ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant:	Murata Manufacturing Co., Ltd. 10-1, Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan
Manufacturer:	Murata Manufacturing Co., Ltd. 10-1, Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan
Product Name:	Communication Module
Brand Name:	muRata
Model No.:	For FCC： LBES5PL2EL, LBEE5PL2DL For ISED： LBES5PL2EL-SANT, LBES5PL2EL-DANT, LBEE5PL2DL-SANT, LBEE5PL2DL-DANT
Model Difference:	Refer to section 1.10
Report Number:	TERF2211002514E2
FCC ID	VPYLBES5PL2EL
IC:	772C-LBES5PL2EL
Date of EUT Received:	Nov. 25, 2022
Date of Test:	Dec. 14, 2022～Feb. 18, 2023
Issue Date:	Mar. 22, 2023

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 §15.407, 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
TERF2211002514E2	00	Original	Mar. 14, 2023	Yami Kuo	
TERF2211002514E2	01	Revise applicant's address and model difference	Mar. 22, 2023	Yami Kuo	*

Note:

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

2、Variant information of model numbers is provided by the applicant, test results of this report are applicable to the sample EUT(s) received.

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Communication Module	
Brand Name:	muRata	
Model No.:	For FCC	LBES5PL2EL, LBEE5PL2DL
	For ISED	LBES5PL2EL-SANT, LBES5PL2EL-DANT, LBEE5PL2DL-SANT, LBEE5PL2DL-DANT
Model Difference:	Refer to section 1.10	
Hardware Version:	1	
Firmware Version:	N/A	
EUT Series No.:	L #4	
Power Supply:	3.3Vdc, 1.8Vdc	
Test Software (Name/Version)	Tera Term V4.106	

1.2 Modulation & Data Rate

Modulation type:	64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11a,11n,11ac
	256QAM in 802.11ac
	1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDMA in 802.11ax
Transition Rate:	802.11 a: 6 - 54 Mbps
	802.11 n_20MHz: up to 72.2 Mbps
	802.11 n_40MHz: up to 150 Mbps
	802.11 ac_20MHz: up to 86.7 Mbps
	802.11 ac_40MHz: up to 200 Mbps
	802.11 ac_80MHz: up to 433.3 Mbps
	802.11 ax_20MHz: up to 143.4 Mbps
	802.11 ax_40MHz: up to 286.8 Mbps
	802.11 ax_80MHz: up to 600.4 Mbps

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1.3 Antenna Designation

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
Dipole	Molex	146153	5150~5250	**4.25**
			5250~5350	
			5475~5725	
			5725~5825	
	Molex	219611	5150~5250	3.67
			5250~5350	
			5475~5725	
			5725~5825	
	Unictron	WT32D1-KX	5150~5250	4
			5250~5350	
			5475~5725	
			5725~5825	
Monopole	Murata	Type2EL_Antenna	5150~5250	**4.60**
			5250~5350	
			5475~5725	
			5725~5825	

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 FCC

WLAN	Frequency Range	Channels	Rated Power(Avg) (dBm) (Worst Case)	Modulation Technology
a/ n_HT/ ac_VHT/ ax_HE 20M	5180~5240	4	17.88 dBm	OFDM / OFDMA
	5260~5320	4	17.83 dBm	OFDM / OFDMA
	5500~5720	12	17.96 dBm	OFDM / OFDMA
	5745-5825	5	17.90 dBm	OFDM / OFDMA
n_HT ac_VHT/ ax_HE 40M	5190~5230	2	15.92 dBm	OFDM / OFDMA
	5270~5310	2	15.91 dBm	OFDM / OFDMA
	5510~5710	6	15.86 dBm	OFDM / OFDMA
	5755-5795	2	15.93 dBm	OFDM / OFDMA
ac_VHT/ ax_HE 80M	5210	1	11.94 dBm	OFDM / OFDMA
	5290	1	12.88 dBm	OFDM / OFDMA
	5530~5690	3	15.92 dBm	OFDM / OFDMA
	5775	1	10.84 dBm	OFDM / OFDMA

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1.5 ISED

Wi-Fi	Frequency Range	Channels	EIRP/Avg	Rated Power(EIRP/Avg) (dBm) (Worst Case)		Modulation Technology
a/ n_HT/ ac_VHT/ ax_HE 20M	5180~5240	4	EIRP	20.54	dBm	OFDMA
	5260~5320	4	Avg	17.83	dBm	OFDM
	5500~5700	11	Avg	17.96	dBm	OFDM
	5720 (U-NII 2C)	1	Avg	16.57	dBm	OFDM
	5720 (U-NII 3)	1	Avg	11.60	dBm	OFDM
	5745-5825	5	Avg	17.90	dBm	OFDM
n_HT ac_VHT/ ax_HE 40M	5190~5230	2	EIRP	20.52	dBm	OFDMA
	5270~5310	2	Avg	15.91	dBm	OFDMA
	5510~5670	5	Avg	15.86	dBm	OFDM
	5710 (U-NII 2C)	1	Avg	15.33	dBm	OFDMA
	5710 (U-NII 3)	1	Avg	6.93	dBm	OFDMA
	5755-5795	2	Avg	15.93	dBm	OFDMA
ac_VHT/ ax_HE 80M	5210	1	EIRP	16.54	dBm	OFDM
	5290	1	Avg	12.88	dBm	OFDM
	5530~5610	2	Avg	15.92	dBm	OFDMA
	5690 (U-NII 2C)	1	Avg	15.65	dBm	OFDMA
	5690 (U-NII 3)	1	Avg	4.25	dBm	OFDM
	5775	1	Avg	10.84	dBm	OFDMA

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1.6 Test Methodology of Applied Standards

FCC Part 15, Subpart E §15.407
FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01
FCC KDB 662911 D01 Multiple Transmitter Output v02r01
FCC KDB 291074 D02 EMC Measurement v01
RSS-247 issue 2 Feb. 2017
RSS-Gen,issue 5 April, 2018
ANSI C63.10:2013

1.7 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation 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.

1.8 Special Accessories

There are no special accessories used while test was conducted.

1.9 Equipment Modifications

There was no modification incorporated into the EUT.

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1.10 Model Difference

1. There are 4 HVINs with 2 PMNs as below

   a. The LBES5PL2EL-SANT and LBES5PL2EL-DANT are electrically identical.

HVIN	PMN	Chip on C101	RF functionss
LBES5PL2EL-SANT	LBES5PL2EL	IW612	WLAN 2.4GHz,5GHz, BT,BLE, IEEE802.15.4
LBES5PL2EL-DANT			

   b. The LBEE5PL2DL-SANT and LBEE5PL2DL-DANT are electrically identical.

HVIN	PMN	Chip on C101	RF functions
LBEE5PL2DL-SANT	LBEE5PL2DL	IW611	WLAN 2.4GHz,5GHz, BT,BLE
LBEE5PL2DL-DANT			

2. In addition, there are 2 HMNs, the differences between the HMN(s) are

HMN	HVIN	Antenna connector(s)	WLAN	BT	BLE	IEEE802.15.4
P2ML10229-D	LBES5PL2EL-DANT	2 (ANT0, ANT1)	ANT0	ANT1	ANT1	ANT1
	LBEE5PL2DL-DANT					NA
P2ML10229-S	LBES5PL2EL-SANT	1 (ANT0)	ANT0	ANT0	ANT0	ANT0
	LBEE5PL2DL-SANT					NA

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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 a 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 a 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

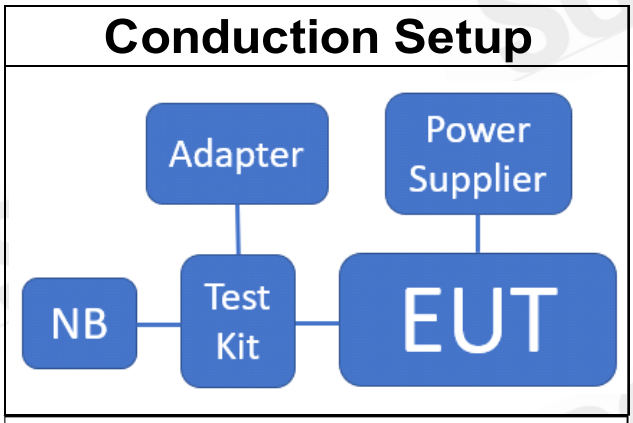
2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

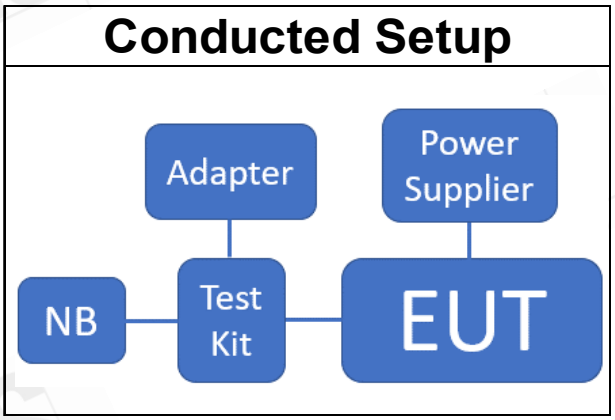
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.
There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

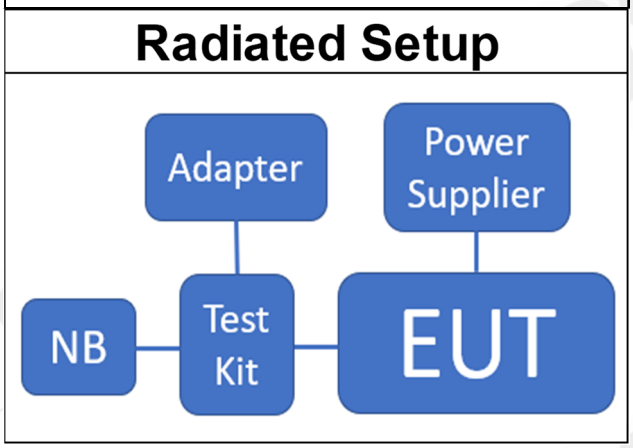
2.4.2 For all conducted test items:

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	T440p	P0000665	N/A	N/A
USB Cable	ZHUANG SHAN CHUAN	E333601	N/A	N/A	N/A
Adapter	EDACPOWER	EA1045CR	N/A	N/A	N/A
Conducted Emission Test Site: Conducted D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
USB Cable	ZHUANG SHAN	E333601	N/A	N/A	N/A
Adapter	EDACPOWER	EA1045CR	N/A	N/A	N/A
Notebook	Lenovo	T420	S0012599	N/A	N/A

Radiated Emission Test Site: SAC C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
USB Cable	ZHUANG SHAN CHUAN	E333601	N/A	N/A	N/A
Adapter	EDACPOWER	EA1045CR	N/A	N/A	N/A
Notebook	Lenovo	T440p	P0000665	N/A	N/A

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3 SUMMARY OF TEST RESULT

FCC Rules	ISED Rules	Description Of Test	Result
§15.207	RSS-Gen §8.8	AC Power Line Conducted Emission	Compliant
§15.407(e)	RSS-Gen §6.7 RSS-247 §6.2.4.1	Emission Bandwidth	Compliant
§15.407(a)	RSS-247 §6.2.1~ 4 (1)	Maximum Conducted Output Power	Compliant
§15.407(a)	RSS-247 §6.2.1~ 4 (1)	Power Spectral Density	Compliant
§15.205 §15.209 §15.407(b)	RSS-247 §6.2.1~ 4 (2)	Undesirable Radiated Emis-sions	Compliant
§15.407(c)	RSS-247 §6.4	Transmission in case of Ab-sence of Information	Compliant
§15.203	N/A	Antenna Requirement	Compliant

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4 DESCRIPTION OF TEST MODES

4.1 Operating Frequencies

Operated band in 5150 MHz ~5250 MHz:

20 M		40 M		80 M	
CH	Freq (MHz)	CH	Freq (MHz)	CH	Freq (MHz)
36	5180	38	5190	42	5210
40	5200	46	5230		
44	5220				
48	5240				

Operated band in 5250 MHz ~5350 MHz:

20 M		40 M		80 M	
CH	Freq (MHz)	CH	Freq (MHz)	CH	Freq (MHz)
52	5260	54	5270	58	5290
56	5280	62	5310		
60	5300				
64	5320				

Operated band in 5470 MHz ~5725 MHz:

20 M		40 M		80 M	
CH	Freq (MHz)	CH	Freq (MHz)	CH	Freq (MHz)
100	5500	102	5510	106	5530
104	5520	110	5550	122	5610
108	5540	118	5590	138	5690
112	5560	126	5630		
116	5580	134	5670		
120	5600	142	5710		
124	5620				
128	5640				
132	5660				
136	5680				
140	5700				
144	5720				

Operated band in 5725 MHz ~5850 MHz:

20 M		40 M		80 M	
CH	Freq (MHz)	CH	Freq (MHz)	CH	Freq (MHz)
149	5745	151	5755	155	5775
153	5765	159	5795		
157	5785				
161	5805				
165	5825				

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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 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
☒ 802.11 a	☒ Ch0	☐ Ch1	☐ Ch2	☐ Ch3	☒ 1TX	☐ 2TX
☒ 802.11 n	☒ Ch0	☐ Ch1	☐ Ch2	☐ Ch3	☒ 1TX	☐ 2TX
☒ 802.11 ac	☒ Ch0	☐ Ch1	☐ Ch2	☐ Ch3	☒ 1TX	☐ 2TX
☒ 802.11 ax	☒ Ch0	☐ Ch1	☐ Ch2	☐ Ch3	☒ 1TX	☐ 2TX

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	FREQUENCY BAND	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11a	5180~5240	36 to 48	36,44,48	OFDM	6	ch0
	5260~5320	52 to 64	52,56,64			
	5500~5720	100 to 144	100,108,116,136,140,144			
	5745~5825	149 to 165	149,157,165			
802.11n_HT20	5180~5240	36 to 48	36,44,48	OFDM	MCS0	ch0
	5260~5320	52 to 64	52,56,64			
	5500~5720	100 to 144	100,108,116,140,144			
	5745~5825	149 to 165	149,157,165			
802.11n_HT40	5190~5230	38 to 46	38,46	OFDM	MCS0	ch0
	5270~5310	54 to 62	54,62			
	5510~5670	102 to 142	102,110,126,134,142			
	5755~5795	151 to 159	151,159			
802.11ac_VHT80	5210	42	42	OFDM	MCS0	ch0
	5290	58	58			
	5530~5610	106 to 138	106,122,138			
	5775	155	155			

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CONDUCTED TEST							
MODE	FREQUENCY BAND	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	RU CONFIGUR	DATA RATE (Mbps)	ANTENNA PORT
802.11ax_HE20	5180~5240	36 to 48	36,44,48	OFDMA	FULL RU,SU 26/0,26/8 52/37,52/40 106/53,106/5	MCS0	ch0
	5260~5320	52 to 64	52,56,64				
	5500~5720	100 to 144	100,108,116,136,140,144				
	5745~5825	149 to 165	149,157,165				
802.11ax_HE40	5190~5230	38 to 46	38,46	OFDMA	FULL RU,SU 242/61,242/62	MCS0	ch0
	5270~5310	54 to 62	54,62				
	5510~5670	102 to 142	102,110,126,134,142				
	5755~5795	151 to 159	151,159				
802.11ax_HE80	5210	42	42	OFDMA	FULL RU,SU 484/65,484/66	MCS0	ch0
	5290	58	58				
	5530~5610	106 to 138	106,122,138				
	5775	155	155				

RADIATED EMISSION TEST (BELOW 1 GHz)						
MODE	FREQUENCY BAND (MHz)	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11a	5180~5240	36 to 48	44	OFDM	6	ch0
	5260~5320	52 to 64	56			
	5500~5720	100 to 144	116			
	5745~5825	149 to 165	157			
802.11ac_VHT80	5210	42	42	OFDM	MCS0	ch0
	5290	58	58			
	5530~5690	106 to 138	106			
	5775	155	155			

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RADIATED EMISSION TEST (ABOVE 1 GHz)						
MODE	FREQUENCY BAND (MHz)	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11a	5180~5240	36 to 48	36,44,48	OFDM	6	ch0
	5260~5320	52 to 64	52,56,64			
	5500~5720	100 to 144	100,116,140,144			
	5745~5825	149 to 165	149,157,165			
802.11n_HT20	5180~5240	36 to 48	36,44,48	OFDM	MCS0	ch0
	5260~5320	52 to 64	52,56,64			
	5500~5720	100 to 144	100,116,140,144			
	5745~5825	149 to 165	149,157,165			
802.11n_HT40	5190~5230	38 to 46	38,46	OFDM	MCS0	ch0
	5270~5310	54 to 62	54,62			
	5510~5710	102 to 142	102,110,134,142			
	5755~5795	151 to 159	151,159			
802.11ac_VHT80	5210	42	42	OFDM	MCS0	ch0
	5290	58	58			
	5530~5690	106 to 138	106,122,138			
	5775	155	155			

RADIATED EMISSION TEST (ABOVE 1 GHz)							
MODE	FREQUENCY BAND (MHz)	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	RU CONFIGURA	DATA RATE (Mbps)	ANTENNA PORT
802.11ax_HE20	5180~5240	36 to 48	36,44,48	OFDMA	FULL RU SU 26/0,26/8 52/37,52/40	MCS0	ch0
	5260~5320	52 to 64	52,56,64				
	5500~5720	100 to 144	100,116,140,144				
	5745~5825	149 to 165	149,157,165				
802.11ax_HE40	5190~5230	38 to 46	38,46	OFDMA	FULL RU SU 242/61,242/62	MCS0	ch0
	5270~5310	54 to 62	54,62				
	5510~5710	102 to 142	102,110,134,142				
	5755~5795	151 to 159	151,159				
802.11ax_HE80	5210	42	42	OFDMA	FULL RU SU 484/65,484/66	MCS0	ch0
	5290	58	58				
	5530~5690	106 to 138	106,122,138				
	5775	155	155				

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	+/-	2.32	dB
Output Power measurement	+/-	1	dB
Emission Bandwidth	+/-	1.53	Hz
Undesignable radiated emission measurement	+/-	1.68	dB
Peak Power Density	+/-	2.16	dB
Temperature	+/-	0.7	°C
Humidity	+/-	3	%
DC / AC Power Source	+/-	1	%

Radiated Spurious Emission Measurement Uncertainty				
Polarization: Vertical	**+/-**	**2.8**	**dB**	9kHz~30MHz
	+/-	**4.82**	**dB**	30MHz - 1000MHz
	+/-	**4.37**	**dB**	1GHz - 18GHz
	+/-	**4.21**	**dB**	18GHz - 40GHz
Polarization: Horizontal	**+/-**	**2.8**	**dB**	9kHz~30MHz
	+/-	**4.54**	**dB**	30MHz - 1000MHz
	+/-	**4.37**	**dB**	1GHz - 18GHz
	+/-	**4.21**	**dB**	18GHz - 40GHz

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	973	04/13/2022	04/12/2023
EMI Test Receiver	R&S	ESCI	101342	04/25/2022	04/24/2023
Coaxial Cable	EC Lab	RF-HY-CAB-250	RF-HY-CAB-250-01	03/27/2022	03/26/2023
Pulse Limiter	EC Lab	VTSD 9561F-N	485	03/27/2022	03/26/2023
DC Power Supply	Agilent	E3640A	MY53170008	09/12/2022	09/11/2023
Test Software	audix	e3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R

6.2 Condcuted Measurement

Conducted Emission Test Site: Conducted D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010B	MY59071573	05/16/2022	05/15/2023
Power Meter	Anritsu	ML2496A	1512003	07/26/2022	07/25/2023
Power Sensor	Anritsu	MA2411B	1339378	07/26/2022	07/25/2023
Power Sensor	Anritsu	MA2411B	1339379	07/26/2022	07/25/2023
DC Power Supply	Agilent	E3640A	MY53170008	09/12/2022	09/11/2023
Test Software	SGS Taiwan	Radio Test Software	Ver.21	N.C.R	N.C.R
Attenuator	Woken	WATT-218FS-10	RF17	11/16/2022	11/15/2023
Attenuator	Woken	WATT-218FS-10	RF18	11/16/2022	11/15/2023
DC Block	PASTERNACK	PE8210	RF158	11/16/2022	11/15/2023

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6.3 Radiated Measurement

Radiated Emission Test Site: SAC C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Broadband Antenna	SCHWARZBECK	VULB 9168	9168-300	11/11/2022	11/10/2023
Horn Antenna	Schwarzbeck	BBHA9170	185	08/22/2022	08/21/2023
Horn Antenna	Schwarzbeck	BBHA9120D	1187	01/12/2023	01/11/2024
Loop Antenna	ETS.LINDGREN	6502	143303	05/14/2022	05/13/2023
3m Site NSA	SGS	966 chamber C	N/A	03/02/2022	03/01/2023
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120290	04/01/2022	03/31/2023
DC Power Supply	Agilent	E3640A	MY53170008	09/12/2022	09/11/2023
Test Software	audix	e3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R
Pre-Amplifier	EMC Instruments	EMC330	980096	11/16/2022	11/15/2023
Pre-Amplifier	EMC Instruments	EMC0011830	980199	11/16/2022	11/15/2023
Pre-Amplifier	EMC Instruments	EMC18405SEE	980881	10/25/2022	10/24/2023
Attenuator	Woken	WATT-218FS-10	RF16	11/16/2022	11/15/2023
Coaxial Cable	Huber Suhner	EMC106-SM-SM-9100	150704	11/16/2022	11/15/2023
Coaxial Cable	Huber Suhner	SUCOFLEX 104	MY17388/4	11/16/2022	11/15/2023
Coaxial Cable	Huber Suhner	RG 214/U	W22.03	11/16/2022	11/15/2023

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

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7 CONDUCTED EMISSION TEST

7.1 Standard Applicable

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

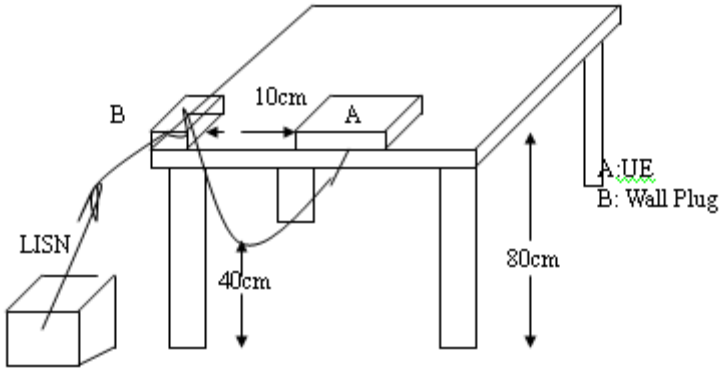
Frequency range MHz	Limits (dBuV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note
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 rear of the EUT and peripherals were placed flushed with the rear of the tabletop.
3. The LISN was connected with 120Vac/60Hz power source.

7.3 Test SET-UP



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.

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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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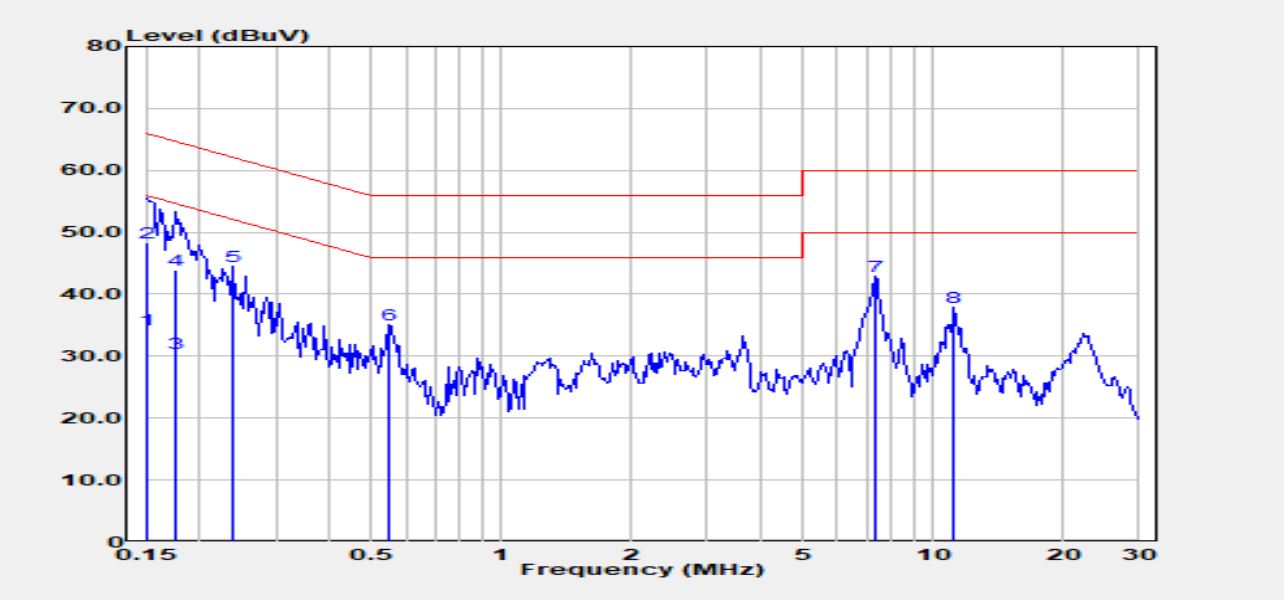
AC POWER LINE CONDUCTED EMISSION TEST DATA

Report Number	:TERF2211002514E2	Test Site	:Conduction C
Test Mode	:5G	Test Date	:2023-02-15
Power	:120/60Hz	Temp./Humi.	:22.4/61
Probe	:L1	Engineer	:Andy Wang



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.152	Average	24.10	10.27	34.37	55.91	-21.54
0.152	QP	38.00	10.27	48.27	65.91	-17.64
0.176	Average	20.30	10.27	30.57	54.68	-24.11
0.176	QP	33.60	10.27	43.87	64.68	-20.81
0.239	Peak	34.27	10.28	44.55	62.13	-17.58
0.546	Peak	24.68	10.32	35.00	56.00	-21.00
7.329	Peak	32.33	10.61	42.93	60.00	-17.07
11.198	Peak	27.15	10.69	37.85	60.00	-22.15

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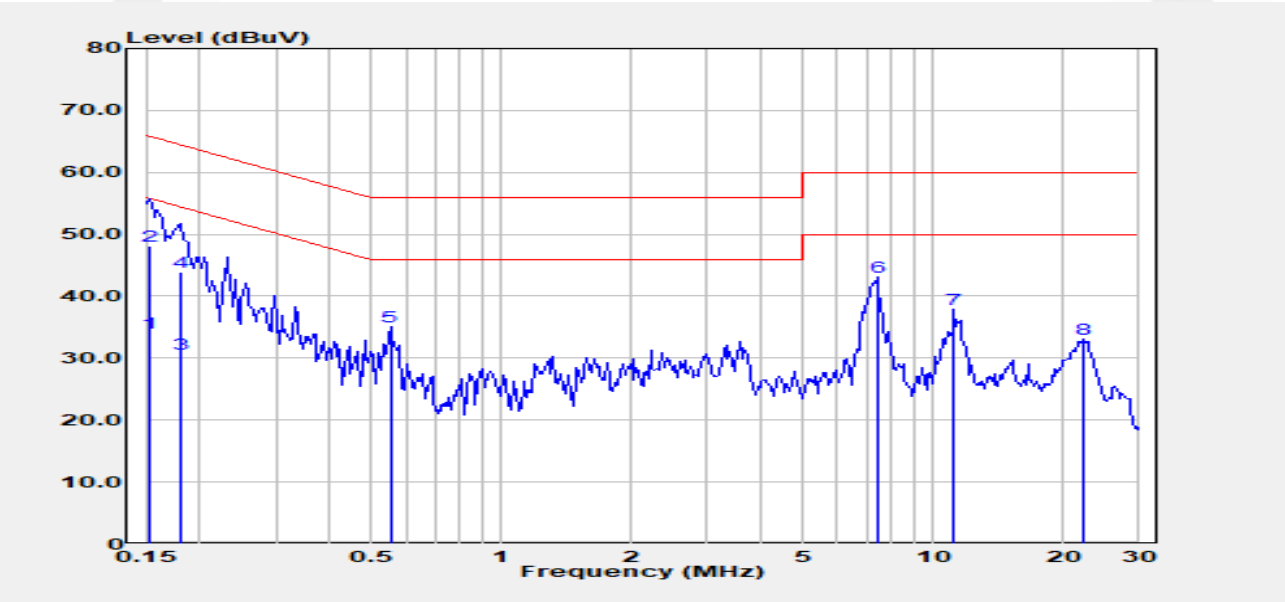
Report Number	:TERF2211002514E2	Test Site	:Conduction C
Test Mode	:5G	Test Date	:2023-02-15
Power	:120/60Hz	Temp./Humi.	:22.4/61
Probe	:N	Engineer	:Andy Wang



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV	Limit dBμV	Margin dB
0.153	Average	23.80	10.28	34.08	55.82	-21.74
0.153	QP	37.90	10.28	48.18	65.82	-17.64
0.182	Average	20.40	10.27	30.67	54.42	-23.74
0.182	QP	33.60	10.27	43.87	64.42	-20.54
0.552	Peak	24.80	10.31	35.10	56.00	-20.90
7.407	Peak	32.46	10.56	43.02	60.00	-16.98
11.198	Peak	27.20	10.65	37.85	60.00	-22.15
22.298	Peak	22.18	10.92	33.09	60.00	-26.91

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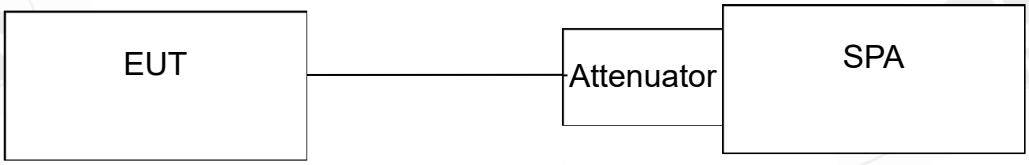
8 EMISSION BANDWIDTH MEASUREMENT

8.1 Standard Applicable

There is no limit bandwidth for U-NII-1, U-NII-2-A and U-NII-2-C.
The minimum of 6dB Bandwidth measurement is 0.5 MHz for U-NII-3.

8.2 Test Setup



8.3 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the Antenna port to the spectrum analyzer.

   3.a. 26dB Band width Measurement: Set the spectrum analyzer as 1% of emission BW
   Sweep=auto,
   Detector = Peak,
   Trace Mode = Max Hold,
   Manually readjust RBW until the RBW/EBW ratio is 1% based on EBW as observed on the result of pre-sequence measurement.

   3.b. Mark the peak frequency and –26dB (upper and lower) frequency.
4. Repeat the procedures as list above until all test default channels (low, middle, and high) are completed.
5. Minimum Emission Bandwidth for the band 5.725-5.850GHz.
   a. Set the spectrum analyzer as
   RBW = 100 kHz,
   VBW = 3*RBW,
   Span = large enough to capture all products of the modulation process,
   Detector=Peak,
   Sweep=auto
   b. Mark the peak frequency and –6dB (upper and lower) frequency.

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6. For 99% Bandwidth: Set the spectrum analyzer as
   RBW = 1%,
   VBW = 3*RBW,
   Span = large enough to capture all products of the modulation process,
   Detector=Sample,
   Sweep=auto.
7. Turn on the 99% bandwidth function, max reading.
8. Repeat above procedures until all frequency of interest measured was complete.

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8.4 Measurement Result

8.4.1 FCC Occupied Bandwidth

802.11a_Ch0

Freq. (MHz)	26dB BW (MHz)	10 Log (B) (dB)
5180	19.39	12.880
5220	19.55	12.910
5240	19.57	12.920
5260	19.45	12.890
5280	19.32	12.860
5320	19.47	12.890
5500	19.21	12.840
5540	19.46	12.890
5580	19.47	12.890
5700	19.35	12.870
5720(U-NII 2C)	14.68	11.670
5720(U-NII 3)	4.68	6.700

802.11a_Ch0

Freq. (MHz)	6dB BW (MHz)	10 Log (B) (dB)
5745	16.37	12.140
5785	16.36	12.140
5825	16.52	12.180

802.11a_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5240	5248.301531	< 5250
5745	5736.745336	> 5725

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802.11n_HT20_Ch0

Freq. (MHz)	26dB BW (MHz)	10 Log (B) (dB)
5180	19.67	12.940
5220	19.81	12.970
5240	19.83	12.970
5260	19.73	12.950
5280	19.85	12.980
5320	19.97	13.000
5500	19.88	12.980
5540	19.64	12.930
5580	19.70	12.940
5700	20.03	13.020
5720(U-NII 2C)	14.85	11.720
5720(U-NII 3)	4.85	6.860

802.11n_HT20_Ch0

Freq. (MHz)	6dB BW (MHz)	10 Log (B) (dB)
5745	17.54	12.440
5785	17.53	12.440
5825	17.56	12.450

802.11n_HT20_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5240	5248.807794	< 5250
5745	5736.191119	> 5725

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802.11n_HT40_Ch0

Freq. (MHz)	26dB BW (MHz)	10 Log (B) (dB)
5190	40.22	16.040
5230	40.09	16.030
5270	40.39	16.060
5310	40.26	16.050
5510	39.81	16.000
5550	**39.89**	16.010
5670	40.27	16.050
5710(U-NII 2C)	34.80	15.420
5710(U-NII 3)	4.80	6.810

802.11n_HT40_Ch0

Freq. (MHz)	6dB BW (MHz)	10 Log (B) (dB)
5755	35.52	15.500
5795	35.51	15.500

802.11n_HT40_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5230	5248.090977	< 5250
5755	5736.967748	> 5725

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802.11ac_VHT80_Ch0

Freq. (MHz)	26dB BW (MHz)	10 Log (B) (dB)
5210	81.19	19.100
5290	81.18	19.090
5530	81.32	19.100
5610	81.62	19.120
5690(U-NII 2C)	75.69	18.790
5690(U-NII 3)	5.69	7.550

802.11ac_VHT80_Ch0

Freq. (MHz)	39.82	10 Log (B) (dB)
5775	76.39	18.830

802.11ac_VHT80_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5210	5248.004760	< 5250
5775	5737.091573	> 5725

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802.11ax_HE20_Ch0

Freq. (MHz)	RU config	26dB BW (MHz)	10 Log (B) (dB)
5180	SU	20.17	13.050
5220	SU	20.12	13.040
5240	SU	20.04	13.020
5260	SU	20.10	13.030
5280	SU	20.11	13.030
5320	SU	20.36	13.090
5500	SU	20.15	13.040
5540	SU	20.05	13.020
5580	SU	20.15	13.040
5700	SU	20.15	13.040
5720 (U-NII 2C)	SU	15.06	11.780
5720 (U-NII 3)	SU	5.06	7.050

802.11ax_HE20_Ch0

Freq. (MHz)	RU config	6dB BW (MHz)	10 Log (B) (dB)
5745	SU	17.76	12.490
5785	SU	18.06	12.570
5825	SU	18.28	12.620

802.11ax_HE20_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5240	5249.409619	< 5250
5745	5735.612931	> 5725

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802.11ax_HE40_Ch0

Freq. (MHz)	RU config	26dB BW (MHz)	10 Log (B) (dB)
5190	SU	39.92	16.010
5230	SU	39.82	16.000
5270	SU	39.65	15.980
5310	SU	39.94	16.010
5510	SU	39.84	16.000
5550	SU	**39.95**	16.020
5670	SU	40.12	16.030
5710 (U-NII 2C)	SU	35.06	15.450
5710 (U-NII 3)	SU	5.06	7.050

802.11ax_HE40_Ch0

Freq. (MHz)	RU config	6dB BW (MHz)	10 Log (B) (dB)
5755	SU	35.73	15.530
5795	SU	35.93	15.550

802.11ax_HE40_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5230	5248.737850	< 5250
5755	5736.230070	> 5725

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802.11ax_HE80_Ch0

Freq. (MHz)	RU config	26dB BW (MHz)	10 Log (B) (dB)
5210	SU	80.37	19.050
5290	SU	80.50	19.060
5530	SU	80.20	19.040
5610	SU	80.33	19.050
5690 (U-NII 2C)	SU	75.06	18.750
5690 (U-NII 3)	SU	5.06	7.050

802.11ax_HE80_Ch0

Freq. (MHz)	RU config	6dB BW (MHz)	10 Log (B) (dB)
5775	SU	**77.91**	18.920

802.11ax_HE80_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5210	5248.741704	< 5250
5775	5736.250426	> 5725

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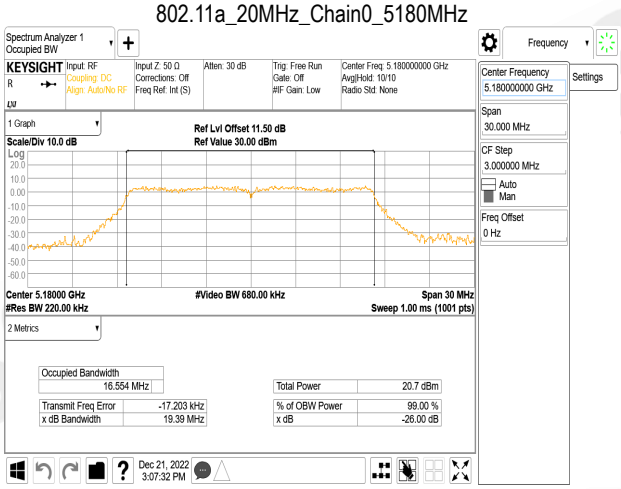
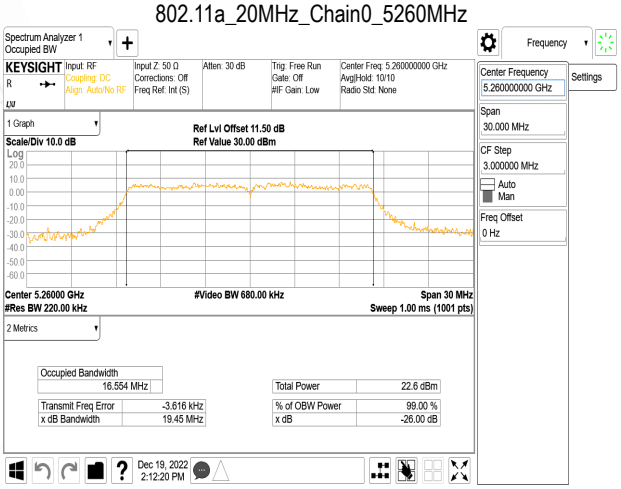
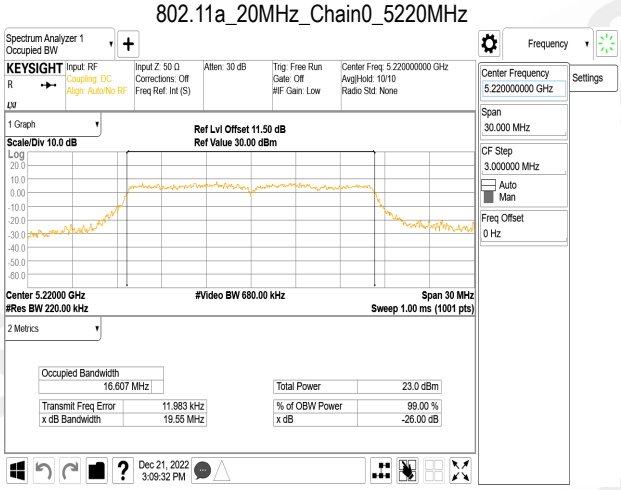
802.11a_20MHz_Chain0_5180MHz



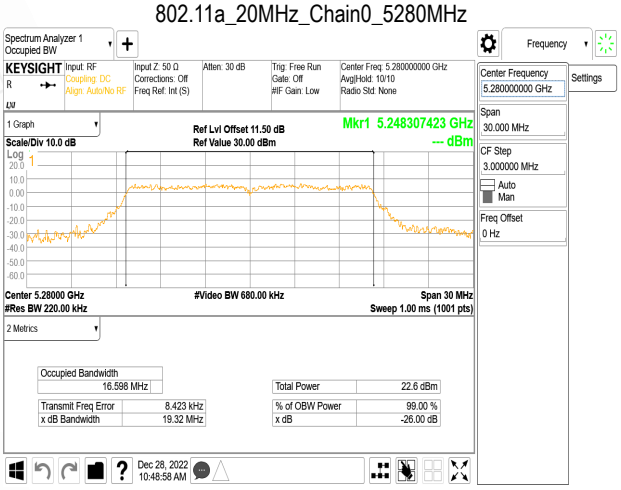
802.11a_20MHz_Chain0_5260MHz



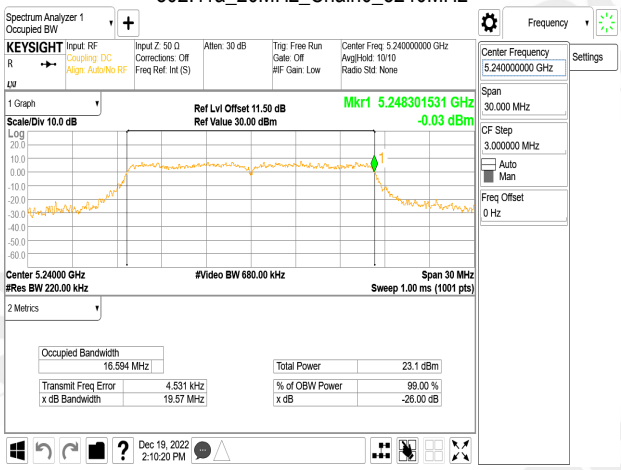
802.11a_20MHz_Chain0_5220MHz



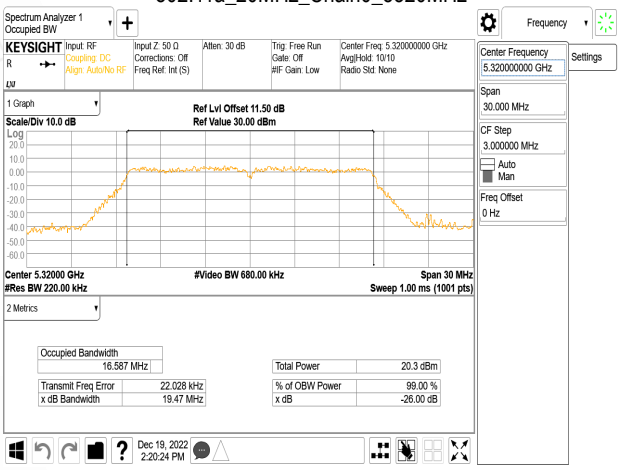
802.11a_20MHz_Chain0_5280MHz



802.11a_20MHz_Chain0_5240MHz



802.11a_20MHz_Chain0_5320MHz



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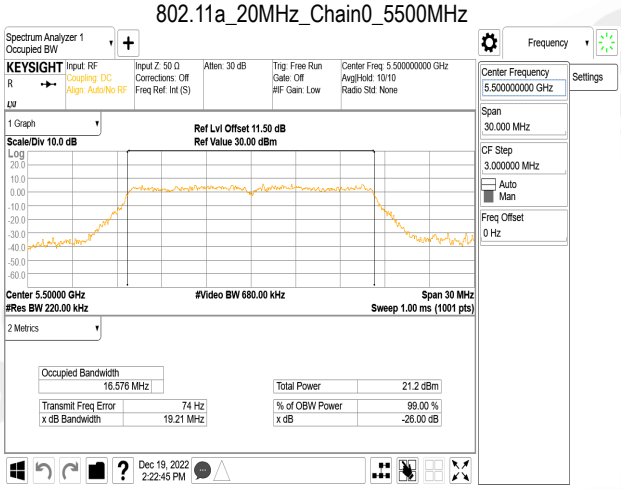
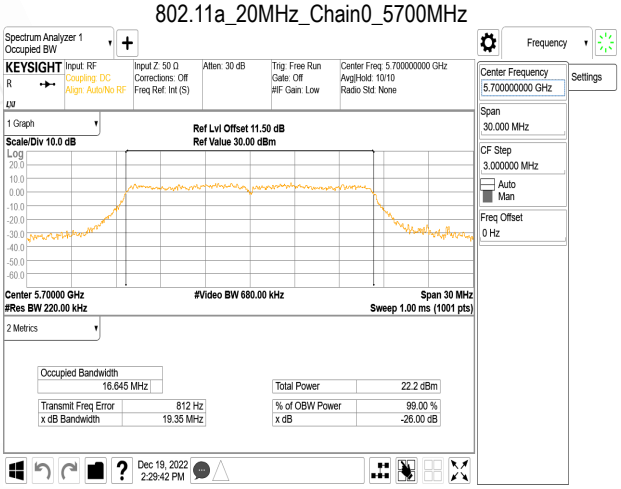
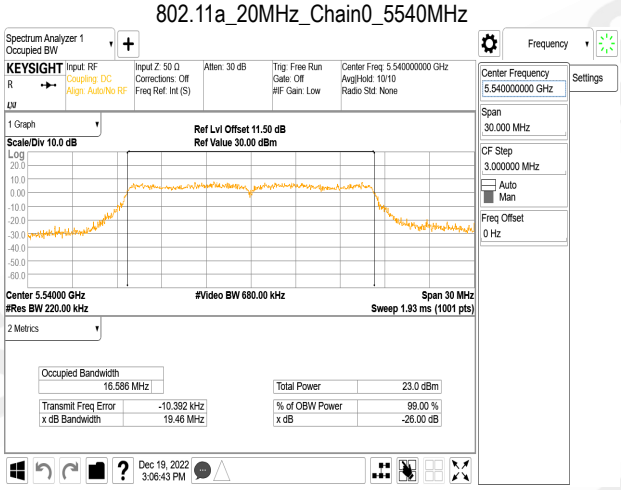
802.11a_20MHz_Chain0_5500MHz



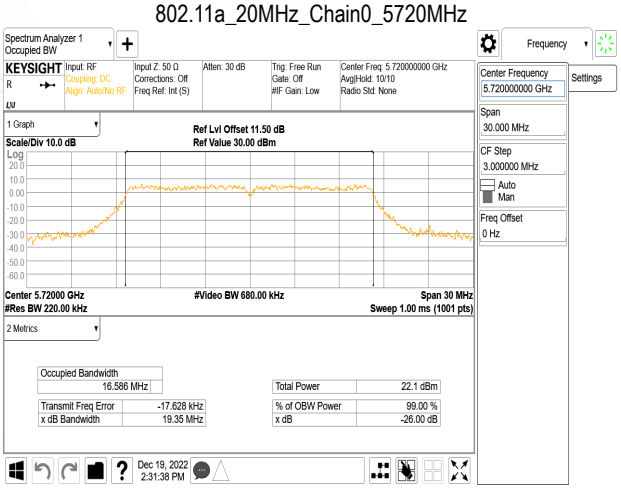
802.11a_20MHz_Chain0_5700MHz



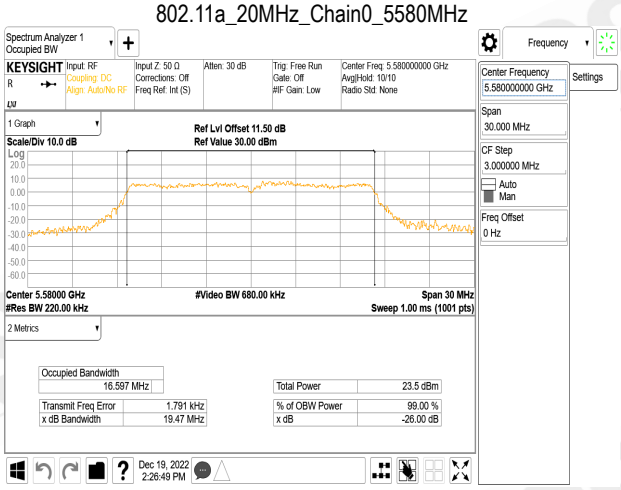
802.11a_20MHz_Chain0_5540MHz



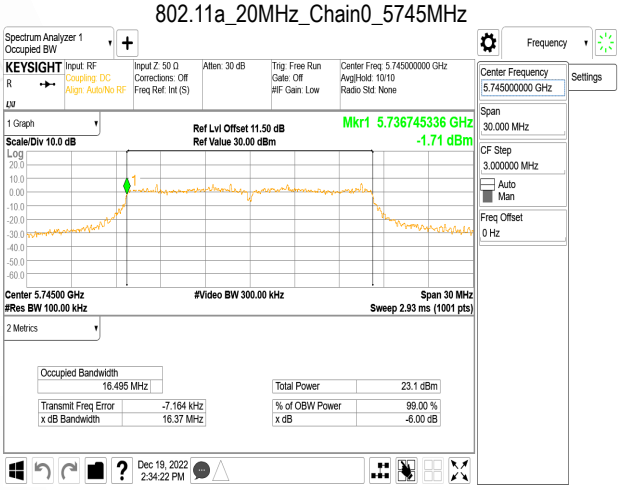
802.11a_20MHz_Chain0_5720MHz



802.11a_20MHz_Chain0_5580MHz



802.11a_20MHz_Chain0_5745MHz



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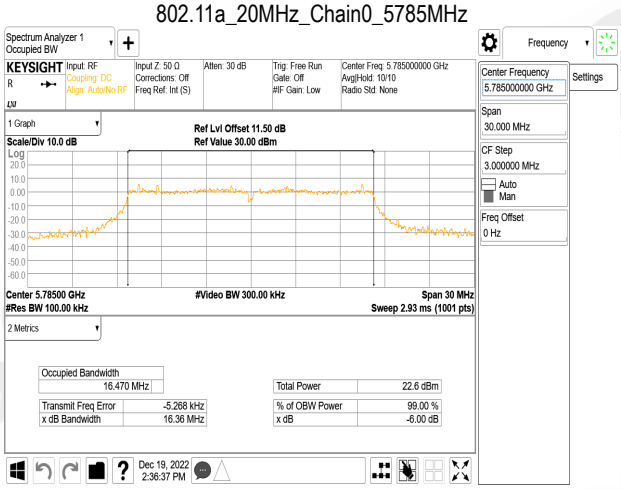
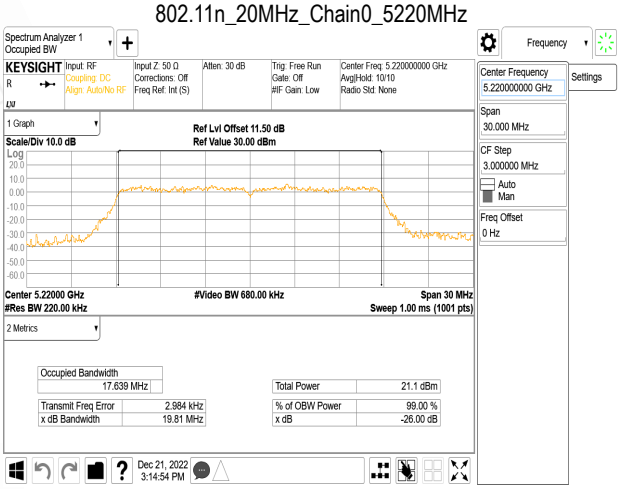
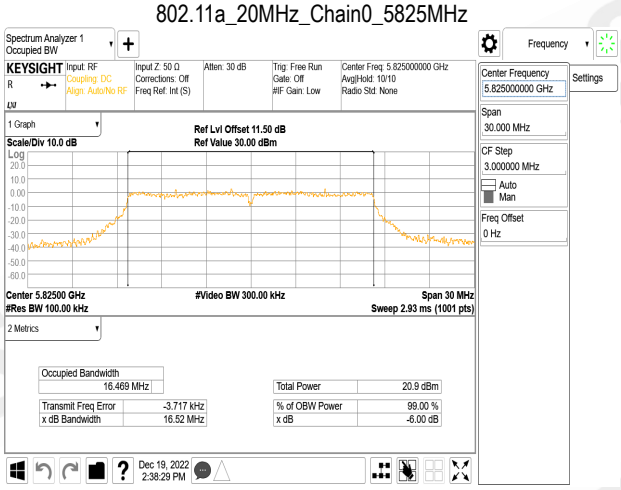
802.11a_20MHz_Chain0_5785MHz



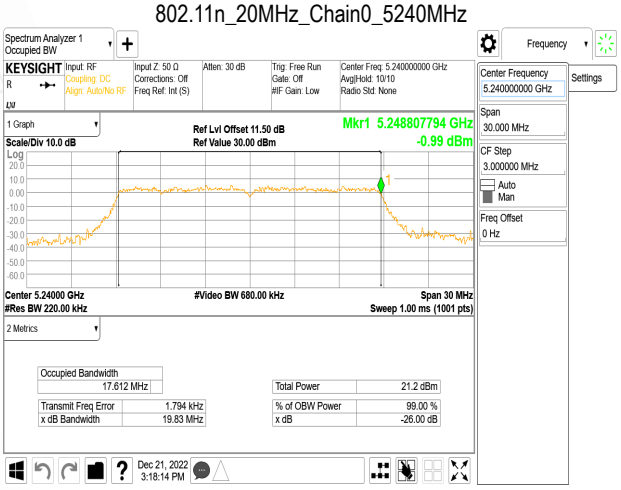
802.11n_20MHz_Chain0_5220MHz



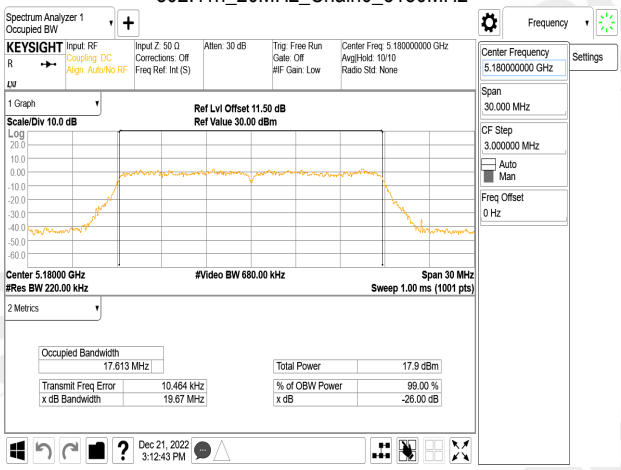
802.11a_20MHz_Chain0_5825MHz



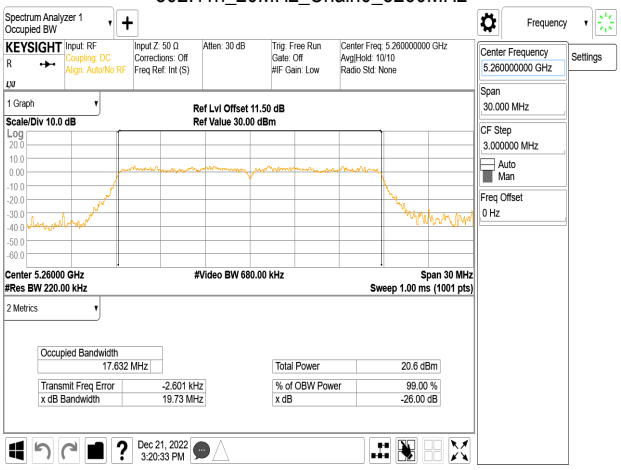
802.11n_20MHz_Chain0_5240MHz



802.11n_20MHz_Chain0_5180MHz



802.11n_20MHz_Chain0_5260MHz



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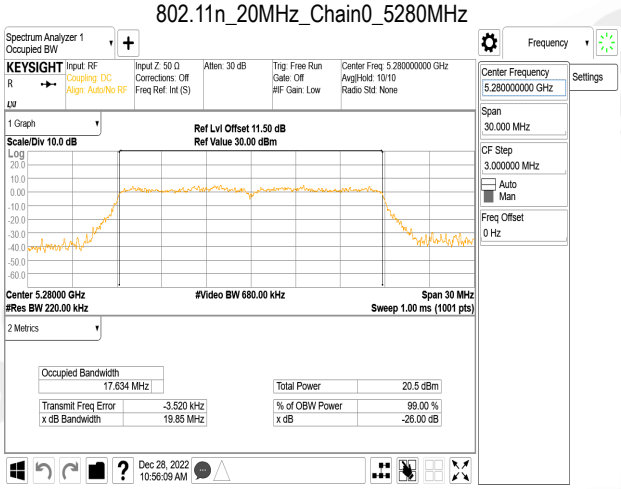
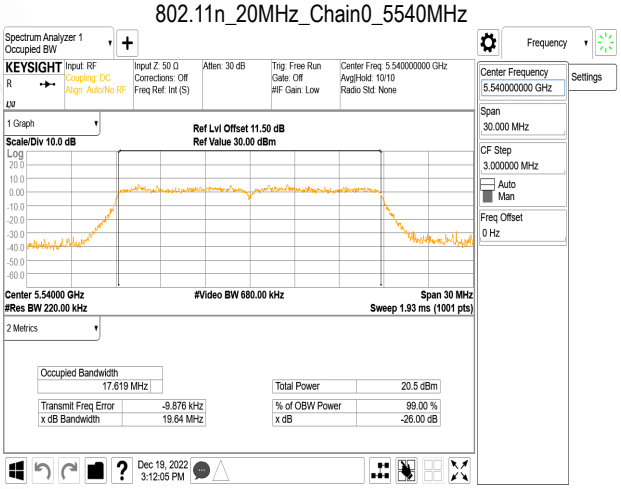
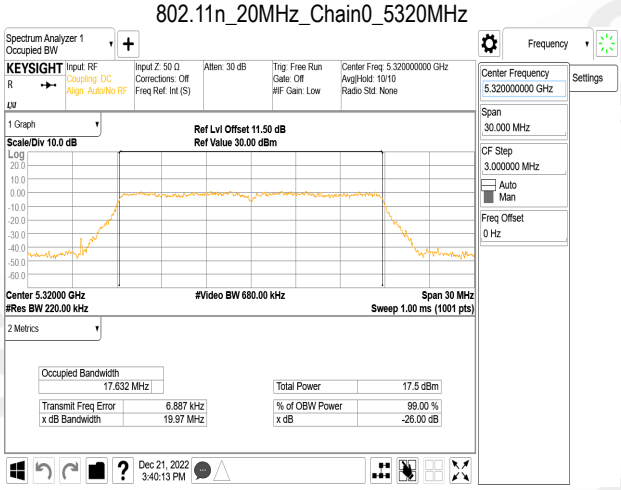
802.11n_20MHz_Chain0_5280MHz



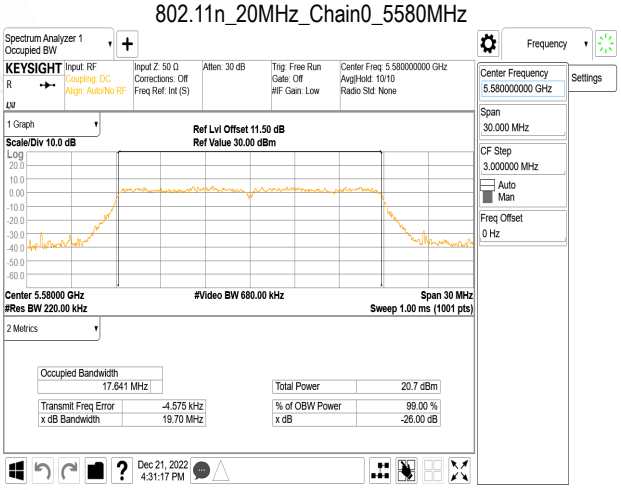
802.11n_20MHz_Chain0_5540MHz



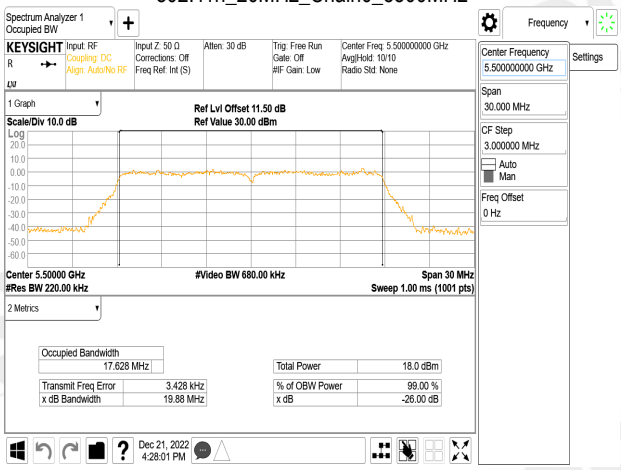
802.11n_20MHz_Chain0_5320MHz



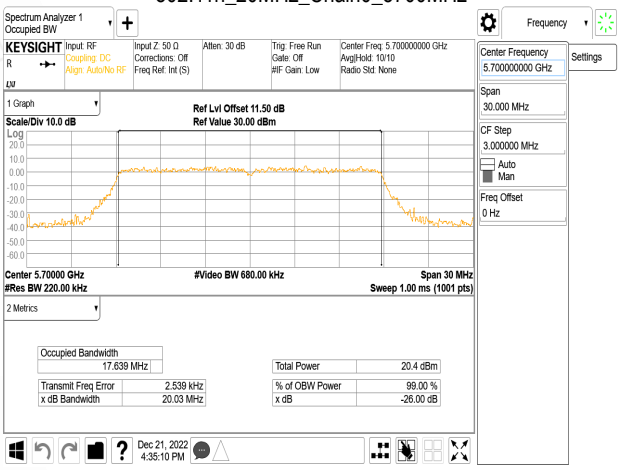
802.11n_20MHz_Chain0_5580MHz



802.11n_20MHz_Chain0_5500MHz



802.11n_20MHz_Chain0_5700MHz



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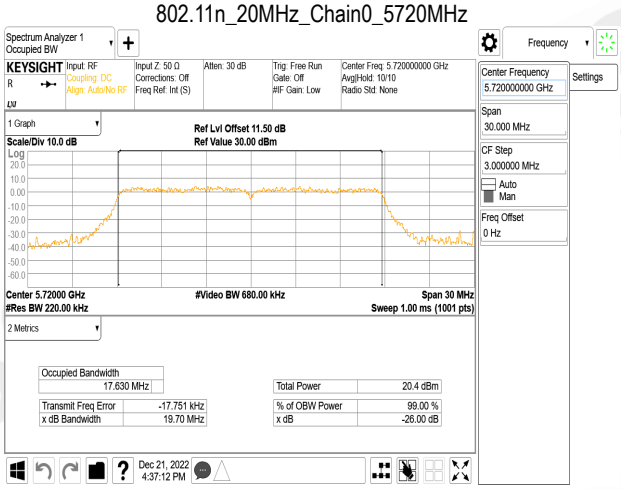
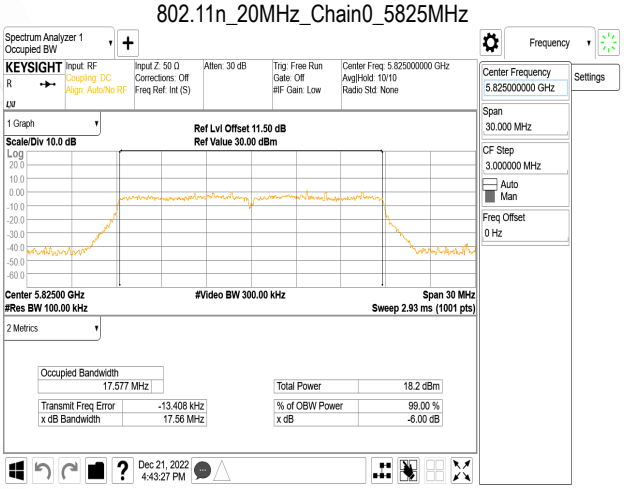
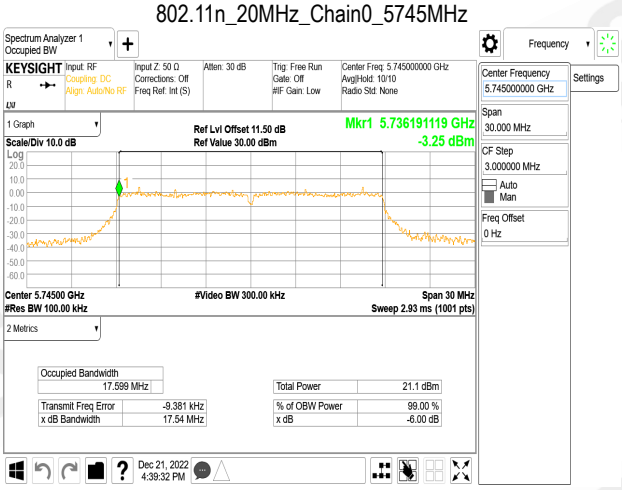
802.11n_20MHz_Chain0_5720MHz



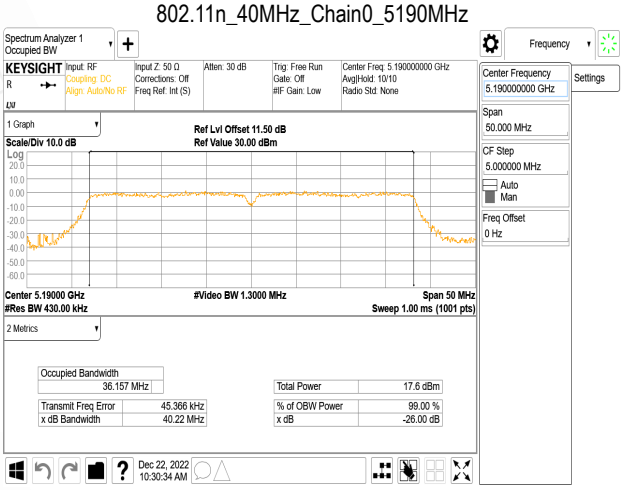
802.11n_20MHz_Chain0_5825MHz



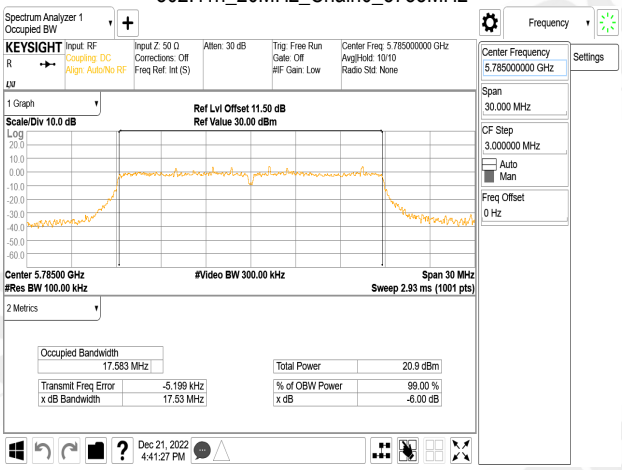
802.11n_20MHz_Chain0_5745MHz



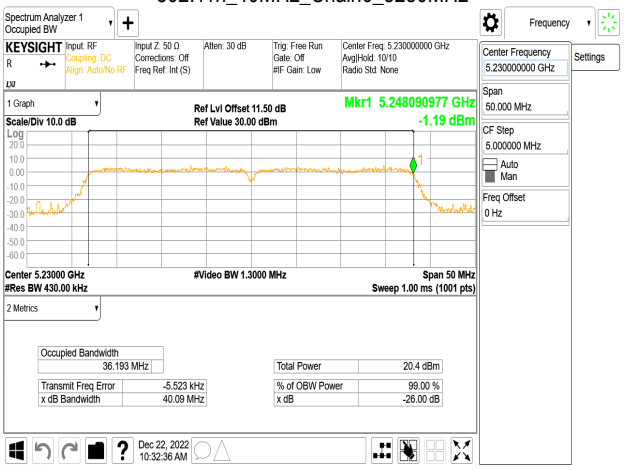
802.11n_40MHz_Chain0_5190MHz



802.11n_20MHz_Chain0_5785MHz



802.11n_40MHz_Chain0_5230MHz



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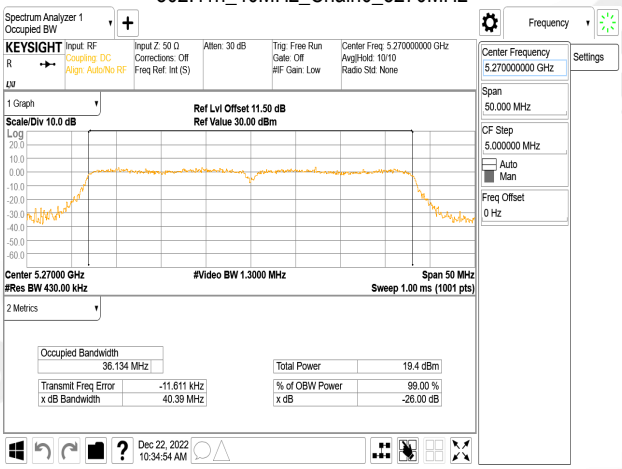
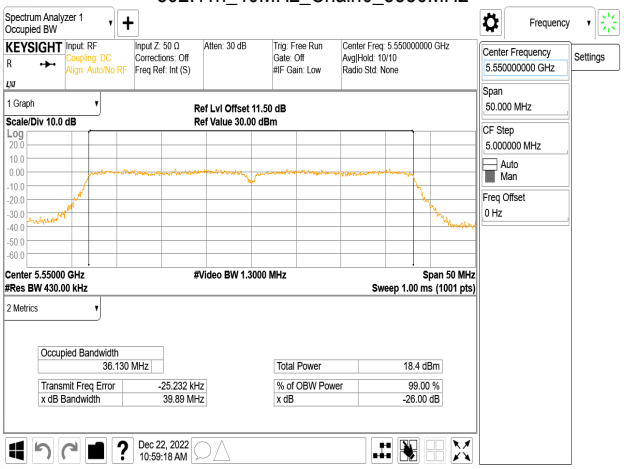
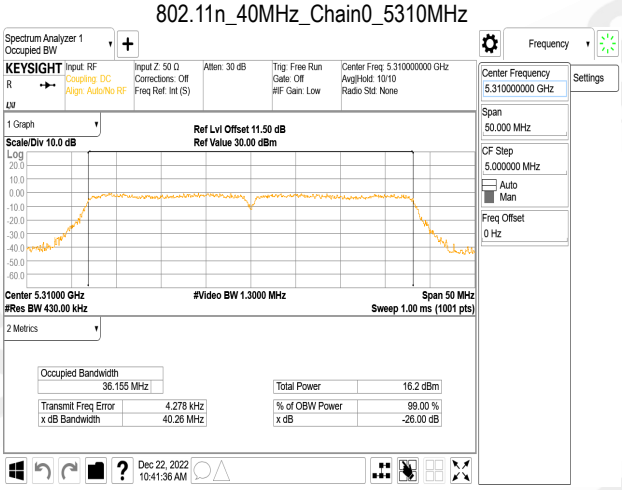
802.11n_40MHz_Chain0_5270MHz



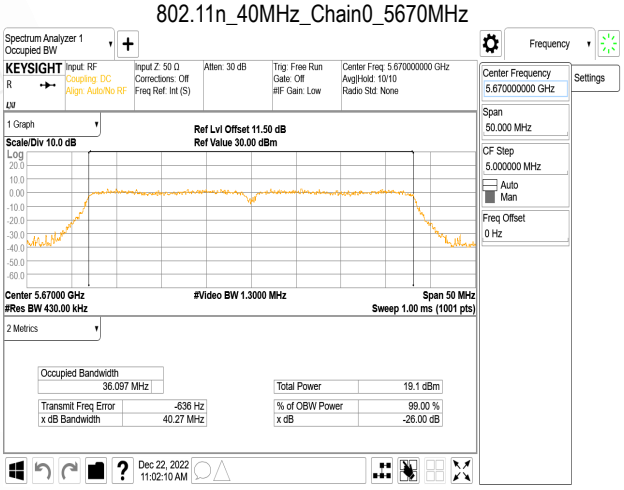
802.11n_40MHz_Chain0_5550MHz



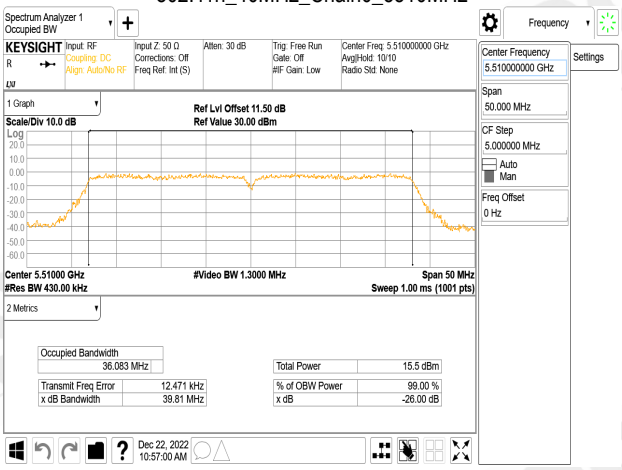
802.11n_40MHz_Chain0_5310MHz



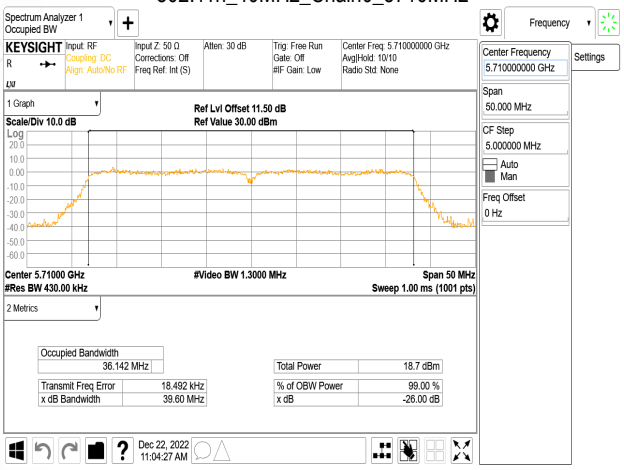
802.11n_40MHz_Chain0_5670MHz



802.11n_40MHz_Chain0_5510MHz



802.11n_40MHz_Chain0_5710MHz



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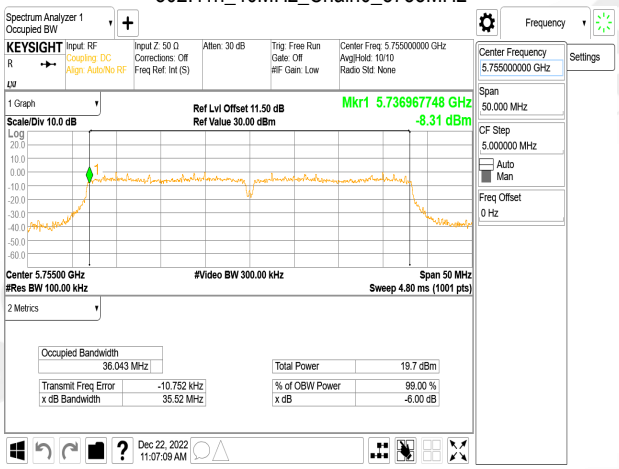
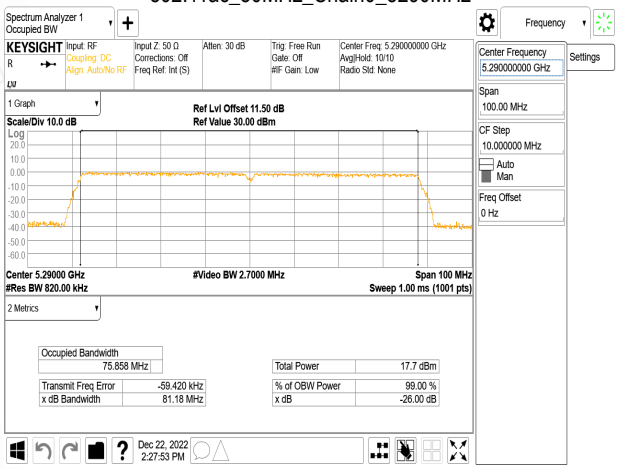
802.11n_40MHz_Chain0_5755MHz



802.11ac_80MHz_Chain0_5290MHz



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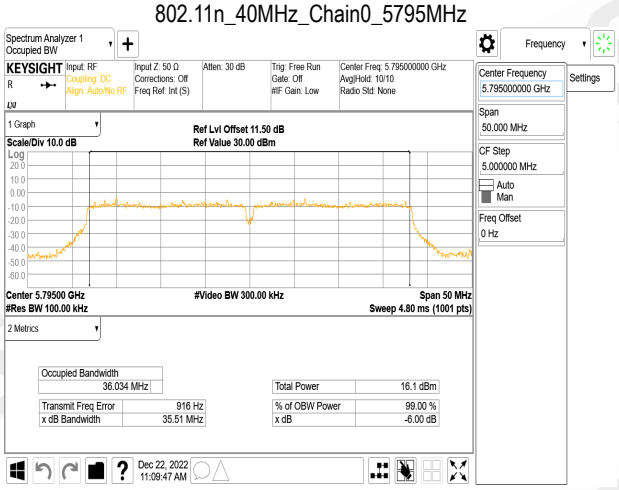
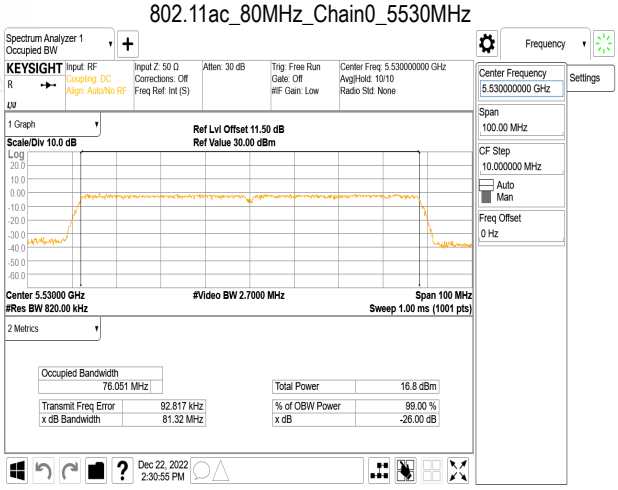
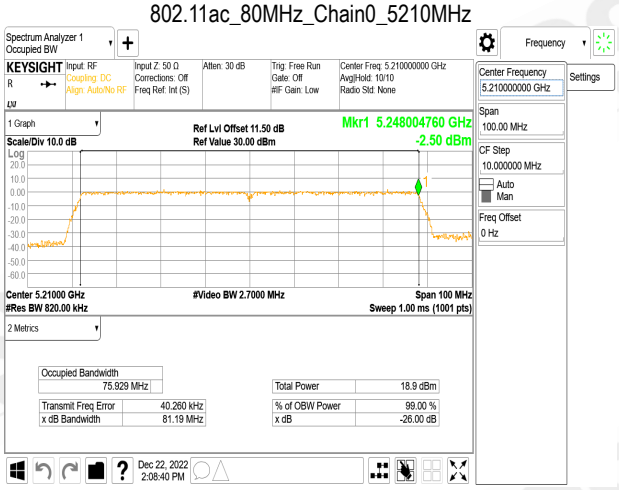


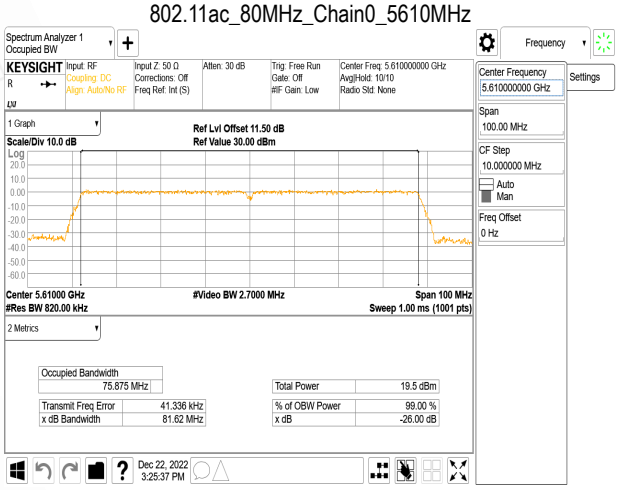
802.11ac_80MHz_Chain0_5530MHz



802.11ac_80MHz_Chain0_5210MHz



802.11ac_80MHz_Chain0_5610MHz



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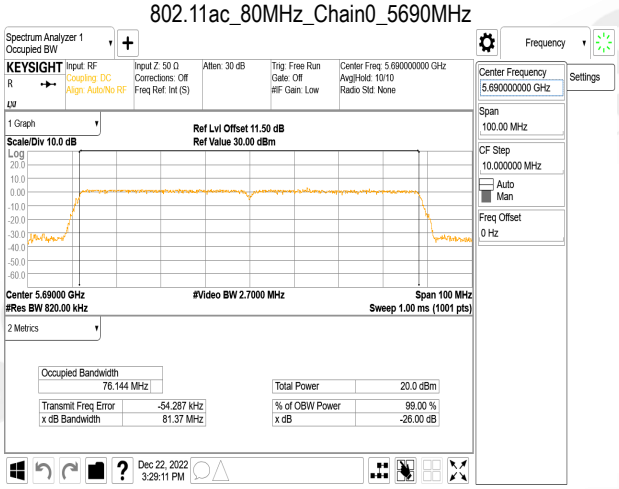
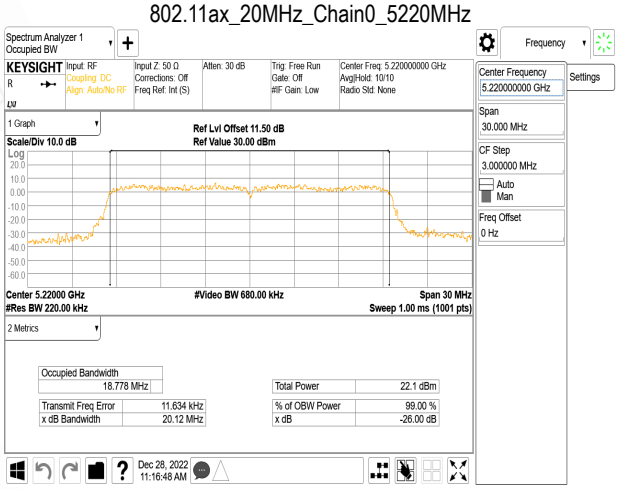
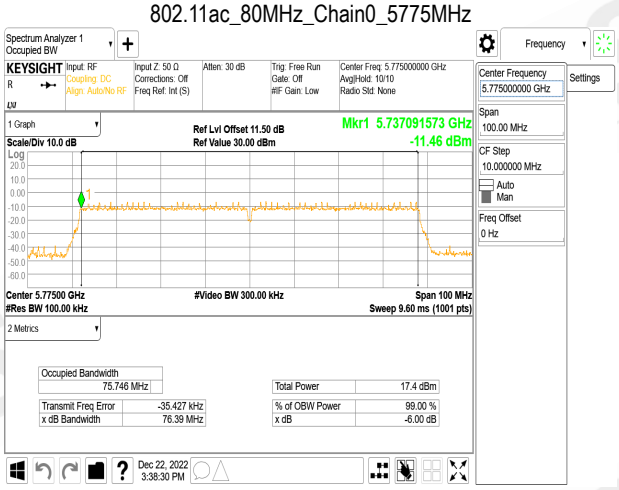
802.11ac_80MHz_Chain0_5690MHz



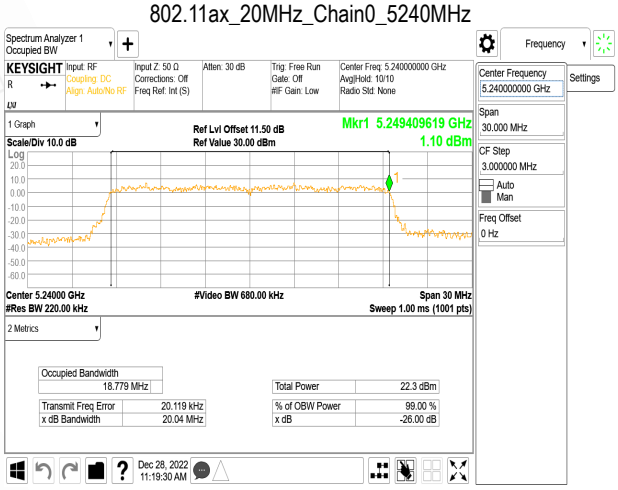
802.11ax_20MHz_Chain0_5220MHz



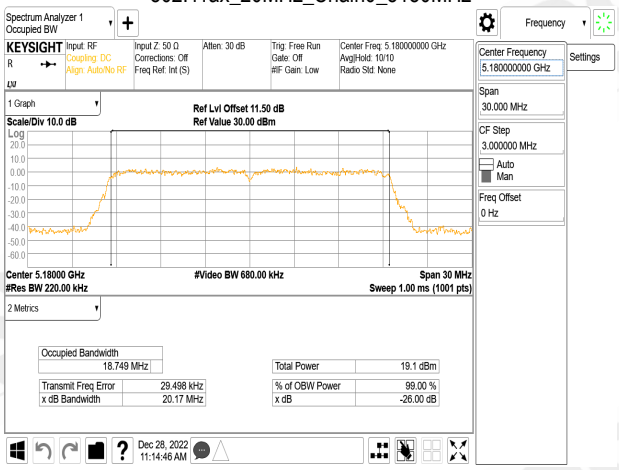
802.11ac_80MHz_Chain0_5775MHz



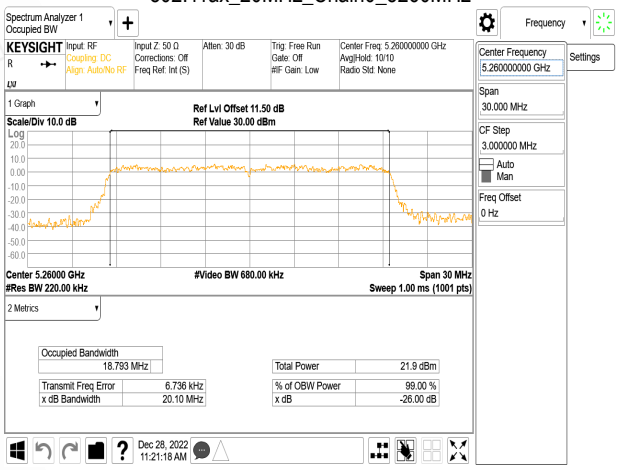
802.11ax_20MHz_Chain0_5240MHz



802.11ax_20MHz_Chain0_5180MHz



802.11ax_20MHz_Chain0_5260MHz



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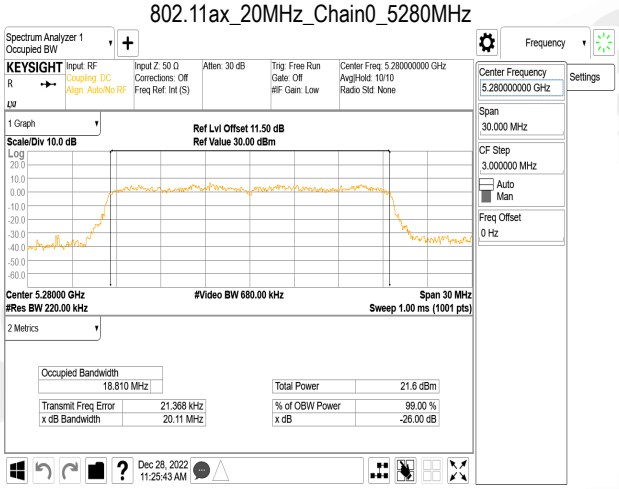
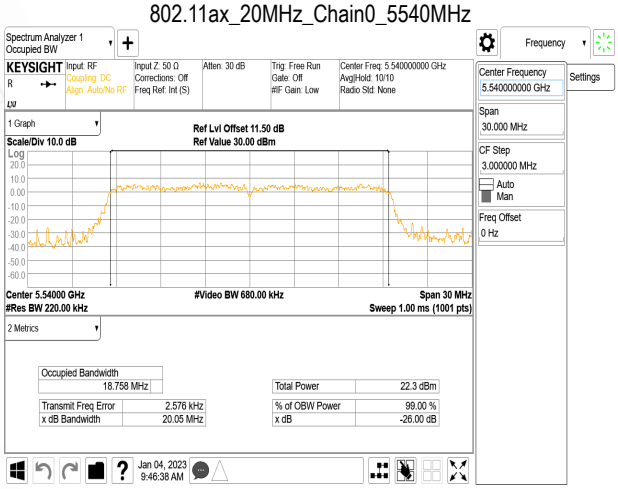
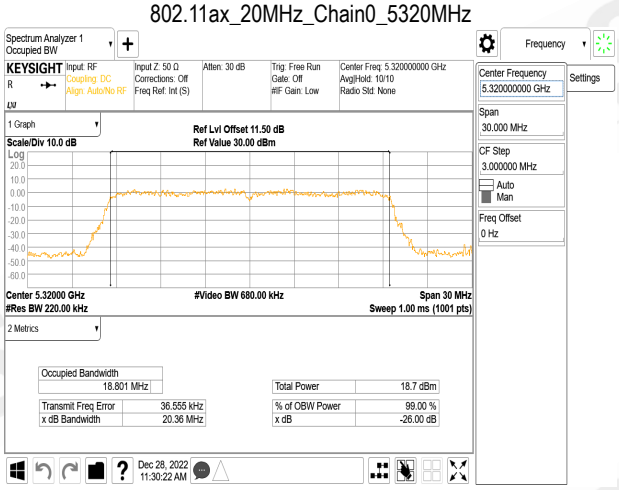
802.11ax_20MHz_Chain0_5280MHz



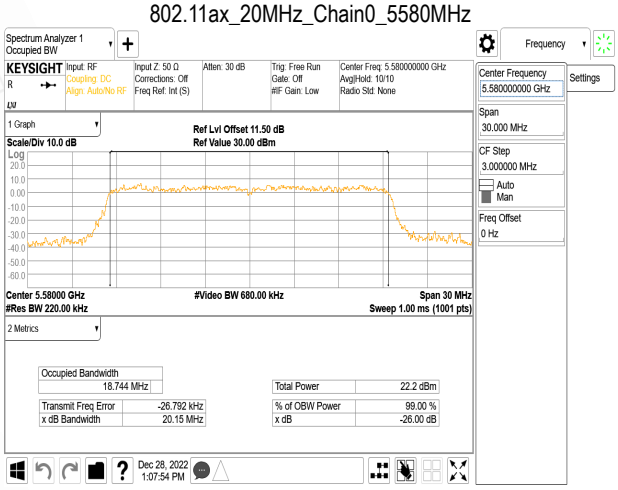
802.11ax_20MHz_Chain0_5540MHz



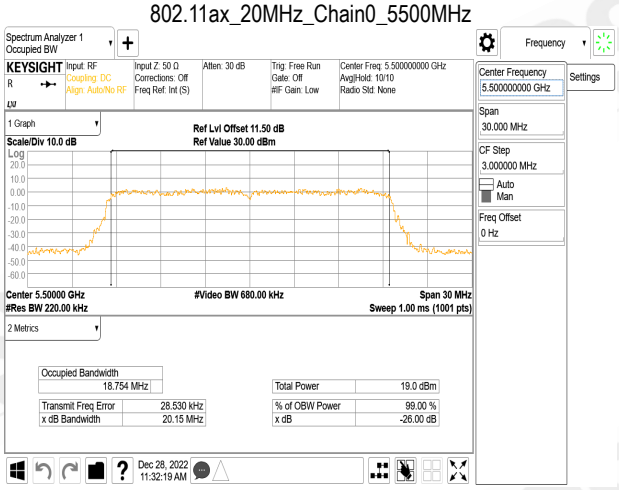
802.11ax_20MHz_Chain0_5320MHz



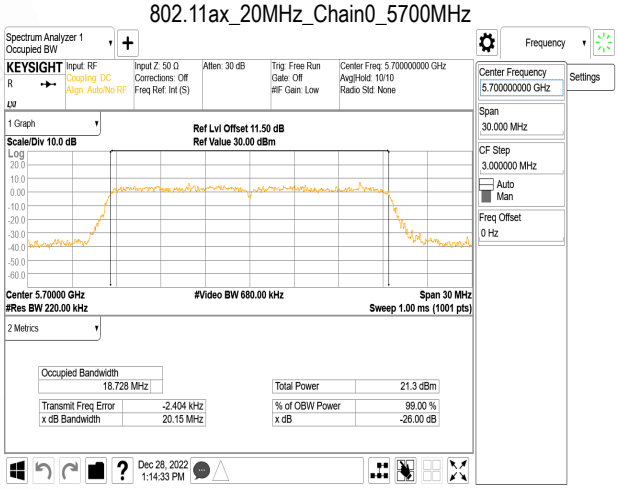
802.11ax_20MHz_Chain0_5580MHz



802.11ax_20MHz_Chain0_5500MHz



802.11ax_20MHz_Chain0_5700MHz



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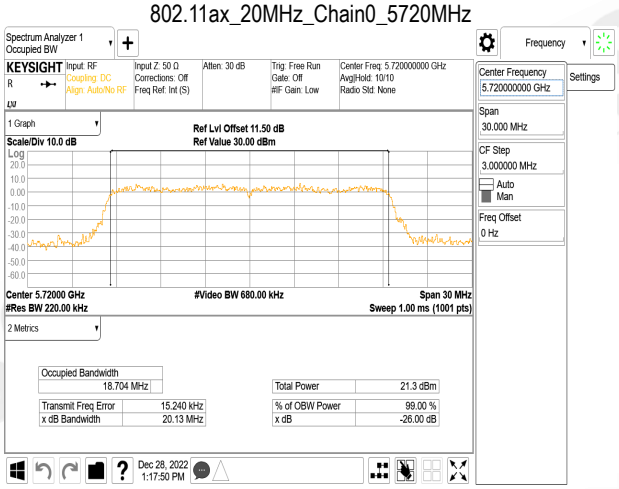
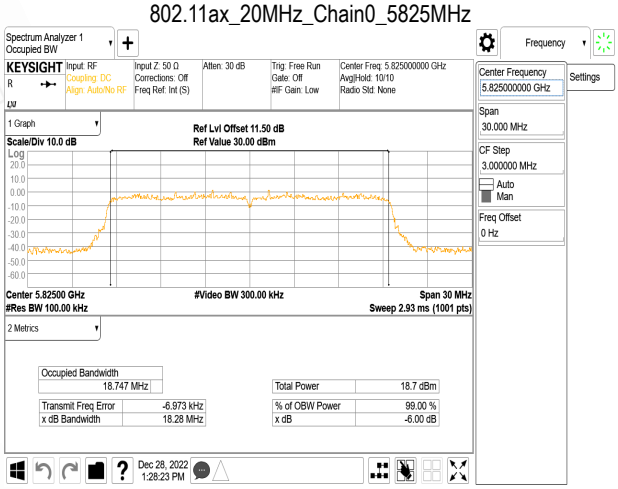
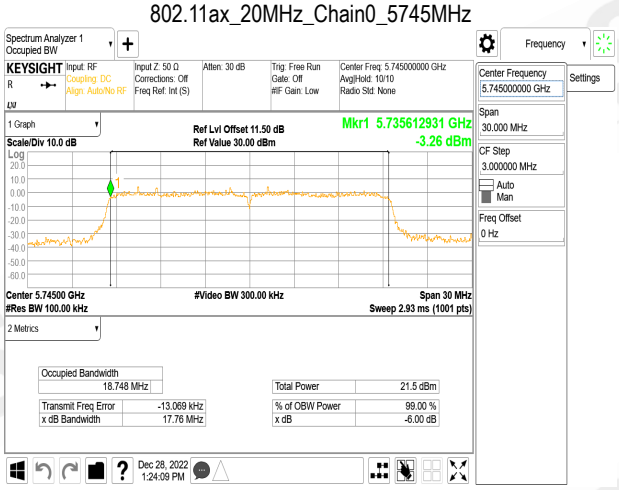
802.11ax_20MHz_Chain0_5720MHz



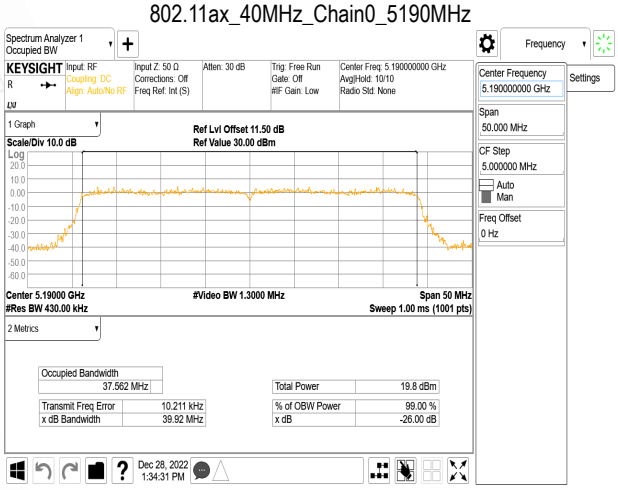
802.11ax_20MHz_Chain0_5825MHz



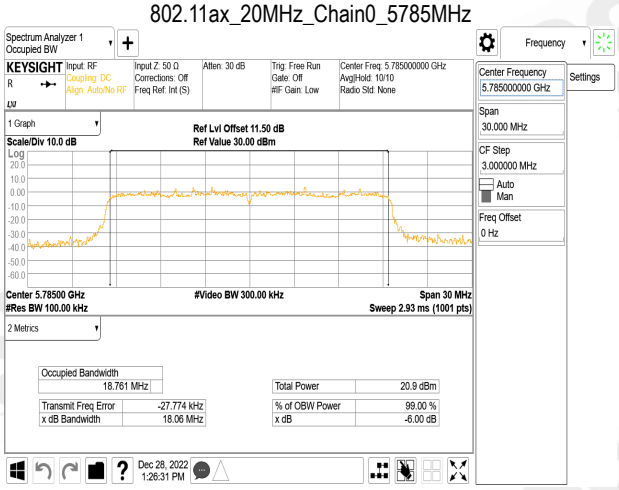
802.11ax_20MHz_Chain0_5745MHz



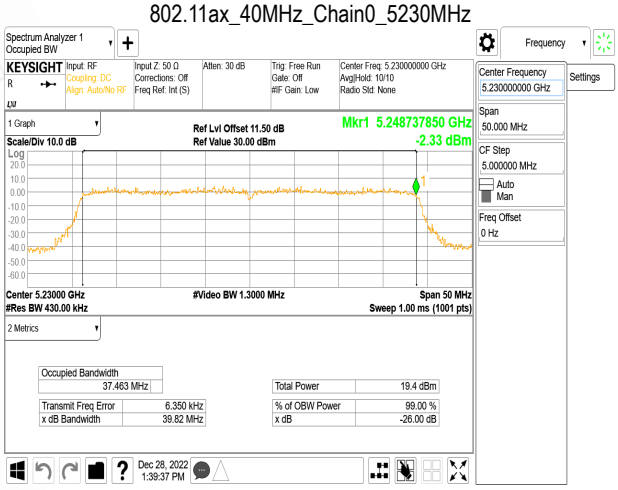
802.11ax_40MHz_Chain0_5190MHz



802.11ax_20MHz_Chain0_5785MHz



802.11ax_40MHz_Chain0_5230MHz



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