5.5. Radiated Emissions Measurement

5.5.1. Standard Applicable

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
\1\ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293.	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(\2\)
13.36-13.41			

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
\2\ Above 38.6

For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz (68.2dBuV/m at 3m).

In addition, In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

5.5.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB/VB 120kHz/1MHz for QP

5.5.3. Test Procedures

1) **Sequence of testing 9 kHz to 30 MHz**

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 1.5 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

2) **Sequence of testing 30 MHz to 1 GHz**

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) **Sequence of testing 1 GHz to 18 GHz**

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) **Sequence of testing above 18 GHz**

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

Premeasurement:

--- The antenna is moved spherical over the EUT in different polarizations of the antenna.

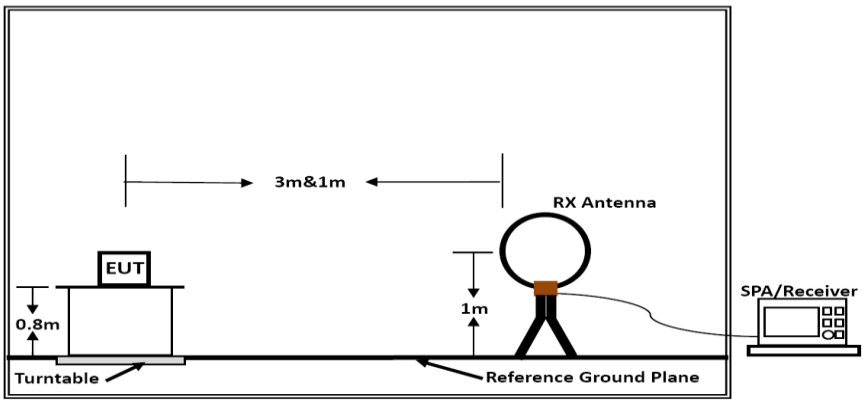
Final measurement:

--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

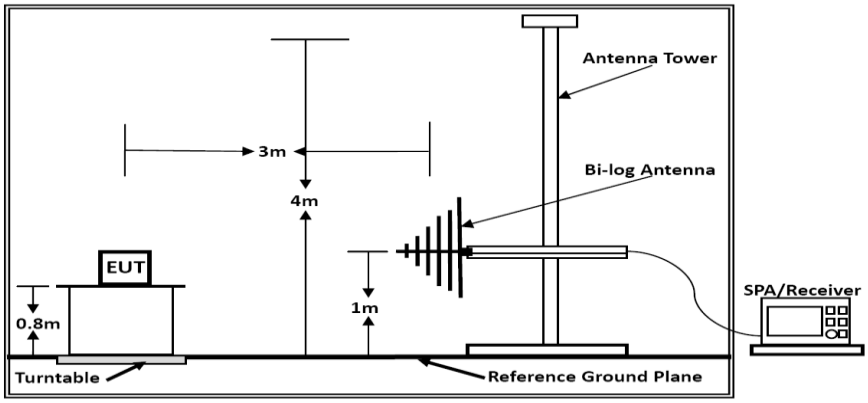
--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

5.5.4. Test Setup Layout

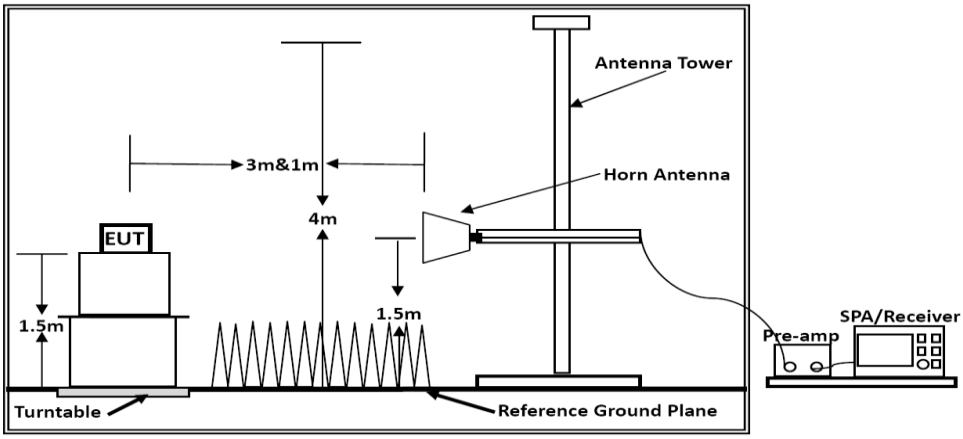
For radiated emissions below 30MHz



Below 30MHz



Below 1GHz



Above 1GHz

Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1m.

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1.5m]) (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.5.6. Results of Radiated Emissions (9 KHz~30MHz)

Temperature	24.5℃	Humidity	56.2%
Test Engineer	Anna Hu	Configurations	IEEE 802.11a/n/ac

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Over Limit (dBuV)	Remark
-	-	-	-	See Note

Note:

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = 40 log (specific distance / test distance) (dB);

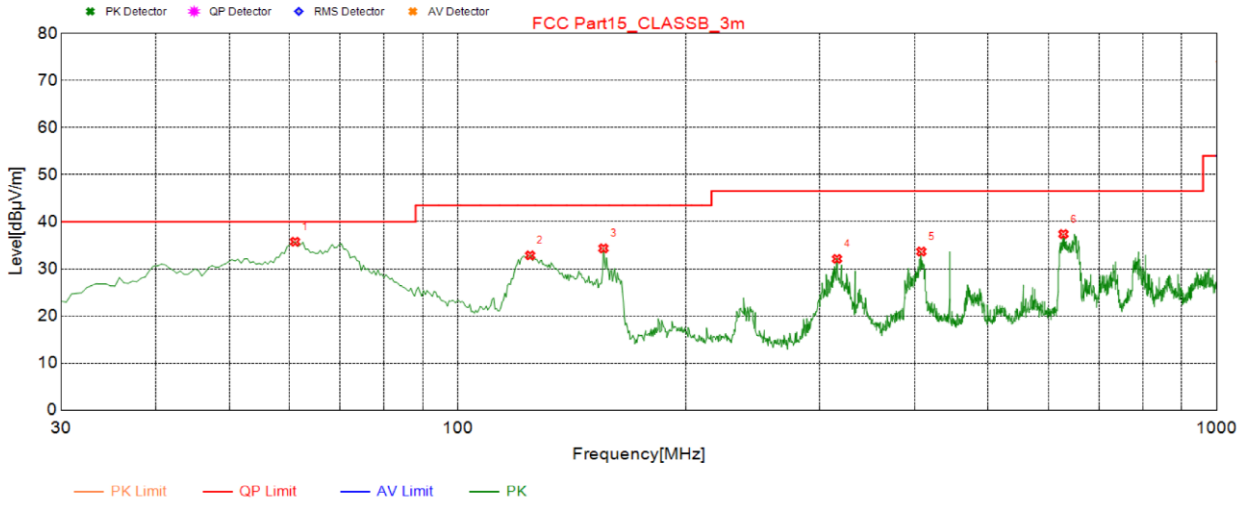
Limit line = specific limits (dBuV) + distance extrapolation factor.

5.5.7. Results of Radiated Emissions (30MHz~1GHz)

Temperature	24.5℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	IEEE 802.11a, 5180MHz

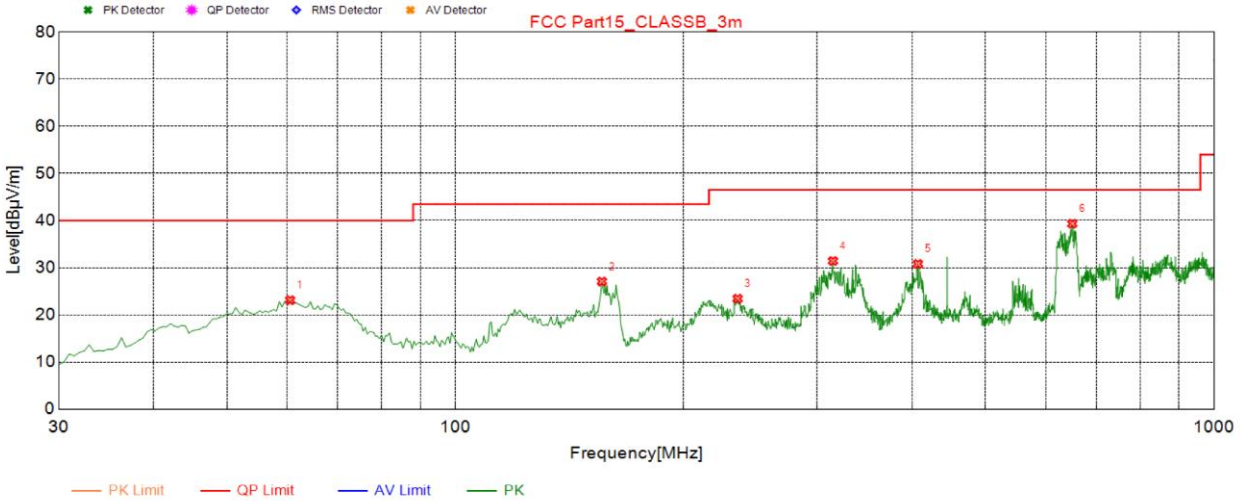
Test result for IEEE 802.11a, 5180MHz

Vertical



Suspected List								
NO.	Freq. [MHz]	Result Level [dBµV/m]	Factor [dB/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	61.040	35.76	-15.92	40	4.24	100	192	Vertical
2	124.575	32.86	-18.30	43.5	10.64	100	265	Vertical
3	155.615	34.35	-18.86	43.5	9.15	100	343	Vertical
4	316.150	32.12	-12.36	46.5	14.38	100	349	Vertical
5	408.300	33.67	-9.88	46.5	12.83	100	245	Vertical
6	628.490	37.39	-5.24	46.5	9.11	100	335	Vertical

Horizontal



Suspected List								
NO.	Freq. [MHz]	Result Level [dBµV/m]	Factor [dB/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle[°]	Polarity
1	60.555	23.11	-15.79	40	16.89	100	246	Horizontal
2	156.100	27.07	-18.84	43.5	16.43	100	265	Horizontal
3	235.640	23.43	-14.32	46.5	23.07	100	305	Horizontal
4	314.695	31.43	-12.41	46.5	15.07	100	249	Horizontal
5	407.330	30.8	-9.89	46.5	15.70	100	145	Horizontal
6	650.800	39.34	-4.96	46.5	7.16	100	313	Horizontal

Note:

1) Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11n HT40, 5190MHz).
2). Margin[dB] = Limit[dBµV/m] – Result Level[dBµV/m]

5.5.8. Results for Radiated Emissions (Above 1GHz)

Remark: Measured all modes and recorded worst case;

IEEE 802.11a

Channel 36/5180 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.54	56.53	33.06	35.04	3.94	58.49	68.20	-9.71	Peak	Horizontal
15.54	42.46	33.06	35.04	3.94	44.42	54.00	-9.58	Average	Horizontal
15.54	54.58	33.06	35.04	3.94	56.54	68.20	-11.66	Peak	Vertical
15.54	42.50	33.06	35.04	3.94	44.46	54.00	-9.54	Average	Vertical

Channel 40 / 5200 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.60	55.81	33.16	35.15	3.96	57.78	68.20	-10.42	Peak	Horizontal
15.60	42.52	33.16	35.15	3.96	44.49	54.00	-9.51	Average	Horizontal
15.60	54.24	33.16	35.15	3.96	56.21	68.20	-11.99	Peak	Vertical
15.60	40.35	33.16	35.15	3.96	42.32	54.00	-11.68	Average	Vertical

Channel 48 / 5240 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.72	55.18	33.26	35.14	3.98	57.28	68.20	-10.92	Peak	Horizontal
15.72	42.73	33.26	35.14	3.98	44.83	54.00	-9.17	Average	Horizontal
15.72	56.28	33.26	35.14	3.98	58.38	68.20	-9.82	Peak	Vertical
15.72	44.38	33.26	35.14	3.98	46.48	54.00	-7.52	Average	Vertical

IEEE 802.11n-HT20

Channel 36/5180 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.54	56.90	33.06	35.04	3.94	58.86	68.20	-9.34	Peak	Horizontal
15.54	44.69	33.06	35.04	3.94	46.65	54.00	-7.35	Average	Horizontal
15.54	54.54	33.06	35.04	3.94	56.50	68.20	-11.70	Peak	Vertical
15.54	42.61	33.06	35.04	3.94	44.57	54.00	-9.43	Average	Vertical

Channel 40 / 5200 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.60	56.72	33.16	35.15	3.96	58.69	68.20	-9.51	Peak	Horizontal
15.60	40.90	33.16	35.15	3.96	42.87	54.00	-11.13	Average	Horizontal
15.60	55.68	33.16	35.15	3.96	57.65	68.20	-10.55	Peak	Vertical
15.60	44.86	33.16	35.15	3.96	46.83	54.00	-7.17	Average	Vertical

Channel 48 / 5240 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.72	57.03	33.26	35.14	3.98	59.13	68.20	-9.07	Peak	Horizontal
15.72	41.88	33.26	35.14	3.98	43.98	54.00	-10.02	Average	Horizontal
15.72	55.83	33.26	35.14	3.98	57.93	68.20	-10.27	Peak	Vertical
15.72	43.59	33.26	35.14	3.98	45.69	54.00	-8.31	Average	Vertical

IEEE 802.11n HT40

Channel 38 / 5190 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.57	54.97	33.06	35.04	3.94	56.93	68.20	-11.27	Peak	Horizontal
15.57	44.22	33.06	35.04	3.94	46.18	54.00	-7.82	Average	Horizontal
15.57	57.69	33.06	35.04	3.94	59.65	68.20	-8.55	Peak	Vertical
15.57	41.06	33.06	35.04	3.94	43.02	54.00	-10.98	Average	Vertical

Channel 46 / 5230 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.69	54.61	33.16	35.15	3.96	56.58	68.20	-11.62	Peak	Horizontal
15.69	41.07	33.16	35.15	3.96	43.04	54.00	-10.96	Average	Horizontal
15.69	58.80	33.16	35.15	3.96	60.77	68.20	-7.43	Peak	Vertical
15.69	40.43	33.16	35.15	3.96	42.40	54.00	-11.60	Average	Vertical

IEEE 802.11ac VHT20

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.54	58.85	33.06	35.04	3.94	60.81	68.20	-7.39	Peak	Horizontal
15.54	40.92	33.06	35.04	3.94	42.88	54.00	-11.12	Average	Horizontal
15.54	56.65	33.06	35.04	3.94	58.61	68.20	-9.59	Peak	Vertical
15.54	44.19	33.06	35.04	3.94	46.15	54.00	-7.85	Average	Vertical

Channel 40 / 5200 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.60	58.42	33.16	35.15	3.96	60.39	68.20	-7.81	Peak	Horizontal
15.60	40.52	33.16	35.15	3.96	42.49	54.00	-11.51	Average	Horizontal
15.60	54.72	33.16	35.15	3.96	56.69	68.20	-11.51	Peak	Vertical
15.60	40.50	33.16	35.15	3.96	42.47	54.00	-11.53	Average	Vertical

Channel 48 / 5240 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.72	55.00	33.26	35.14	3.98	57.10	68.20	-11.10	Peak	Horizontal
15.72	40.48	33.26	35.14	3.98	42.58	54.00	-11.42	Average	Horizontal
15.72	57.76	33.26	35.14	3.98	59.86	68.20	-8.34	Peak	Vertical
15.72	43.86	33.26	35.14	3.98	45.96	54.00	-8.04	Average	Vertical

IEEE 802.11ac VHT40

Channel 38 / 5190 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.57	55.60	33.06	35.04	3.94	57.56	68.20	-10.64	Peak	Horizontal
15.57	43.48	33.06	35.04	3.94	45.44	54.00	-8.56	Average	Horizontal
15.57	58.91	33.06	35.04	3.94	60.87	68.20	-7.33	Peak	Vertical
15.57	42.11	33.06	35.04	3.94	44.07	54.00	-9.93	Average	Vertical

Channel 46 / 5230 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.69	56.05	33.16	35.15	3.96	58.02	68.20	-10.18	Peak	Horizontal
15.69	44.51	33.16	35.15	3.96	46.48	54.00	-7.52	Average	Horizontal
15.69	54.65	33.16	35.15	3.96	56.62	68.20	-11.58	Peak	Vertical
15.69	41.95	33.16	35.15	3.96	43.92	54.00	-10.08	Average	Vertical

IEEE 802.11ac VHT80

Channel 42 / 5210 MHz

Freq GHz	Read Level dBuV	Ant. Fac dB/m	Pre. Fac dB	Cab.Los dB	Measured Level dBuV	Limit Line dBuV/m	Over limit dB	Remark	Pol/Phase
15.63	54.93	33.06	35.04	3.94	56.89	68.20	-11.31	Peak	Horizontal
15.63	43.66	33.06	35.04	3.94	45.62	54.00	-8.38	Average	Horizontal
15.63	57.67	33.06	35.04	3.94	59.63	68.20	-8.57	Peak	Vertical
15.63	44.18	33.06	35.04	3.94	46.14	54.00	-7.86	Average	Vertical

Notes:

1. *Measuring frequencies from 9 KHz ~40 GHz, No emission found between lowest internal used/generated frequencies to 30MHz.*
2. *Radiated emissions measured in frequency range from 9 KHz ~40GHz were made with an instrument using Peak detector mode.*
3. *Data of measurement within this frequency range shown "---" in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.*
4. *Worst case data at 6Mbps at IEEE 802.11a; MCS0 at IEEE 802.11n HT20, IEEE 802.11n HT40*
5. *Measured[dBμv/m] = Reading[dBμv/m] + Ant. Fac.[dB/m] - Pre. Fac.[dB] + Cab. Loss[dB];*
   Margin[dB] = Limit[dBμV/m] –Measured Level[dBμV/m]

5.6. Power line conducted emissions

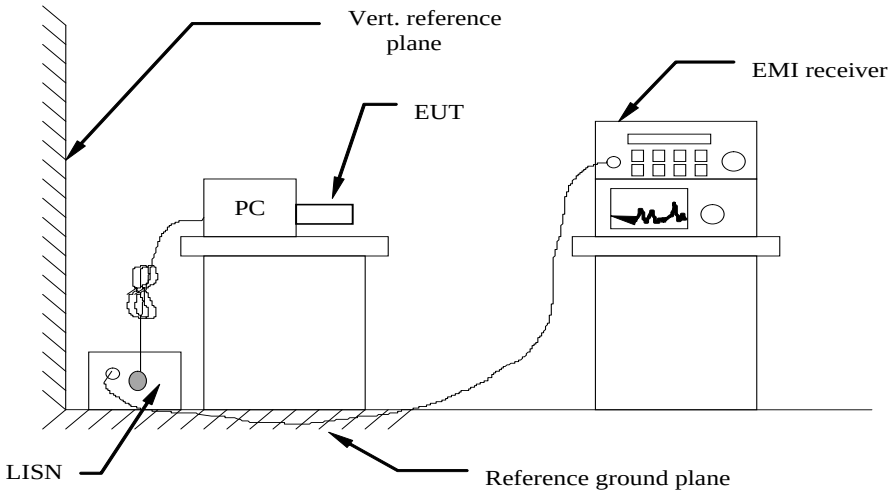
5.6.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBμV)	
	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

* Decreasing linearly with the logarithm of the frequency

5.6.2 Block Diagram of Test Setup



5.6.3 Test Results

PASS.

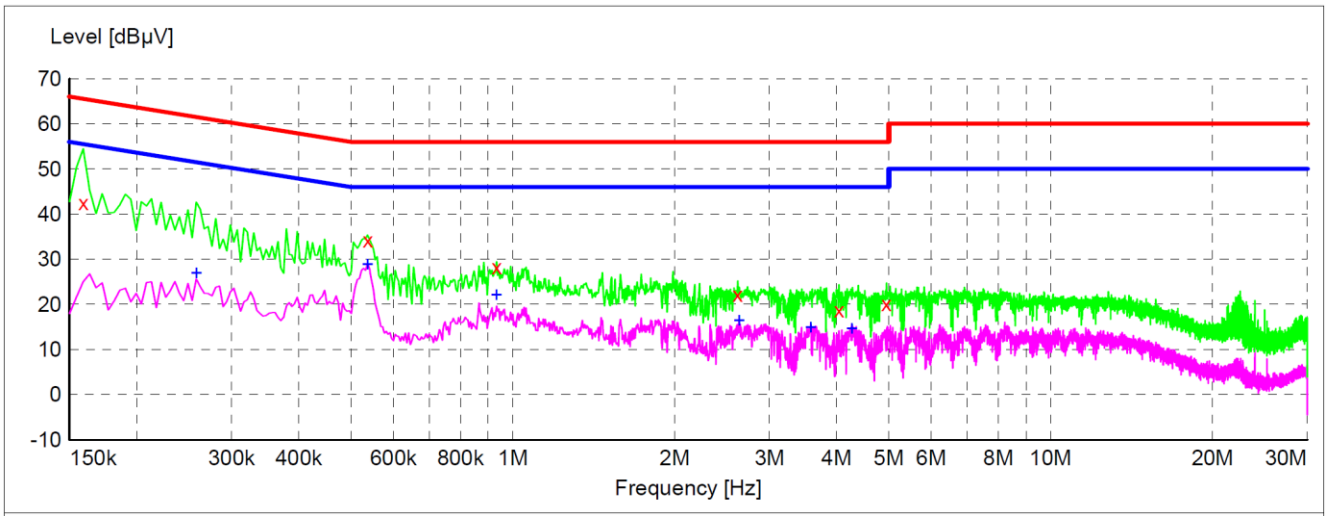
The test data please refer to following page.

Temperature	22.8℃	Humidity	50%
Test Engineer	Anna Hu	Configurations	BT

The test data please refer to following page.

The worst result for IEEE 802.11a, 5180MHz

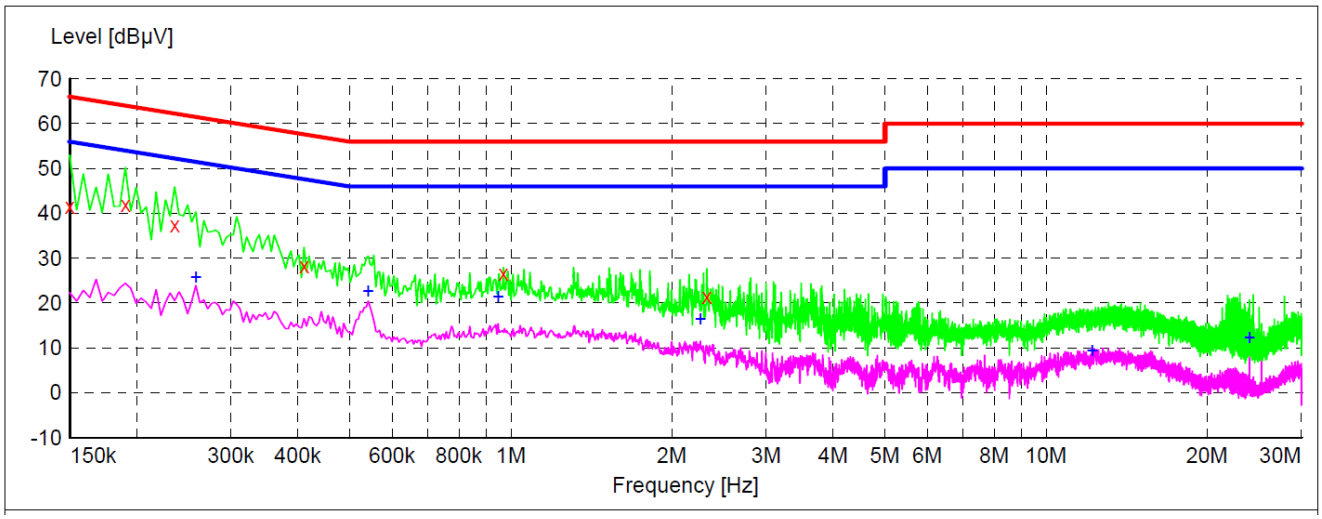
Line



Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.159000	42.50	10.0	66	23.0	QP	L1	GND
0.537000	34.20	9.9	56	21.8	QP	L1	GND
0.933000	28.20	9.8	56	27.8	QP	L1	GND
2.620500	22.10	9.7	56	33.9	QP	L1	GND
4.042500	18.70	9.7	56	37.3	QP	L1	GND
4.951500	20.10	9.8	56	35.9	QP	L1	GND

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.258000	26.90	10.4	52	24.6	AV	L1	GND
0.537000	28.80	9.9	46	17.2	AV	L1	GND
0.933000	22.00	9.8	46	24.0	AV	L1	GND
2.634000	16.40	9.7	46	29.6	AV	L1	GND
3.583500	14.80	9.7	46	31.2	AV	L1	GND
4.276500	14.60	9.8	46	31.4	AV	L1	GND

Neutral



Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.150000	41.60	9.8	66	24.4	QP	N	GND
0.190500	42.00	10.5	64	22.0	QP	N	GND
0.235500	37.40	10.5	62	24.9	QP	N	GND
0.411000	28.20	10.0	58	29.4	QP	N	GND
0.969000	26.50	9.8	56	29.5	QP	N	GND
2.323500	21.50	9.7	56	34.5	QP	N	GND

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.258000	25.80	10.4	52	25.7	AV	N	GND
0.541500	22.70	9.9	46	23.3	AV	N	GND
0.946500	21.50	9.8	46	24.5	AV	N	GND
2.260500	16.40	9.7	46	29.6	AV	N	GND
12.187500	9.40	9.8	50	40.6	AV	N	GND
23.977500	12.40	10.1	50	37.6	AV	N	GND

******Note: Pre-scan all modes and recorded the worst case results in this report***

5.7 Undesirable Emissions Measurement

5.7.1 LIMIT

According to ξ15.407 (b) Undesirable emission limits. Except as shown in paragraph (b) (7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(a) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(b) For transmitters operating in the 5.25-5.35 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(c) For transmitters operating in the 5.47-5.725 GHz band: All emissions outside of the 5.47-5.725 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(d) For transmitters operating in the 5.725-5.85 GHz band:

(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

(ii) Devices certified before March 2, 2017 with antenna gain greater than 10 dBi may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease by March 2, 2018. Devices certified before March 2, 2018 with antenna gain of 10 dBi or less may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease before March 2, 2020.

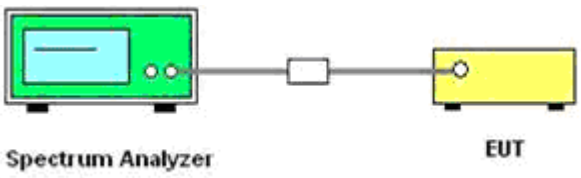
(e) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

(f) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.

(g) The provisions of §15.205 apply to intentional radiators operating under this section.

(h) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

5.7.2 TEST CONFIGURATION



5.7.3 TEST PROCEDURE

According to KDB789033 D02 General UNII Test Procedures New Rules v02r01 Section G: Unwanted Emission Measurement

1. Unwanted Emissions in the Restricted Bands

a) For all measurements, follow the requirements in section II.G.3. “General Requirements for Unwanted Emissions Measurements.”

b) At frequencies below 1000 MHz, use the procedure described in section II.G.4. “Procedure for Unwanted Emissions Measurements below 1000 MHz.”

c) At frequencies above 1000 MHz, measurements performed using the peak and average measurement procedures described in sections II.G.5. and II.G.6, respectively, must satisfy the respective peak and average limits. If all peak measurements satisfy the average limit, then average measurements are not required.

d) For conducted measurements above 1000 MHz, EIRP shall be computed as specified in section II.G.3.b) and then field strength shall be computed as follows (see KDB Publication 412172):

i) E[dBµV/m] = EIRP[dBm] - 20 log (d[meters]) + 104.77, where E = field strength and d = distance at which field strength limit is specified in the rules;

ii) E[dBµV/m] = EIRP[dBm] + 95.2, for d = 3 meters

e) For conducted measurements below 1000 MHz, the field strength shall be computed as specified in d), above, and then an additional 4.7 dB shall be added as an upper bound on the field strength that would be observed on a test range with a ground plane for frequencies between 30 MHz and 1000 MHz, or an additional 6 dB shall be added for frequencies below 30 MHz.

2. Unwanted Emissions that fall Outside of the Restricted Bands

a) For all measurements, follow the requirements in section II.G.3. “General Requirements for Unwanted Emissions Measurements.”

b) At frequencies below 1000 MHz, use the procedure described in section II.G.4. “Procedure for Unwanted Emissions Measurements below 1000 MHz.”

c) At frequencies above 1000 MHz, use the procedure for maximum emissions described in section II.G.5., “Procedure for Unwanted Maximum Unwanted Emissions Measurements Above 1000 MHz.”

d) Section 15.407(b) (1-3) specifies the unwanted emissions limit for the U-NII-1 and 2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz. However, an out-of-band emission that complies with both the average and peak limits of Section 15.209 is not required to satisfy the -27 dBm/MHz dBm/MHz peak emission limit.

i) Section 15.407(b) (4) specifies the unwanted emissions limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b) (4) (i). An alternative to the band emissions mask is specified in Section 15.407(b) (4) (ii). The alternative limits are based on the highest antenna gain specified in the filing. There are also marketing and importation restrictions for the alternative limit.

e) If radiated measurements are performed, field strength is then converted to EIRP as follows:

i) EIRP = ((E×d) ^2) / 30

Where:

- E is the field strength in V/m;
- d is the measurement distance in meters;
- EIRP is the equivalent isotopically radiated power in watts;

ii) Working in dB units, the above equation is equivalent to:

EIRP [dBm] = E [dBµV/m] + 20 log (d [meters]) - 104.77

iii) Or, if d is 3 meters:

EIRP [dBm] = E [dBµV/m] - 95.23

3) Radiated versus Conducted Measurements.

The unwanted emission limits in both the restricted and non-restricted bands are based on radiated measurements; however, as an alternative, antenna-port conducted measurements in conjunction with cabinet emissions tests will be permitted to demonstrate compliance provided that the following steps are performed:

(i) Cabinet emissions measurements. A radiated test shall be performed to ensure that cabinet emissions are below the emission limits. For the cabinet-emission measurements the antenna may be replaced by a termination matching the nominal impedance of the antenna.

(ii) Impedance matching. Conducted tests shall be performed using equipment that matches the nominal impedance of the antenna assembly used with the EUT.

(iii) EIRP calculation. A value representative of an upper bound on out-of-band antenna gain (in dBi) shall be added to the measured antenna-port conducted emission power to compute EIRP within the specified measurement bandwidth. (For emissions in the restricted bands, additional calculations are required to convert EIRP to field strength at the specified distance.) The upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands or 2 dBi, whichever is greater.[3] However, for devices that operate in multiple bands using the same transmit antenna, the highest gain of the antenna within the operating band nearest to the out-of-band frequency being measured may be used in lieu of the overall highest gain when measuring emissions at frequencies within 20% of the absolute frequency at the nearest edge of that band, but in no case shall a value less than 2 dBi be selected.

(iv) EIRP adjustments for multiple outputs. For devices with multiple outputs occupying the same or overlapping frequency ranges in the same band (e.g., MIMO or beamforming devices), compute the total EIRP as follows:

- Compute EIRP for each output, as described in (iii), above.
- Follow the procedures specified in KDB Publication 662911 for summing emissions across the outputs or adjusting emission levels measured on individual outputs by 10 log (N_{ANT}), where N_{ANT} is the number of outputs.
- Add the array gain term specified in KDB Publication 662911 for out-of-band and spurious signals.

(v) Direction of maximum emission.

For all radiated emissions tests, measurements shall correspond to the direction of maximum emission level for each measured emission (see ANSI C63.10 for guidance).

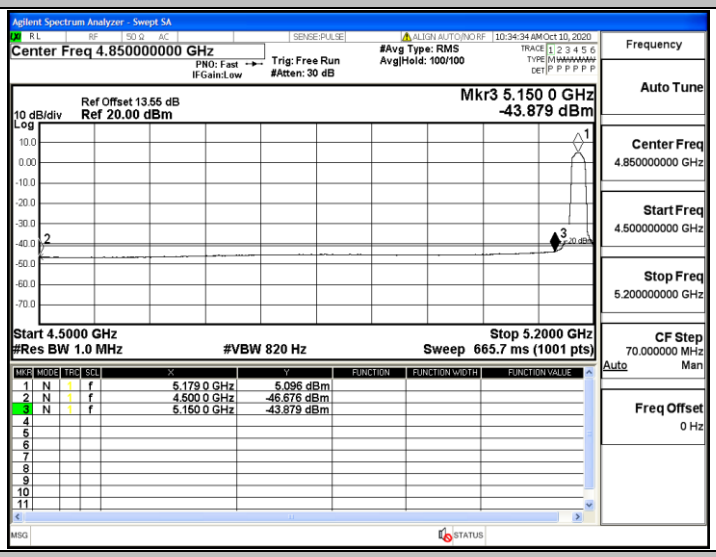
5.7.4 TEST RESULT

TestMode	Antenna	ChName	Channel	Detector	Freq [MHz]	EIRP [dBm]	Limit [dBm]	Verdict
11A	Ant1	Low	5180	AV	4500.000	-46.68	<=-41.20	PASS
				AV	5150.000	-43.88	<=-41.20	PASS
				Peak	4500.000	-39.94	<=-21.20	PASS
				Peak	5150.000	-37.68	<=-21.20	PASS
		High	5240	AV	5350.000	-44.58	<=-41.20	PASS
				AV	5460.000	-45.61	<=-41.20	PASS
				Peak	5350.000	-37.79	<=-21.20	PASS
				Peak	5460.000	-37.69	<=-21.20	PASS
11N20SISO	Ant1	Low	5180	AV	4500.000	-46.71	<=-41.20	PASS
				AV	5150.000	-44.21	<=-41.20	PASS
				Peak	4500.000	-39.47	<=-21.20	PASS
				Peak	5150.000	-35.29	<=-21.20	PASS
		High	5240	AV	5350.000	-44.47	<=-41.20	PASS
				AV	5460.000	-45.54	<=-41.20	PASS
				Peak	5350.000	-37.93	<=-21.20	PASS
				Peak	5460.000	-37.83	<=-21.20	PASS
11N40SISO	Ant1	Low	5190	AV	4500.000	-46.5	<=-41.20	PASS
				AV	5150.000	-42.44	<=-41.20	PASS
				Peak	4500.000	-37.38	<=-21.20	PASS
				Peak	5150.000	-28.9	<=-21.20	PASS
		High	5230	AV	5350.000	-44.47	<=-41.20	PASS
				AV	5460.000	-45.35	<=-41.20	PASS
				Peak	5350.000	-37.59	<=-21.20	PASS
				Peak	5460.000	-38.56	<=-21.20	PASS
11AC20SISO	Ant1	Low	5180	AV	4500.000	-46.77	<=-41.20	PASS
				AV	5150.000	-44.01	<=-41.20	PASS
				Peak	4500.000	-39.08	<=-21.20	PASS
				Peak	5150.000	-36.21	<=-21.20	PASS
		High	5240	AV	5350.000	-44.49	<=-41.20	PASS
				AV	5460.000	-45.52	<=-41.20	PASS
				Peak	5350.000	-38.24	<=-21.20	PASS
				Peak	5460.000	-38.24	<=-21.20	PASS
11AC40SISO	Ant1	Low	5190	AV	4500.000	-46.46	<=-41.20	PASS
				AV	5150.000	-43.08	<=-41.20	PASS
				Peak	4500.000	-38.96	<=-21.20	PASS
				Peak	5150.000	-35.06	<=-21.20	PASS
		High	5230	AV	5350.000	-44.41	<=-41.20	PASS
				AV	5460.000	-45.41	<=-41.20	PASS
				Peak	5350.000	-37.52	<=-21.20	PASS
				Peak	5460.000	-37.9	<=-21.20	PASS
11AC80SISO	Ant1	Low	5210	AV	4500.000	-46.03	<=-41.20	PASS
				AV	5150.000	-41.68	<=-41.20	PASS
				Peak	4500.000	-40.6	<=-21.20	PASS
				Peak	5150.000	-35.3	<=-21.20	PASS
		High	5210	AV	5350.000	-44.38	<=-41.20	PASS
				AV	5460.000	-45.47	<=-41.20	PASS
				Peak	5350.000	-38.29	<=-21.20	PASS
				Peak	5460.000	-38.4	<=-21.20	PASS

Remark:

1. *Measured Undesirable emission at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 6Mbps at IEEE 802.11a; MCS0 at IEEE 802.11n HT20, IEEE 802.11n HT40*
4. *For MIMO with CCD technology device, The Directional Gain= Gain of individual transmit antennas (dBi) + Array gain;*
   Array gain = 10 log (N_{ant}), where N_{ant} is the number of transmit antennas.
5. *Covert Radiated E Level At 3m = Conducted average power + Directional Gain + 104.77-20*log(3);*
6. *Please refer to following test plots;*

11A_Ant1_Low_5180_AV



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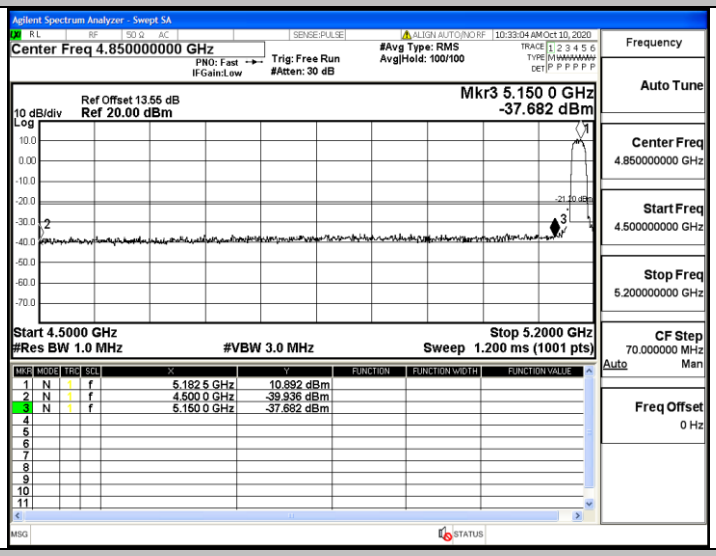
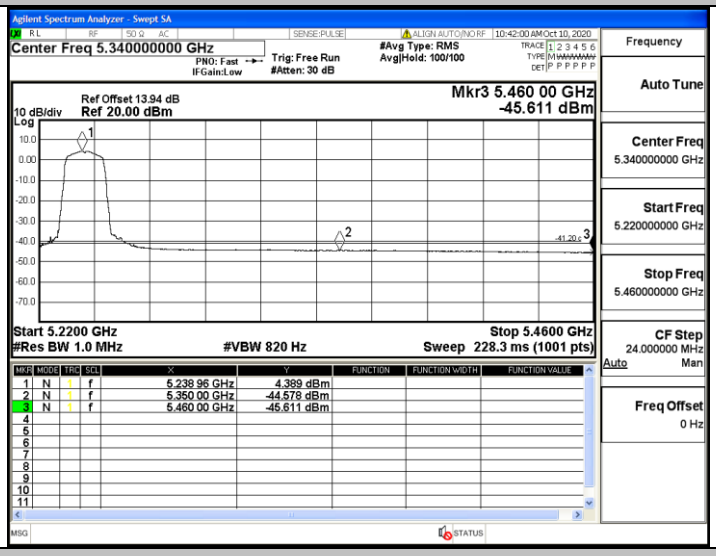
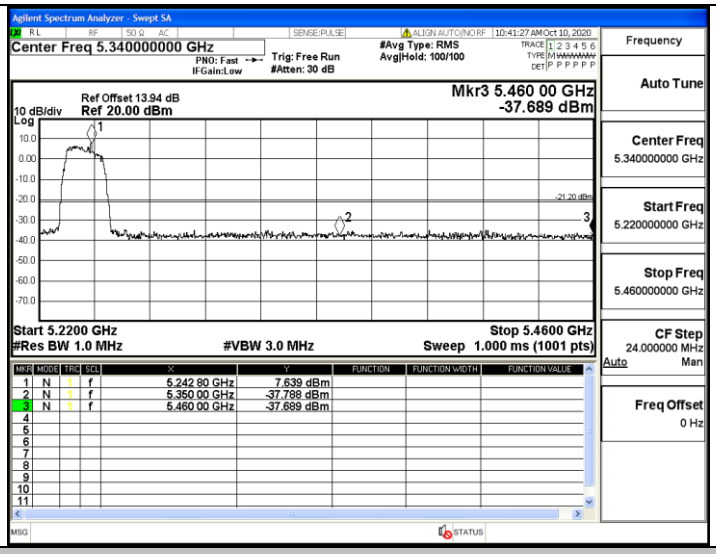


11A_Ant1_High_5240_AV



11A_Ant1_High_5240_Peak



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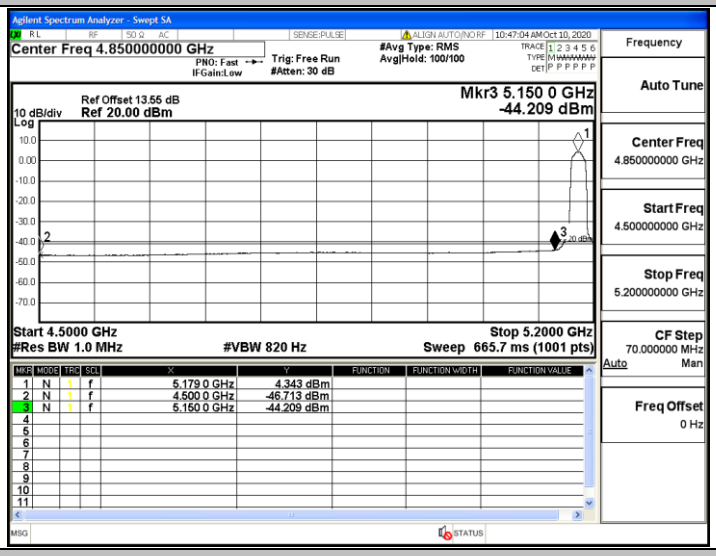

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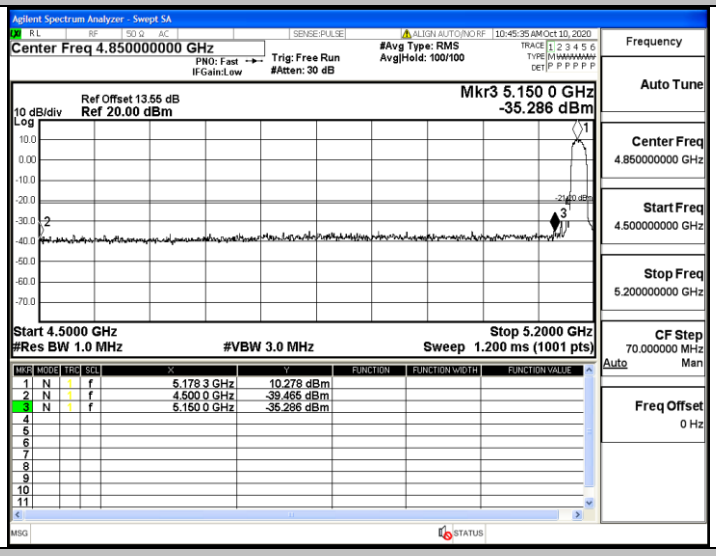

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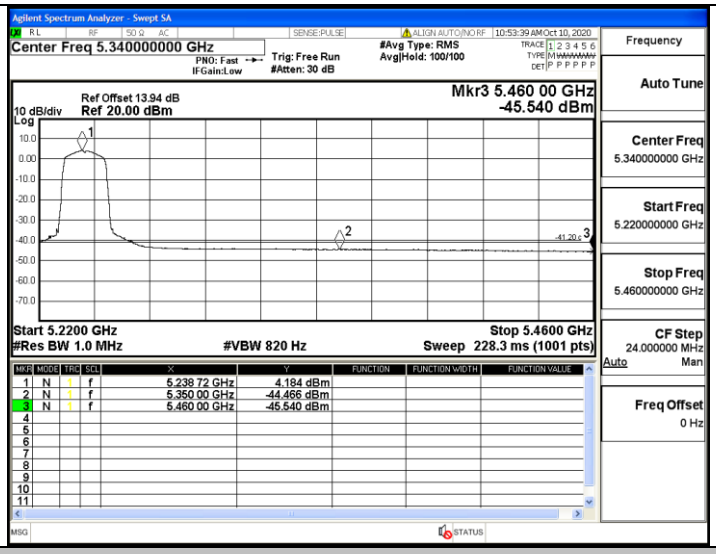

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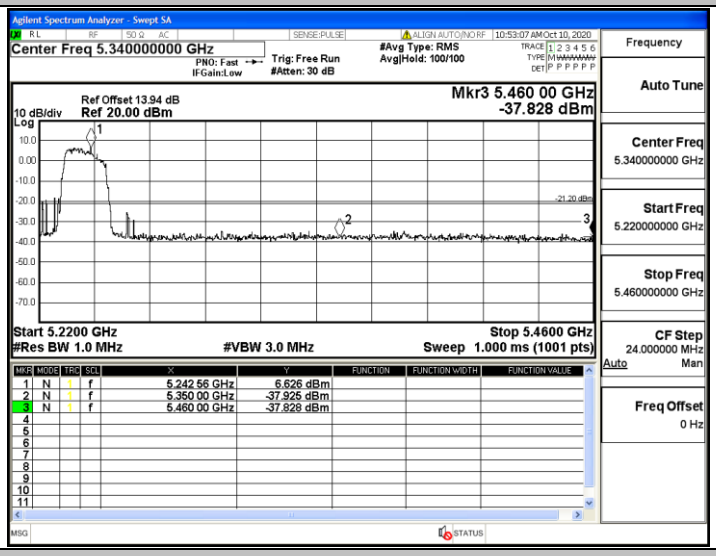

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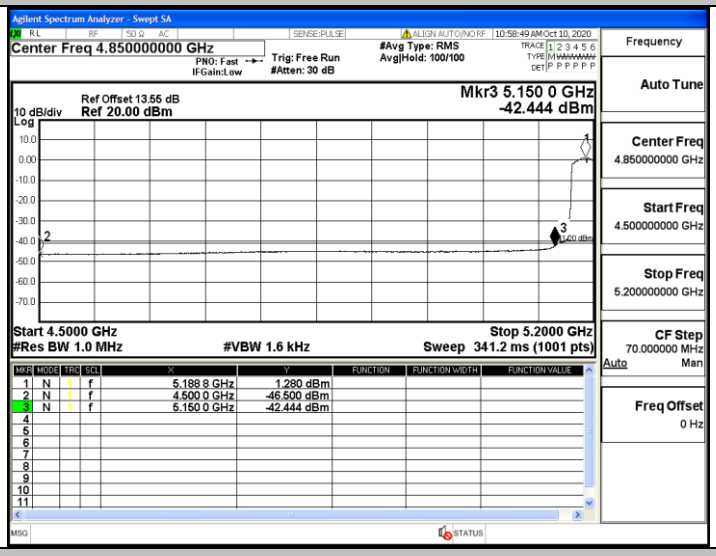

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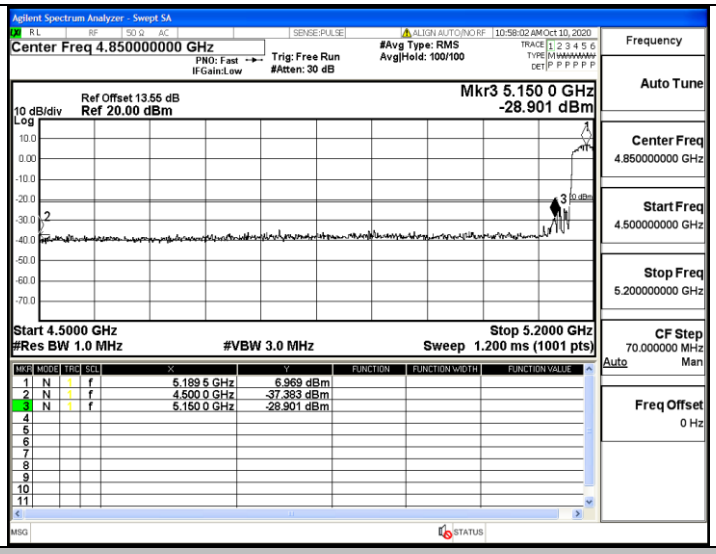

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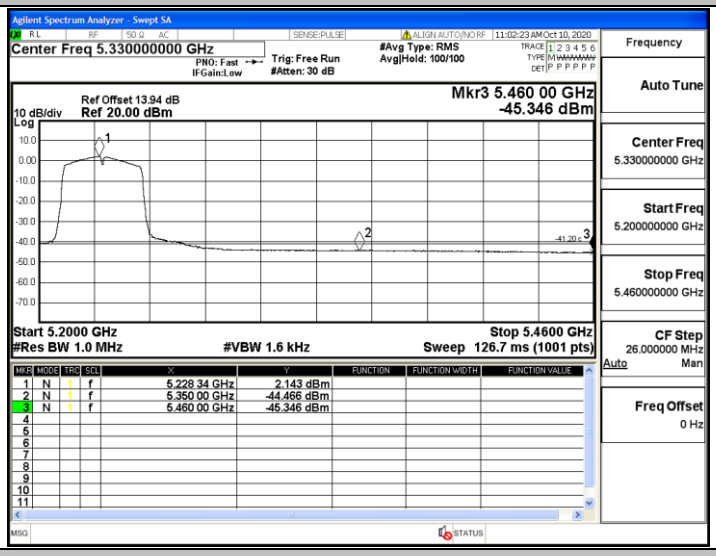

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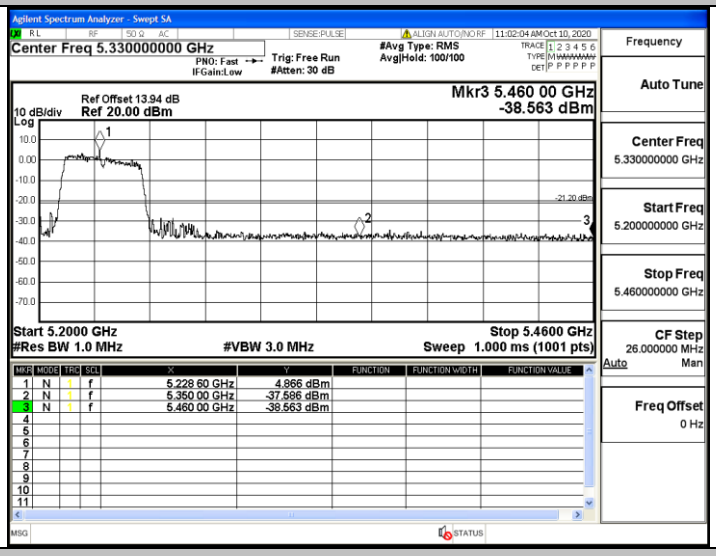

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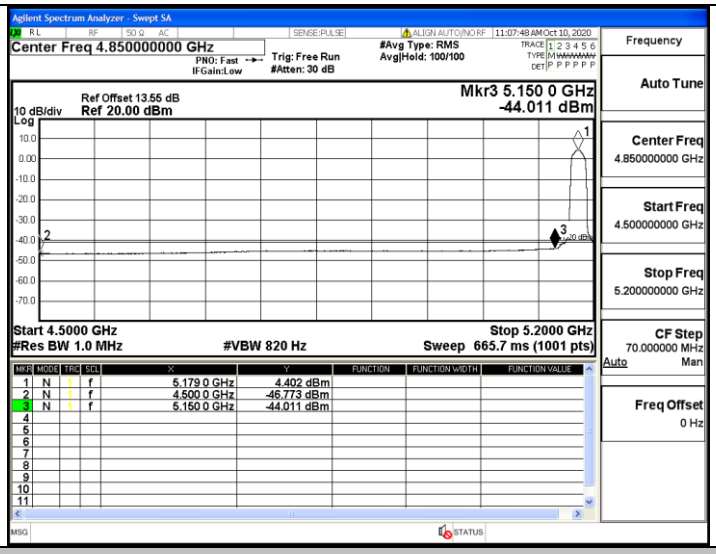

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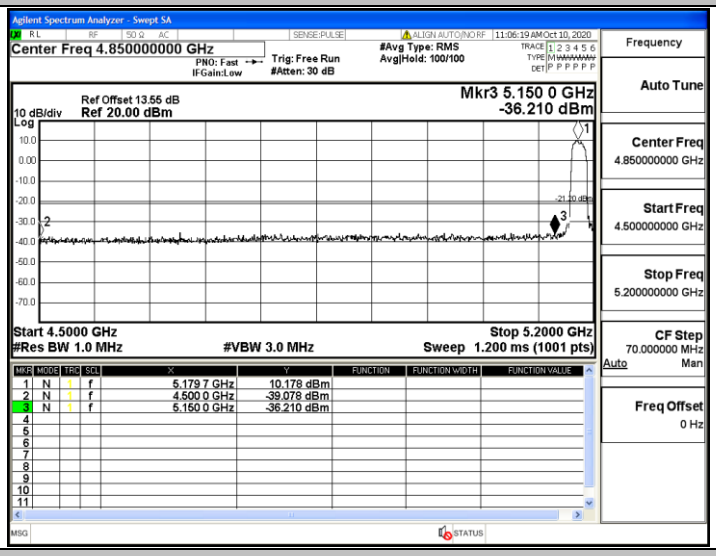

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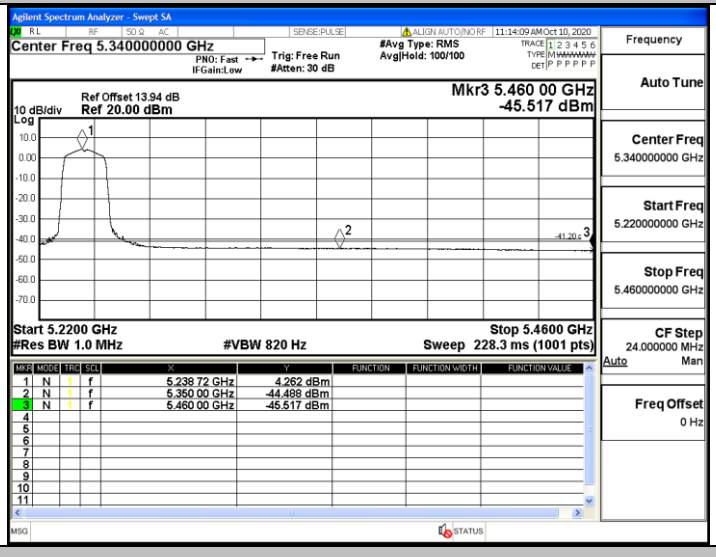

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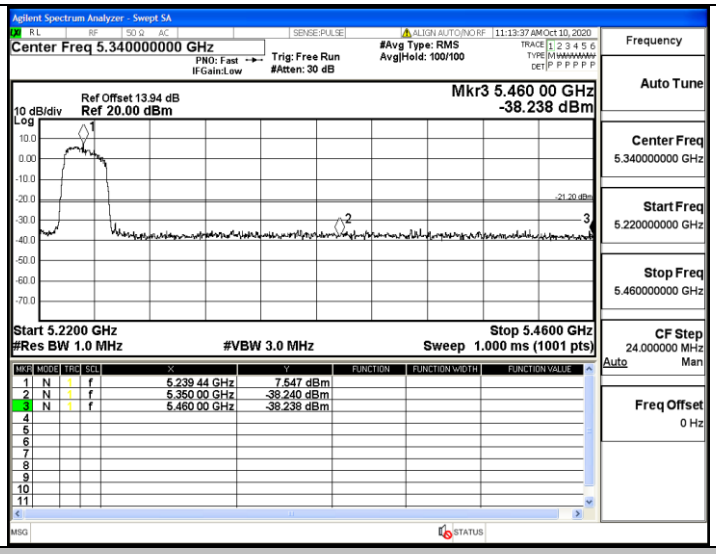

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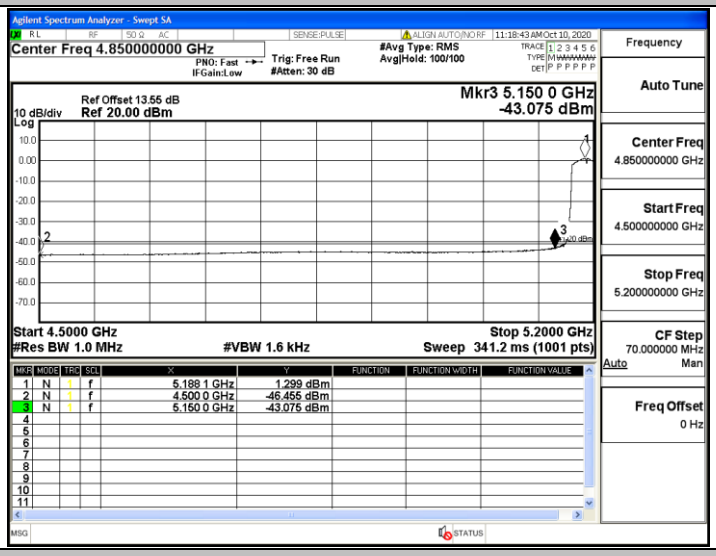

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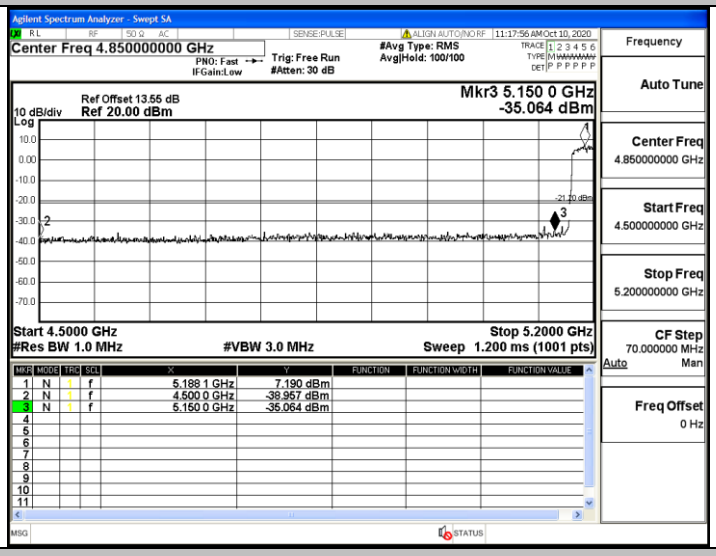

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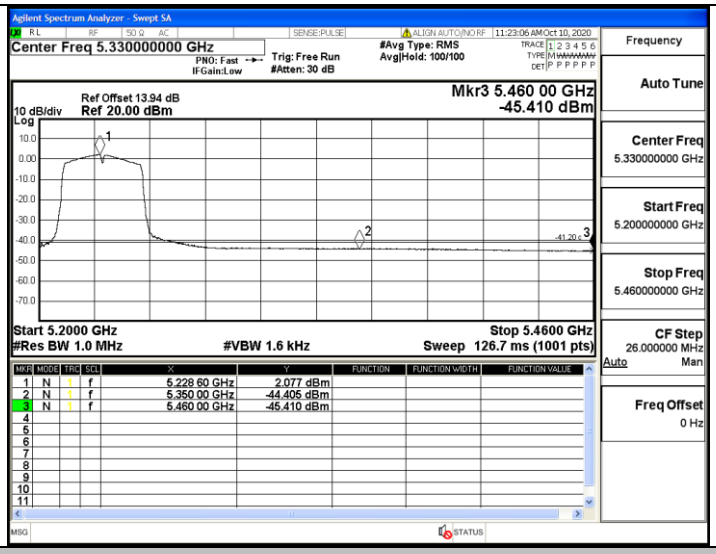

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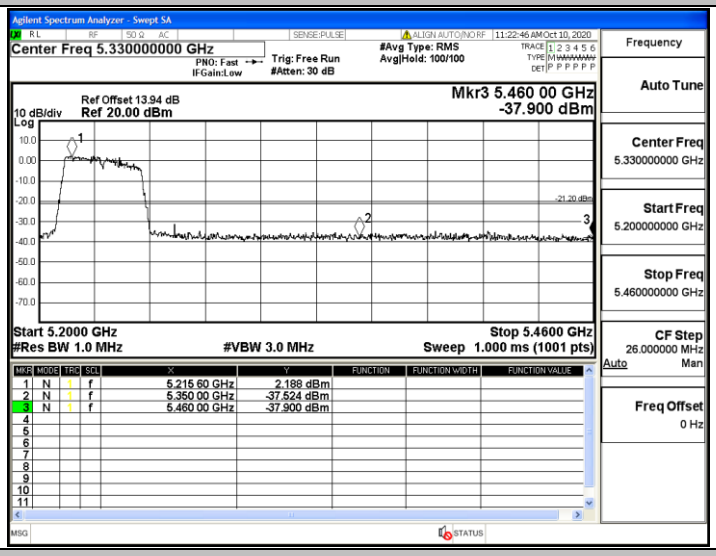

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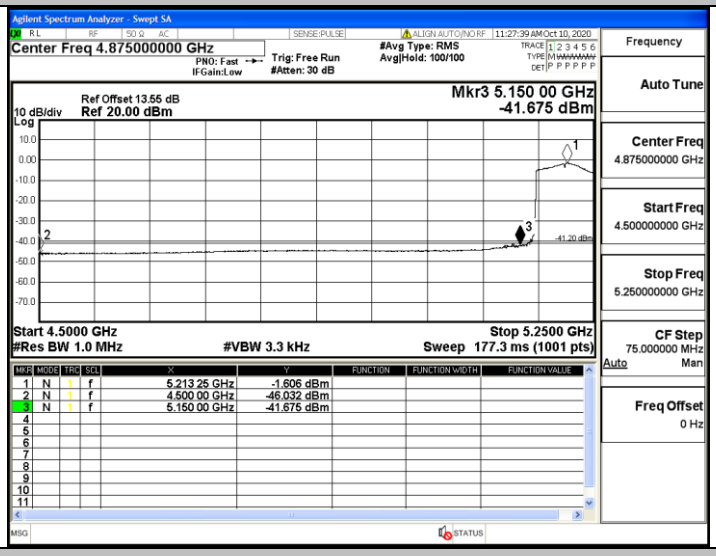

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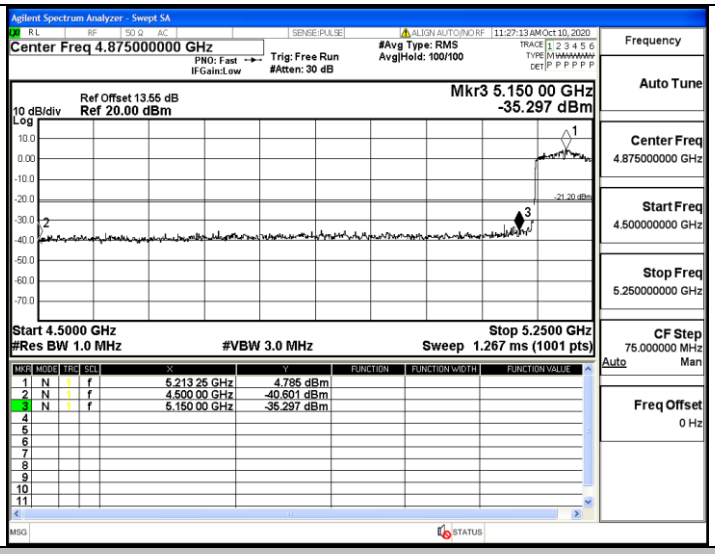

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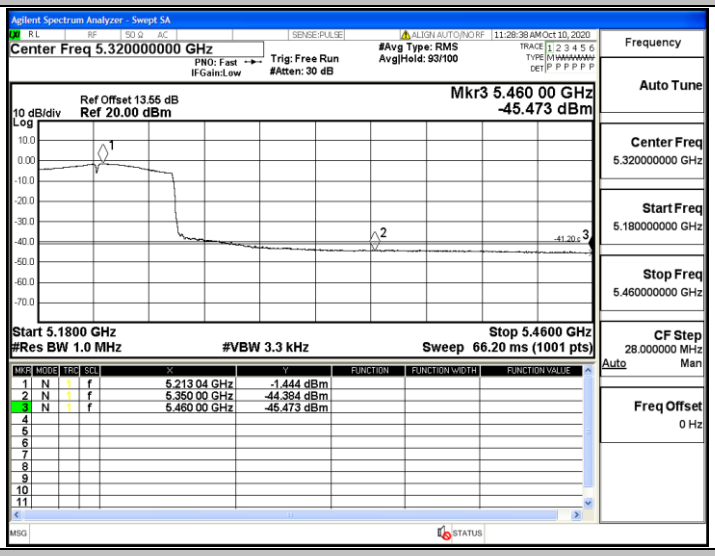

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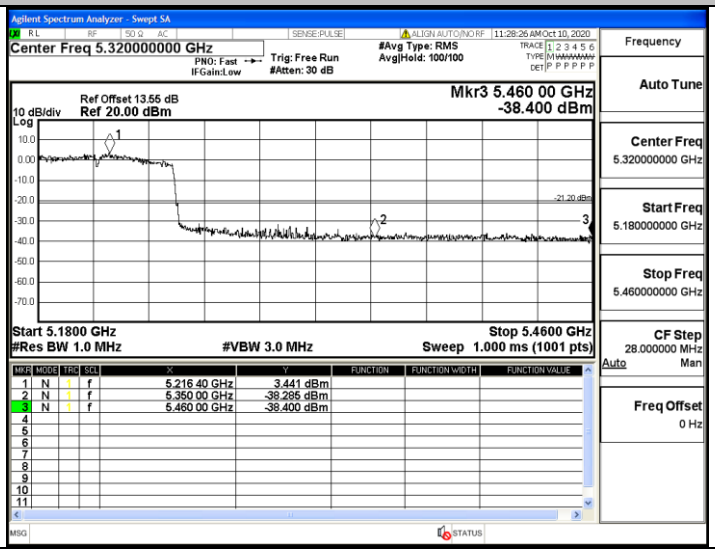


5.8. Antenna Requirements

5.8.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section 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, 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
And according to FCC 47 CFR Section 15.407 (a), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

5.8.2. Antenna Connector Construction

The directional gains of antenna refer to section 1.1, and the antenna is an internal antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.

5.8.3. Results: Compliance.

5.9. Frequency Stability

5.9.1 Standard Applicable

According to FCC §15.407(g) “Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user manual.”

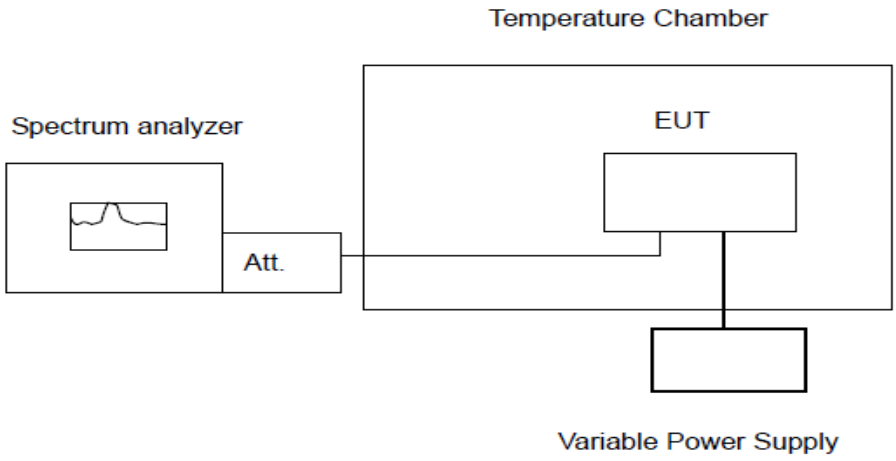
According to FCC §2.1055(a) “The frequency stability shall be measured with variation of ambient temperature as follows:”

(1) From −30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

(2) From −20° to + 50° centigrade for equipment to be licensed for use in the Maritime Services under part 80 of this chapter, except for Class A, B, and S Emergency Position Indicating Radiobeacons (EPIRBS), and equipment to be licensed for use above 952 MHz at operational fixed stations in all services, stations in the Local Television Transmission Service and Point-to-Point Microwave Radio Service under part 21 of this chapter, equipment licensed for use aboard aircraft in the Aviation Services under part 87 of this chapter, and equipment authorized for use in the Family Radio Service under part 95 of this chapter.

(3) From 0° to + 50° centigrade for equipment to be licensed for use in the Radio Broadcast Services under part 73 of this chapter.

5.9.2 Test Configuration



5.9.3 Test Procedure

The equipment under test was connected to an external AC or DC power supply and input rated voltage. RF output was connected to a frequency counter or spectrum anzlyer via feed through attenators. The EUT was placed inside the temperature chamber. Set the spectrum analyzer RBW low engouh to obtain the desired frequency resoluation and measure EUT 20 degree operating frequency as reference frequency. Turn EUT off and set the chamber temperature to -30 degree. After the temperature stabilized for approximately 30 minutes recorded the frequency. Repeat step measure wuth 10 degree increased per stage until the highest temperature of +50 degree reached.

5.9.4 Test Results

PASS

Remark:

1. *Measured all conditions and recorded worst case.*

IEEE 802.11a Mode / 5180 – 5240 MHz / 5180 MHz

Environment Temperature (Degree)	Voltage (VDC)	Measured Frequency (MHz)	Limit Range (MHz)	Test Results
20	13.2	5180.001089	5150 – 5250	PASS
20	10.8	5179.981376	5150 – 5250	PASS
50	12.0	5180.063779	5150 – 5250	PASS
40	12.0	5180.051581	5150 – 5250	PASS
30	12.0	5180.021395	5150 – 5250	PASS
20	12.0	5179.929464	5150 – 5250	PASS
10	12.0	5180.081542	5150 – 5250	PASS
0	12.0	5179.935443	5150 – 5250	PASS
-10	12.0	5179.998167	5150 – 5250	PASS
-20	12.0	5179.952662	5150 – 5250	PASS
-30	12.0	5180.007210	5150 – 5250	PASS

IEEE 802.11a Mode / 5180 – 5240 MHz / 5200 MHz

Environment Temperature (Degree)	Voltage (VDC)	Measured Frequency (MHz)	Limit Range (MHz)	Test Results
20	13.2	5199.946673	5150 – 5250	PASS
20	10.8	5200.007768	5150 – 5250	PASS
50	12.0	5199.933685	5150 – 5250	PASS
40	12.0	5199.953627	5150 – 5250	PASS
30	12.0	5200.011767	5150 – 5250	PASS
20	12.0	5200.035884	5150 – 5250	PASS
10	12.0	5200.032722	5150 – 5250	PASS
0	12.0	5200.039049	5150 – 5250	PASS
-10	12.0	5199.964757	5150 – 5250	PASS
-20	12.0	5199.969164	5150 – 5250	PASS
-30	12.0	5200.061473	5150 – 5250	PASS

IEEE 802.11a Mode / 5180 – 5240 MHz / 5240 MHz

Environment Temperature (Degree)	Voltage (VAC)	Measured Frequency (MHz)	Limit Range (MHz)	Test Results
20	13.2	5240.005004	5150 – 5250	PASS
20	10.8	5239.938080	5150 – 5250	PASS
50	12.0	5239.976887	5150 – 5250	PASS
40	12.0	5240.076149	5150 – 5250	PASS
30	12.0	5240.010554	5150 – 5250	PASS
20	12.0	5240.016845	5150 – 5250	PASS
10	12.0	5239.939885	5150 – 5250	PASS
0	12.0	5239.942771	5150 – 5250	PASS
-10	12.0	5239.967105	5150 – 5250	PASS
-20	12.0	5239.964734	5150 – 5250	PASS
-30	12.0	5239.906027	5150 – 5250	PASS

IEEE 802.11a Mode / 5180 – 5240 MHz / 5190 MHz

Environment Temperature (Degree)	Voltage (VDC)	Measured Frequency (MHz)	Limit Range (MHz)	Test Results
20	13.2	5189.976062	5150 – 5250	PASS
20	10.8	5190.033949	5150 – 5250	PASS
50	12.0	5189.962677	5150 – 5250	PASS
40	12.0	5190.064091	5150 – 5250	PASS
30	12.0	5190.091521	5150 – 5250	PASS
20	12.0	5189.969159	5150 – 5250	PASS
10	12.0	5189.975751	5150 – 5250	PASS
0	12.0	5190.079371	5150 – 5250	PASS
-10	12.0	5189.981324	5150 – 5250	PASS
-20	12.0	5189.913883	5150 – 5250	PASS
-30	12.0	5189.990941	5150 – 5250	PASS

IEEE 802.11a Mode / 5180 – 5240 MHz / 5230 MHz

Environment Temperature (Degree)	Voltage (VDC)	Measured Frequency (MHz)	Limit Range (MHz)	Test Results
20	13.2	5240.076655	5150 – 5250	PASS
20	10.8	5239.921013	5150 – 5250	PASS
50	12.0	5240.099996	5150 – 5250	PASS
40	12.0	5240.014995	5150 – 5250	PASS
30	12.0	5239.962217	5150 – 5250	PASS
20	12.0	5239.962407	5150 – 5250	PASS
10	12.0	5239.917897	5150 – 5250	PASS
0	12.0	5240.096154	5150 – 5250	PASS
-10	12.0	5240.059842	5150 – 5250	PASS
-20	12.0	5239.962795	5150 – 5250	PASS
-30	12.0	5240.013940	5150 – 5250	PASS

IEEE 802.11a Mode / 5180 – 5240 MHz / 5210 MHz

Environment Temperature (Degree)	Voltage (VDC)	Measured Frequency (MHz)	Limit Range (MHz)	Test Results
20	13.2	5210.078957	5150 – 5250	PASS
20	10.8	5209.970649	5150 – 5250	PASS
50	12.0	5210.010703	5150 – 5250	PASS
40	12.0	5209.975574	5150 – 5250	PASS
30	12.0	5210.023143	5150 – 5250	PASS
20	12.0	5209.994466	5150 – 5250	PASS
10	12.0	5209.975765	5150 – 5250	PASS
0	12.0	5209.971425	5150 – 5250	PASS
-10	12.0	5209.998042	5150 – 5250	PASS
-20	12.0	5209.992584	5150 – 5250	PASS
-30	12.0	5209.968984	5150 – 5250	PASS

6. LIST OF MEASURING EQUIPMENTS

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Due Date
1	MXA Signal Analyzer	Keysight	N9020A	MY52091623	2020/1/2	2021/1/1
2	Power Sensor	Agilent	U2021XA	MY5365004	2020/1/2	2021/1/1
3	Power Meter	Agilent	U2531A	TW53323507	2020/1/2	2021/1/1
4	Wideband Antenna	schwarzbeck	VULB 9163	958	2019/11/16	2022/11/15
5	Horn Antenna	schwarzbeck	9120D-1141	1574	2019/11/16	2022/11/15
6	EMI Test Receiver	R&S	ESCI	100849/003	2020/1/2	2021/1/1
7	Controller	MF	MF7802	N/A	N/A	N/A
8	Amplifier	schwarzbeck	BBV 9743	209	2020/1/2	2021/1/1
9	Amplifier	Tonscend	TSAMP-0518 SE	--	2020/1/2	2021/1/1
10	RF Cable(below 1GHz)	HUBER+SUHNER	RG214	N/A	2020/1/2	2021/1/1
11	RF Cable(above 1GHz)	HUBER+SUHNER	RG214	N/A	2020/1/2	2021/1/1
12	Artificial Mains	ROHDE & SCHWARZ	ENV 216	101333-IP	2020/1/2	2021/1/1
12	EMI Test Software	ROHDE & SCHWARZ	ESK1	V1.71	N/A	N/A
14	RE test software	Tonscend	JS32-RE	V2.0.2.0	N/A	N/A
15	Test Software	Tonscend	JS1120-3	V2.5.77.0418	N/A	N/A
16	Horn Antenna	A-INFO	LB-180400-KF	J211020657	2019/11/16	2022/11/15
17	Amplifier	SKET	LNPA_1840-50	SK2018101801	2019/10/22	2020/10/21

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