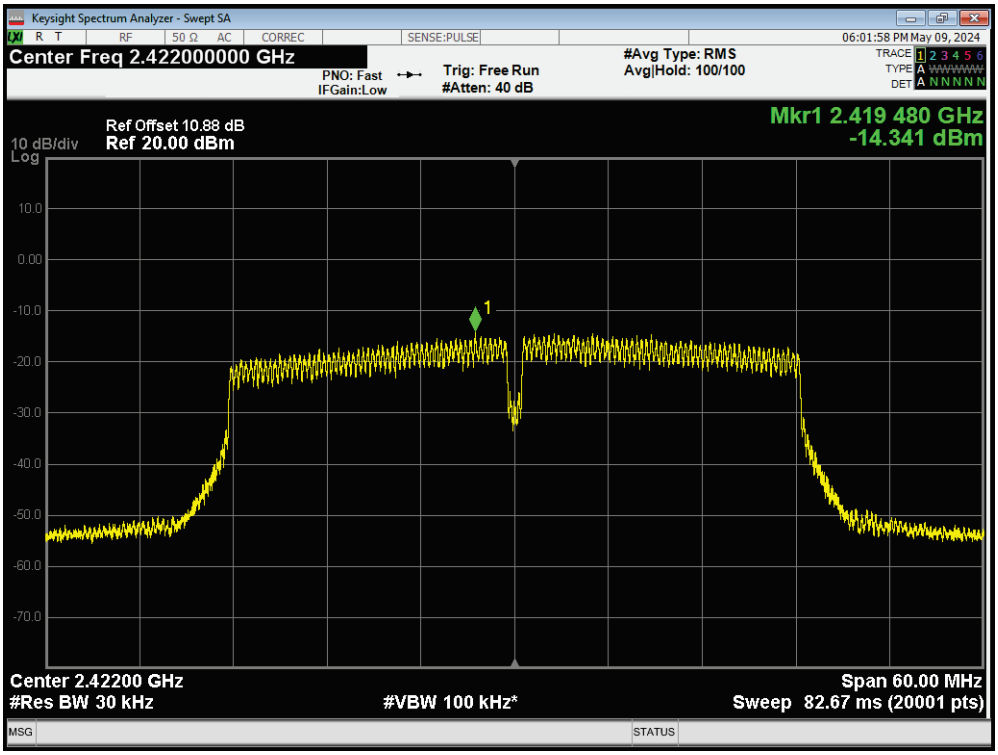
PSD 802.11n(HT20) 2462MHz Ant1



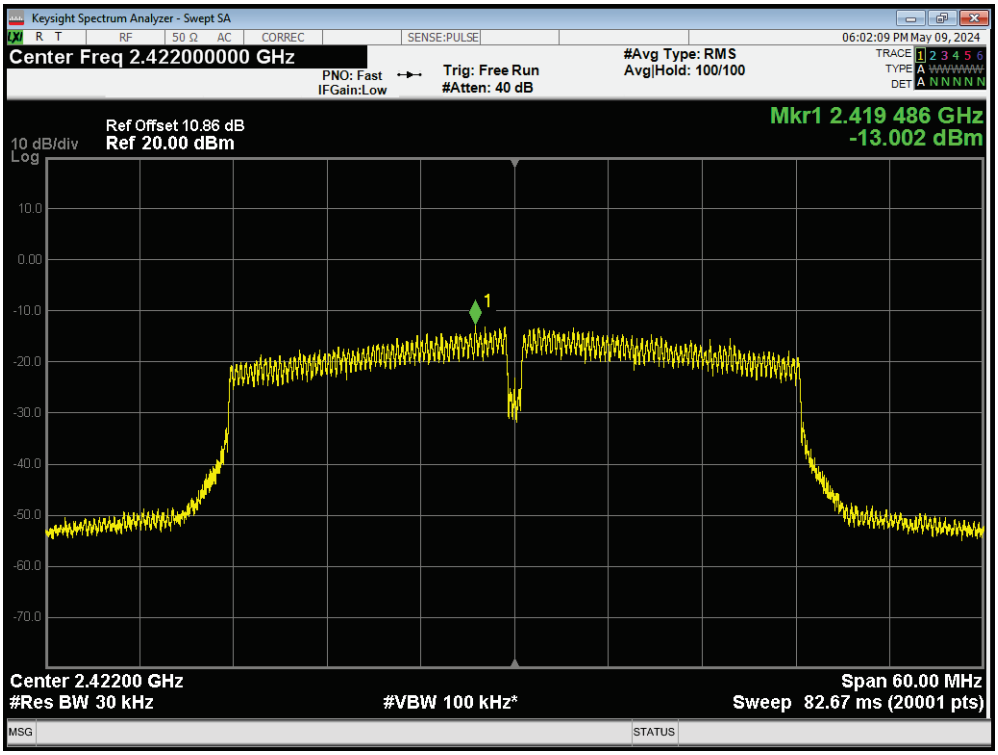
PSD 802.11n(HT20) 2462MHz Ant2



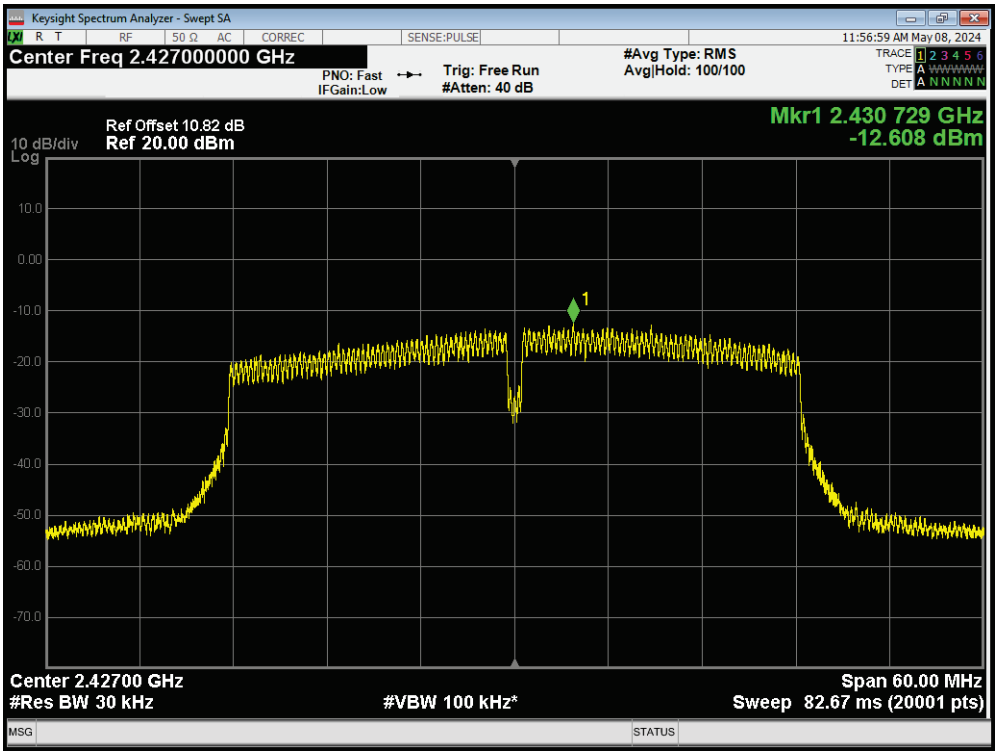
PSD 802.11n(HT40) 2422MHz Ant1



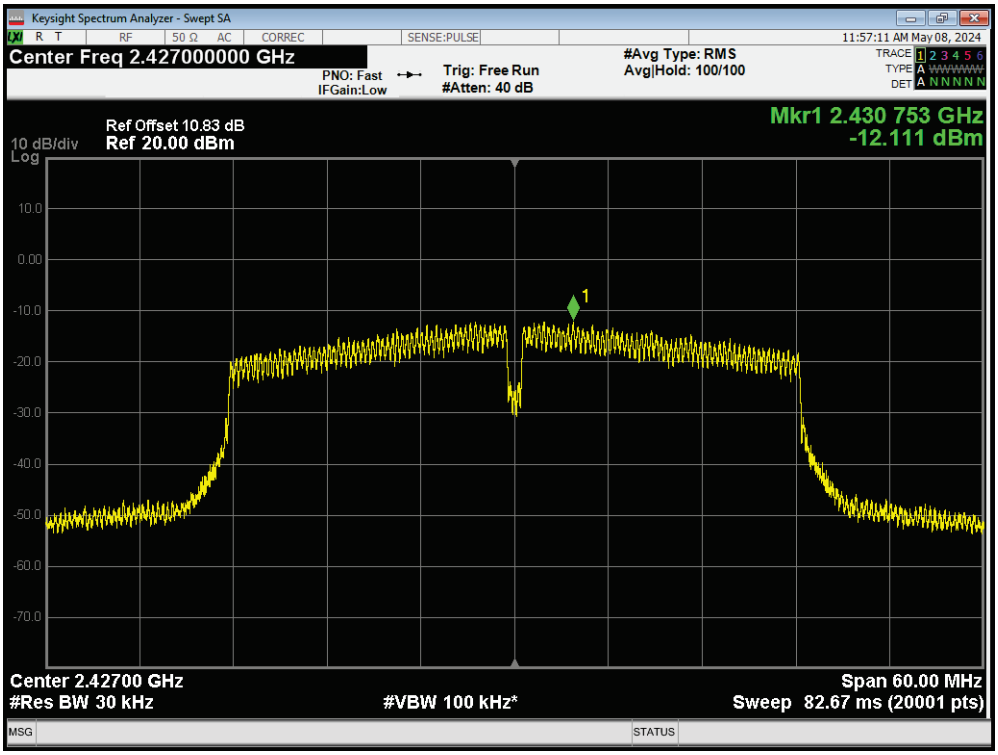
PSD 802.11n(HT40) 2422MHz Ant2



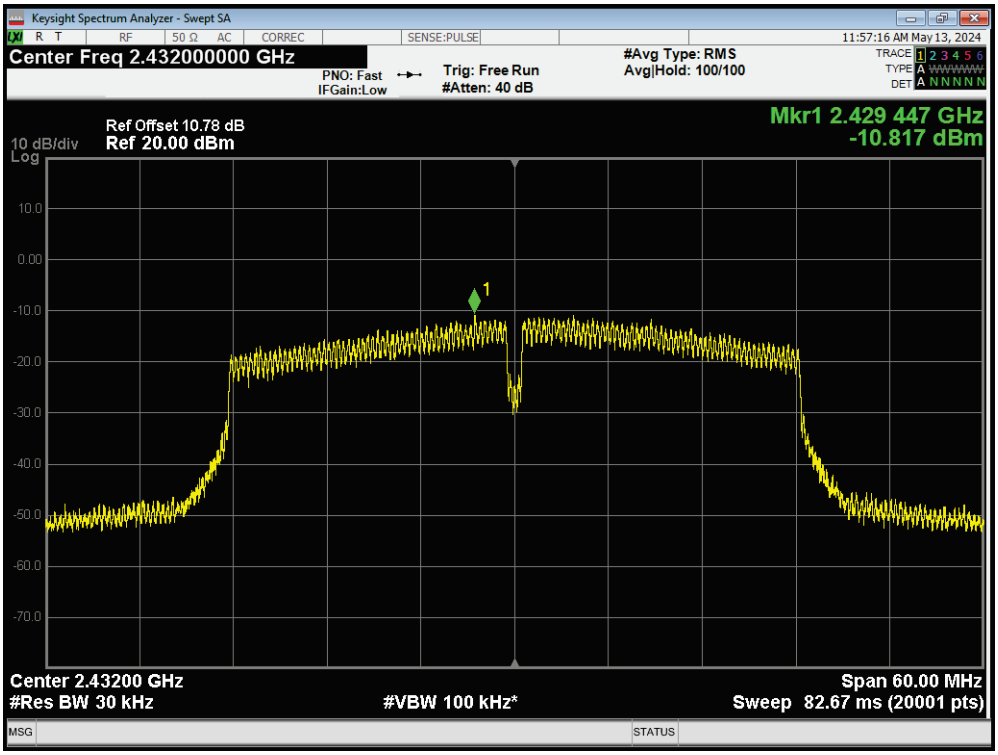
PSD 802.11n(HT40) 2427MHz Ant1



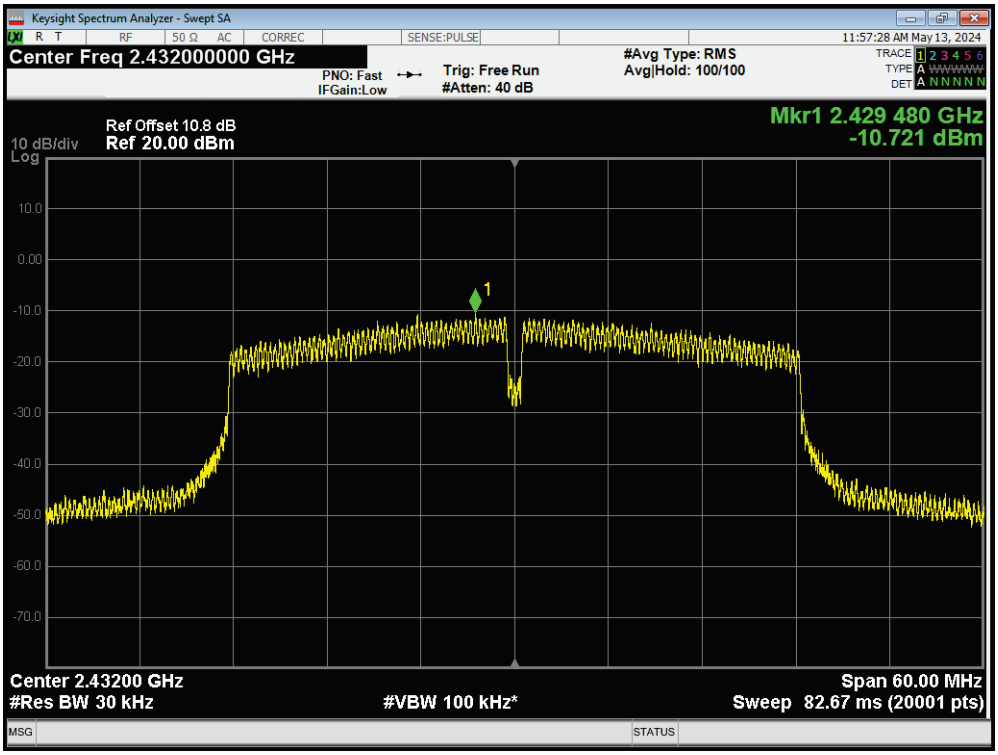
PSD 802.11n(HT40) 2427MHz Ant2



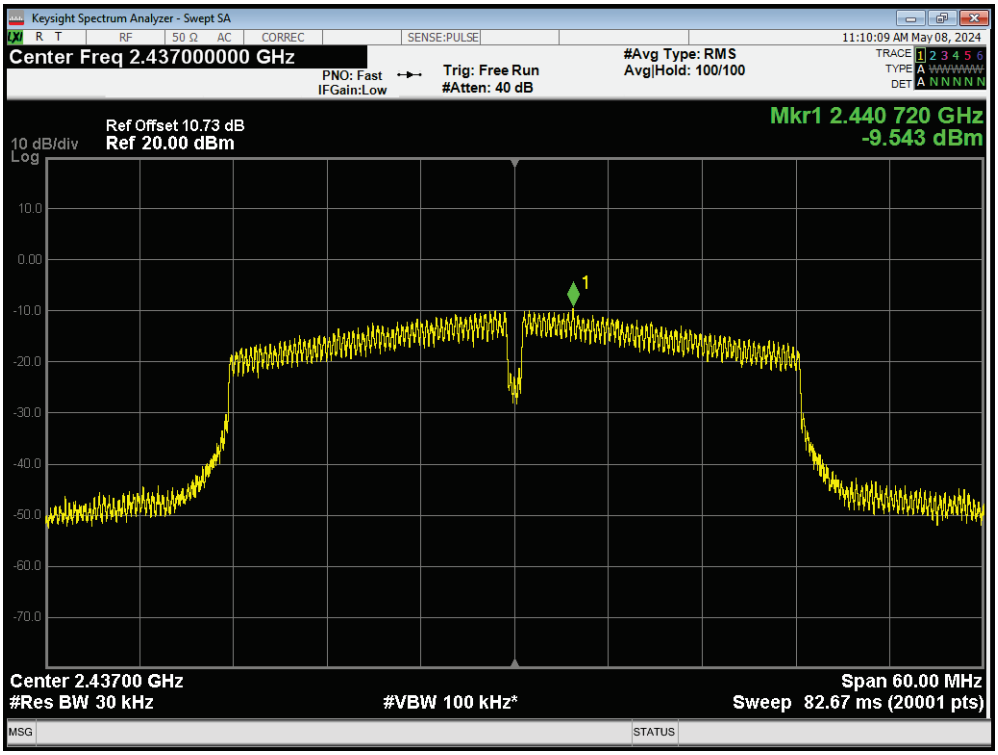
PSD 802.11n(HT40) 2432MHz Ant1



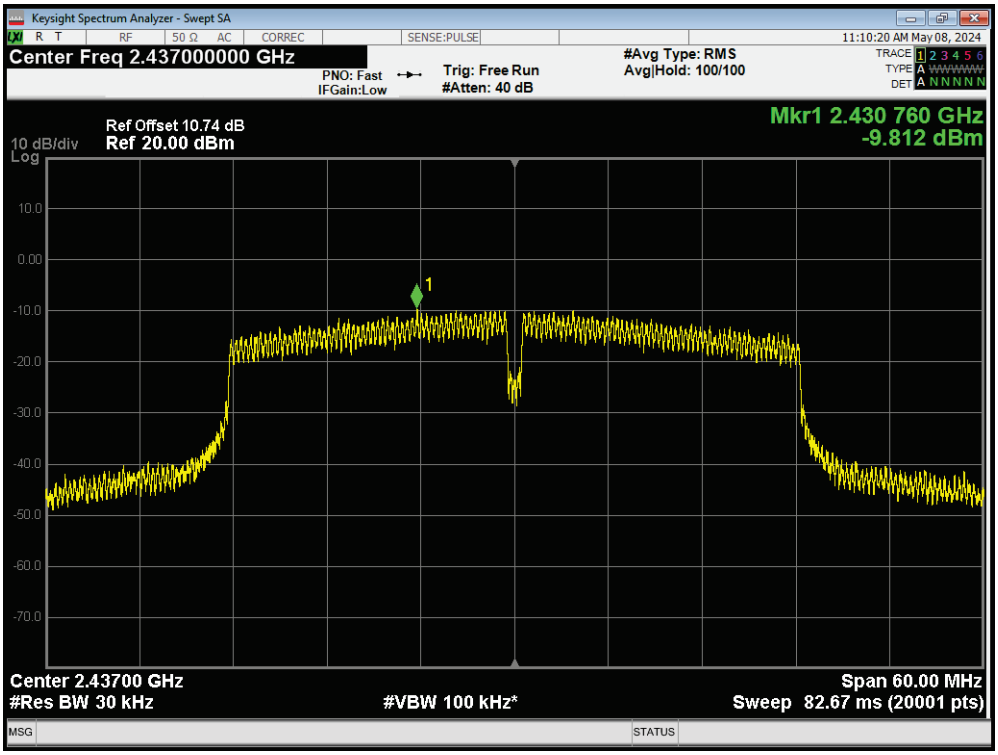
PSD 802.11n(HT40) 2432MHz Ant2



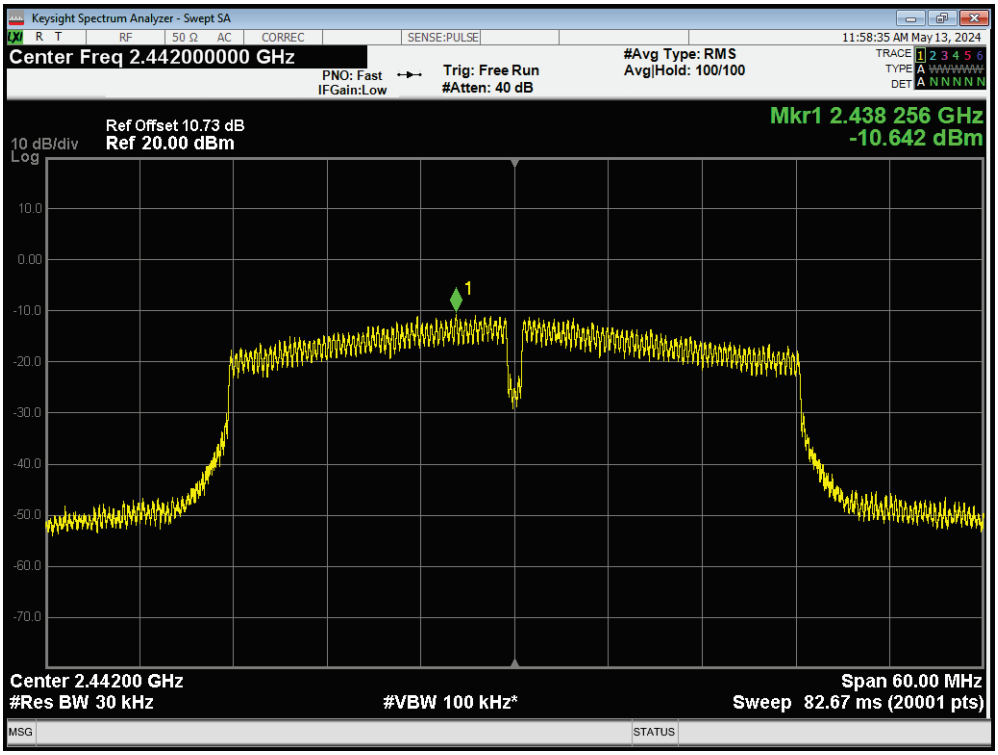
PSD 802.11n(HT40) 2437MHz Ant1



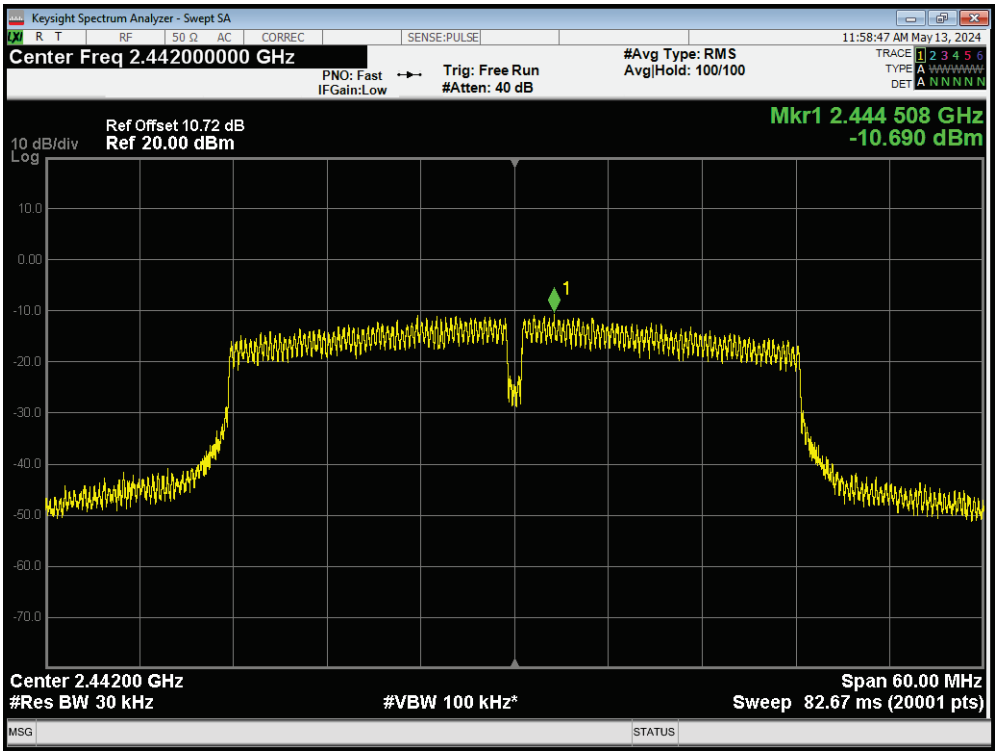
PSD 802.11n(HT40) 2437MHz Ant2



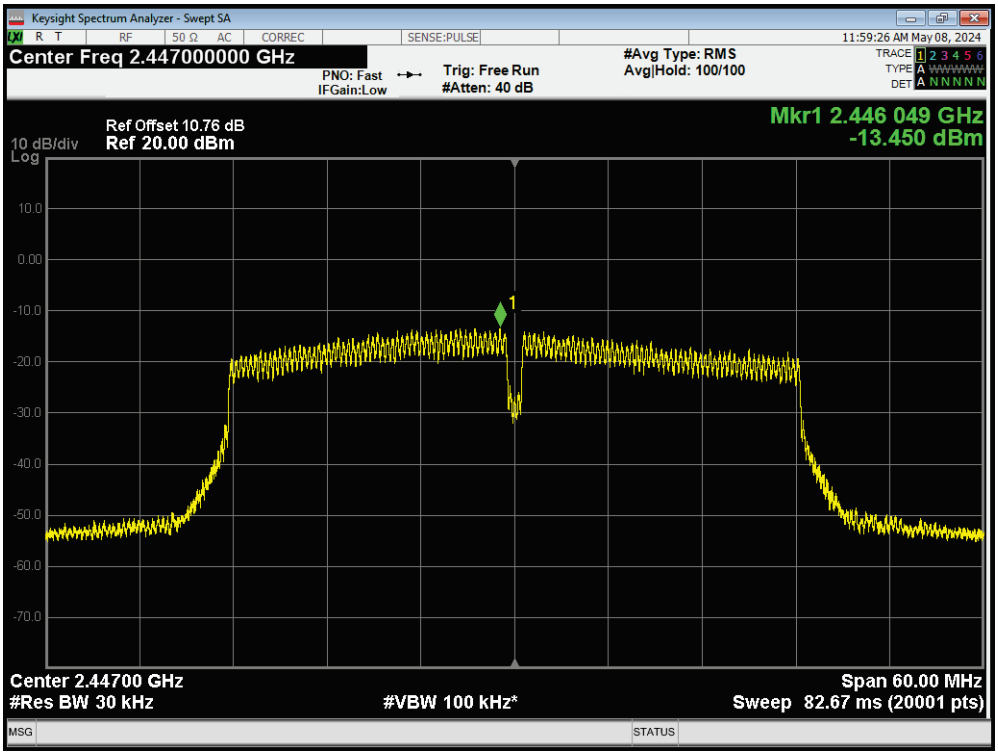
PSD 802.11n(HT40) 2442MHz Ant1



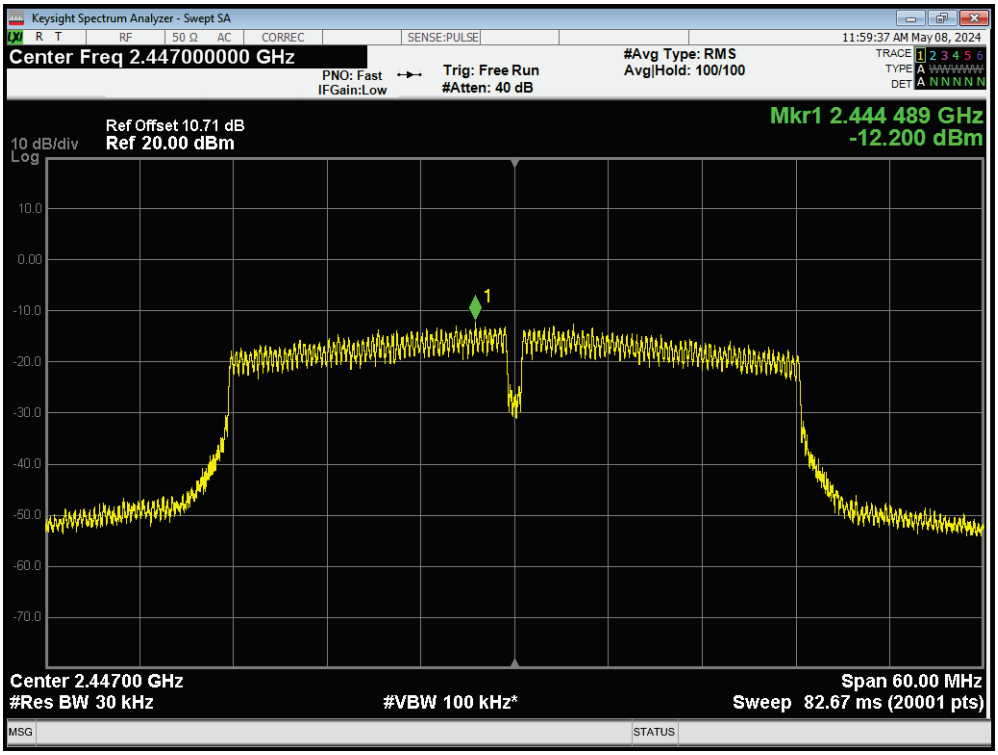
PSD 802.11n(HT40) 2442MHz Ant2



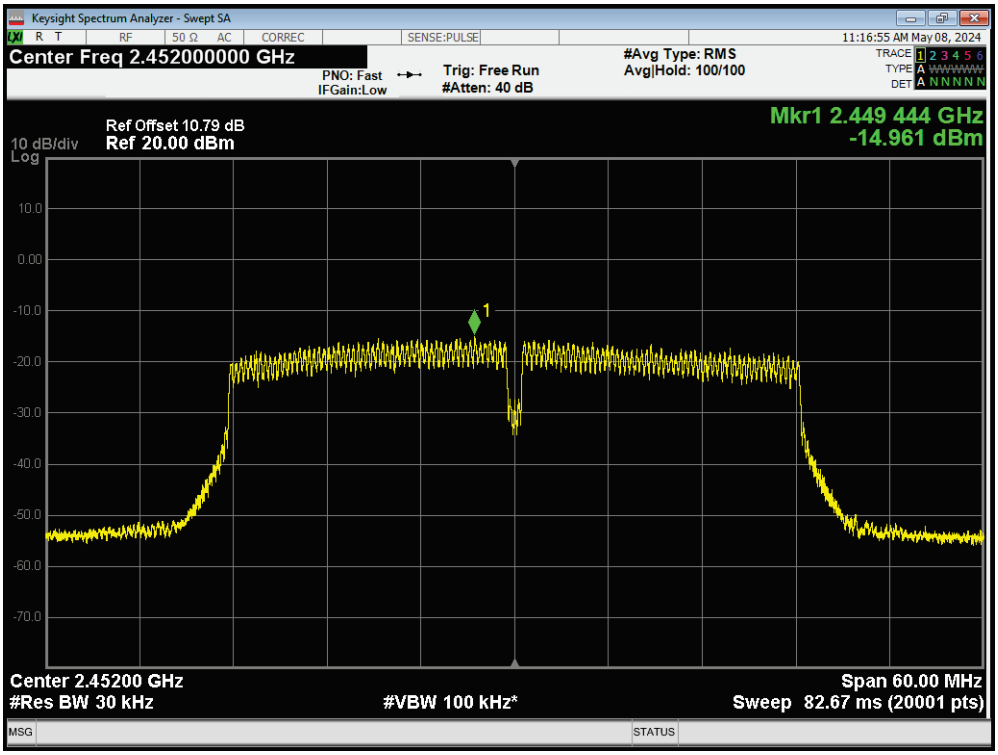
PSD 802.11n(HT40) 2447MHz Ant1



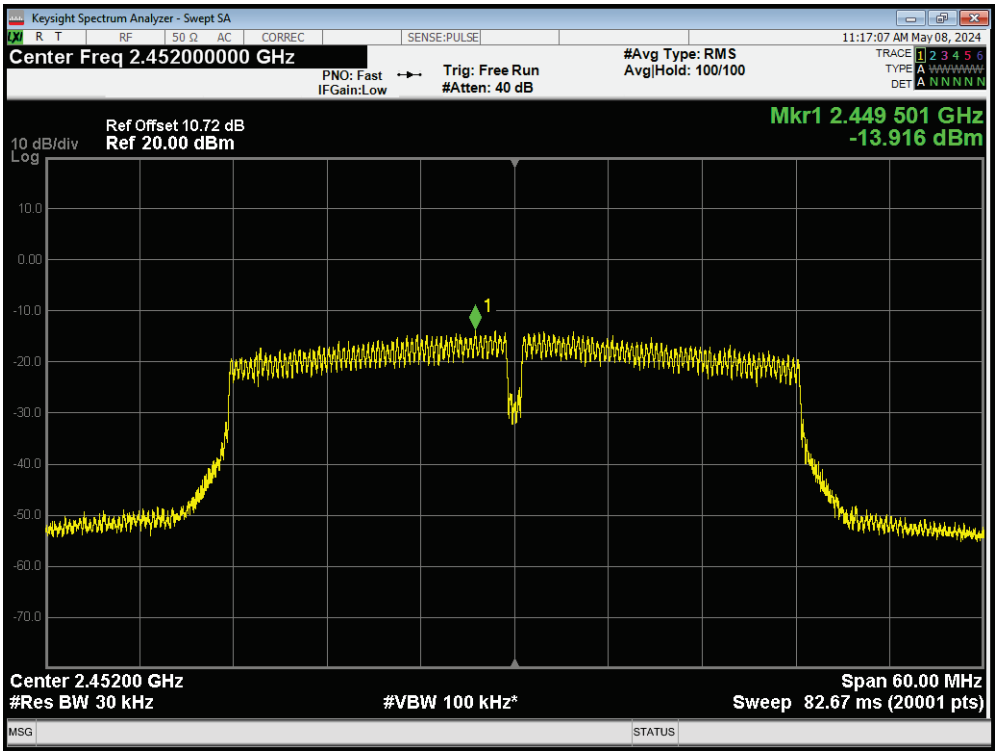
PSD 802.11n(HT40) 2447MHz Ant2



PSD 802.11n(HT40) 2452MHz Ant1



PSD 802.11n(HT40) 2452MHz Ant2



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
802.11b	2412	8.98	-21.02
	2437	9.42	-20.58
	2462	8.75	-21.25
802.11g	2412	3.94	-26.06
	2417	6.99	-23.01
	2422	8.89	-21.11
	2437	8.82	-21.18
	2452	8.30	-21.70
	2457	6.78	-23.22
	2462	8.71	-21.29
802.11n	2412	3.71	-26.29

HT20	2417	7.63	-22.37
	2422	9.39	-20.61
	2437	9.39	-20.61
	2452	7.88	-22.12
	2457	6.33	-23.67
	2462	8.69	-21.31
802.11n HT40	2422	-1.18	-31.18
	2427	1.54	-28.46
	2432	3.24	-26.76
	2437	4.14	-25.86
	2442	3.52	-26.48
	2447	0.95	-29.05
	2452	-0.20	-30.20

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