RF TEST REPORT

Applicant	Shanghai Smawave Technology Co. ,Ltd
FCC ID	2AU8HSPH320-AQ
Product	Industrial smart handheld terminal
Brand	Smawave
Model	SPH320-aq
Report No.	R2212A1268-R4
Issue Date	January 12, 2023

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2022)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Prepared by: Xu Ying

Approved by: Xu Kai

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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 6.7	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: December 12, 2022~ January 9, 2023 Date of Sample Received: December 12, 2022			
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:	Building 3, No.145, Jintang Rd, Pudong Shanghai, P.R.China
City:	Shanghai
Post code:	201201
Country:	P. R. China
Contact:	Xu Kai
Telephone:	+86-021-50791141/2/3
Fax:	+86-021-50791141/2/3-8000
Website:	http://www.ta-shanghai.com
E-mail:	xukai@ta-shanghai.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	SPH320-aq
IMEI	862165040696583
Hardware Version	V1.0.2
Software Version	20230106_01_SPHX20-aq_NDAC_V1.0.23
Power Supply	Battery / AC adapter
Antenna Type	Internal Antenna
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)
Antenna Gain	-0.03 dBi
additional beamforming gain	NA
Operating Frequency Range(s)	802.11b/g/n(HT20): 2412 ~ 2462 MHz 802.11n(HT40): 2422 ~ 2452 MHz Bluetooth LE V5.0: 2402 ~2480 MHz
Modulation Type	802.11b: DSSS 802.11g/n(HT20/HT40): OFDM Bluetooth LE: GFSK
Max. Output Power	Wi-Fi 2.4G: 16.65 dBm Bluetooth LE: 3.81 dBm
EUT Accessory	
Adapter	Manufacturer: Zhuzhou Dachuan Electronic Technology Co.,Ltd Model: DCT12W050200ZZ-H1 (Adapters: 94001-00001-EU; 94001-00002-UK; 94001-00003-US)
Battery	Manufacturer: GuangDong FengHua New Energy Co., Ltd. Model: FHPK626263P
Note: 1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant. 2. There is more than one Adapter, each one should be applied throughout the compliance test respectively, and however, only the worst case (94001-00003-US) 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 (2022) Radio Frequency Devices

ANSI C63.10-2013

Reference standard:

KDB 558074 D01 15.247 Meas Guidance v05r02

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
Bluetooth(Low Energy)	1Mbps; 2Mbps
802.11b	1 Mbps
802.11g	6 Mbps
802.11n HT20	MCS0
802.11n HT40	MCS0

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.

Test Setup
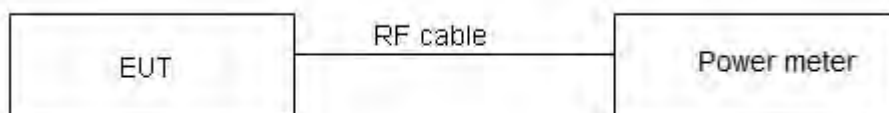
Limits

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

Power Index					
Channel	**802.11b**	**802.11g**	**802.11n HT20**	**Channel**	**802.11n HT40**
CH1	15	11	10	**CH3**	9
CH6	15	11	10	**CH6**	9
CH11	15	11	10	**CH9**	9

Test Mode	Duty cycle	Duty cycle correction Factor(dB)
802.11b	0.99	0.00
802.11g	0.98	0.00
802.11n HT20	0.98	0.00
802.11n HT40	0.95	0.22
Bluetooth LE (1M)	0.63	2.04
Bluetooth LE (2M)	0.33	4.81
Note: when Duty cycle≥0.98, Duty cycle correction Factor not required.		

Test Mode	Carrier frequency (MHz))/ Channel	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
802.11b	2412/CH 1	15.71	15.71	30	PASS
	2437/CH 6	16.28	16.28	30	PASS
	2462/CH11	16.65	16.65	30	PASS
802.11g	2412/CH 1	11.36	11.36	30	PASS
	2437/CH 6	11.89	11.89	30	PASS
	2462/CH11	12.34	12.34	30	PASS
802.11n HT20	2412/CH 1	10.28	10.28	30	PASS
	2437/CH 6	10.21	10.21	30	PASS
	2462/CH11	11.03	11.03	30	PASS
802.11n HT40	2422/CH3	9.87	10.09	30	PASS
	2437/CH6	10.31	10.53	30	PASS
	2452/CH9	10.38	10.60	30	PASS
Bluetooth (Low Energy) (1M)	2402/CH0	-0.20	1.84	30	PASS
	2440/CH19	1.11	3.15	30	PASS
	2480/CH39	1.77	3.81	30	PASS
Bluetooth (Low Energy) (2M)	2402/CH0	-3.29	1.52	30	PASS
	2440/CH19	-1.53	3.28	30	PASS
	2480/CH39	-1.16	3.65	30	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

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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
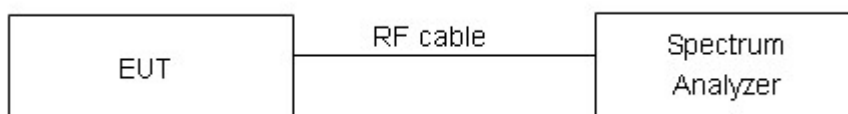
Limits

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.

Test Results:

Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11b	2412	13.823	8.082	500	PASS
	2437	13.601	8.073	500	PASS
	2462	13.949	9.035	500	PASS
802.11g	2412	16.638	15.717	500	PASS
	2437	16.574	14.088	500	PASS
	2462	16.718	16.047	500	PASS
802.11n HT20	2412	17.830	14.978	500	PASS
	2437	17.769	13.894	500	PASS
	2462	17.899	16.825	500	PASS
802.11n HT40	2422	36.543	35.652	500	PASS
	2437	36.054	32.496	500	PASS
	2452	36.256	35.662	500	PASS
Bluetooth (Low Energy) (1M)	2402	1.035	0.650	500	PASS
	2440	1.033	0.655	500	PASS
	2480	1.037	0.659	500	PASS
Bluetooth (Low Energy) (2M)	2402	2.042	0.563	500	PASS
	2440	2.042	0.560	500	PASS
	2480	2.043	0.563	500	PASS

99%bandwidth

OBW 802.11b 2412MHz

OBW 802.11b 2437MHz

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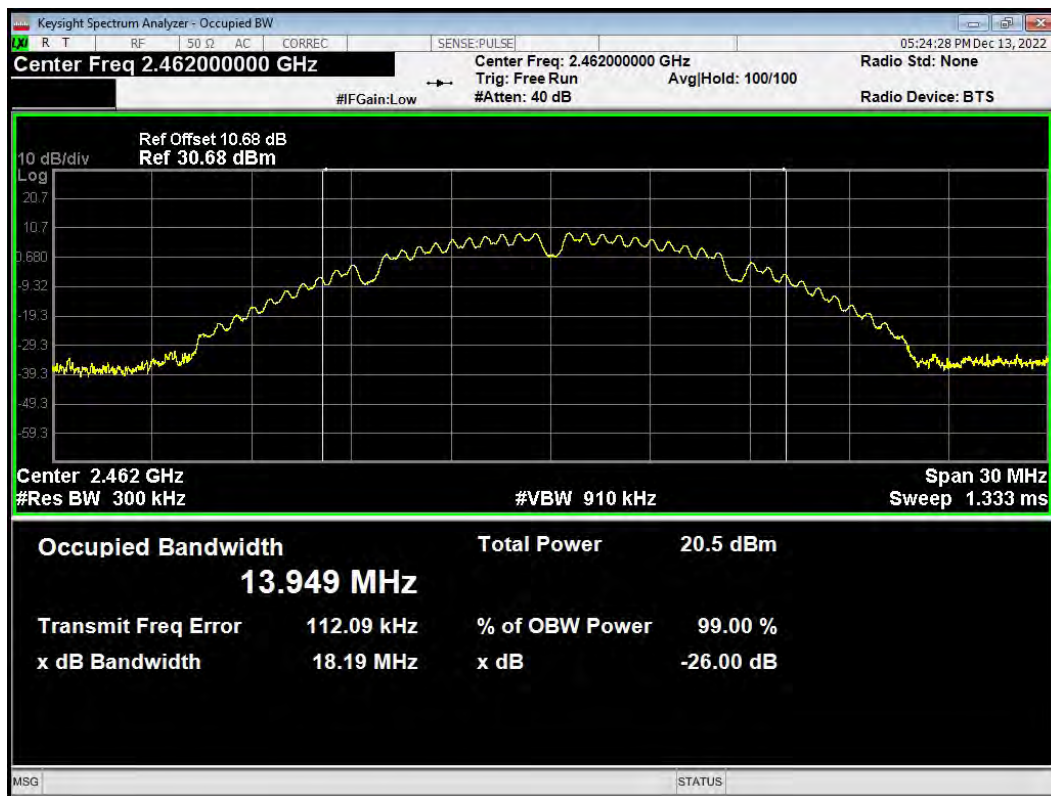
OBW 802.11b 2462MHz

OBW 802.11g 2412MHz
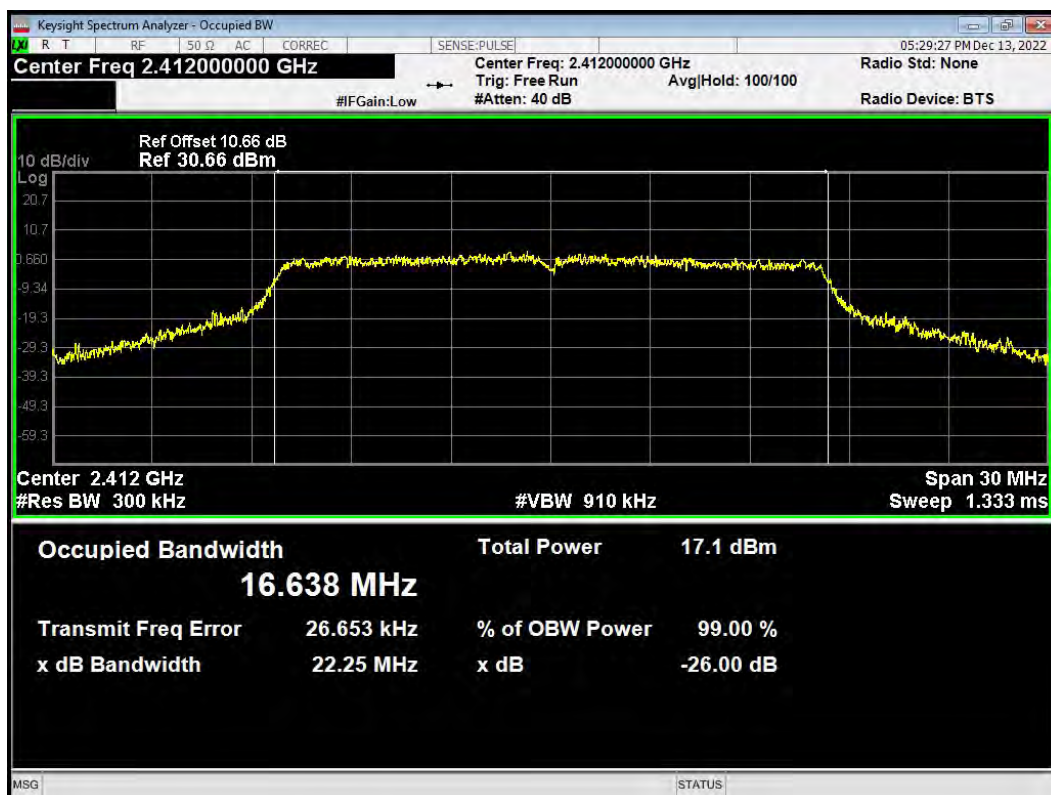
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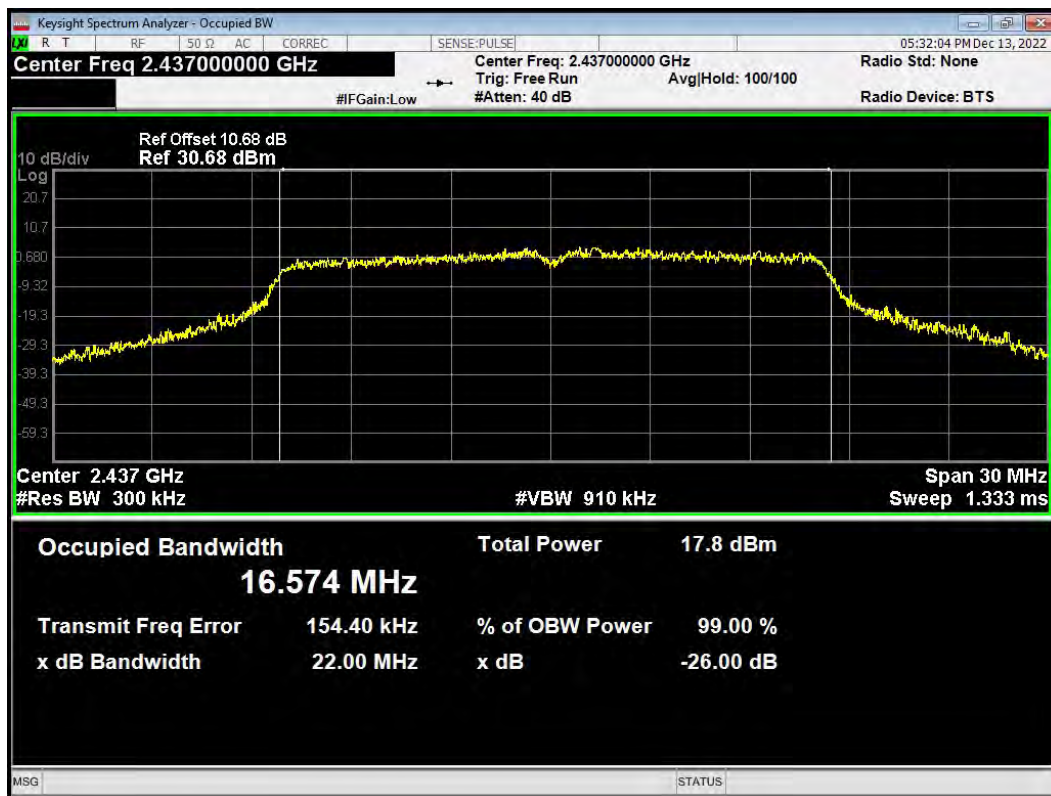
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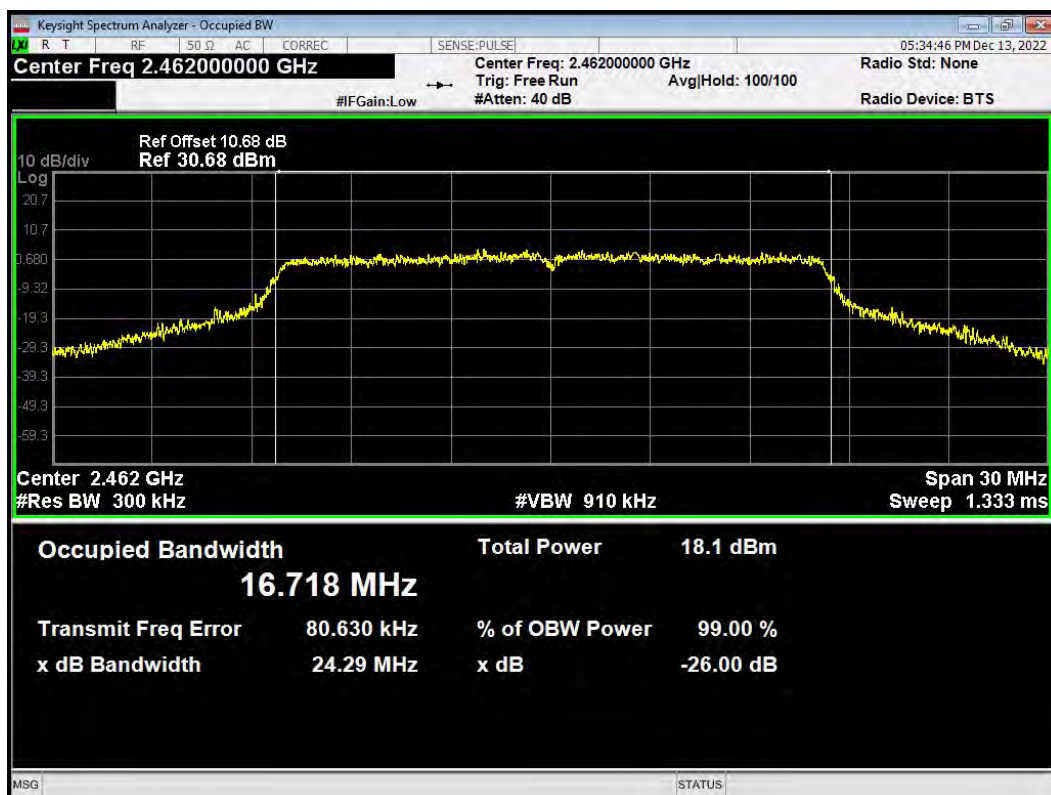
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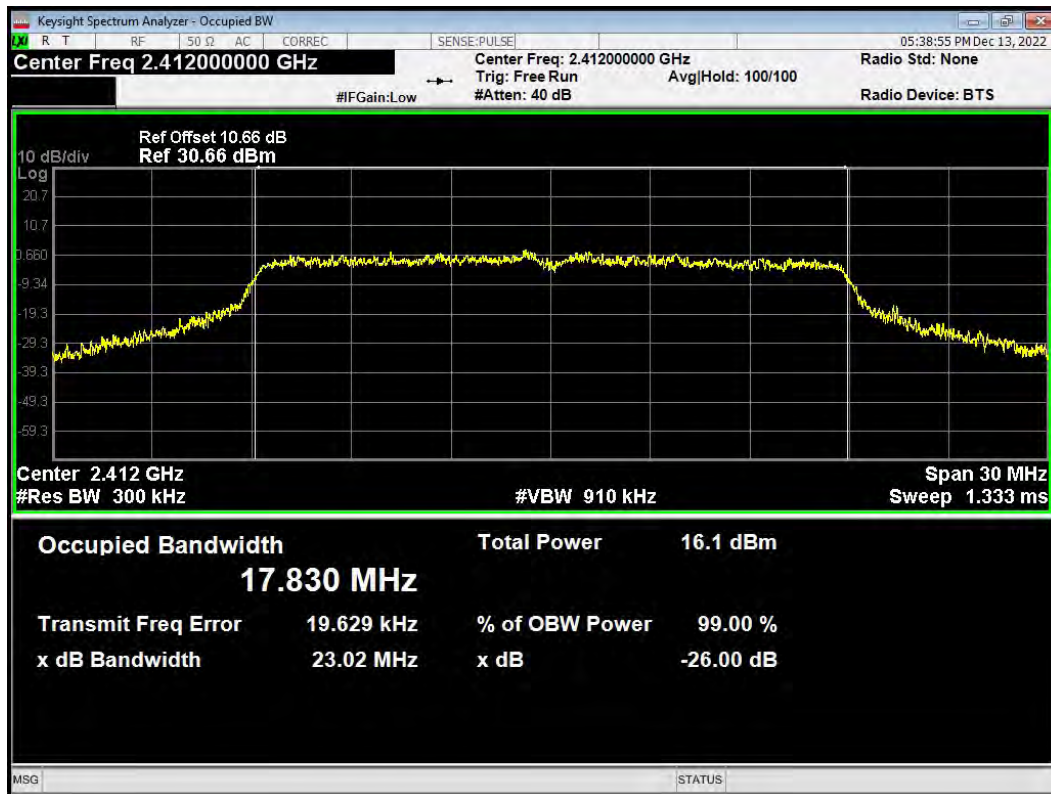
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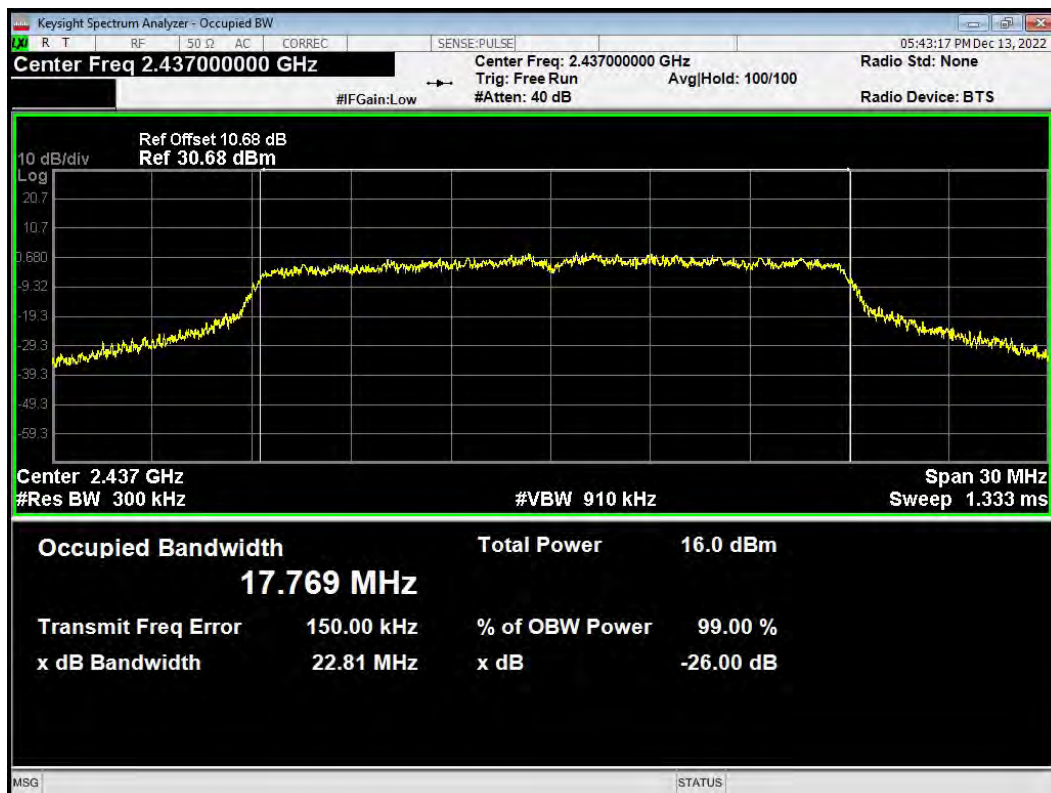
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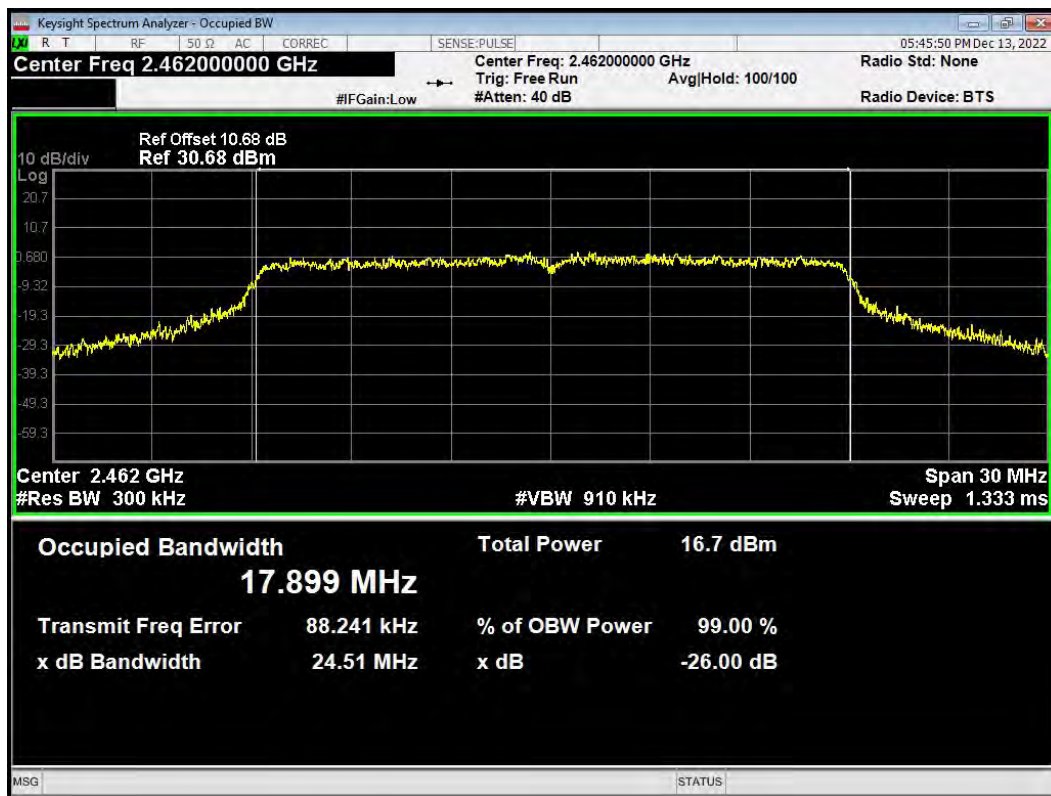
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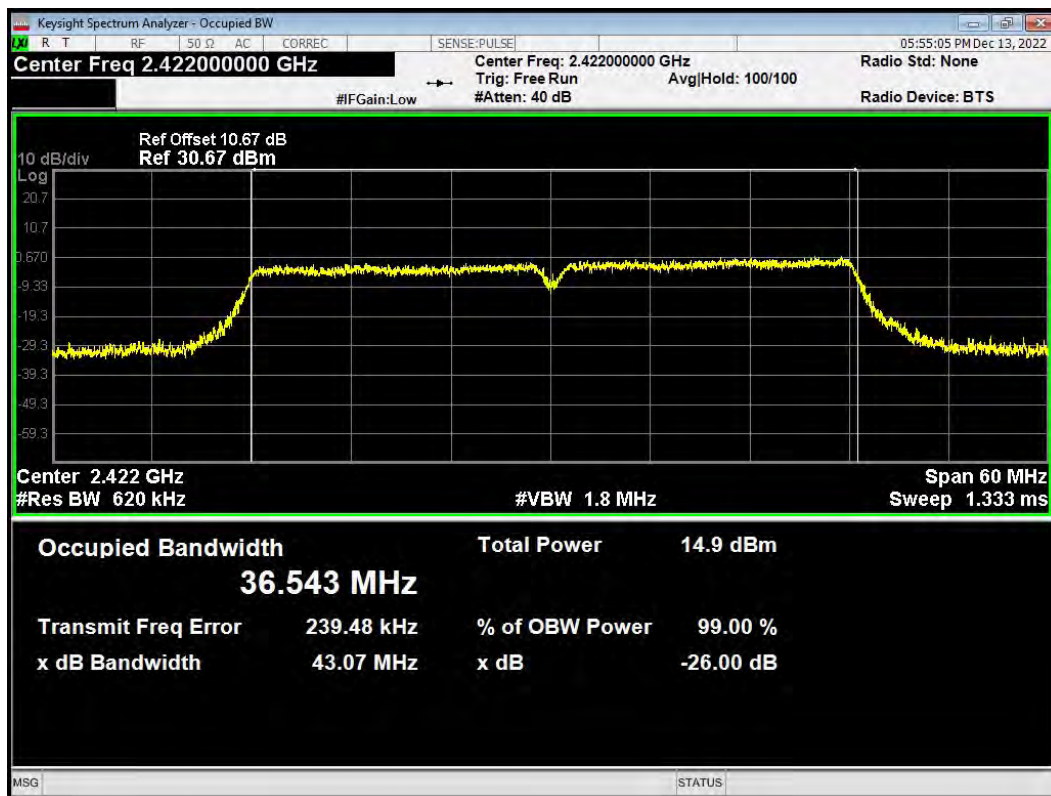
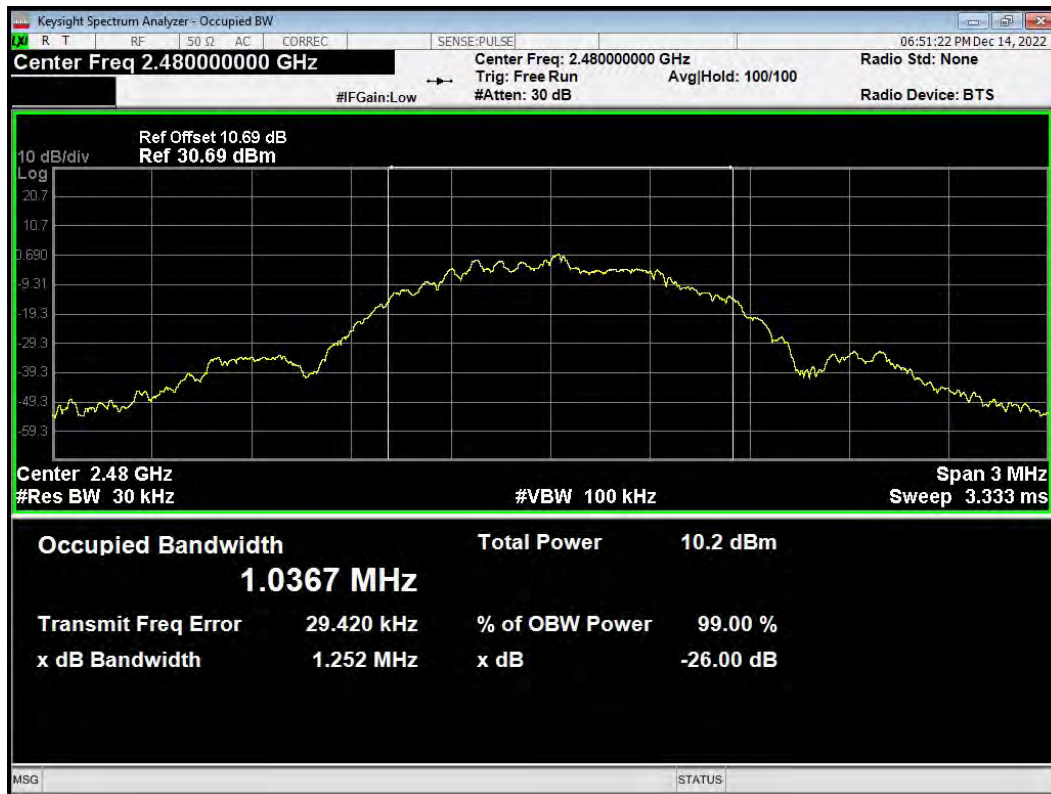## OBW 802.11n(HT40) 2437MHz
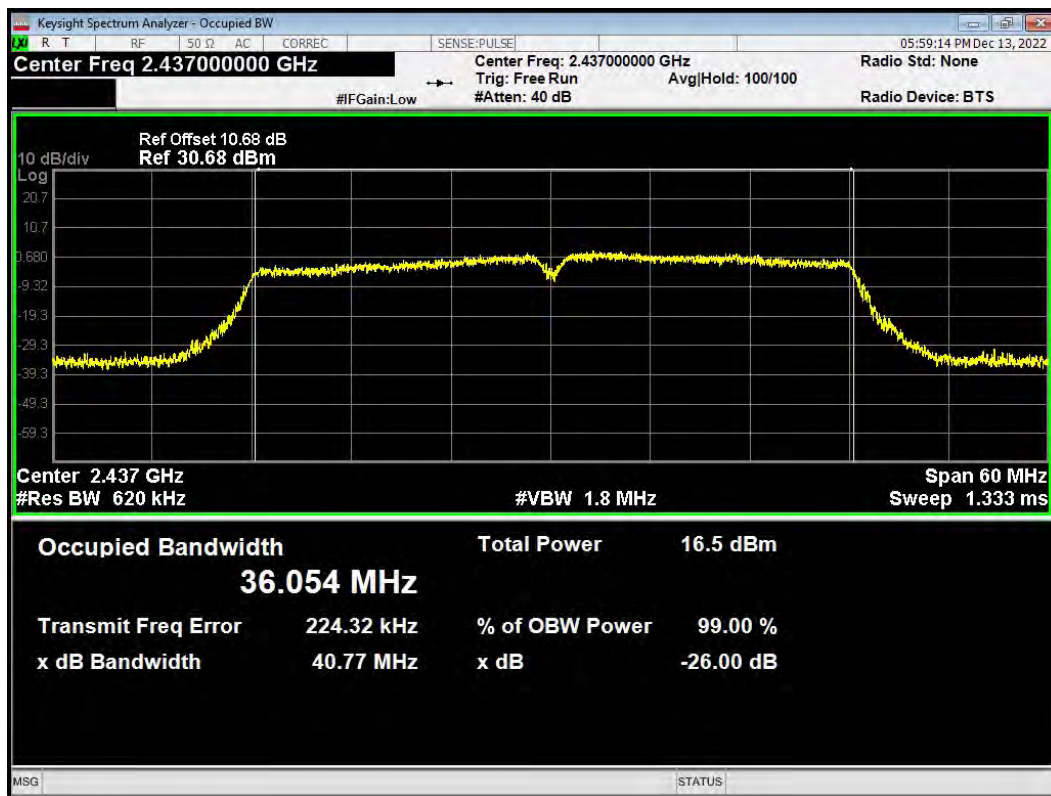
OBW 802.11n(HT40) 2452MHz

OBW BLE(1M) 2402MHz

OBW BLE(1M) 2440MHz

OBW BLE(1M) 2480MHz

OBW BLE(2M) 2402MHz

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OBW BLE(2M) 2440MHz

OBW BLE(2M) 2480MHz

6 dB bandwidth

-6dB Bandwidth 802.11b 2412MHz

-6dB Bandwidth 802.11b 2437MHz

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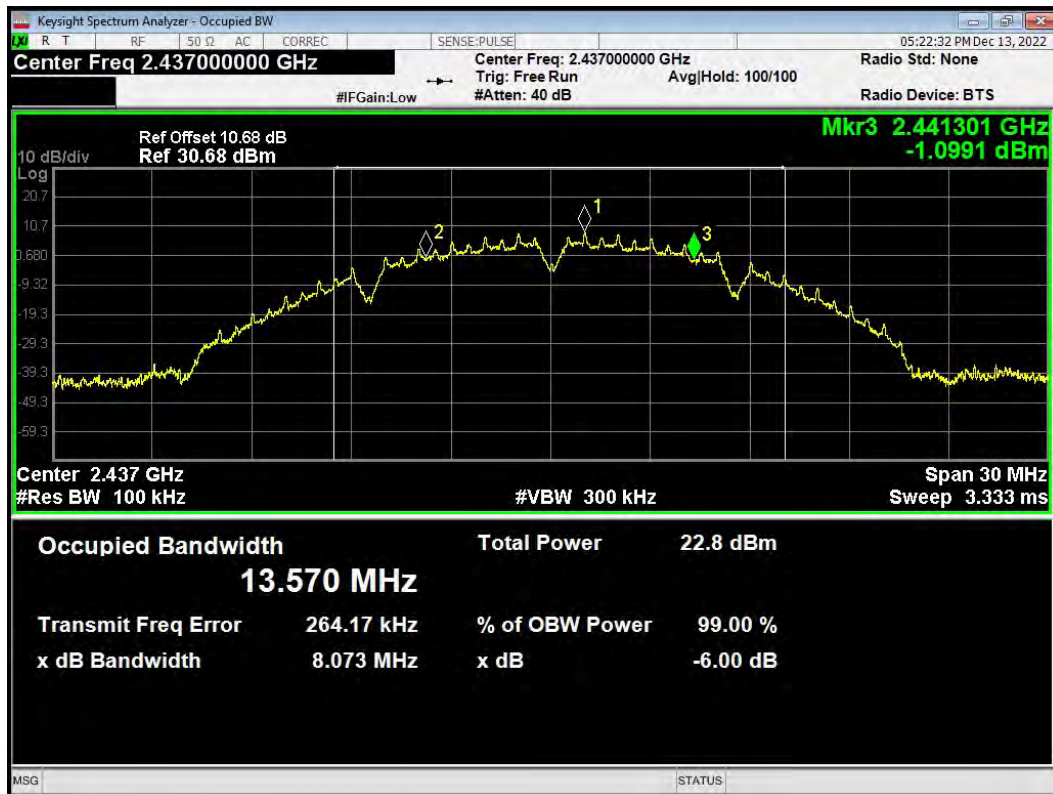
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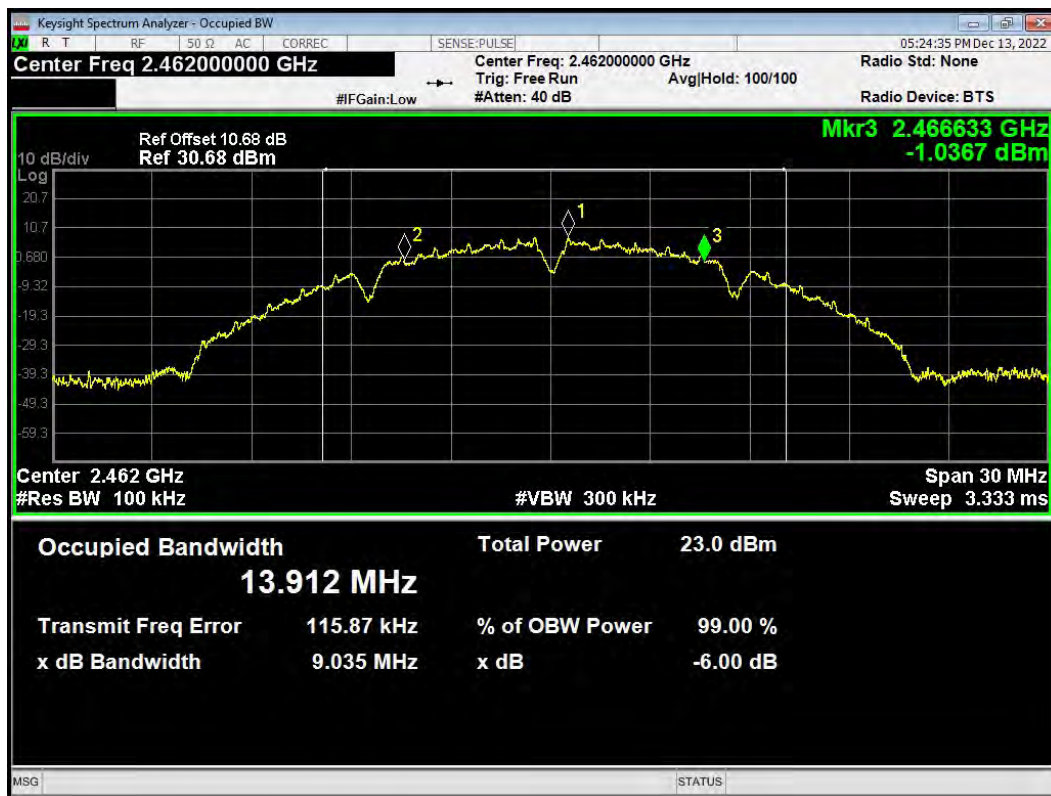
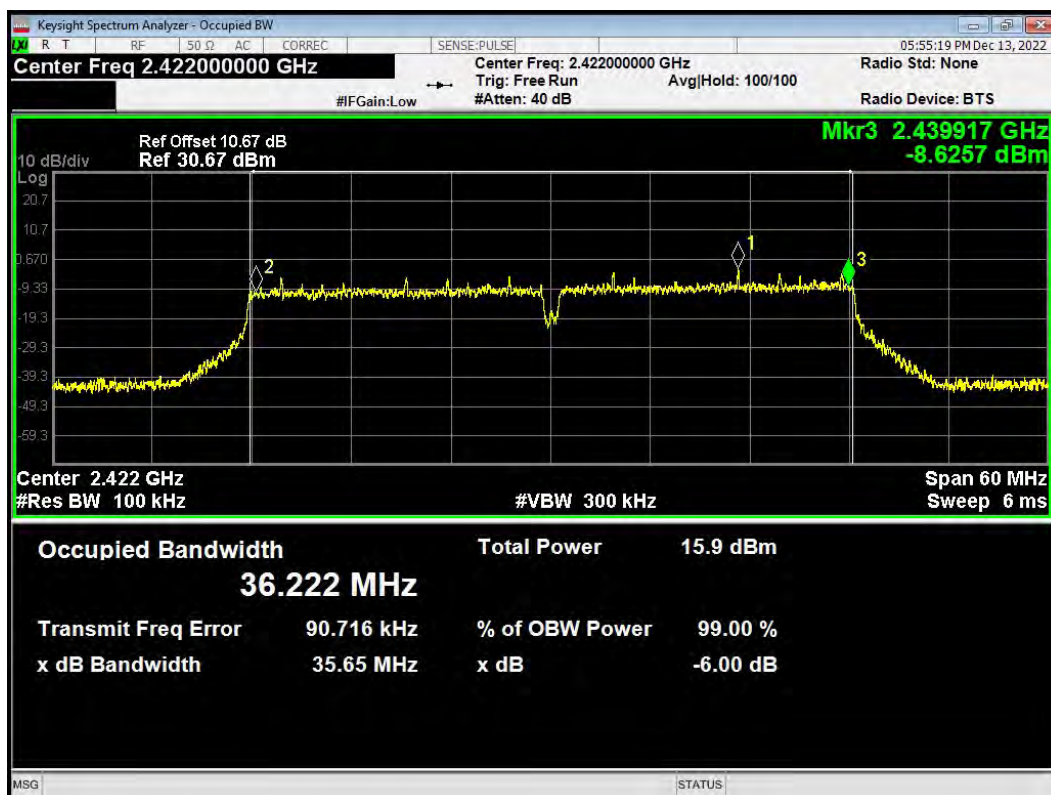-6dB Bandwidth 802.11g 2412MHz
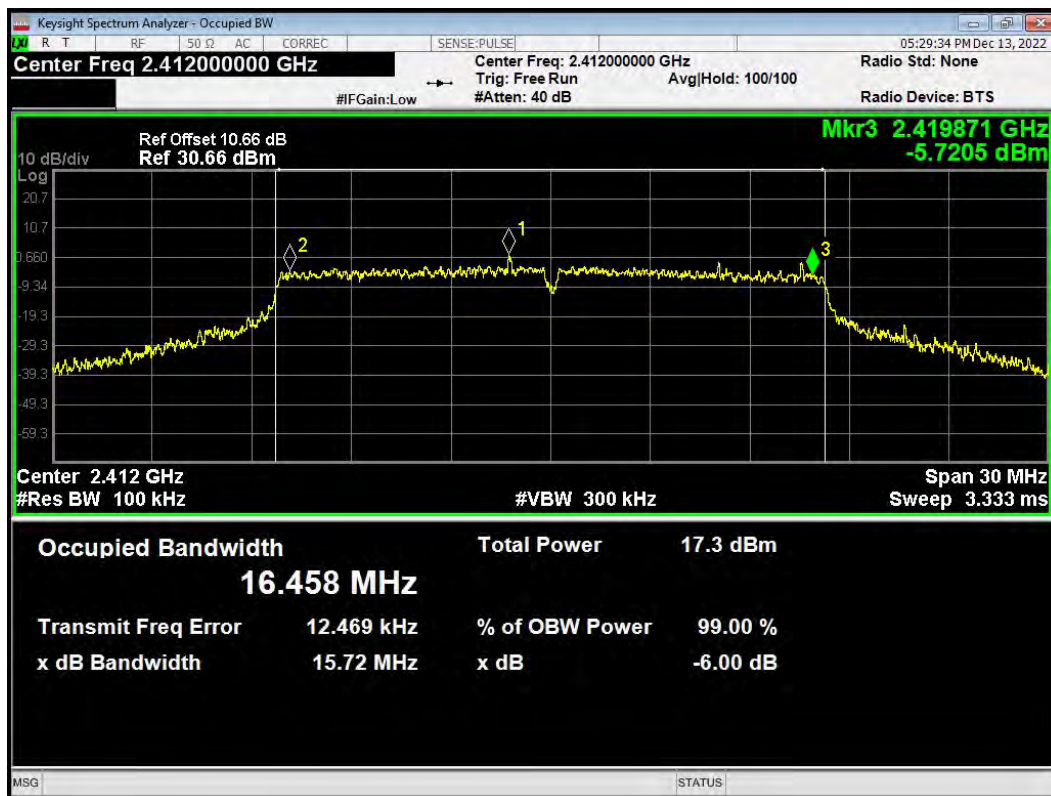
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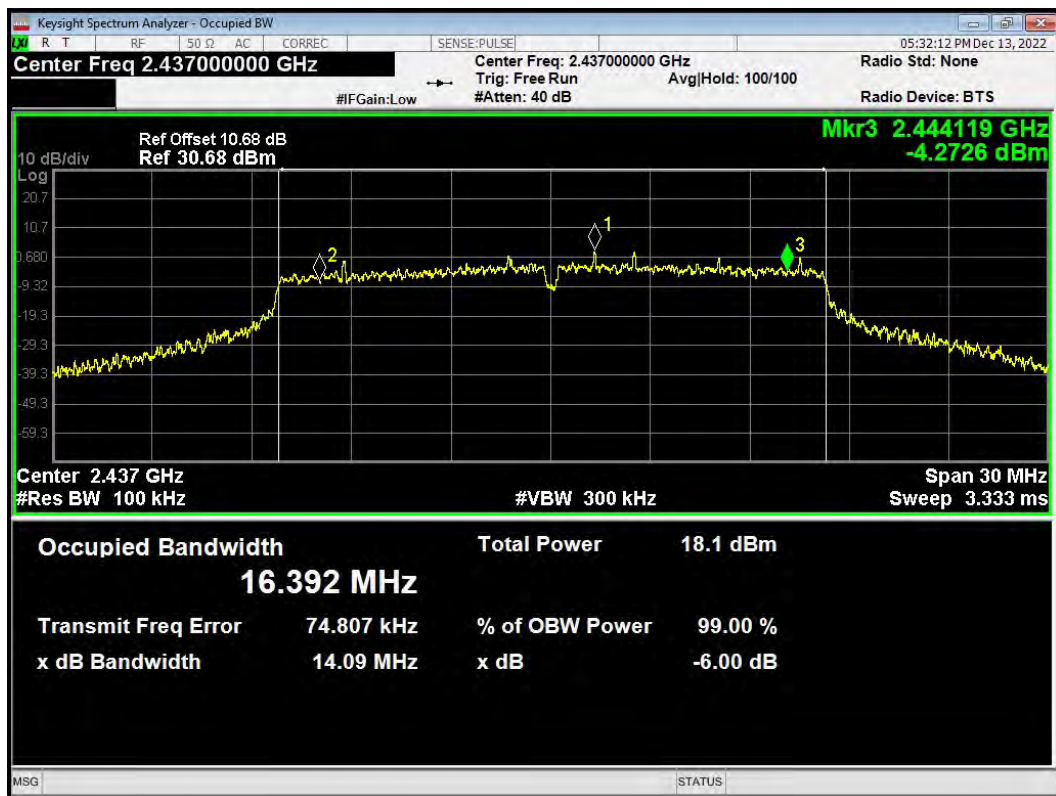
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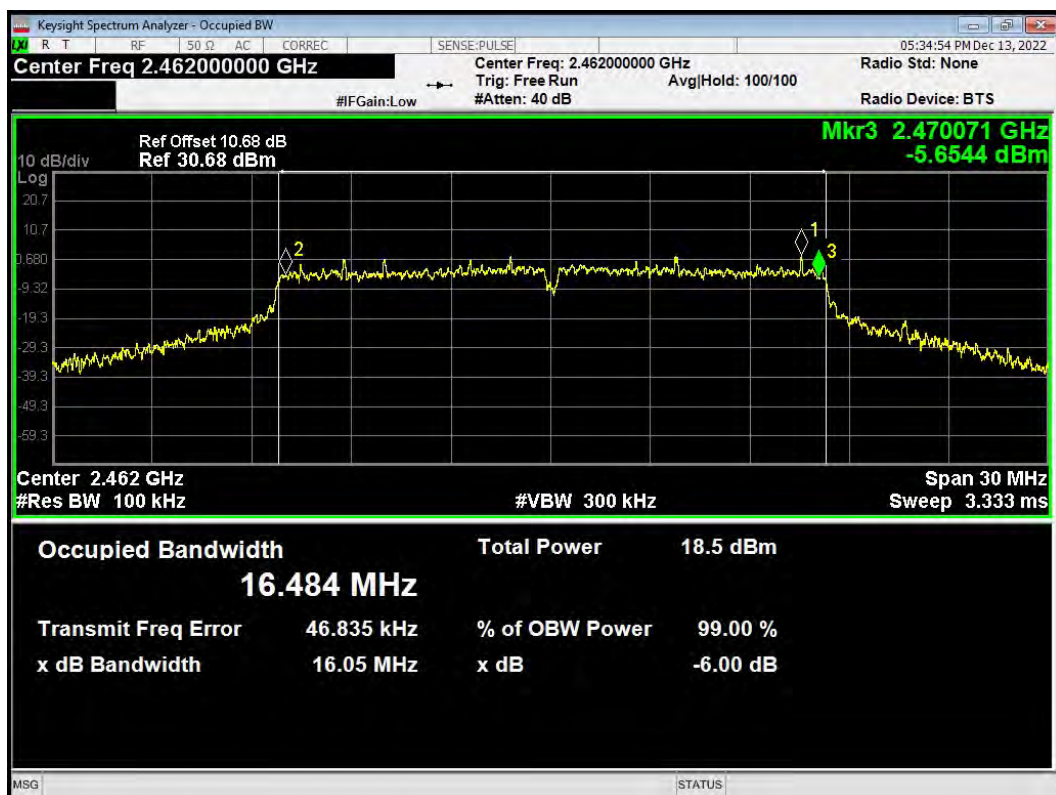
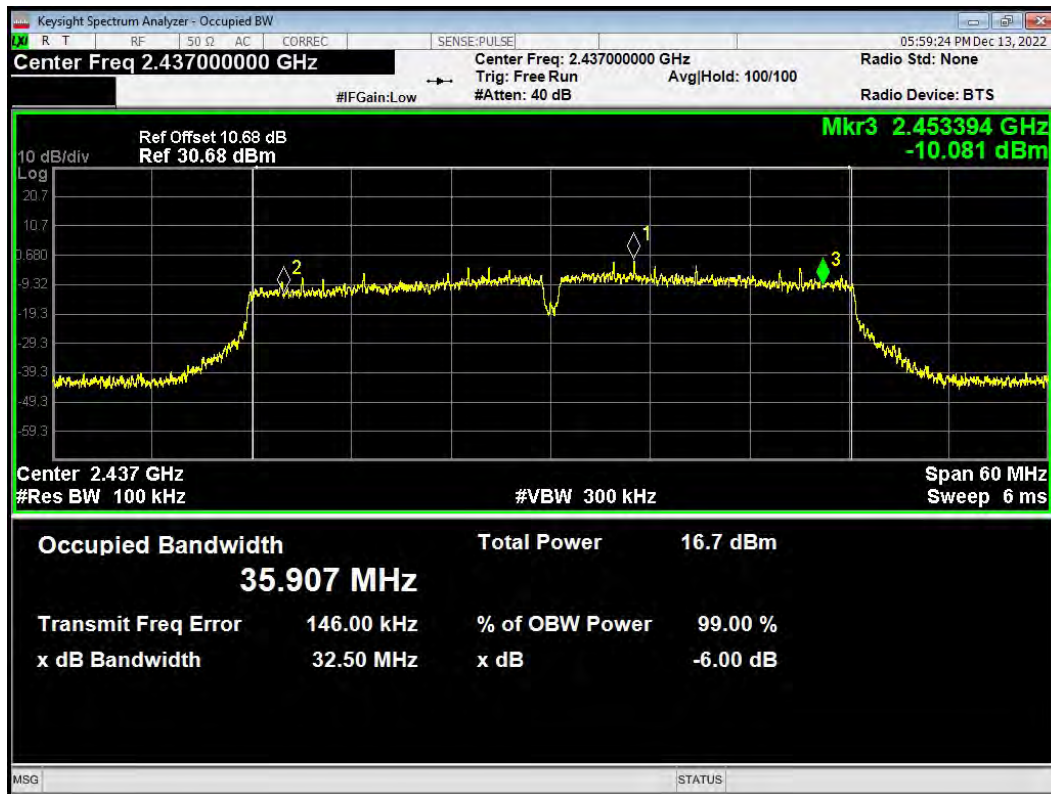-6dB Bandwidth 802.11n(HT20) 2412MHz

-6dB Bandwidth 802.11n(HT20) 2437MHz

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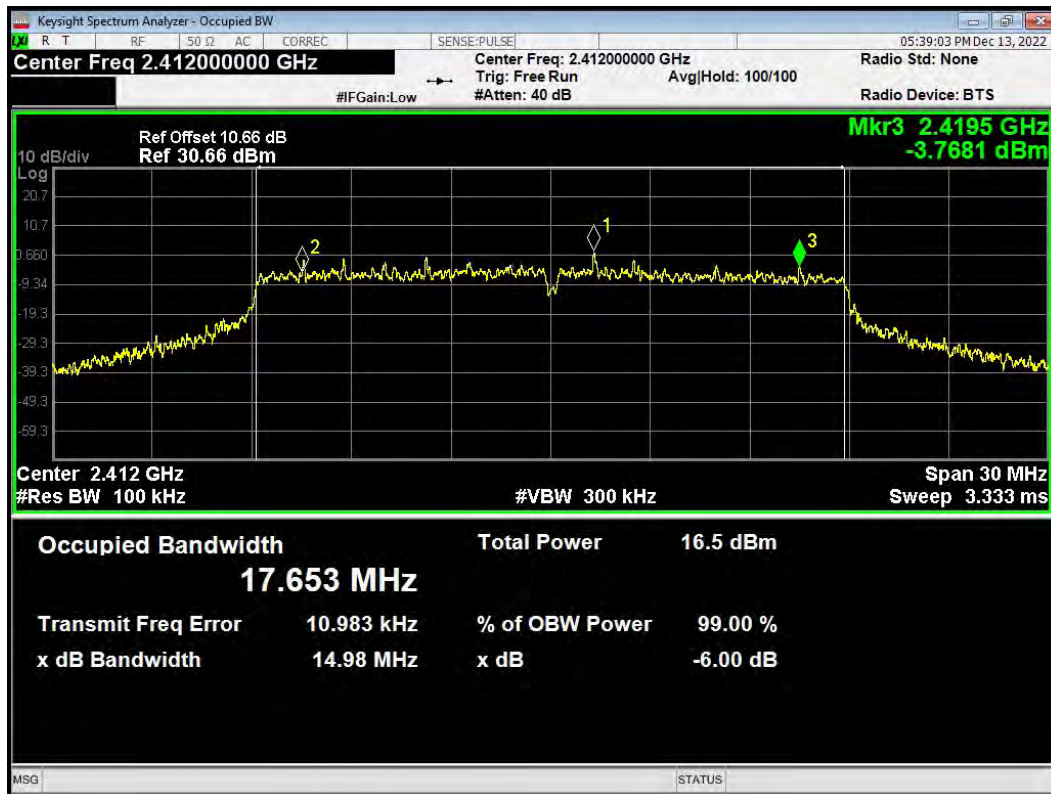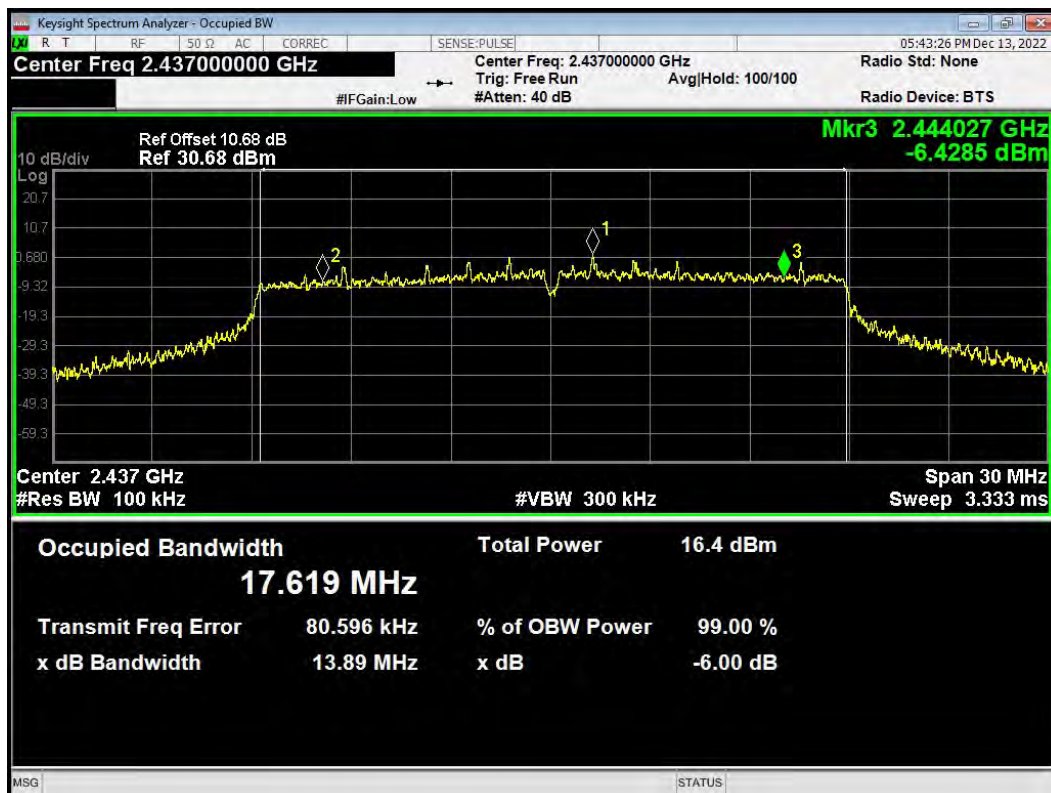
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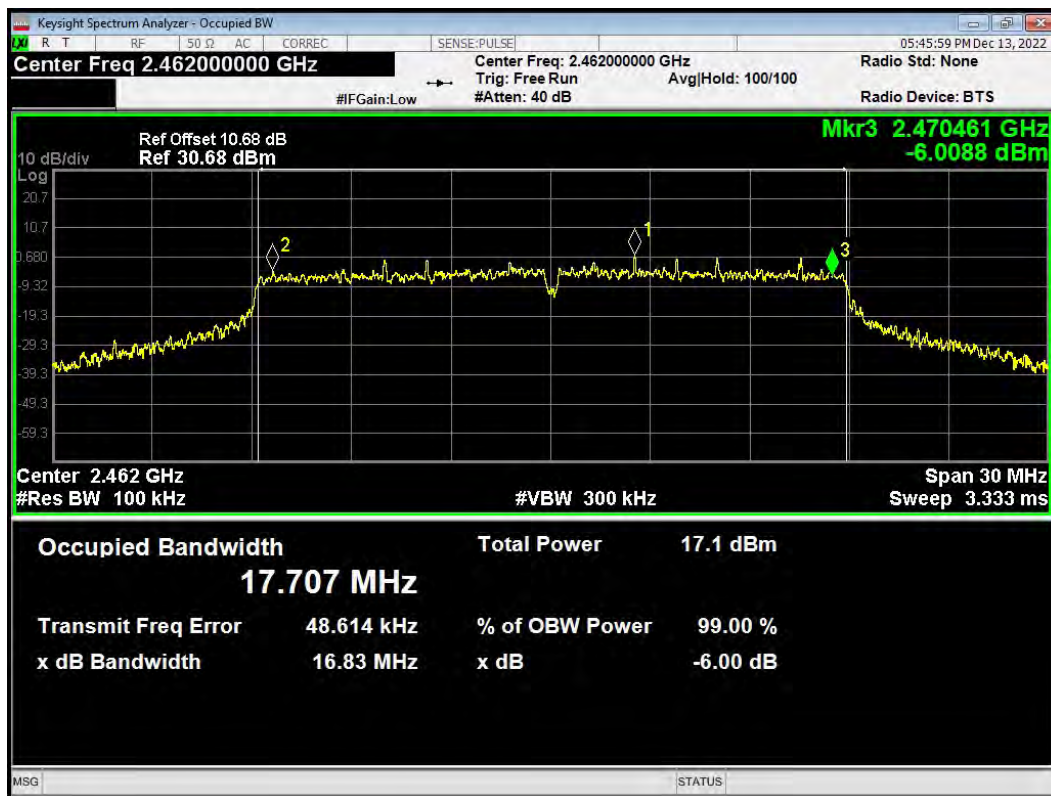
-6dB Bandwidth 802.11n(HT40) 2422MHz

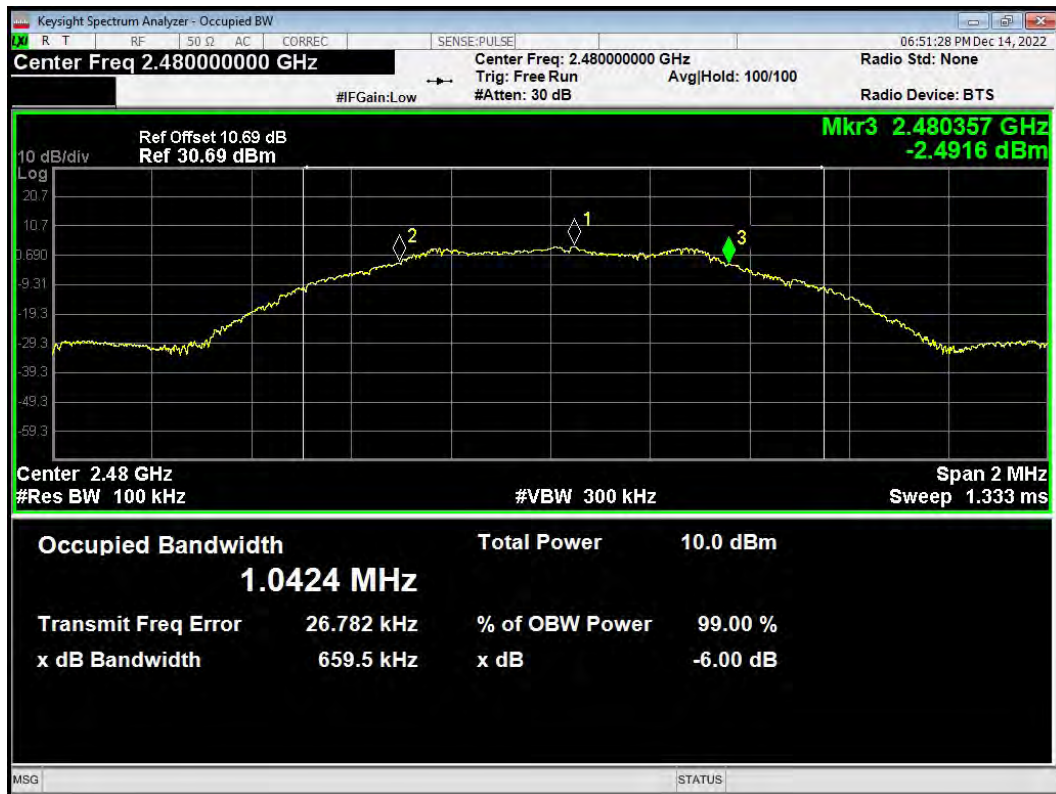-6dB Bandwidth 802.11n(HT40) 2437MHz

-6dB Bandwidth 802.11n(HT40) 2452MHz

-6dB Bandwidth BLE(1M) 2402MHz
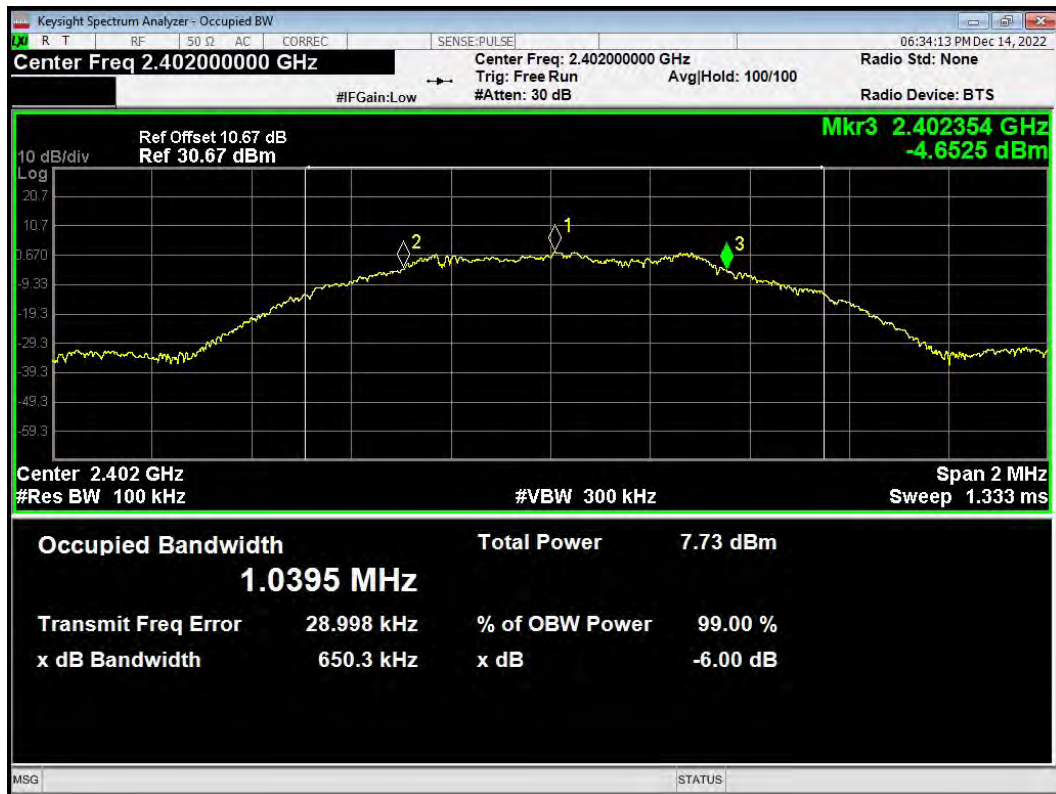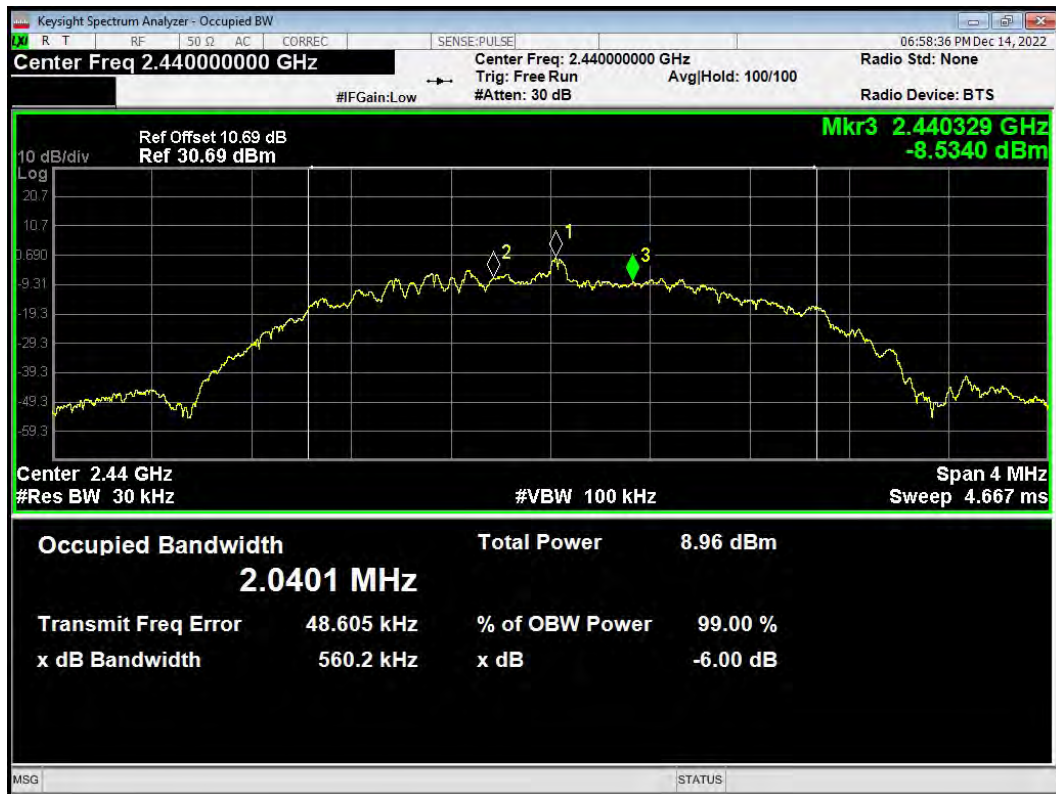

-6dB Bandwidth BLE(1M) 2440MHz

-6dB Bandwidth BLE(1M) 2480MHz

-6dB Bandwidth BLE(2M) 2402MHz

-6dB Bandwidth BLE(2M) 2440MHz


-6dB Bandwidth BLE(2M) 2480MHz

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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
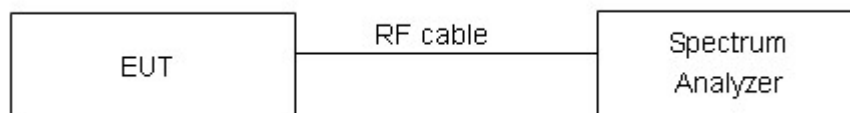
Limits

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."
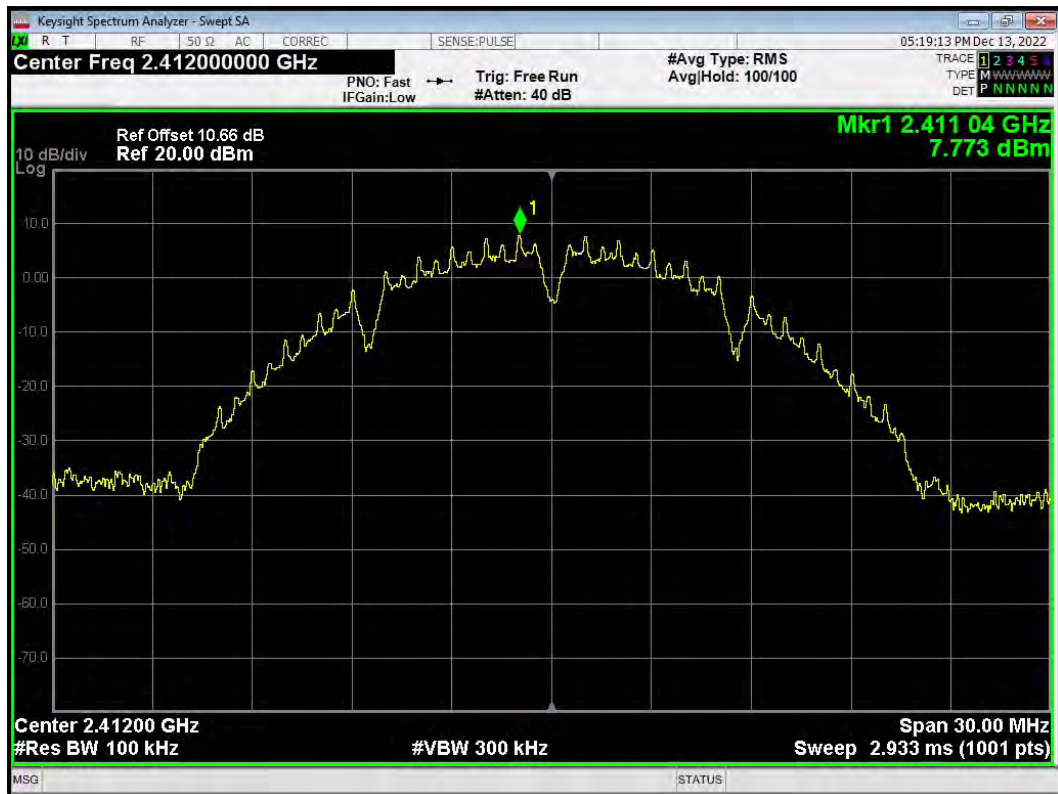
Measurement Uncertainty

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

Test Results: PASS

Band Edge 802.11b 2412MHz Ref

Band Edge 802.11b 2412MHz Emission

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.411 0 GHz	7.500 dBm			
2	N	1	f	2.400 0 GHz	-36.042 dBm			
3	N	1	f	2.390 0 GHz	-41.011 dBm			
4	N	1	f	2.366 3 GHz	-38.480 dBm			
5								
6								
7								
8								
9								
10								
11								

Band Edge 802.11b 2462MHz Ref

Band Edge 802.11b 2462MHz Emission

Band Edge 802.11g 2412MHz Ref

Band Edge 802.11g 2412MHz Emission
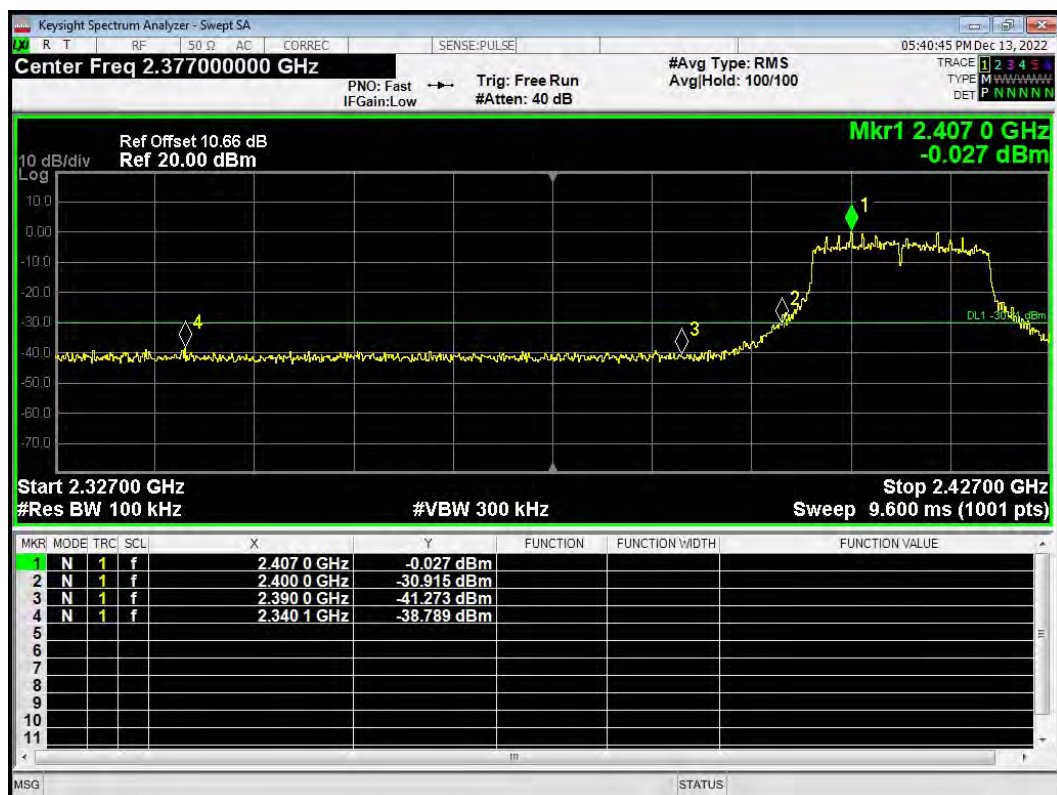
Band Edge 802.11g 2462MHz Ref

Band Edge 802.11g 2462MHz Emission

Band Edge 802.11n(HT20) 2412MHz Ref
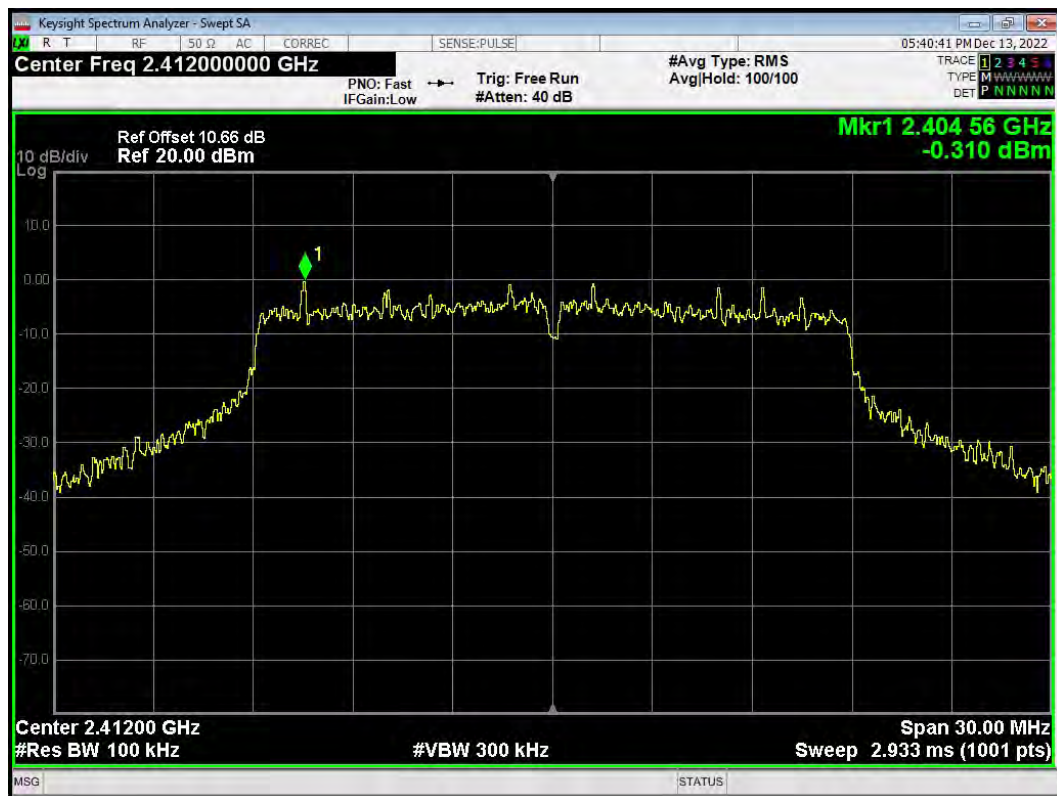
Band Edge 802.11n(HT20) 2412MHz Emission
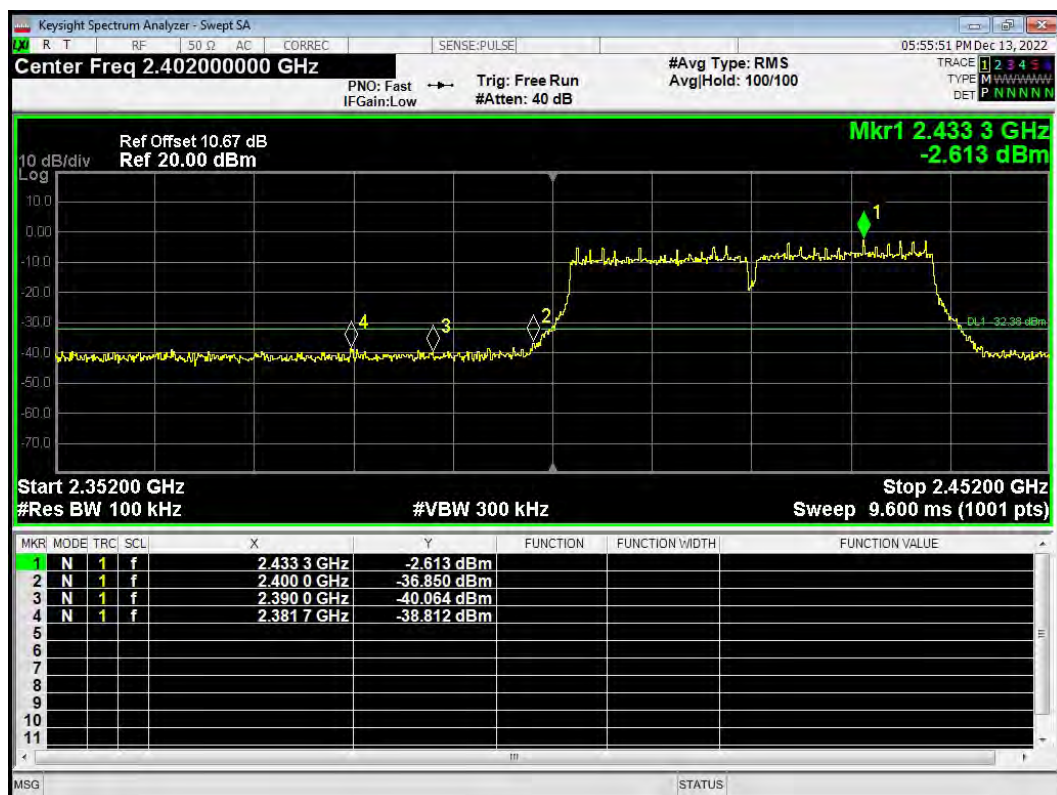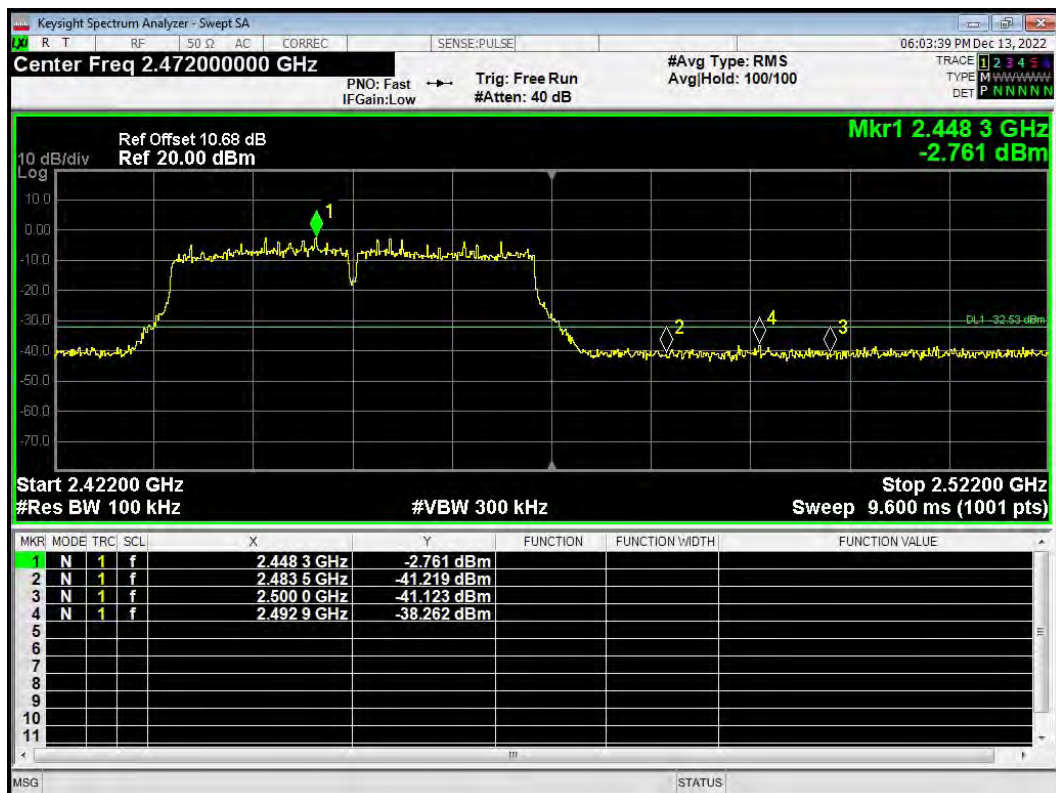
Band Edge 802.11n(HT20) 2462MHz Ref
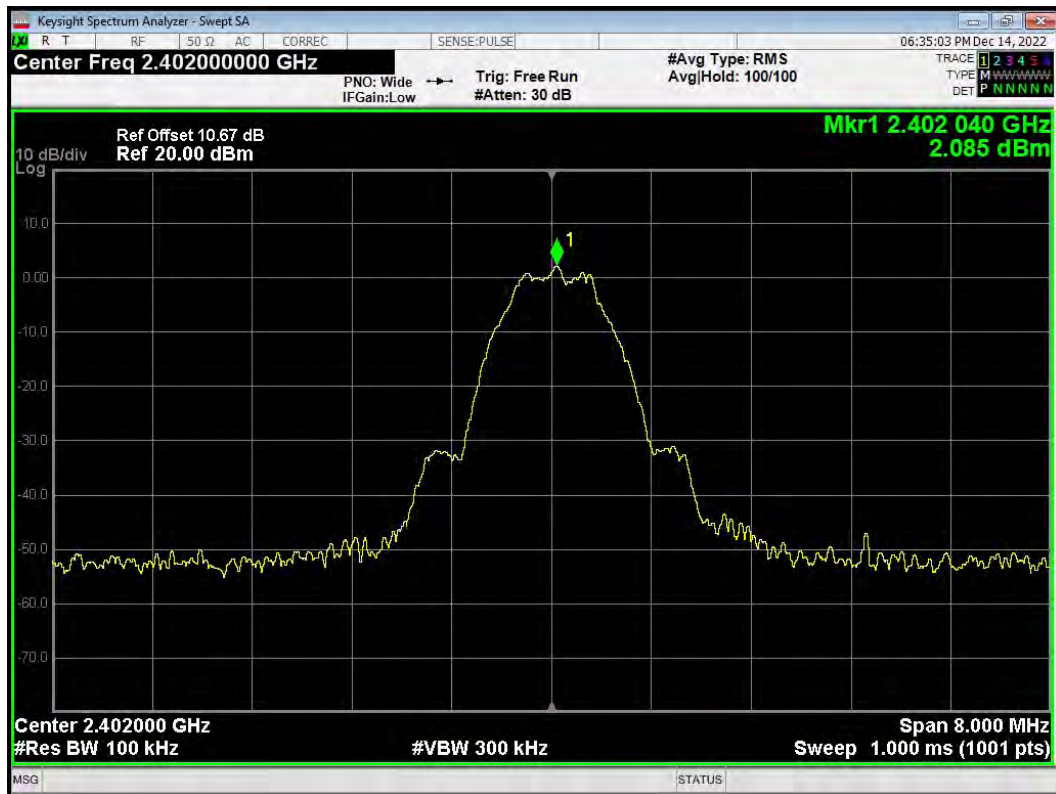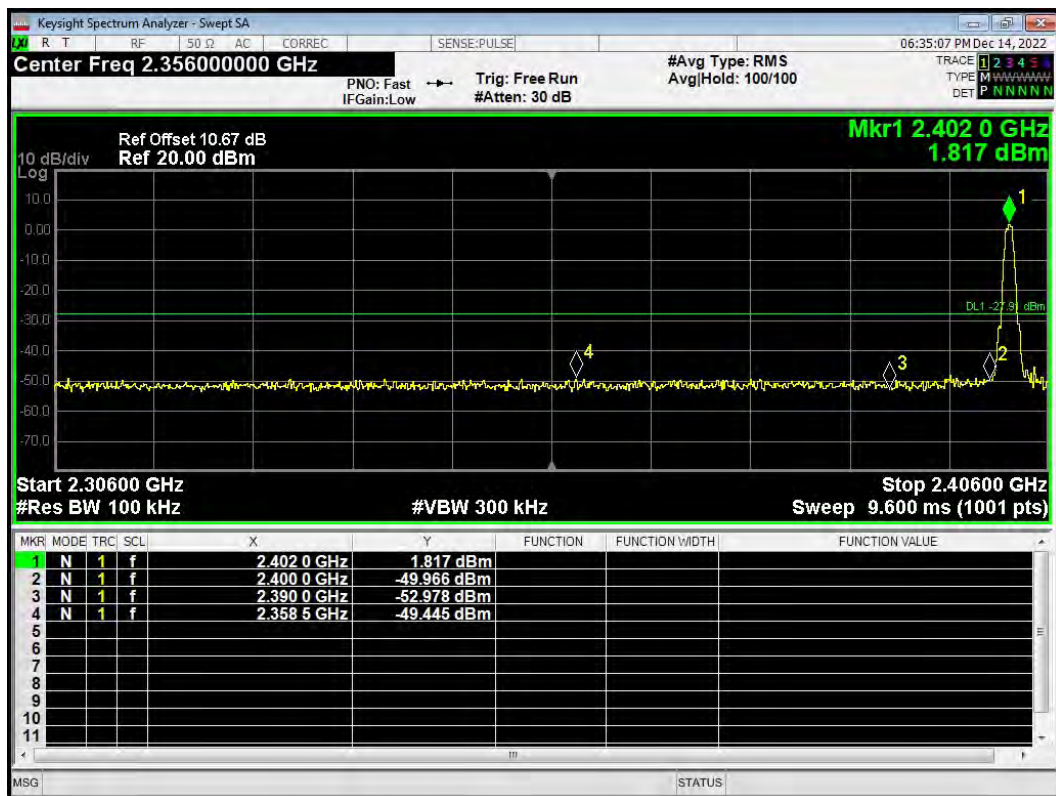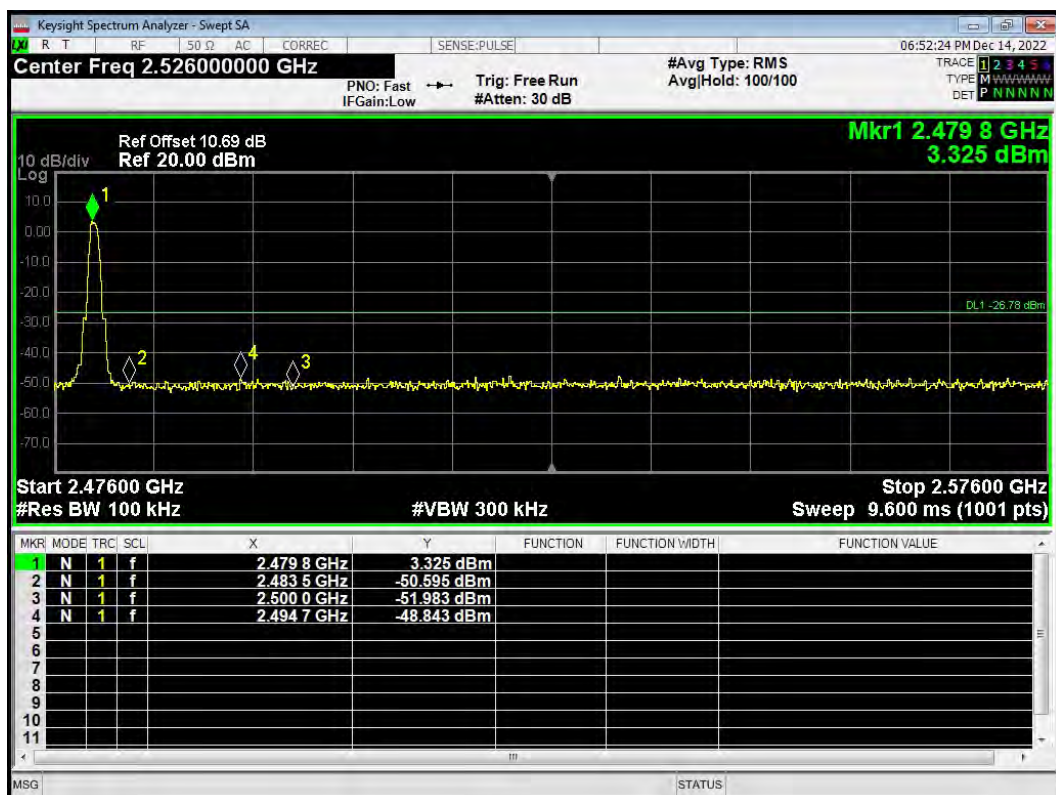

Band Edge 802.11n(HT20) 2462MHz Emission

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Band Edge 802.11n(HT40) 2422MHz Ref

Band Edge 802.11n(HT40) 2422MHz Emission

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Band Edge 802.11n(HT40) 2452MHz Ref

Band Edge 802.11n(HT40) 2452MHz Emission

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Band Edge BLE(1M) 2402MHz Ref

Band Edge BLE(1M) 2402MHz Emission

Band Edge BLE(1M) 2480MHz Ref
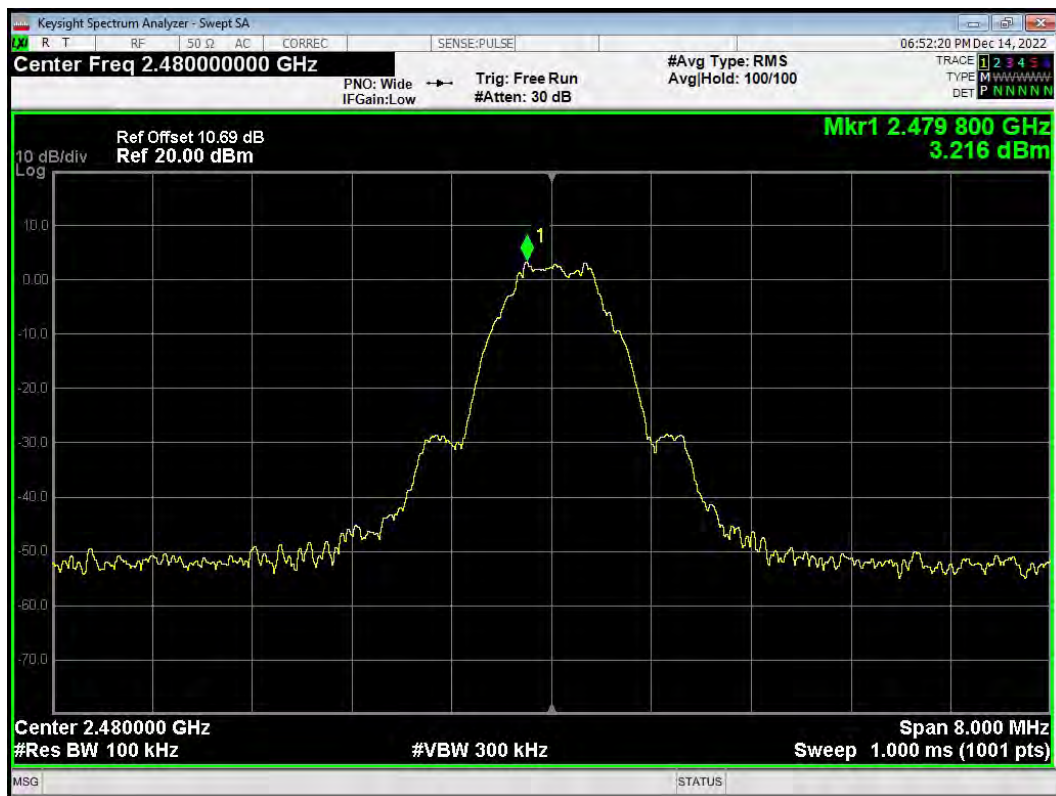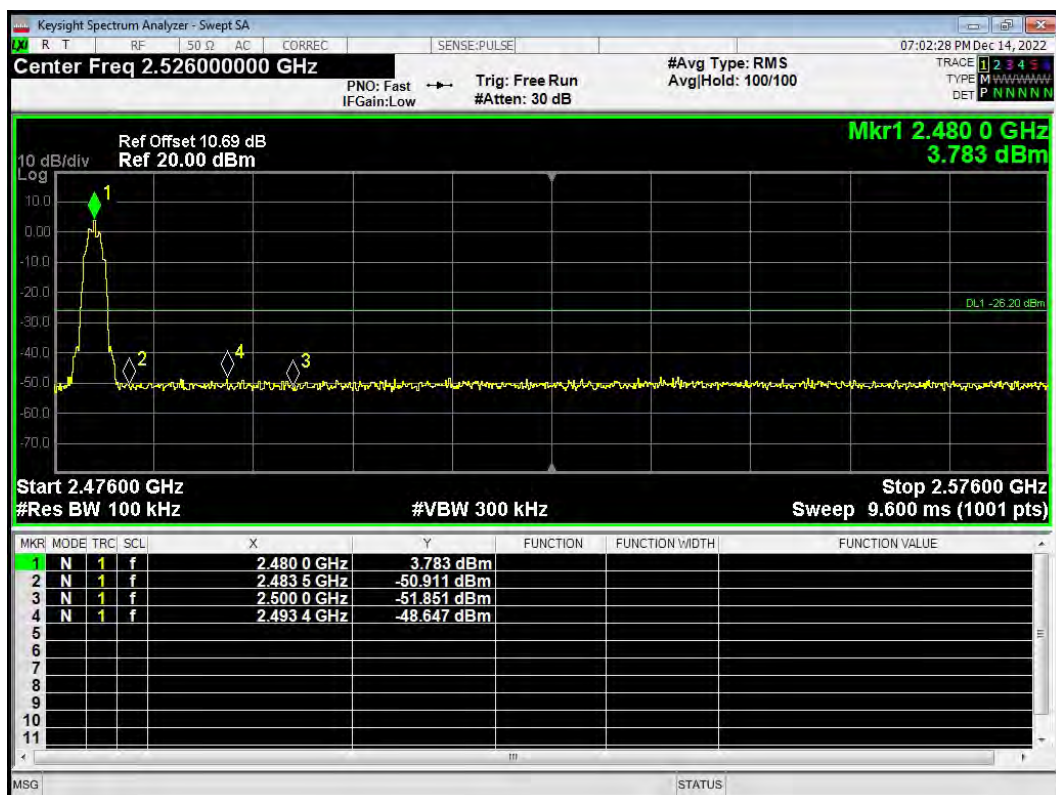

Band Edge BLE(1M) 2480MHz Emission

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.479 8 GHz	3.325 dBm			
2	N	1	f	2.483 5 GHz	-50.595 dBm			
3	N	1	f	2.500 0 GHz	-51.983 dBm			
4	N	1	f	2.494 7 GHz	-48.843 dBm			
5								
6								
7								
8								
9								
10								
11								

Band Edge BLE(2M) 2402MHz Ref

Band Edge BLE(2M) 2402MHz Emission
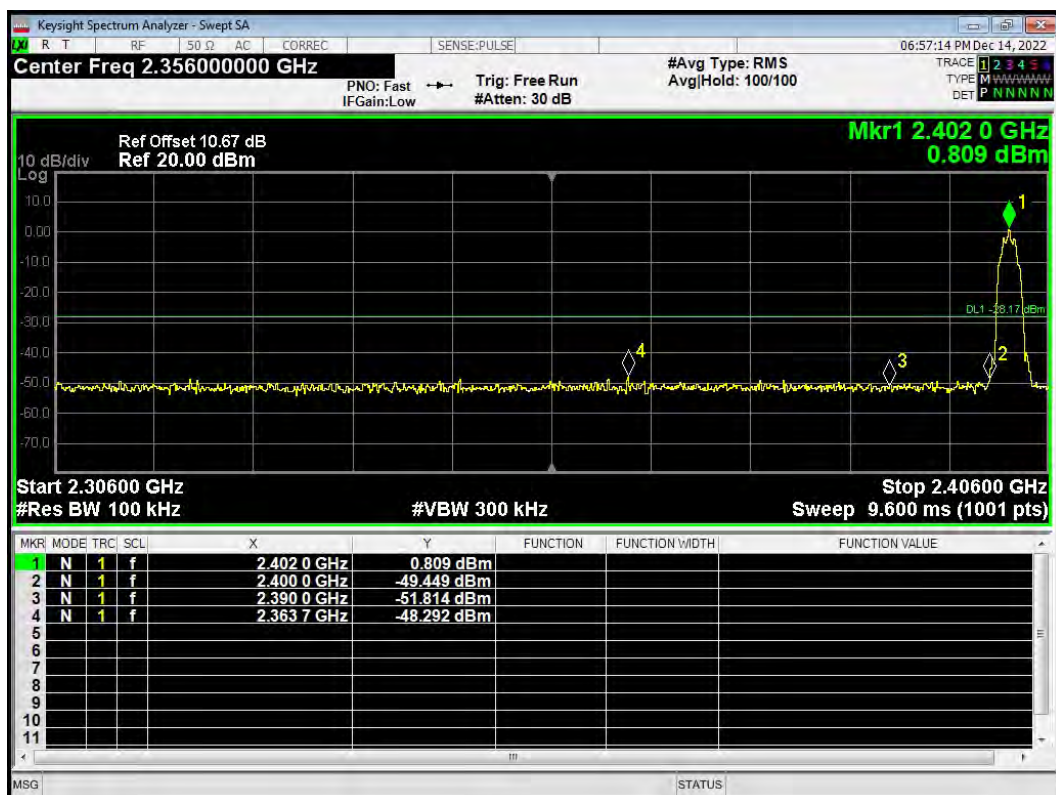
Band Edge BLE(2M) 2480MHz Ref

Band Edge BLE(2M) 2480MHz Emission

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 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≤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 X span/RBW]

h) Sweep time =auto couple

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

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

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

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

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

Test setup
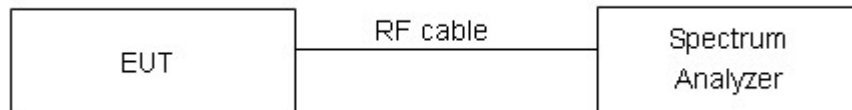
Limits

Rule Part 15.247(e) specifies that" For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. ''

Limits	≤ 8 dBm / 3kHz

Measurement Uncertainty

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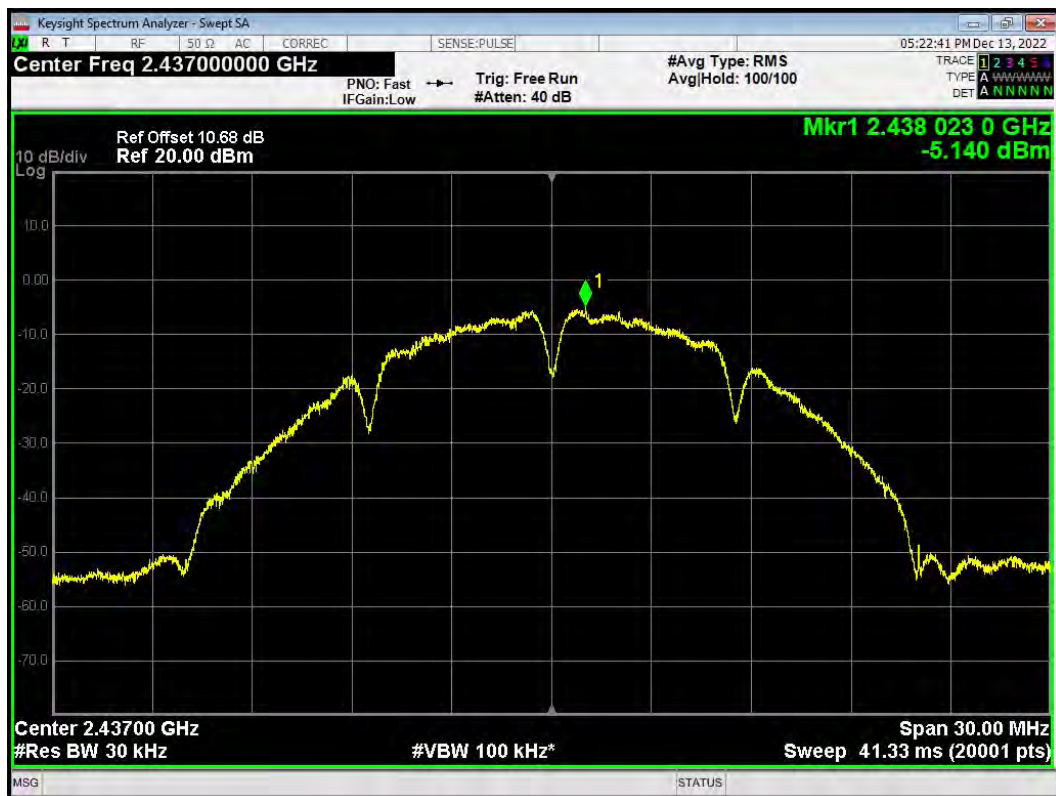
Test Results:

Test Mode	Channel Number	Read Value (dBm / 30kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	1	-6.00	-16.00	8	PASS
	6	-5.14	-15.14	8	PASS
	11	-5.20	-15.20	8	PASS
802.11g	1	-12.20	-22.20	8	PASS
	6	-11.34	-21.34	8	PASS
	11	-11.39	-21.39	8	PASS
802.11n HT20	1	-13.50	-23.50	8	PASS
	6	-13.58	-23.58	8	PASS
	11	-13.19	-23.19	8	PASS
802.11n HT40	3	-16.43	-26.21	8	PASS
	6	-15.34	-25.12	8	PASS
	9	-15.85	-25.63	8	PASS

Note: Power Spectral Density (dBm/3kHz) =Read Value+Duty cycle correction factor + $10*\log 10(3 / 30)$

Test Mode	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy) (1M)	0	-16.86	-14.82	8	PASS
	19	-15.24	-13.20	8	PASS
	39	-15.32	-13.28	8	PASS
Bluetooth (Low Energy) (2M)	0	-22.18	-17.37	8	PASS
	19	-20.73	-15.92	8	PASS
	39	-19.97	-15.16	8	PASS

Note: Power Spectral Density =Read Value+Duty cycle correction factor
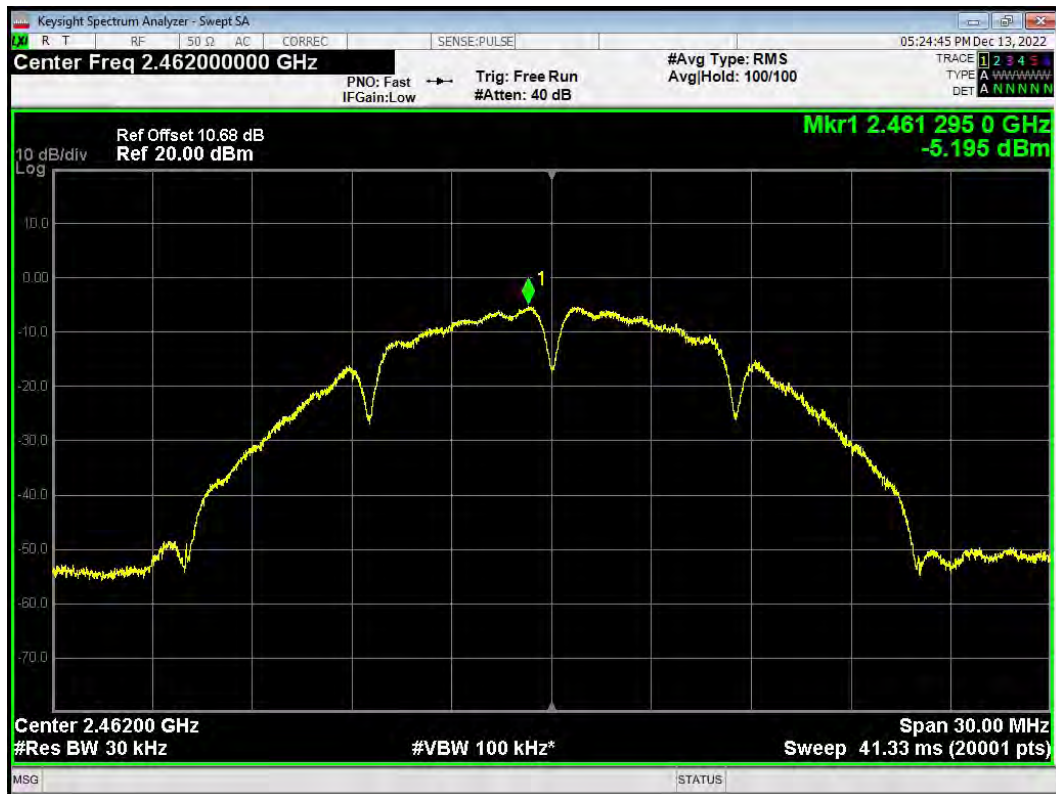
PSD 802.11b 2412MHz

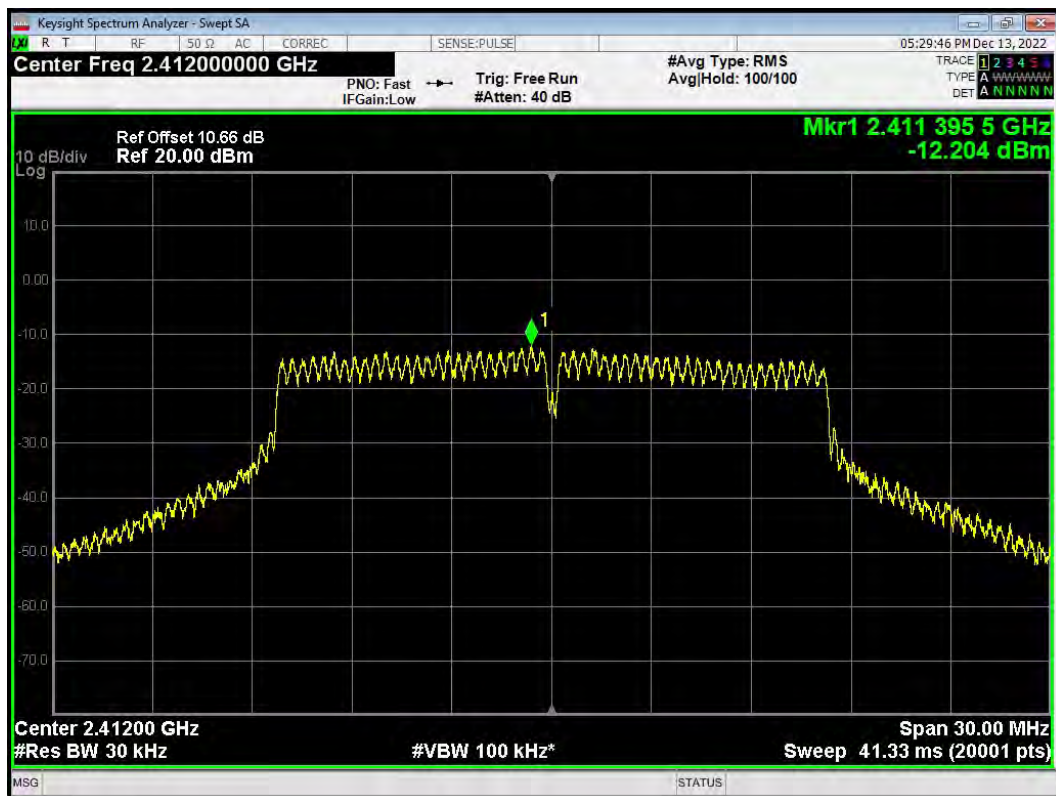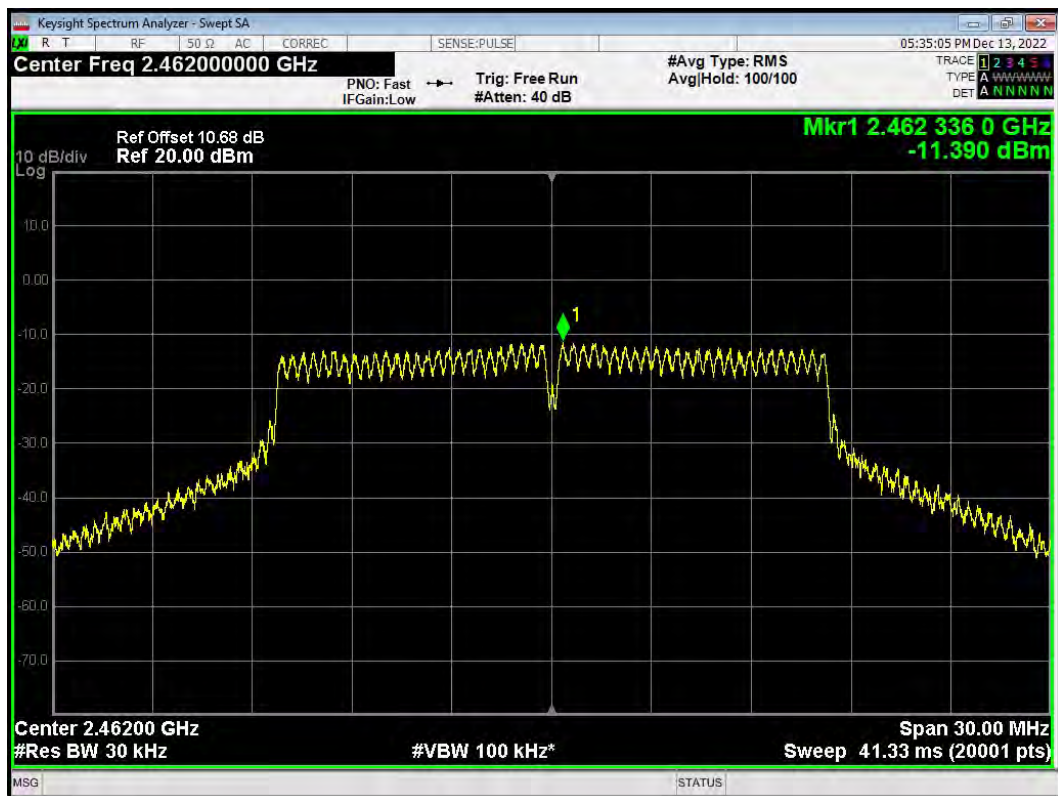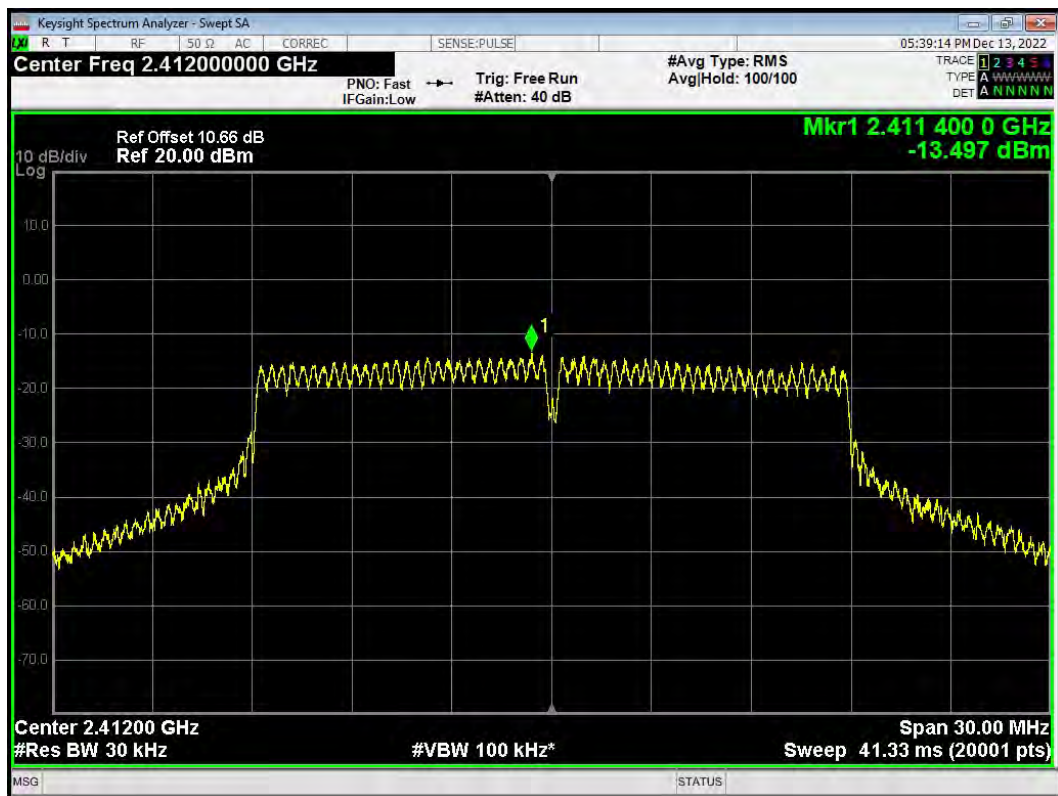## PSD 802.11b 2437MHz

PSD 802.11b 2462MHz

PSD 802.11g 2412MHz

PSD 802.11g 2437MHz

PSD 802.11g 2462MHz

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PSD 802.11n(HT20) 2412MHz

PSD 802.11n(HT20) 2437MHz

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PSD 802.11n(HT20) 2462MHz

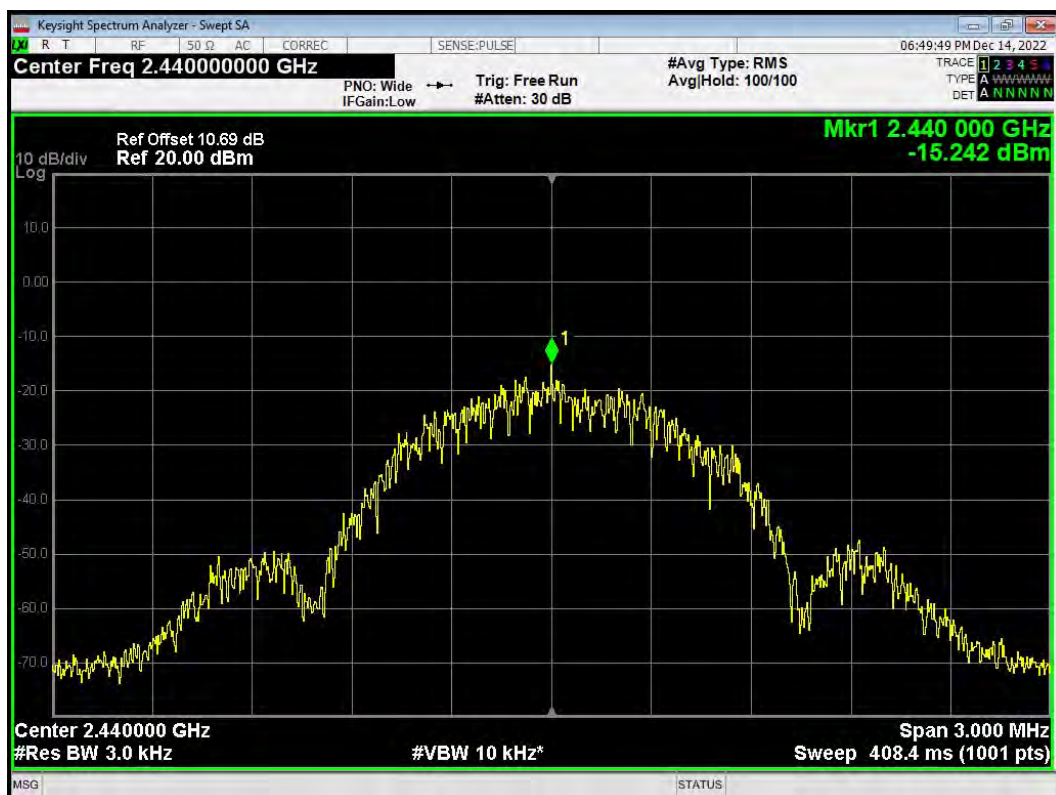## PSD 802.11n(HT40) 2422MHz
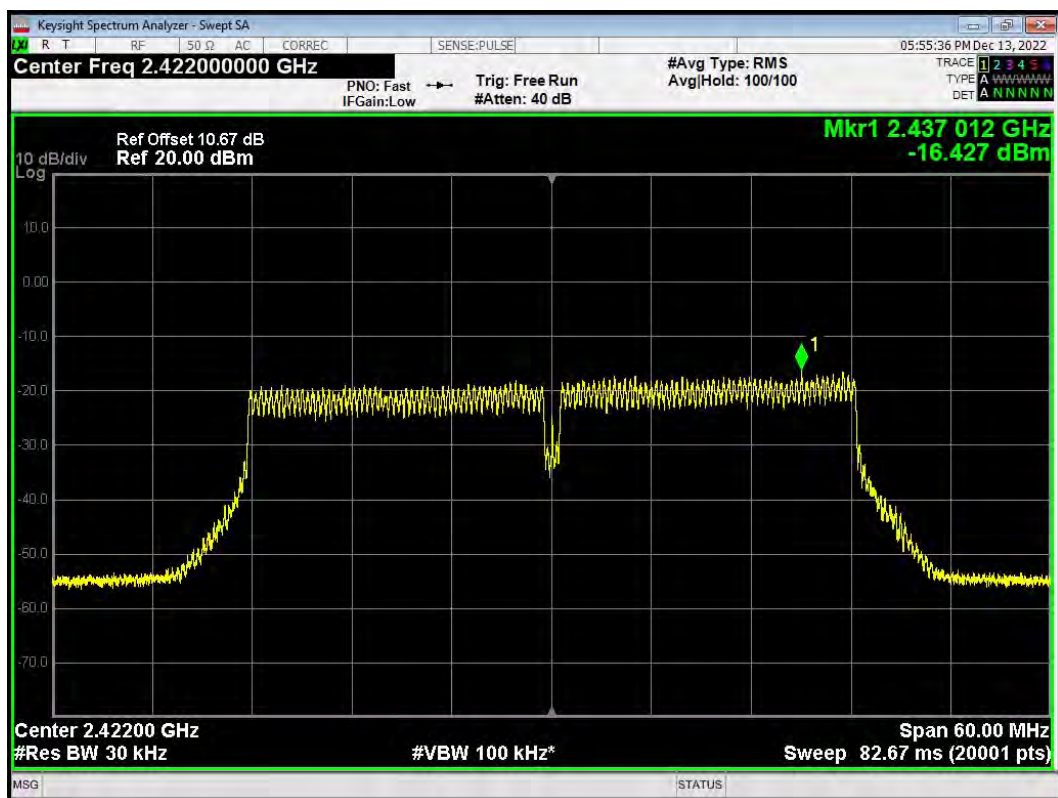
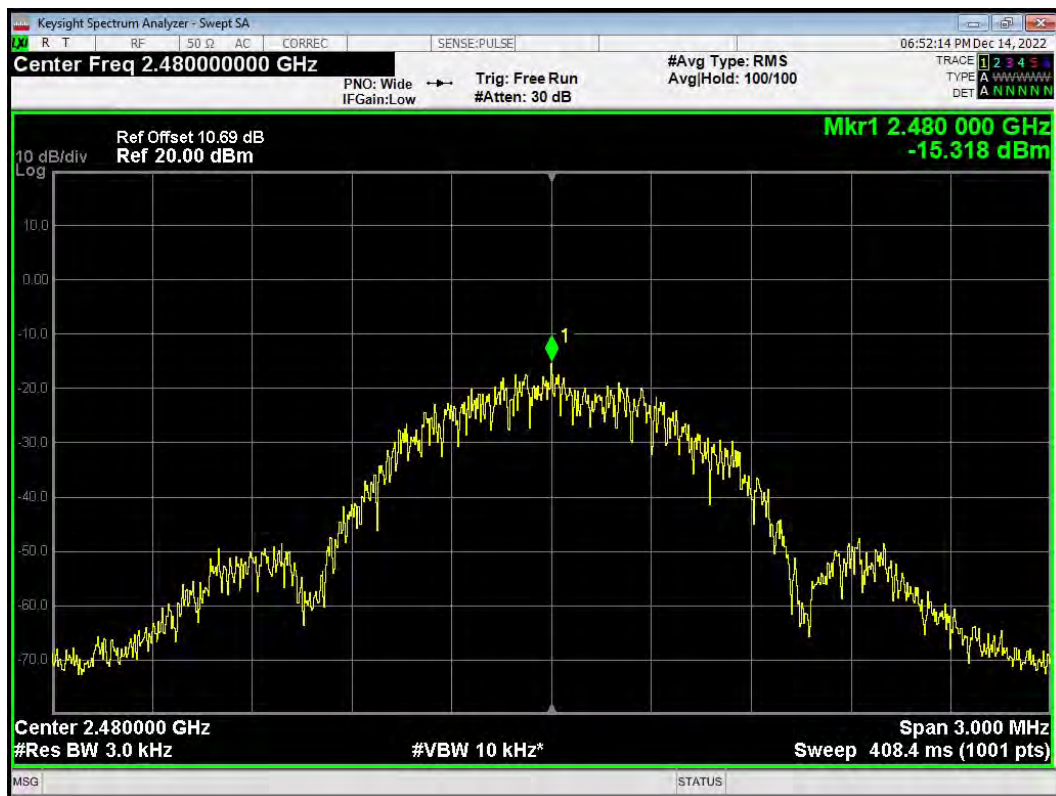## PSD 802.11n(HT40) 2437MHz
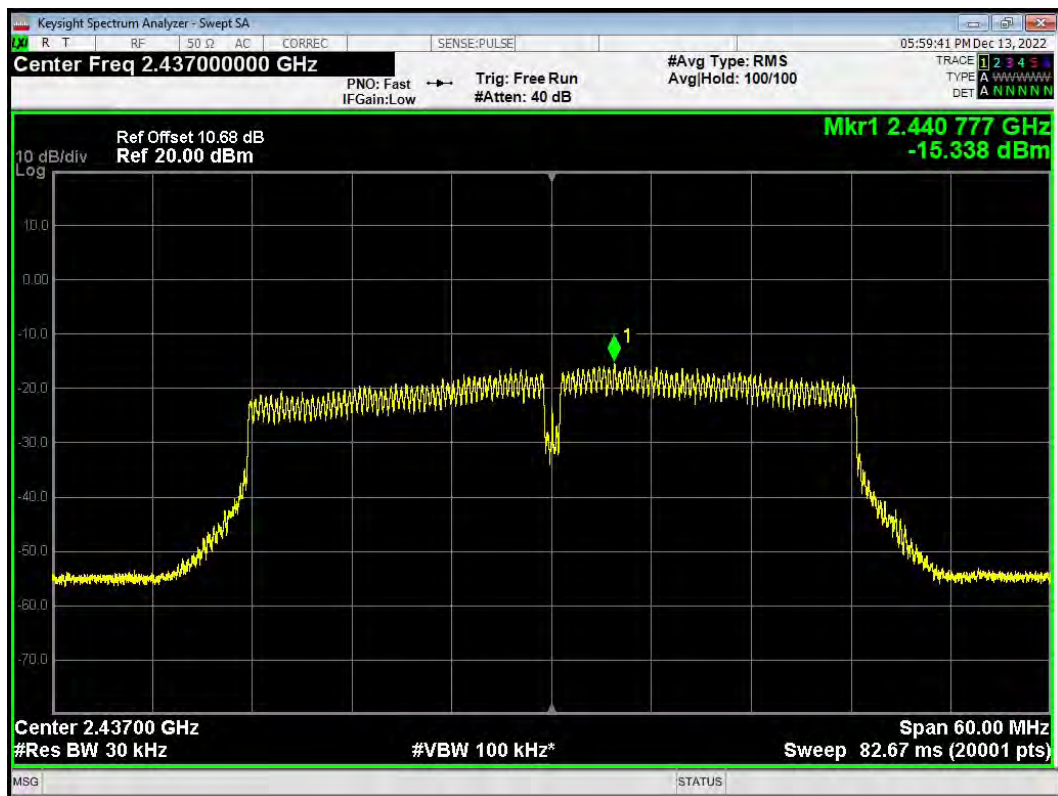
PSD 802.11n(HT40) 2452MHz
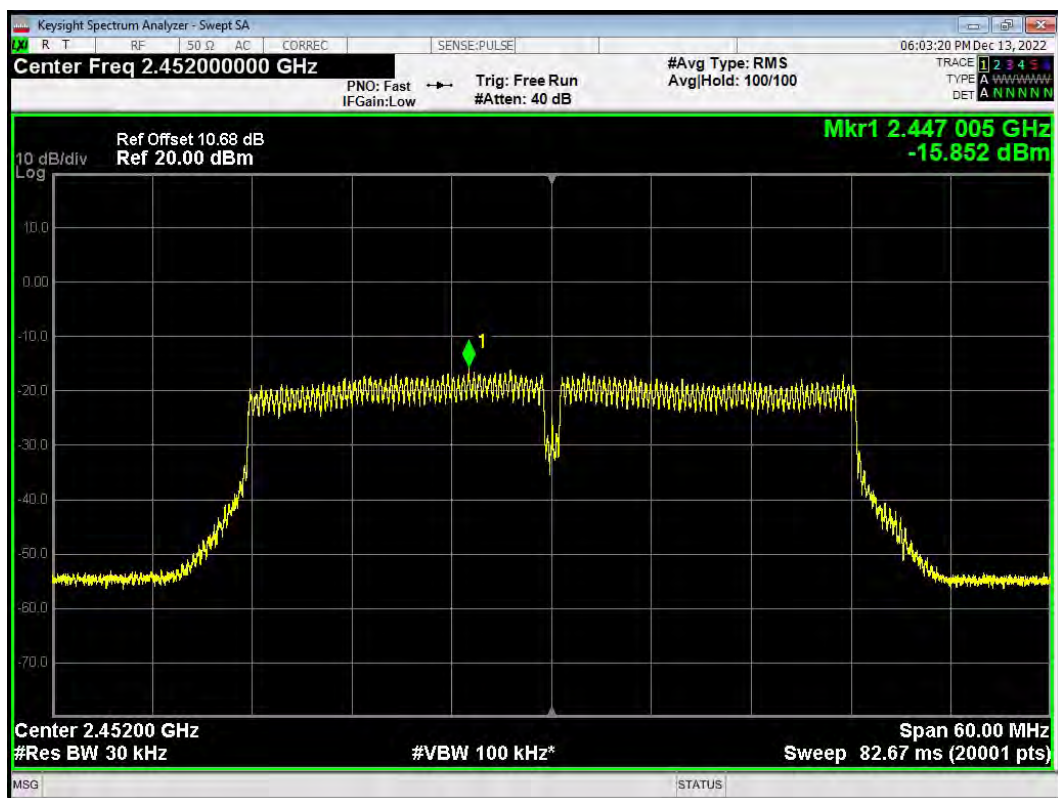
PSD BLE(1M) 2402MHz
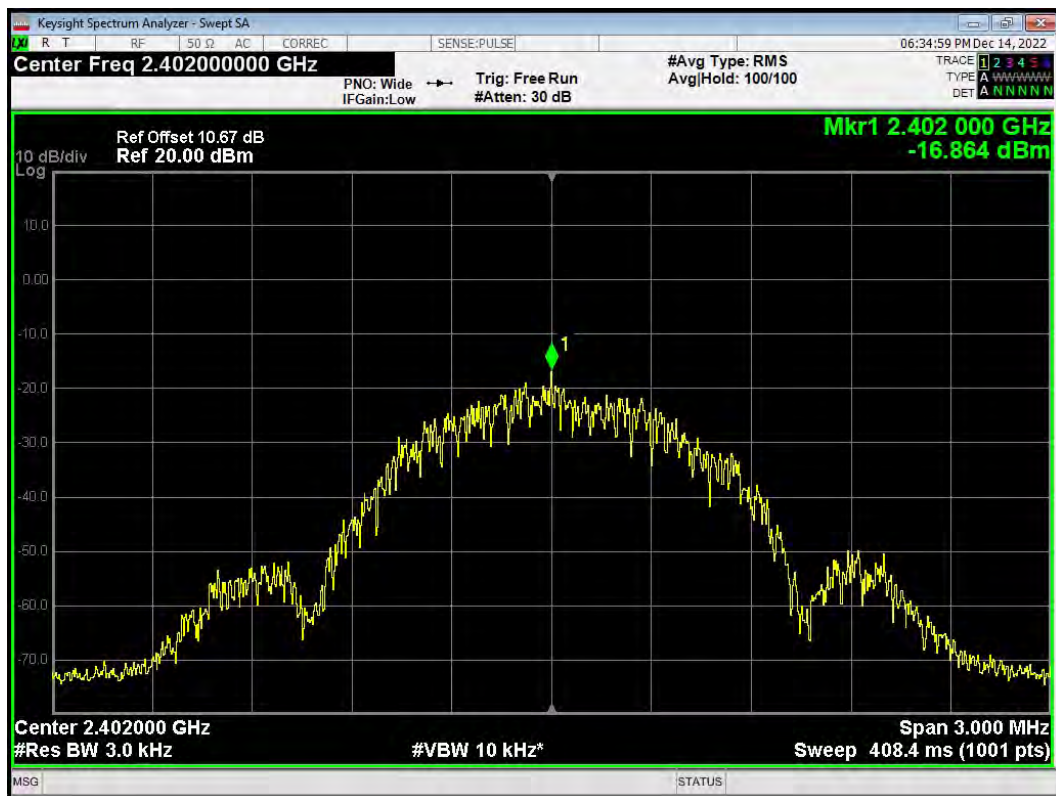
PSD BLE(1M) 2440MHz

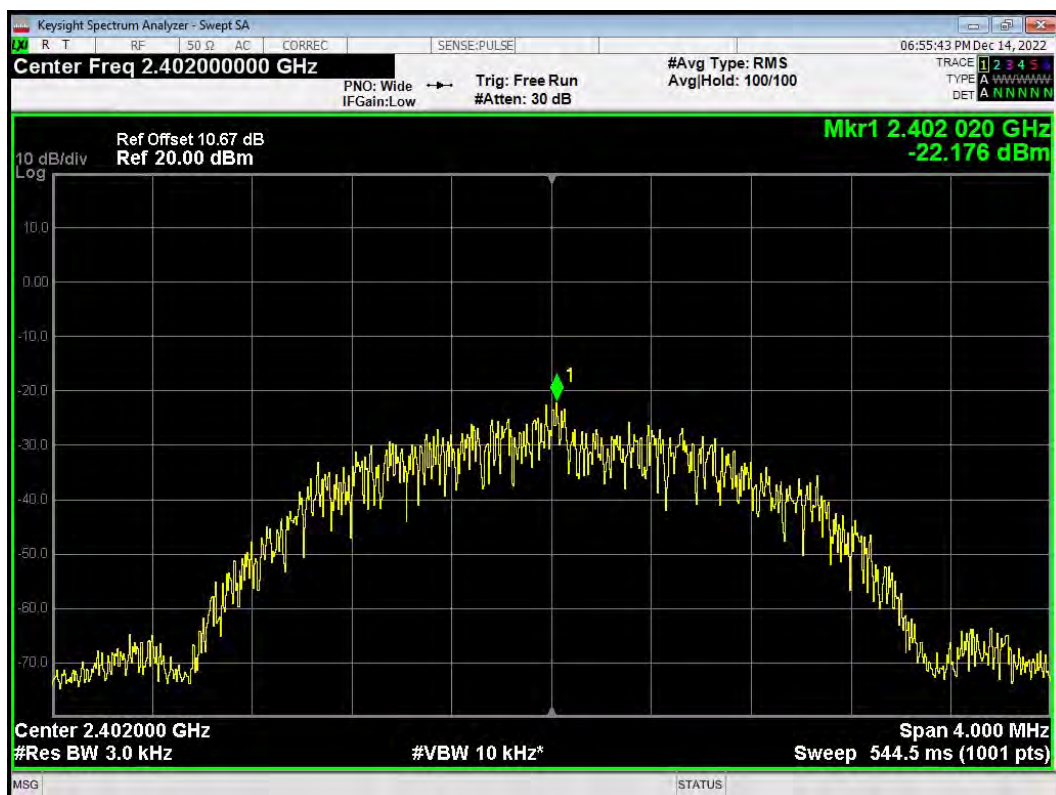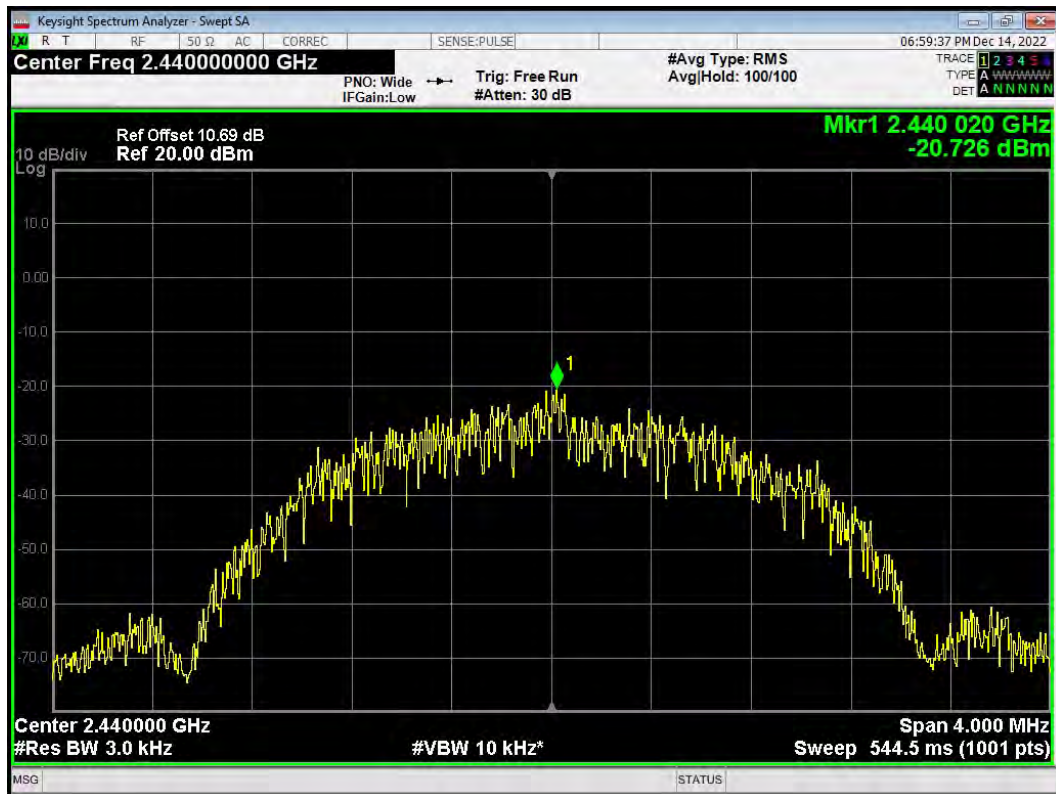## PSD BLE(1M) 2480MHz

PSD BLE(2M) 2402MHz

PSD BLE(2M) 2440MHz

PSD BLE(2M) 2480MHz