ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

FCC Applicant:	CASTLES TECHNOLOGY CO., LTD. 6F., NO. 207-5, SEC. 3, BEIXIN RD., XINDIAN DISTRICT, NEW TAIPEI CITY 23143, TAIWAN (R.O.C)
FCC Manufacturer:	CASTLES TECHNOLOGY CO., LTD. 6F., NO. 207-5, SEC. 3, BEIXIN RD., XINDIAN DISTRICT, NEW TAIPEI CITY 23143, TAIWAN (R.O.C)
ISED Applicant:	CASTLES TECHNOLOGY CO., LTD. 6F., NO. 207-5, SEC. 3, BEISHIN RD., XINDIAN DISTRICT, NEW TAIPEI CITY 23143, Taiwan (R.O.C)
ISED Manufacturer:	CASTLES TECHNOLOGY CO., LTD. 6F., NO. 207-5, SEC. 3, BEISHIN RD., XINDIAN DISTRICT, NEW TAIPEI CITY 23143, Taiwan (R.O.C)
Product Name:	Smart module
Brand Name:	CASTLES TECHNOLOGY
Model No.:	SNM758
Model Difference:	N/A
Report Number:	TERF2309002387E2
FCC ID	WIYSNM758L
IC:	27350-SNM758L
Date of EUT Received:	July 24, 2023
Date of Test:	July 24,2023～December 05,2023
Issue Date:	December 08, 2023

Approved By Vito Pei

Vito Pei

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
TERF2309002387E2	00	Original	Nov. 3, 2023	Candice Li	
TERF2309002387E2	01	Modify comments	Dec. 5, 2023	Candice Li	*
TERF2309002387E2	02	Modify comments	Dec. 8, 2023	Candice Li	*

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:	Smart module
Brand Name:	CASTLES TECHNOLOGY
Model No.:	SNM758
Model Difference:	N/A
Hardware Version:	N/A
Firmware Version:	N/A
EUT Series No.:	173232315138
Product Name of Host:	POS Terminal
Brand Name of Host:	CASTLES TECHNOLOGY
Model No. of Host:	S2L
Power Supply:	12Vdc from Adapter
Test Software (Name/Version)	Qualcomm® Radio Control Toolkit / 4.0.00206.0

1.2 Modulation & Data Rate

Modulation type:	64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11a,11n
	256QAM, 64QAM, 16QAM, QPSK, BPSK for OFDM in 802.11ac
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

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1.3 Antenna Designation

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
PIFA	AWAN	ALP6P-10000	5150~5250	1.77
			5250~5350	2.05
			5470~5725	2.57
			5725~5850	0.82

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

Wi-Fi	Frequency Range	Channels	Rated Power(Avg) (dBm) (Worst Case)	Modulation Technology
a/ n_HT/ ac_VHT 20M	5180~5240	4	10.96 dBm	OFDM
	5745-5825	5	8.47 dBm	OFDM
n_HT/ ac_VHT 40M	5190~5230	2	9.65 dBm	OFDM
	5755-5795	2	8.10 dBm	OFDM
ac_VHT 80M	5210	1	3.54 dBm	OFDM
	5775	1	6.81 dBm	OFDM

1.5 ISED

WLAN 5 GHz for ISED (Slave)

Wi-Fi	Frequency Range	Channels	EIRP/Avg	Rated Power(EIRP/Avg) (dBm) (Worst Case)	Modulation Technology
a/ n_HT/ ac_VHT 20M	5180~5240	4	EIRP	12.73 dBm	OFDM
	5745-5825	5	Avg	8.47 dBm	OFDM
n_HT/ ac_VHT 40M	5190~5230	2	EIRP	11.42 dBm	OFDM
	5755-5795	2	Avg	8.10 dBm	OFDM
ac_VHT 80M	5210	1	EIRP	5.31 dBm	OFDM
	5775	1	Avg	6.81 dBm	OFDM

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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 3 Aug. 2023
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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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 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.

2.3.2 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

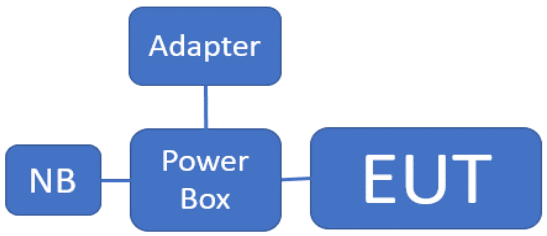
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.
There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

2.4.2 For all conducted test items:

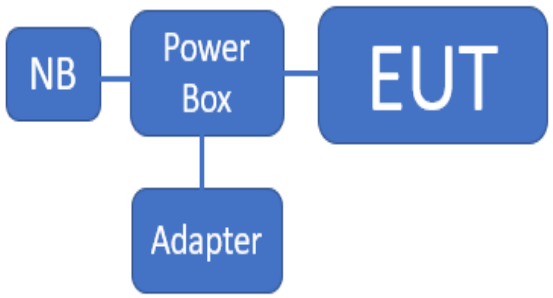
The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

2.5 Test Configuration

Conducted Setup



Radiated Setup



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2.6 Control Unit(s)

Conducted Emission Test Site: Conducted G					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
POE	CASTLES	SATURN-PX	N/A	N/A	N/A
Adapter	ABP	AD0181-1201000UC	N/A	N/A	N/A
USB TypeC Cable	CHANG YANG ELECTRONICS CO., LTD.	CY-AS-HK0059	N/A	N/A	N/A
Notebook	Lenovo	T470	P0001293	N/A	N/A

Radiated Emission Test Site: SAC G					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Power Box	CASTLES	SATURN-PX	N/A	N/A	N/A
Adapter	ABP	AD0181-1201000UC	N/A	N/A	N/A
USB TypeC Cable	CHANG YANG ELECTRONICS CO., LTD.	CY-AS-HK0059	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
§15.407(e)	RSS-Gen §6.7	Emission Bandwidth	Compliant
§15.407(a)	RSS-247 §6.2.1~4 (1) RSS-247 §6.2.5 (2)	Maximum Conducted Output Power	Compliant
§15.407(a)	RSS-247 §6.2.1~ 4 (1) RSS-247 §6.2.5 (2)	Power Spectral Density	Compliant
§15.205 §15.209 §15.407(b)	RSS-247 §6.2.1~3 (2) §6.2.4 (3) RSS-247 §6.2.5 (3)	Undesirable Radiated Emissions	Compliant
§15.407(c)	RSS-247 §6.4	Transmission in case of Absence of Information	Compliant
§15.203	N/A	Antenna Requirement	Compliant

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4 DESCRIPTION OF TEST MODES

4.1 Operating Frequencies

UNII-1 5150 MHz ~ 5250MHz

20MHz	
CH	Freq. (MHz)
36	5180
40	5200
44	5220
48	5240

40MHz	
CH	Freq. (MHz)
38	5190
46	5230

80MHz	
CH	Freq. (MHz)
42	5210

UNII-3 5725 MHz ~ 5850MHz

20MHz	
CH	Freq. (MHz)
149	5745
153	5765
157	5785
161	5805
165	5825

40MHz	
CH	Freq. (MHz)
151	5755
159	5795

80MHz	
CH	Freq. (MHz)
155	5775

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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	
v	802.11 a	v	Ch0		Ch1		Ch2		Ch3	v	1TX		1TX
v	802.11 n	v	Ch0		Ch1		Ch2		Ch3	v	1TX		1TX
v	802.11 ac	v	Ch0		Ch1		Ch2		Ch3	v	1TX		1TX

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 (MHz)	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)	ANTENNA PORT
802.11a	5180~5240	36 to 48	36,44,48	OFDM	6	ch0
	5745~5825	149 to 165	149,157,165			
802.11n_HT20	5180~5240	36 to 48	36,44,48	OFDM	MCS0	ch0
	5745~5825	149 to 165	149,157,165			
802.11n_HT40	5190~5230	38 to 46	38,46	OFDM	MCS0	ch0
	5755~5795	151 to 159	151,159			
802.11ac_VHT80	5210	42	42	OFDM	MCS0	ch0
	5775	155	155			

TRANSMIT 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	1TX
	5745~5825	149 to 165	157			

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TRANSMIT 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	1TX
	5745~5825	149 to 165	149,157,165			
802.11n_HT20	5180~5240	36 to 48	36,44,48	OFDM	MCS0	1TX
	5745~5825	149 to 165	149,157,165			
802.11n_HT40	5190~5230	38 to 46	38,46	OFDM	MCS0	1TX
	5755~5795	151 to 159	151,159			
802.11ac_VHT80	5210	42	42	OFDM	MCS0	1TX
	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		
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 Condcuted Measurement

Conducted Emission Test Site: Conducted G					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	KEYSIGHT	N9010B	MY60240506	06/20/2023	06/19/2024
Power Meter	Anritsu	ML2496A	1512003	09/08/2023	09/07/2024
Power Sensor	Anritsu	MA2411B	1339378	09/08/2023	09/07/2024
Power Sensor	Anritsu	MA2411B	1339379	09/08/2023	09/07/2024
Test Software	SGS Taiwan	Radio Test Software	Ver.21	N.C.R	N.C.R
Attenuator	Woken	WATT-218FS-10	RF16	11/15/2023	11/14/2024
DC Block	PASTERNACK	PE8210	RF158	11/15/2023	11/14/2024
Attenuator	Woken	WATT-218FS-10	RF16	11/16/2022	11/15/2023
DC Block	PASTERNACK	PE8210	RF158	11/16/2022	11/15/2023

6.2 Radiated Measurement

Radiated Emission Test Site: SAC G					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Broadband Antenna	SCHWARZBECK	VULB 9168	1206	01/17/2023	01/16/2024
Horn Antenna	Schwarzbeck	BBHA9170	184	12/30/2022	12/29/2023
Horn Antenna	RF SPIN	DRH18-E	210105A18E	04/18/2023	04/17/2024
Loop Antenna	ETS.LINDGREN	6502	14303	05/23/2023	05/22/2024
3m Site NSA	SGS	966 chamber G	N/A	03/30/2023	03/29/2024
Spectrum Analyzer	KEYSIGHT	N9010A	MY51440113	07/17/2023	07/16/2024
Test Software	audix	e3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R
Pre-Amplifier	EMC Instruments	EMC18405SEE	980881	10/25/2022	10/24/2023
Pre-Amplifier	EMC Instruments	EMC330N	980781	03/15/2023	03/14/2024
Pre-Amplifier	EMC Instruments	EMC118A45SE	980815	03/15/2023	03/14/2024
Coaxial Cable	EMC Instruments	EMCCFD400-NM-NM-8000-5000-2000	210216、210217、210218	03/15/2023	03/14/2024
Coaxial Cable	EMC Instruments	EMC104-SM-SM-8000-5000-5000	210219、210220、210221	03/15/2023	03/14/2024
Coaxial Cable	EMC Instruments	EMC105-NM-NM-5000-15000	210224、210306	03/15/2023	03/14/2024

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

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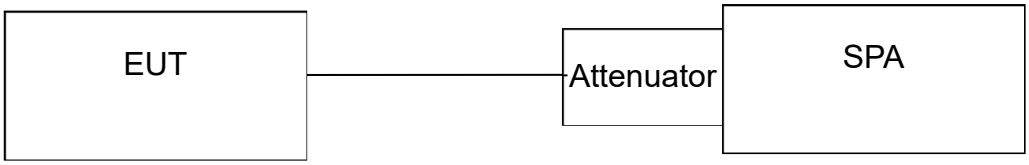
7 EMISSION BANDWIDTH MEASUREMENT

7.1 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.

7.2 Test Setup



7.3 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.
6. For 99% Bandwidth: Set the spectrum analyzer as
   RBW = 1% to 5%,
   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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7.4 Measurement Result

7.4.1 FCC Occupied Bandwidth

802.11a_Ch0

Freq. (MHz)	26dB BW (MHz)	10 Log (B) (dB)
5180	26.71	14.270
5220	35.90	15.550
5240	35.85	15.540

802.11n_HT20_Ch0

Freq. (MHz)	26dB BW (MHz)	10 Log (B) (dB)
5180	24.78	13.940
5220	36.31	15.600
5240	36.71	15.650

802.11a_Ch0

Freq. (MHz)	6dB BW (MHz)	10 Log (B) (dB)
5745	16.36	12.140
5785	16.37	12.140
5825	16.42	12.150

802.11n_HT20_Ch0

Freq. (MHz)	6dB BW (MHz)	10 Log (B) (dB)
5745	17.58	12.450
5785	17.04	12.310
5825	17.37	12.400

802.11a_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5240	5249.200000	< 5250
5745	5733.529683	> 5725

802.11n_HT20_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5240	5249.280000	< 5250
5745	5736.056443	> 5725

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802.11n_HT40_Ch0

Freq. (MHz)	26dB BW (MHz)	10 Log (B) (dB)
5190	42.61	16.300
5230	63.91	18.060

802.11n_HT40_Ch0

Freq. (MHz)	6dB BW (MHz)	10 Log (B) (dB)
5755	35.14	15.460
5795	35.12	15.460

802.11n_HT40_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5230	5248.090000	< 5250
5755	5736.891490	> 5725

802.11ac_VHT80_Ch0

Freq. (MHz)	26dB BW (MHz)	10 Log (B) (dB)
5210	83.46	19.210

802.11ac_VHT80_Ch0

Freq. (MHz)	6dB BW (MHz)	10 Log (B) (dB)
5775	71.36	18.530

802.11ac_VHT80_Ch0

Freq. (MHz)	Measured Freq. (MHz)	Limit (MHz)
5210	5247.319255	< 5250
5775	5737.061067	> 5725

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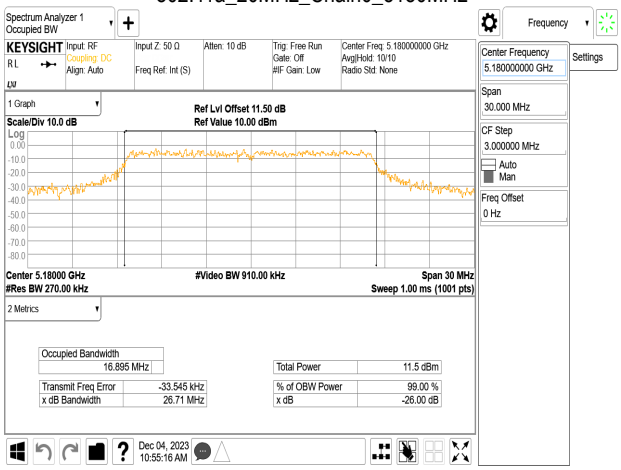
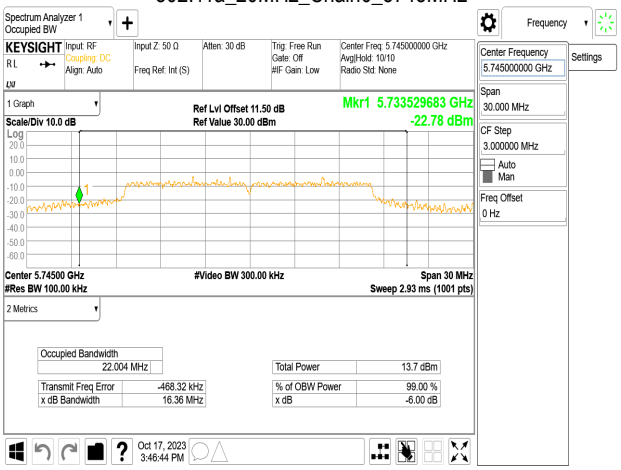
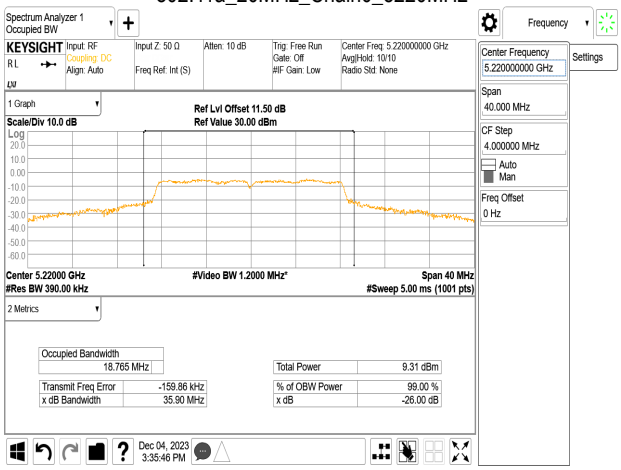
802.11a_20MHz_Chain0_5180MHz



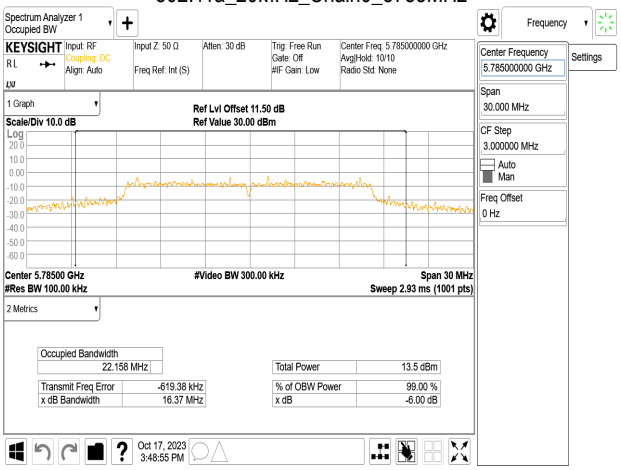
802.11a_20MHz_Chain0_5745MHz



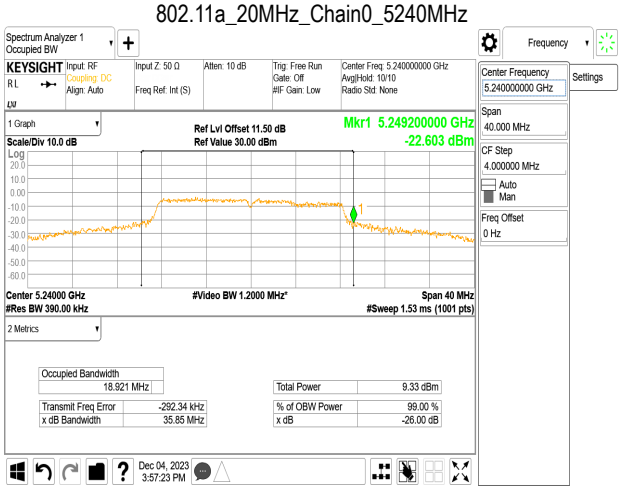
802.11a_20MHz_Chain0_5220MHz



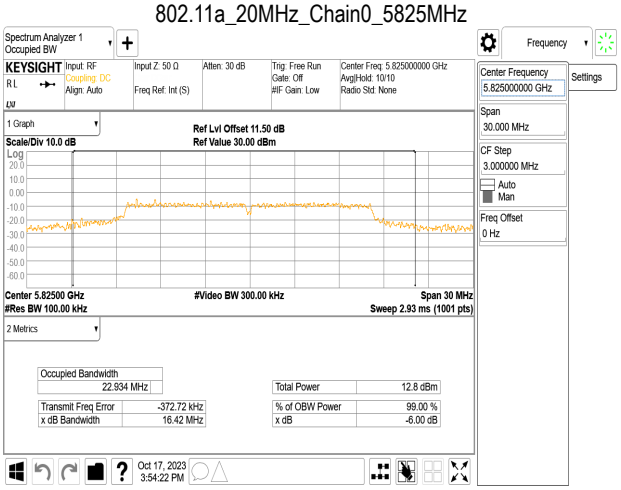
802.11a_20MHz_Chain0_5785MHz



802.11a_20MHz_Chain0_5240MHz



802.11a_20MHz_Chain0_5825MHz



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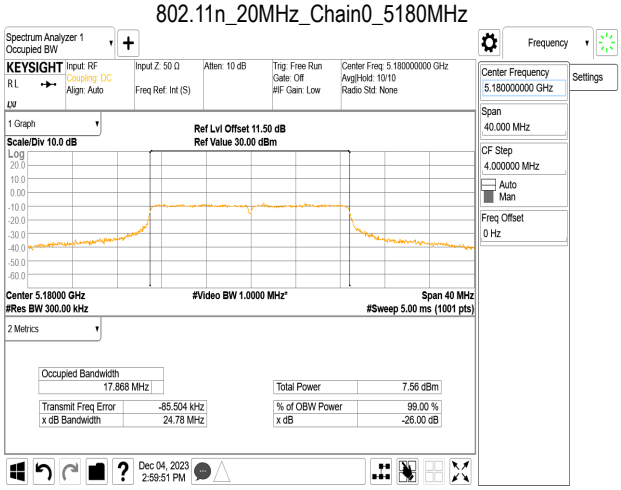
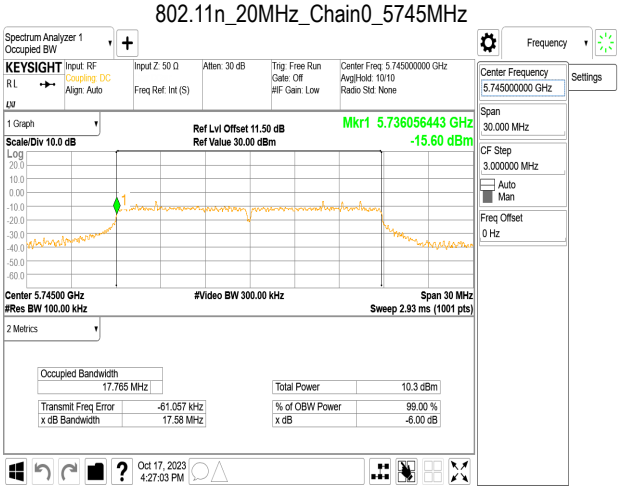
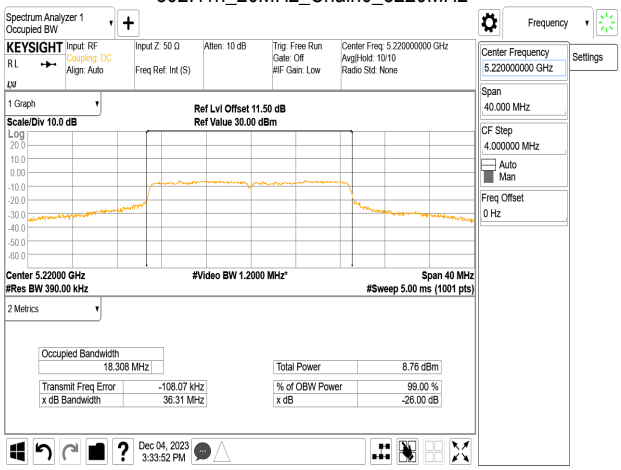
802.11n_20MHz_Chain0_5180MHz



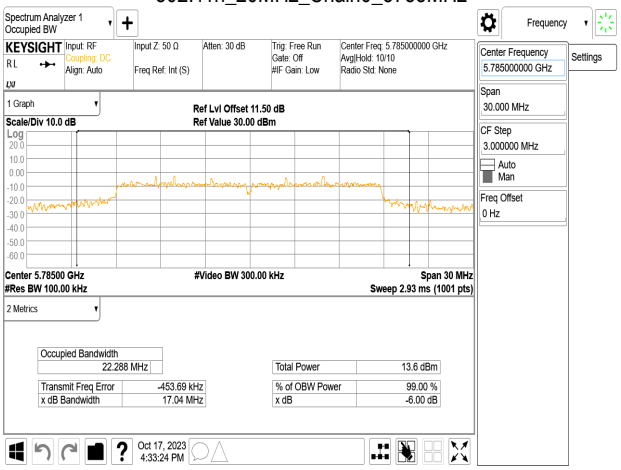
802.11n_20MHz_Chain0_5745MHz



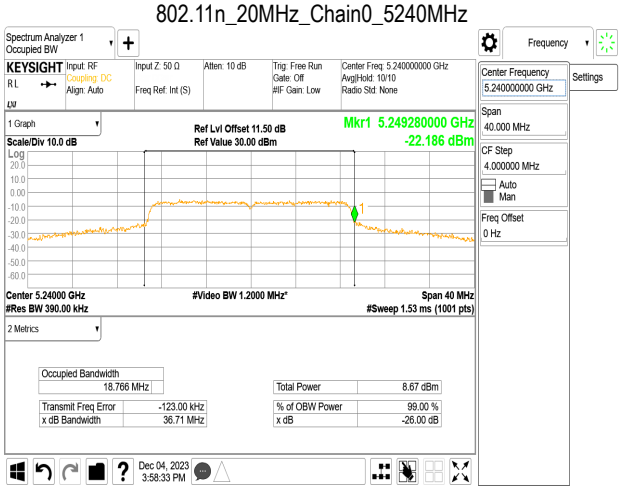
802.11n_20MHz_Chain0_5220MHz



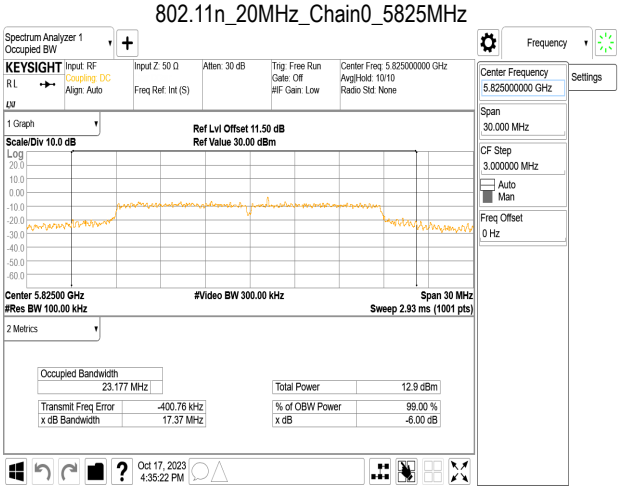
802.11n_20MHz_Chain0_5785MHz



802.11n_20MHz_Chain0_5240MHz



802.11n_20MHz_Chain0_5825MHz



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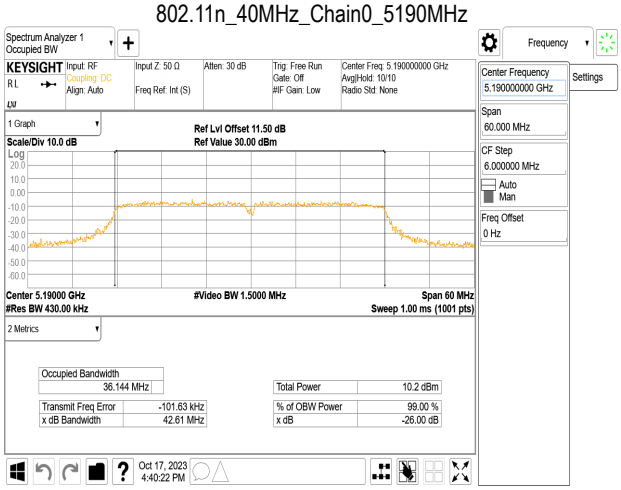
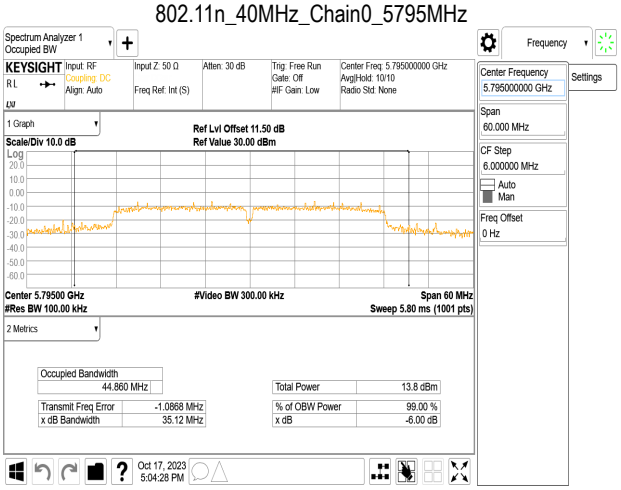
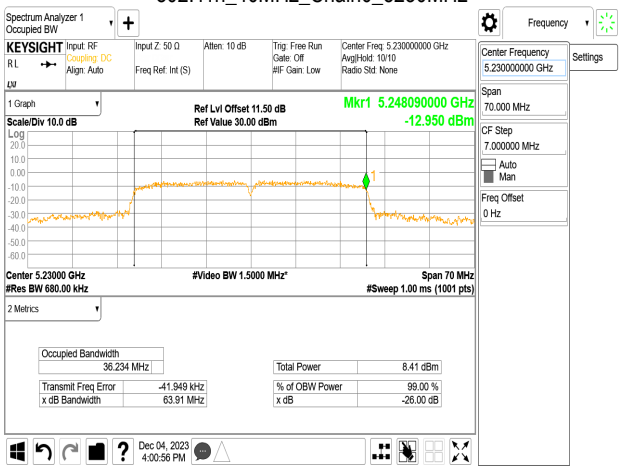
802.11n_40MHz_Chain0_5190MHz



802.11n_40MHz_Chain0_5795MHz

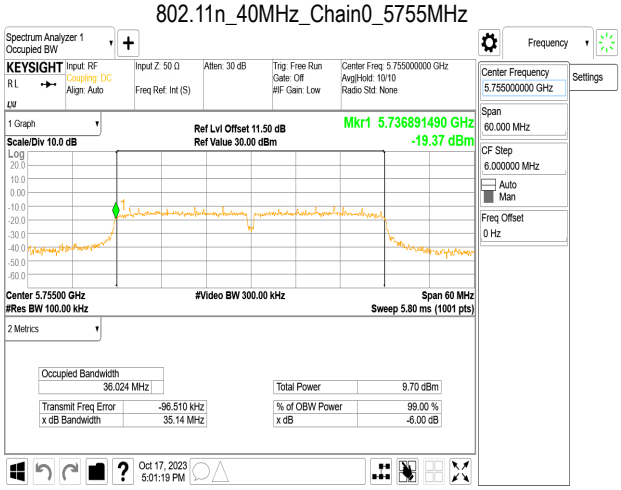


802.11n_40MHz_Chain0_5230MHz

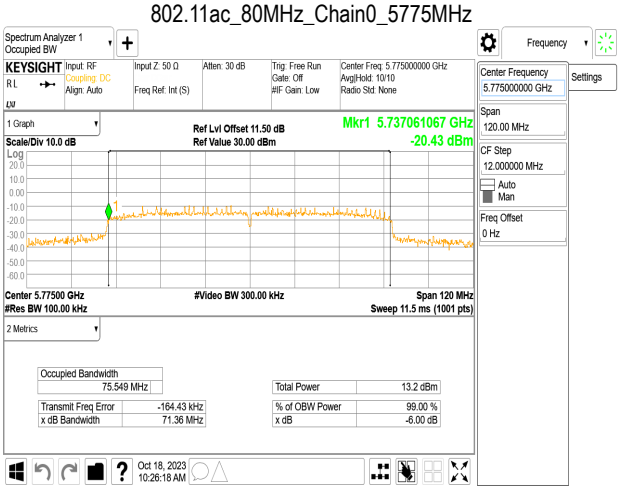


802.11ac_80MHz_Chain0_5210MHz

802.11n_40MHz_Chain0_5755MHz



802.11ac_80MHz_Chain0_5775MHz



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7.4.2 ISED Occupied Bandwidth

802.11a_Ch0

Frequency (MHz)	99% BW (MHz)	10 Log (B) (dB)
5180	16.941	12.290
5220	18.490	12.670
5240	18.654	12.710

802.11a_Ch0

Frequency (MHz)	99% BW (MHz)	6dB BW (MHz)
5745	21.860	16.360
5785	22.737	16.370
5825	23.176	16.420

802.11n_HT20_Ch0

Frequency (MHz)	99% BW (MHz)	10 Log (B) (dB)
5180	19.509	12.900
5220	19.384	12.870
5240	19.172	12.830

802.11n_HT20_Ch0

Frequency (MHz)	99% BW (MHz)	6dB BW (MHz)
5745	17.874	17.580
5785	22.618	17.040
5825	23.204	17.370

802.11n_HT40_Ch0

Frequency (MHz)	99% BW (MHz)	10 Log (B) (dB)
5190	36.193	15.590
5230	36.675	15.640

802.11n_HT40_Ch0

Frequency (MHz)	99% BW (MHz)	6dB BW (MHz)
5755	36.157	35.140
5795	43.068	35.120

802.11ac_VHT80_Ch0

Frequency (MHz)	99% BW (MHz)	10 Log (B) (dB)
5210	74.646	18.530

802.11ac_VHT80_Ch0

Frequency (MHz)	99% BW (MHz)	6dB BW (MHz)
5775	75.676	71.360

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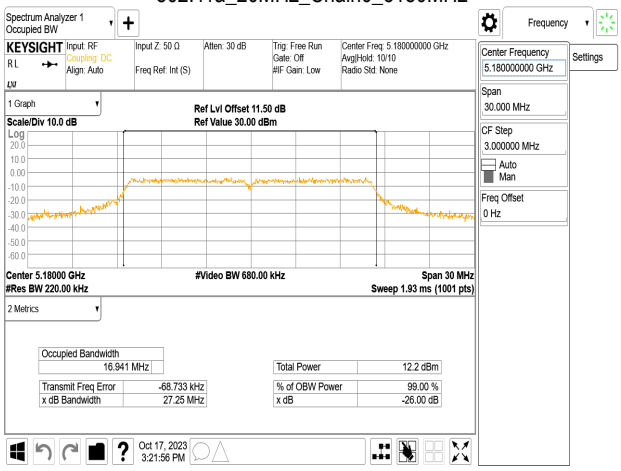
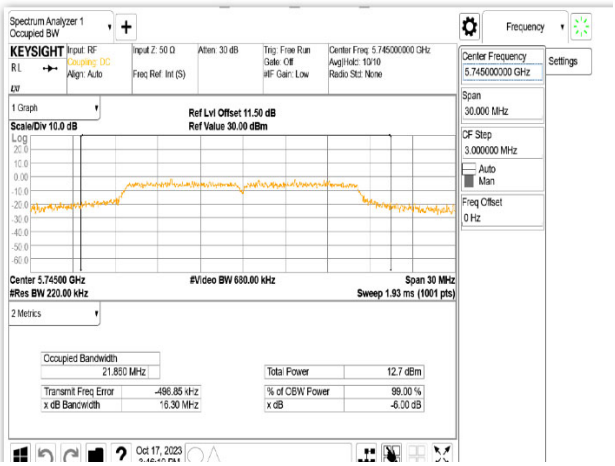
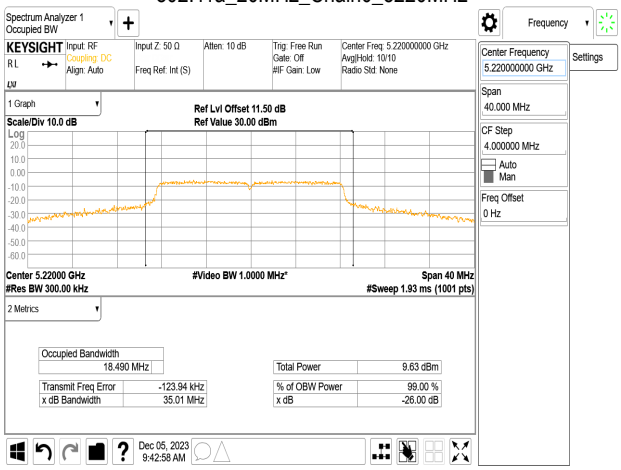
802.11a_20MHz_Chain0_5180MHz



802.11a_20MHz_Chain0_5745MHz

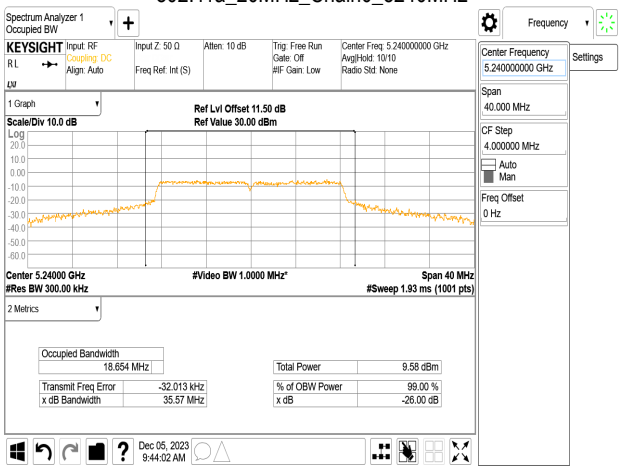


802.11a_20MHz_Chain0_5220MHz



802.11a_20MHz_Chain0_5785MHz

802.11a_20MHz_Chain0_5240MHz



802.11a_20MHz_Chain0_5825MHz

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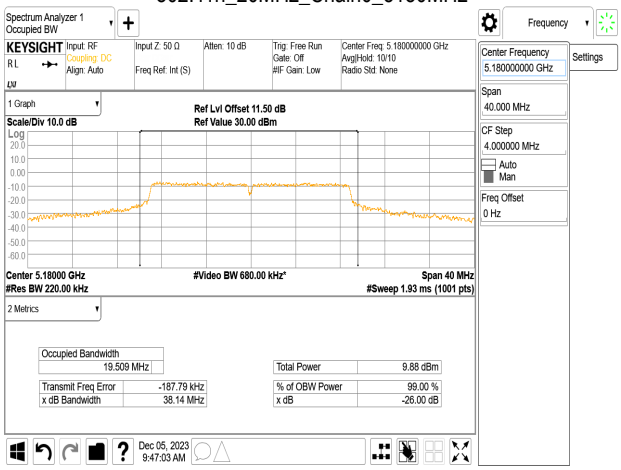
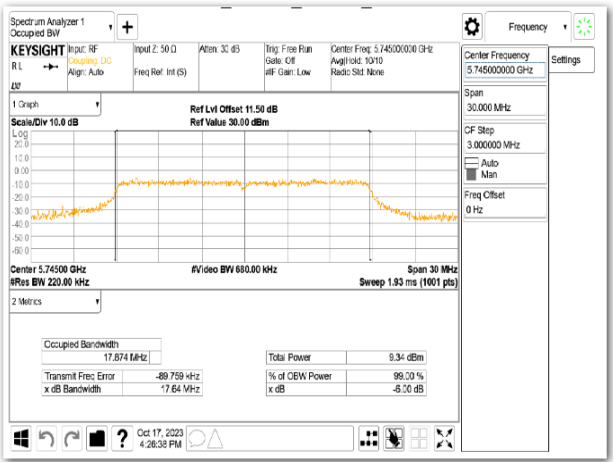
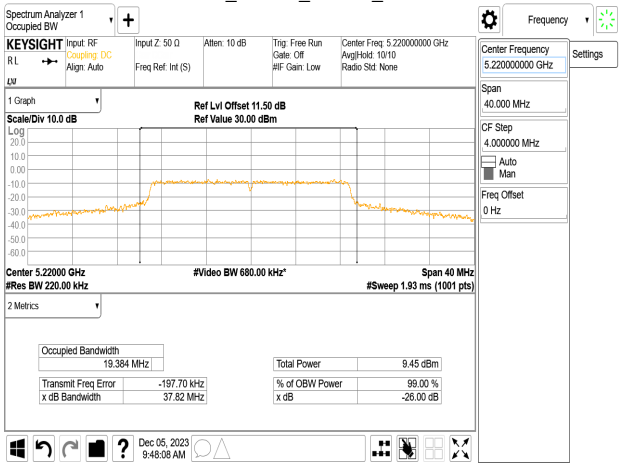
802.11n_20MHz_Chain0_5180MHz



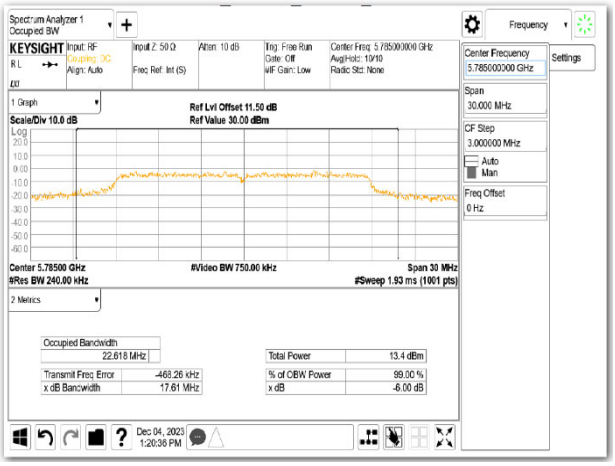
802.11n_20MHz_Chain0_5745MHz



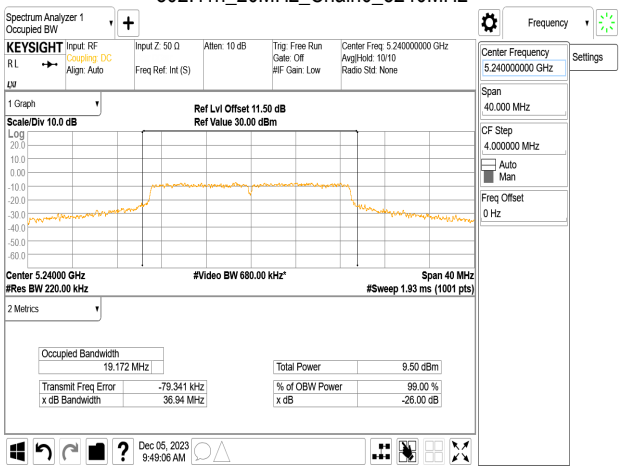
802.11n_20MHz_Chain0_5220MHz



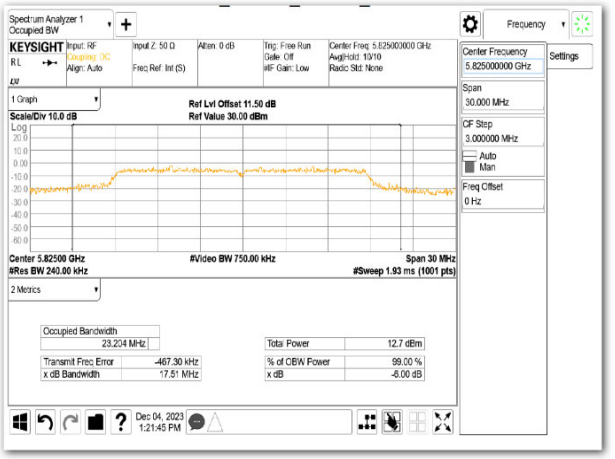
802.11n_20MHz_Chain0_5785MHz



802.11n_20MHz_Chain0_5240MHz



802.11n_20MHz_Chain0_5825MHz



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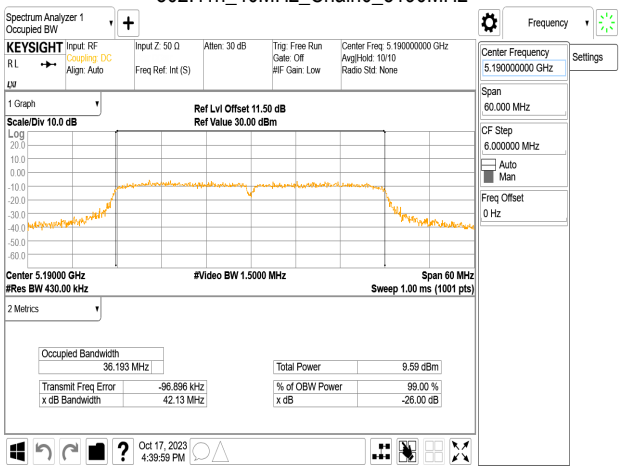
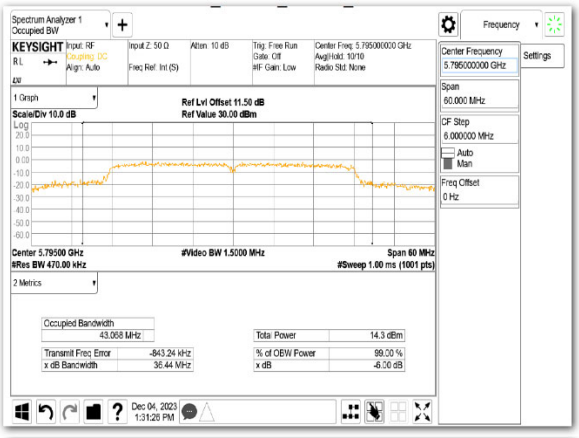
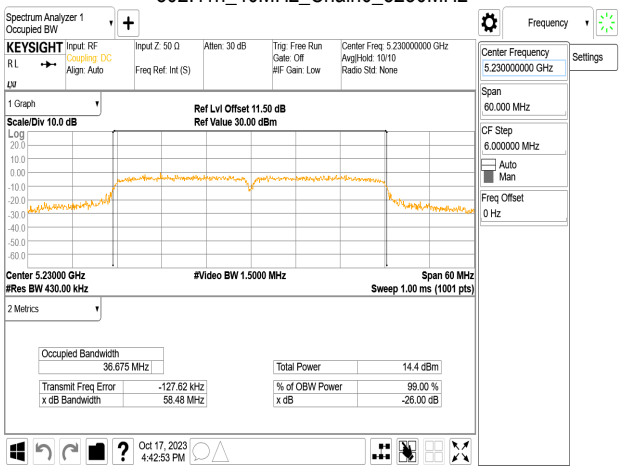
802.11n_40MHz_Chain0_5190MHz



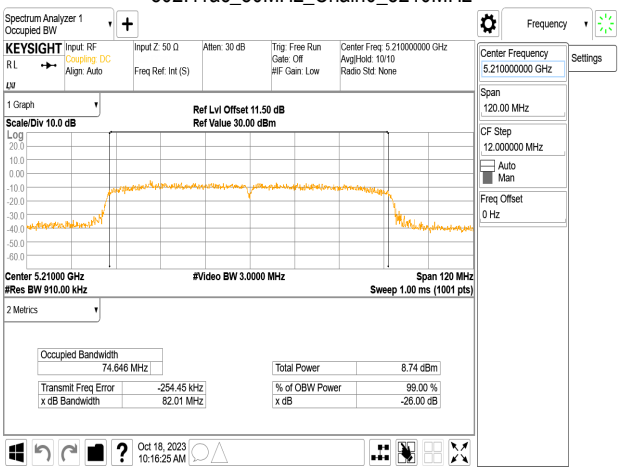
802.11n_40MHz_Chain0_5795MHz



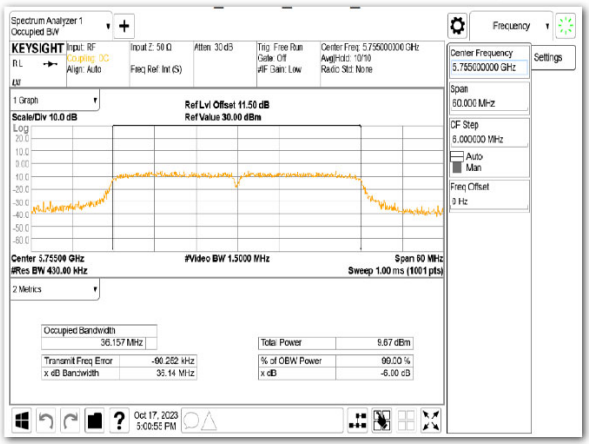
802.11n_40MHz_Chain0_5230MHz



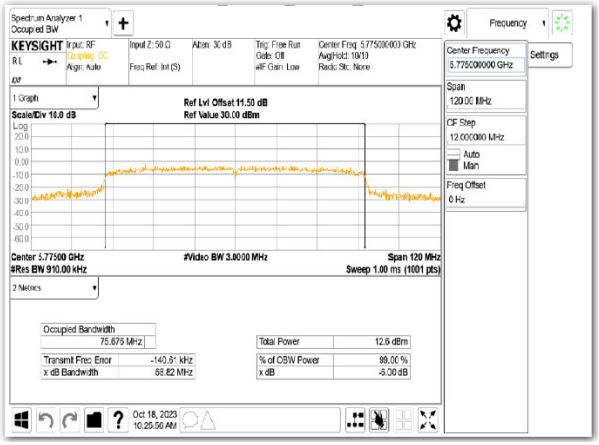
802.11ac_80MHz_Chain0_5210MHz



802.11n_40MHz_Chain0_5755MHz



802.11ac_80MHz_Chain0_5775MHz



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8 MAXIMUM CONDUCTED 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

Band	EUT CATEGORY		e-CRF Title 47 §15.407			
			Conducted Output Power	EIRP	TPC	Antenna Directional Gain Requirements
U-NII-1		Fixed point-to-point	1 Watt(30dBm)	Not required	Not required	23dBi
		Outdoor AP	1 Watt(30dBm)	Elevation angle above 30 degrees 125mW (21dBm)	Not required	6dBi
		Indoor AP	1 Watt(30dBm)	Not required	Not required	6dBi
	V	Other	250mW(23.98dBm)	Not required	Not required	6dBi
U-NII-2A		Other	250mW(23.98dBm) or 11dBm+10 log B	Not required	When EIRP >500mW At least 6dB below EIRP 1W (30dBm)	6dBi
U-NII-2C		Other	250mW(23.98dBm) or 11dBm+10 log B	Not required		6dBi
U-NII-3	V	Other	1 Watt(30dBm)	Not required	Not required	6dBi
		Fixed point-to-point	1 Watt(30dBm)	Not required	Not required	Not required
U-NII-4		Indoor AP (a channel spans 5725~5850 and 5850~5895MHz)	Not required	36dBm	Not required	Not required
		indoor client (a channel spans 5725~5850 and 5850~5895MHz)	Not required	30dBm	Not required	Not required
		subordinate device	Not required	36dBm	Not required	Not required

1. If transmitting antennas of directional gain greater than the antenna requirements column, the Maximum transmit power shall be reduced by the amount in dB that the direction-al gain of the antenna.
2. For the 10 log B, B is the 26 dB emission bandwidth.

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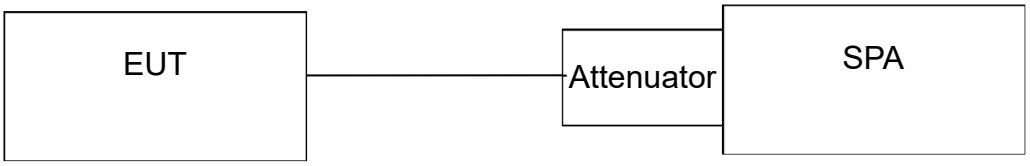
8.1.3 ISED

FREQUENCY BAND (MHz)	EUT CATEGORY		RSS-247 §6.2.1~6.2.4		
			EIRP	Conducted Output Power	TPC
5150~5250		OEM devices installed in vehicles	30 mW or 1.76 + 10 log10B	N/A	At least 3dB below 30mW EIRP
	V	Other device	200 mW or 10 + 10 log10B dBm	N/A	N/A
5250~5350		OEM devices installed in vehicles	30 mW or 1.76 + 10 log10B	N/A	At least 3dB below 30mW EIRP
		Other device	1.0 W or 17 + 10 log10B dBm	250 mW or 11 +10 log10B	EIRP >500mW, at least 6dB below 1W EIRP
		Outdoor Fixed with EIRP>200mW	-13 dBW/MHz for 0°≤ θ< 8° -13 −0.716 (θ-8) dBW/MHz for 8° ≤ θ< 40° -35.9 −1.22 (θ-40) dBW/MHz for 40° ≤ θ ≤45° -42 dBW/MHz for θ > 45°	N/A	EIRP >500mW, at least 6dB below 1W EIRP
5470-5600 and 5650-5725		All	1.0 W or 17 + 10 log10B dBm	250 mW or 11 +10 log10B	EIRP >500mW, at least 6dB below 1W EIRP
5725~5850	V	All	N/A	1 W	N/A

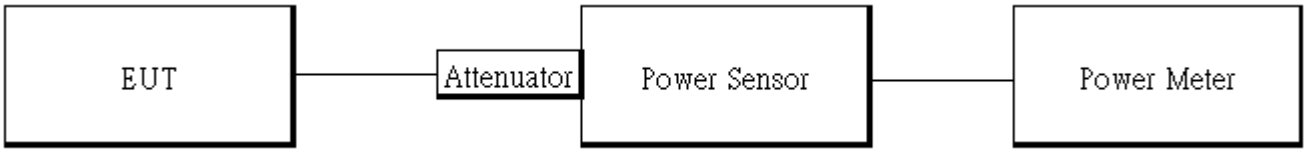
1 For equipment operating in the band 5725-5850 MHz, If transmitting antennas of directional gain greater than 6 dBi are used, the Maximum transmit power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
2. For the 10 log B, B is the 99% emission bandwidth.

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 Measurements

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

8.3.2 Output Power Measurements

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 power meter
4. Power Meter is used as the auxiliary test equipment to conduct the output power measurement.
5. Record the max. reading and add 10 log(1/duty cycle).
6. Repeat above procedures until all frequency (low, middle, and high channel) measured were complete.

8.4 Duty Cycle Measurement Result

Mode	Duty Cycle (%) =Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
802.11a	87.18	0.60	0.74	1.00
802.11n_20	86.41	0.63	0.79	1.00
802.11ac_20	82.99	0.81	1.02	2.00
802.11n_40	75.96	1.19	1.58	2.00
802.11ac_40	71.30	1.47	2.03	3.00
802.11ac_80	55.36	2.57	4.03	5.00

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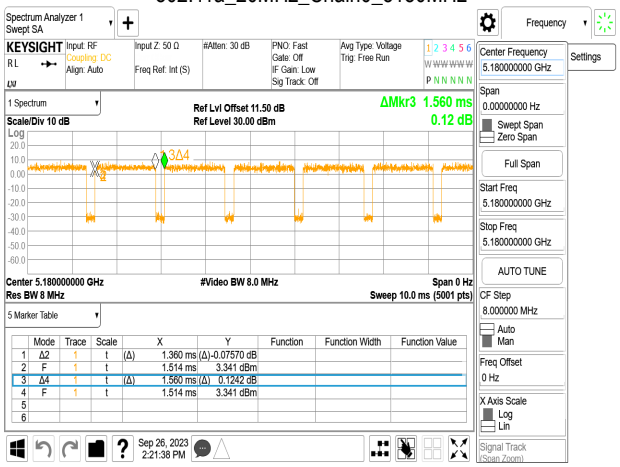
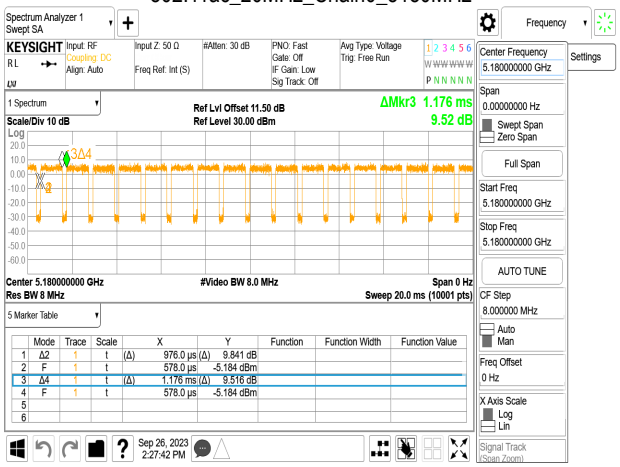
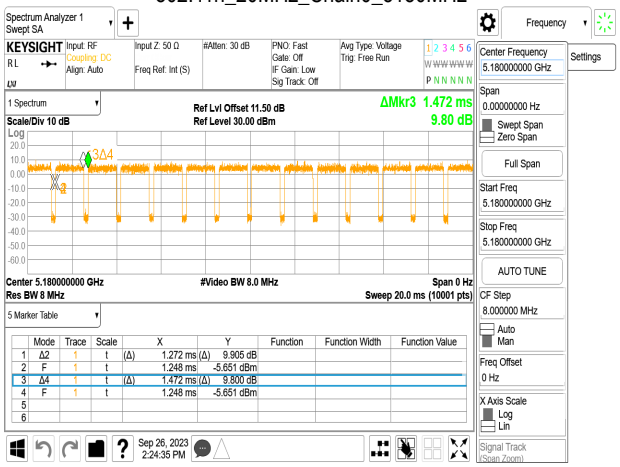
802.11a_20MHz_Chain0_5180MHz



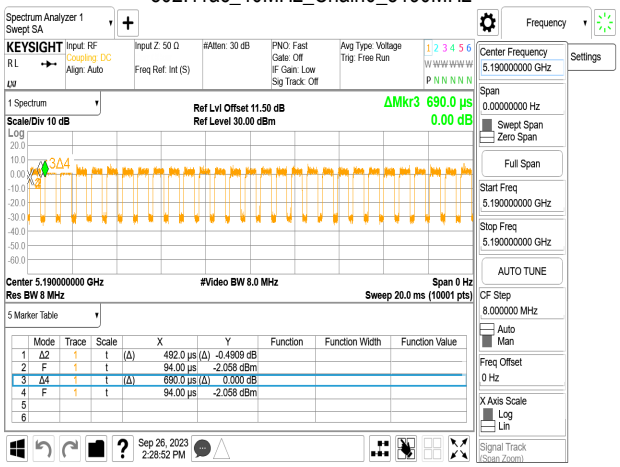
802.11ac_20MHz_Chain0_5180MHz



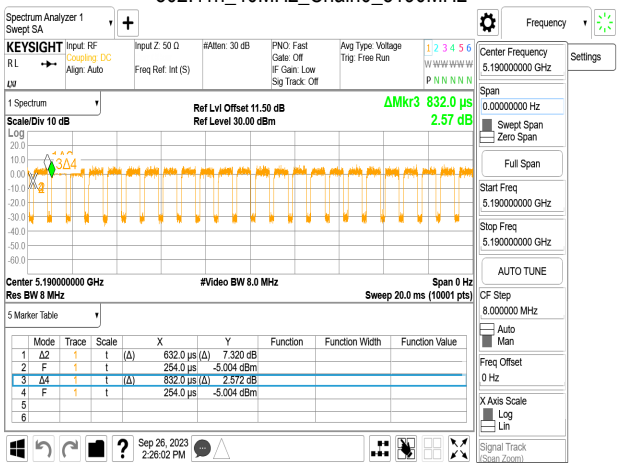
802.11n_20MHz_Chain0_5180MHz



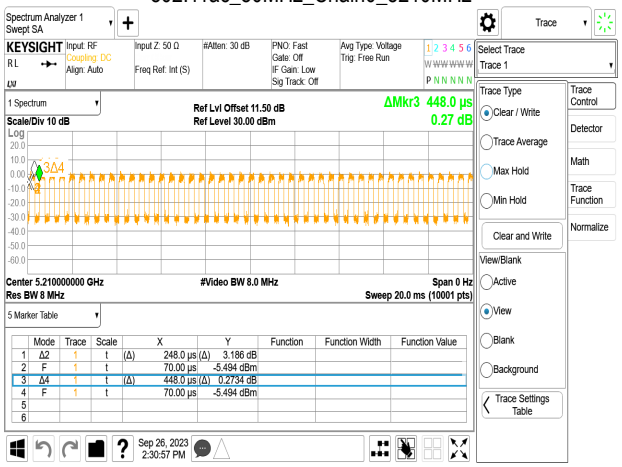
802.11ac_40MHz_Chain0_5190MHz



802.11n_40MHz_Chain0_5190MHz



802.11ac_80MHz_Chain0_5210MHz



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8.5 Output Power Measurement Result

8.5.1 FCC Output power

802.11a_Ch0

CH	Frequency (MHz)	Data Rate	Power set	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	6	17	8.07	6.406	23.98	PASS
44	5220	6	22	**10.96**	12.462	23.98	PASS
48	5240	6	22	10.85	12.150	23.98	PASS
149	5745	6	22	**8.34**	6.817	30	PASS
157	5785	6	22	8.13	6.495	30	PASS
165	5825	6	22	7.75	5.951	30	PASS

802.11n_HT20_Ch0

CH	Frequency (MHz)	Data Rate	Power set	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	MCS0	18	8.71	7.438	23.98	PASS
44	5220	MCS0	21	**10.86**	12.202	23.98	PASS
48	5240	MCS0	21	10.75	11.897	23.98	PASS
149	5745	MCS0	17	5.04	3.195	30	PASS
157	5785	MCS0	22	**8.47**	7.038	30	PASS
165	5825	MCS0	22	7.91	6.186	30	PASS

802.11n_HT40_Ch0

CH	Frequency (MHz)	Data Rate	Power set	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
38	5190	MCS0	12	5.33	3.415	23.98	PASS
46	5230	MCS0	19	**9.65**	9.235	23.98	PASS
151	5755	MCS0	15	5.17	3.292	30	PASS
159	5795	MCS0	22	**8.10**	6.463	30	PASS

802.11ac_VHT20_Ch0

CH	Frequency (MHz)	Data Rate	Power set	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	MCS0	17	8.70	7.413	23.98	PASS
44	5220	MCS0	21	**10.70**	11.748	23.98	PASS
48	5240	MCS0	21	10.54	11.323	23.98	PASS
149	5745	MCS0	16	4.72	2.965	30	PASS
157	5785	MCS0	22	**8.36**	6.854	30	PASS
165	5825	MCS0	22	7.80	6.025	30	PASS

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802.11ac_VHT40_Ch0

CH	Frequency (MHz)	Data Rate	Power set	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
38	5190	MCS0	12	4.77	2.999	23.98	PASS
46	5230	MCS0	18	**9.39**	8.688	23.98	PASS
151	5755	MCS0	15	4.68	2.937	30	PASS
159	5795	MCS0	22	**8.09**	6.440	30	PASS

802.11ac_VHT80_Ch0

CH	Frequency (MHz)	Data Rate	Power set	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
42	5210	MCS0	11	**3.54**	2.258	23.98	PASS
155	5775	MCS0	18	**6.81**	4.795	30	PASS

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8.5.2 ISED Conducted output power and EIRP

802.11a_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
149	5745	**8.34**	**6.817**	30	PASS
157	5785	8.13	6.495	30	PASS
165	5825	7.75	5.951	30	PASS

802.11n_HT20_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
149	5745	5.04	3.195	30	PASS
157	5785	**8.47**	**7.038**	30	PASS
165	5825	7.91	6.186	30	PASS

802.11n_HT40_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
151	5755	5.17	3.292	30	PASS
159	5795	**8.10**	**6.463**	30	PASS

802.11ac_VHT20_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
149	5745	4.72	2.965	30	PASS
157	5785	**8.36**	**6.854**	30	PASS
165	5825	7.80	6.025	30	PASS

802.11ac_VHT40_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
151	5755	4.68	2.937	30	PASS
159	5795	**8.09**	**6.440**	30	PASS

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802.11ac_VHT80_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	TOTAL POWER (mW)	REQUIRED LIMIT (dBm)	RESULT
155	5775	**6.81**	**4.795**	30	PASS

802.11a_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	8.07	1.77	9.84	9.638	22.29	PASS
44	5220	**10.96**	1.77	**12.73**	**18.750**	22.93	PASS
48	5240	10.85	1.77	12.62	18.281	23.01	PASS

802.11n_HT20_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	8.71	1.77	10.48	11.169	22.56	PASS
44	5220	**10.86**	1.77	**12.63**	**18.323**	22.54	PASS
48	5240	10.75	1.77	12.52	17.865	22.8	PASS

802.11n_HT40_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	REQUIRED LIMIT (dBm)	RESULT
38	5190	5.33	1.77	7.10	5.129	23.01	PASS
46	5230	**9.65**	1.77	**11.42**	**13.868**	23.01	PASS

802.11ac_VHT20_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	REQUIRED LIMIT (dBm)	RESULT
36	5180	8.70	1.77	10.47	11.143	22.56	PASS
44	5220	**10.70**	1.77	**12.47**	**17.660**	22.54	PASS
48	5240	10.54	1.77	12.31	17.022	22.8	PASS

802.11ac_VHT40_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	REQUIRED LIMIT (dBm)	RESULT
38	5190	4.77	1.77	6.54	4.508	23.01	PASS
46	5230	**9.39**	1.77	**11.16**	**13.062**	23.01	PASS

802.11ac_VHT80_Ch0

CH	Frequency (MHz)	TOTAL POWER (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	REQUIRED LIMIT (dBm)	RESULT
42	5210	**3.54**	1.77	**5.31**	**3.396**	23.01	PASS

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9 MAXIMUM POWER SPECTRAL DENSITY

9.1 FCC Standard

Operation Bands	EUT CATEGORY		e-CRF Title 47 §15.407 Power Spectral Density	Antenna Directional Gain Requirements
U-NII-1		Outdoor Access Point (Master)	1. 17dBm/ MHz 2. EIRP<=125mW(21dBm) at any elevation angle > 30°	6dBi
		Indoor Access Point (Master)	17dBm / MHz	6dBi
		Fixed point-to-point Access Ponit	17dBm / MHz	23dBi
	V	Client device	11dBm / MHz	6dBi
U-NII-2A		All	11dBm / MHz	6dBi
U-NII-2C		All	11dBm / MHz	6dBi
U-NII-3	V	All	30dBm / 500kHz	6dBi
U-NII-4		Indoor AP	20dBm / MHz e.i.r.p.	Not required
		indoor client	14dBm / MHz e.i.r.p.	Not required
		subordinate device	20dBm / MHz e.i.r.p.	Not required
If transmitting antennas of directional gain greater than the antenna requirements column, the Maximum transmit power shall be reduced by the amount in dB that the direction-al gain of the antenna.				

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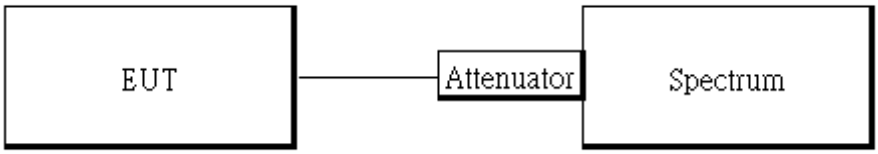
9.2 ISED Standard

FREQUENCY BAND (MHz)	EUT CATEGORY		RSS-247 §6.2.1~6.2.4	
			EIRP Density	Power Density
5150~5250		OEM devices installed in vehicles	N/A	N/A
	V	Other device	10 dBm/MHz	N/A
5250~5350		OEM devices installed in vehicles	N/A	N/A
		Other device	N/A	11 dBm/MHz
5470-5600 and 5650-5725		All	N/A	11 dBm/MHz
5725~5850	V	All	N/A	30 dBm/500kHz
For equipment operating in the band 5725-5850 MHz, If transmitting antennas of directional gain greater than 6 dBi are used, the Maximum transmit power shall be reduced by the amount in dB that the				

9.3 Test Setup



9.4 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 Spectrum.
4. **For U-NII1, U-NII-2A, U-NII-2C Band**:
   Set RBW=1MHz, VBW=3MHz, where span is enough to capture the entire bandwidth, Sweep time = Auto (1001 pts), Detector = power averaging (rms), if available. Otherwise, use sample detector mode, traces 100 sweeps of video averaging. (SA-2 with the omission of procedure x, the integration with 26dB EBW bandwidth)
   For U-NII-3 Band:
   Set RBW=300kHz, VBW=1MHz, where span is enough to capture the entire bandwidth, Sweep time = Auto, detector = RMS or sample, traces 100 sweeps of video averaging.

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In addition, measurement bandwidth of Maximum PSD is specified in 500 kHz, add 10 log (500 kHz/RBW) to the measured result.

5. User the cursor on spectrum to peak search the highest level of trace
6. (1)Duty cycle ≥ 98%：Record the max. reading.
   (2)Duty cycle < 98%：Record the max. reading and add 10 log(1/duty cycle).
7. Repeat above procedures until all default test channel (low, middle, and high) was complete.

9.5 Measurement Result

POWER DENSITY 802.11a MODE						
Frequency (MHz)	Ch0 meas PSD (dBm/MHz)	Duty Factor (dB)	Maxmum Corr'd PSD(dBm/MHz)		Limit	Margin (dB)
5180	-2.915	0.60	-2.32		11.00 dBm/MHz	-13.32
5220	-0.140	0.60	0.46		11.00 dBm/MHz	-10.54
5240	-0.482	0.60	0.12		11.00 dBm/MHz	-10.88
Frequency (MHz)	Ch0 meas PSD (dBm/300kHz)	Duty Factor (dB)	10log (500kHz/RBW) Factor(dB)	Maxmum Corr'd PSD (dBm/500kHz)	Limit	Margin (dB)
5745	-7.943	0.60	2.22	-5.12	30.00 dBm/500kHz	-35.12
5785	-8.345	0.60	2.22	-5.53	30.00 dBm/500kHz	-35.53
5825	-8.915	0.60	2.22	-6.10	30.00 dBm/500kHz	-36.10

POWER DENSITY 802.11n HT20 MODE						
Frequency (MHz)	Ch0 meas PSD (dBm/MHz)	Duty Factor (dB)	Maxmum Corr'd PSD(dBm/MHz)		Limit	Margin (dB)
5180	-2.351	0.63	-1.72		11.00 dBm/MHz	-12.72
5220	-3.906	0.63	-3.28		11.00 dBm/MHz	-14.28
5240	-1.640	0.63	-1.01		11.00 dBm/MHz	-12.01
Frequency (MHz)	Ch0 meas PSD (dBm/300kHz)	Duty Factor (dB)	10log (500kHz/RBW) Factor(dB)	Maxmum Corr'd PSD (dBm/500kHz)	Limit	Margin (dB)
5745	-11.278	0.63	2.22	-8.43	30.00 dBm/500kHz	-38.43
5785	-8.530	0.63	2.22	-5.68	30.00 dBm/500kHz	-35.68
5825	-8.850	0.63	2.22	-6.00	30.00 dBm/500kHz	-36.00

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POWER DENSITY 802.11n HT40 MODE						
Frequency (MHz)	Ch0 meas PSD (dBm/MHz)	Duty Factor (dB)	Maxmum Corr'd PSD(dBm/MHz)		Limit	Margin (dB)
5190	-10.746	1.19	-9.56		11.00 dBm/MHz	-20.56
5230	-5.892	1.19	-4.70		11.00 dBm/MHz	-15.70
Frequency (MHz)	Ch0 meas PSD (dBm/300kHz)	Duty Factor (dB)	10log (500kHz/RBW) Factor(dB)	Maxmum Corr'd PSD (dBm/500kHz)	Limit	Margin (dB)
5755	-15.690	1.19	2.22	-12.28	30.00 dBm/500kHz	-42.28
5795	-11.712	1.19	2.22	-8.30	30.00 dBm/500kHz	-38.30

POWER DENSITY 802.11ac VHT80 MODE						
Frequency (MHz)	Ch0 meas PSD (dBm/MHz)	Duty Factor (dB)	Maxmum Corr'd PSD(dBm/MHz)		Limit	Margin (dB)
5210	-15.494	2.57	-12.92		11.00 dBm/MHz	-23.92
Frequency (MHz)	Ch0 meas PSD (dBm/300kHz)	Duty Factor (dB)	10log (500kHz/RBW) Factor(dB)	Maxmum Corr'd PSD (dBm/500kHz)	Limit	Margin (dB)
5775	-14.836	2.57	2.22	-10.05	30.00 dBm/500kHz	-40.05

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EIRP spectral density 802.11a MODE					
Freq. (MHz)	PSD (dBm)	Ant. Gain (dBi)	EIRP PSD (dBm)	Limit (dBm)	Margin (dB)
5180	-2.315	1.77	-0.55	10	-10.55
5220	0.460	1.77	2.23	10	-7.77
5240	0.118	1.77	1.89	10	-8.11
EIRP spectral density 802.11n HT20 MODE					
Freq. (MHz)	PSD (dBm)	Ant. Gain (dBi)	EIRP PSD (dBm)	Limit (dBm)	Margin (dB)
5180	-1.721	1.77	0.05	10	-9.95
5220	-3.276	1.77	-1.51	10	-11.51
5240	-1.010	1.77	0.76	10	-9.24
EIRP spectral density 802.11n HT40 MODE					
Freq. (MHz)	PSD (dBm)	Ant. Gain (dBi)	EIRP PSD (dBm)	Limit (dBm)	Margin (dB)
5190	-9.556	1.77	-7.79	10	-17.79
5230	-4.702	1.77	-2.93	10	-12.93
EIRP spectral density 802.11ac VHT80 MODE					
Freq. (MHz)	PSD (dBm)	Ant. Gain (dBi)	EIRP PSD (dBm)	Limit (dBm)	Margin (dB)
5210	-12.924	1.77	-11.15	10	-21.15

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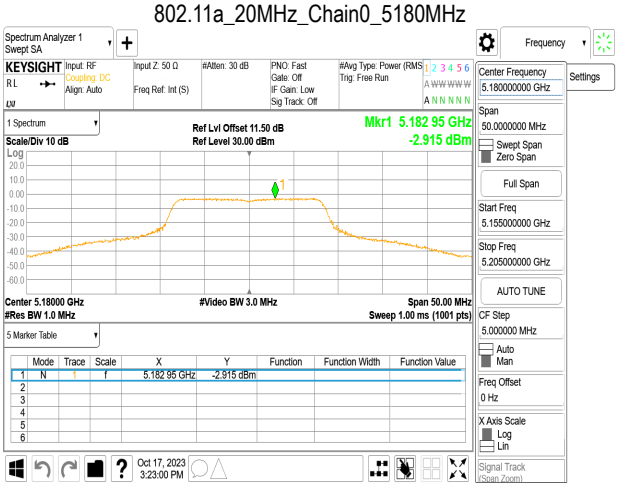
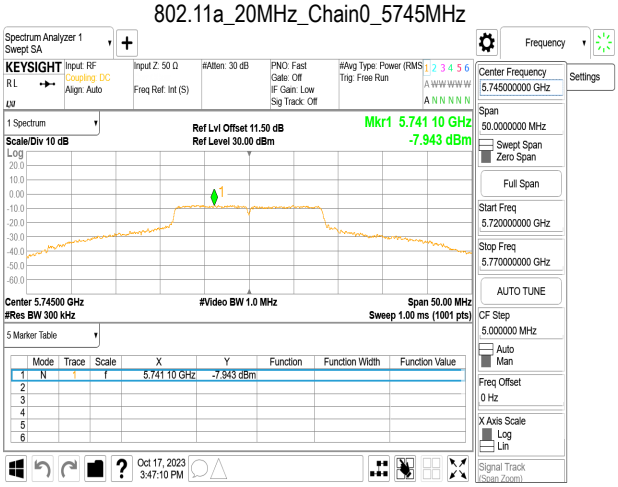
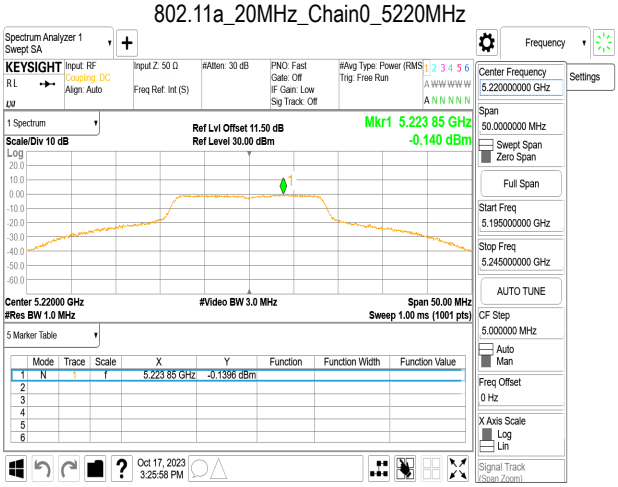
802.11a_20MHz_Chain0_5180MHz



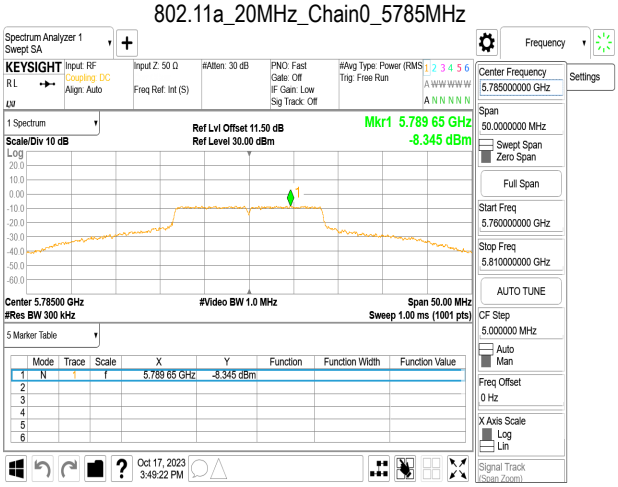
802.11a_20MHz_Chain0_5745MHz



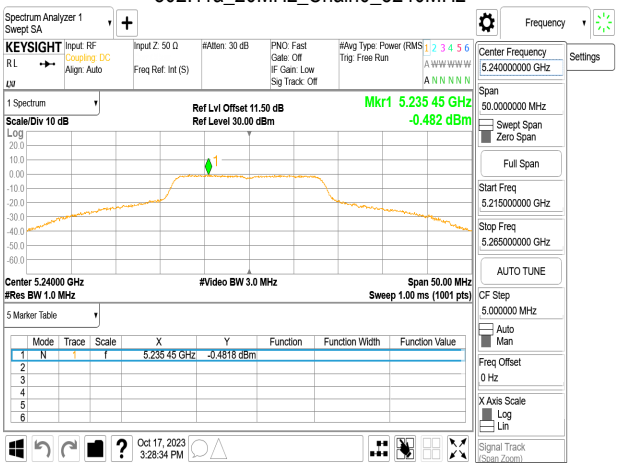
802.11a_20MHz_Chain0_5220MHz



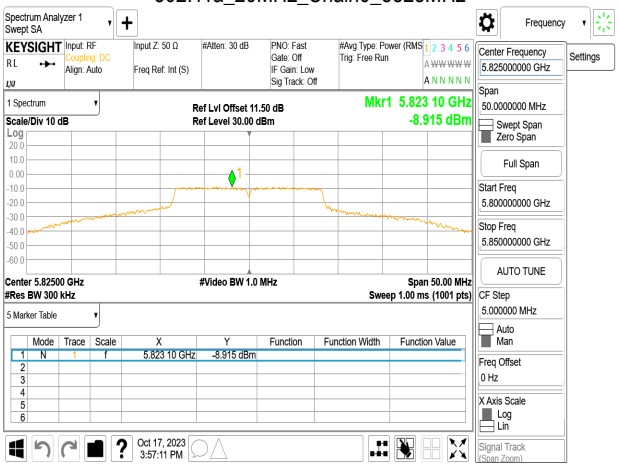
802.11a_20MHz_Chain0_5785MHz



802.11a_20MHz_Chain0_5240MHz



802.11a_20MHz_Chain0_5825MHz



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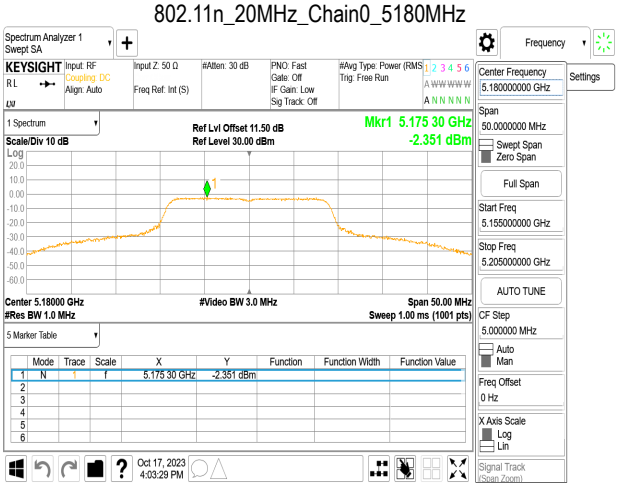
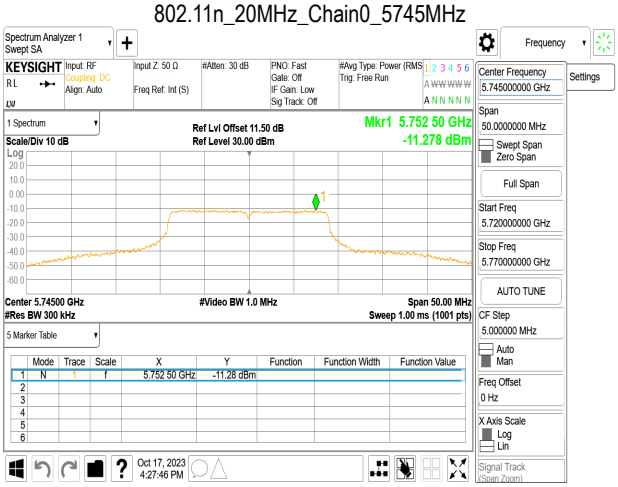
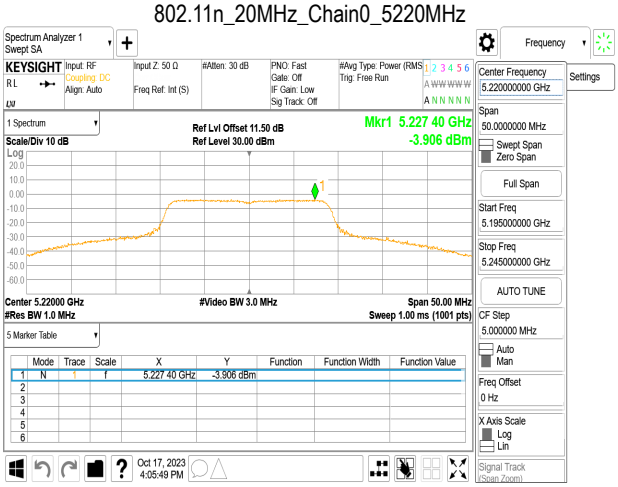
802.11n_20MHz_Chain0_5180MHz



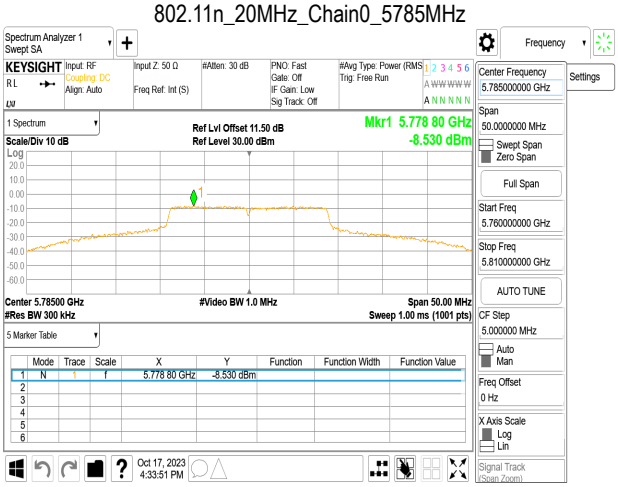
802.11n_20MHz_Chain0_5745MHz



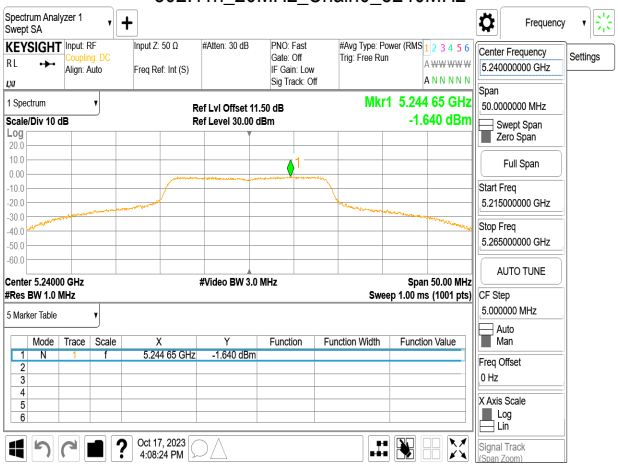
802.11n_20MHz_Chain0_5220MHz



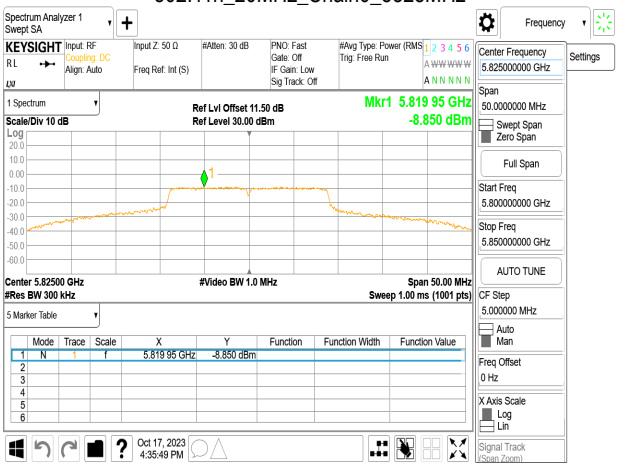
802.11n_20MHz_Chain0_5785MHz



802.11n_20MHz_Chain0_5240MHz



802.11n_20MHz_Chain0_5825MHz



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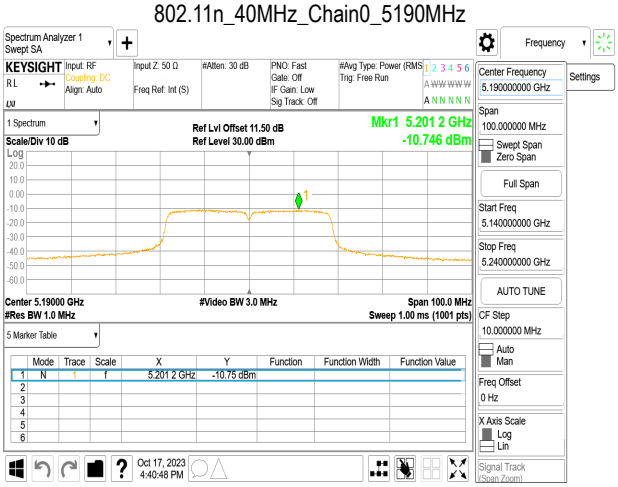
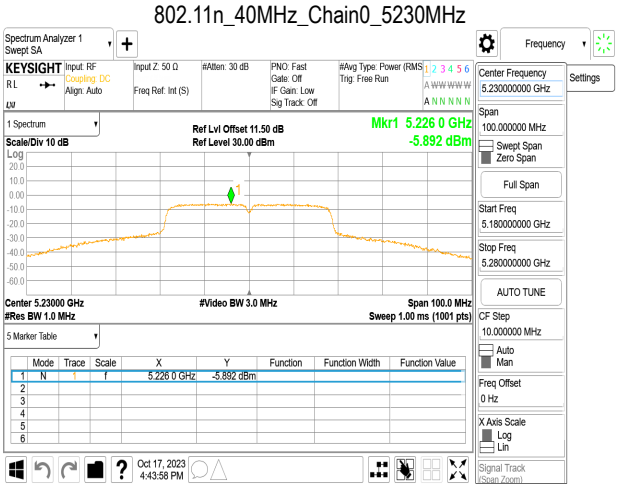
802.11n_40MHz_Chain0_5190MHz

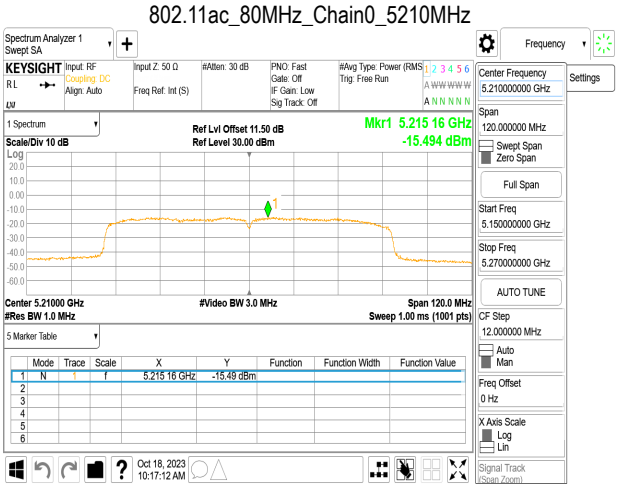


802.11n_40MHz_Chain0_5795MHz

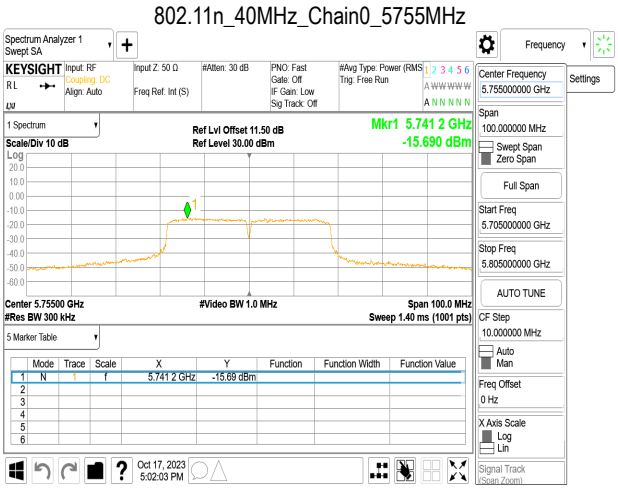
802.11n_40MHz_Chain0_5230MHz



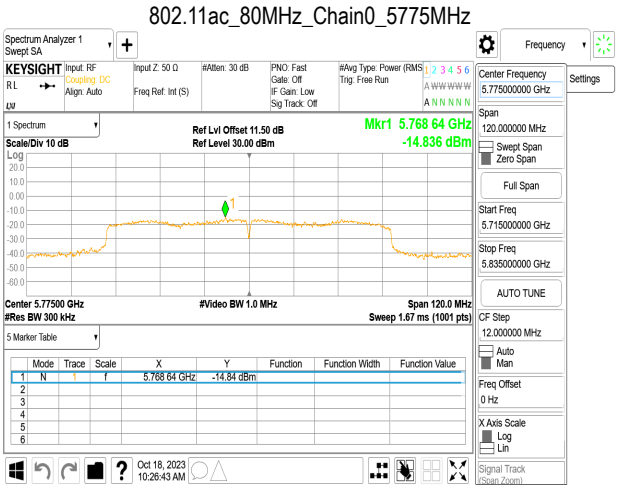
802.11ac_80MHz_Chain0_5210MHz



802.11n_40MHz_Chain0_5755MHz



802.11ac_80MHz_Chain0_5775MHz



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