9. AC POWER LINE CONDUCTED EMISSIONS

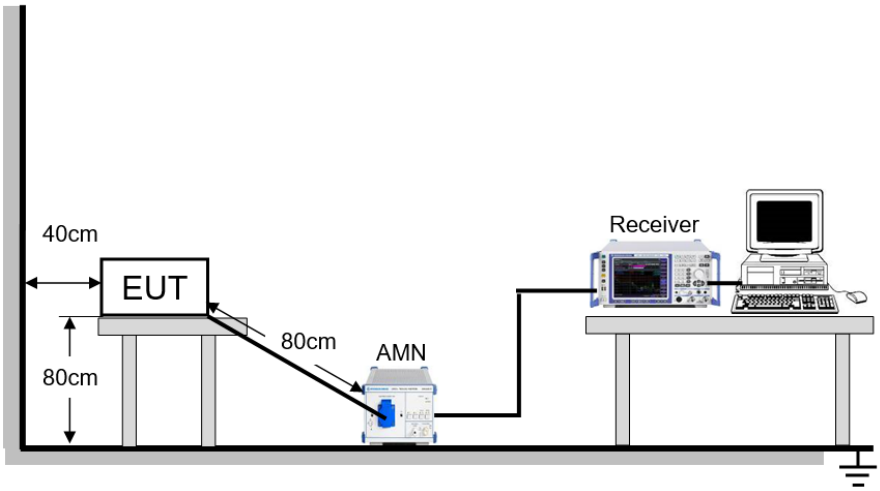
LIMITS

Please refer to CFR 47 FCC §15.207 (a) and ISED RSS-Gen Clause 8.8

FREQUENCY (MHz)	Quasi-peak	Average
0.15 -0.5	66 - 56 *	56 - 46 *
0.50 -5.0	56.00	46.00
5.0 -30.0	60.00	50.00

TEST SETUP AND PROCEDURE

Refer to ANSI C63.10-2013 clause 6.2.



The EUT is put on a table of non-conducting material that is 80cm high. The vertical conducting wall of shielding is located 40cm to the rear of the EUT. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.). A EMI Measurement Receiver (R&S Test Receiver ESR3) is used to test the emissions from both sides of AC line. According to the requirements in Section 6.2 of ANSI C63.10-2013.Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-Peak and average detector mode. The bandwidth of EMI test receiver is set at 9kHz.

The arrangement of the equipment is installed to meet the standards and operating in a manner, which tends to maximize its emission characteristics in a normal application.

TEST ENVIRONMENT

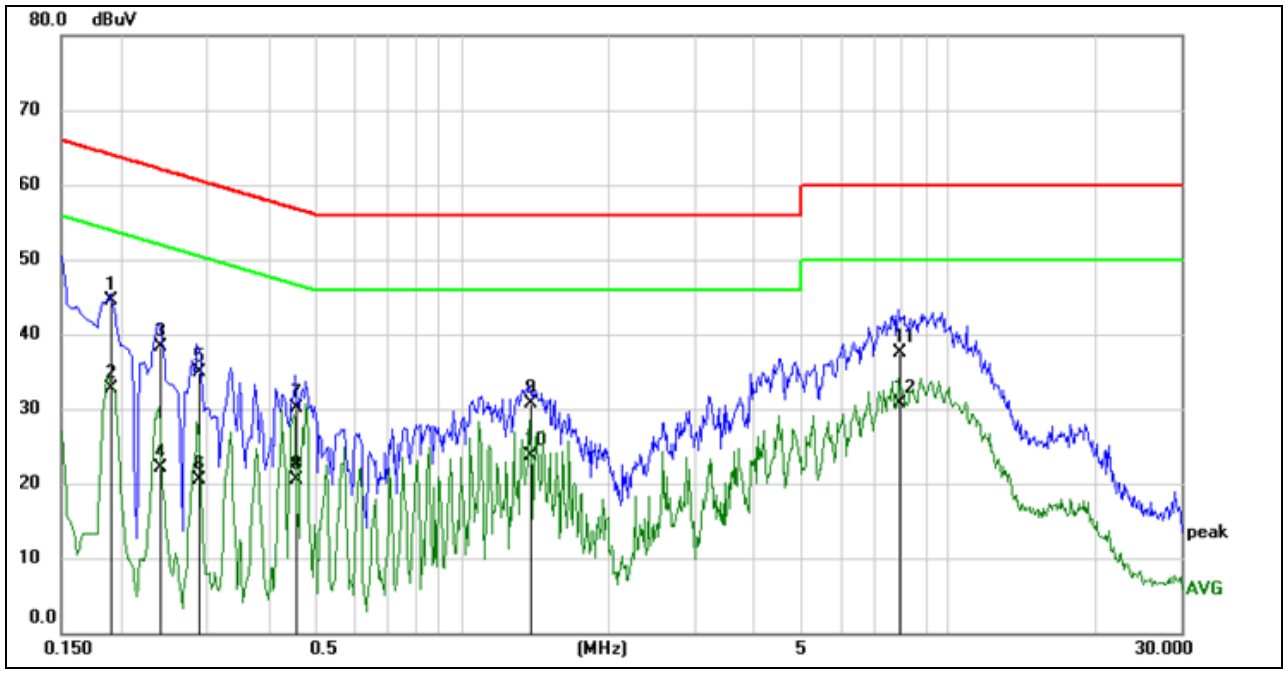
Temperature	25°C	Relative Humidity	72.1%
Atmosphere Pressure	101kPa	Test Voltage	DC 11.55V

RESULTS

9.1. 802.11a SISO MODE

ANTENNA 2 TEST RESULTS (WORST CASE)

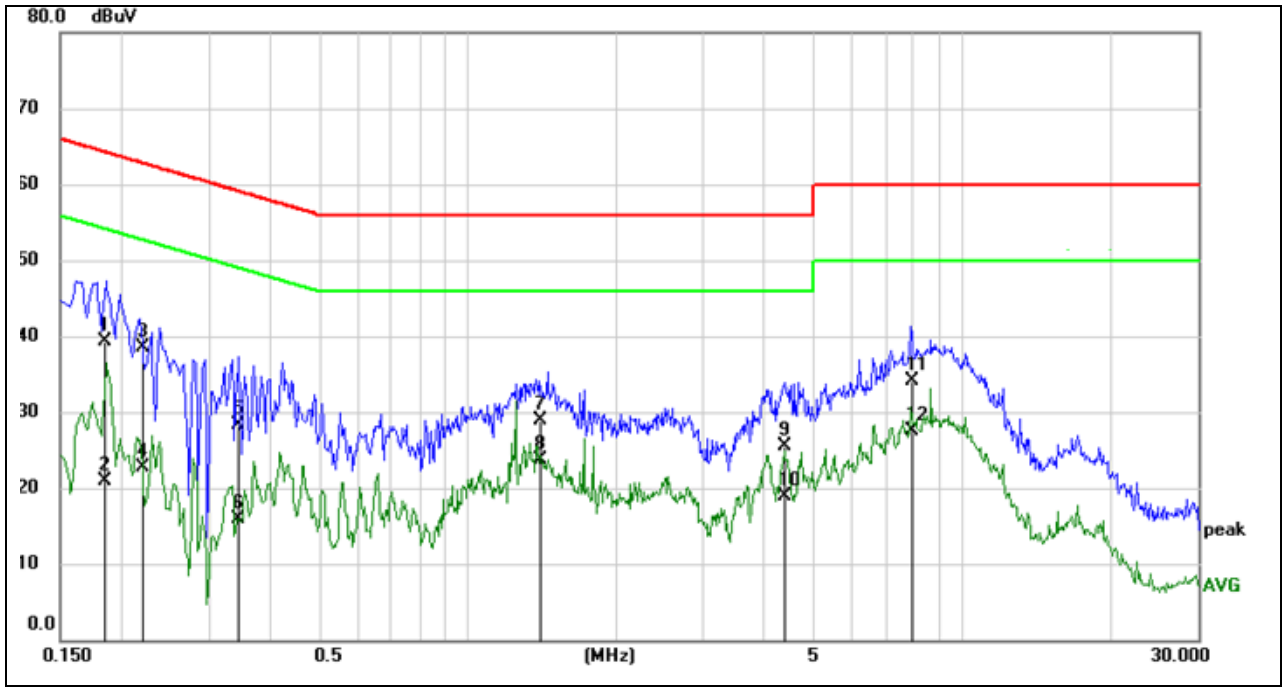
LINE N RESULTS (UNII-1 BAND HIGH CHANNEL, WORST-CASE CONFIGURATION)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1903	34.93	9.60	44.53	64.02	-19.49	QP
2	0.1903	23.07	9.60	32.67	54.02	-21.35	AVG
3	0.2413	28.64	9.60	38.24	62.05	-23.81	QP
4	0.2413	12.55	9.60	22.15	52.05	-29.90	AVG
5	0.2883	25.39	9.60	34.99	60.57	-25.58	QP
6	0.2883	10.87	9.60	20.47	50.57	-30.10	AVG
7	0.4586	20.58	9.60	30.18	56.72	-26.54	QP
8	0.4586	10.89	9.60	20.49	46.72	-26.23	AVG
9	1.3863	21.06	9.61	30.67	56.00	-25.33	QP
10	1.3863	14.09	9.61	23.70	46.00	-22.30	AVG
11	7.9330	27.75	9.72	37.47	60.00	-22.53	QP
12	7.9330	20.89	9.72	30.61	50.00	-19.39	AVG

Note: 1. Result = Reading +Correct Factor.
2. If QP Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 200 Hz (9 kHz—150 kHz), 9 kHz (150 kHz—30 MHz).
4. Step size: 80Hz (0.009MHz-0.15MHz), 4 kHz (0.15MHz-30MHz), Scan time: auto.

LINE L RESULTS (UNII-1 BAND HIGH CHANNEL, WORST-CASE CONFIGURATION)



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1836	29.63	9.61	39.24	64.32	-25.08	QP
2	0.1836	11.29	9.61	20.90	54.32	-33.42	AVG
3	0.2200	28.81	9.60	38.41	62.82	-24.41	QP
4	0.2200	13.15	9.60	22.75	52.82	-30.07	AVG
5	0.3451	18.75	9.60	28.35	59.08	-30.73	QP
6	0.3451	6.40	9.60	16.00	49.08	-33.08	AVG
7	1.4153	19.32	9.61	28.93	56.00	-27.07	QP
8	1.4153	14.05	9.61	23.66	46.00	-22.34	AVG
9	4.4064	15.77	9.66	25.43	56.00	-30.57	QP
10	4.4064	9.24	9.66	18.90	46.00	-27.10	AVG
11	7.9719	24.32	9.72	34.04	60.00	-25.96	QP
12	7.9719	17.75	9.72	27.47	50.00	-22.53	AVG

Note: 1. Result = Reading +Correct Factor.
2. If QP Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 200 Hz (9 kHz—150 kHz), 9 kHz (150 kHz—30 MHz).
4. Step size: 80Hz (0.009MHz-0.15MHz), 4 kHz (0.15MHz-30MHz), Scan time: auto.

Note: All the modes had been tested, but only the worst data was recorded in the report.

10. FREQUENCY STABILITY

LIMITS

The frequency of the carrier signal shall be maintained within band of operation.

TEST PROCEDURE

1. The EUT was placed inside an environmental chamber as the temperature in the chamber was varied between 0°C ~ 40°C (declared by customer).

2. The temperature was incremented by 10°C intervals and the unit allowed to stabilize at each temperature before each measurement. The center frequency of the transmitting channel was evaluated at each temperature and the frequency deviation from the channel's center frequency was recorded.

3. The primary supply voltage is varied from 85 % to 115 % of the nominal value for non hand-carried battery and AC powered equipment. For hand-carried, battery-powered equipment, primary supply voltage is reduced to the battery operating end point which shall be specified by the manufacturer.

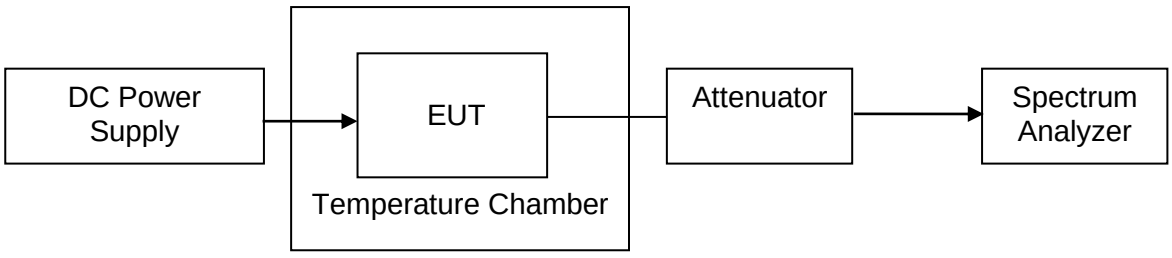
Connect the EUT to the spectrum analyser and use the following settings:

Center Frequency	The center frequency of the channel under test
Detector	Peak
RBW	10 kHz
VBW	≥3 × RBW
Span	Encompass the entire emissions bandwidth (EBW) of the signal
Trace	Max hold
Sweep time	Auto

4. While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup, and at 2 minutes, 5minutes, and 10 minutes after the EUT is energized.

5. Allow the trace to stabilize, find the peak value of the power envelope and record the frequency, then calculated the frequency drift.

TEST SETUP



TEST ENVIRONMENT

	Normal Test Conditions	Extreme Test Conditions
Relative Humidity	20% - 75%	/
Atmospheric Pressure	100kPa ~102kPa	/
Temperature	T_N (Normal Temperature): 22°C - 28°C	T_L (Low Temperature): 5°C
		T_H (High Temperature): 35°C
Supply Voltage	V_N (Normal Voltage): DC 11.55V	V_L (Low Voltage): DC 9.82V
		V_H (High Voltage): DC 12.71V

RESULTS

Please refer to Appendix D.

11. DYNAMIC FREQUENCY SELECTION

APPLICABILITY OF DFS REQUIREMENTS

A U-NII network will employ a DFS function to detect signals from radar systems and to avoid co-channel operation with these systems. This applies to the 5250-5350 MHz and/or 5470-5725 MHz bands.
Within the context of the operation of the DFS function, a U-NII device will operate in either Master Mode or Client Mode. U-NII devices operating in Client Mode can only operate in a network controlled by a U-NII device operating in Master Mode.

Table 1: Applicability of DFS Requirements Prior to Use of a Channel

Requirement	Operational Mode		
	☐ Master	☒ Client Without Radar Detection	☐ Client With Radar Detection
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	☐ Master Device or Client with Radar Detection	☒ Client Without Radar Detection
DFS Detection Threshold	Yes	Not required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required

Additional requirements for devices with multiple bandwidth modes	☐ Master Device or Client with Radar Detection	☒ Client Without Radar Detection
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.		

LIMITS

(1) DFS Detection Thresholds

Table 3: DFS Detection Thresholds for Master Devices and Client Devices With Radar Detection

Maximum Transmit Power	Value (See Notes 1, 2, and 3)
EIRP ≥ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna. Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response. Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.	

(2) DFS Response Requirements

Table 4: DFS Response Requirement Values

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note 1.
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
U-NII Detection Bandwidth	Minimum 100% of the U-NII 99% transmission power bandwidth. See Note 3.
Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst. Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required facilitating a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions. Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.	

PARAMETERS OF RADAR TEST WAVEFORMS

This section provides the parameters for required test waveforms, minimum percentage of successful detections, and the minimum number of trials that must be used for determining DFS conformance. Step intervals of 0.1 microsecond for Pulse Width, 1 microsecond for PRI, 1 MHz for chirp width and 1 for the number of pulses will be utilized for the random determination of specific test waveforms.

Table 5 Short Pulse Radar Test Waveforms

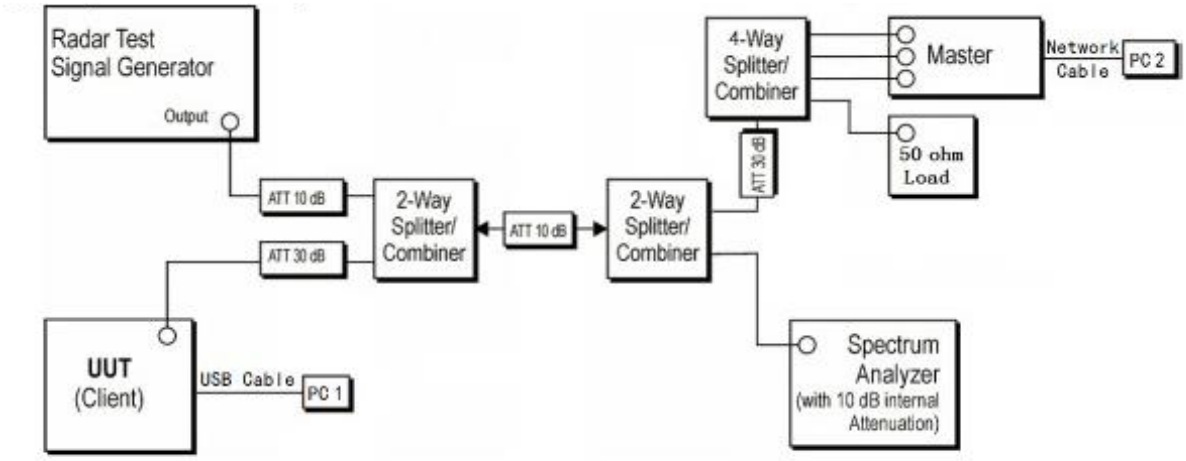
Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	See Note 1
1	1	Test A	$\text{Roundup}\left\{\left(\frac{1}{360}\right)\cdot\left(\frac{19\cdot 10^6}{\text{PRI}_{\mu\text{sec}}}\right)\right\}$	60%	30
		Test B			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.
Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a
Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A

A minimum of 30 unique waveforms are required for each of the Short Pulse Radar Types 2 through 4. If more than 30 waveforms are used for Short Pulse Radar Types 2 through 4, then each additional waveform must also be unique and not repeated from the previous waveforms. If more than 30 waveforms are used for Short Pulse Radar Type 1, then each additional waveform is generated with Test B and must also be unique and not repeated from the previous waveforms in Tests A or B. Test aggregate is average of the percentage of successful detections of short pulse radar types 1-4.

TEST SETUP

Setup for Client with injection at the Master



RESULTS

Please refer to Appendix E.

12. ANTENNA REQUIREMENTS

APPLICABLE REQUIREMENTS

Please refer to FCC §15.203
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Please refer to FCC §15.247(b)(4)
The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RESULTS

Complies

Appendix A1: 26dB Emission Bandwidth

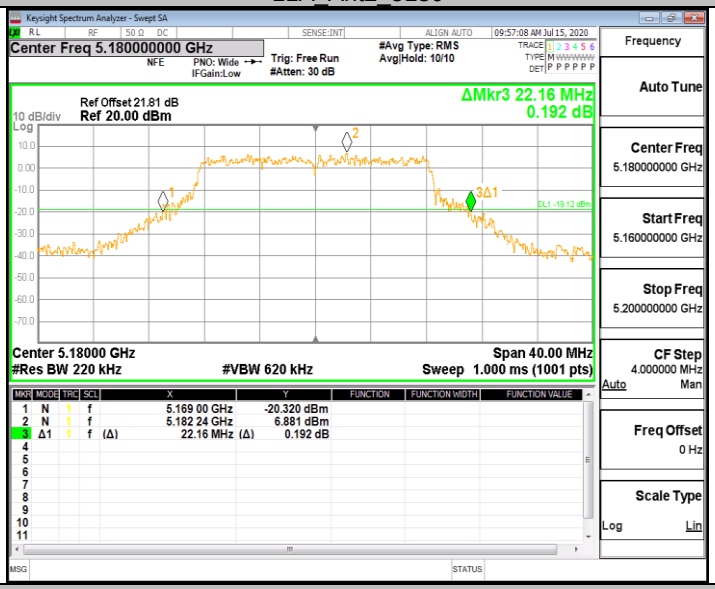
Test Result

Test Mode	Antenna	Channel	26db EBW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11A	Ant2	5180	22.160	5169.000	5191.160	---	PASS
		5200	22.400	5188.960	5211.360	---	PASS
		5240	22.280	5228.800	5251.080	---	PASS
		5260	22.640	5248.960	5271.600	---	PASS
		5280	23.040	5268.360	5291.400	---	PASS
		5320	21.920	5309.240	5331.160	---	PASS
		5500	22.080	5489.080	5511.160	---	PASS
		5600	22.840	5588.800	5611.640	---	PASS
		5700	22.200	5688.800	5711.000	---	PASS
		5745	22.200	5733.640	5755.840	---	PASS
		5785	22.600	5773.360	5795.960	---	PASS
		5825	22.720	5813.720	5836.440	---	PASS
11N20MIMO	Ant2	5180	22.480	5168.640	5191.120	---	PASS
		5200	22.160	5188.680	5210.840	---	PASS
		5240	22.800	5228.880	5251.680	---	PASS
		5260	22.120	5248.800	5270.920	---	PASS
		5280	22.720	5268.280	5291.000	---	PASS
		5320	23.240	5308.400	5331.640	---	PASS
		5500	22.080	5489.280	5511.360	---	PASS
		5600	22.480	5588.360	5610.840	---	PASS
		5700	22.440	5688.600	5711.040	---	PASS
		5745	23.680	5732.440	5756.120	---	PASS
		5785	22.720	5773.280	5796.000	---	PASS
		5825	22.720	5813.120	5835.840	---	PASS
11N40MIMO	Ant2	5190	42.320	5168.640	5210.960	---	PASS
		5230	41.200	5209.680	5250.880	---	PASS
		5270	42.080	5249.200	5291.280	---	PASS
		5310	42.800	5288.480	5331.280	---	PASS
		5510	43.200	5488.240	5531.440	---	PASS
		5590	41.360	5569.440	5610.800	---	PASS
		5670	42.640	5648.080	5690.720	---	PASS
		5755	43.120	5733.080	5776.200	---	PASS
		5795	41.360	5774.120	5815.480	---	PASS
11AC80MIMO	Ant2	5210	82.240	5169.200	5251.440	---	PASS
		5290	81.120	5249.040	5330.160	---	PASS
		5530	80.480	5489.520	5570.000	---	PASS
		5610	81.280	5568.880	5650.160	---	PASS
		5775	79.520	5734.680	5814.200	---	PASS
11AC160MIMO	Ant2	5250	161.920	5168.400	5330.320	---	PASS
		5570	163.200	5487.120	5650.320	---	PASS

Note: Both the two antennas had been tested, but only the worst data was recorded in the report.

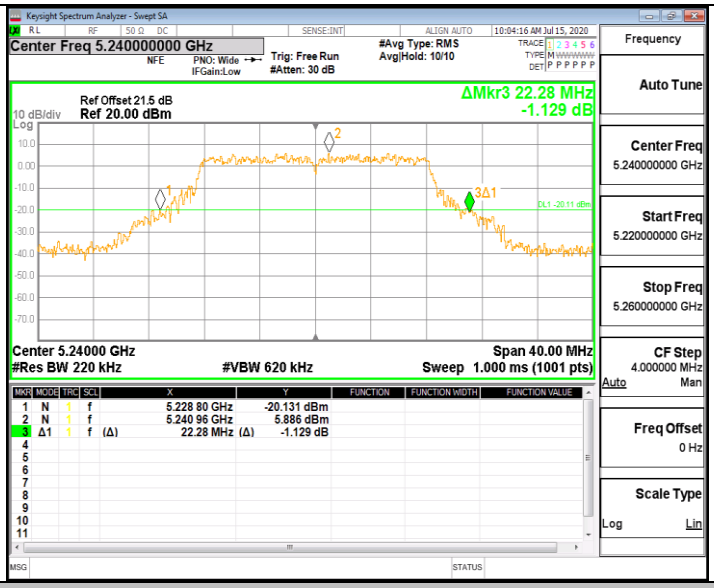
Test Graphs

11A_Ant2_5180



11A_Ant2_5200

11A_Ant2_5240



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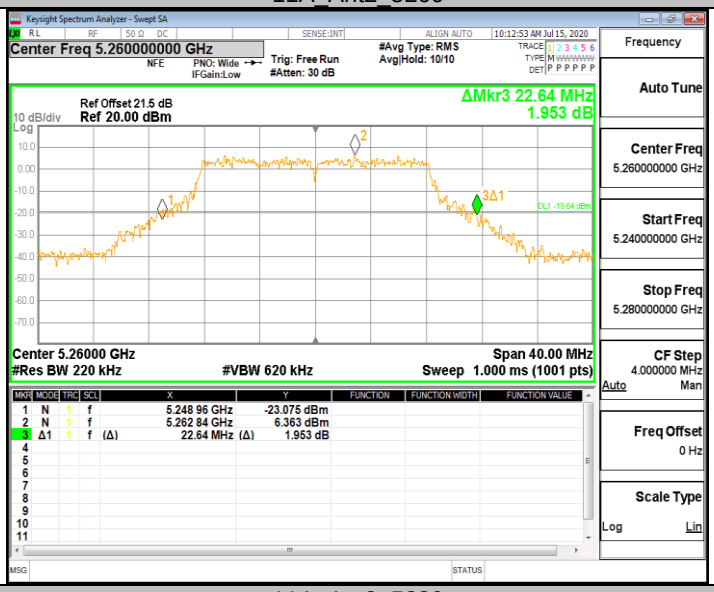

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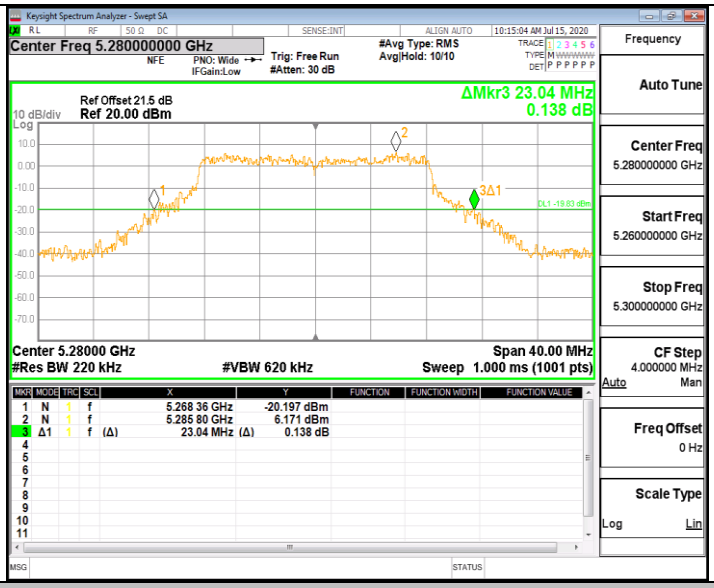

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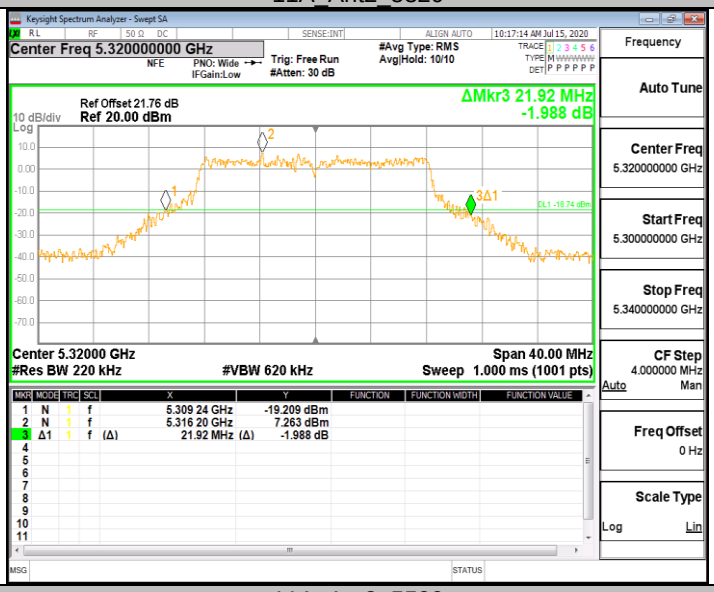
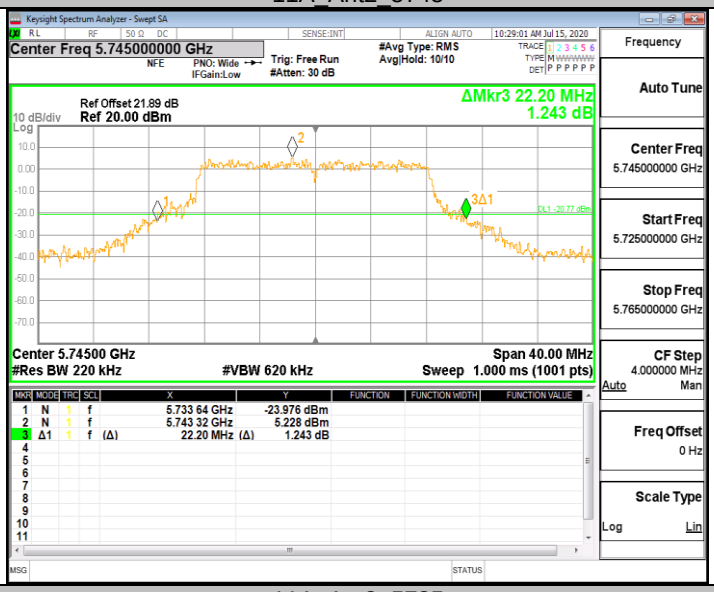


11A_Ant2_5500

11A_Ant2_5600

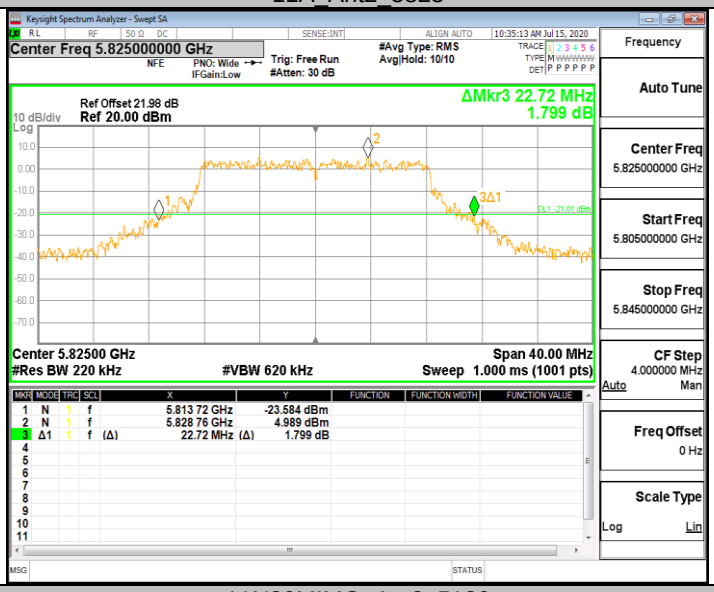
11A_Ant2_5700

11A_Ant2_5745

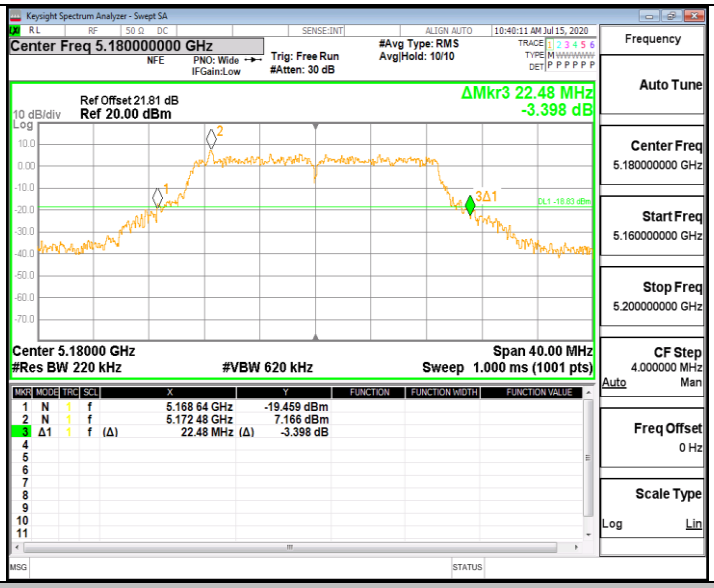


11A_Ant2_5785

11A_Ant2_5825



11N20MIMO_Ant2_5180



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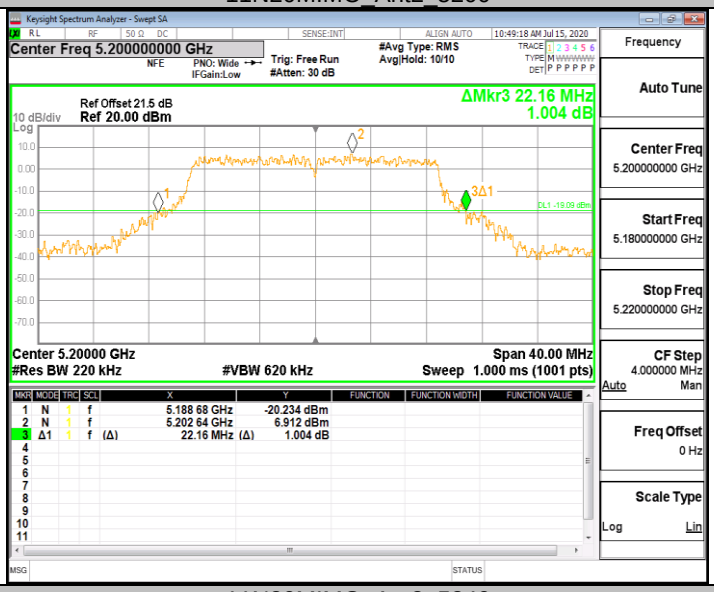

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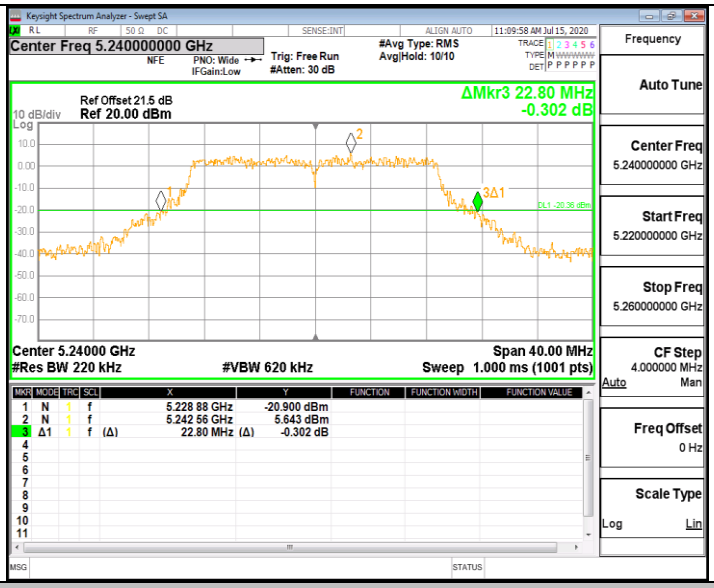

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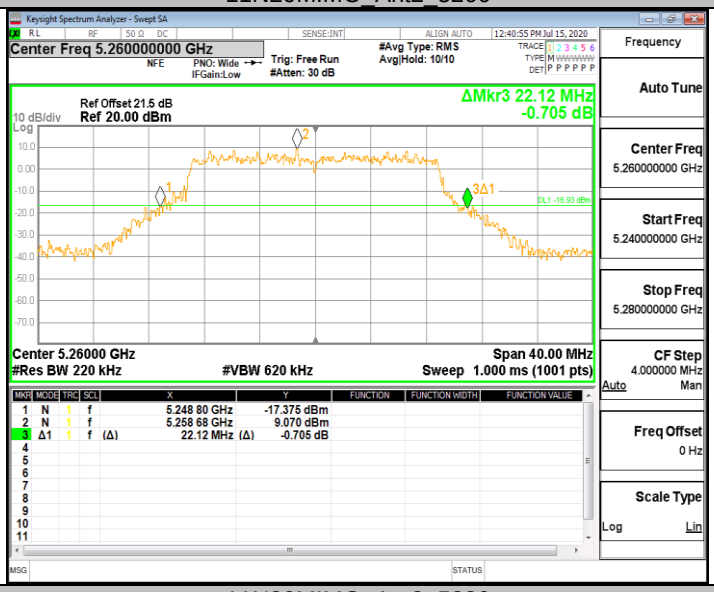

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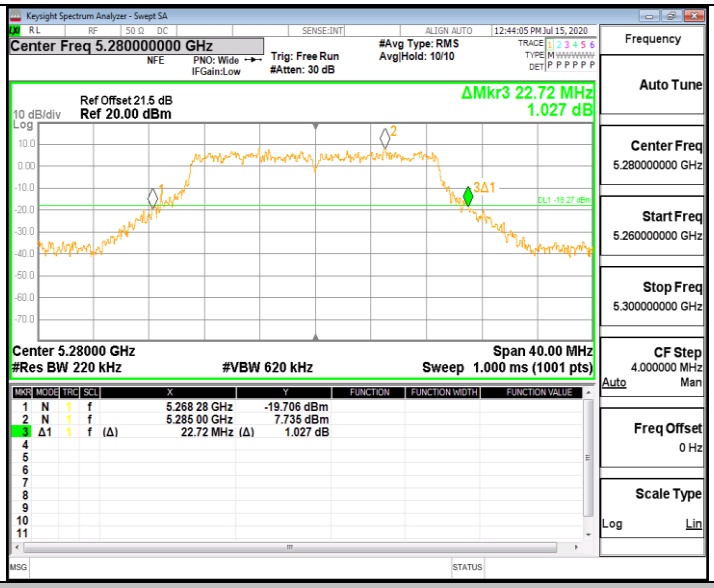
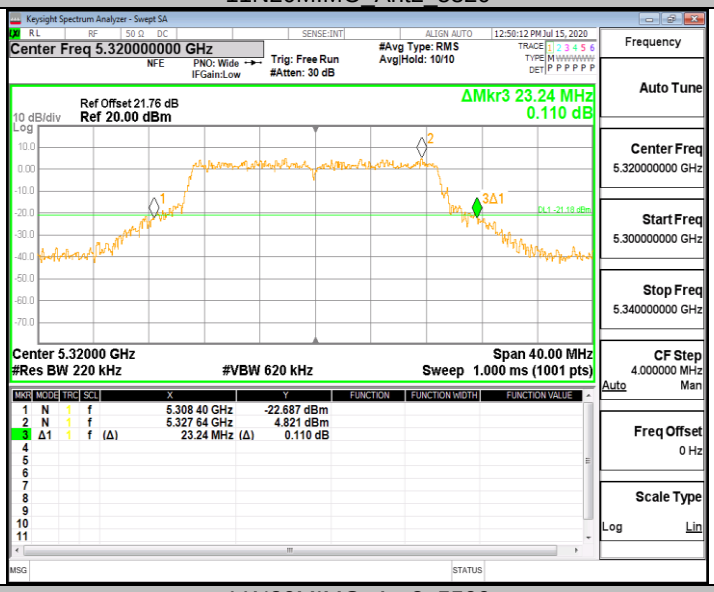
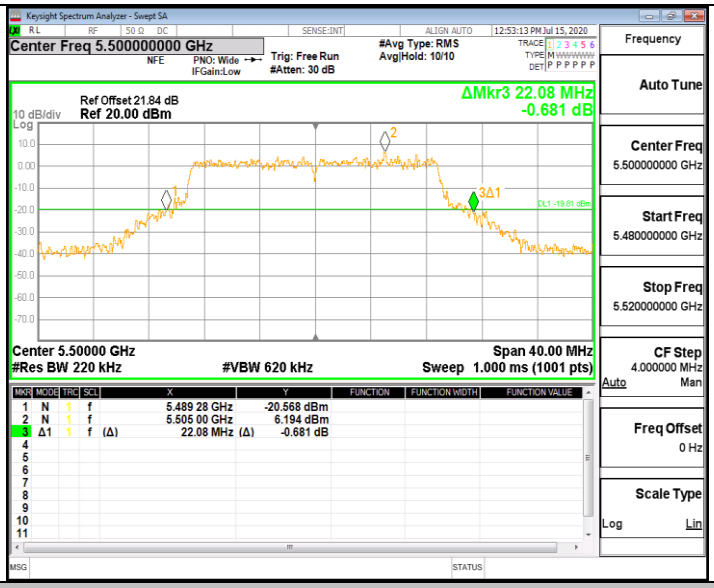


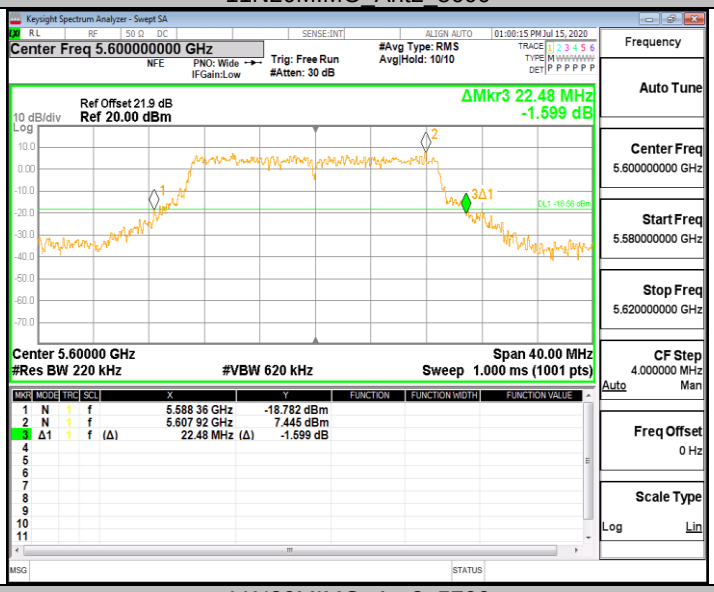
11N20MIMO_Ant2_5320



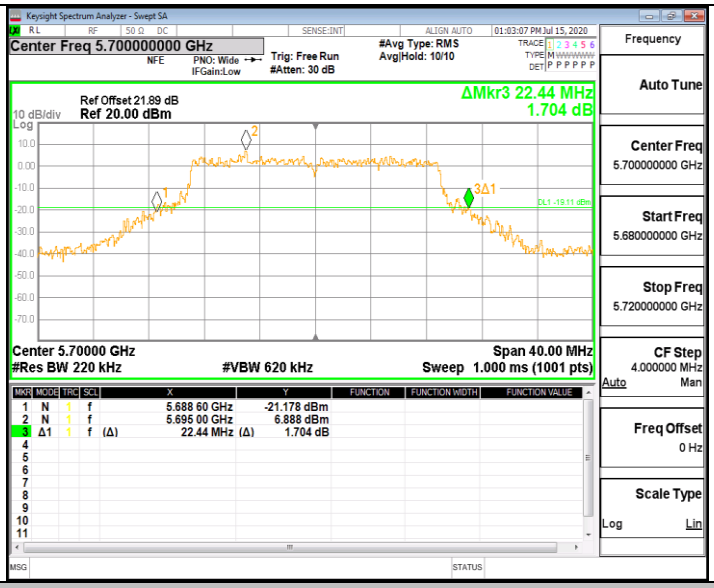
11N20MIMO_Ant2_5500



11N20MIMO_Ant2_5600



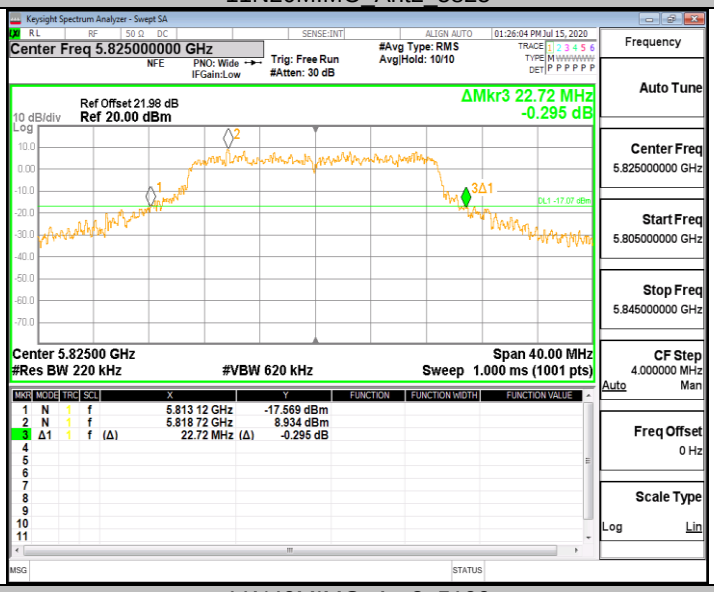
11N20MIMO_Ant2_5700



11N20MIMO_Ant2_5745

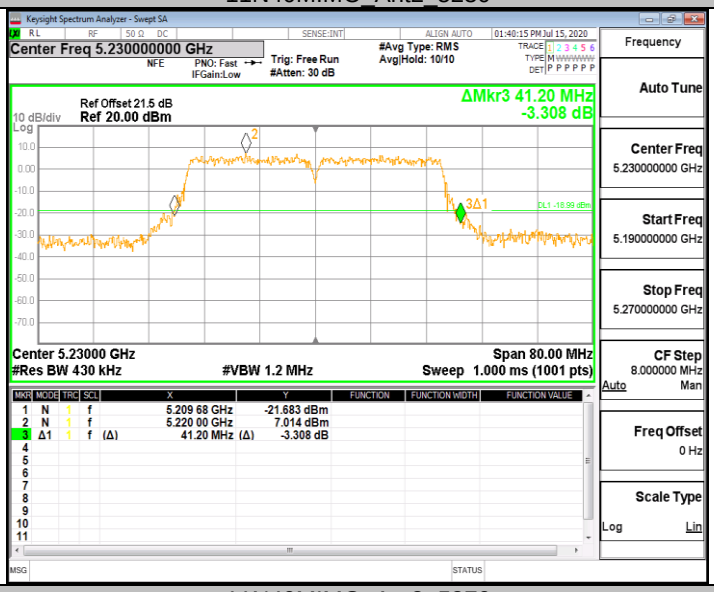
11N20MIMO_Ant2_5785

11N20MIMO_Ant2_5825

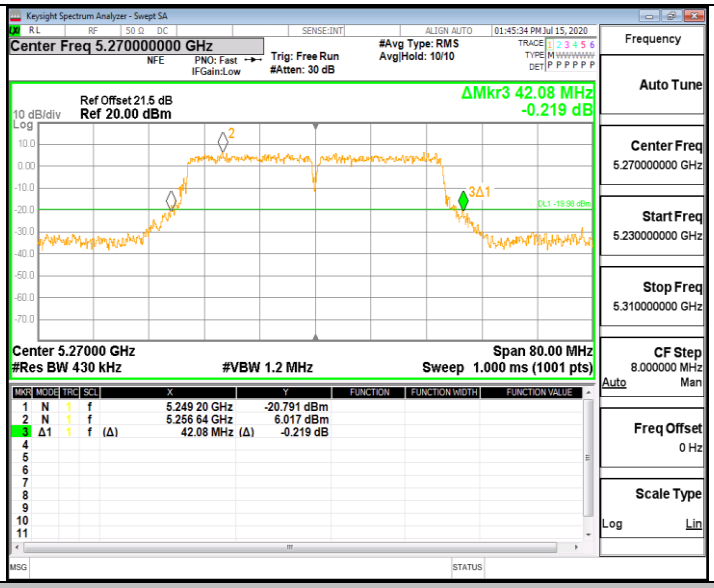


11N40MIMO_Ant2_5190

11N40MIMO_Ant2_5230



11N40MIMO_Ant2_5270

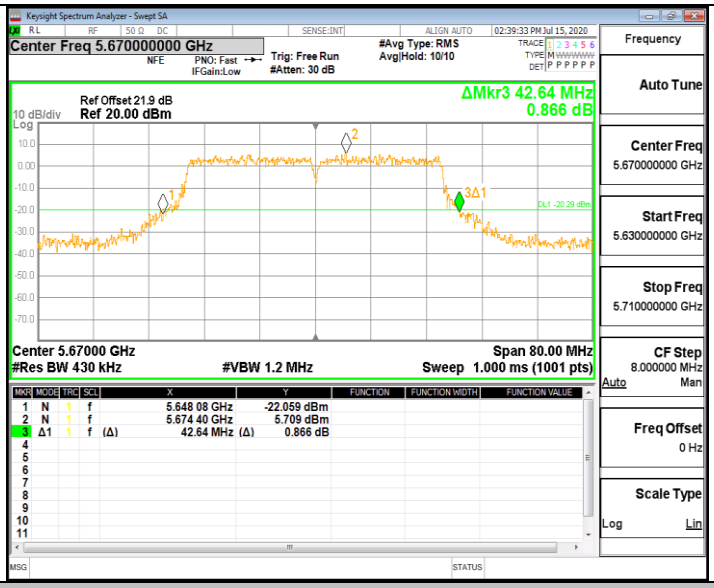


11N40MIMO_Ant2_5310

11N40MIMO_Ant2_5510

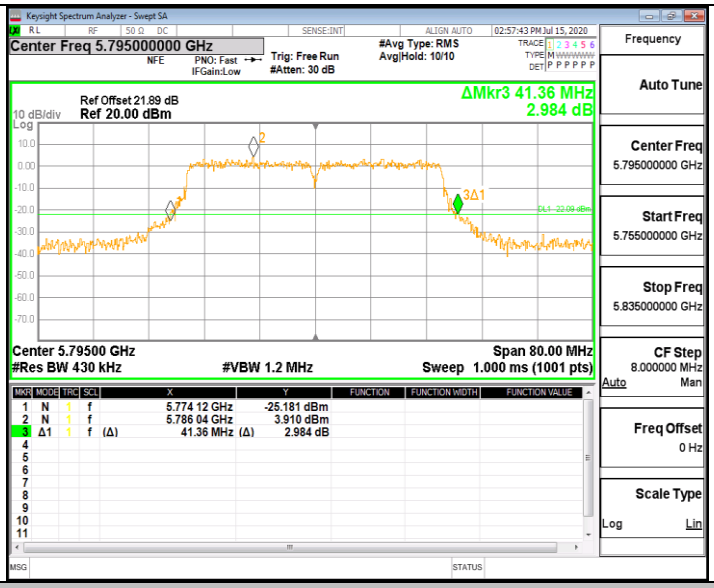
11N40MIMO_Ant2_5590

11N40MIMO_Ant2_5670

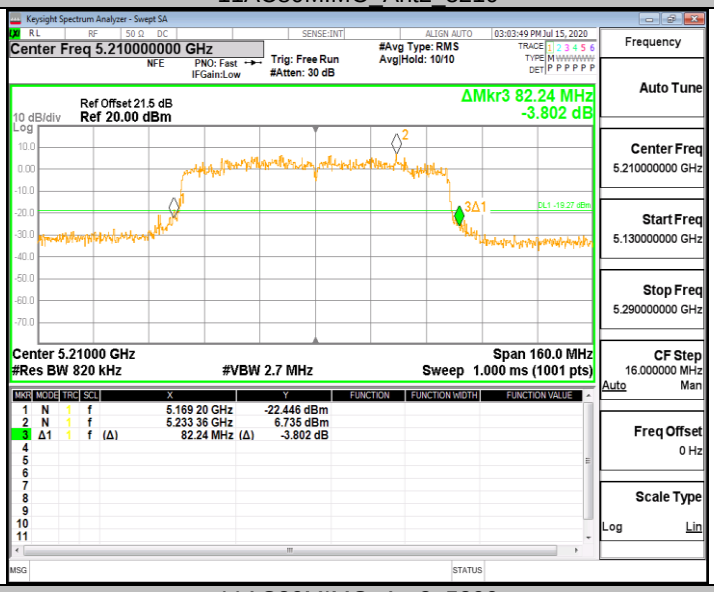


11N40MIMO_Ant2_5755

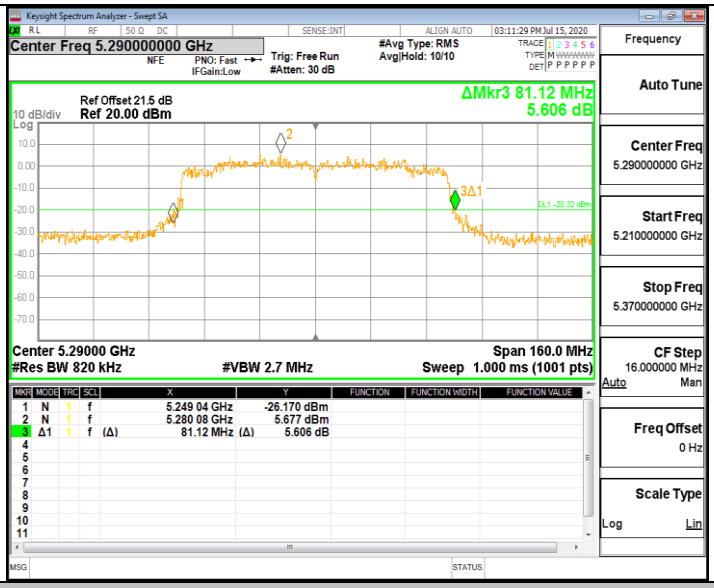
11N40MIMO_Ant2_5795



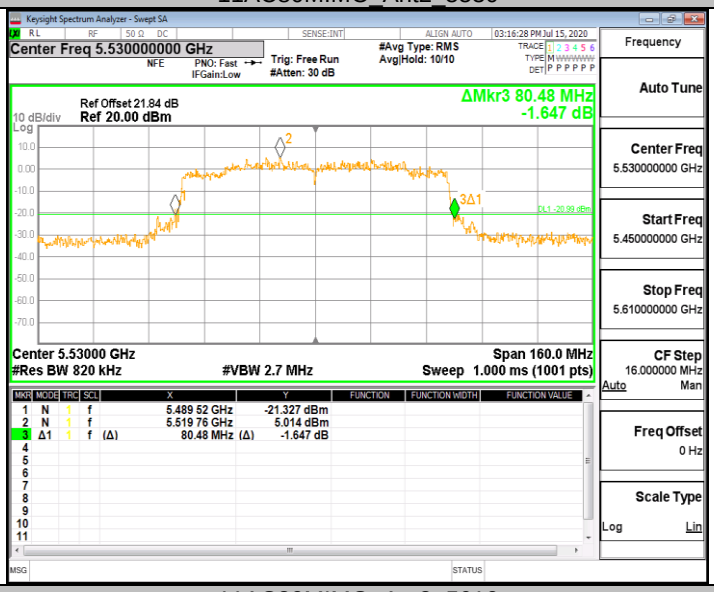
11AC80MIMO_Ant2_5210



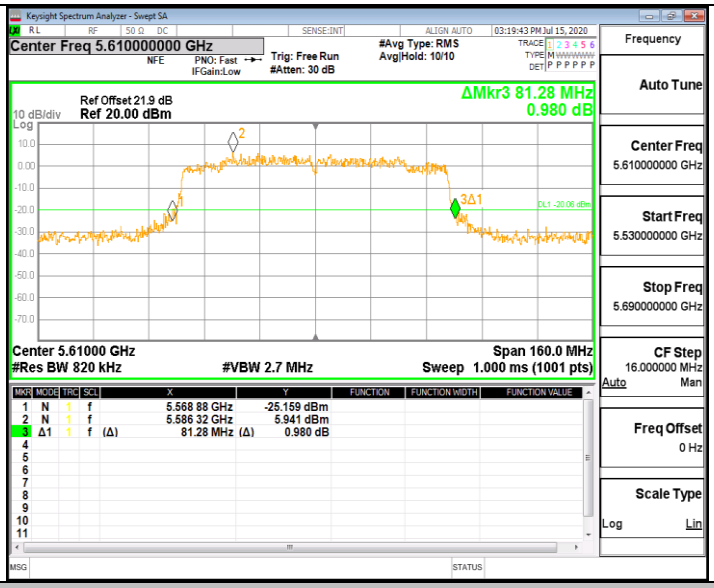
11AC80MIMO_Ant2_5290



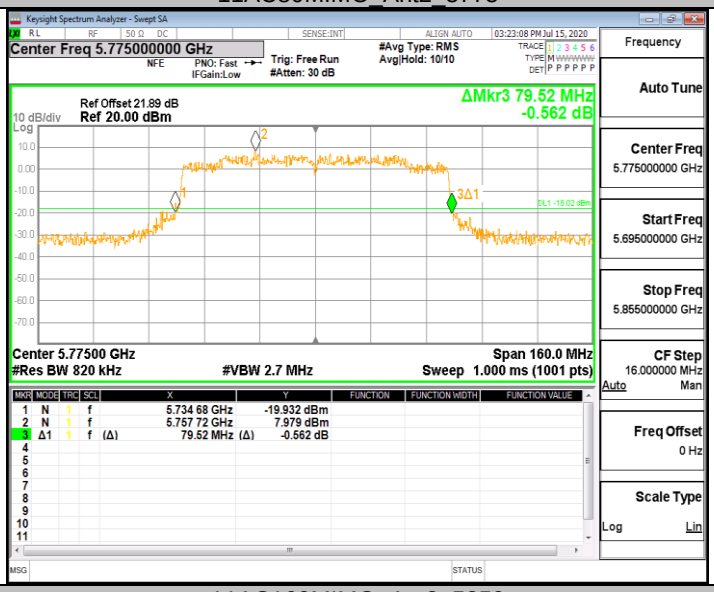
11AC80MIMO_Ant2_5530



11AC80MIMO_Ant2_5610



11AC80MIMO_Ant2_5775



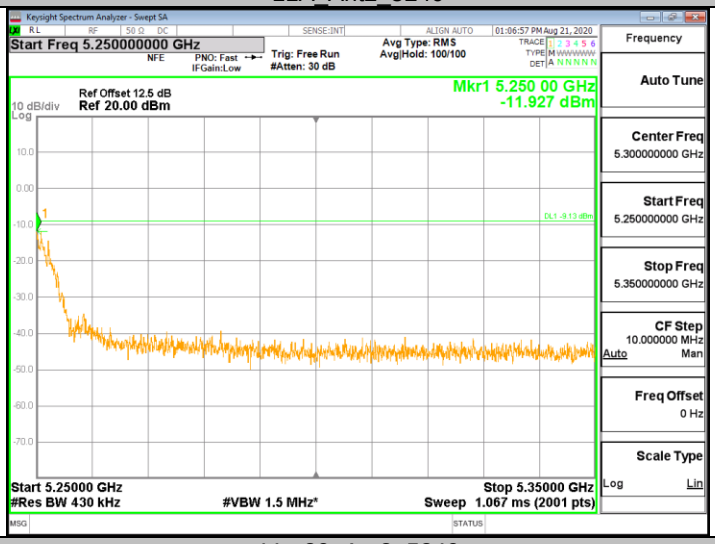
11AC160MIMO_Ant2_5250

11AC160MIMO_Ant2_5570

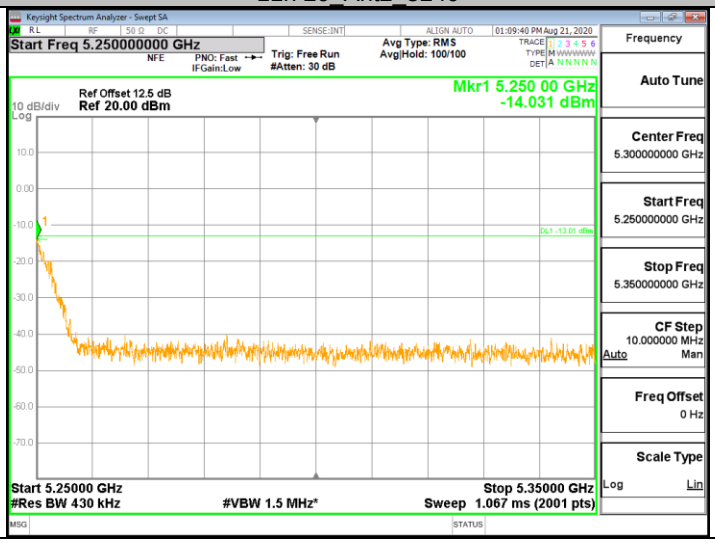
Appendix A2: UNII Band-1 Unwanted Emissions

Test Graphs

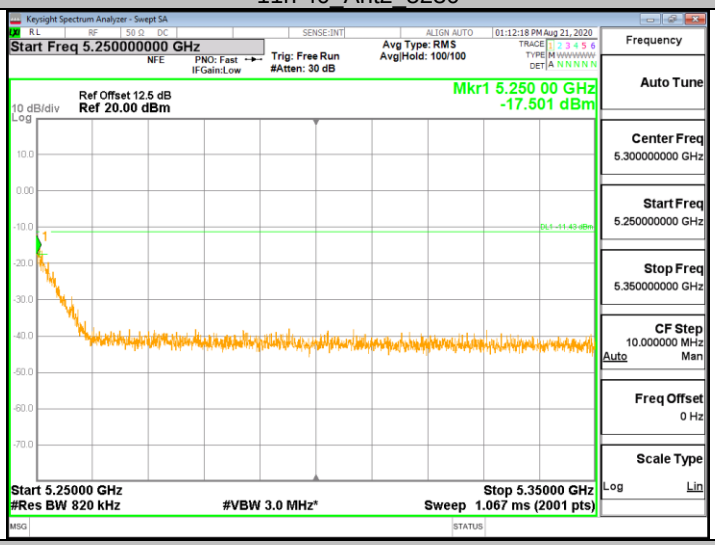
11A_Ant2_5240



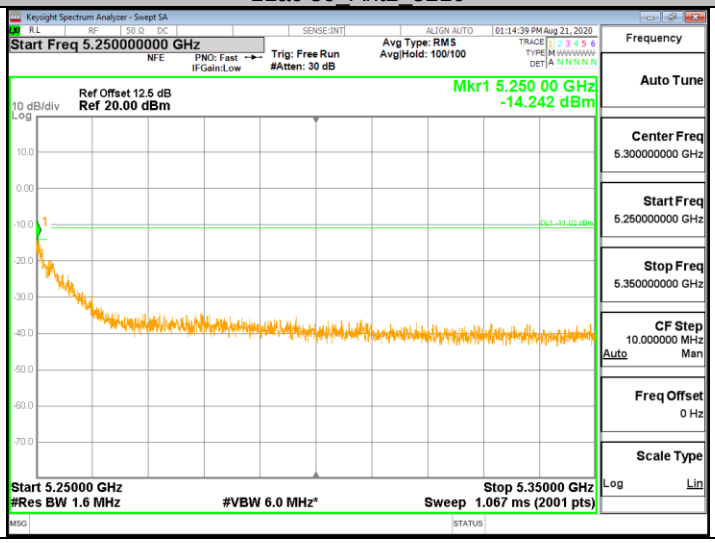
11n 20_Ant2_5240



11n 40_Ant2_5230



11ac 80_Ant2_5210



Note: All the modes had been tested, but only the worst data was recorded in the report.

Appendix A3: Occupied channel bandwidth

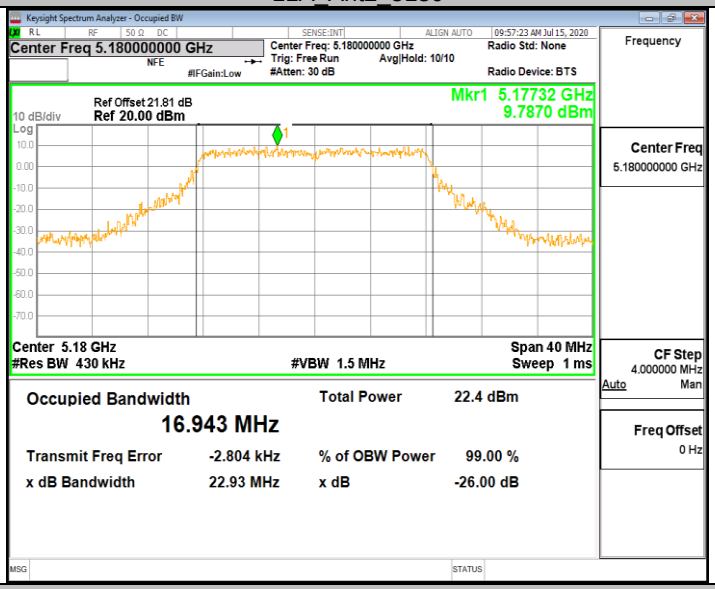
Test Result

Test Mode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11A	Ant2	5180	16.943	5171.526	5188.469	---	PASS
		5200	16.899	5191.479	5208.378	---	PASS
		5240	16.972	5231.512	5248.484	---	PASS
		5260	16.835	5251.620	5268.455	---	PASS
		5280	16.815	5271.580	5288.395	---	PASS
		5320	16.941	5311.483	5328.424	---	PASS
		5500	16.993	5491.455	5508.448	---	PASS
		5600	16.975	5591.506	5608.481	---	PASS
		5700	16.944	5691.521	5708.465	---	PASS
		5745	16.898	5736.467	5753.365	---	PASS
		5785	16.902	5776.522	5793.424	---	PASS
		5825	16.784	5816.547	5833.331	---	PASS
11N20MIMO	Ant2	5180	17.993	5170.998	5188.991	---	PASS
		5200	18.062	5190.948	5209.010	---	PASS
		5240	17.938	5231.032	5248.970	---	PASS
		5260	17.975	5250.980	5268.955	---	PASS
		5280	17.981	5270.989	5288.970	---	PASS
		5320	18.030	5310.975	5329.005	---	PASS
		5500	18.135	5490.919	5509.054	---	PASS
		5600	17.932	5591.001	5608.933	---	PASS
		5700	17.943	5691.009	5708.952	---	PASS
		5745	18.143	5735.814	5753.957	---	PASS
		5785	18.219	5775.858	5794.077	---	PASS
		5825	18.064	5815.864	5833.928	---	PASS
11N40MIMO	Ant2	5190	36.438	5171.731	5208.169	---	PASS
		5230	36.508	5211.781	5248.289	---	PASS
		5270	36.557	5251.629	5288.186	---	PASS
		5310	36.592	5291.617	5328.209	---	PASS
		5510	36.546	5491.710	5528.256	---	PASS
		5590	36.499	5571.767	5608.266	---	PASS
		5670	36.447	5651.727	5688.174	---	PASS
		5755	36.485	5736.679	5773.164	---	PASS
		5795	36.499	5776.705	5813.204	---	PASS
11AC80MIMO	Ant2	5210	75.354	5172.058	5247.412	---	PASS
		5290	75.323	5252.264	5327.587	---	PASS
		5530	75.002	5492.477	5567.479	---	PASS
		5610	75.086	5572.351	5647.437	---	PASS
		5775	75.211	5737.318	5812.529	---	PASS
11AC160MIMO	Ant2	5250	153.86	5173.390	5327.250	---	PASS
		5570	153.09	5493.811	5646.901	---	PASS

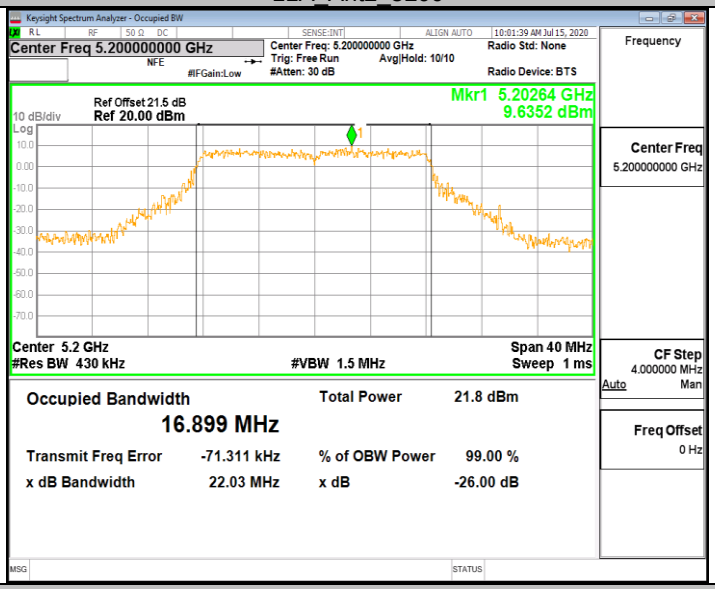
Note: Both the two antennas had been tested, but only the worst data was recorded in the report.

Test Graphs

11A_Ant2_5180



11A_Ant2_5200



11A_Ant2_5240