RF TEST REPORT

Applicant	Huawei Device Co., Ltd.
Product	1500Mbps Wireless Router
FCC ID	2ATEYWS7001
Model	WS7001
Report No.	R2108A0722-R1V3
Issue Date	October 11, 2021

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2020)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Prepared by: Peng Tao *Approved by: Kai Xu*

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Version	Revision description	Issue Date
Rev.0	Initial issue of report.	September 15, 2021
Rev.1	Update data in Page11.	September 22, 2021
Rev.2	Update data.	September 24, 2021
Rev.3	Add data.	October 11, 2021
Note: This revised report (Report No. R2108A0722-R1V3) supersedes and replaces the previously issued report (Report No. R2108A0722-R1V2). Please discard or destroy the previously issued report and dispose of it accordingly.		

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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	6 dB bandwidth	15.247(a)(2)	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: August 13, 2021 ~ September 10, 2021 and September 24, 2021 Date of Sample Received: August 10, 2021			
Note: All indications of Pass/Fail in this report are opinions expressed by TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.			

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1. Test Laboratory

1.1. Notes of the test report

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1.2. Test facility

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

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

A2LA (Certificate Number: 3857.01)

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

1.3. Testing Location

Company:	TA Technology (Shanghai) Co., Ltd.
Address:	No.145, Jintang Rd, Tangzhen Industry Park, Pudong
City:	Shanghai
Post code:	201201
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2. General Description of Equipment under Test

2.1. Applicant and Manufacturer Information

Applicant	Huawei Device Co., Ltd.
Applicant address	No.2 of Xincheng Road, Songshan Lake Zone, Dongguan, Guangdong 523808, People's Republic of China
Manufacturer	Huawei Device Co., Ltd.
Manufacturer address	No.2 of Xincheng Road, Songshan Lake Zone, Dongguan, Guangdong 523808, People's Republic of China

2.2. General information

EUT Description	
Model	WS7001
SN	PDUQU21705000031
Hardware Version	AM1TC7001M
Software Version	11.0.3.3
Power Supply	DC / AC adapter
Antenna Type	External Antenna
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)
Antenna Gain	Antenna 1: 4.5dBi Antenna 2: 4.5dBi
Test Mode	802.11b, 802.11g, 802.11n(HT20/HT40)
Modulation Type	802.11b: DSSS 802.11g/n(HT20/HT40): OFDM
Max. Output Power	24.11dBm
Operating Frequency Range(s)	802.11b/g/n(HT20): 2412 ~ 2462 MHz 802.11n(HT40): 2422 ~ 2452 MHz

EUT Accessory			
Accessory	**Model**	**Manufacture**	**No.**
Adapter	HW-120100U01	UE/HONOR	1
	HW-120100E01		2
	HW-120100B01		3

Note: 1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.
2.There are more than one Adapter, each one should be applied throughout the compliance test respectively, however, only the worst case (Adapter 1) will be recorded in this report.

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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 (2020) Radio Frequency Devices

ANSI C63.10 (2013)

Reference standard:

KDB 558074 D01 15.247 Meas Guidance v05r02

KDB 662911 D01 Multiple Transmitter Output v02r01

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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.

Test Mode	Data Rate		
	Antenna 1	Antenna 2	MIMO
802.11b	1Mbps	1Mbps	/
802.11g	6Mbps	6Mbps	6Mbps
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	CDD/MIMO
Maximum conducted output power	O	O	802.11g 802.11n HT20 802.11n HT40
6dB Bandwidth	802.11b	--	802.11g 802.11n HT20 802.11n HT40
Band Edge	802.11b	--	802.11g 802.11n HT20 802.11n HT40
Power Spectral Density	O	O	802.11g 802.11n HT20 802.11n HT40
Spurious RF Conducted Emissions	802.11b	--	802.11g 802.11n HT20 802.11n HT40
Unwanted Emissions	802.11b	--	802.11g 802.11n HT20 802.11n HT40

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Conducted Emission	802.11b	--	802.11g 802.11n HT20 802.11n HT40
Note: “O”: test all bands			

According to RF Output power results in chapter 5.1, MIMO was selected as the worst antenna for 802.11g/n HT20/ HT40. SISO Antenna 1 was selected as the worst SISO antenna for 802.11b.

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5. Test Case Results

5.1. Maximum output power

Ambient condition

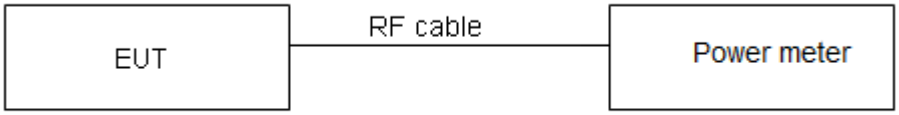
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

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.

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Test Results

SISO Antenna 1

Test Mode	T_{on} (ms)	$T_{(on+off)}$ (ms)	Duty cycle	Duty cycle correction Factor(dB)
802.11b	8.42	8.47	0.99	NA
802.11g	1.40	1.57	0.89	0.50
802.11n HT20	1.30	1.48	0.88	0.56
802.11n HT40	0.65	0.81	0.80	0.96
Note: when Duty cycle⩾0.98, Duty cycle correction Factor not required.				

SISO Antenna 2

Test Mode	T_{on} (ms)	$T_{(on+off)}$ (ms)	Duty cycle	Duty cycle correction Factor(dB)
802.11b	8.42	8.49	0.99	NA
802.11g	1.40	1.59	0.88	0.55
802.11n HT20	1.31	1.50	0.87	0.59
802.11n HT40	0.65	0.81	0.80	0.96
Note: when Duty cycle⩾0.98, Duty cycle correction Factor not required.				

MIMO

Without Beamforming

Test Mode	T_{on} (ms)	$T_{(on+off)}$ (ms)	Duty cycle	Duty cycle correction Factor(dB)
802.11g	1.40	1.56	0.90	0.47
802.11n HT20	1.30	1.48	0.88	0.56
802.11n HT40	0.65	0.83	0.78	1.06
Note: when Duty cycle⩾0.98, Duty cycle correction Factor not required.				

With Beamforming

Test Mode	T_{on} (ms)	$T_{(on+off)}$ (ms)	Duty cycle	Duty cycle correction Factor(dB)
802.11g	1.39	1.58	0.88	0.56
802.11n HT20	1.31	1.50	0.87	0.59
802.11n HT40	0.65	0.83	0.78	1.06
Note: when Duty cycle⩾0.98, Duty cycle correction Factor not required.				

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SISO Antenna 1

Test Mode	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412	21.41	21.41	30	PASS
	2417	22.33	22.33	30	PASS
	2437	22.39	22.39	30	PASS
	2462	22.04	22.04	30	PASS
802.11g	2412	15.46	15.96	30	PASS
	2417	16.25	16.75	30	PASS
	2422	20.74	21.24	30	PASS
	2437	20.83	21.33	30	PASS
	2457	20.47	20.97	30	PASS
	2462	19.67	20.17	30	PASS
802.11n HT20	2412	15.50	16.06	30	PASS
	2417	16.86	17.42	30	PASS
	2422	20.74	21.30	30	PASS
	2437	20.71	21.27	30	PASS
	2457	20.72	21.28	30	PASS
	2462	19.62	20.18	30	PASS
802.11n HT40	2422	15.54	16.50	30	PASS
	2427	15.69	16.65	30	PASS
	2432	17.00	17.96	30	PASS
	2437	17.84	18.80	30	PASS
	2442	18.51	19.47	30	PASS
	2447	18.60	19.56	30	PASS
	2452	18.93	19.89	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

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SISO Antenna 2

Test Mode	Carrier frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412	21.70	21.70	30	PASS
	2417	22.06	22.06	30	PASS
	2437	21.87	21.87	30	PASS
	2462	21.83	21.83	30	PASS
802.11g	2412	15.32	15.87	30	PASS
	2417	15.76	16.31	30	PASS
	2422	20.25	20.80	30	PASS
	2437	20.60	21.15	30	PASS
	2457	20.41	20.96	30	PASS
	2462	19.48	20.03	30	PASS
802.11n HT20	2412	15.39	15.98	30	PASS
	2417	15.95	16.54	30	PASS
	2422	20.56	21.15	30	PASS
	2437	20.84	21.43	30	PASS
	2457	20.36	20.95	30	PASS
	2462	18.92	19.51	30	PASS
802.11n HT40	2422	15.15	16.11	30	PASS
	2427	16.20	17.16	30	PASS
	2432	16.72	17.68	30	PASS
	2437	17.19	18.15	30	PASS
	2442	18.01	18.97	30	PASS
	2447	19.09	20.05	30	PASS
	2452	18.86	19.82	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

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MIMO

Without Beamforming

Test Mode	Carrier frequency (MHz)	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)			
802.11g	2412	14.50	15.31	14.50	15.28	18.78	30.00	PASS
	2417	15.50	16.38	15.50	16.12	19.73	30.00	PASS
	2422	20.00	20.86	20.00	20.69	24.26	30.00	PASS
	2437	20.00	20.61	20.00	20.85	24.21	30.00	PASS
	2457	20.00	20.78	20.00	20.97	24.36	30.00	PASS
	2462	19.00	19.69	19.00	19.38	23.02	30.00	PASS
802.11n HT20	2412	14.50	14.89	14.50	15.46	18.76	30.00	PASS
	2417	16.00	16.73	16.00	16.52	20.20	30.00	PASS
	2422	20.00	20.68	20.00	20.82	24.32	30.00	PASS
	2437	20.00	20.36	20.00	20.69	24.10	30.00	PASS
	2457	20.00	20.54	20.00	20.46	24.07	30.00	PASS
	2462	19.00	19.27	19.00	19.62	23.02	30.00	PASS
802.11n HT40	2422	15.00	15.31	15.00	15.12	19.29	30.00	PASS
	2427	16.00	16.08	16.00	16.12	20.17	30.00	PASS
	2432	16.50	16.81	16.50	16.68	20.82	30.00	PASS
	2437	17.50	17.86	17.50	17.73	21.87	30.00	PASS
	2442	18.50	18.84	18.50	18.82	22.90	30.00	PASS
	2447	19.00	18.97	19.00	18.95	23.03	30.00	PASS
	2452	19.00	19.07	19.00	19.32	23.27	30.00	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 transmitter output signals is CDD mode. And N_{SS}=1. According to KDB 662911 D01 Multiple Transmitter Output v02r01 2)f)(i): If all antennas have the same gain, Directional gain = G_{ANT} + 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 = 4.5dBi<6dBi. So the power limt is 30dBm

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With Beamforming

Test Mode	Carrier frequency (MHz)	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)			
802.11g	2412	14.50	15.23	14.50	15.19	18.78	28.49	PASS
	2417	15.50	16.21	15.50	16.01	19.68	28.49	PASS
	2422	20.00	20.57	20.00	20.38	24.04	28.49	PASS
	2437	20.00	20.59	20.00	20.80	24.26	28.49	PASS
	2457	20.00	20.78	20.00	20.97	24.44	28.49	PASS
	2462	19.00	19.71	19.00	19.42	23.13	28.49	PASS
802.11n HT20	2412	14.50	14.67	14.50	15.41	18.65	28.49	PASS
	2417	16.00	16.59	16.00	16.57	20.18	28.49	PASS
	2422	20.00	20.51	20.00	20.67	24.19	28.49	PASS
	2437	20.00	20.36	20.00	20.51	24.03	28.49	PASS
	2457	20.00	20.57	20.00	20.38	24.07	28.49	PASS
	2462	19.00	19.33	19.00	19.62	23.08	28.49	PASS
802.11n HT40	2422	15.00	15.28	15.00	15.17	19.30	28.49	PASS
	2427	16.00	16.03	16.00	16.01	20.09	28.49	PASS
	2432	16.50	16.82	16.50	16.73	20.85	28.49	PASS
	2437	17.50	17.86	17.50	17.73	21.87	28.49	PASS
	2442	18.50	18.66	18.50	18.71	22.76	28.49	PASS
	2447	19.00	19.02	19.00	18.95	23.06	28.49	PASS
	2452	19.00	19.01	19.00	19.22	23.19	28.49	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. Direction gain calculation according to KDB662911 D01 Multiple Transmitter Output v02r01 F) 2) e）Directional gain = 7.51dBi<6dBi. So the limt is 30-(7.51-6)=28.49dBm.

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5.2. 99% Bandwidth and 6dB Bandwidth

Ambient condition

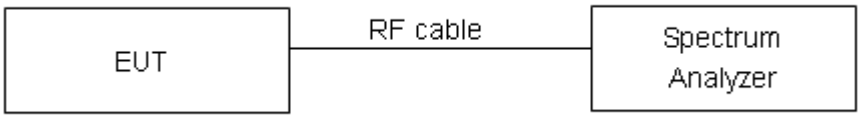
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

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.

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Test Results:

Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11b	2412	15.696	9.600	500	PASS
	2417	15.706	10.120	500	PASS
	2437	15.640	10.120	500	PASS
	2462	15.580	10.120	500	PASS
802.11g	2412	17.055	16.360	500	PASS
	2417	17.046	16.400	500	PASS
	2422	17.807	16.360	500	PASS
	2437	17.811	16.440	500	PASS
	2457	17.771	16.360	500	PASS
	2462	17.370	16.400	500	PASS
802.11n HT20	2412	18.097	17.120	500	PASS
	2417	18.036	17.160	500	PASS
	2422	18.873	16.760	500	PASS
	2437	18.595	17.240	500	PASS
	2457	18.664	17.000	500	PASS
	2462	18.280	16.400	500	PASS
802.11n HT40	2422	35.792	35.200	500	PASS
	2427	35.791	35.280	500	PASS
	2432	35.822	35.280	500	PASS
	2437	35.939	35.200	500	PASS
	2442	36.020	35.200	500	PASS
	2447	36.002	35.520	500	PASS
	2452	35.893	35.200	500	PASS

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99% bandwidth

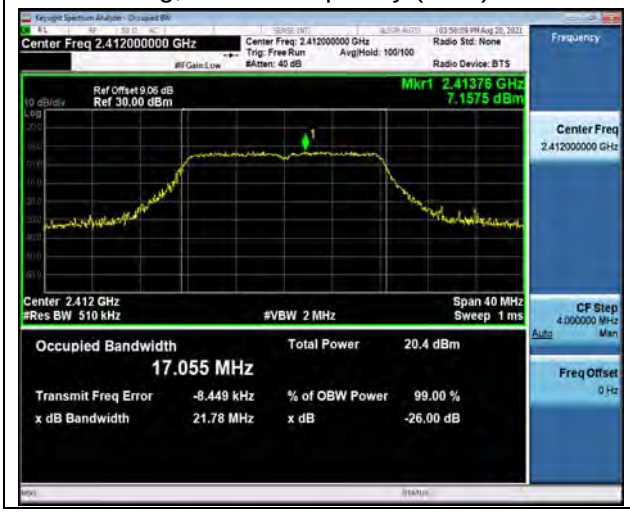
802.11b, Carrier frequency (MHz): 2412

802.11b, Carrier frequency (MHz): 2437

802.11b, Carrier frequency (MHz): 2417

802.11b, Carrier frequency (MHz): 2462

802.11g, Carrier frequency (MHz): 2412



802.11g, Carrier frequency (MHz): 2437

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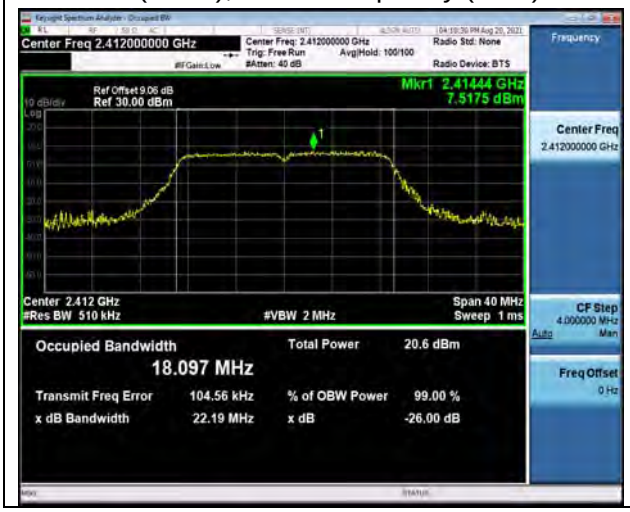
802.11g, Carrier frequency (MHz): 2417

802.11g, Carrier frequency (MHz): 2457

802.11g, Carrier frequency (MHz): 2422

802.11g, Carrier frequency (MHz):2462

802.11n(HT20), Carrier frequency (MHz): 2412



802.11n(HT40), Carrier frequency (MHz): 2422

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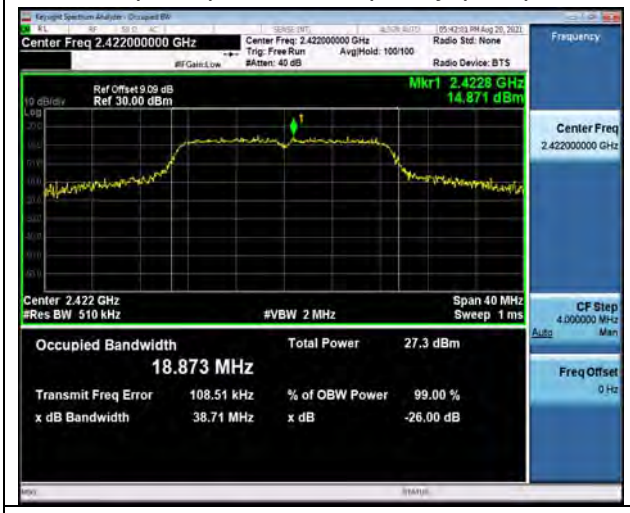
802.11n(HT20), Carrier frequency (MHz): 2417

802.11n(HT40), Carrier frequency (MHz): 2427

802.11n(HT20), Carrier frequency (MHz): 2422



802.11n(HT40), Carrier frequency (MHz): 2432

802.11n(HT20), Carrier frequency (MHz): 2437

802.11n(HT40), Carrier frequency (MHz): 2437

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802.11n(HT20), Carrier frequency (MHz): 2457

802.11n(HT40), Carrier frequency (MHz): 2442

802.11n(HT20), Carrier frequency (MHz): 2462

802.11n(HT40), Carrier frequency (MHz): 2447

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802.11n(HT40), Carrier frequency (MHz): 2452

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6 dB bandwidth

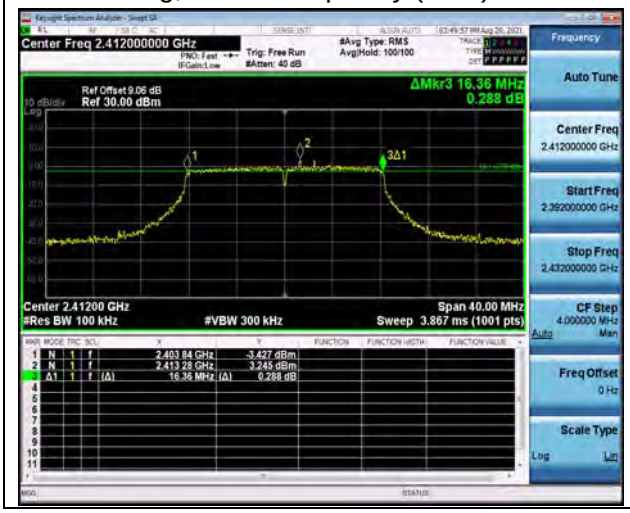
802.11b, Carrier frequency (MHz): 2412

802.11b, Carrier frequency (MHz): 2437

802.11b, Carrier frequency (MHz): 2417

802.11b, Carrier frequency (MHz): 2462

802.11g, Carrier frequency (MHz): 2412



802.11g, Carrier frequency (MHz): 2437

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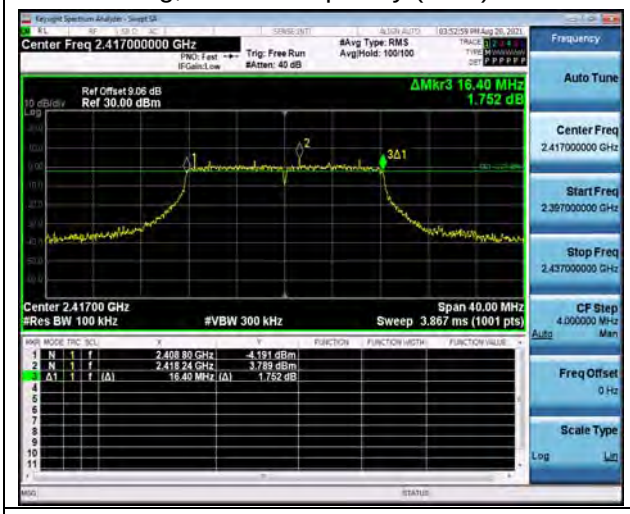
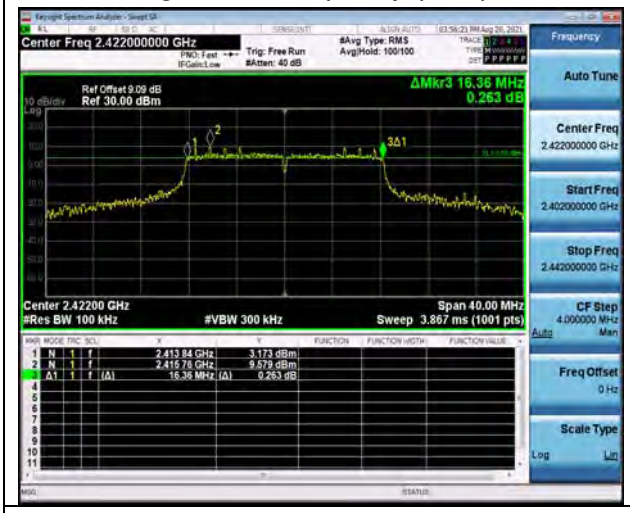
802.11g, Carrier frequency (MHz): 2417



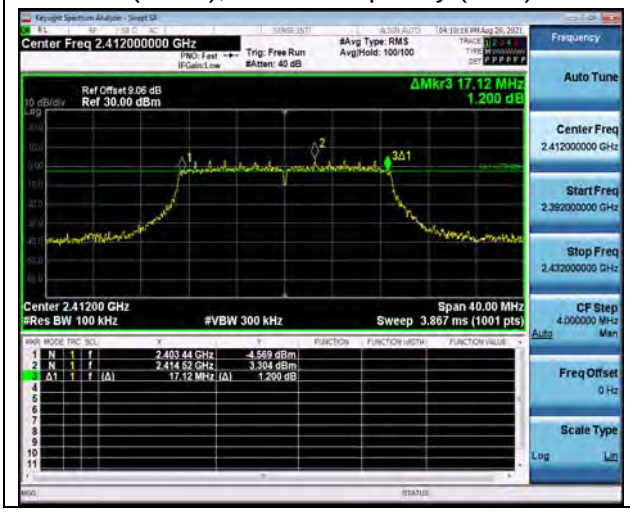
802.11g, Carrier frequency (MHz): 2457

802.11g, Carrier frequency (MHz): 2422

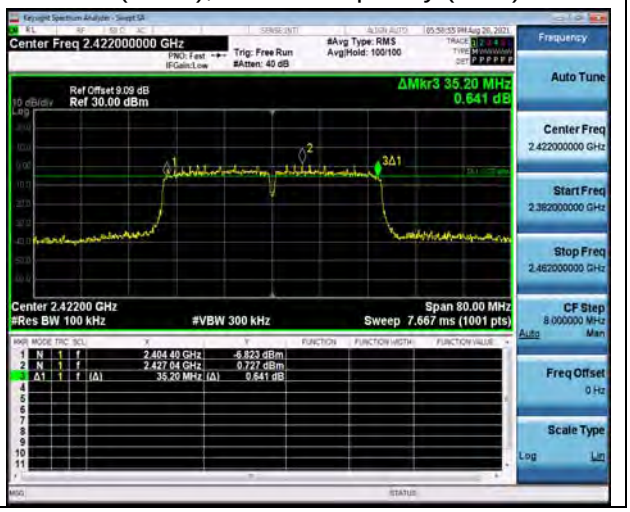


802.11g, Carrier frequency (MHz):2462

802.11n(HT20), Carrier frequency (MHz): 2412



802.11n(HT40), Carrier frequency (MHz): 2422



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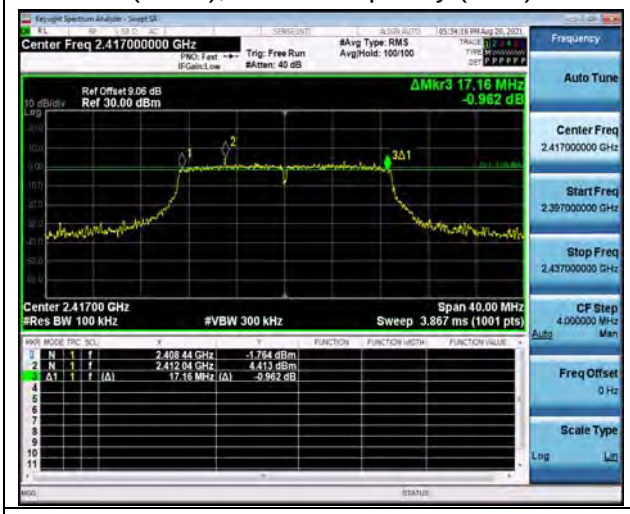
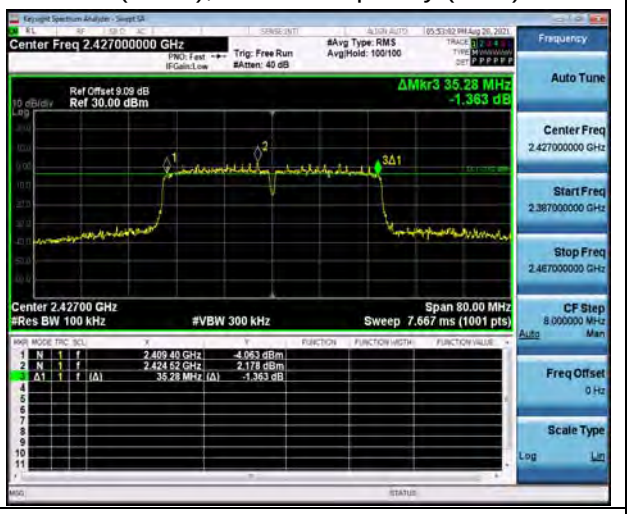
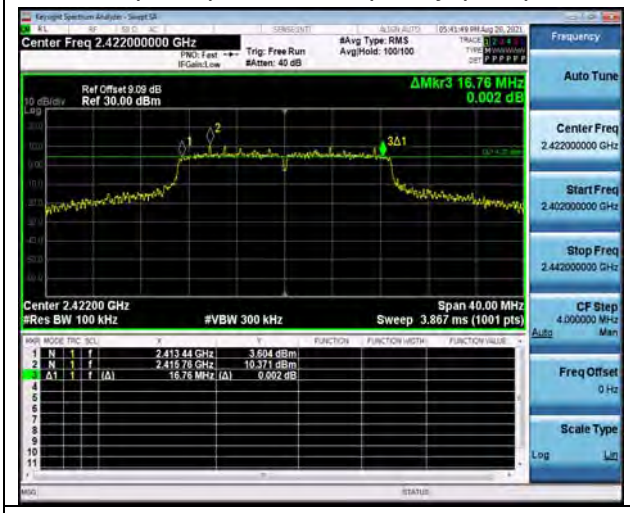
802.11n(HT20), Carrier frequency (MHz): 2417



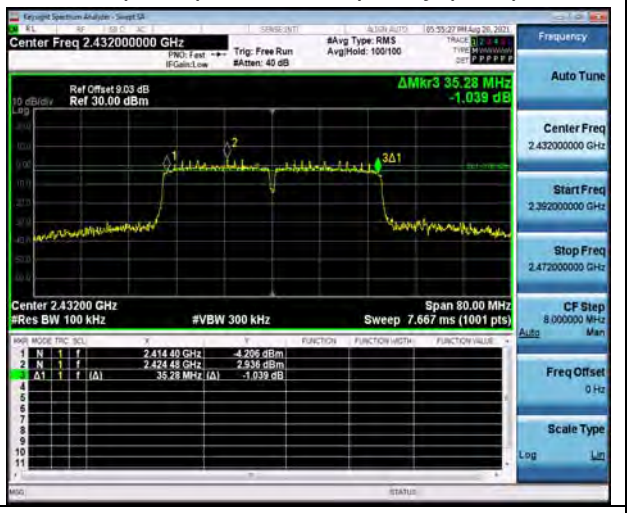
802.11n(HT40), Carrier frequency (MHz): 2427



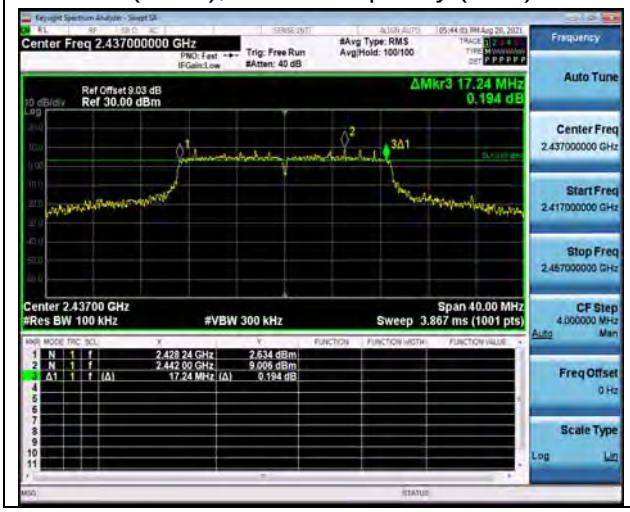
802.11n(HT20), Carrier frequency (MHz): 2422



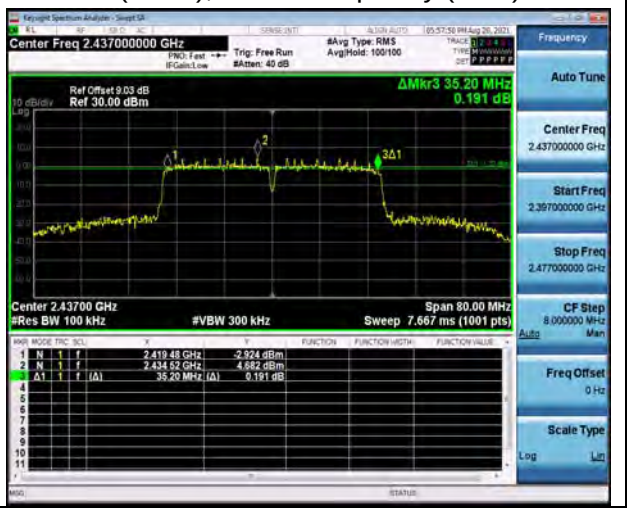
802.11n(HT40), Carrier frequency (MHz): 2432



802.11n(HT20), Carrier frequency (MHz): 2437



802.11n(HT40), Carrier frequency (MHz): 2437



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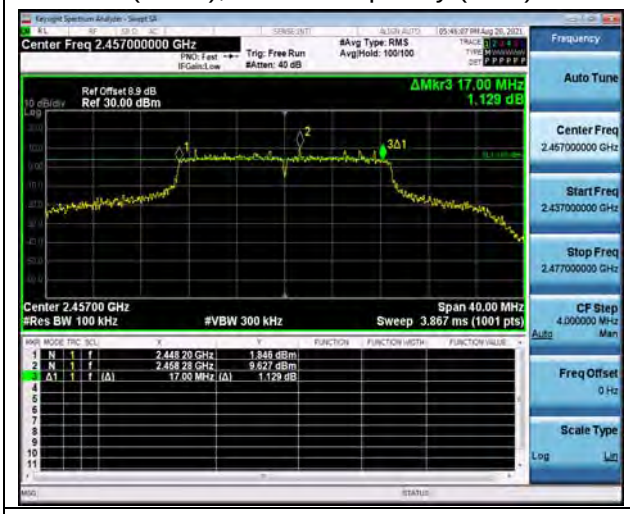
802.11n(HT20), Carrier frequency (MHz): 2457



802.11n(HT40), Carrier frequency (MHz): 2442

802.11n(HT20), Carrier frequency (MHz): 2462

802.11n(HT40), Carrier frequency (MHz): 2447

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802.11n(HT40), Carrier frequency (MHz): 2452

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5.3. Band Edge

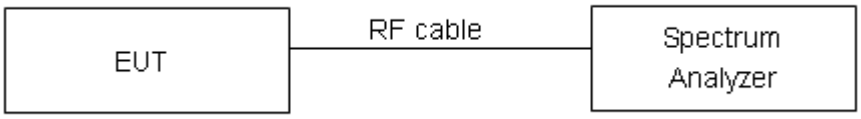
Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

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

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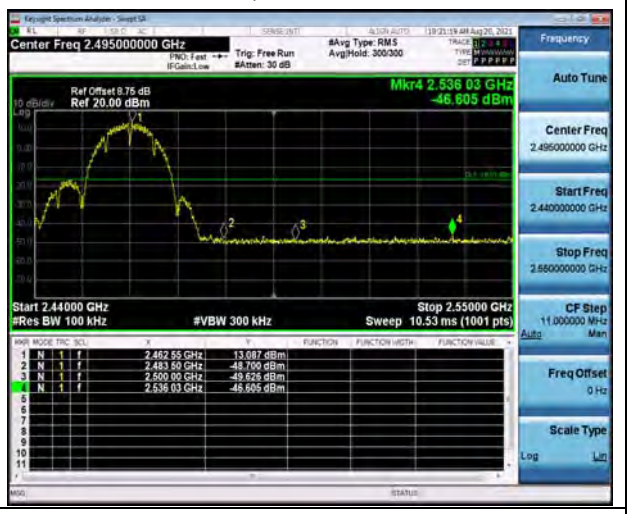
Test Results: PASS

802.11b, Channel No.: 1

802.11b, Channel No.: 11



802.11g, Channel No.: 1

802.11g, Channel No.: 11

802.11n(HT20), Channel No.: 1

802.11n(HT20), Channel No.: 11

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802.11n(HT40), Channel No.: 3	802.11n(HT40), Channel No.: 9

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5.4. Power Spectral Density

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

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[2 X span/RBWT]

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≤100Kh

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[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

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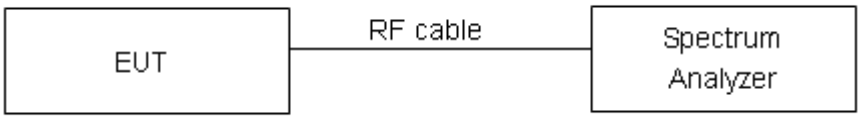
compute the average PSD during the actual transmission time

m) If measured value exceeds requirement specified by regulatory agency then reduce RBW(but o 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:

SISO Antenna 1

Test Mode	Channel Number	PSD (dBm/30kHz)	PSD (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	1	-0.99	-10.99	8	PASS
	2	0.24	-9.76	8	PASS
	6	-0.02	-10.02	8	PASS
	11	-0.02	-10.02	8	PASS
802.11g	1	-7.99	-17.99	8	PASS
	2	-6.87	-16.87	8	PASS
	3	-2.52	-12.52	8	PASS
	6	-2.47	-12.47	8	PASS
	10	-3.15	-13.15	8	PASS
	11	-3.69	-13.69	8	PASS
802.11n HT20	1	-8.23	-18.23	8	PASS
	2	-6.64	-16.64	8	PASS
	3	-2.62	-12.62	8	PASS
	6	-2.89	-12.89	8	PASS
	10	-3.08	-13.08	8	PASS
	11	-5.56	-15.56	8	PASS
802.11n HT40	3	-9.21	-19.21	8	PASS
	4	-10.01	-20.01	8	PASS
	5	-8.82	-18.82	8	PASS
	6	-7.84	-17.84	8	PASS
	7	-6.16	-16.16	8	PASS
	8	-6.61	-16.61	8	PASS
	9	-7.32	-17.32	8	PASS

Note: 1. Offset already includes Duty cycle correction factor, so all read value in test plots are already the final results of the power spectrum density.

2. PSD(dBm/3kHz)=RSD(dBm/30kHz)+10*LOG10(3/30) 10*LOG10(3/30)=-10

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SISO Antenna 2

Test Mode	Channel Number	Read Value (dBm / 30kHz)	Read Value (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	1	-0.35	-10.35	8	PASS
	2	-0.26	-10.26	8	PASS
	6	-0.46	-10.46	8	PASS
	11	-0.16	-10.16	8	PASS
802.11g	1	-8.06	-18.06	8	PASS
	2	-7.25	-17.25	8	PASS
	3	-2.90	-12.90	8	PASS
	6	-2.80	-12.80	8	PASS
	10	-3.65	-13.65	8	PASS
	11	-4.32	-14.32	8	PASS
802.11n HT20	1	-7.78	-17.78	8	PASS
	2	-7.35	-17.35	8	PASS
	3	-3.54	-13.54	8	PASS
	6	-2.88	-12.88	8	PASS
	10	-3.35	-13.35	8	PASS
	11	-4.40	-14.40	8	PASS
802.11n HT40	3	-10.61	-20.61	8	PASS
	4	-9.47	-19.47	8	PASS
	5	-9.17	-19.17	8	PASS
	6	-8.23	-18.23	8	PASS
	7	-7.19	-17.19	8	PASS
	8	-6.55	-16.55	8	PASS
	9	-6.48	-16.48	8	PASS

Note: 1. Offset already includes Duty cycle correction factor, so all read value in test plots are already the final results of the power spectrum density.
2. PSD(dBm/3kHz)=RSD(dBm/30kHz)+10*LOG10(3/30) 10*LOG10(3/30)=-10

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MIMO Antenna
Without Beamforming

Test Mode	Channel Number	Power Spectral Density				Total PSD (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
		Antenna 1		Antenna 2				
		PSD (dBm /30kHz)	PSD (dBm /3kHz)	PSD (dBm /30kHz)	PSD (dBm /3kHz)			
802.11g	1	-9.59	-19.59	-9.17	-19.17	-16.36	6.49	PASS
	2	-8.57	-18.57	-8.23	-18.23	-15.39	6.49	PASS
	3	-3.80	-13.80	-2.87	-12.87	-10.30	6.49	PASS
	6	-4.10	-14.10	-4.11	-14.11	-11.09	6.49	PASS
	10	-3.49	-13.49	-4.00	-14.00	-10.73	6.49	PASS
	11	-4.72	-14.72	-4.63	-14.63	-11.66	6.49	PASS
802.11n HT20	1	-9.62	-19.62	-9.32	-19.32	-16.45	6.49	PASS
	2	-8.02	-18.02	-8.68	-18.68	-15.32	6.49	PASS
	3	-3.06	-13.06	-3.76	-13.76	-10.38	6.49	PASS
	6	-4.14	-14.14	-3.75	-13.75	-10.93	6.49	PASS
	10	-3.81	-13.81	-4.07	-14.07	-10.92	6.49	PASS
	11	-4.27	-14.27	-4.96	-14.96	-11.59	6.49	PASS
802.11n HT40	3	-10.33	-20.33	-11.24	-21.24	-17.75	6.49	PASS
	4	-10.88	-20.88	-10.51	-20.51	-17.68	6.49	PASS
	5	-9.92	-19.92	-9.47	-19.47	-16.68	6.49	PASS
	6	-8.67	-18.67	-7.95	-17.95	-15.28	6.49	PASS
	7	-6.68	-16.68	-7.23	-17.23	-13.93	6.49	PASS
	8	-7.62	-17.62	-6.60	-16.60	-14.07	6.49	PASS
	9	-7.47	-17.47	-7.80	-17.80	-14.62	6.49	PASS

Note: 1. Offset already includes Duty cycle correction factor, so all read value in test plots are already the final results of the power spectrum density.

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

3. The manufacturer declared the transmitter output signals is CDD mode. And N_{SS}=1. According to KDB 662911 D01 Multiple Transmitter Output v02r01 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=GANT+Array Gain=4.5+10log(2/1)=7.51 >6dBi.

So the power limt is 8+6-7.51dBm=6.49dBm

4. PSD(dBm/3kHz)=RSD(dBm/30kHz)+10*LOG10(3/30) 10*LOG10(3/30)=-10

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Test Mode	Channel Number	Power Spectral Density				Total PSD (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
		Antenna 1		Antenna 2				
		PSD (dBm / 30kHz)	PSD (dBm / 3kHz)	PSD (dBm / 30kHz)	PSD (dBm /3kHz)			
802.11g	1	-9.27	-19.27	-9.50	-19.50	-16.38	6.49	PASS
	2	-7.57	-17.57	-8.31	-18.31	-14.92	6.49	PASS
	3	-3.06	-13.06	-2.91	-12.91	-9.98	6.49	PASS
	6	-3.82	-13.82	-3.70	-13.70	-10.75	6.49	PASS
	10	-3.29	-13.29	-3.87	-13.87	-10.56	6.49	PASS
	11	-5.03	-15.03	-4.63	-14.63	-11.82	6.49	PASS
802.11n HT20	1	-8.92	-18.92	-10.39	-20.39	-16.58	6.49	PASS
	2	-8.09	-18.09	-8.86	-18.86	-15.45	6.49	PASS
	3	-3.14	-13.14	-3.38	-13.38	-10.25	6.49	PASS
	6	-3.98	-13.98	-4.22	-14.22	-11.09	6.49	PASS
	10	-3.68	-13.68	-3.62	-13.62	-10.64	6.49	PASS
	11	-4.70	-14.70	-5.14	-15.14	-11.91	6.49	PASS
802.11n HT40	3	-11.24	-21.24	-11.28	-21.28	-18.25	6.49	PASS
	4	-10.13	-20.13	-10.30	-20.30	-17.20	6.49	PASS
	5	-9.11	-19.11	-9.67	-19.67	-16.37	6.49	PASS
	6	-8.82	-18.82	-8.25	-18.25	-15.51	6.49	PASS
	7	-6.81	-16.81	-6.74	-16.74	-13.76	6.49	PASS
	8	-6.90	-16.90	-6.63	-16.63	-13.75	6.49	PASS
	9	-7.29	-17.29	-7.27	-17.27	-14.27	6.49	PASS

Note: 1. Offset already includes Duty cycle correction factor, so all read value in test plots are already the final results of the power spectrum density.

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 transmitter output signals is CDD mode. And N_{SS}=1. According to KDB 662911 D01 Multiple Transmitter Output v02r01 2)e)(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=GANT+Array Gain=4.5+10log(2/1)=7.51 >6dBi.

So the power limt is 8+6-7.51dBm=6.49dBm

4. PSD(dBm/3kHz)=PSD(dBm/30kHz)+10*LOG10(3/30) 10*LOG10(3/30)=-10

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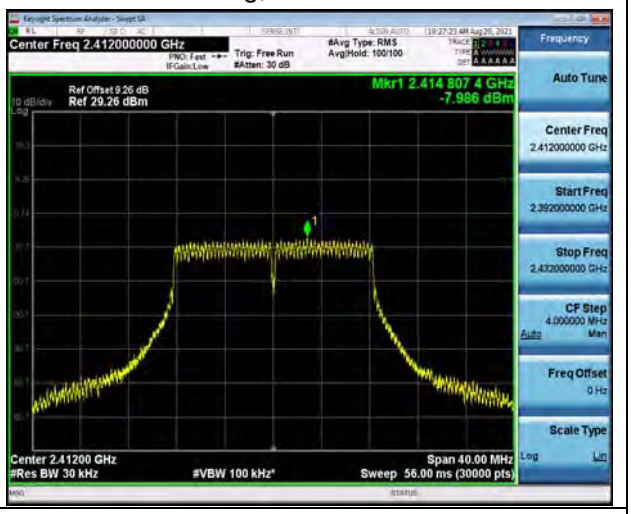
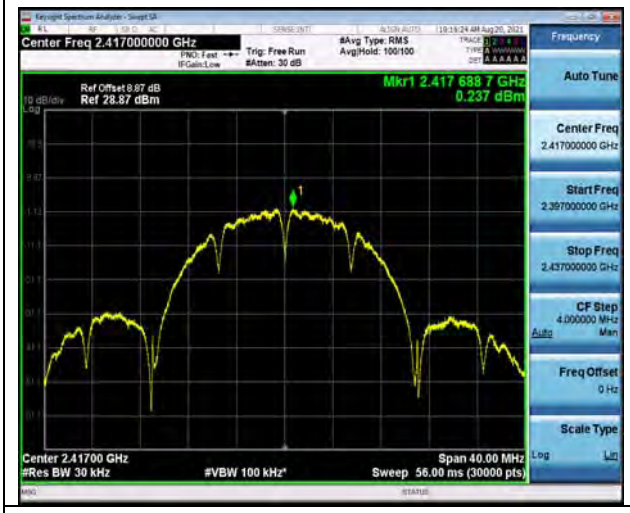
SISO Antenna 1

802.11b, Channel No.: 1

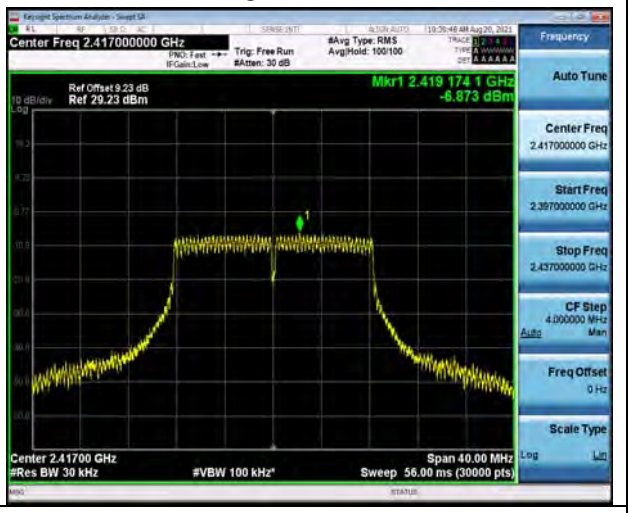
802.11g, Channel No.: 1



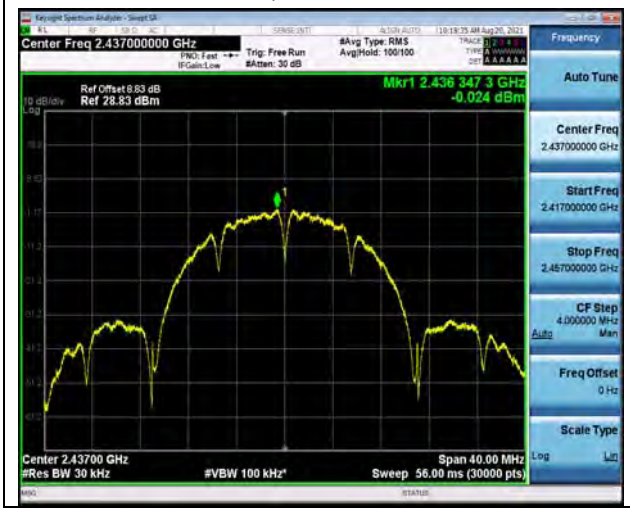
802.11b, Channel No.: 2



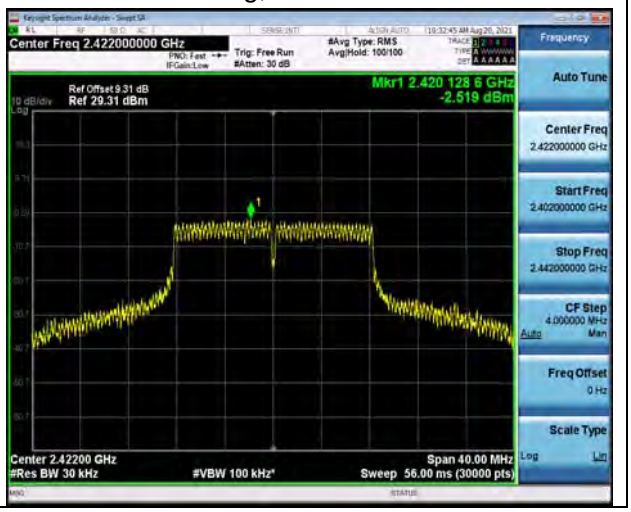
802.11g, Channel No.: 2



802.11b, Channel No.: 6



802.11g, Channel No.: 3



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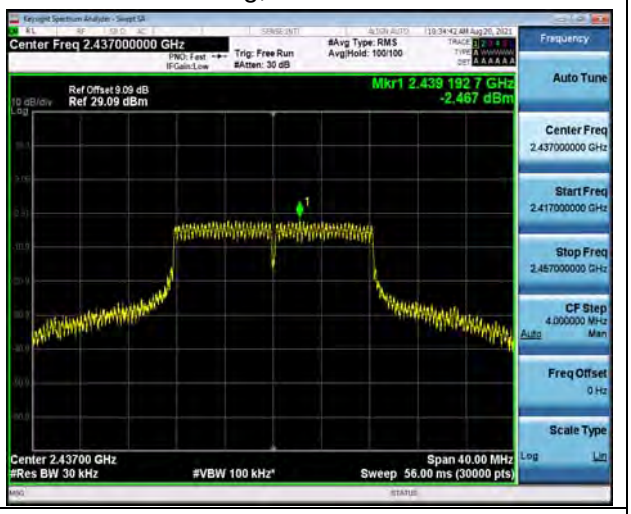
802.11b, Channel No.: 11

802.11g, Channel No.: 6



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802.11g, Channel No.: 10

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802.11g, Channel No.: 11

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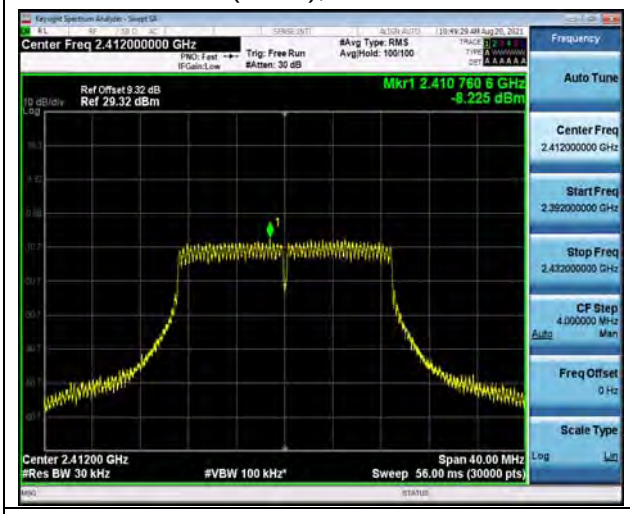
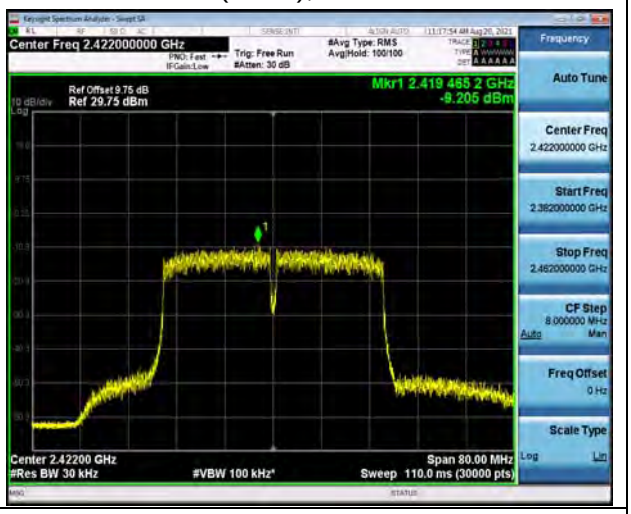
802.11n(HT20), Channel No. 1



802.11n(HT40), Channel No. 3



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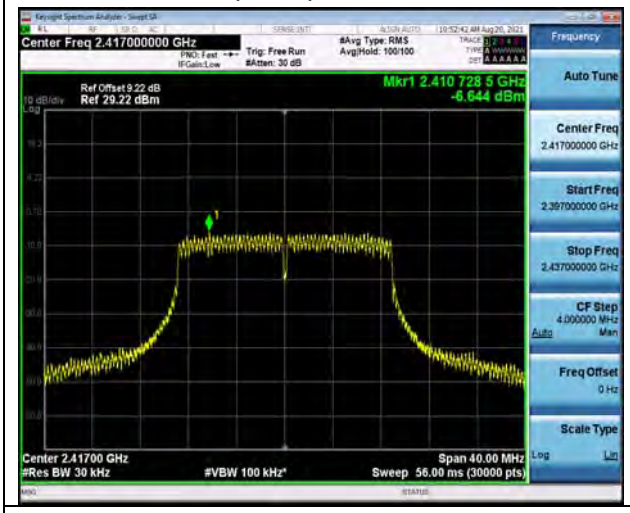
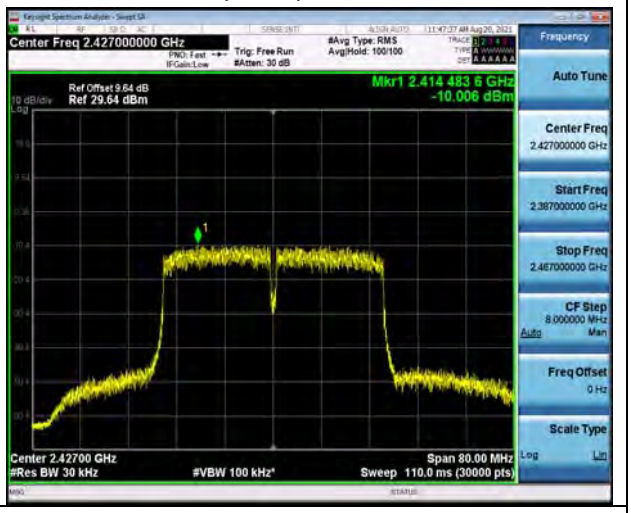


802.11n(HT40), Channel No. 4



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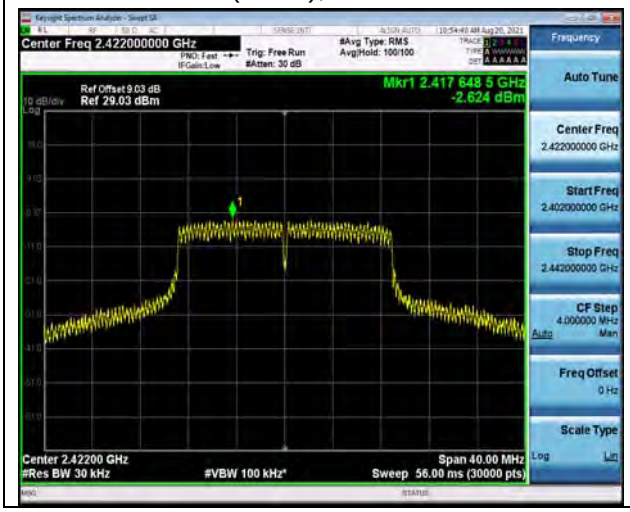

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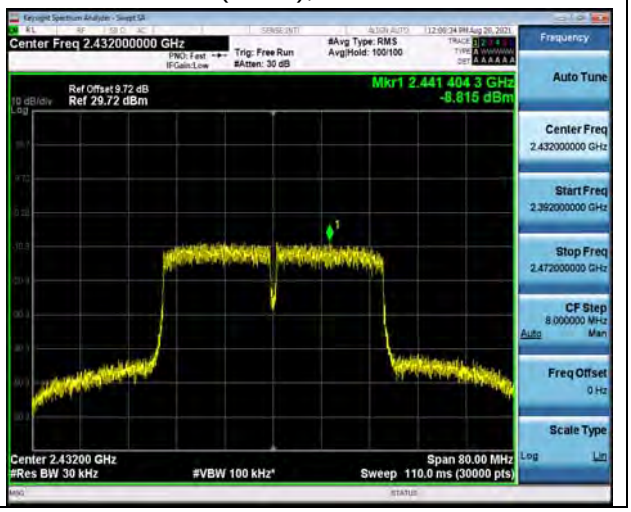

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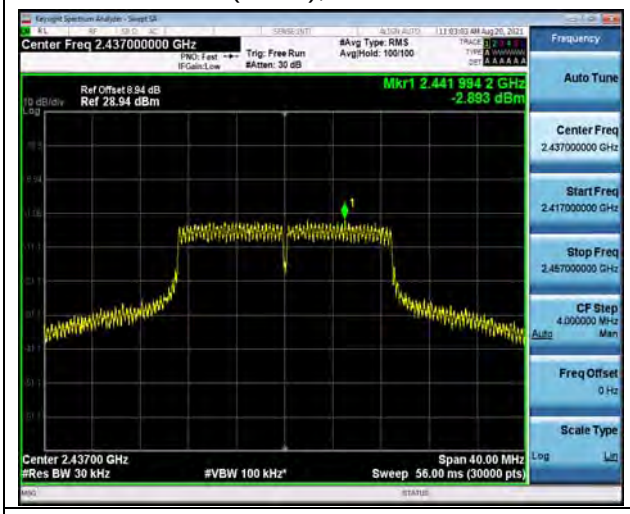
802.11n(HT20), Channel No. 6



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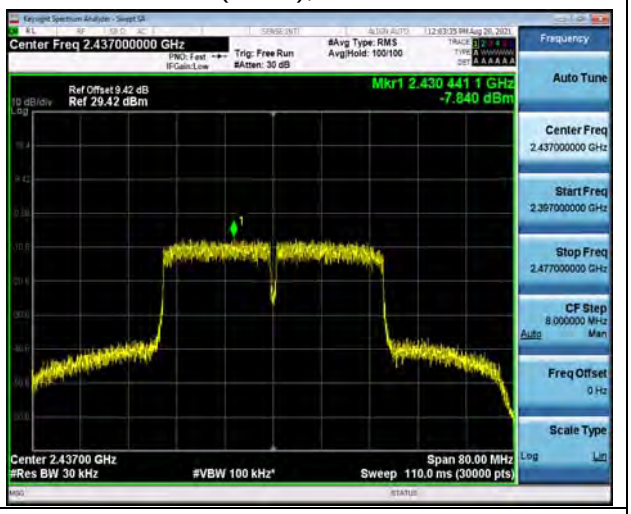

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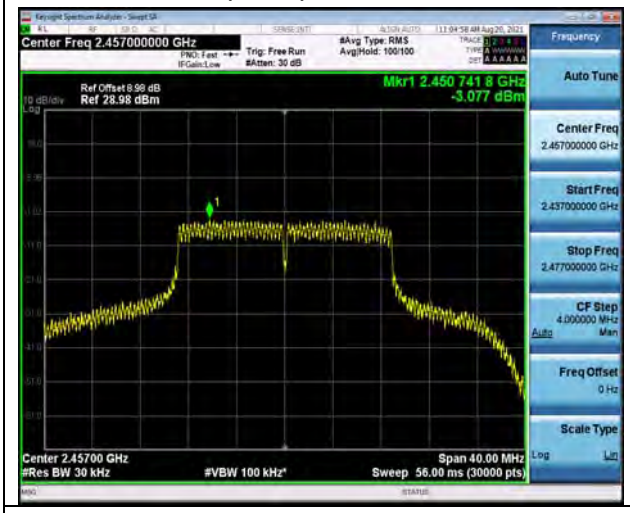

802.11n(HT40), Channel No. 7

802.11n(HT20), Channel No. 11

802.11n(HT40), Channel No. 8

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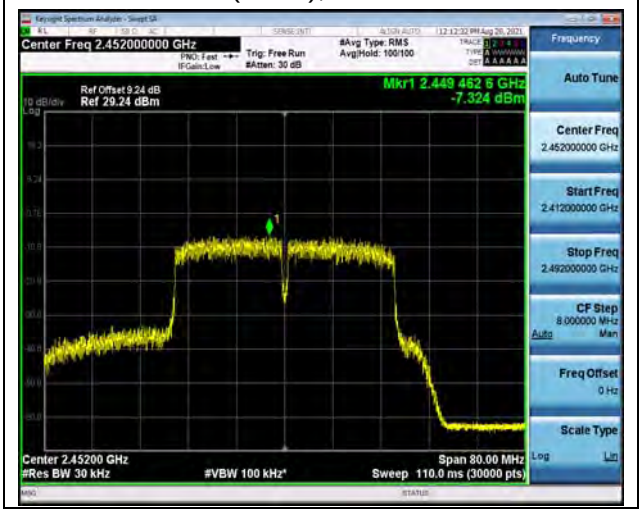
802.11n(HT40), Channel No. 9



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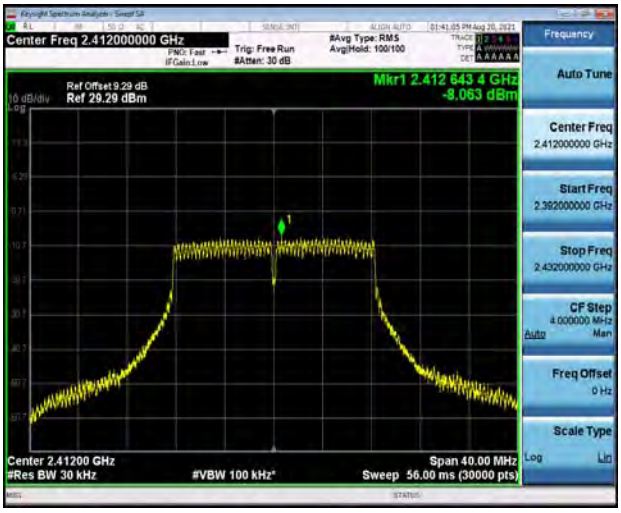
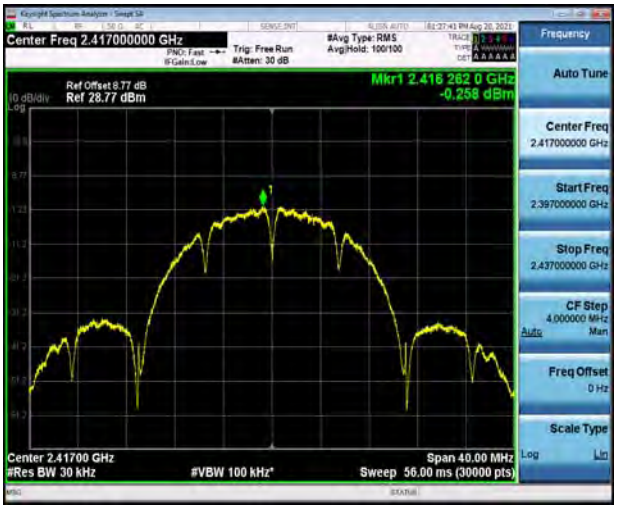
SISO Antenna 2

802.11b, Channel No.: 1

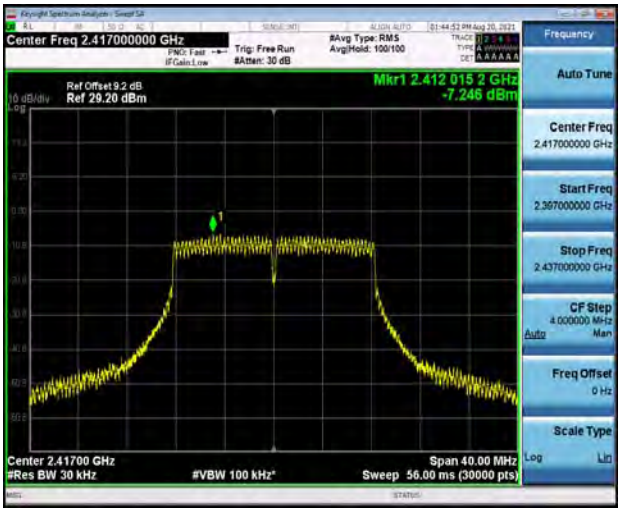
802.11g, Channel No.: 1



802.11b, Channel No.: 2

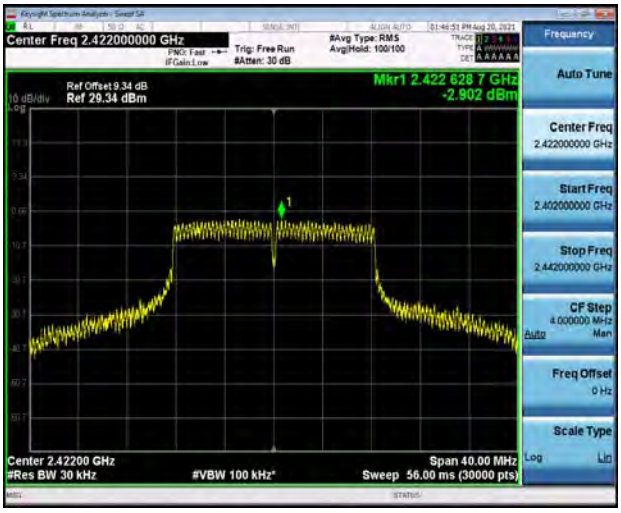


802.11g, Channel No.: 2



802.11b, Channel No.: 6

802.11g, Channel No.: 3



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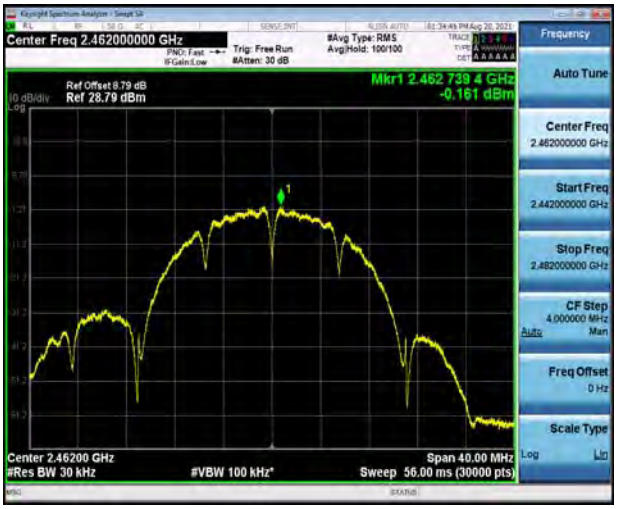
802.11b, Channel No.: 11



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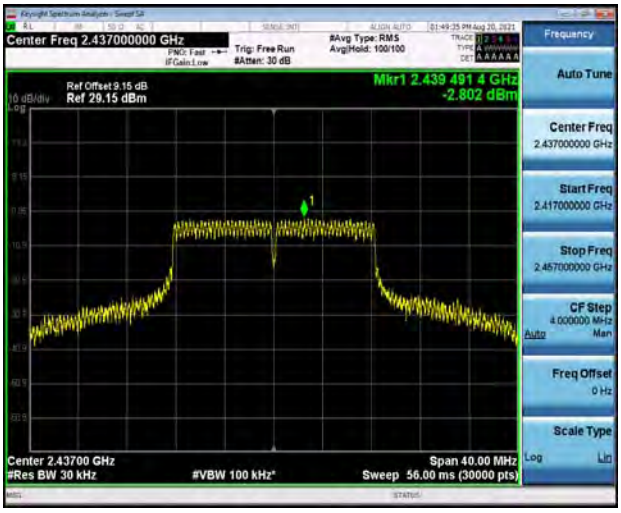

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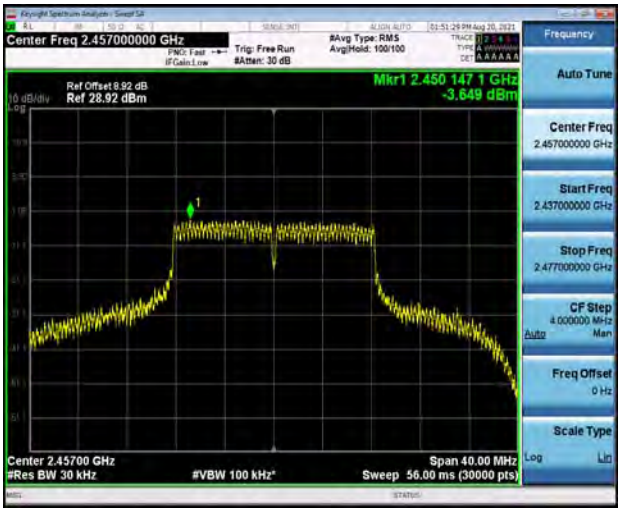

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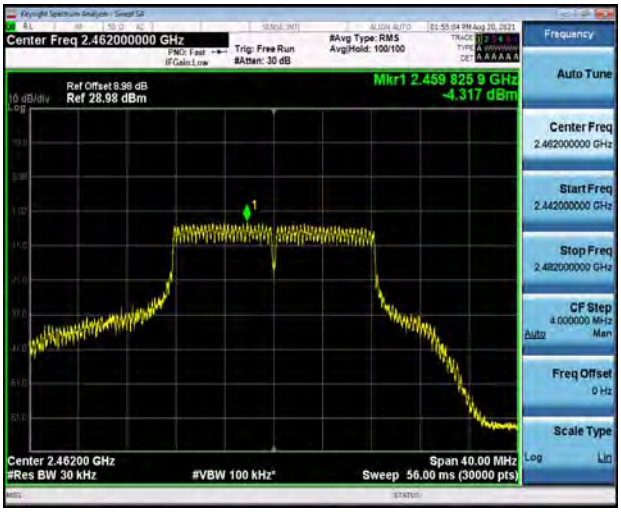

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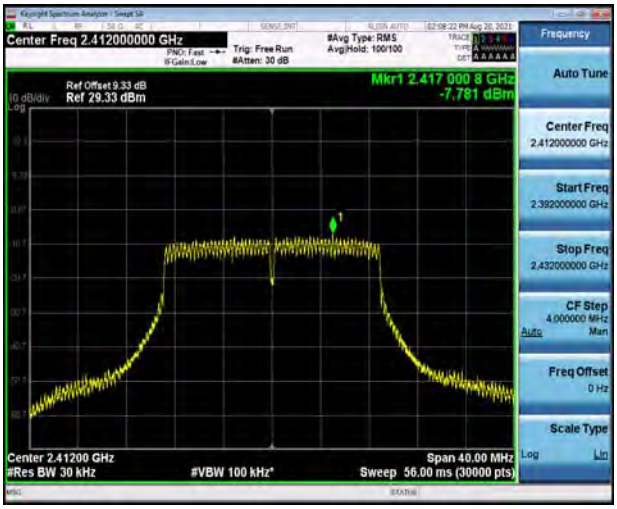
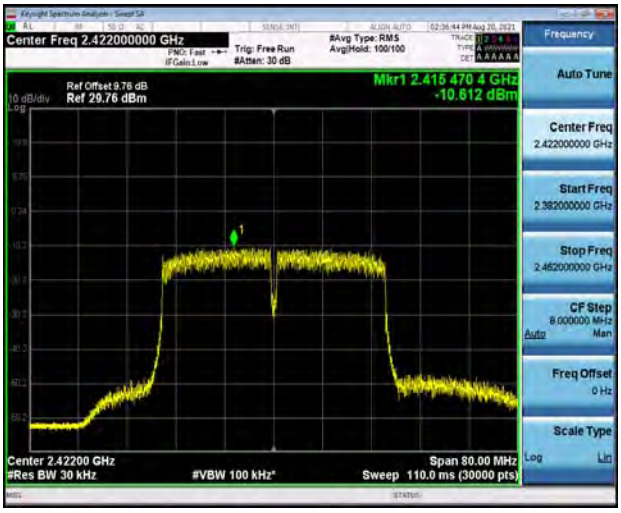
802.11n(HT20), Channel No. 1



802.11n(HT40), Channel No. 3



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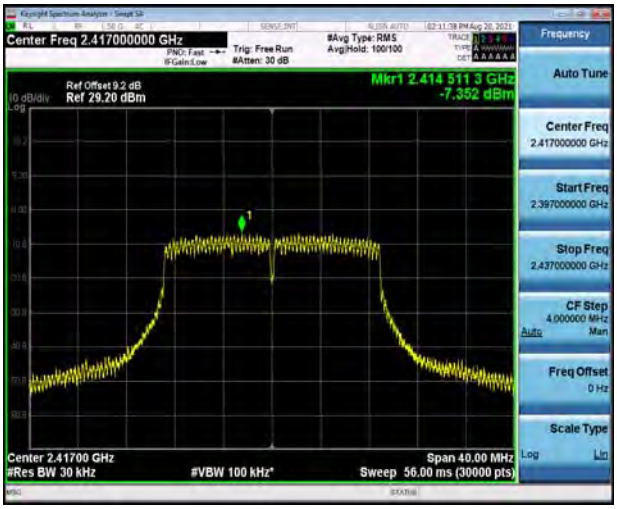

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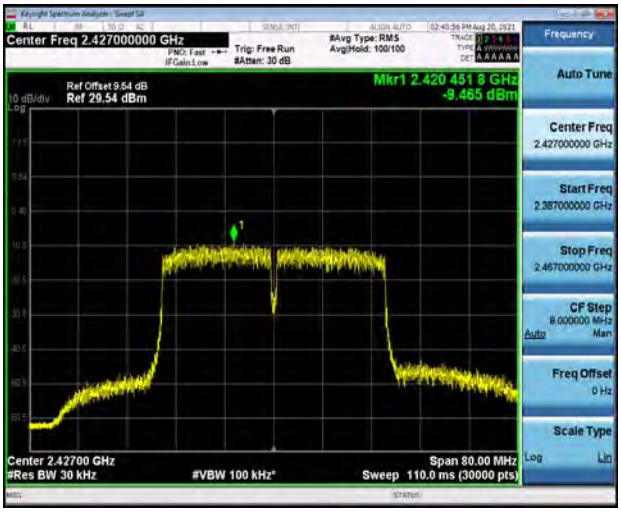

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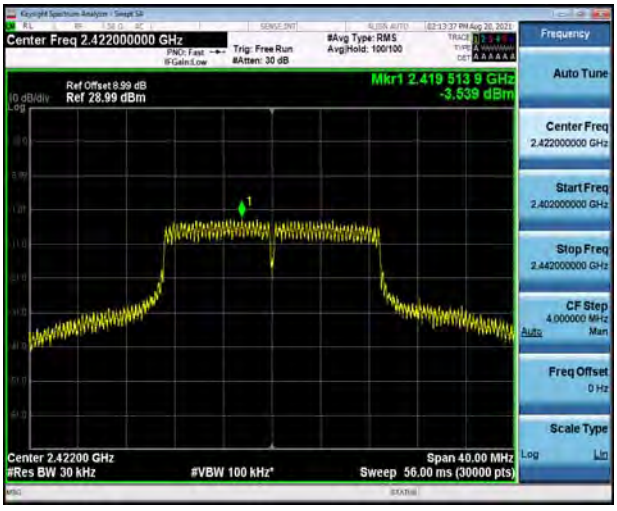

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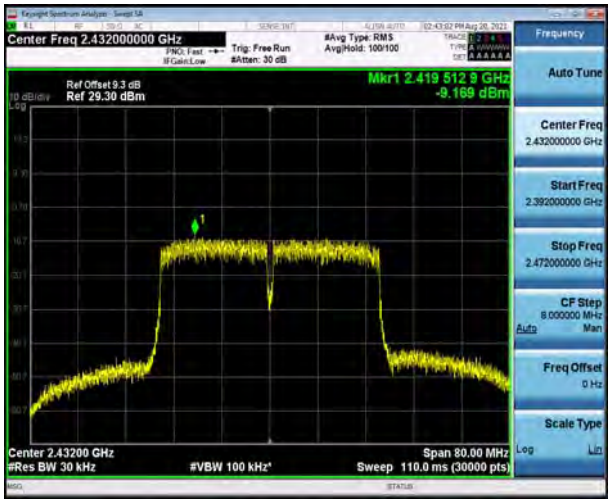

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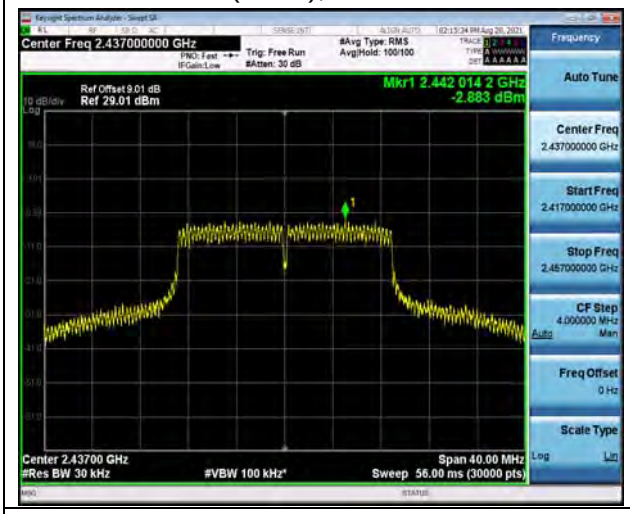
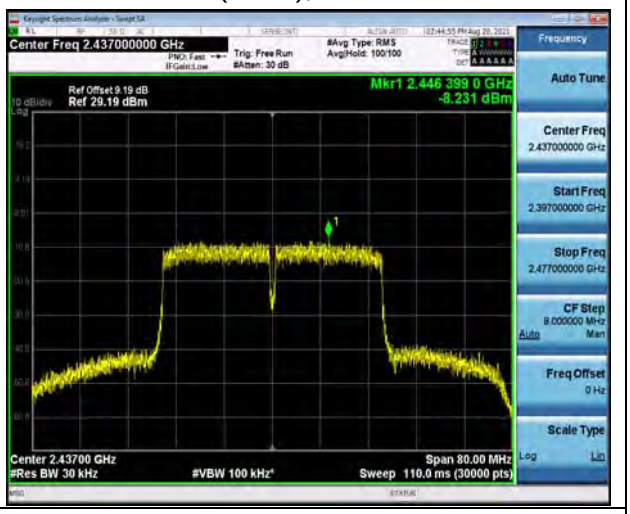
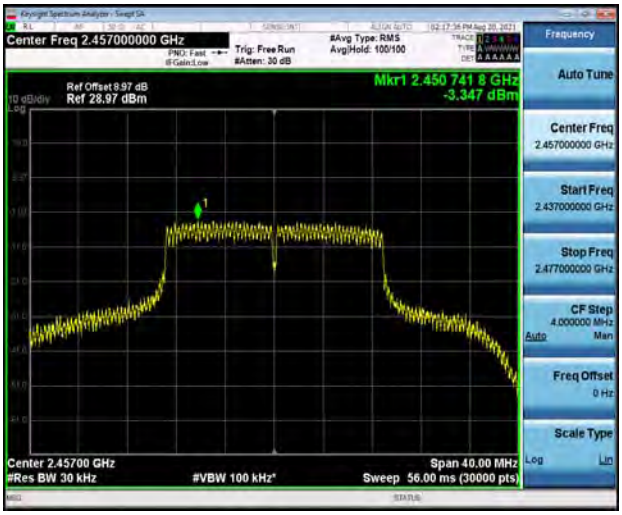
802.11n(HT20), Channel No. 6



802.11n(HT40), Channel No. 6

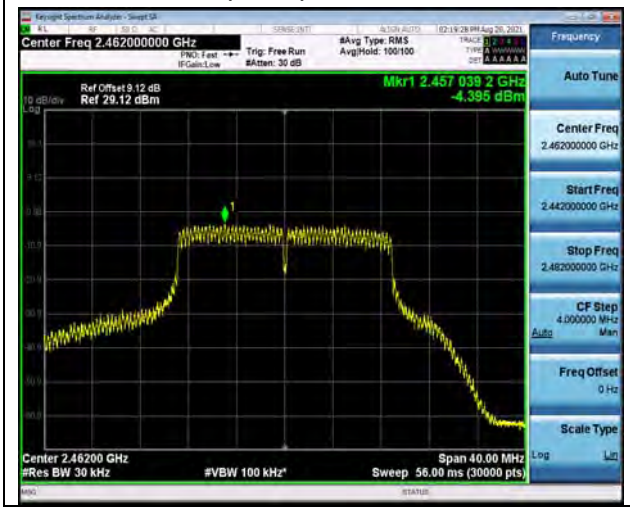


802.11n(HT20), Channel No. 10



802.11n(HT40), Channel No. 7

802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 8

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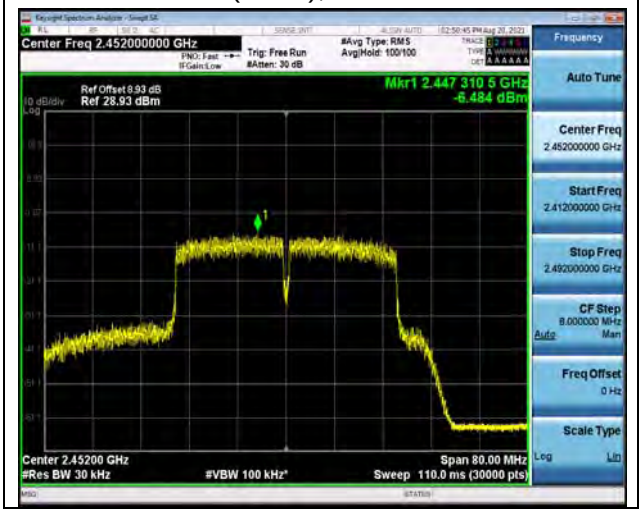
802.11n(HT40), Channel No. 9



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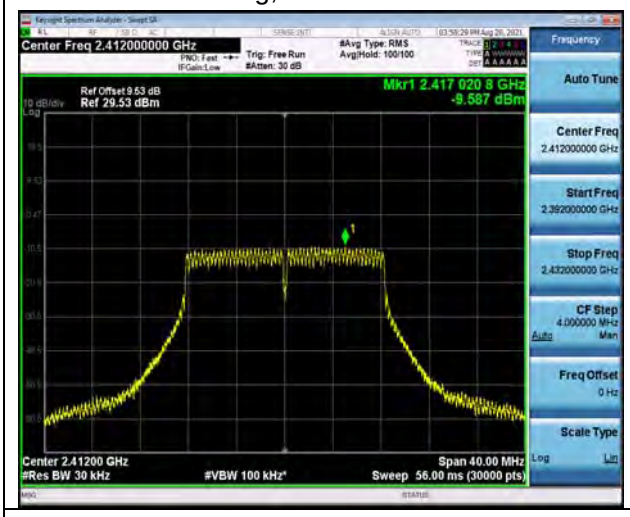
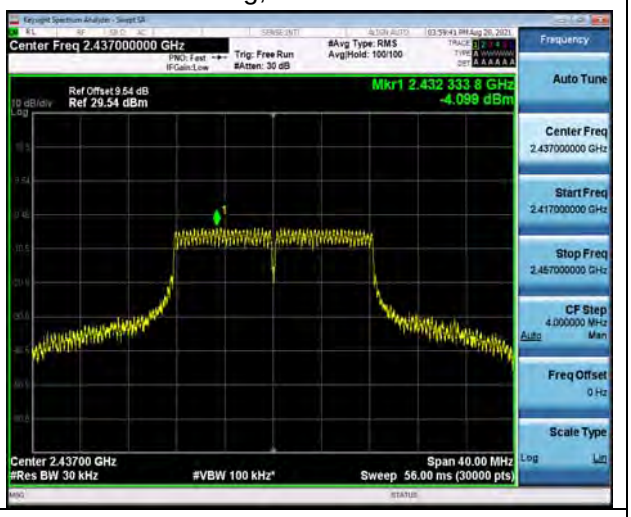
Without Beamforming

MIMO Antenna 1

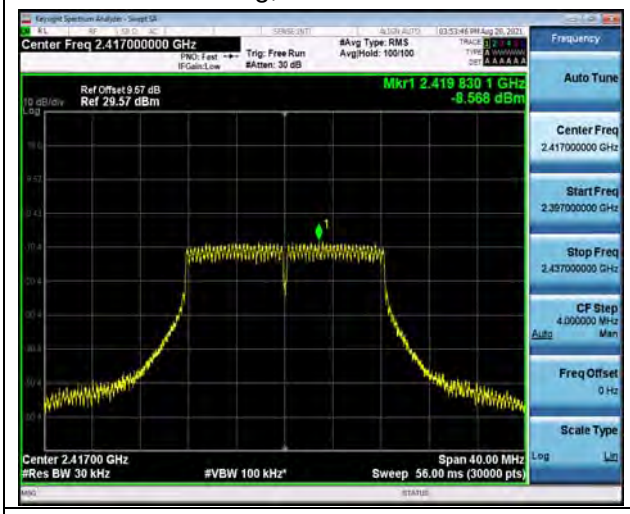
802.11g, Channel No.: 1



802.11g, Channel No.: 6

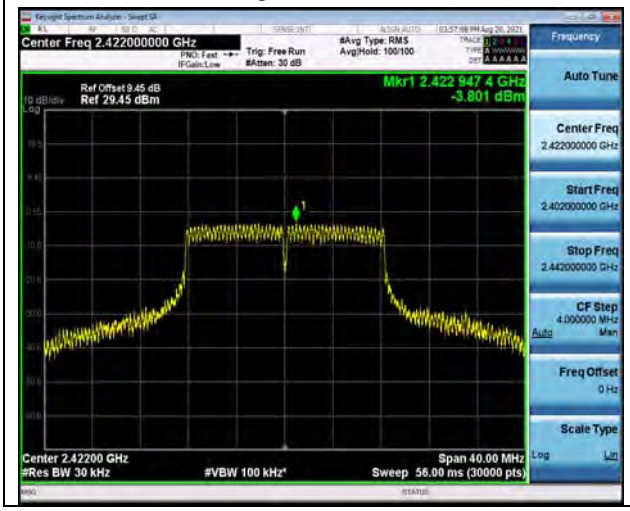


802.11g, Channel No.: 2



802.11g, Channel No.: 10

802.11g, Channel No.: 3



802.11g, Channel No.: 11

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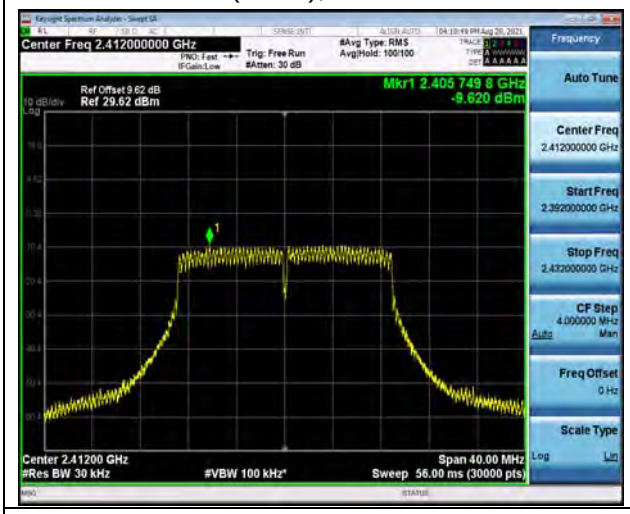
802.11n(HT20), Channel No. 1



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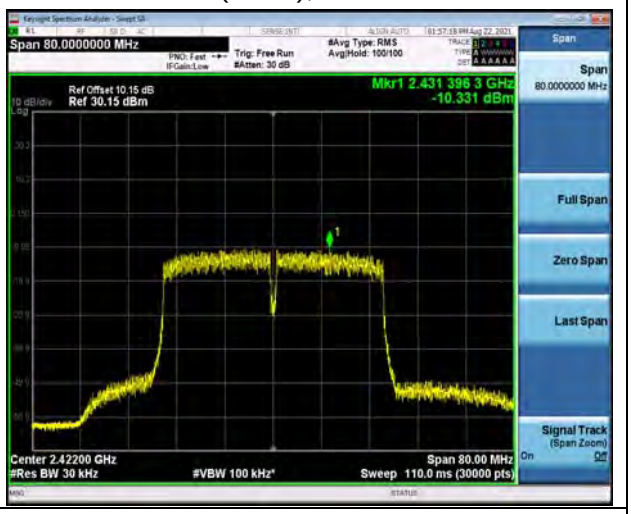

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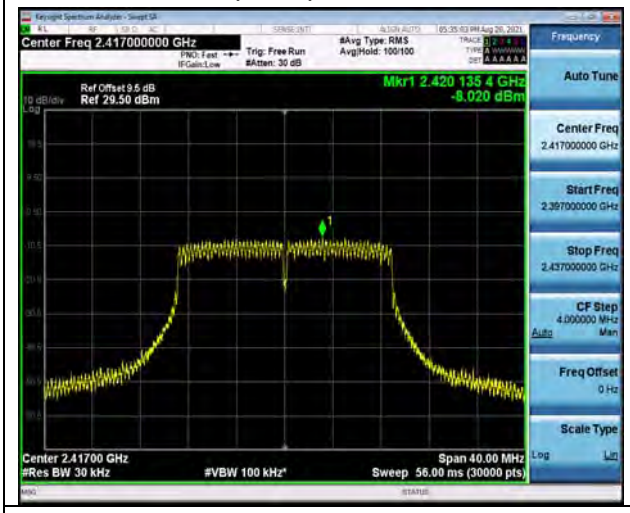

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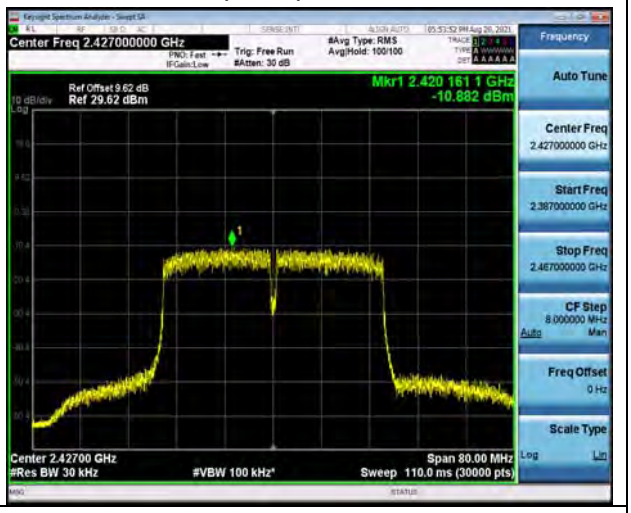

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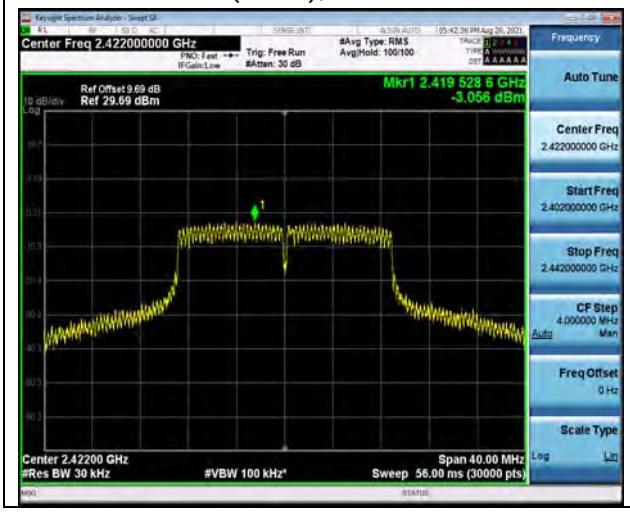
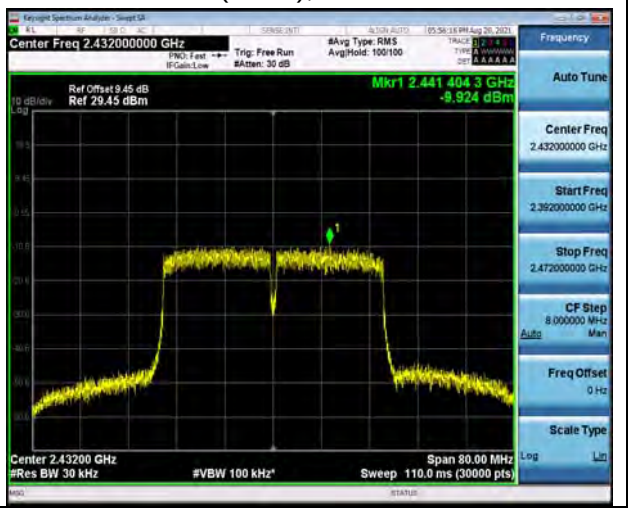


802.11n(HT40), Channel No. 5



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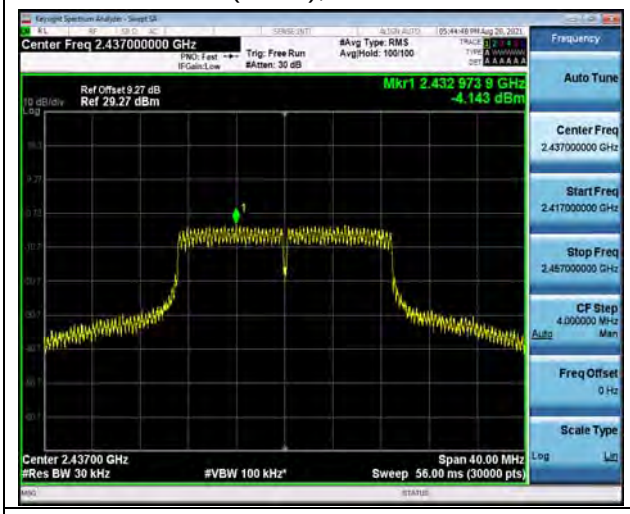
802.11n(HT20), Channel No. 6



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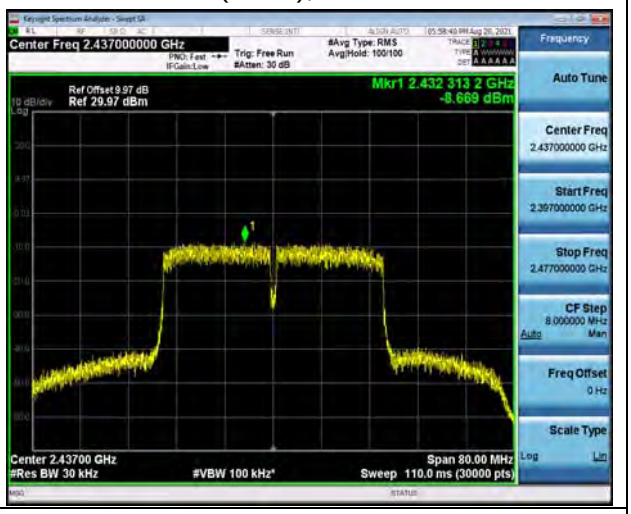

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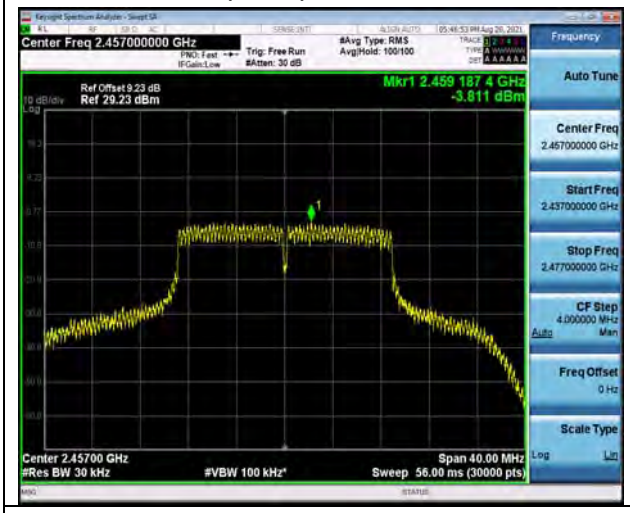
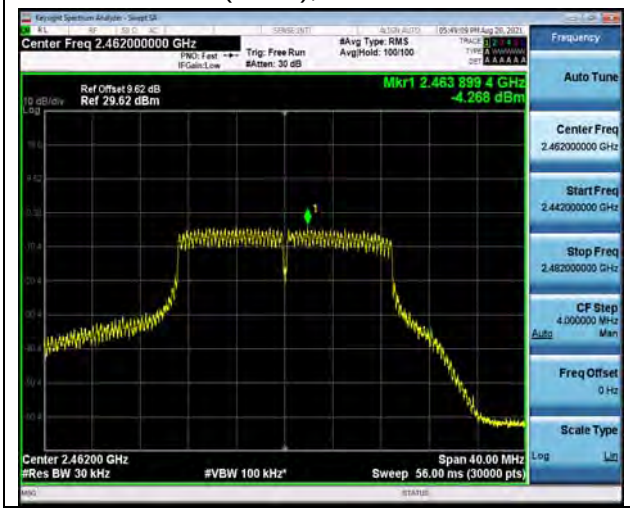


802.11n(HT40), Channel No. 7

802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 8

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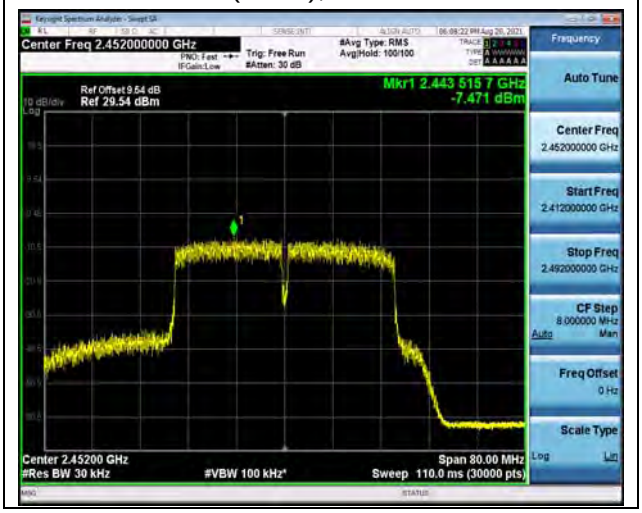
802.11n(HT40), Channel No. 9



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MIMO Antenna 2

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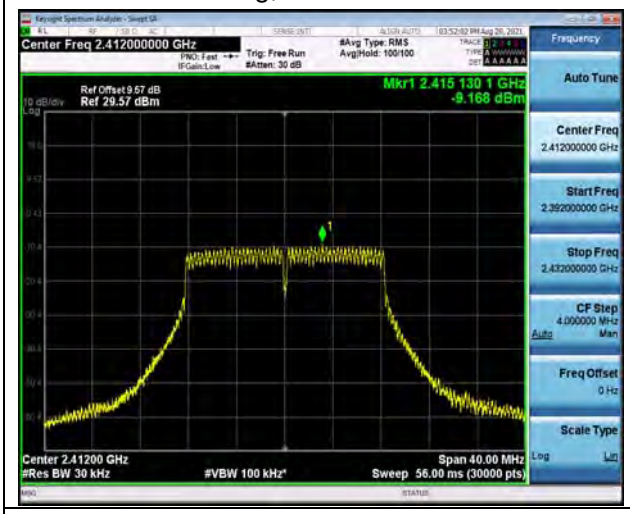
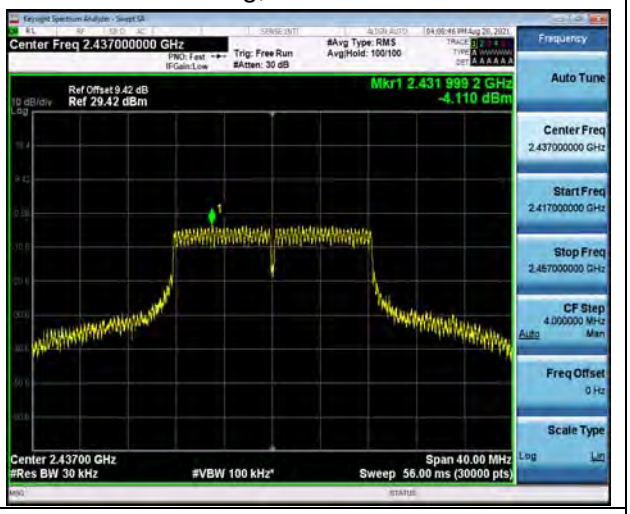
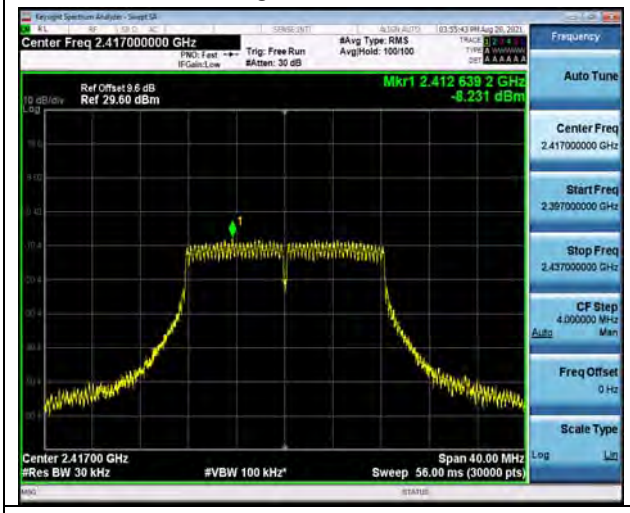


802.11g, Channel No.: 6



802.11g, Channel No.: 2



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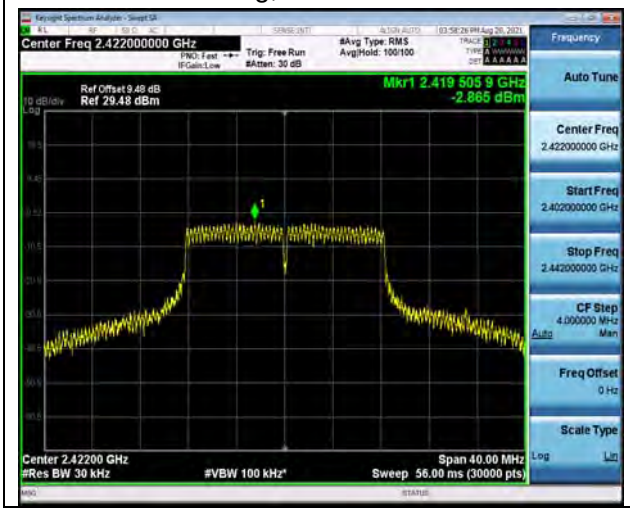
802.11g, Channel No.: 3



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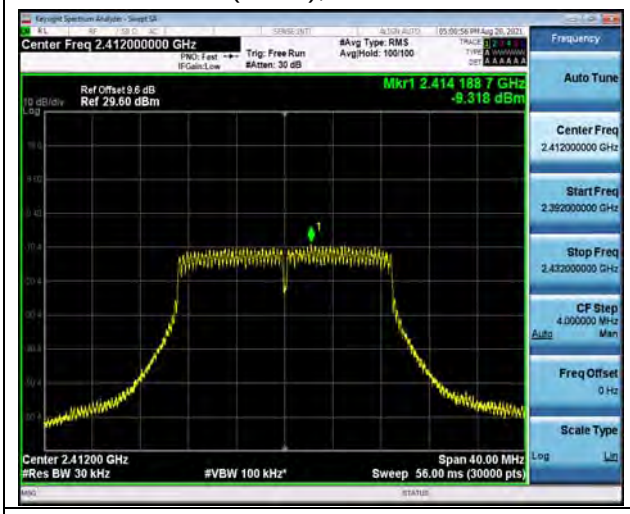
802.11n(HT20), Channel No. 1



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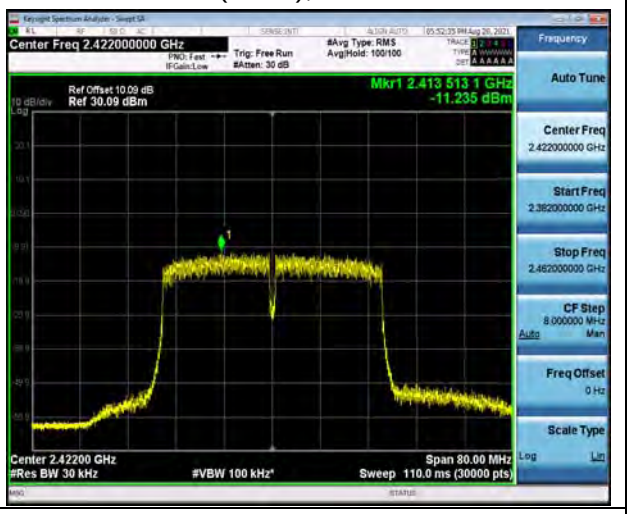

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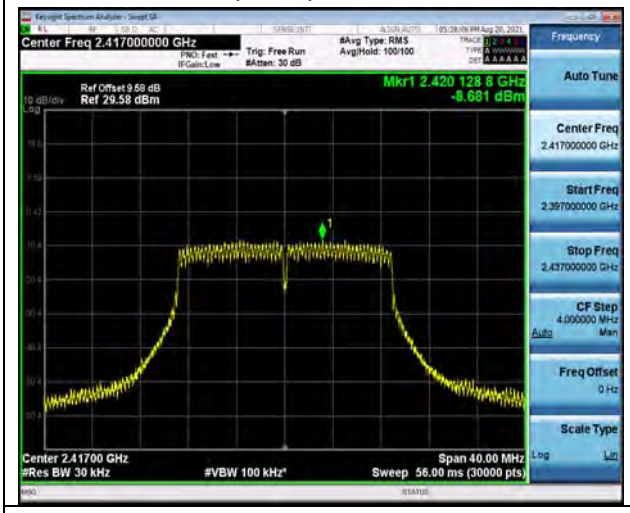

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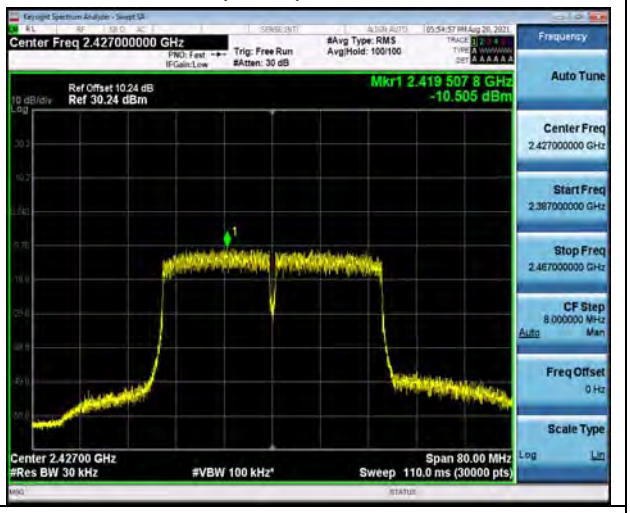

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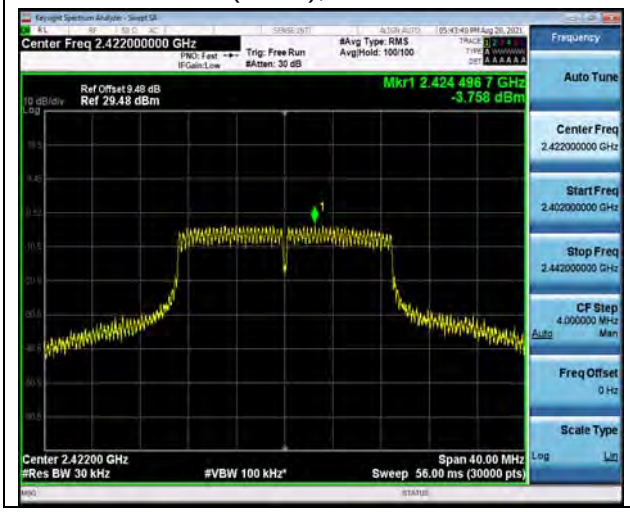

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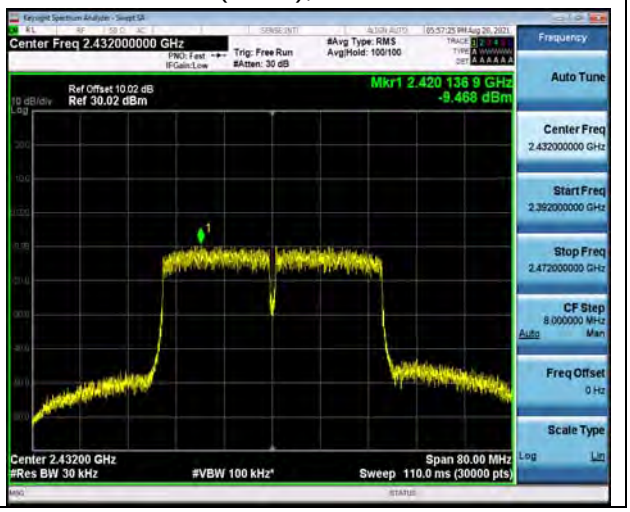

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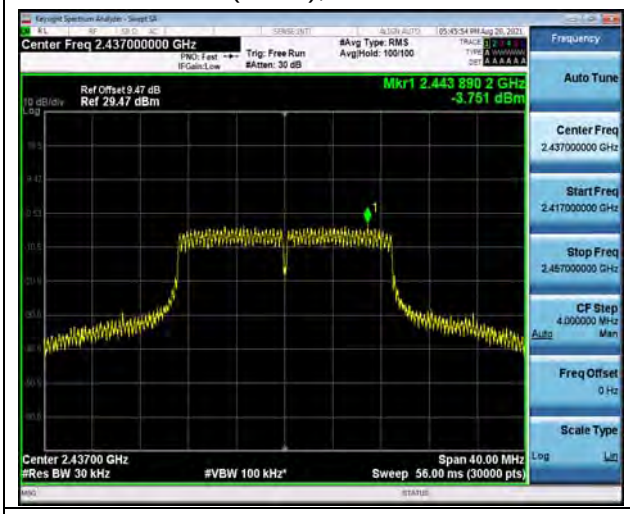
802.11n(HT20), Channel No. 6



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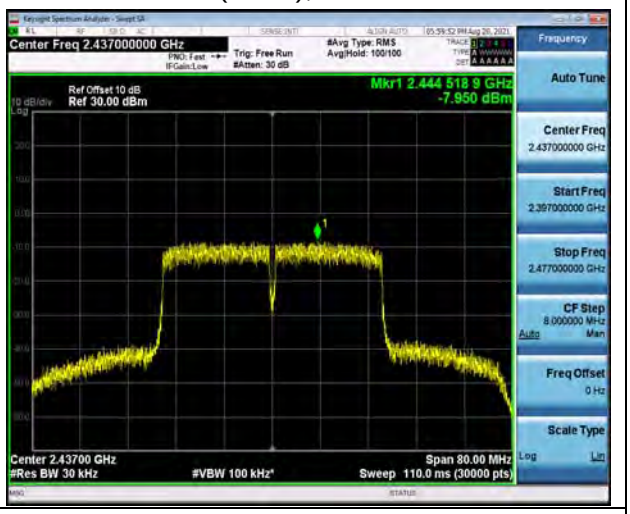

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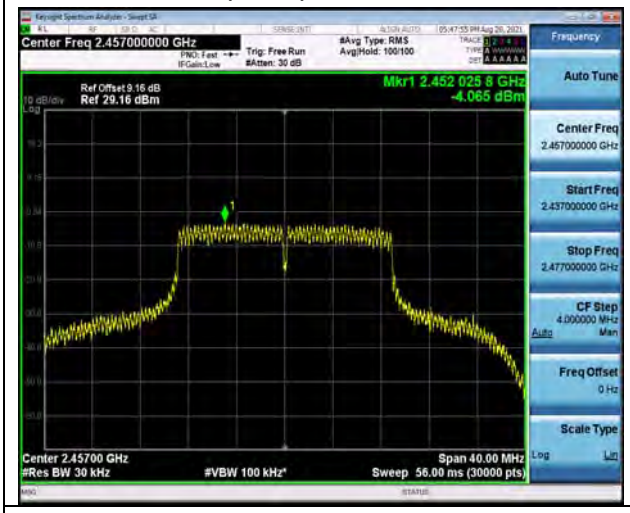
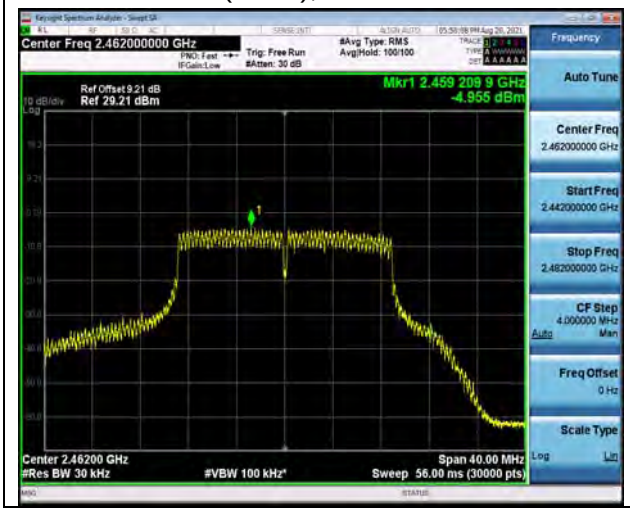


802.11n(HT40), Channel No. 7

802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 8

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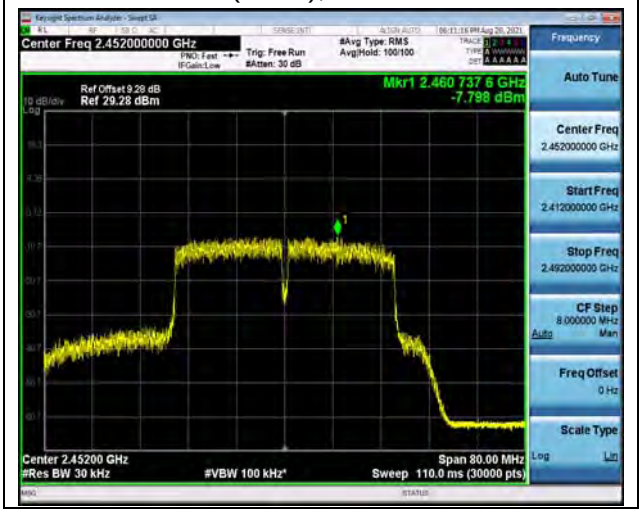
802.11n(HT40), Channel No. 9



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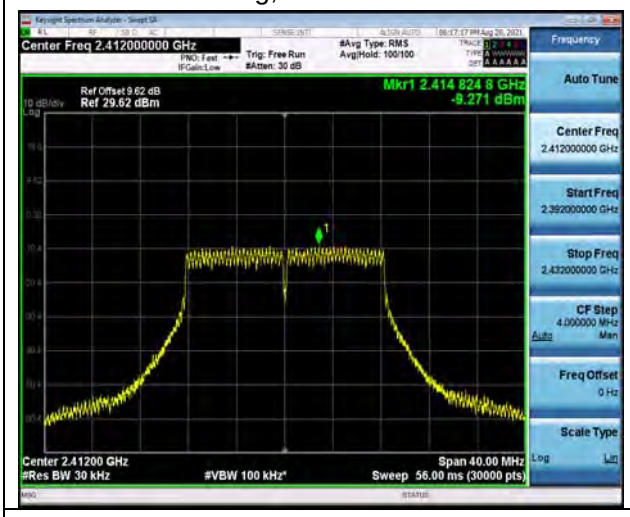
With Beamforming

MIMO Antenna 1

802.11g, Channel No.: 1



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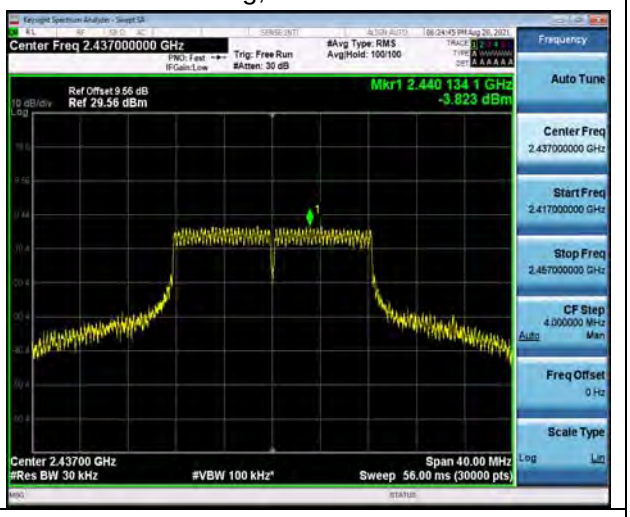
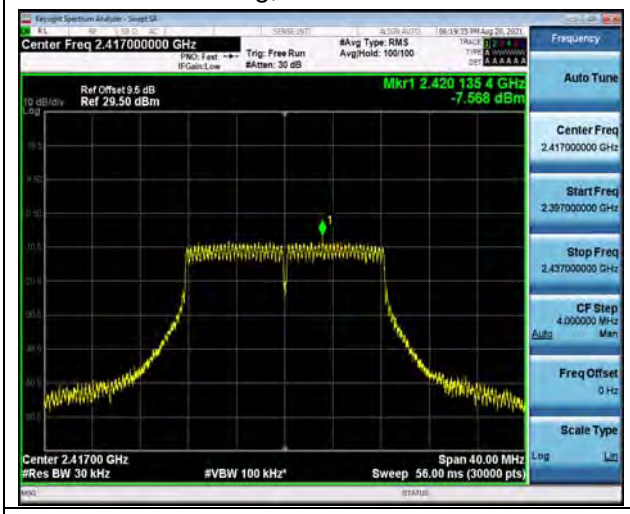
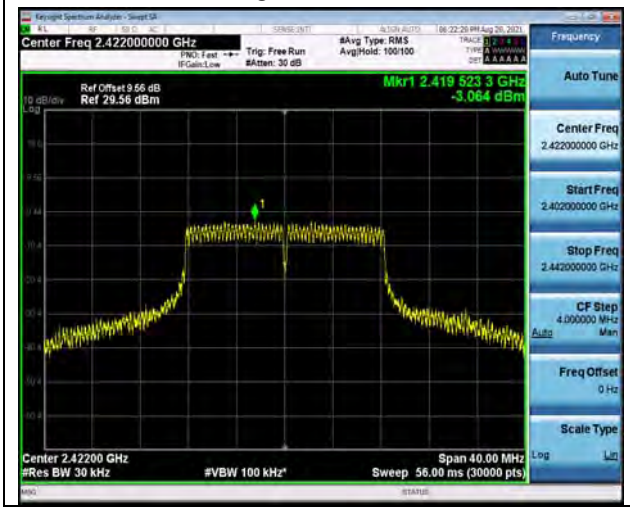


802.11g, Channel No.: 2



802.11g, Channel No.: 10

802.11g, Channel No.: 3



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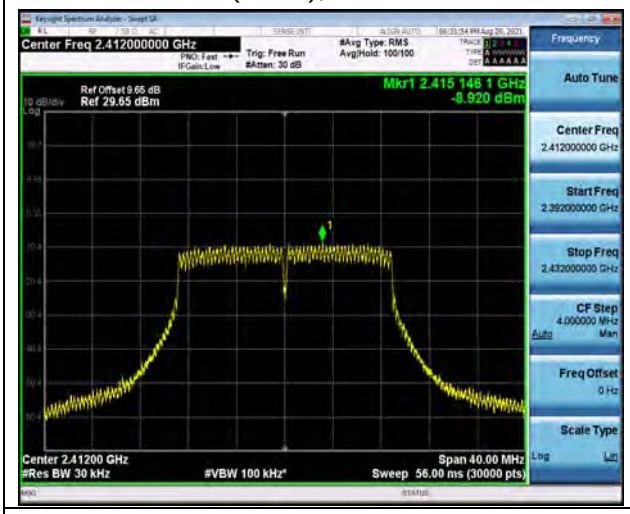
802.11n(HT20), Channel No. 1



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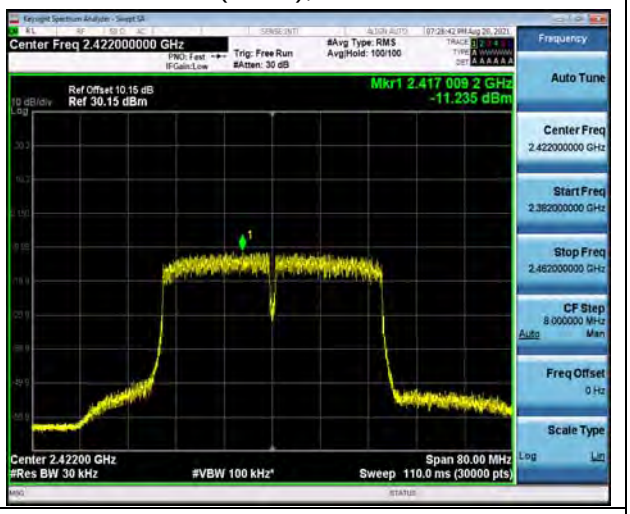

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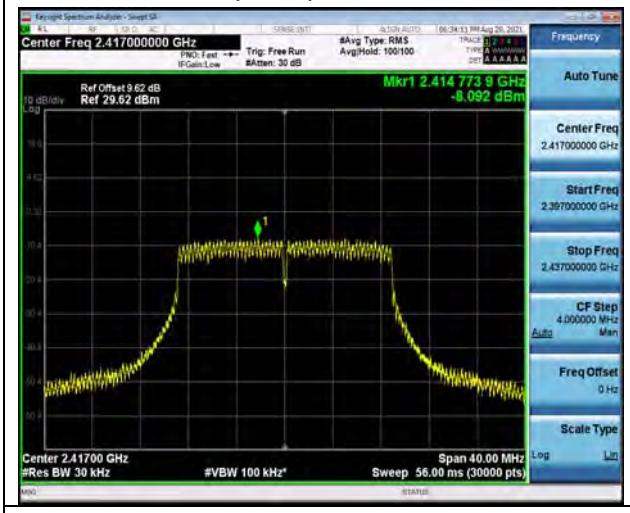
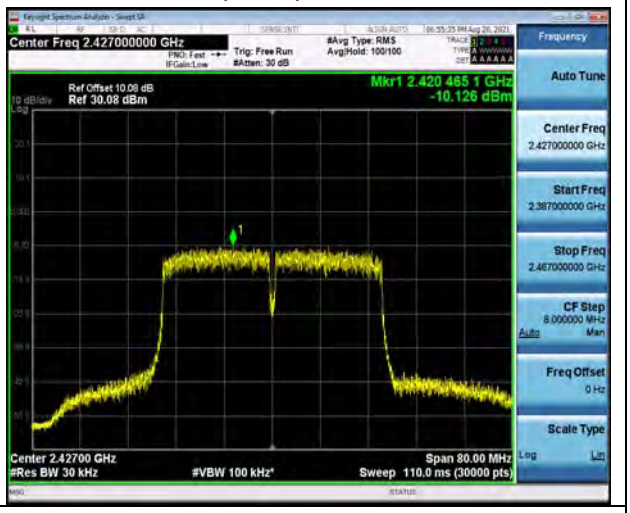


802.11n(HT40), Channel No. 4



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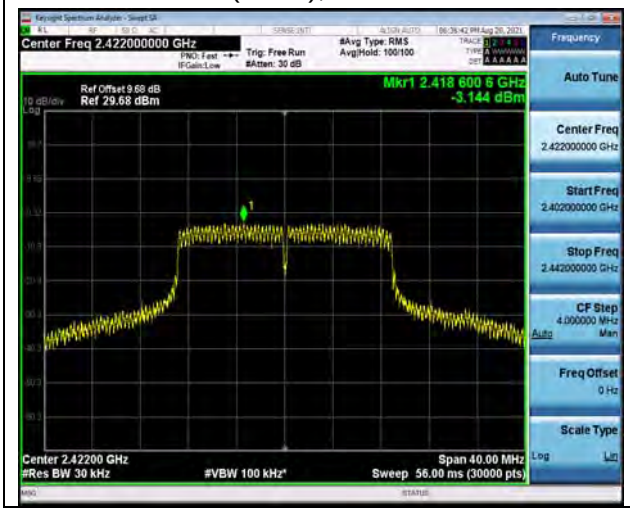

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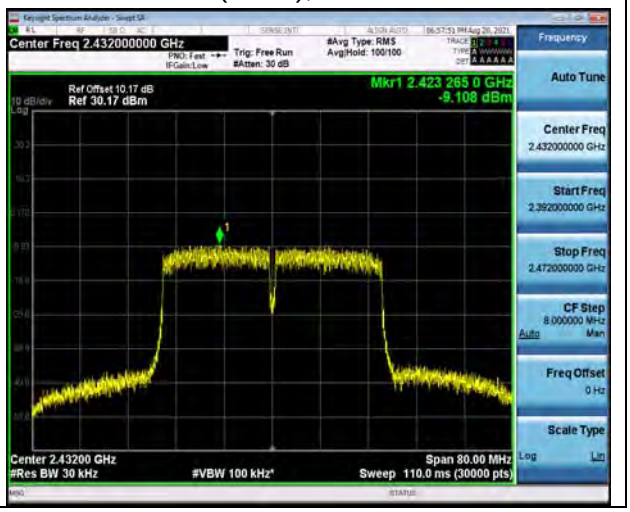

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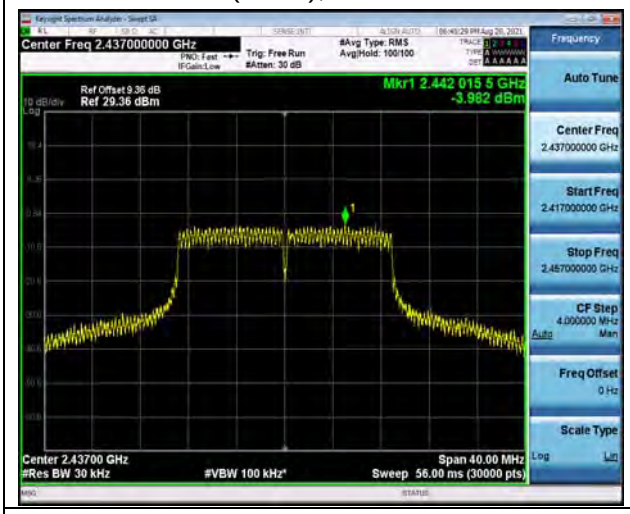
802.11n(HT20), Channel No. 6



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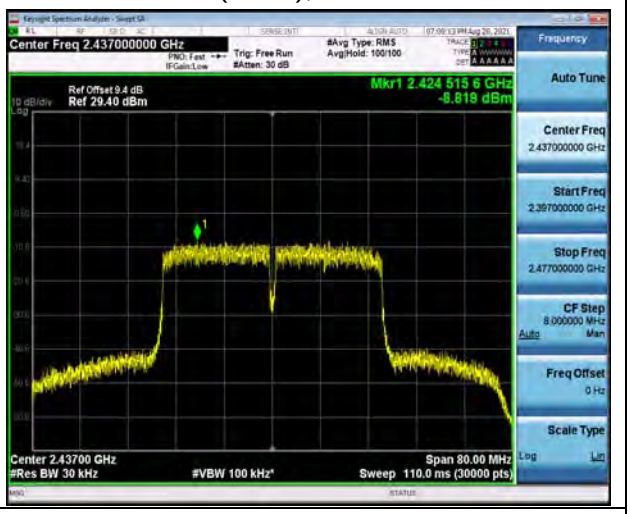

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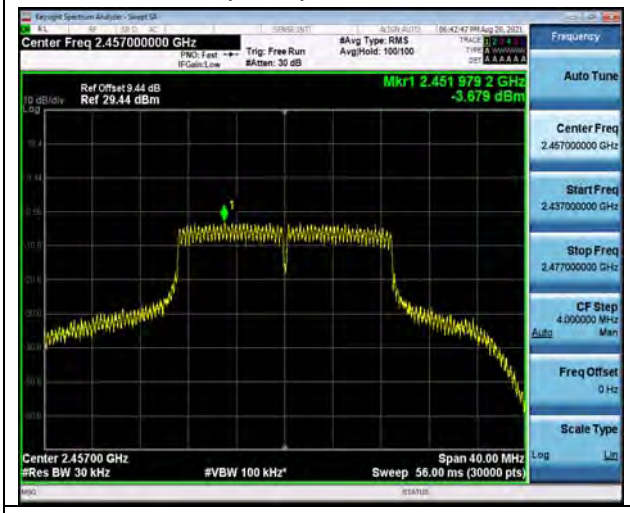
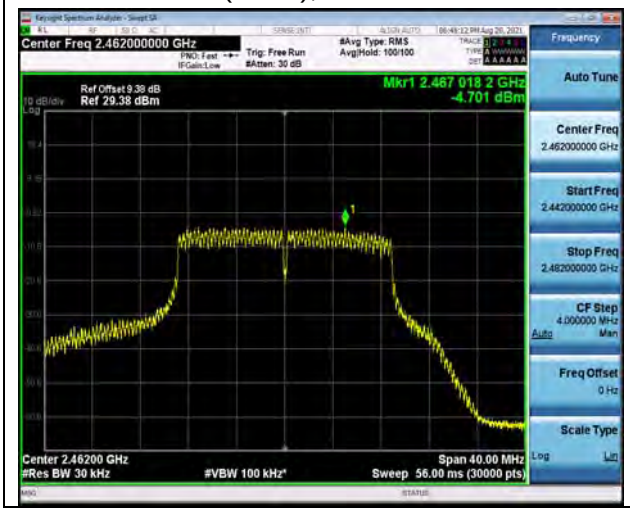


802.11n(HT40), Channel No. 7

802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 8

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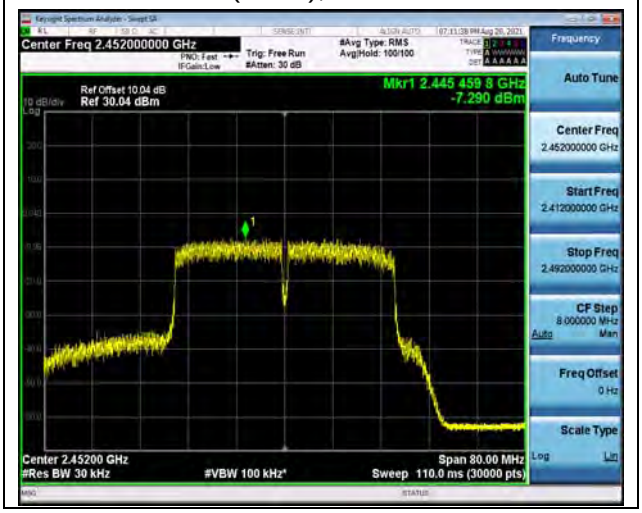
802.11n(HT40), Channel No. 9



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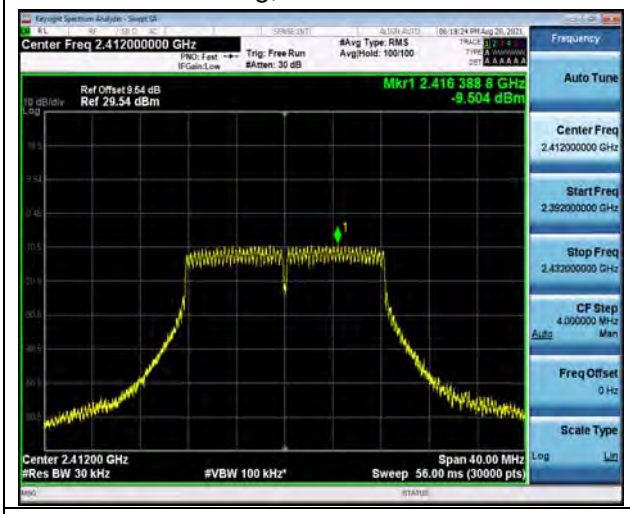
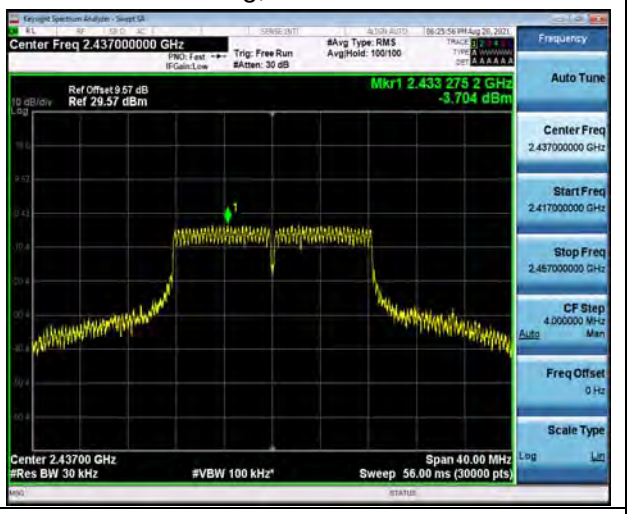
MIMO Antenna 2

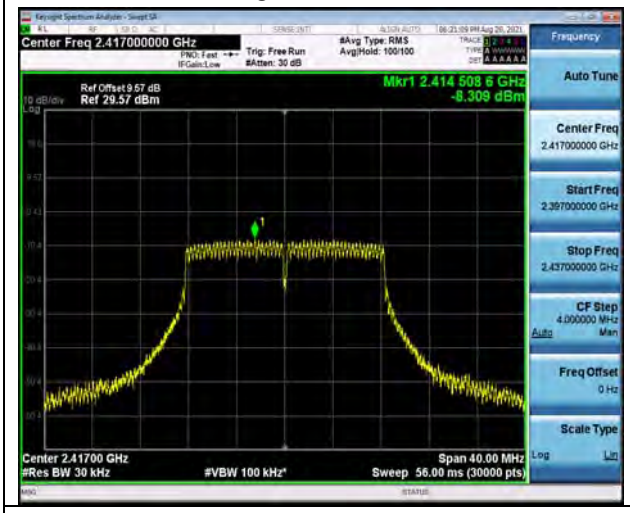
802.11g, Channel No.: 1



802.11g, Channel No.: 6

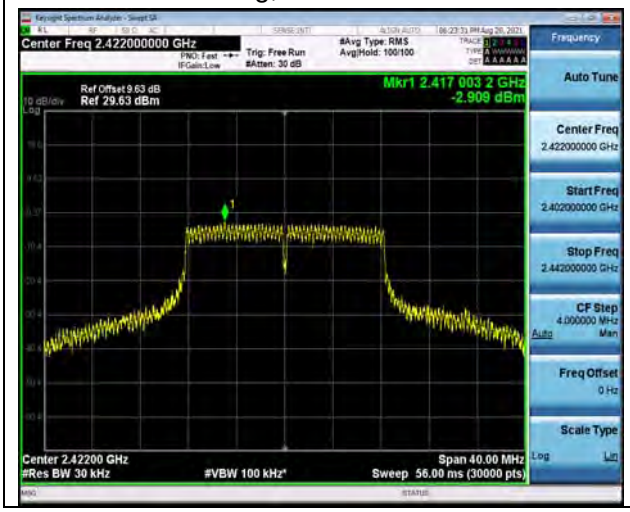


802.11g, Channel No.: 2



802.11g, Channel No.: 10

802.11g, Channel No.: 3



802.11g, Channel No.: 11

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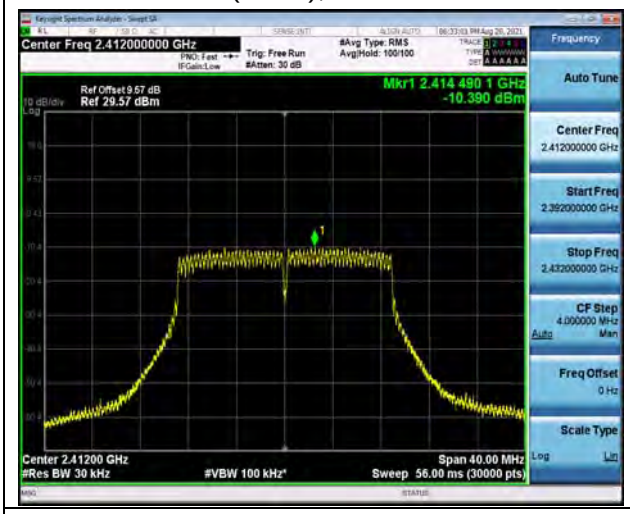
802.11n(HT20), Channel No. 1



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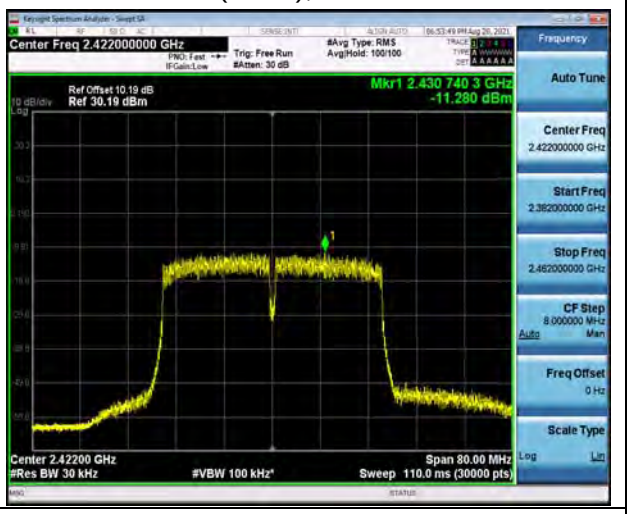

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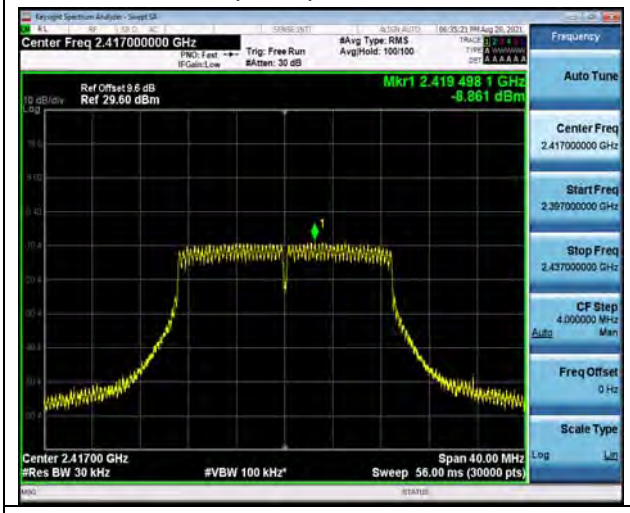

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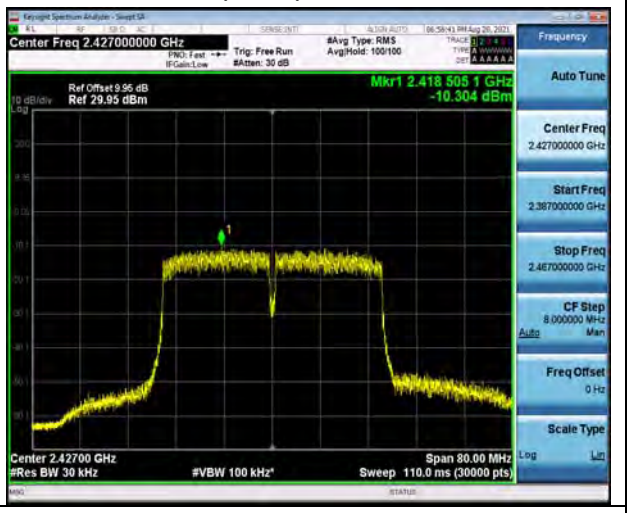

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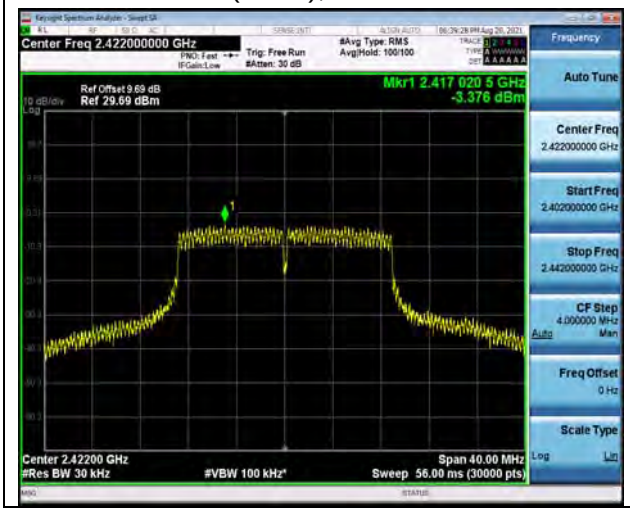

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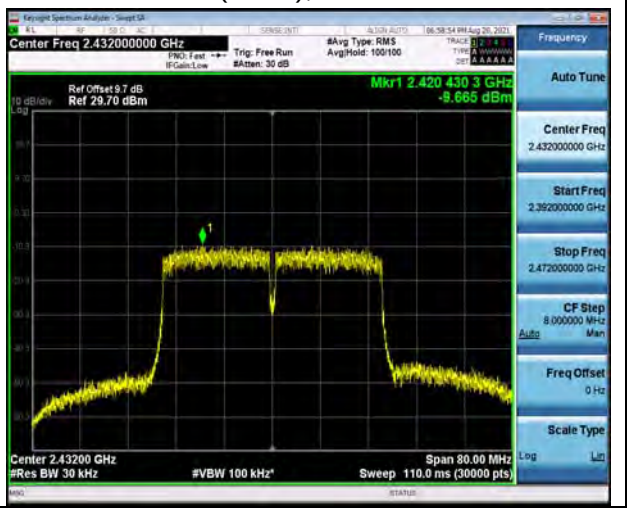

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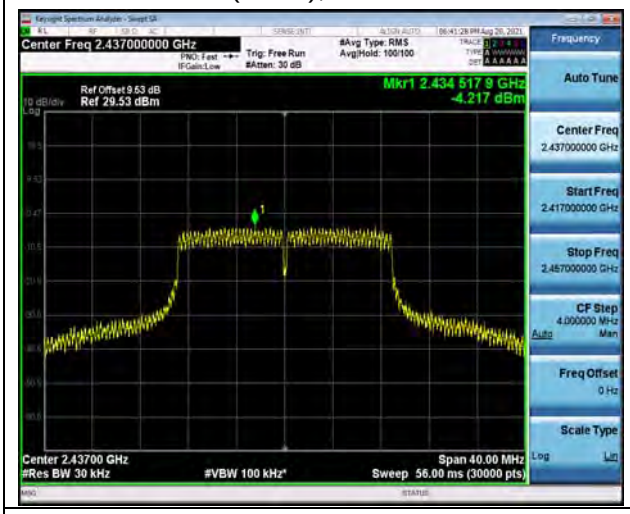
802.11n(HT20), Channel No. 6



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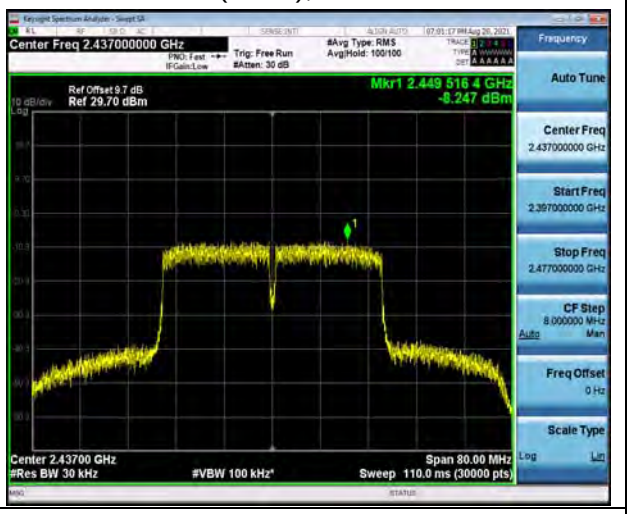

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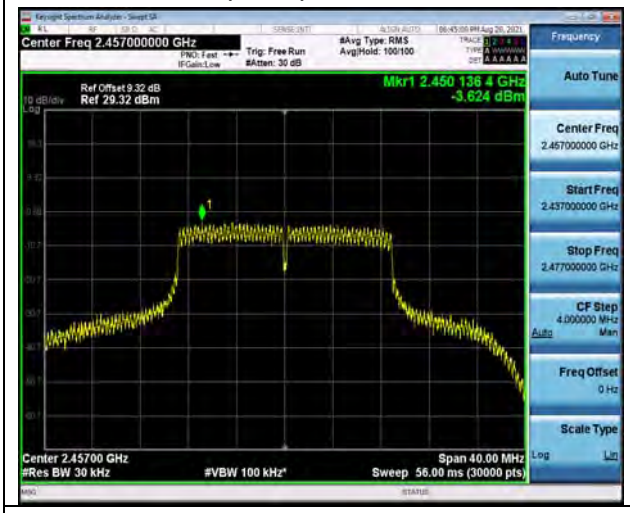
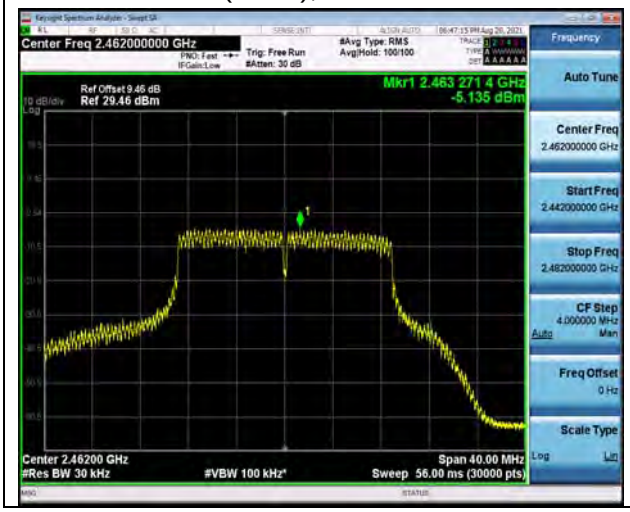


802.11n(HT40), Channel No. 7

802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 8

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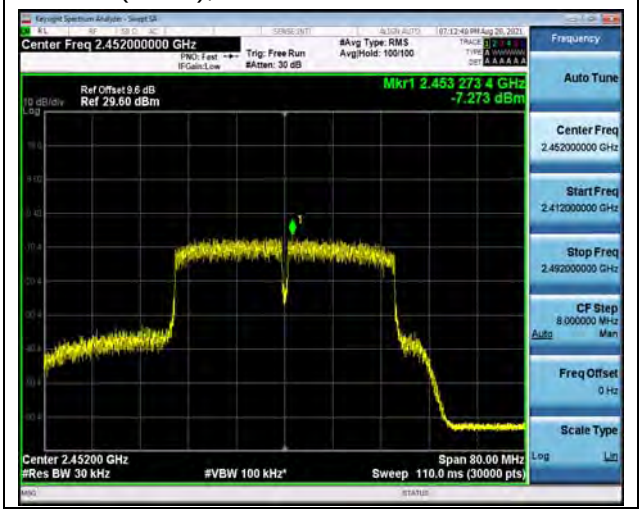
802.11n(HT40), Channel No. 9



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5.5. Spurious RF Conducted Emissions

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

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 ATUO.
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	12.08	-17.92
	2437	12.64	-17.36
	2462	13.05	-16.95
802.11g	2412	4.75	-25.25
	2437	10.36	-19.64
	2462	9.57	-20.43
802.11n HT20	2412	4.61	-25.39
	2437	10.62	-19.38
	2462	7.98	-22.02
802.11n HT40	2422	2.18	-27.82
	2437	5.06	-24.94
	2452	5.97	-24.03

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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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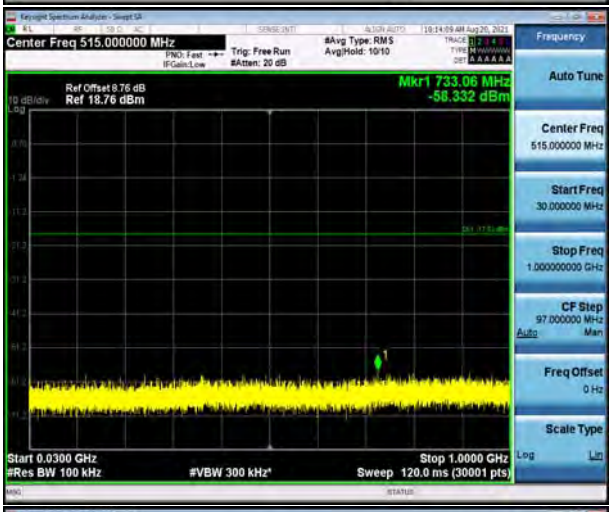
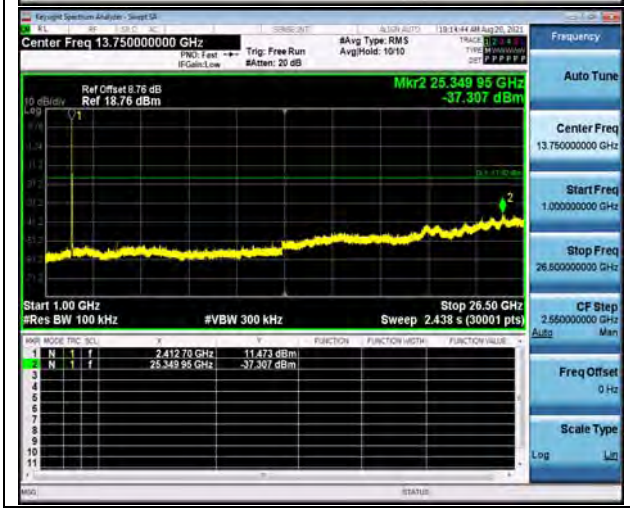
Test Results:

802.11b, Channel No.: 1





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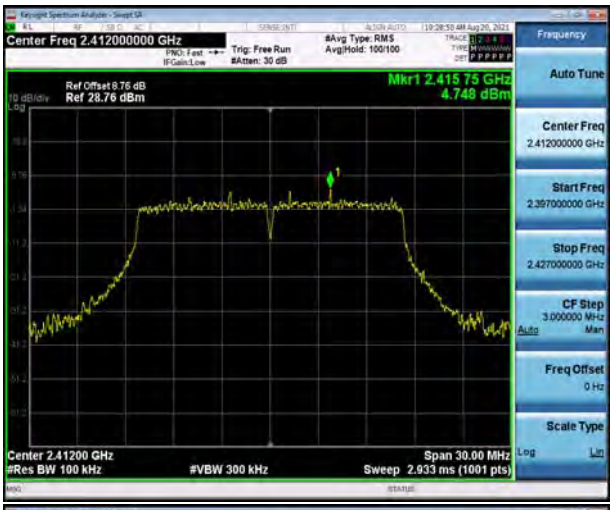

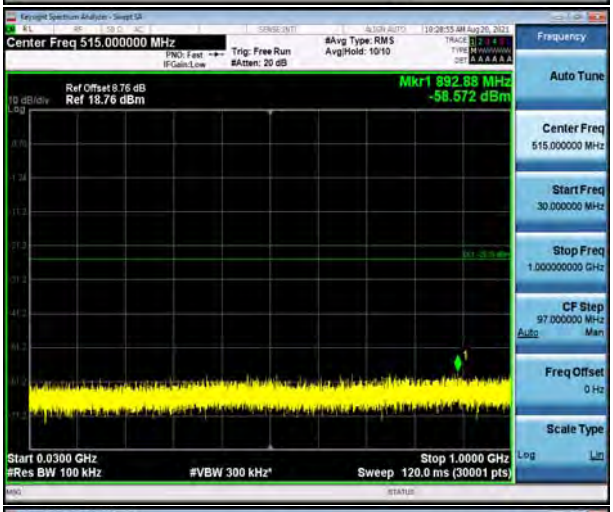

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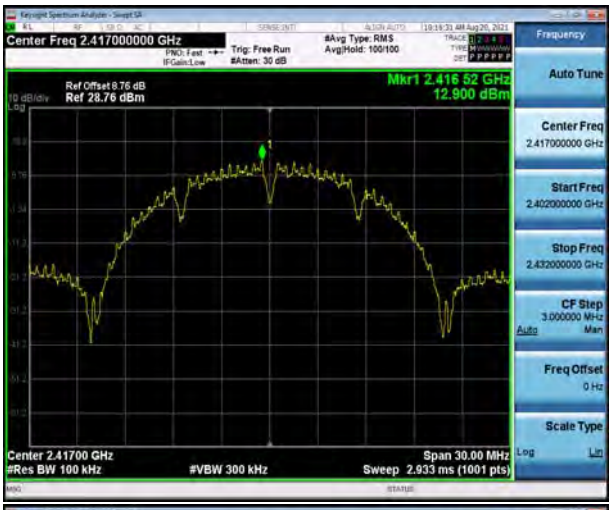

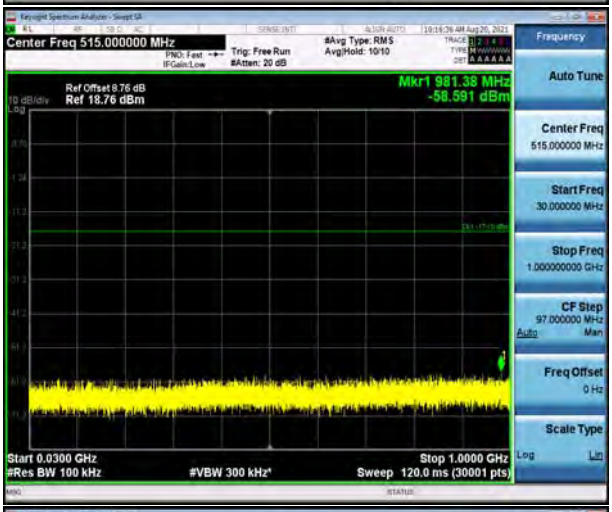

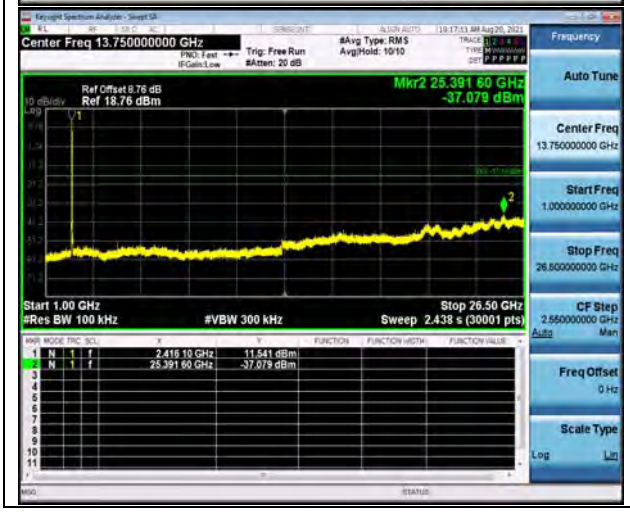

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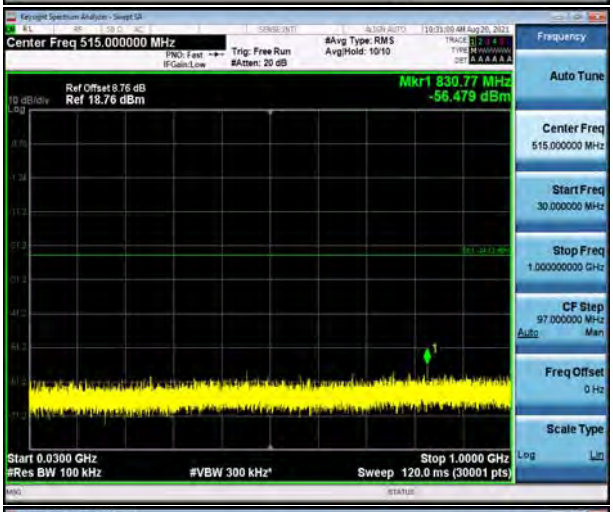

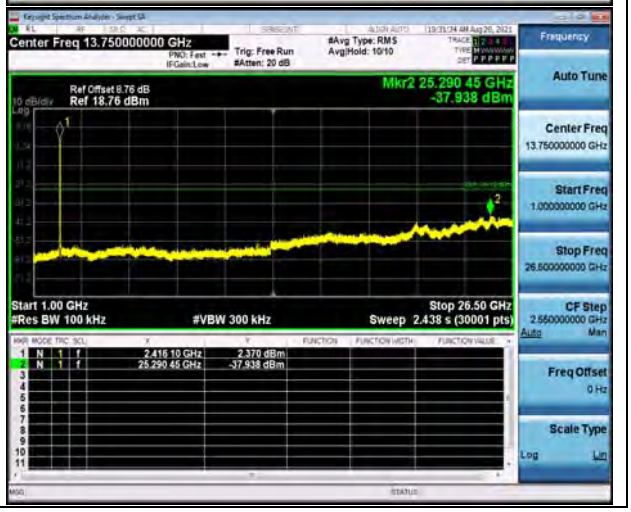

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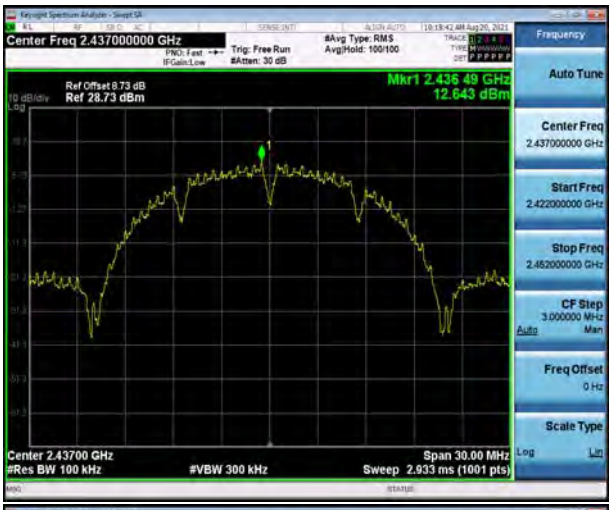
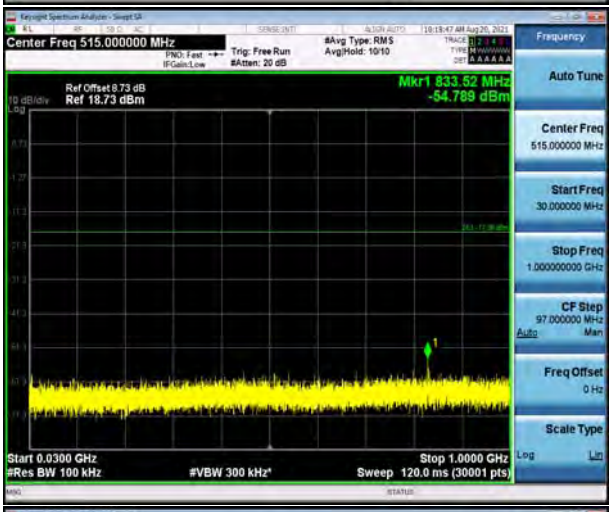
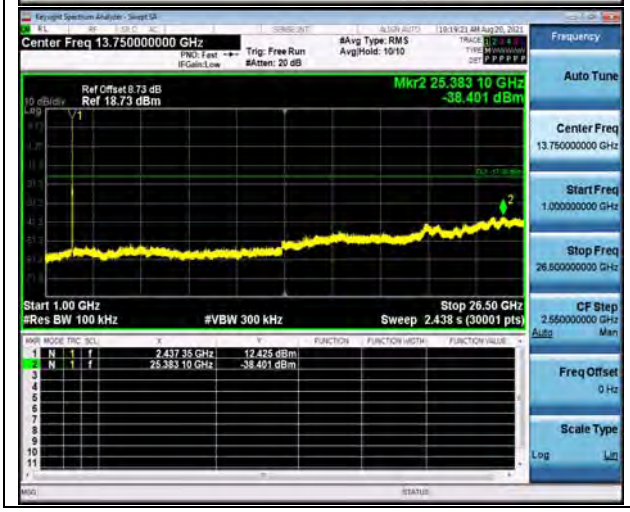
802.11b, Channel No.: 6







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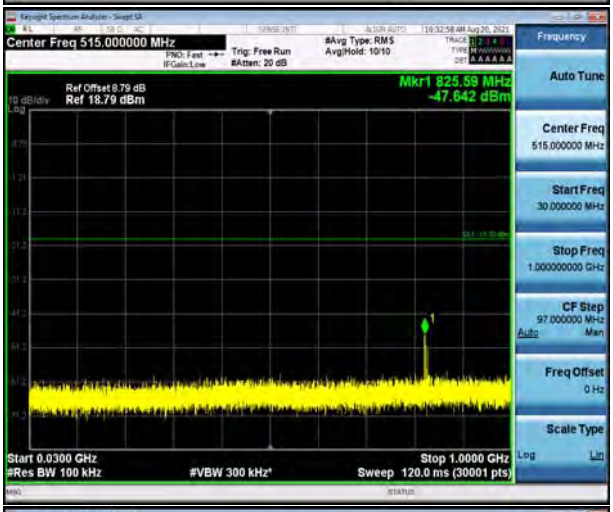

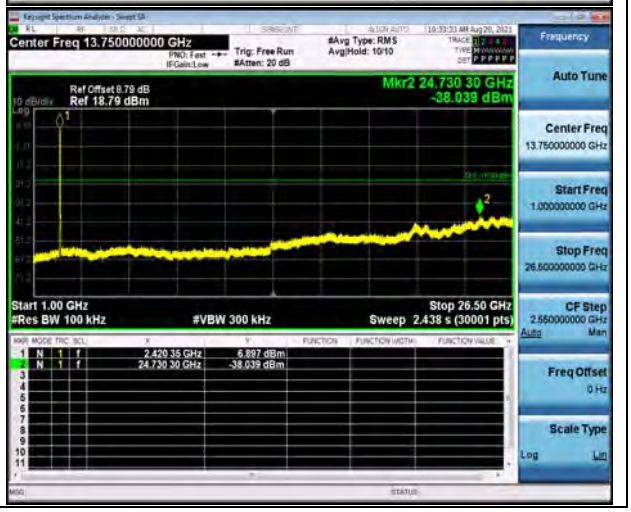

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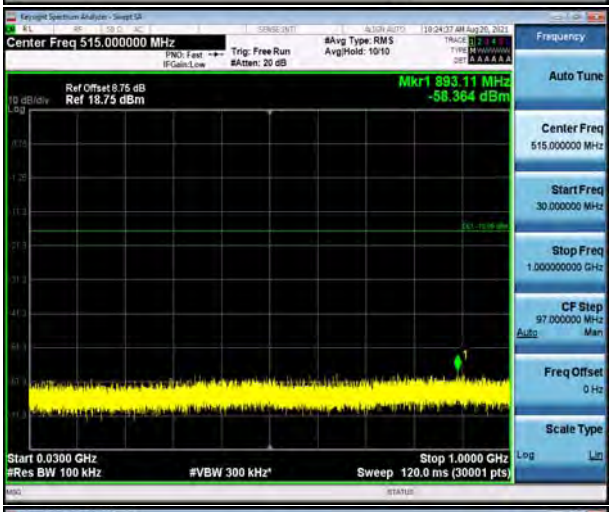
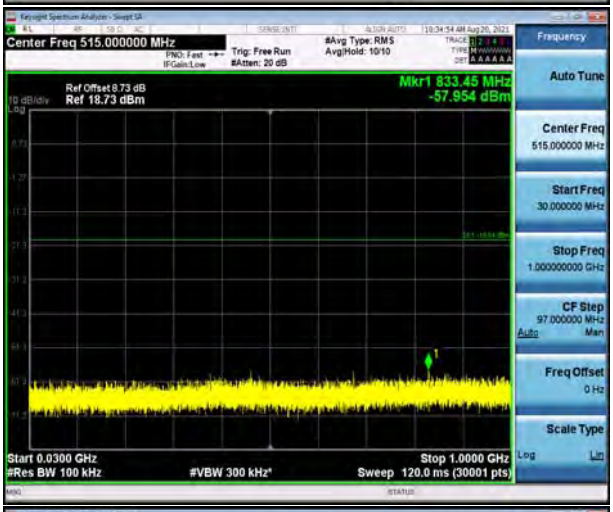
802.11b, Channel No.: 11



802.11g, Channel No.: 6



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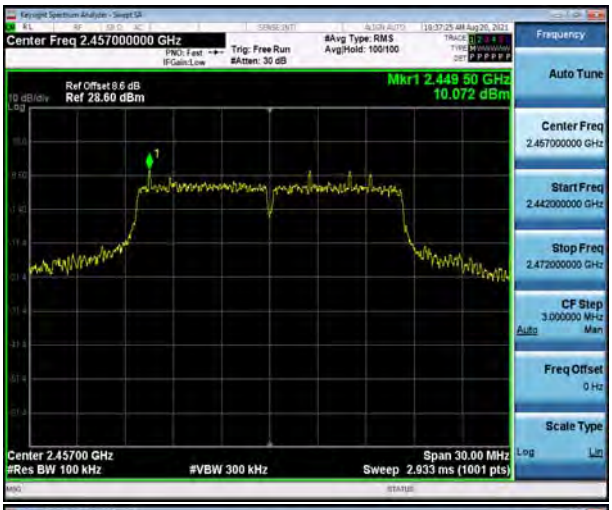
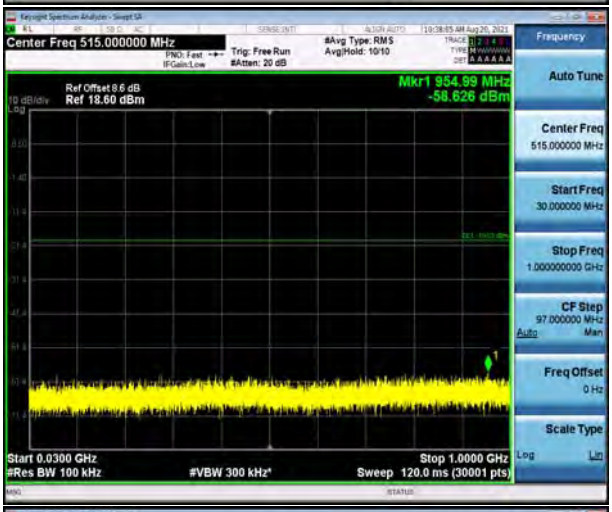
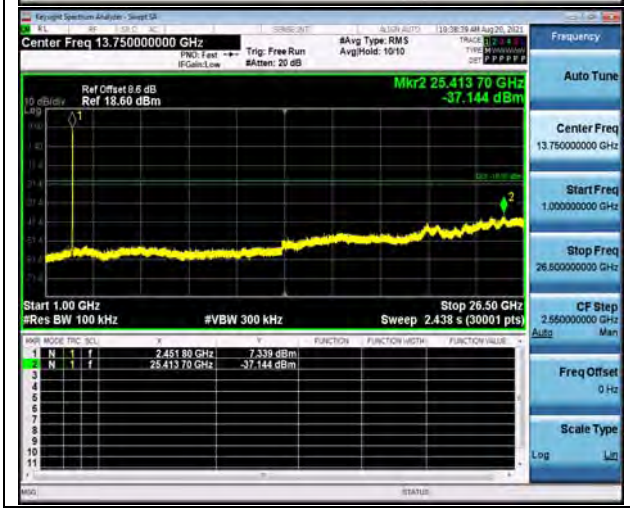
802.11g, Channel No.: 10







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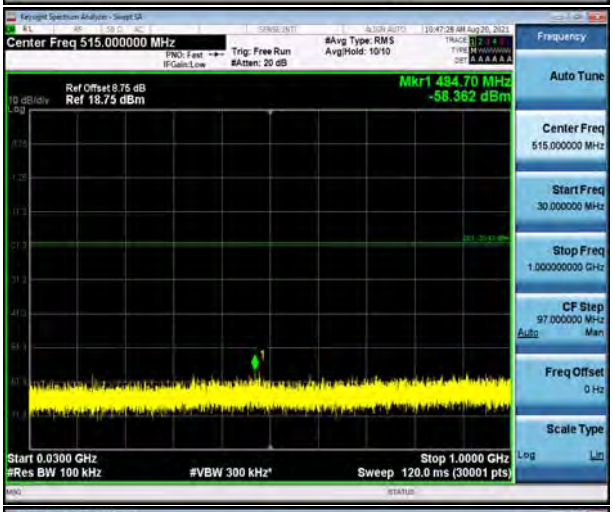

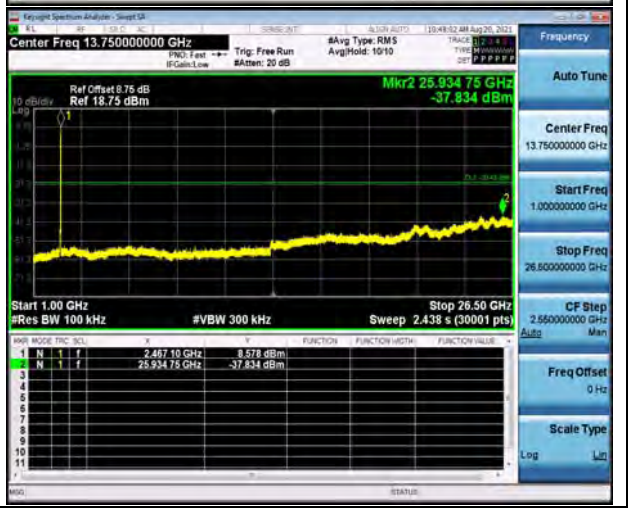

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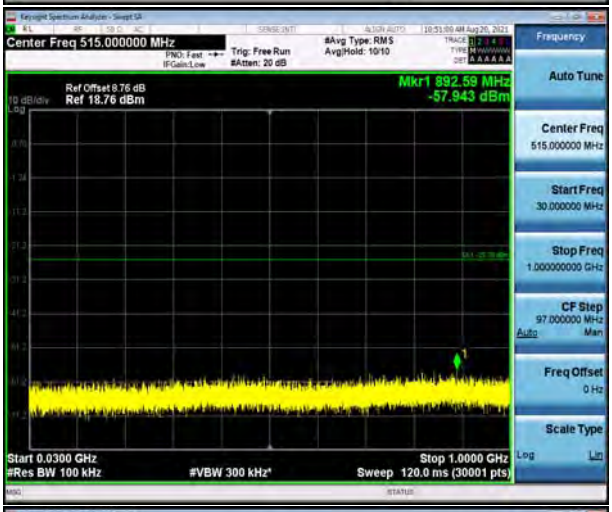
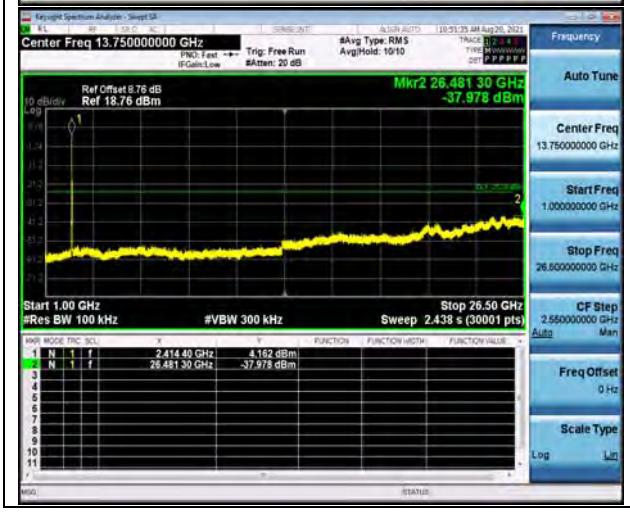
802.11n(HT20), Channel No. 1





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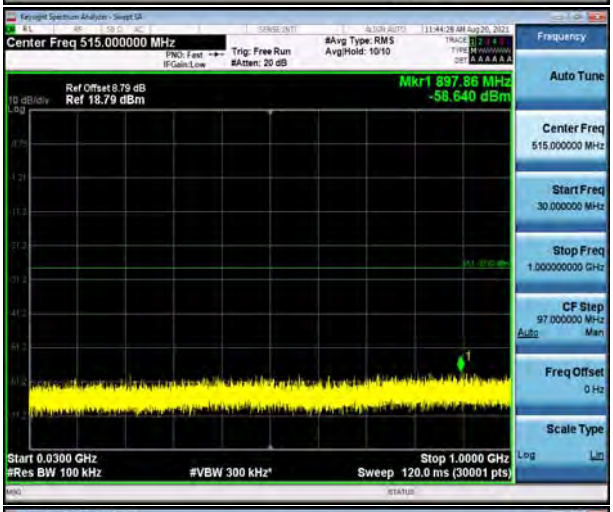

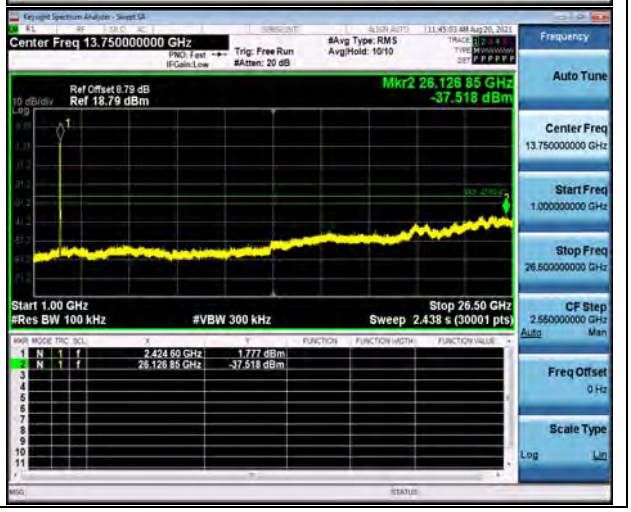

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