

# ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



**Applicant:** Murata Electronics North America  
2200 Lake Park Drive Smyrna Georgia United States 30080-7604

**Manufacturer:** Murata Electronics North America  
2200 Lake Park Drive Smyrna Georgia United States 30080-7604

**Product Name:** LBES0ZZ2FR

**Brand Name:** Murata Electronics North America

**Model No./ISED HVIN:** LBES0ZZ2FR

**Report Number:** TERF2312003243E2

**FCC ID** HSW2FR

**IC:** 4492A-2FR

**Date of EUT Received:** Dec. 29, 2023

**Date of Test:** Dec. 29, 2023 ~ Jun. 26, 2024

**Issue Date:** Aug. 13, 2024

Approved By

Arno Hsieh

Arno Hsieh

## We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.247, ISED RSS-247.

The results of this report relate only to the sample identified in this report.

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## Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2312003243E2	00	Original.	Aug. 13, 2024	Yami Kuo	

**Note:**

- 1、The remark "\*" indicates modification of the report upon requests from certification body.

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## 1 GENERAL INFORMATION

### 1.1 Product Description

Product Name:	LBES0ZZ2FR
Brand Name:	Murata Electronics North America
Model No./ISED HVIN:	LBES0ZZ2FR
Hardware Version:	1
Firmware Version:	1
EUT Series No.:	NO.2-1
Power Supply:	3.3Vdc, 1.8Vdc
Test Software (Name/Version)	DutApiSisoApApp_RW610

### 1.2 RF Specification

#### WLAN 2.4GHz

Wi-Fi	Frequency Range	Channels	Rated Power (dBm)		Modulation Technology
			Peak	Avg.	
802.11b	2412~2462	11	22.24	19.89	DSSS
802.11g	2412~2462	11	23.65	19.73	OFDM
802.11n_HT20	2412~2462	11	23.81	19.99	OFDM
802.11ax_HE20	2412~2462	11	23.80	19.94	OFDMA
Modulation type:		CCK, DQPSK, DBPSK for DSSS in 802.11b			
		64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11g, 11n			
		256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11ac			
		1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDMA in 802.11ax			
Data Rate:		802.11b: 1/2/5.5/11 Mbps			
		802.11g: 6/9/12/18/24/36/48/54 Mbps			
		802.11n_HT20: up to 72.2Mbps			
		802.11ax_HE20: up to 143.4Mbps			

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### WLAN 2.4GHz for IC

Wi-Fi	Frequency Range	Channels	Rated Power (dBm)		Rated Power in dBm (EIRP)	Modulation Technology
			Peak	Avg.		
802.11b	2412~2462	11	22.24	19.89	23.09	DSSS
802.11g	2412~2462	11	23.65	19.73	22.93	OFDM
802.11n_HT20	2412~2462	11	23.81	19.99	23.19	OFDM
802.11ax_HE20	2412~2462	11	23.80	19.94	23.14	OFDMA
Modulation type:		CCK, DQPSK, DBPSK for DSSS in 802.11b				
		64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11g,11n				
		256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11ac				
		1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDMA in 802.11ax				
Data Rate:		802.11b: 1/2/5.5/11 Mbps				
		802.11g: 6/9/12/18/24/36/48/54 Mbps				
		802.11n_HT20:up to 72.2Mbps				
		802.11ax_HE20:up to 143.4Mbps				

### 1.3 Antenna Designation

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
PCB Monopole	Murata	Type2FR	2400-2500	2.6
Flex Dipole	Molex	146153	2400-2500	3.2

#### Note:

1. Pre-scanned was done on the above antennas, measurements were demonstrated by using the antenna with the highest gain as the worst case scenarios.
2. Antenna information is provided by the applicant.

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## 1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

RSS-247 issue 3 Aug. 2023

RSS-Gen, Issue 5 April 2018, Amendment 2 (February 2021)

ANSI C63.10:2013

## 1.5 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designa- tion number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 2		
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction C	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
Conducted G				

**Note:** Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

## 1.6 Special Accessories

There are no special accessories used while test was conducted.

## 1.7 Equipment Modifications

There was no modification incorporated into the EUT.

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## 2 SYSTEM TEST CONFIGURATION

### 2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

### 2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

### 2.3 Test Procedure

#### 2.3.1 Conducted Emissions

The EUT is placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

#### 2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

#### 2.3.3 Radiated Emissions

The EUT is placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

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## 2.4 Measurement Results Explanation Example

### 2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

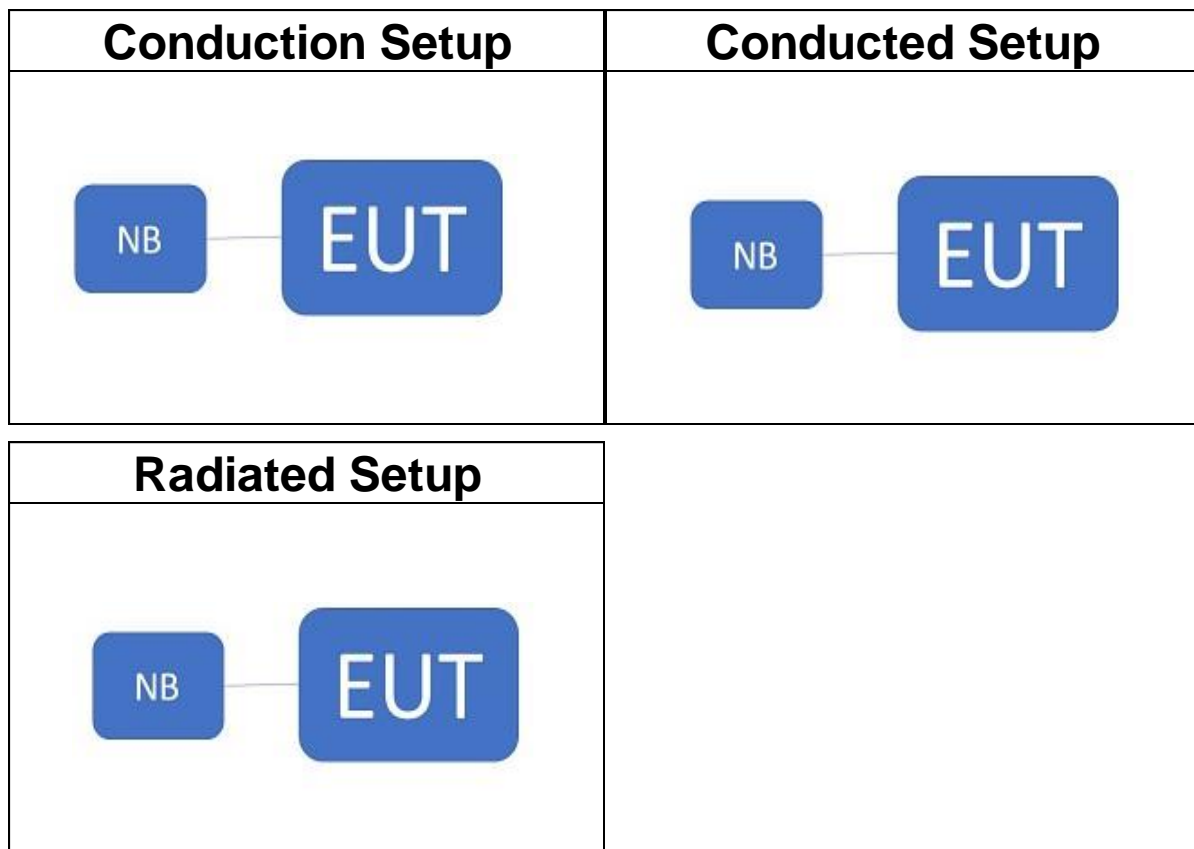
Radiated emission below 30MHz is measured in a 9m\*6m\*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

### 2.4.2 For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

## 2.5 Test Configuration



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## 2.6 Control Unit(s)

AC Power-Line Conducted Emission Test Site: Conduction C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Notebook	Lenovo	L480	P0002332	N/A	N/A
USB Cable	PowerSync	CUBCVARA0010	N/A	N/A	N/A

Conducted Emission Test Site: Conducted D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Notebook	Lenovo	T14	P0003332	N/A	N/A
USB Cable	PowerSync	CUBCVARA0010	N/A	N/A	N/A

Radiated Emission Test Site: SAC D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
USB Cable	PowerSync	CUBCVARA0010	N/A	N/A	N/A

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### 3 SUMMARY OF TEST RESULTS

FCC Rules	ISED Rules	Description Of Test	Result
§15.207(a)	RSS-Gen §8.8	AC Power Line Conducted Emission	Compliant
§15.247(b)(3)	RSS-247 §5.4 d	Peak Output Power	Compliant
§15.247(a)(2)	RSS-247 §5.2 a RSS-Gen §6.7	Emission Bandwidth	Compliant
§15.209 §15.247(d)	RSS-247 §5.5	Conducted Band Edge and Spurious Emission	Compliant
§15.209 §15.247(d)	RSS-247 §5.5	Radiated Band Edge and Spurious Emission	Compliant
§15.205	RSS-Gen § 8.10	Restricted Bands	Compliant
§15.247(e)	RSS-247 §5.2 b	Power Spectral Density	Compliant
§15.203	N/A	Antenna Requirement	Compliant

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## 4 DESCRIPTION OF TEST MODES

### 4.1 Operating Frequencies

2400~2483.5 MHz	
20MHz	
CH	Freq. (MHz)
1	2412
2	2417
3	2422
4	2427
5	2432
6	2437
7	2442
8	2447
9	2452
10	2457
11	2462

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## 4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3. Investigation has been done on all the possible configurations for searching the worst case.

The given UE is pre-scanned among below modes.

Modulation	Transmission Chain				Single Transmission Spatial	Multiple Transmission Spatial
<input checked="" type="checkbox"/> 802.11 b	<input checked="" type="checkbox"/> Ch0	<input type="checkbox"/> Ch1	<input type="checkbox"/> Ch2	<input type="checkbox"/> Ch3	<input checked="" type="checkbox"/> 1TX	<input type="checkbox"/> 2TX
<input checked="" type="checkbox"/> 802.11 g	<input checked="" type="checkbox"/> Ch0	<input type="checkbox"/> Ch1	<input type="checkbox"/> Ch2	<input type="checkbox"/> Ch3	<input checked="" type="checkbox"/> 1TX	<input type="checkbox"/> 2TX
<input checked="" type="checkbox"/> 802.11 n	<input checked="" type="checkbox"/> Ch0	<input type="checkbox"/> Ch1	<input type="checkbox"/> Ch2	<input type="checkbox"/> Ch3	<input checked="" type="checkbox"/> 1TX	<input type="checkbox"/> MIMO
<input checked="" type="checkbox"/> 802.11 ax	<input checked="" type="checkbox"/> Ch0	<input type="checkbox"/> Ch1	<input type="checkbox"/> Ch2	<input type="checkbox"/> Ch3	<input checked="" type="checkbox"/> 1TX	<input type="checkbox"/> MIMO

4. Therefore, below summary is the modes of test configuration that yield the highest reading and generate the highest emission chosen to carry out the relevantly mandatory test items.

CONDUCTED TEST					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11b	1 to 11	1,6,11	DSSS	1	ch0
802.11g	1 to 11	1,6,11	OFDM	6	ch0
802.11n_HT20	1 to 11	1,6,11	OFDM	MCS0	ch0

CONDUCTED TEST						
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	RU CONFIGURATION	DATA RATE (Mbps)	ANTENNA PORT
802.11ax_HE20	1 to 11	1,6,11	OFDMA	FULL RU 26/0,26/8 52/37,52/40 106/53,106/54	MCS0	ch0

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TRANSMIT RADIATED EMISSION TEST (BELOW 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11g	1 to 11	6	OFDM	6	ch0

TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)					
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11b	1 to 11	1,2,3,6,9,10,11	DSSS	1	ch0
802.11g	1 to 11	1,2,3,4,5,6,7,8,9,10,11	OFDM	6	ch0
802.11n_HT20	1 to 11	1,2,3,4,6,7,8,9,10,11	OFDM	MCS0	ch0

TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)						
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	RU CONFIGURATION	DATA RATE (Mbps)	ANTENNA PORT
802.11ax_HE20	1 to 11	1,2,3,4,6,7,8,9,10,11	OFDMA	FULL RU 26/0,26/8 52/37,52/40 106/53,106/54	MCS0	ch0

#### Note:

The field strength of radiated emission was measured as the EUT positioned in different orthogonal planes (E1/E2/H) based on actual usage of the EUT to pre-scan the emissions for determining the worst case scenario.

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## 5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 1.54 dB
Output Power measurement	+/- 0.97 dB
Emission Bandwidth	+/- 1.38 Hz
Conducted emission measurement	+/- 0.77 dB
Peak Power Density	+/- 0.61 dB
Temperature	+/- 0.6 °C
Humidity	+/- 3 %
DC / AC Power Source	+/- 1 %

Radiated Spurious Emission Measurement Uncertainty			
Polarization: Vertical	+/-	1.89 dB	9kHz~30MHz
	+/-	4.15 dB	30MHz - 1000MHz
	+/-	3.43 dB	1GHz - 18GHz
	+/-	3.86 dB	18GHz - 40GHz
Polarization: Horizontal	+/-	1.89 dB	9kHz~30MHz
	+/-	4.02 dB	30MHz - 1000MHz
	+/-	3.43 dB	1GHz - 18GHz
	+/-	3.86 dB	18GHz - 40GHz
Radiated Spurious Emission	+/-	2 dB	33GHz-50GHz
	+/-	1.59 dB	50GHz-60GHz
	+/-	1.7 dB	60GHz-90GHz
	+/-	1.64 dB	90GHz-140GHz
	+/-	3.83 dB	140GHz-220GHz

### Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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## 6 MEASUREMENT EQUIPMENT USED

### 6.1 Emission from AC power line

AC Power-Line Conducted Emission Test Site: Conduction C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
LISN	SCHWARZBECK Mess-Elektronik	NSLK8127	974	06/19/2023	06/18/2024
EMI Test Receiver	R&S	ESCI	101342	04/24/2023	04/23/2024
Coaxial Cable	EC Lab	RF-HY-CAB-250	RF-HY-CAB-250-01	03/27/2023	03/26/2024
Pulse Limiter	EC Lab	VTSD 9561F-N	485	03/27/2023	03/26/2024
Test Software	audix	e3	E3 20923 SGS Ver.9 ( C )	N.C.R	N.C.R

### 6.2 Conducted Measurement

Conducted Emission Test Site: Conducted D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010B	MY59071573	05/23/2023	05/22/2024
Spectrum Analyzer	KEYSIGHT	N9010B	MY59071573	05/24/2024	05/23/2025
Power Meter	Anritsu	ML2496A	2138005	09/25/2023	09/24/2024
Power Sensor	Anritsu	MA2411B	1911395	09/25/2023	09/24/2024
Power Sensor	Anritsu	MA2411B	1911396	09/25/2023	09/24/2024
Test Software	SGS Taiwan	Radio Test Software	Ver.21	N.C.R	N.C.R
Attenuator	Woken	WATT-218FS-10	RF18	11/15/2023	11/14/2024
Attenuator	Woken	WATT-218FS-10	RF19	11/15/2023	11/14/2024
DC Block	PASTERNAK	PE8210	RF155	11/15/2023	11/14/2024

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## 6.3 Radiated Measurement

Radiated Emission Test Site: SAC D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
3m Site NSA	SGS	966 chamber D	N/A	04/30/2024	04/29/2025
Active Loop Antenna	COM-POWER	AL-130R	10160105	12/04/2023	12/03/2024
Broadband Antenna	SCHWARZBECK	VULB 9168	9168-617	12/14/2023	12/13/2024
Coaxial Cable	Huber+Suhner	EMC106-SM-SM-7200	150703	11/15/2023	11/14/2024
Coaxial Cable	Huber+Suhner	RG 214/U	W21.01	11/15/2023	11/14/2024
Horn Antenna	Schwarzbeck	BBHA9120D	1341	05/30/2024	05/29/2025
Horn Antenna	SCHWARZBECK	BBHA9170	185	08/21/2023	08/20/2024
Pre-Amplifier	EMC Instruments	EMC12630SE	980273	11/15/2023	11/14/2024
Pre-Amplifier	EMC Instruments	EMC18405SEE	980881	11/15/2023	11/14/2024
Pre-Amplifier	EMC Instruments	EMC9135	980234	11/15/2023	11/14/2024
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120200	04/03/2024	04/02/2025
Test Software	audix	e3	E3 20923 SGS Ver.9 ( C )	N.C.R	N.C.R

**NOTE:** N.C.R refers to Not Calibrated Required.

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## 7 CONDUCTED EMISSION TEST

### 7.1 Standard Applicable

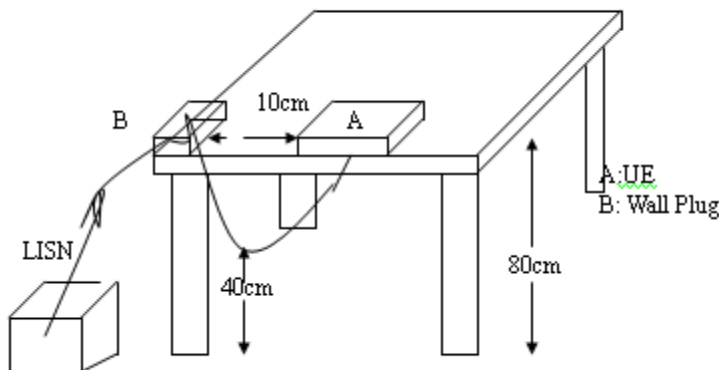
Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits (dBuV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
<b>Note</b> 1.The lower limit shall apply at the transition frequencies 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.		

### 7.2 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

### 7.3 Test Setup



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#### 7.4 Measurement Procedure

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

#### 7.5 Measurement Result

Note: Refer to next page for measurement data and plots.

Note2: The \* reveals the worst-case results that closest to the limit.

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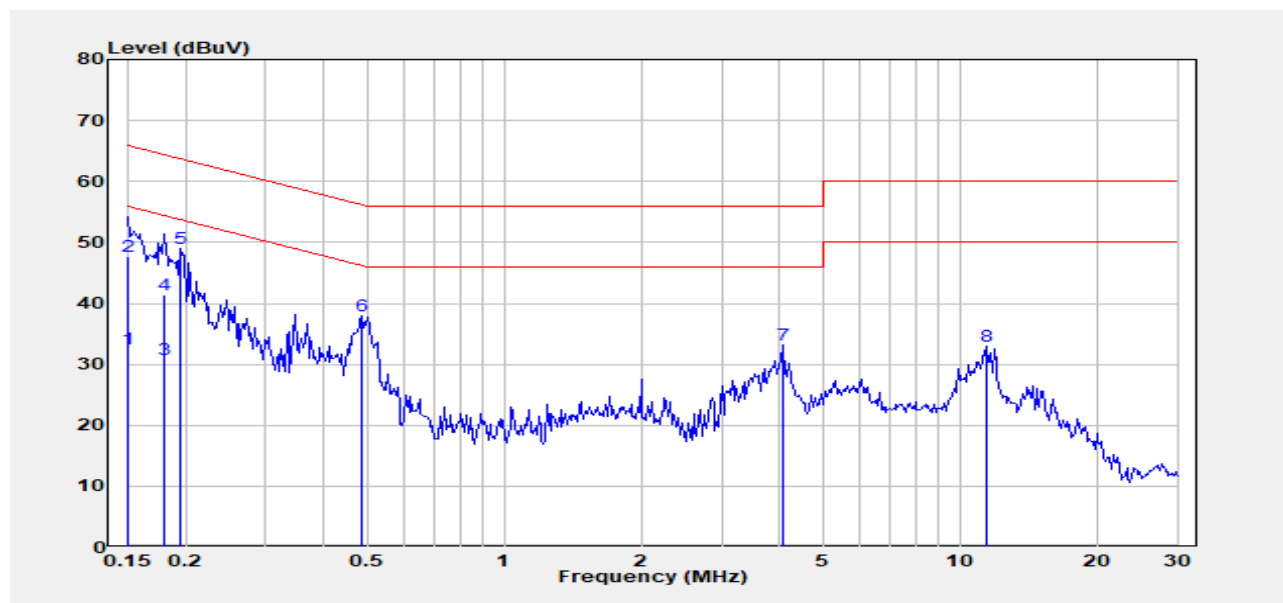
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## AC POWER LINE CONDUCTED EMISSION TEST DATA

Report Number	:TERF2312003243E2	Test Site	:Conduction C
Test Mode	:2.4G	Test Date	:2024-01-08
Power	:120V/60Hz	Temp./Humi.	:21.9°C/54%
Probe	:L1	Engineer	:Sam Huang



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
Mode		Reading Level		FS		
MHz	PK/QP/AV	dBμV	dB	dBμV	dBμV	dB
0.150	Average	21.80	10.69	32.49	56.00	-23.51
0.150	QP	37.10	10.69	47.79	66.00	-18.21
0.179	Average	20.20	10.68	30.88	54.52	-23.64
0.179	QP	30.70	10.68	41.38	64.52	-23.14
0.195	Peak	38.31	10.68	48.99	63.81	-14.82
0.488	Peak	27.23	10.63	37.86	56.20	-18.34
4.079	Peak	22.19	10.91	33.10	56.00	-22.90
11.493	Peak	21.97	11.01	32.97	60.00	-27.03

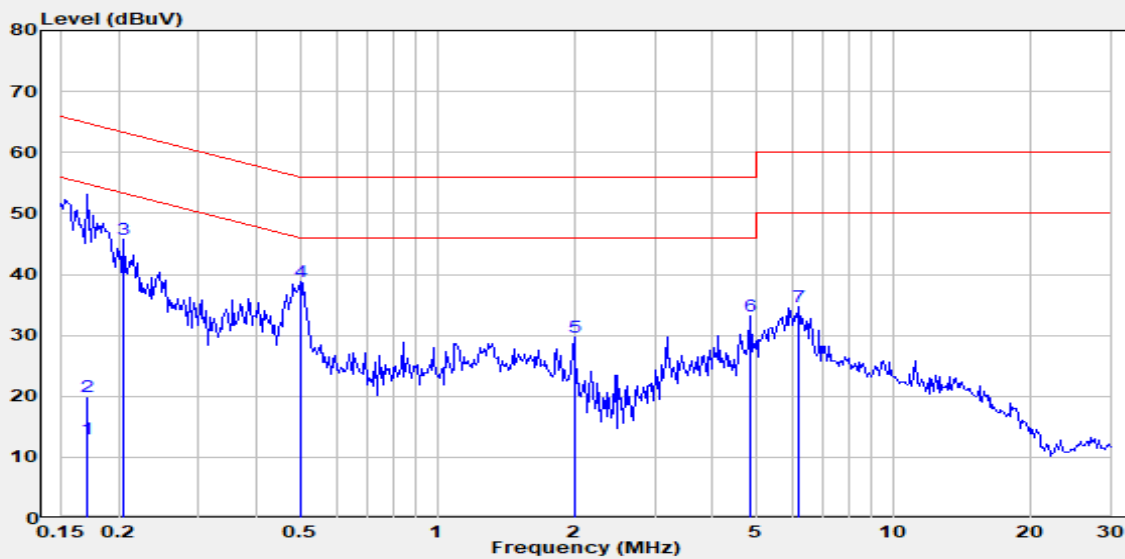
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Report Number :TERF2312003243E2  
Test Mode :2.4G  
Power :120V/60Hz  
Probe :N

Test Site :Conduction C  
Test Date :2024-01-08  
Temp./Humi. :21.9°C/54%  
Engineer :Sam Huang



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level		FS		
MHz	PK/QP/AV	dBμV	dB	dBμV	dBμV	dB
0.170	Average	2.40	10.67	13.07	54.94	-41.87
0.170	QP	9.20	10.67	19.87	64.94	-45.07
0.205	Peak	35.07	10.67	45.74	63.39	-17.65
0.501	Peak	28.25	10.62	38.87	56.00	-17.13
1.999	Peak	18.94	10.77	29.71	56.00	-26.29
4.875	Peak	22.15	10.97	33.12	56.00	-22.88
6.236	Peak	23.62	10.99	34.61	60.00	-25.39

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## 8 PEAK OUTPUT POWER MEASUREMENT

### 8.1 Standard Applicable

#### 8.1.1 Duty Cycle

Pre-analysis Check: While conducting average power measurement, duty cycle of each mode shall be checked to ensure its duty cycle in order to compensate for the loss due to insufficient ratio of duty cycle.

All duty cycle is pre-scanned, and result as obtained below shows only the most representative ones where duty cycle is conducted as the given transmission with given virtual operation that expresses the percentage.

#### 8.1.2 FCC

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

If the transmitting antenna of directional gain greater than 6dBi are used the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

#### 8.1.3 ISED

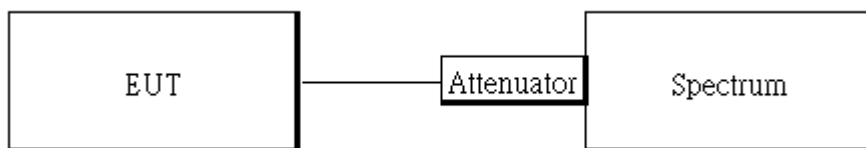
For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt and the e.i.r.p. shall not exceed 4 W (ISED only).

#### Note:

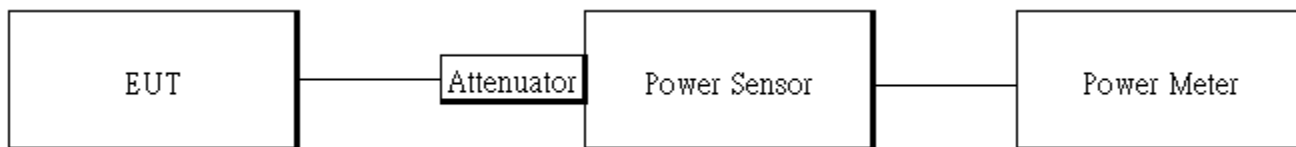
When the antenna gain is greater than 6 dBi, the power limit attenuated accordingly.

### 8.2 Test Setup

#### 8.2.1 Duty Cycle



#### 8.2.2 Output Power:



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### 8.3 Measurement Procedure

#### 8.3.1 Duty Cycle:

1. Set span = Zero
2. RBW = 8MHz
3. VBW = 8MHz,
4. Detector = Peak

#### 8.3.2 Output Power

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

##### **Power Meter:**

It is used as the auxiliary test equipment to conduct the output power measurement.

4. Record the max. Reading as observed from Spectrum or Power Meter.

**\* Note: The duty cycle factor and below is compensated to obtain the maximum value of measurement in average.**

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## 8.4 Measurement Result

### 8.4.1 Duty Cycle:

Mode		Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log ( 1/Duty Cycle )	1/T (kHz)	VBW setting (kHz)
802.11b		99.86	0.01	0.12	0.01
802.11g		98.96	0.05	0.70	0.01
802.11n_20		98.89	0.05	0.75	0.01
Mode	RU Config	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log ( 1/Duty Cycle )	1/T (kHz)	VBW setting (kHz)
802.11ax_20	Full	98.58	0.06	0.96	0.01
	26 RU	97.16	0.13	0.49	1.00
	52 RU	96.47	0.16	0.49	1.00
	106 RU	97.16	0.13	0.49	1.00

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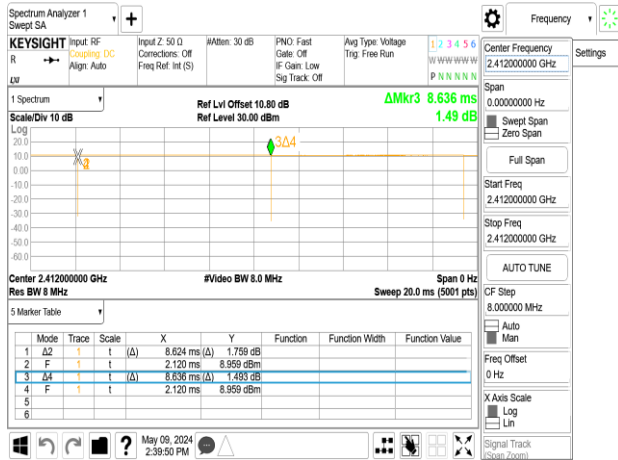
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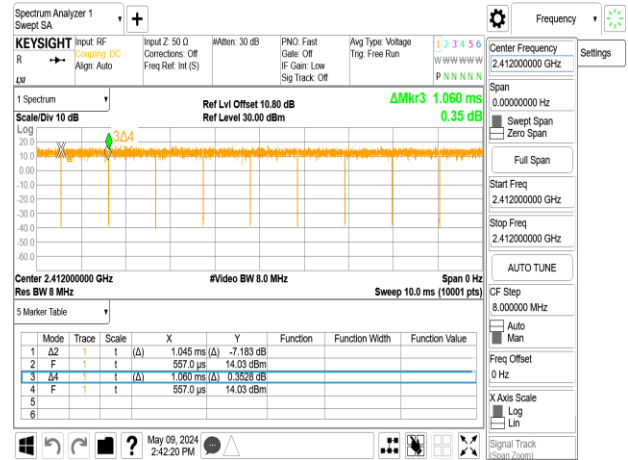
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## 8.4.2 Duty Cycle test plots

802.11b\_20MHz\_Chain0\_2412MHz



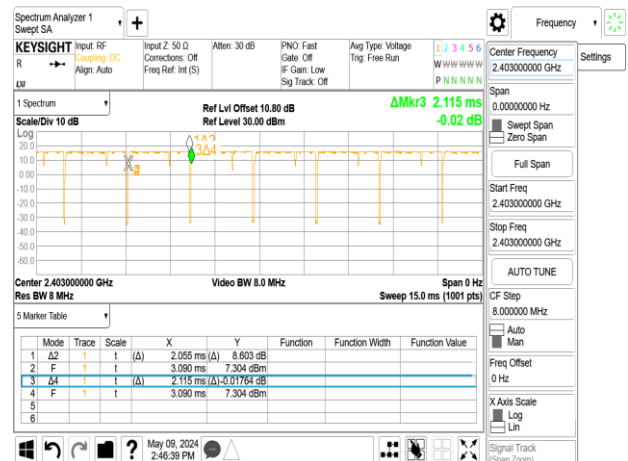
802.11ax\_20MHz\_Chain0\_2412MHz



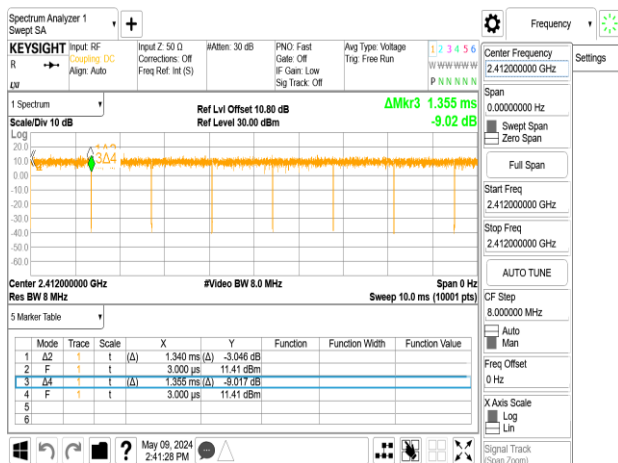
802.11g\_20MHz\_Chain0\_2412MHz



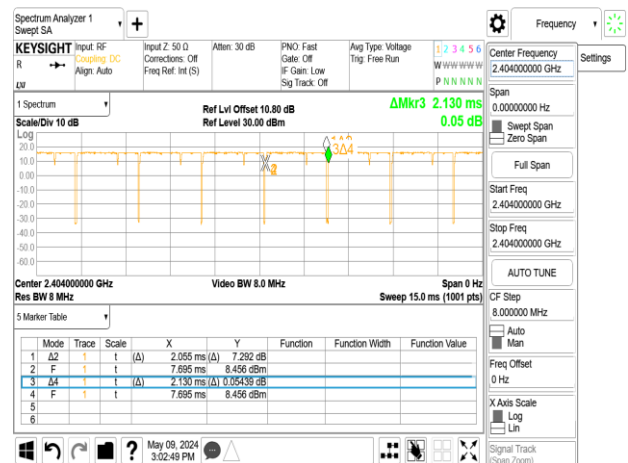
802.11ax\_20MHz\_Chain0\_2412MHz\_RU26



802.11n\_20MHz\_Chain0\_2412MHz



802.11ax\_20MHz\_Chain0\_2412MHz\_RU52



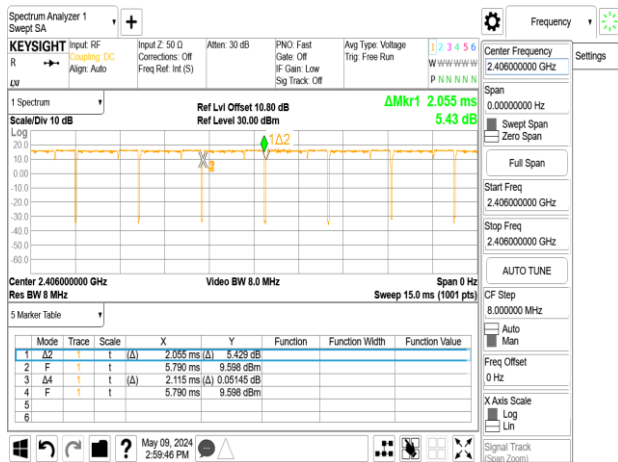
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802.11ax\_20MHz\_Chain0\_2412MHz\_RU106



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## 8.4.3 Output Power

802.11b Ch0						
CH	Freq. (MHz)	Data Rate	Power Setting	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	1	19.5	20.35	30.00	PASS
2	2417	1	20.25	21.13	30.00	PASS
3	2422	1	21.25	21.81	30.00	PASS
6	2437	1	21.25	<b>22.24</b>	30.00	PASS
9	2452	1	21.25	22.20	30.00	PASS
10	2457	1	18.75	20.15	30.00	PASS
11	2462	1	18	19.41	30.00	PASS
802.11b Ch0						
CH	Freq. (MHz)	Data Rate	Power Setting	Avg. Output Power (dBm)	Limit (dBm)	RESULT
1	2412	1	19.5	17.90	30.00	PASS
2	2417	1	20.25	18.52	30.00	PASS
3	2422	1	21.25	19.45	30.00	PASS
6	2437	1	21.25	<b>19.89</b>	30.00	PASS
9	2452	1	21.25	19.86	30.00	PASS
10	2457	1	18.75	17.50	30.00	PASS
11	2462	1	18	16.81	30.00	PASS

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## 802.11g Ch0

CH	Freq. (MHz)	Data Rate	Power Setting	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	6	16.75	20.02	30.00	PASS
2	2417	6	17.75	20.98	30.00	PASS
3	2422	6	19	22.00	30.00	PASS
4	2427	6	19.25	22.70	30.00	PASS
5	2432	6	19.5	22.89	30.00	PASS
6	2437	6	20.25	<b>23.65</b>	30.00	PASS
7	2442	6	19.25	22.71	30.00	PASS
8	2447	6	19	22.51	30.00	PASS
9	2452	6	18	21.74	30.00	PASS
10	2457	6	15.75	19.19	30.00	PASS
11	2462	6	14.25	17.86	30.00	PASS

## 802.11g Ch0

CH	Freq. (MHz)	Data Rate	Power Setting	Avg. Output Power (dBm)	Limit (dBm)	RESULT
1	2412	6	16.75	14.35	30.00	PASS
2	2417	6	17.75	15.53	30.00	PASS
3	2422	6	19	16.81	30.00	PASS
4	2427	6	19.25	17.33	30.00	PASS
5	2432	6	19.5	17.56	30.00	PASS
6	2437	6	20.25	<b>19.73</b>	30.00	PASS
7	2442	6	19.25	17.44	30.00	PASS
8	2447	6	19	17.30	30.00	PASS
9	2452	6	18	16.50	30.00	PASS
10	2457	6	15.75	13.51	30.00	PASS
11	2462	6	14.25	12.29	30.00	PASS

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## 802.11n\_HT\_20M Ch0

CH	Freq. (MHz)	Data Rate	Power Setting	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	MCS0	16.75	19.95	30.00	PASS
2	2417	MCS0	17.75	21.03	30.00	PASS
3	2422	MCS0	19	22.03	30.00	PASS
4	2427	MCS0	20.5	23.78	30.00	PASS
6	2437	MCS0	20.5	23.74	30.00	PASS
7	2442	MCS0	20.5	<b>23.81</b>	30.00	PASS
8	2447	MCS0	19.75	23.63	30.00	PASS
9	2452	MCS0	18.75	22.31	30.00	PASS
10	2457	MCS0	17	20.37	30.00	PASS
11	2462	MCS0	14.5	18.14	30.00	PASS

## 802.11n\_HT\_20M Ch0

CH	Freq. (MHz)	Data Rate	Power Setting	Avg. Output Power (dBm)	Limit (dBm)	RESULT
1	2412	MCS0	16.75	14.12	30.00	PASS
2	2417	MCS0	17.75	15.32	30.00	PASS
3	2422	MCS0	19	16.66	30.00	PASS
4	2427	MCS0	20.5	19.89	30.00	PASS
6	2437	MCS0	20.5	19.86	30.00	PASS
7	2442	MCS0	20.5	<b>19.99</b>	30.00	PASS
8	2447	MCS0	19.75	19.47	30.00	PASS
9	2452	MCS0	18.75	17.07	30.00	PASS
10	2457	MCS0	17	14.60	30.00	PASS
11	2462	MCS0	14.5	12.23	30.00	PASS

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## 802.11ax HE 20M Ch0

CH	Freq. (MHz)	Data Rate	RU Config	Power Setting	Peak Output Power (dBm)	Limit (dBm)	RESULT
1	2412	MCS0	SU	15.25	21.49	30.00	PASS
			RU	17	20.13	30.00	PASS
			26/0	16.25	22.32	30.00	PASS
			26/8	16.5	22.56	30.00	PASS
			52/37	16	22.14	30.00	PASS
			52/40	16.5	22.53	30.00	PASS
			106/53	17.75	23.48	30.00	PASS
			106/54	17.75	23.45	30.00	PASS
2	2417	MCS0	RU	17.25	20.37	30.00	PASS
3	2422	MCS0	RU	18	21.18	30.00	PASS
4	2427	MCS0	RU	19.75	23.03	30.00	PASS
5	2432	MCS0	RU	19.75	23.06	30.00	PASS
6	2437	MCS0	SU	20.25	23.77	30.00	PASS
			RU	20.25	<b>23.80</b>	30.00	PASS
7	2442	MCS0	RU	19.75	23.11	30.00	PASS
8	2447	MCS0	RU	18.75	22.26	30.00	PASS
9	2452	MCS0	RU	17.75	21.51	30.00	PASS
10	2457	MCS0	RU	16.5	20.01	30.00	PASS
11	2462	MCS0	SU	14.75	21.71	30.00	PASS
			RU	15	18.55	30.00	PASS
			26/8	15.5	22.33	30.00	PASS
			26/0	16.5	23.16	30.00	PASS
			52/40	15.25	22.16	30.00	PASS
			52/37	16.5	23.18	30.00	PASS
			106/54	16	22.78	30.00	PASS
			106/53	16.5	0.00	30.00	PASS

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## 802.11ax HE 20M Ch0

CH	Freq. (MHz)	Data Rate	RU Config	Power Setting	Avg. Output Power (dBm)	Limit (dBm)	RESULT
1	2412	MCS0	SU	15.25	13.17	30.00	PASS
			RU	17	14.28	30.00	PASS
			26/0	16.25	13.58	30.00	PASS
			26/8	16.5	14.08	30.00	PASS
			52/37	16	13.39	30.00	PASS
			52/40	16.5	14.20	30.00	PASS
			106/53	17.75	15.37	30.00	PASS
			106/54	17.75	15.67	30.00	PASS
2	2417	MCS0	RU	17.25	14.65	30.00	PASS
3	2422	MCS0	RU	18	15.60	30.00	PASS
4	2427	MCS0	RU	19.75	17.48	30.00	PASS
5	2432	MCS0	RU	19.75	17.51	30.00	PASS
6	2437	MCS0	SU	20.25	19.90	30.00	PASS
			RU	20.25	<b>19.94</b>	30.00	PASS
7	2442	MCS0	RU	19.75	17.75	30.00	PASS
8	2447	MCS0	RU	18.75	16.95	30.00	PASS
9	2452	MCS0	RU	17.75	16.07	30.00	PASS
10	2457	MCS0	RU	16.5	14.20	30.00	PASS
11	2462	MCS0	SU	14.75	12.50	30.00	PASS
			RU	15	12.79	30.00	PASS
			26/8	15.5	13.80	30.00	PASS
			26/0	16.5	14.27	30.00	PASS
			52/40	15.25	13.70	30.00	PASS
			52/37	16.5	14.52	30.00	PASS
			106/54	16	14.28	30.00	PASS
			106/53	16.5	14.93	30.00	PASS

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802.11b Ch0							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
1	2412	1	17.90	3.20	21.10	36	PASS
2	2417	1	18.52	3.20	21.72	36	PASS
3	2422	1	19.45	3.20	22.65	36	PASS
6	2437	1	19.89	3.20	<b>23.09</b>	36	PASS
9	2452	1	19.86	3.20	23.06	36	PASS
10	2457	1	17.50	3.20	20.70	36	PASS
11	2462	1	16.81	3.20	20.01	36	PASS

802.11g Ch0							
CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
1	2412	6	14.35	3.20	17.55	36	PASS
2	2417	6	15.53	3.20	18.73	36	PASS
3	2422	6	16.81	3.20	20.01	36	PASS
4	2427	6	17.33	3.20	20.53	36	PASS
5	2432	6	17.56	3.20	20.76	36	PASS
6	2437	6	19.73	3.20	<b>22.93</b>	36	PASS
7	2442	6	17.44	3.20	20.64	36	PASS
8	2447	6	17.30	3.20	20.50	36	PASS
9	2452	6	16.50	3.20	19.70	36	PASS
10	2457	6	13.51	3.20	16.71	36	PASS
11	2462	6	12.29	3.20	15.49	36	PASS

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## 802.11n\_HT\_20M Ch0

CH	Freq. (MHz)	Data Rate	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit (dBm)	RESULT
1	2412	MCS0	14.12	3.20	17.32	36	PASS
2	2417	MCS0	15.32	3.20	18.52	36	PASS
3	2422	MCS0	16.66	3.20	19.86	36	PASS
4	2427	MCS0	19.89	3.20	23.09	36	PASS
6	2437	MCS0	19.86	3.20	23.06	36	PASS
7	2442	MCS0	19.99	3.20	<b>23.19</b>	36	PASS
8	2447	MCS0	19.47	3.20	22.67	36	PASS
9	2452	MCS0	17.07	3.20	20.27	36	PASS
10	2457	MCS0	14.60	3.20	17.80	36	PASS
11	2462	MCS0	12.23	3.20	15.43	36	PASS

## 802.11ax\_HE\_20M Ch0

CH	Freq. (MHz)	Data Rate	RU Config	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit	RESULT
1	2412	MCS0	SU	13.17	3.20	16.37	36	PASS
			RU	14.28	3.20	17.48	36	PASS
			26/0	13.58	3.20	16.78	36	PASS
			26/8	14.08	3.20	17.28	36	PASS
			52/37	13.39	3.20	16.59	36	PASS
			52/40	14.20	3.20	17.40	36	PASS
			106/53	15.37	3.20	18.57	36	PASS
			106/54	15.67	3.20	18.87	36	PASS
6	2437	MCS0	SU	19.90	3.20	23.10	36	PASS
			RU	19.94	3.20	<b>23.14</b>	36	PASS
11	2462	MCS0	SU	12.50	3.20	15.70	36	PASS
			RU	12.79	3.20	15.99	36	PASS
			26/8	13.80	3.20	17.00	36	PASS
			26/0	14.27	3.20	17.47	36	PASS
			52/40	13.70	3.20	16.90	36	PASS
			52/37	14.52	3.20	17.72	36	PASS
			106/54	14.28	3.20	17.48	36	PASS
			106/53	14.93	3.20	18.13	36	PASS

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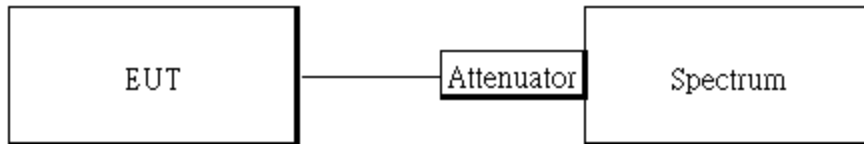


## 9 EMISSION BANDWIDTH MEASUREMENT

### 9.1 Standard Applicable

The minimum 6 dB bandwidth shall be at least 500 kHz.

### 9.2 Test Setup



### 9.3 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

#### 9.3.1 6dB BW measurements

1. The testing follows the Measurement Procedure of the KDB 558074 D01.
2. Set the spectrum analyzer as  
RBW= 100 kHz ,  
VBW = 3 X RBW,  
Span= 2 to 5 times of the OBW,  
Sweep=auto, Detector = Peak, and Max hold.
3. Mark the upper and lower frequencies of -6dB.
4. Repeat above procedures until all test default channel is completed.

#### 9.3.2 99% BW measurements

1. The testing follows the Measurement Procedure of the RSS-Gen section 6.7.
2. Set the spectrum analyzer as  
RBW= 1 % to 5% of 99%,  
VBW  $\geq$  3 X RBW,  
Span= large enough to capture all products of the modulation process  
Sweep=auto, Detector = Peak, and Max hold.
3. Mark the upper and lower frequencies of 99%.
4. Repeat above procedures until all test default channel is completed.

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## 9.4 Measurement Result:

### 9.4.1 6dB BW measurements

#### 802.11b Ch0

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	10110.00	$\geq 500$	PASS
2437	<b>10120.00</b>	$\geq 500$	PASS
2462	<b>10120.00</b>	$\geq 500$	PASS

#### 802.11g Ch0

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	16370.00	$\geq 500$	PASS
2437	<b>16380.00</b>	$\geq 500$	PASS
2462	<b>16380.00</b>	$\geq 500$	PASS

#### 802.11n HT\_20M Ch0

Freq. (MHz)	6dB BW (kHz)	Limit (kHz)	Result
2412	17220.00	$\geq 500$	PASS
2437	<b>17330.00</b>	$\geq 500$	PASS
2462	17310.00	$\geq 500$	PASS

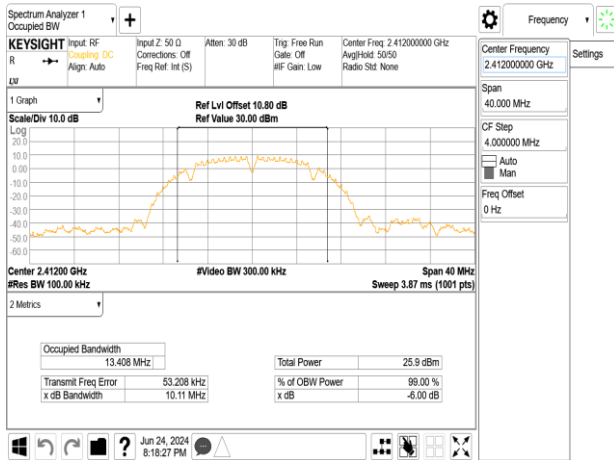
#### 802.11ax HE\_20M Ch0

Freq. (MHz)	RU Config	6dB BW (kHz)	Limit (kHz)	Result
2412	full	18000.00	$\geq 500$	PASS
2437	full	<b>18340.00</b>	$\geq 500$	PASS
2462	full	18120.00	$\geq 500$	PASS

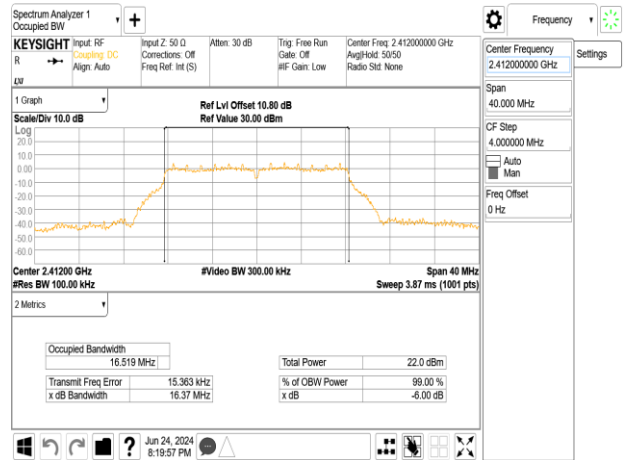
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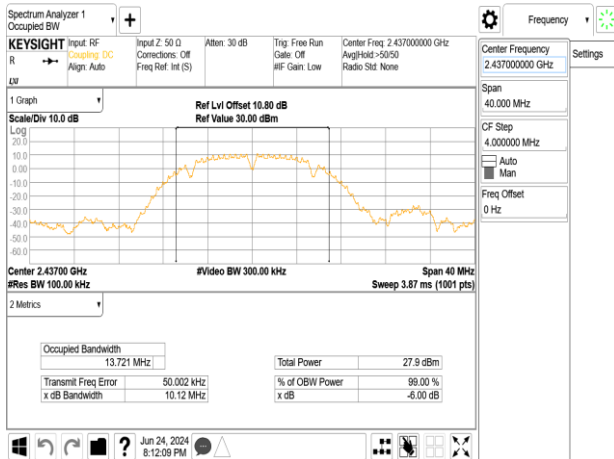
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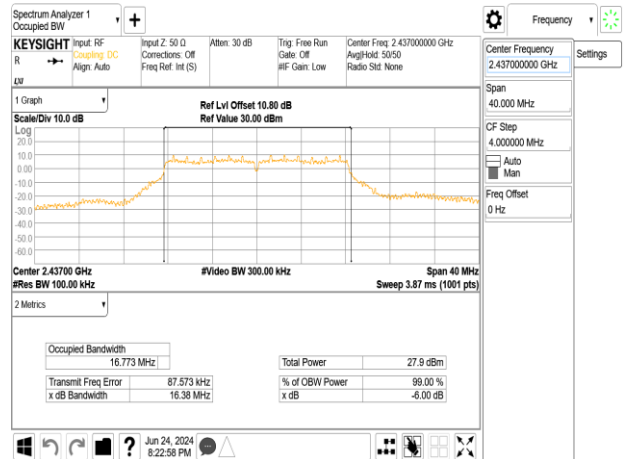
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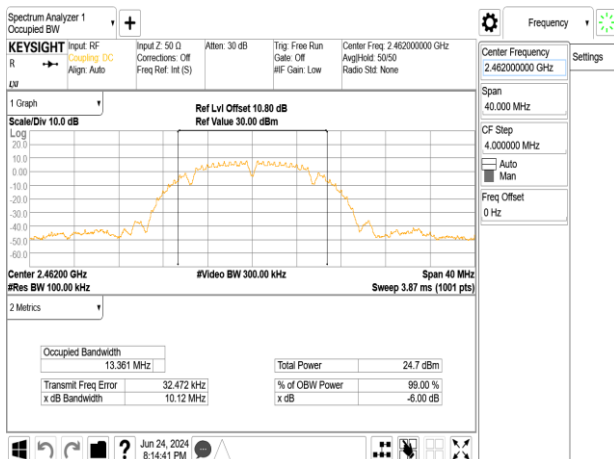
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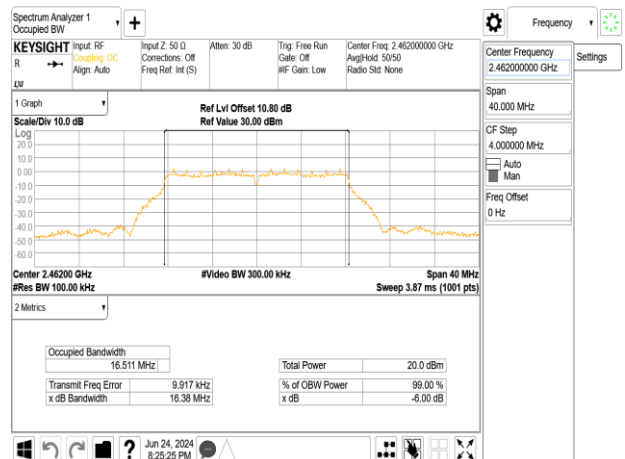
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802.11b\_20MHz\_Chain0\_2462MHz



802.11g\_20MHz\_Chain0\_2462MHz

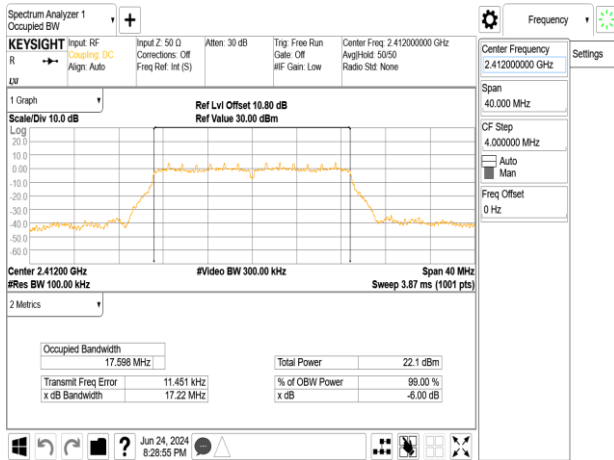


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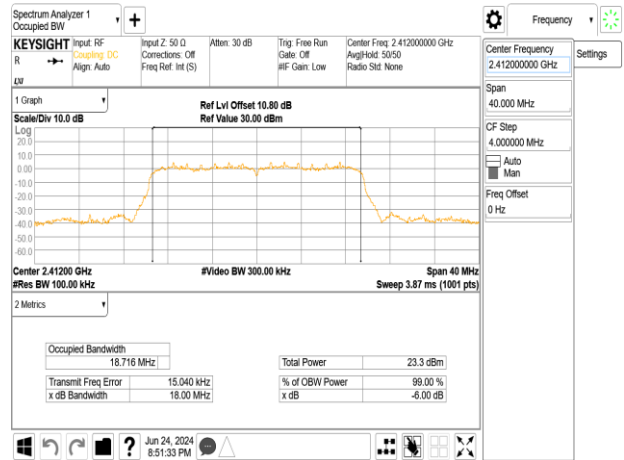
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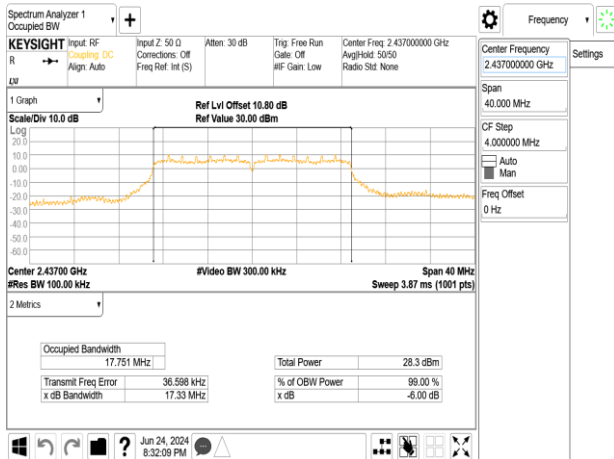
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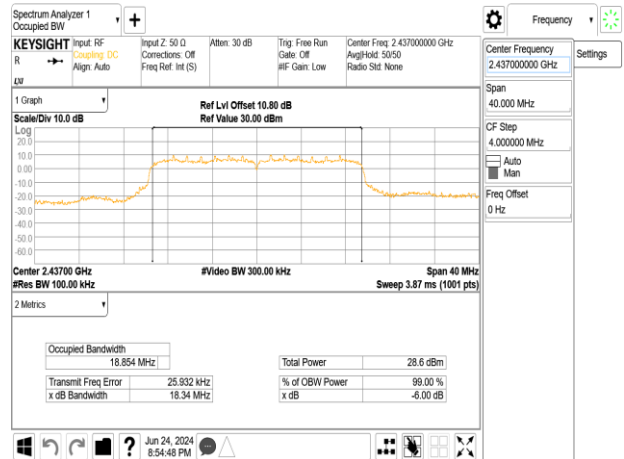
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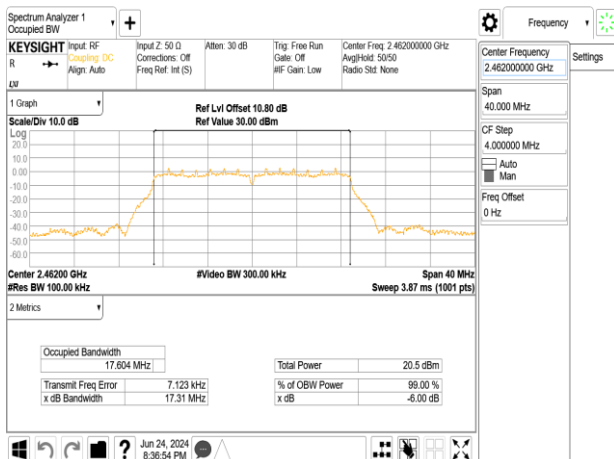
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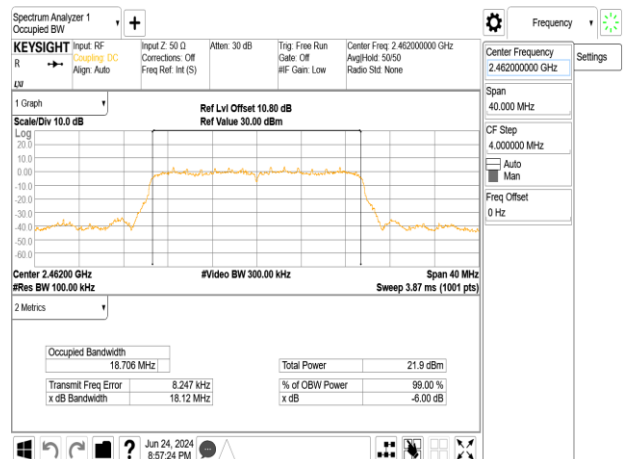
802.11ax\_20MHz\_Chain0\_2437MHz



802.11n\_20MHz\_Chain0\_2462MHz



802.11ax\_20MHz\_Chain0\_2462MHz



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## 9.4.2 99% Bandwidth

## 802.11b Ch0

Freq. (MHz)	99% BW (MHz)
2412	13.43
2437	<b>13.776</b>
2462	13.363

## 802.11g Ch0

Freq. (MHz)	99% BW (MHz)
2412	16.813
2437	<b>17.13</b>
2462	16.809

## 802.11n\_HT20M Ch0

Freq. (MHz)	99% BW (MHz)
2412	17.704
2437	<b>17.995</b>
2462	17.709

## 802.11ax\_HE20M Ch0

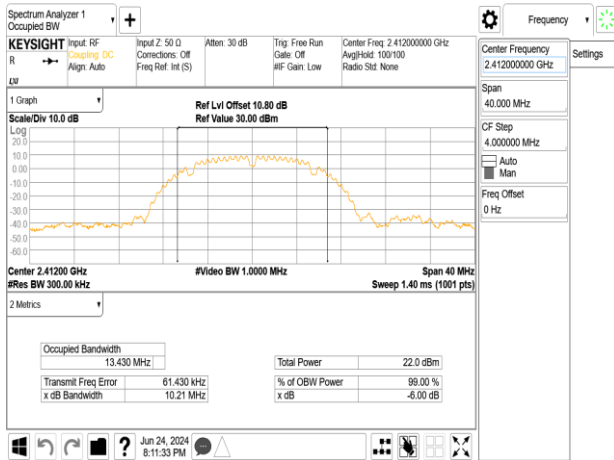
Freq. (MHz)	RU Config	99% BW (MHz)
2412	full	18.789
2437	full	<b>18.91</b>
2462	full	18.785

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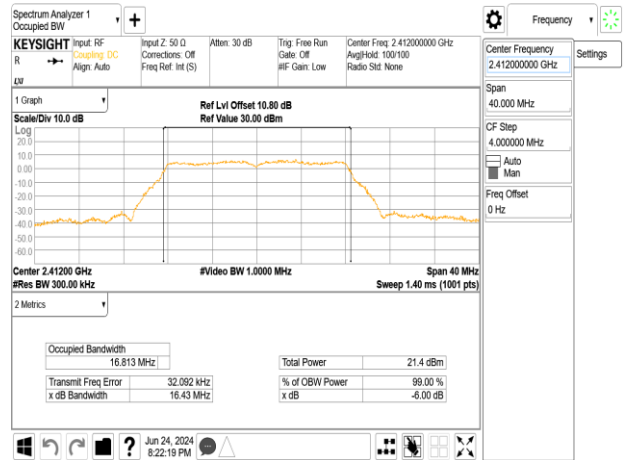
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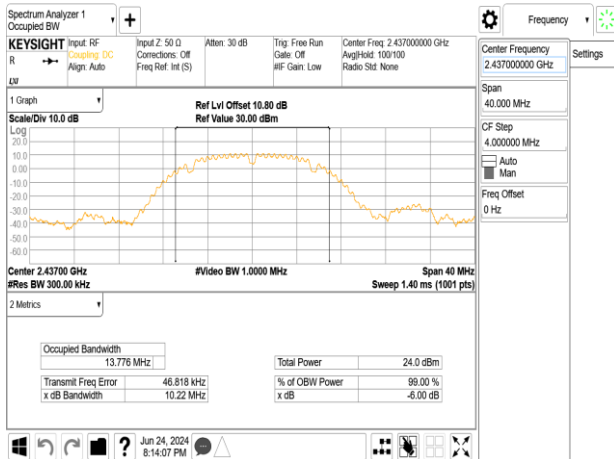
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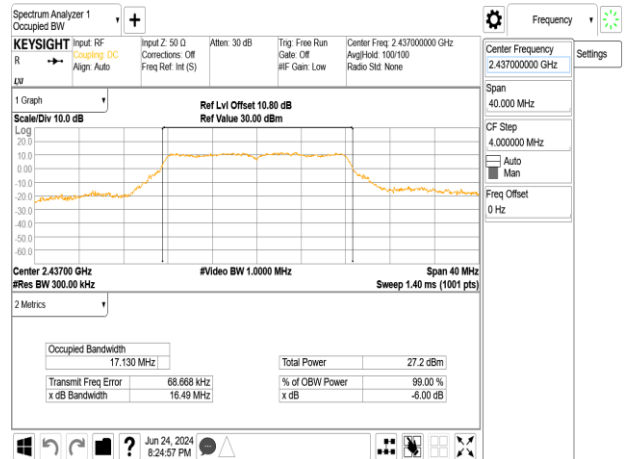
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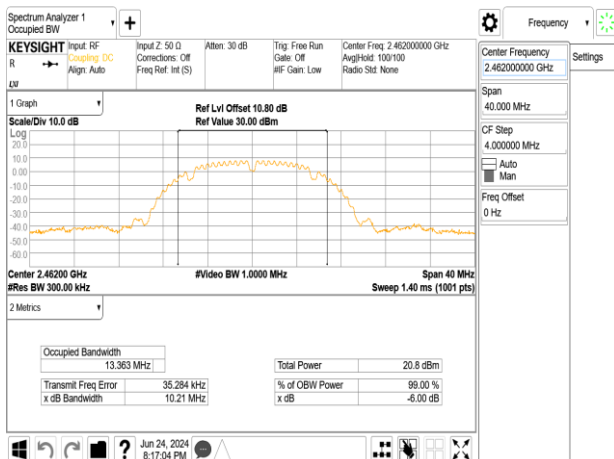
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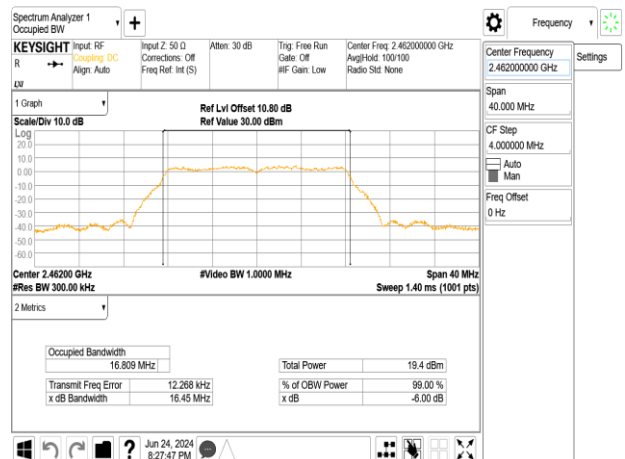
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802.11b\_20MHz\_Chain0\_2462MHz



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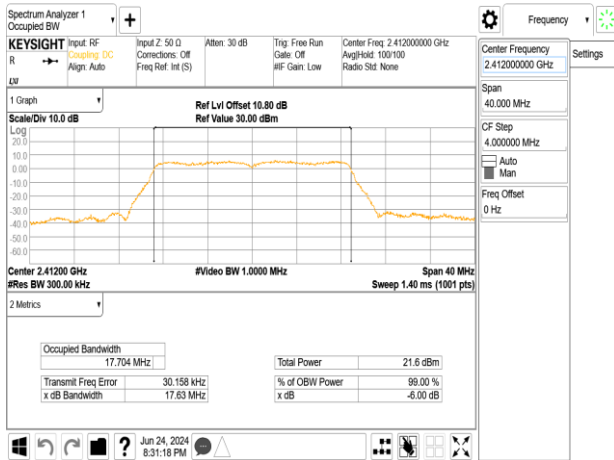
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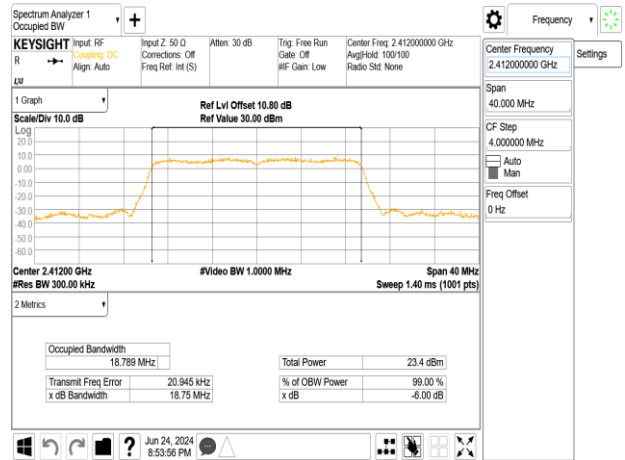
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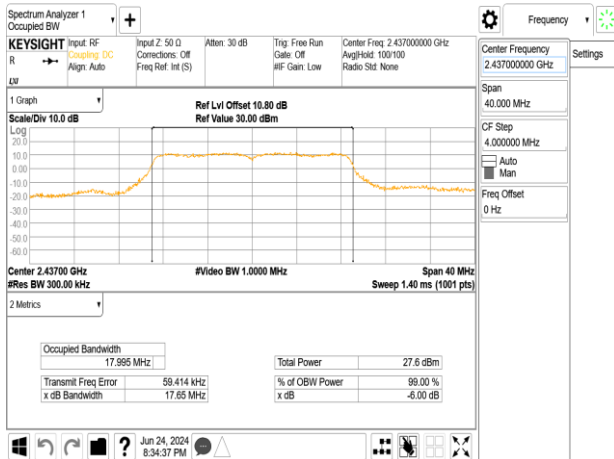
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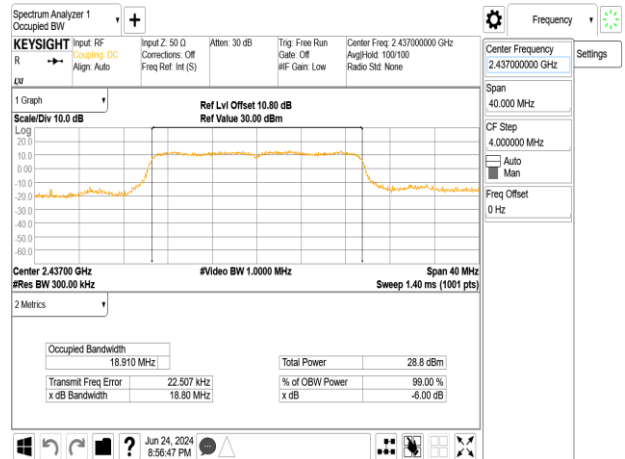
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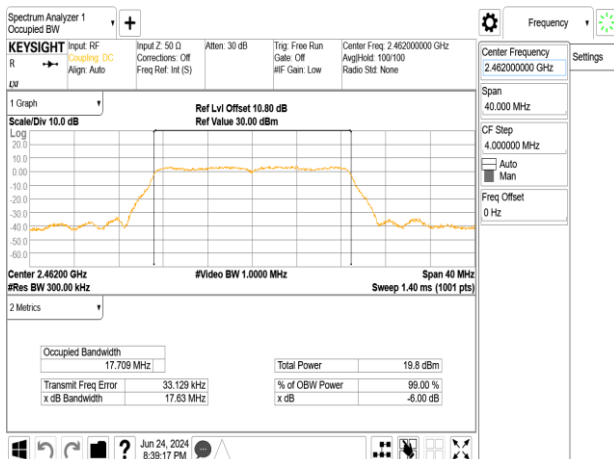
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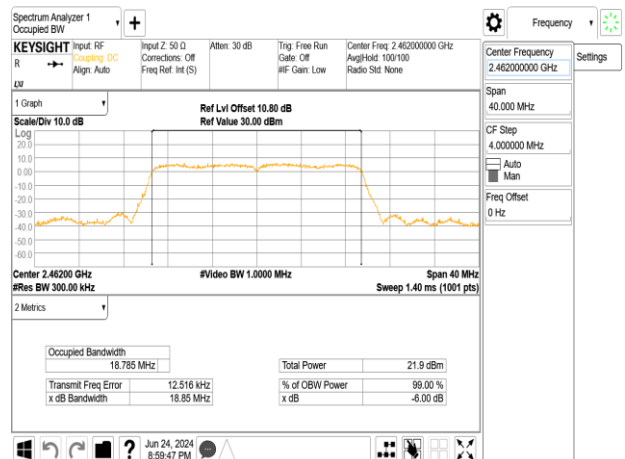
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802.11n\_20MHz\_Chain0\_2462MHz



802.11ax\_20MHz\_Chain0\_2462MHz



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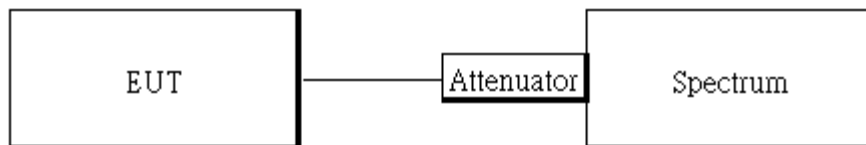
## 10 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

### 10.1 Standard Applicable

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.

In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) & RSS-Gen §8.10, must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9.

### 10.2 Test Setup



### 10.3 Measurement Procedure

#### 10.3.1 Reference Level of Emission Limit:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 100kHz & VBW = 300 kHz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.

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**10.3.2 Conducted Band Edge:**

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Mark the highest reading of the emission as the reference level measurement.
7. Set DL as the limit = reading on marker of reference level measurement -20 dBm
8. Mark the highest readings of the emissions outside of 2400MHz~2483.5MHz.
9. Repeat above procedures until all default test channel (low, middle, and high) was complete.

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### Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance .
3. Set RBW = 100 kHz & VBW= 300 kHz, Detector =Peak, Sweep = Auto.
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

### 10.4 Measurement Result

802.11b Ch0

Reference Level of Limit		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	9.04	-10.96
2437	11.07	-8.93
2462	7.92	-12.08

802.11g Ch0

Reference Level of Limit		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	4.27	-15.73
2437	10.08	-9.92
2462	2.31	-17.69

802.11n\_HT\_20M Ch0

Reference Level of Limit		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	4.58	-15.42
2437	10.45	-9.55
2462	2.83	-17.17

802.11ax\_HE\_20M Ch0

Reference Level of Limit		
Freq. (MHz)	PSD (dBm)	Reference Level of Limit (dBm)
2412	4.94	-15.06
2437	10.12	-9.88
2462	3.32	-16.68

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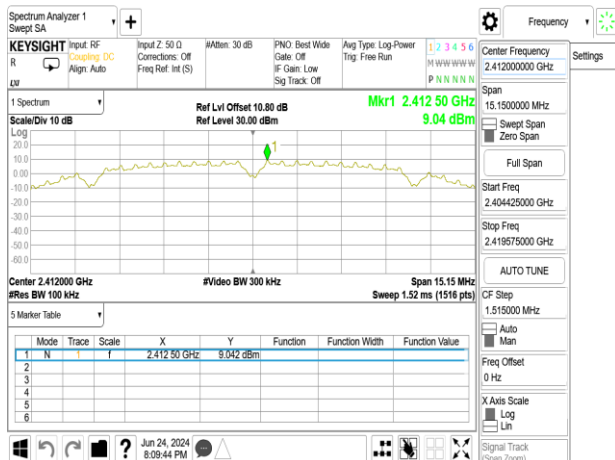
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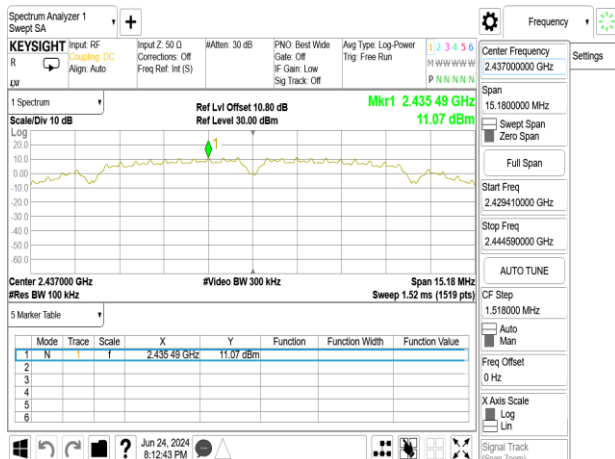
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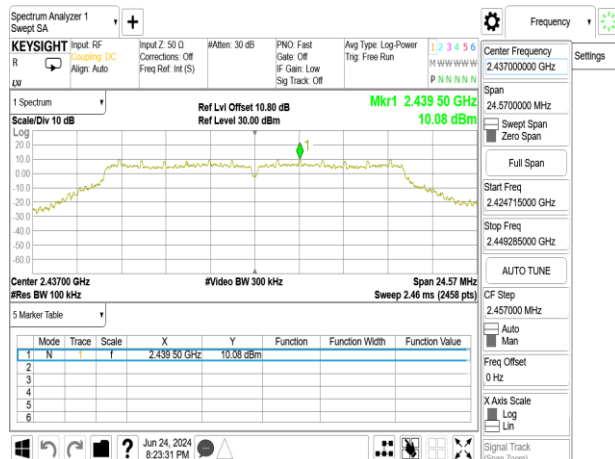
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802.11b\_20MHz\_Chain0\_2437MHz



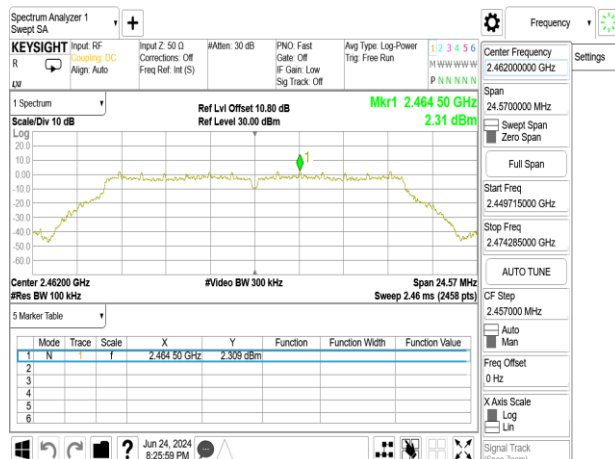
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802.11b\_20MHz\_Chain0\_2462MHz



802.11g\_20MHz\_Chain0\_2462MHz



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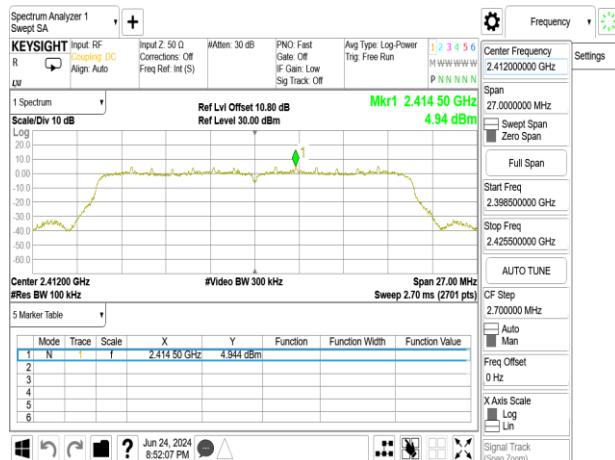
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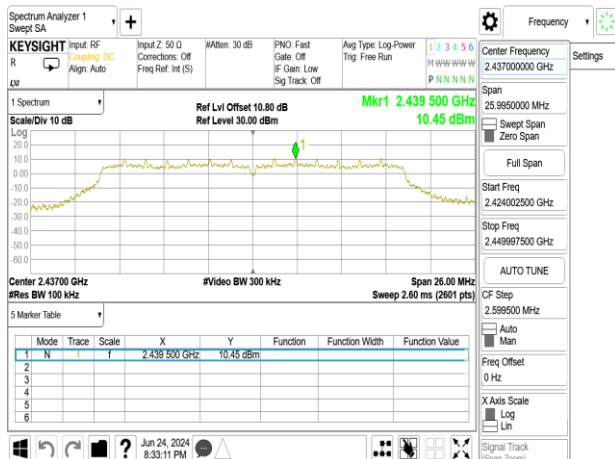
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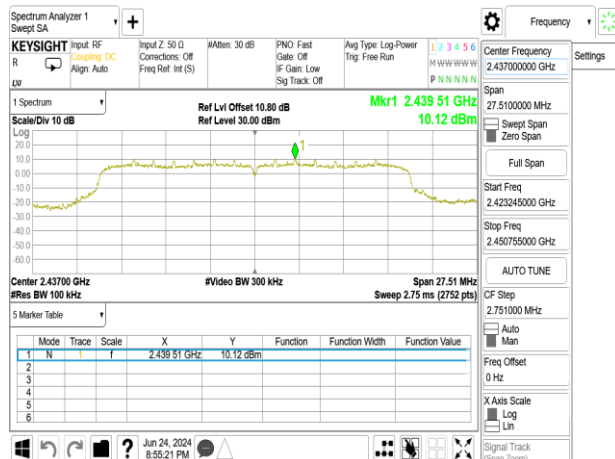
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802.11n\_20MHz\_Chain0\_2437MHz



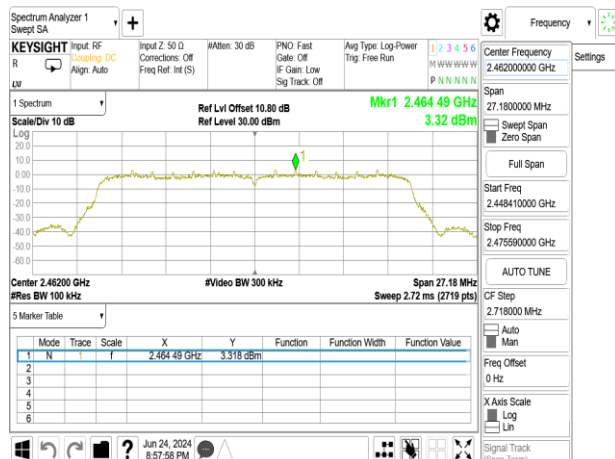
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802.11n\_20MHz\_Chain0\_2462MHz



802.11ax\_20MHz\_Chain0\_2462MHz

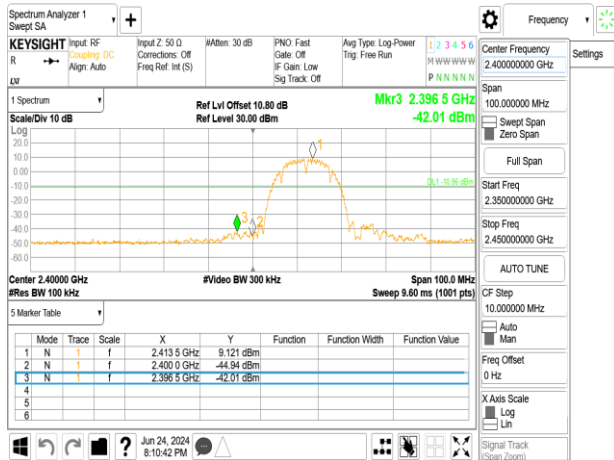


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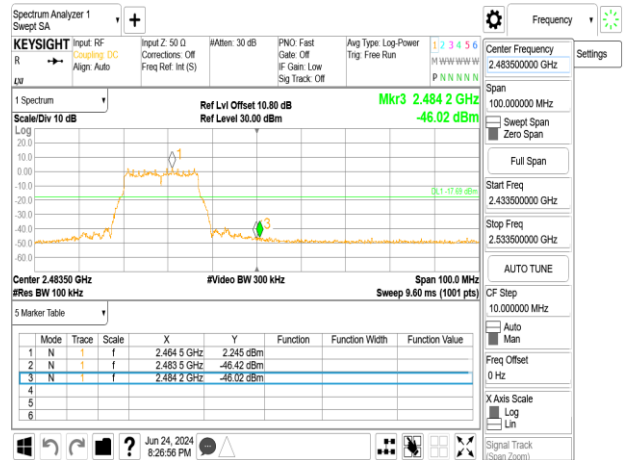
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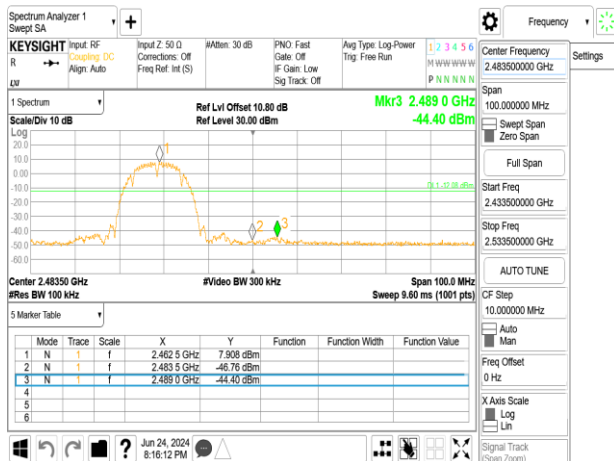
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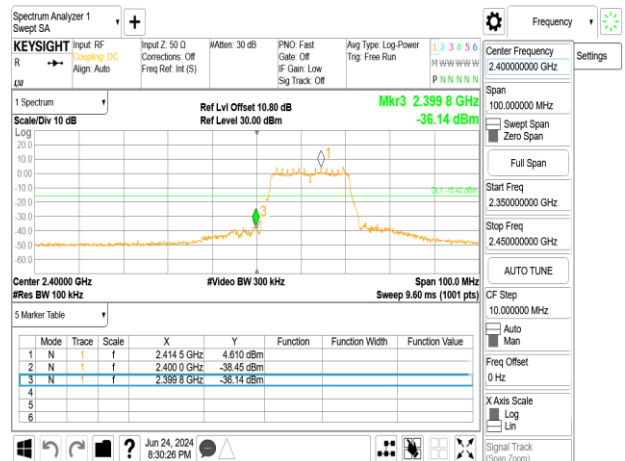
802.11g\_20MHz\_Chain0\_2462MHz



802.11b\_20MHz\_Chain0\_2462MHz



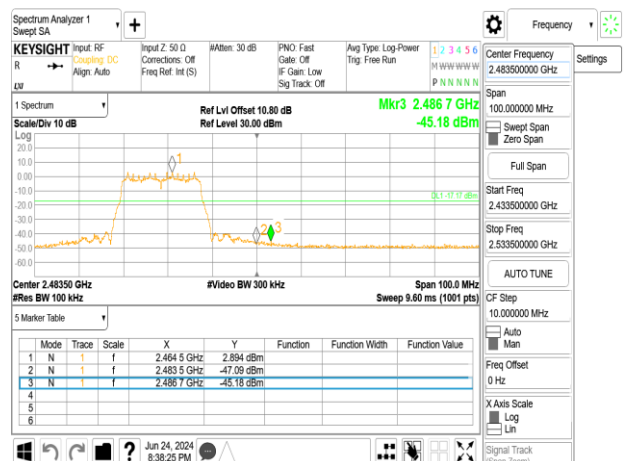
802.11n\_20MHz\_Chain0\_2412MHz



802.11g\_20MHz\_Chain0\_2412MHz



802.11n\_20MHz\_Chain0\_2462MHz



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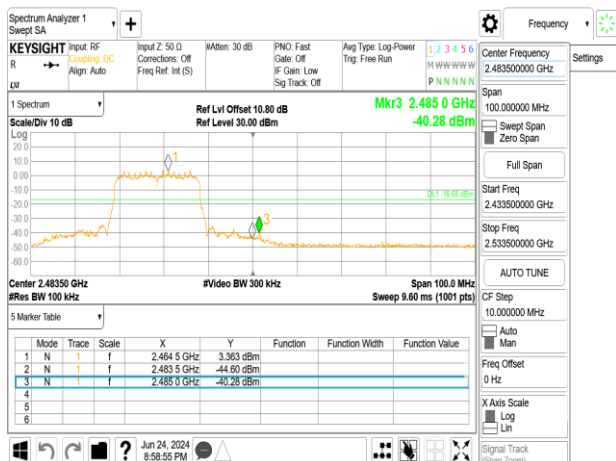
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## 802.11ax\_20MHz\_Chain0\_2412MHz



## 802.11ax\_20MHz\_Chain0\_2462MHz



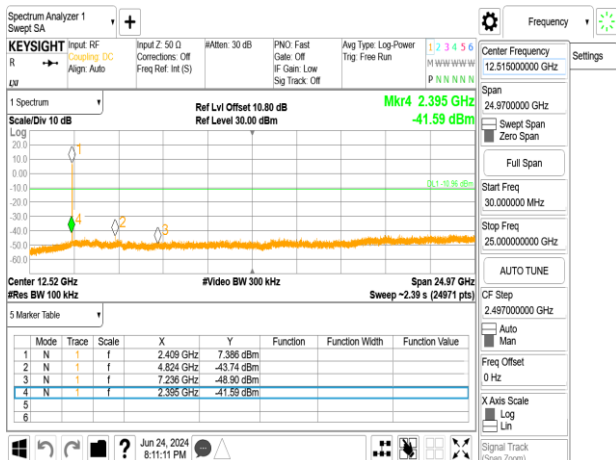
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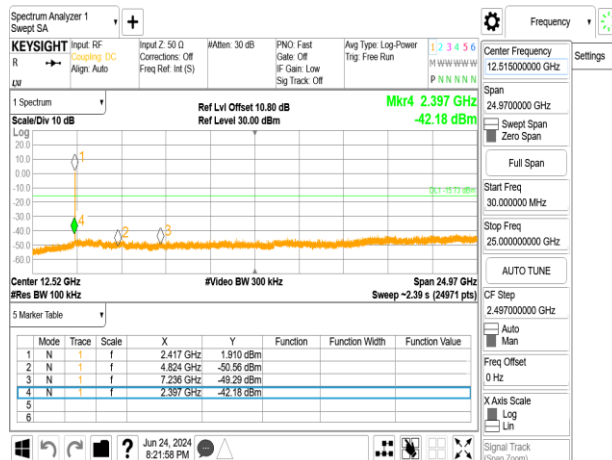
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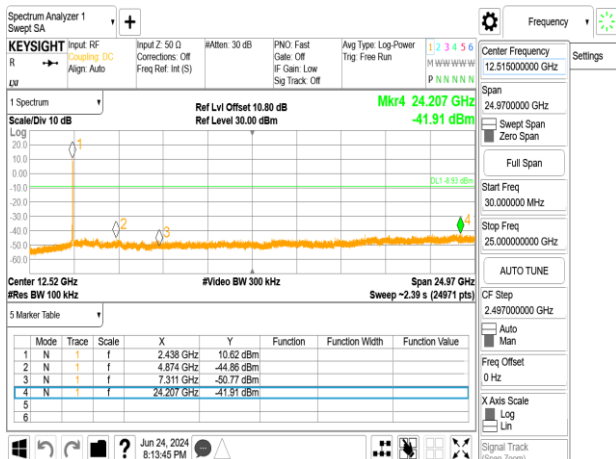
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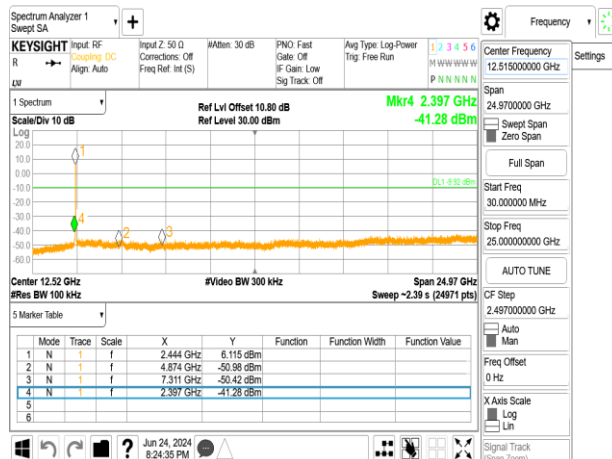
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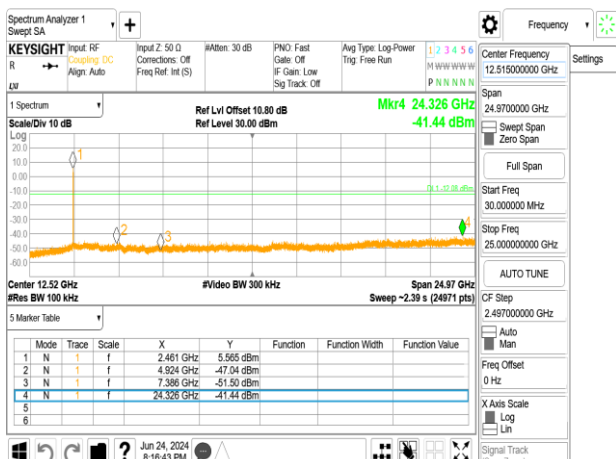
802.11b\_20MHz\_Chain0\_2437MHz



802.11g\_20MHz\_Chain0\_2437MHz



802.11b\_20MHz\_Chain0\_2462MHz



802.11g\_20MHz\_Chain0\_2462MHz



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