



RF TEST REPORT

Applicant Espressif Systems (Shanghai)Co.,Ltd.
FCC ID 2AC7Z-ESPC3MINII
Product Wi-Fi & Bluetooth Internet of Things Module
Brand ESPRESSIF
Model ESP32-C3-MINI-1U
Report No. R2107A0598-R1
Issue Date April 19, 2022

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C (2021)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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Approved by: Kai Xu

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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: April 4, 2022 ~ April 12, 2022 and April 19, 2022			
Date of Sample Received: July14, 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.			



1. Test Laboratory

1.1. Notes of the test report

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

1.2. Test facility

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

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
Country: P. R. China
Contact: Xu Kai
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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	Espressif Systems (Shanghai) Co.,Ltd.
Applicant address	Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China
Manufacturer	Espressif Systems (Shanghai) Co.,Ltd.
Manufacturer address	Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China

2.2. General information

EUT Description	
Model	ESP32-C3-MINI-1U
Lab internal SN	R2107A0598/S01
Hardware Version	V1.2
Software Version	V1.1.3.0
Power Supply	External power supply
Antenna Type	External Antenna
Antenna Connector	IPEX (meet with the standard FCC Part 15.203 requirement)
Antenna Gain	2.33dBi
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. Conducted Power	Wi-Fi 2.4G: 18.01dBm Bluetooth LE: 7.03dBm
Note: 1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.	



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 (2021) 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

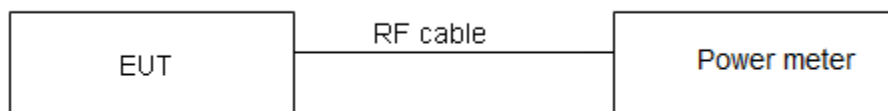
Ambient condition

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	$\leq 1W$ (30dBm)
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Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U = 0.44$ dB.

Test Results

Power Index					
Channel	802.11b	802.11g	802.11n HT20	Channel	802.11n HT40
CH1	4	24	28	CH3	28
CH2	/	8	8	CH4	20
CH3	/	8	0	CH5	12
CH4	/	0	0	CH6	0
CH6	4	0	0	CH7	16
CH8	/	0	4	CH8	24
CH9	/	12	8	CH9	32
CH10	/	12	28	/	/
CH11	4	30	28	/	/

Test Mode	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
802.11b	1.00	1.00	1.00	0.00
802.11g	1.00	1.00	1.00	0.00
802.11n HT20	1.00	1.00	1.00	0.00
802.11n HT40	2.46	2.50	0.98	0.00
Bluetooth LE (1M)	2.10	2.50	0.84	0.76
Bluetooth LE (2M)	1.06	1.87	0.57	2.47

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	17.65	17.65	30	PASS
	2437/CH 6	17.58	17.58	30	PASS
	2462/CH11	17.93	17.93	30	PASS
802.11g	2412/CH 1	11.89	11.89	30	PASS
	2417/CH 2	15.85	15.85	30	PASS
	2422/CH 3	15.97	15.97	30	PASS
	2427/CH 4	18.01	18.01	30	PASS
	2437/CH 6	17.68	17.68	30	PASS
	2447/CH 8	17.89	17.89	30	PASS



	2452/CH 9	15.50	15.50	30	PASS
	2457/CH 10	15.58	15.58	30	PASS
	2462/CH11	10.80	10.80	30	PASS
802.11n HT20	2412/CH 1	9.92	9.92	30	PASS
	2417/CH 2	15.09	15.09	30	PASS
	2422/CH 3	16.77	16.77	30	PASS
	2437/CH 6	16.80	16.80	30	PASS
	2447/CH 8	16.91	16.91	30	PASS
	2452/CH 9	16.15	16.15	30	PASS
	2457/CH 10	15.49	15.49	30	PASS
	2462/CH11	10.33	10.33	30	PASS
802.11n HT40	2422/CH3	9.14	9.14	30	PASS
	2427/CH4	11.22	11.22	30	PASS
	2432/CH5	13.23	13.23	30	PASS
	2437/CH6	16.14	16.14	30	PASS
	2442/CH7	12.14	12.14	30	PASS
	2447/CH8	10.39	10.39	30	PASS
	2452/CH9	8.39	8.39	30	PASS
Bluetooth (Low Energy) (1M)	2402/CH0	6.09	6.85	30	PASS
	2440/CH19	6.13	6.89	30	PASS
	2480/CH39	6.27	7.03	30	PASS
Bluetooth (Low Energy) (2M)	2402/CH0	3.92	6.39	30	PASS
	2440/CH19	4.22	6.69	30	PASS
	2480/CH39	4.47	6.94	30	PASS

Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor

5.2. 99% Bandwidth and 6dB Bandwidth

Ambient condition

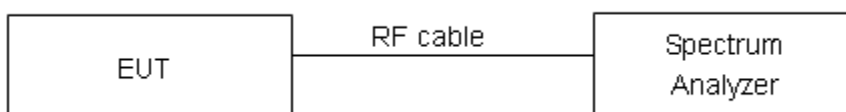
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

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
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Measurement Uncertainty

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

Test Results:

Test Mode	Carrier frequency (MHz)	99% bandwidth (MHz)	Minimum 6 dB bandwidth (MHz)	Limit (kHz)	Conclusion
802.11b	2412	12.996	8.60	500	PASS
	2437	13.047	9.02	500	PASS
	2462	13.002	9.54	500	PASS
802.11g	2412	16.720	16.35	500	PASS
	2417	16.720	16.35	500	PASS
	2422	16.726	16.37	500	PASS
	2427	16.753	16.57	500	PASS
	2437	16.814	16.38	500	PASS
	2447	16.755	16.54	500	PASS
	2452	16.717	16.34	500	PASS
	2457	16.735	16.36	500	PASS
	2462	16.703	16.38	500	PASS
802.11n HT20	2412	17.871	17.61	500	PASS
	2417	17.867	17.67	500	PASS
	2422	17.900	17.56	500	PASS
	2437	17.909	17.56	500	PASS
	2447	17.912	17.60	500	PASS
	2452	17.882	17.60	500	PASS
	2457	17.867	17.59	500	PASS
	2462	17.888	17.59	500	PASS
802.11n HT40	2422	35.189	32.61	500	PASS
	2427	35.233	32.56	500	PASS
	2432	35.195	32.64	500	PASS
	2437	35.188	32.93	500	PASS
	2442	35.179	32.64	500	PASS
	2447	35.190	32.60	500	PASS



	2452	35.194	33.77	500	PASS
Bluetooth (Low Energy) (1M)	2402	1.035	0.65	500	PASS
	2440	1.035	0.63	500	PASS
	2480	1.031	0.64	500	PASS
Bluetooth (Low Energy) (2M)	2402	2.030	1.08	500	PASS
	2440	2.044	1.13	500	PASS
	2480	2.048	1.057	500	PASS

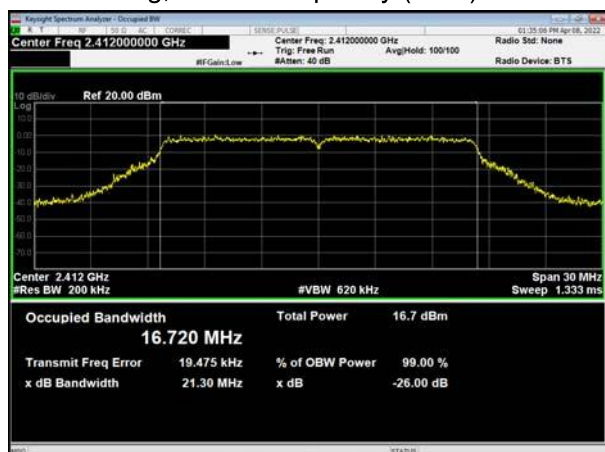


99%bandwidth

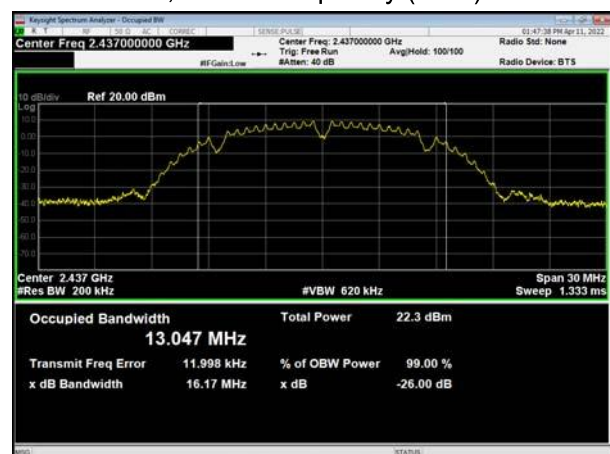
802.11b, Carrier frequency (MHz): 2412



802.11g, Carrier frequency (MHz): 2412



802.11b, Carrier frequency (MHz): 2437



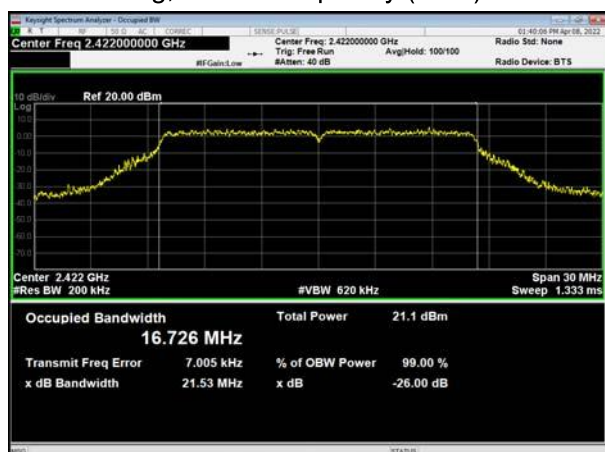
802.11g, Carrier frequency (MHz): 2417



802.11b, Carrier frequency (MHz): 2462



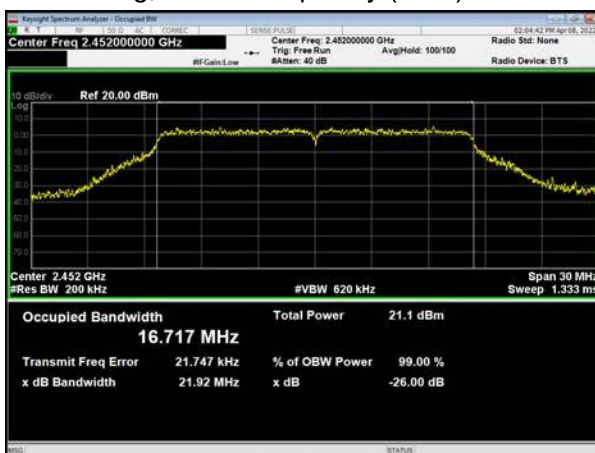
802.11g, Carrier frequency (MHz): 2422



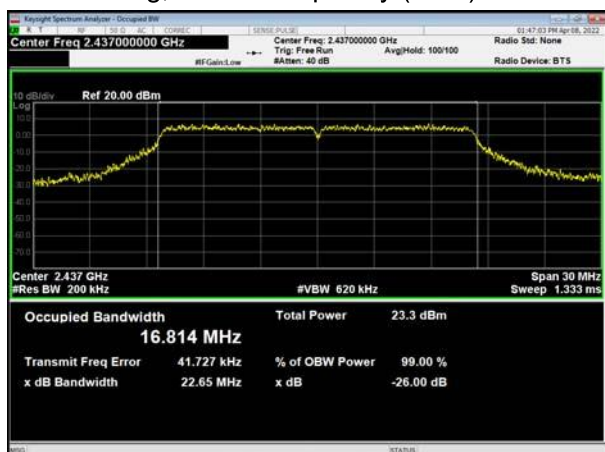
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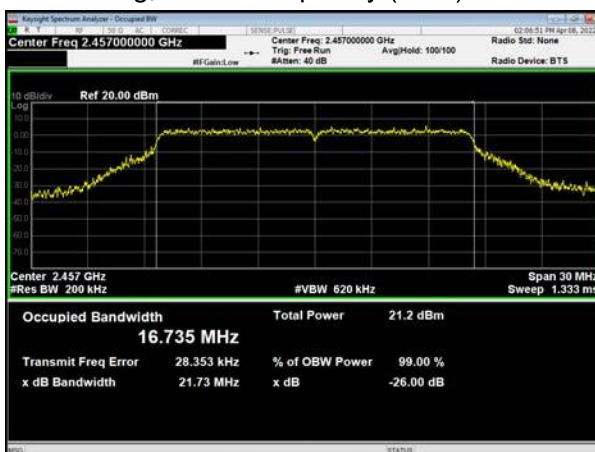
802.11g, Carrier frequency (MHz): 2452



802.11g, Carrier frequency (MHz): 2437



802.11g, Carrier frequency (MHz): 2457



802.11g, Carrier frequency (MHz): 2447



802.11g, Carrier frequency (MHz): 2462



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



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



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



802.11n(HT20), Carrier frequency (MHz): 2447



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



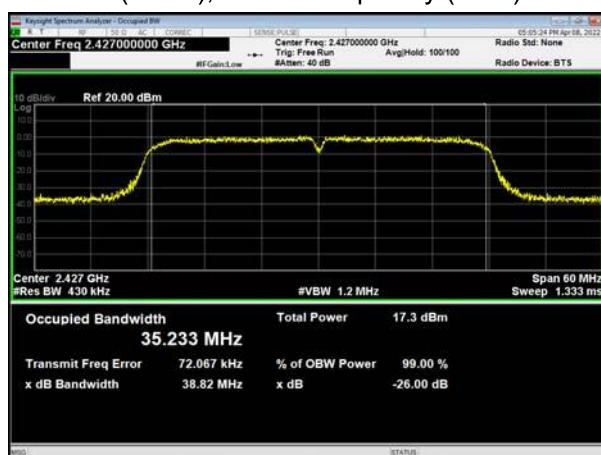
802.11n(HT20), Carrier frequency (MHz): 2452



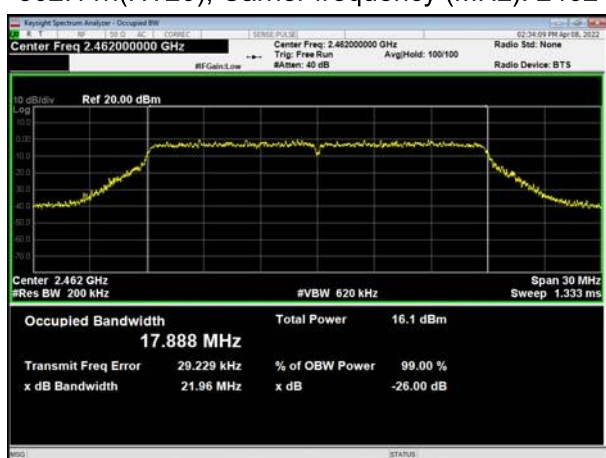
802.11n(HT20), Carrier frequency (MHz): 2457



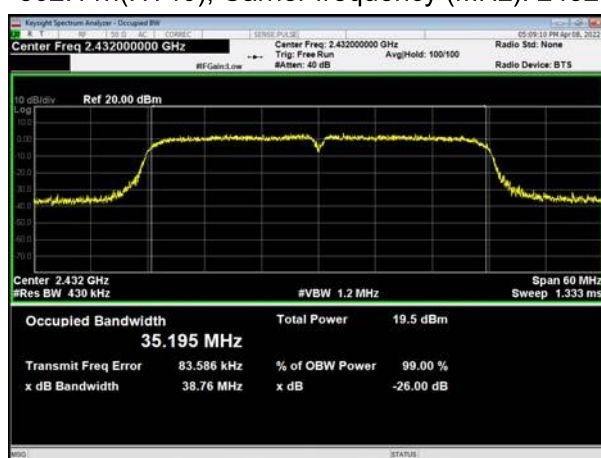
802.11n(HT40), Carrier frequency (MHz): 2427



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



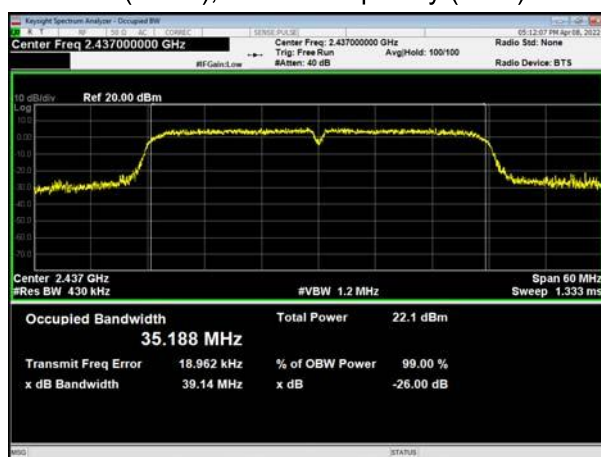
802.11n(HT40), Carrier frequency (MHz): 2432



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



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



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

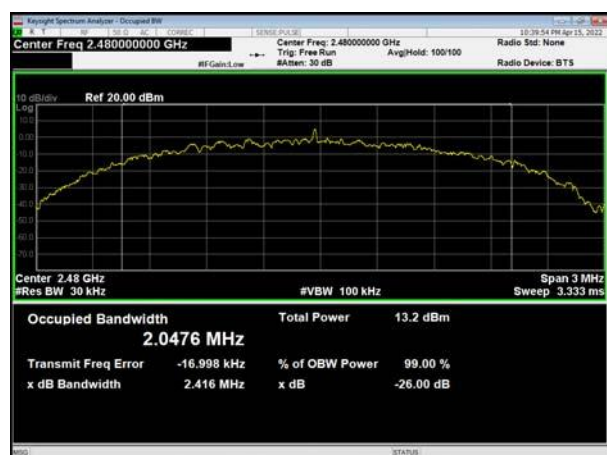


802.11n(HT40), Carrier frequency (MHz): 2447



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



Bluetooth LE (1M) Carrier frequency (MHz):
2402Bluetooth LE (2M) Carrier frequency (MHz):
2402Bluetooth LE (1M) Carrier frequency (MHz):
2440Bluetooth LE (2M) Carrier frequency (MHz):
2440Bluetooth LE (1M) Carrier frequency (MHz):
2480Bluetooth LE (2M) Carrier frequency (MHz):
2480

6 dB bandwidth

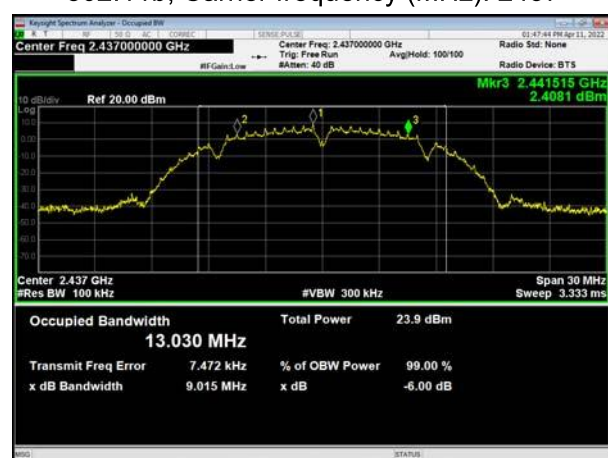
802.11b, Carrier frequency (MHz): 2412



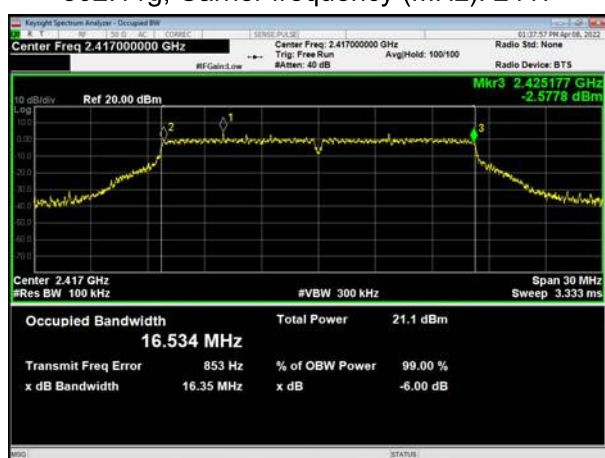
802.11g, Carrier frequency (MHz): 2412



802.11b, Carrier frequency (MHz): 2437



802.11g, Carrier frequency (MHz): 2417



802.11b, Carrier frequency (MHz): 2462



802.11g, Carrier frequency (MHz): 2422



802.11g, Carrier frequency (MHz): 2427



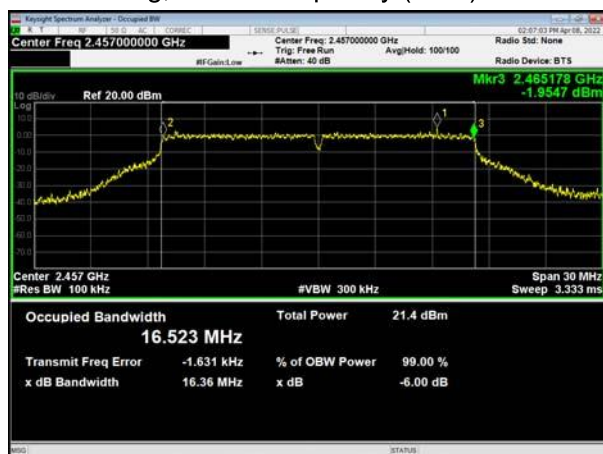
802.11g, Carrier frequency (MHz): 2452



802.11g, Carrier frequency (MHz): 2437



802.11g, Carrier frequency (MHz): 2457



802.11g, Carrier frequency (MHz): 2447



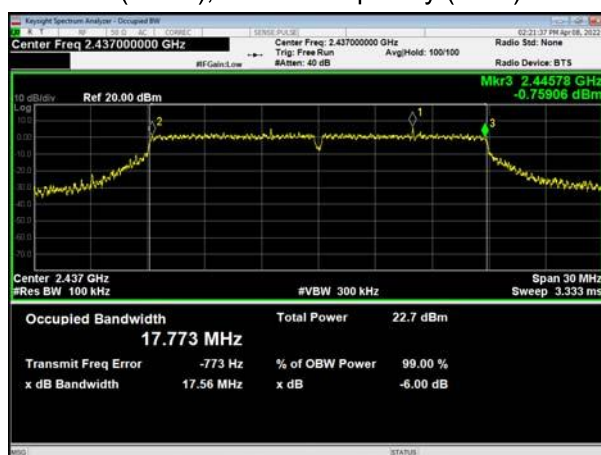
802.11g, Carrier frequency (MHz): 2462



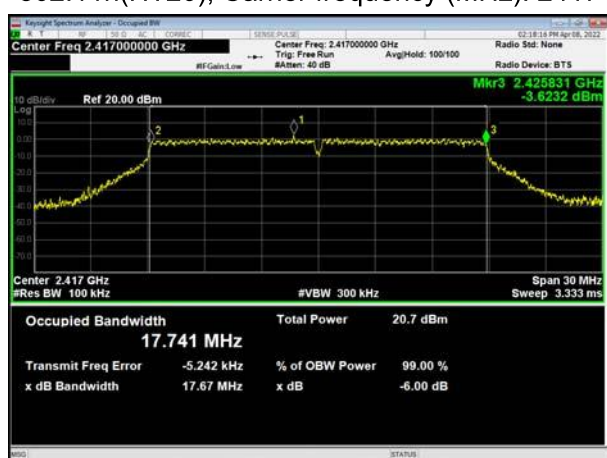
802.11n(HT20), Carrier frequency (MHz): 2412



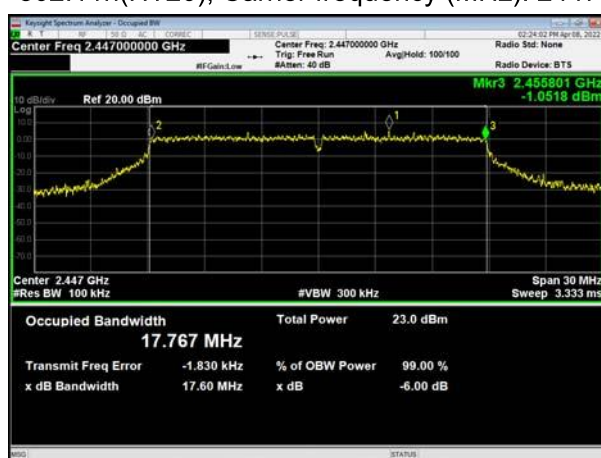
802.11n(HT20), Carrier frequency (MHz): 2437



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



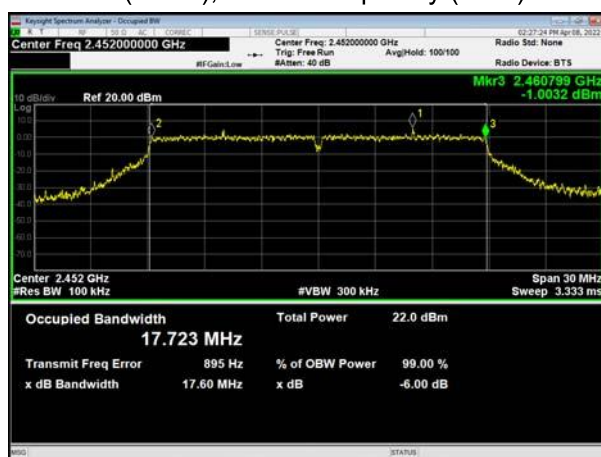
802.11n(HT20), Carrier frequency (MHz): 2447



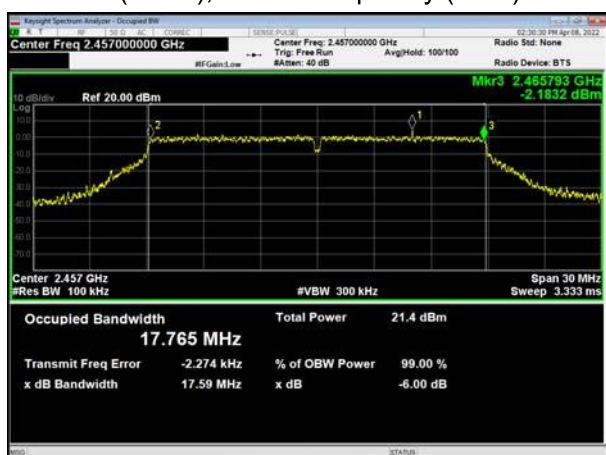
802.11n(HT20), Carrier frequency (MHz): 2422



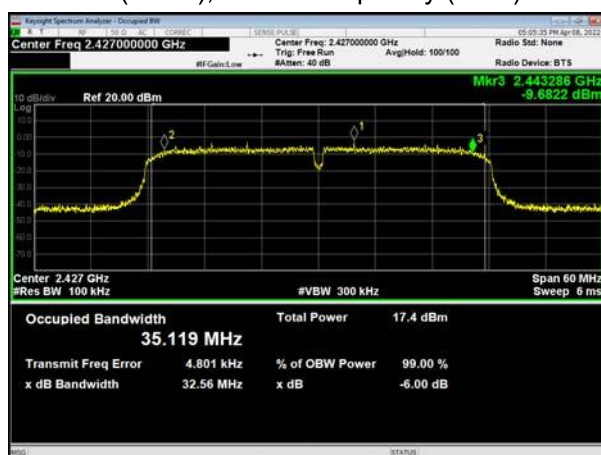
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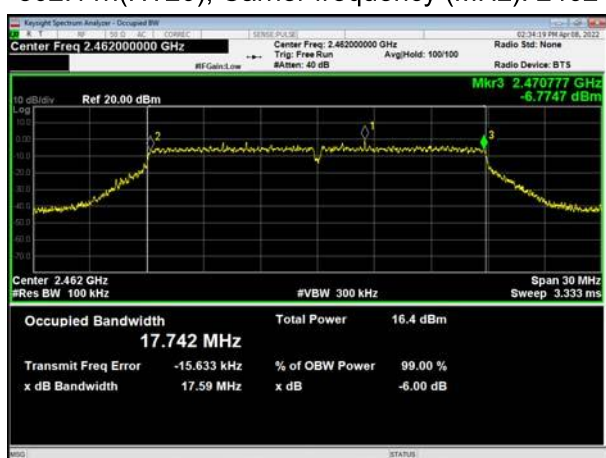
802.11n(HT20), Carrier frequency (MHz): 2457



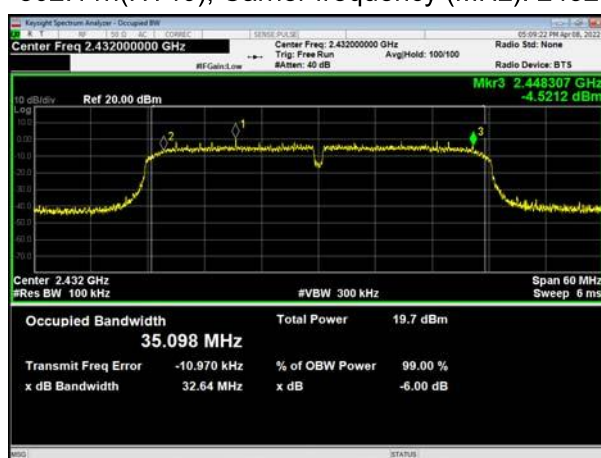
802.11n(HT40), Carrier frequency (MHz): 2427



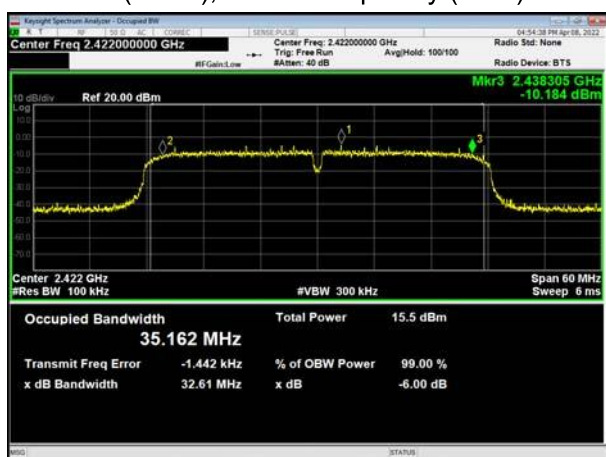
802.11n(HT20), Carrier frequency (MHz): 2462



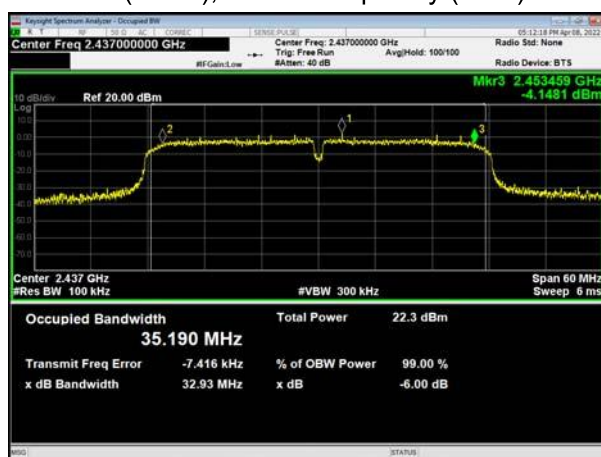
802.11n(HT40), Carrier frequency (MHz): 2432



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



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



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



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



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



Bluetooth LE (1M) Carrier frequency (MHz): 2402



Bluetooth LE (2M) Carrier frequency (MHz): 2402



Bluetooth LE (1M) Carrier frequency (MHz): 2440



Bluetooth LE (2M) Carrier frequency (MHz): 2440



Bluetooth LE (1M) Carrier frequency (MHz): 2480



Bluetooth LE (2M) Carrier frequency (MHz): 2480



5.3. Band Edge

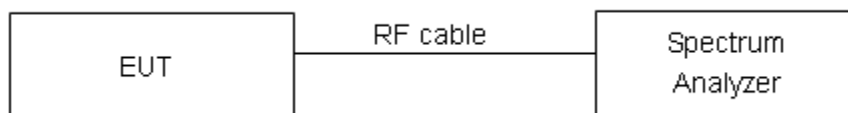
Ambient condition

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

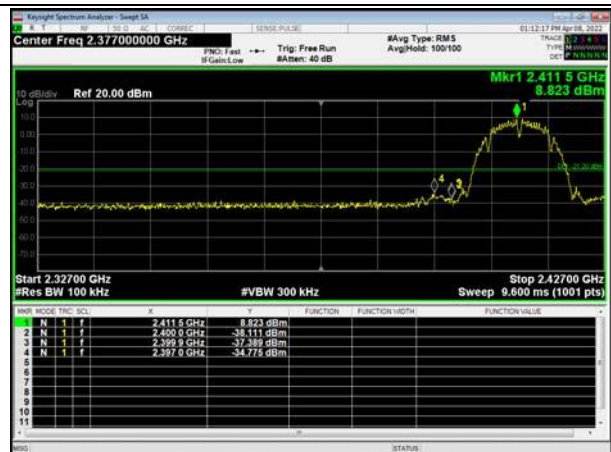
The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$.

Frequency	Uncertainty
2GHz-3GHz	1.407 dB

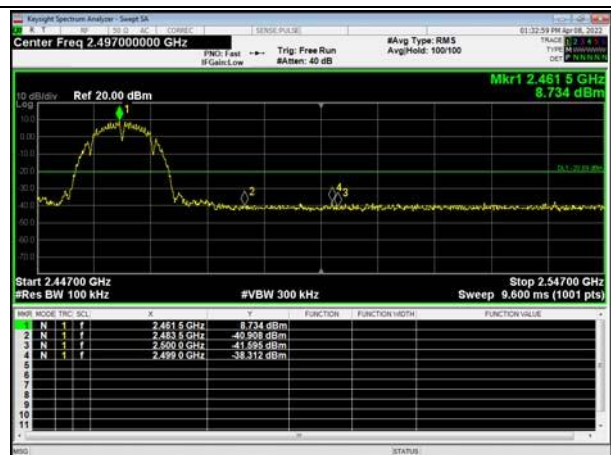


Test Results: PASS

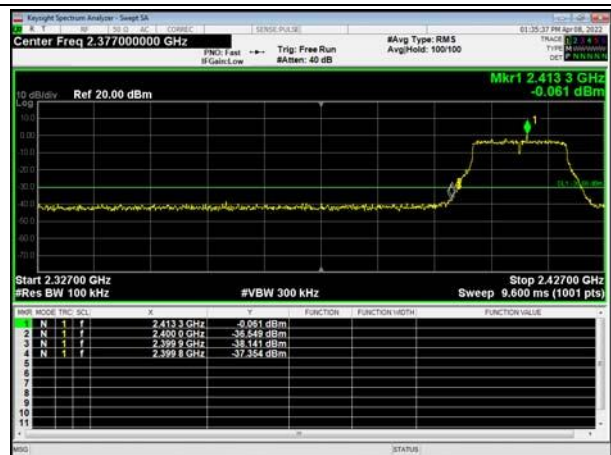
802.11b, Channel No.: 1



802.11b, Channel No.: 11

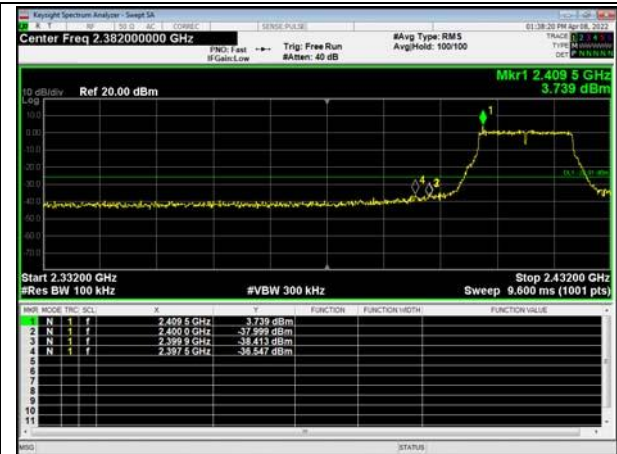


802.11g, Channel No.: 1

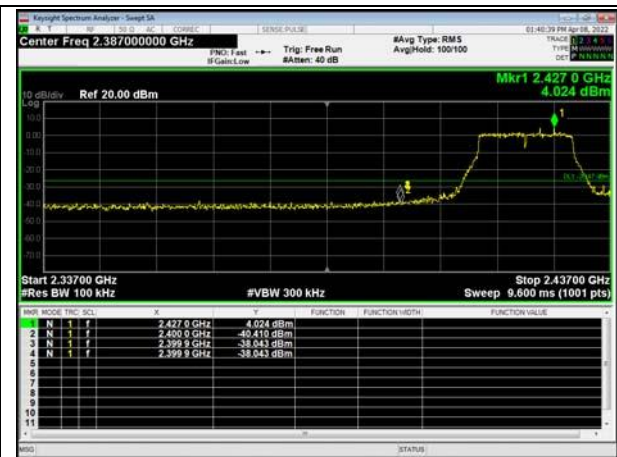




802.11g, Channel No.: 2



802.11g, Channel No.: 3



802.11g, Channel No.: 4





802.11g, Channel No.: 8



802.11g, Channel No.: 9

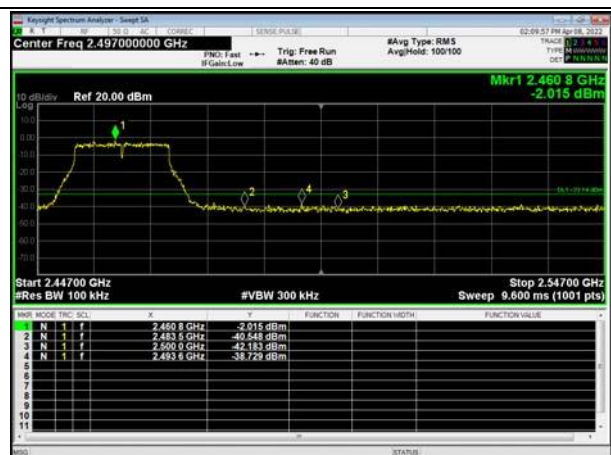


802.11g, Channel No.: 10

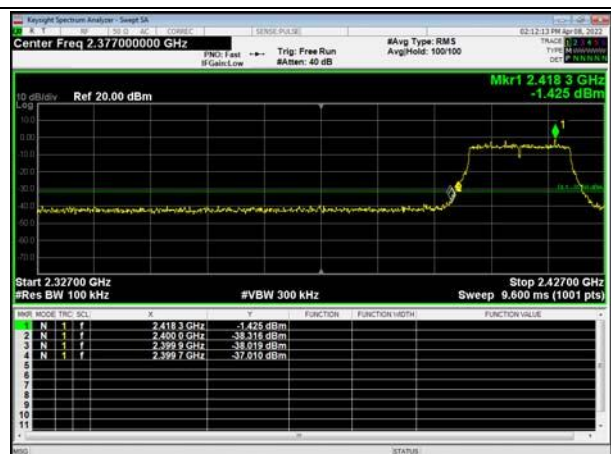




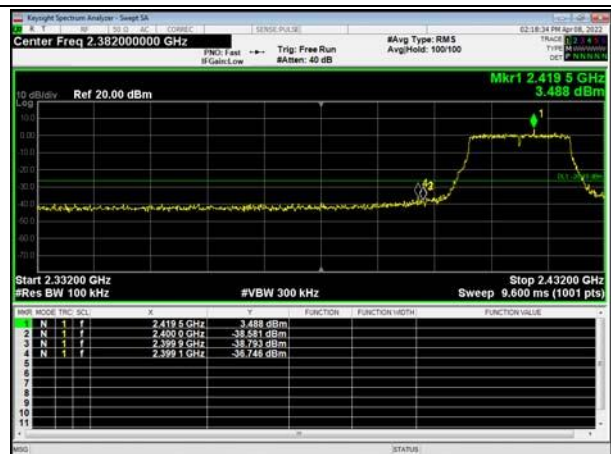
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802.11n(HT20), Channel No. 1



802.11n(HT20), Channel No. 2

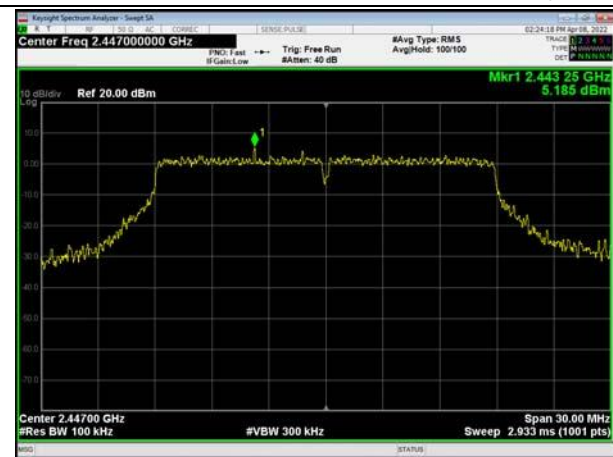




802.11n(HT20), Channel No. 3



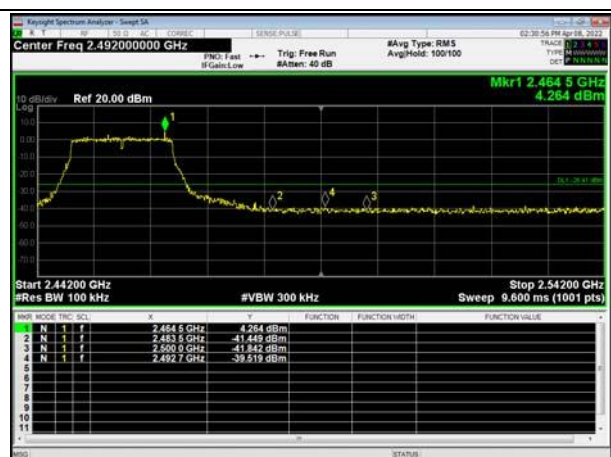
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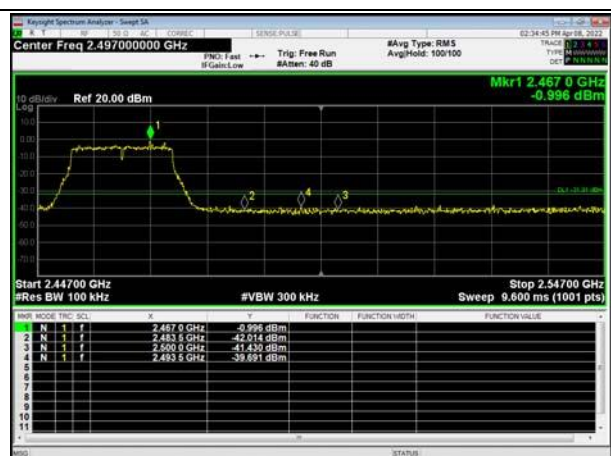
802.11n(HT20), Channel No. 9



802.11n(HT20), Channel No. 10



802.11n(HT20), Channel No. 11



802.11n(HT40), Channel No. 3

