3.9 Radiated Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205				
Test Method:	ANSI C63.10: 2013 Section 11.12				
Test Site:	Measurement Distance: 3m or 10m (Semi-Anechoic Chamber)				
Receiver Setup:	Frequency	Detector	RBW	VBW	Remark
	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	30MHz-1GHz	Quasi-peak	120kHz	300kHz	Quasi-peak
	Above 1GHz	Peak	1MHz	3MHz	Peak
		Peak	1MHz	10Hz (DC⩾0.98) ⩾1/T (DC<0.98)	Average
Limit:	Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz-88MHz	100	40.0	Quasi-peak	3
	88MHz-216MHz	150	43.5	Quasi-peak	3
	216MHz-960MHz	200	46.0	Quasi-peak	3
	960MHz-1GHz	500	54.0	Quasi-peak	3
	Above 1GHz	500	54.0	Average	3
	Remark: 15.35(b),Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.				

Test Setup:

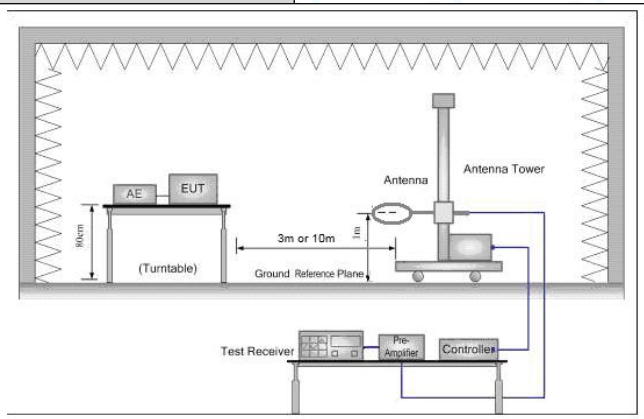


Figure 1. Below 30MHz

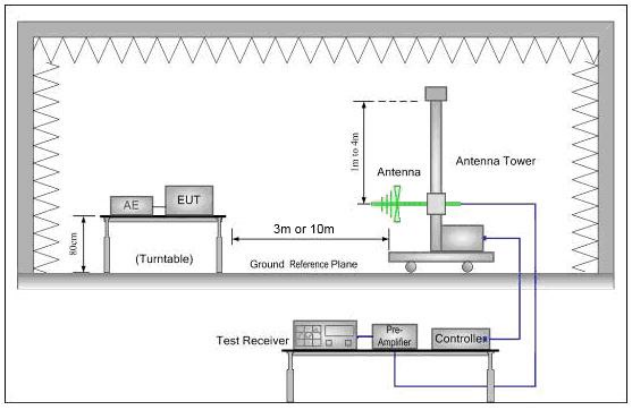


Figure 2. 30MHz to 1GHz

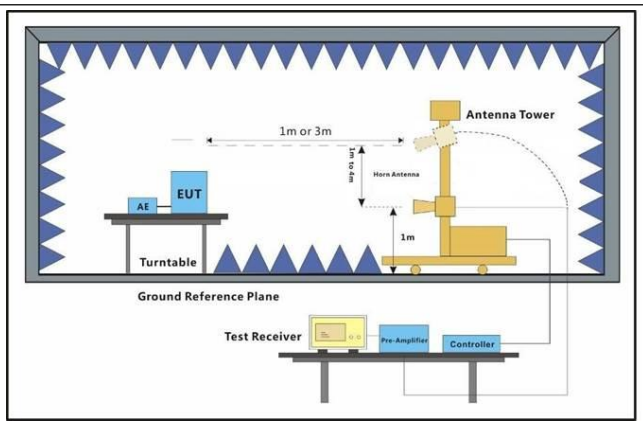


Figure 3. Above 1 GHz

Test Procedure:

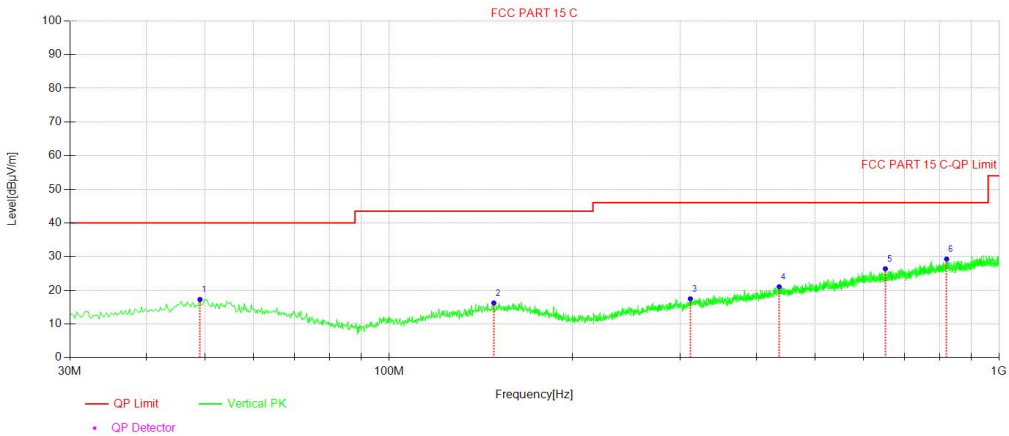
a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation
c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters(for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
h. Test the EUT in the lowest channel, the middle channel ,the Highest channel.
i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, And found the X axis positioning which it is worse case.
j. Repeat above procedures until all frequencies measured was complete.

Test Configuration:	Measurements Below 1000MHz • RBW = 120 kHz • VBW = 300 kHz • Detector = Peak • Trace mode = max hold Peak Measurements Above 1000 MHz • RBW = 1 MHz • VBW ⩾ 3 MHz • Detector = Peak • Sweep time = auto • Trace mode = max hold Average Measurements Above 1000MHz • RBW = 1 MHz • VBW = 10 Hz, when duty cycle is no less than 98 percent. • VBW ⩾ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates. Charge+Transmitting mode.
Final Test Mode:	Pretest the EUT at Transmitting mode. Through Pre-scan, find the 3DH5 of data type is the worst case of All modulation type.
Instruments Used:	Refer to section 2.9 for details
Test Results:	Pass

Test data

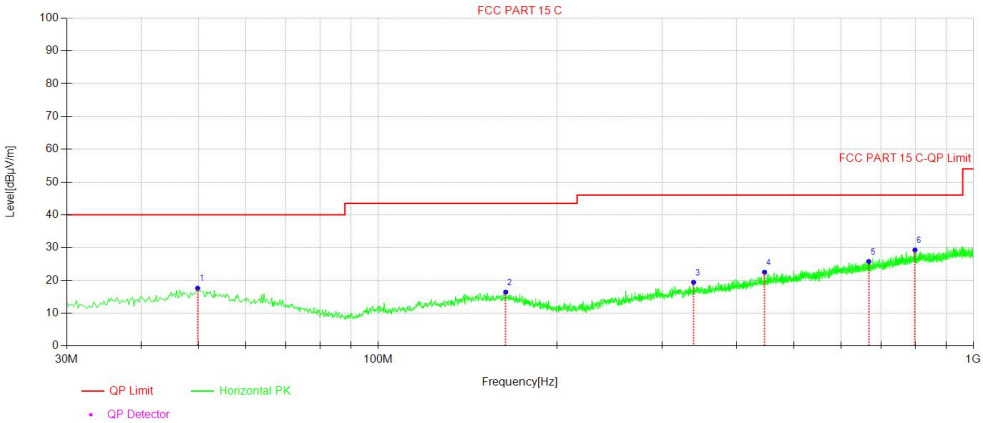
For 30-1000MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	49.015	23.97	-6.68	17.29	40.00	22.71	100	0	QP
2	148.55	24.21	-7.95	16.26	43.50	27.24	200	312	QP
3	311.93	24.09	-6.60	17.49	46.00	28.51	200	110	QP
4	436.12	24.30	-3.25	21.05	46.00	24.95	200	184	QP
5	651.11	24.96	1.44	26.40	46.00	19.60	100	313	QP
6	820.51	24.40	4.89	29.29	46.00	16.71	100	52	QP

Horizontal :

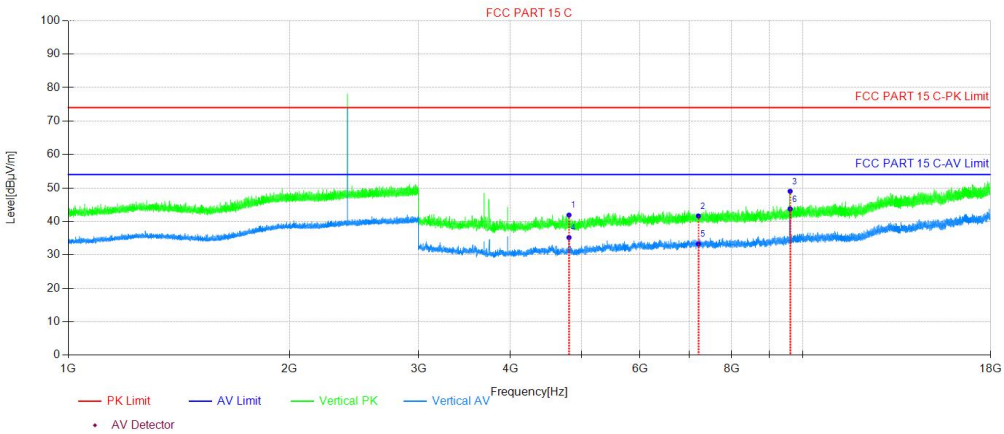


NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	49.79	23.59	-5.96	17.63	40.00	22.37	200	41	QP
2	163.88	24.47	-8.02	16.45	43.50	27.05	100	271	QP
3	338.90	25.39	-5.95	19.44	46.00	26.56	200	117	QP
4	446.01	25.44	-2.93	22.51	46.00	23.49	200	16	QP
5	667.22	24.08	1.71	25.79	46.00	20.21	100	278	QP
6	797.81	24.99	4.29	29.28	46.00	16.72	100	83	QP

For above 1GHz

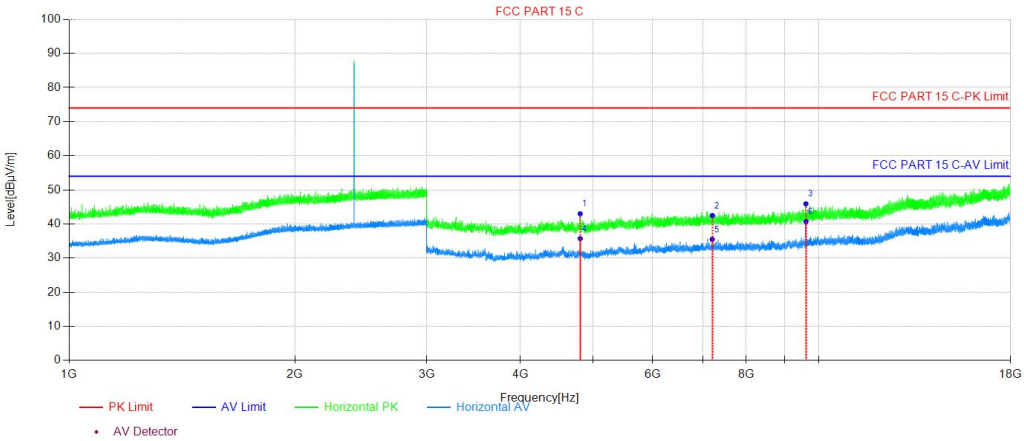
3DH5 2402MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	4803.84	43.01	-1.11	41.90	74.00	32.10	150	201	Peak
2	7206.21	39.24	2.39	41.63	74.00	32.37	150	103	Peak
3	9607.83	43.78	5.23	49.01	74.00	24.99	130	159	Peak
4	4804.59	36.28	-1.10	35.18	54.00	18.82	150	159	AV
5	7206.21	30.89	2.39	33.28	54.00	20.72	150	28	AV
6	9608.58	38.51	5.23	43.74	54.00	10.26	150	159	AV

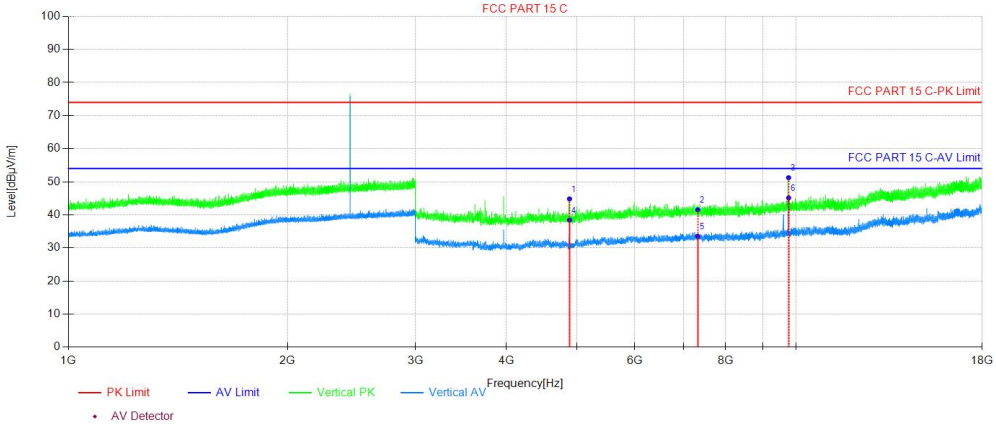
Horizontal:



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	4803.84	44.11	-1.11	43.00	74.00	31.00	150	102	Peak
2	7206.21	40.10	2.39	42.49	74.00	31.51	150	37	Peak
3	9607.83	40.69	5.23	45.92	74.00	28.08	120	37	Peak
4	4804.59	36.84	-1.10	35.74	54.00	18.26	120	102	AV
5	7206.21	33.14	2.39	35.53	54.00	18.47	150	28	AV
6	9608.58	35.47	5.23	40.70	54.00	13.30	150	37	AV

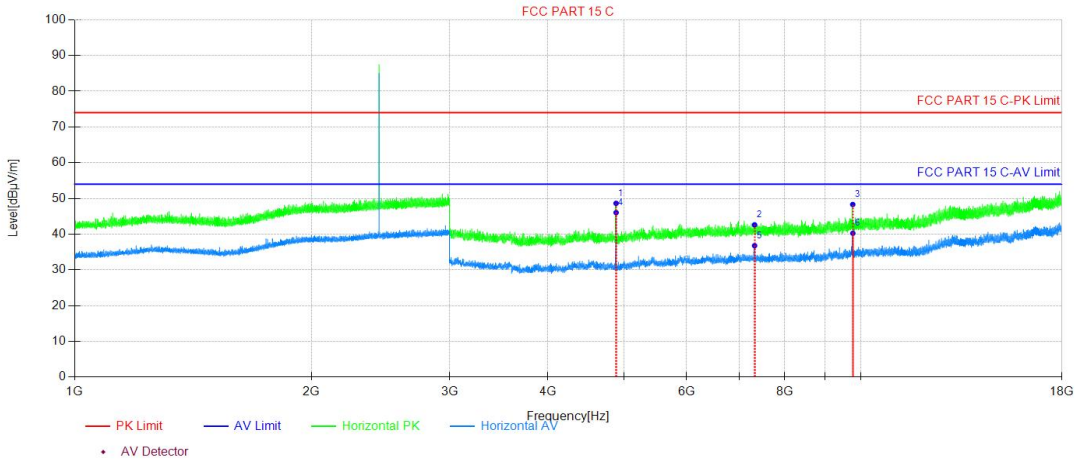
3DH5 2441MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	4881.84	46.56	-1.73	44.83	74.00	29.17	150	211	Peak
2	7323.21	39.09	2.47	41.56	74.00	32.44	150	359	Peak
3	9763.83	44.84	6.41	51.25	74.00	22.75	140	125	Peak
4	4882.59	40.16	-1.72	38.44	54.00	15.56	150	211	AV
5	7323.21	31.05	2.47	33.52	54.00	20.48	160	72	AV
6	9764.58	38.72	6.42	45.14	54.00	8.86	150	125	AV

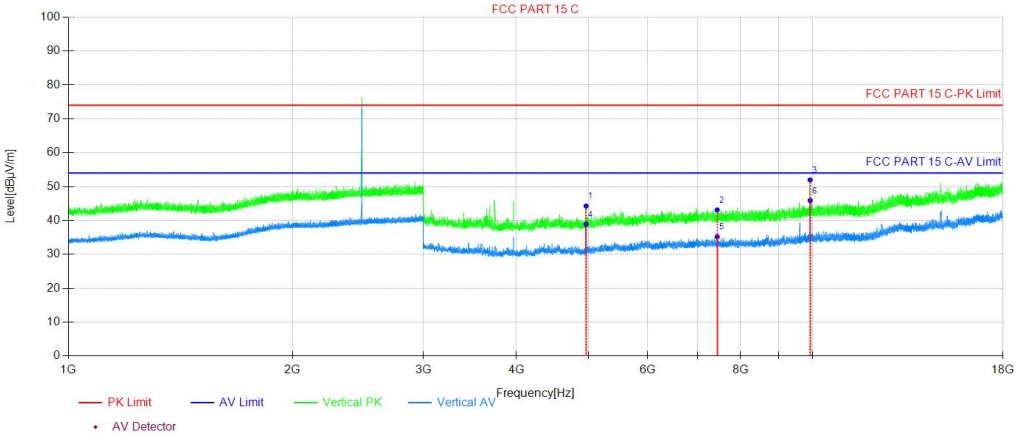
Horizontal:



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	4881.84	50.37	-1.73	48.64	74.00	25.36	150	83	Peak
2	7323.21	40.16	2.47	42.63	74.00	31.37	140	94	Peak
3	9763.08	41.91	6.40	48.31	74.00	25.69	150	147	Peak
4	4882.59	47.77	-1.72	46.05	54.00	7.95	150	83	AV
5	7323.21	34.33	2.47	36.80	54.00	17.20	150	28	AV
6	9764.58	33.85	6.42	40.27	54.00	13.73	150	83	AV

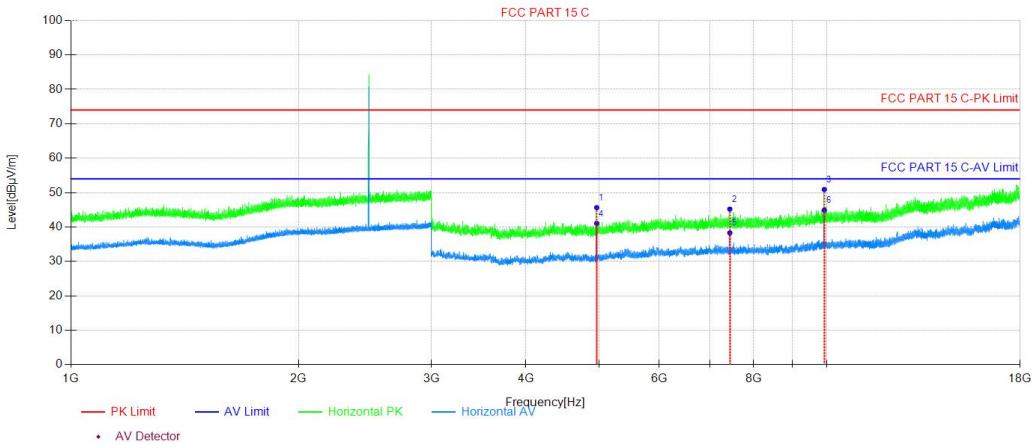
3DH5 2480MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	4960.59	46.01	-1.75	44.26	74.00	29.74	150	207	Peak
2	7440.22	40.39	2.73	43.12	74.00	30.88	150	112	Peak
3	9919.84	45.77	6.20	51.97	74.00	22.03	150	101	Peak
4	4960.59	40.65	-1.75	38.90	54.00	15.10	150	239	AV
5	7440.22	32.44	2.73	35.17	54.00	18.83	150	101	AV
6	9920.59	39.71	6.19	45.90	54.00	8.10	150	123	AV

Horizontal:



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	4960.59	47.40	-1.75	45.65	74.00	28.35	150	91	Peak
2	7440.22	42.49	2.73	45.22	74.00	28.78	150	91	Peak
3	9920.59	44.73	6.19	50.92	74.00	23.08	160	147	Peak
4	4960.59	42.79	-1.75	41.04	54.00	12.96	150	125	AV
5	7440.22	35.58	2.73	38.31	54.00	15.69	150	91	AV
6	9920.59	38.73	6.19	44.92	54.00	9.08	150	147	AV

Note:

1. The Measurement (Result Level) is calculated by Reading Level adding the Correct Factor(maybe including Ant.Factor and the Cable Factor etc.), The basic equation is as follows:

   Result Level= Reading Level + Correct Factor(including Ant.Factor, Cable Factor etc.)

2. The amplitude of 9KHz to 30MHz spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.

3. The amplitude of 18GHz to 25GHz spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be report.

4. All channels had been pre-test, 3DH5 is the worst case, only the worst case was reported.

3.10 Restricted bands around fundamental frequency

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205		
Test Method:	ANSI C63.10: 2013 Section 11.12		
Test Site:	Measurement Distance: 3m or 10m (Semi-Anechoic Chamber)		
Limit:	Frequency	Limit (dBuV/m)	Remark
	30MHz-88MHz	40.0	Quasi-peak
	88MHz-216MHz	43.5	Quasi-peak
	216MHz-960MHz	46.0	Quasi-peak
	960MHz-1GHz	54.0	Quasi-peak
	Above 1GHz	54.0	Average Value
		74.0	Peak Value
Test Setup:			

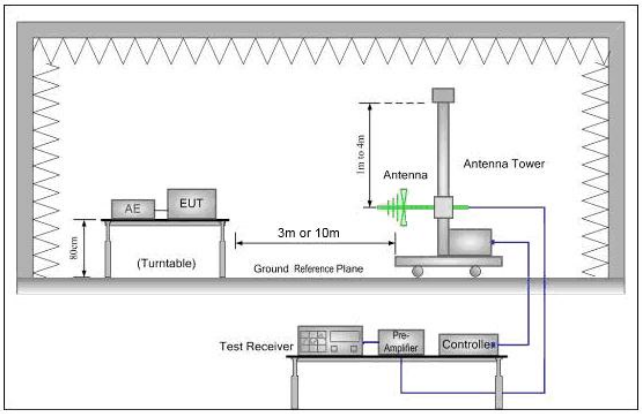


Figure 1. 30MHz to 1GHz

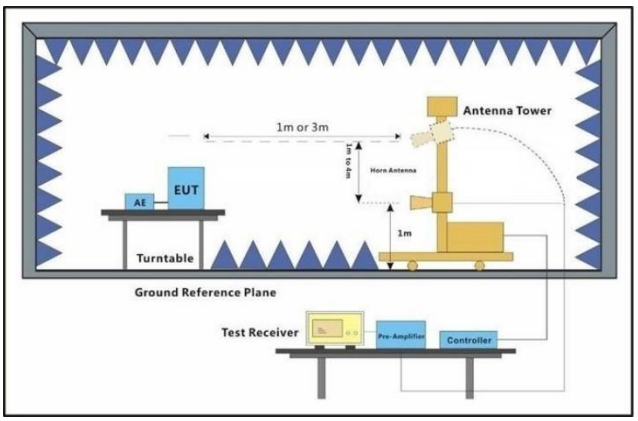


Figure 2. Above 1 GHz

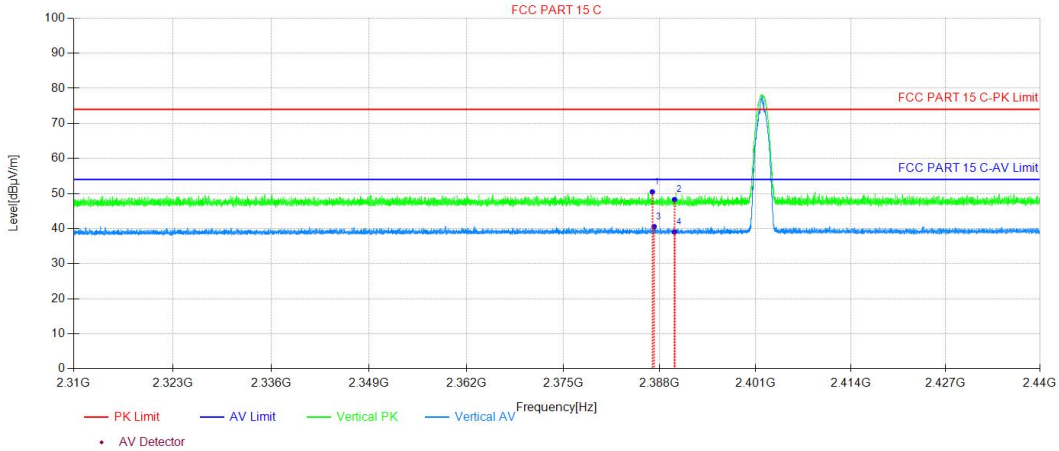
Test Procedure:	a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. g. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel h. Test the EUT in the lowest channel , the Highest channel i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode,And found the X axis positioning which it is worse case. j. Repeat above procedures until all frequencies measured was complete.
Test Configuration:	Measurements Below 1000MHz

	• RBW = 120 kHz • VBW = 300 kHz • Detector = Peak • Trace mode = max hold Peak Measurements Above 1000 MHz • RBW = 1 MHz • VBW ⩾ 3 MHz • Detector = Peak • Sweep time = auto • Trace mode = max hold Average Measurements Above 1000MHz • RBW = 1 MHz • VBW = 10 Hz, when duty cycle is no less than 98 percent. • VBW ⩾ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates. Transmitting mode.
Final Test Mode:	Pretest the EUT Transmitting mode. Through Pre-scan, find the 3DH5 of data type is the worst case of all modulation type. Only the worst case is recorded in the report.
Instruments Used:	Refer to section 2.9 for details
Test Results:	Pass

Test Date

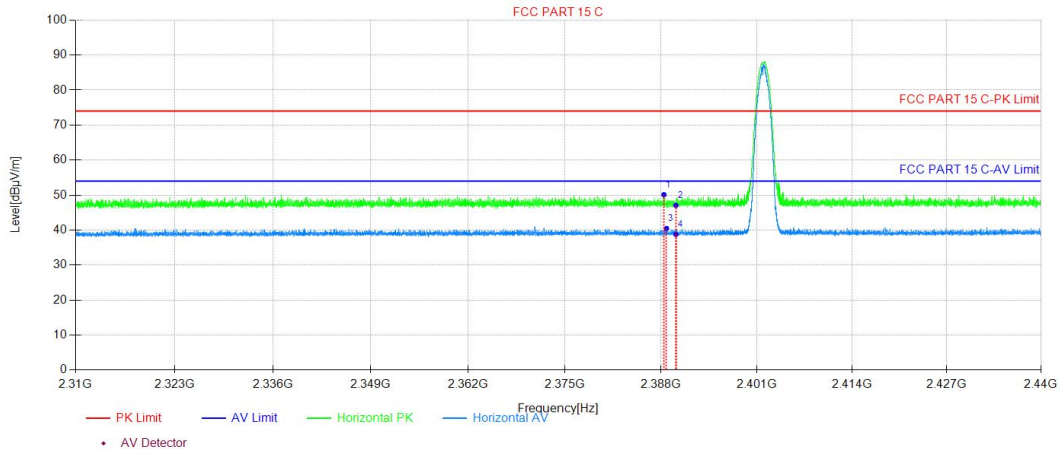
3DH5 2402MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	AV Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	2387.00	49.11	1.37	50.48	74.00	23.52	150	13	Peak
2	2390.01	46.92	1.37	48.29	74.00	25.71	140	176	Peak
3	2387.25	39.21	1.37	40.58	54.00	13.42	140	139	AV
4	2390.01	37.68	1.37	39.05	54.00	14.95	150	146	AV

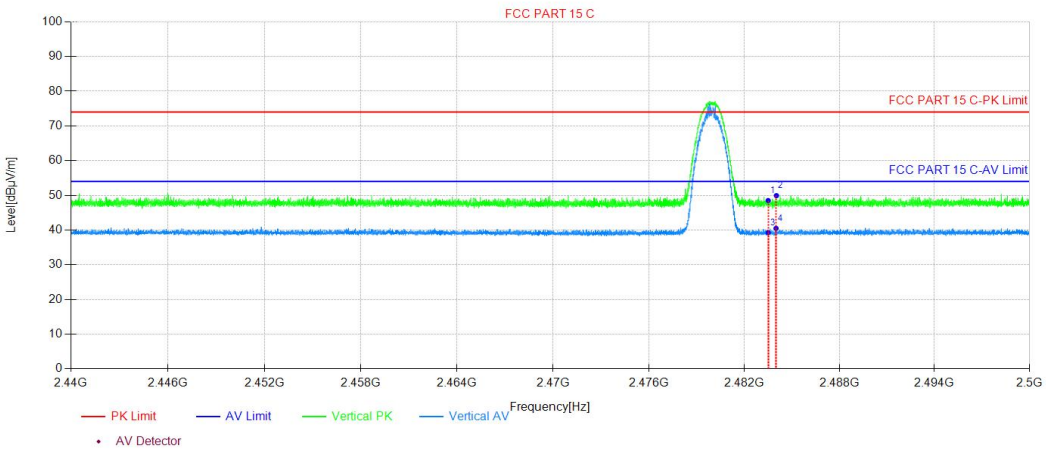
Horizontal:



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	AV Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	2388.38	48.76	1.37	50.13	74.00	23.87	150	339	Peak
2	2390.01	45.71	1.37	47.08	74.00	26.92	160	359	Peak
3	2388.73	39.11	1.37	40.48	54.00	13.52	150	275	AV
4	2390.01	37.40	1.37	38.77	54.00	15.23	150	358	AV

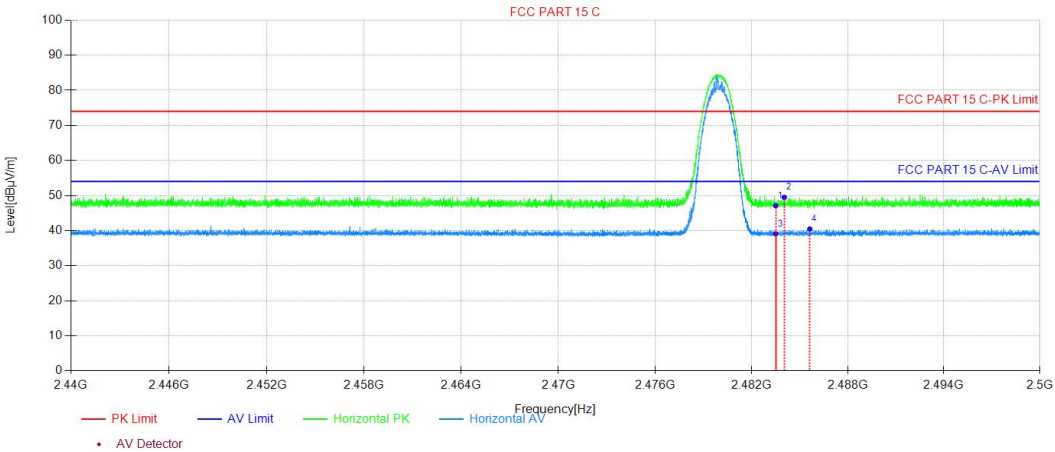
3DH5 2480MHz

Vertical:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	2483.50	46.65	1.86	48.51	74.00	25.49	150	223	Peak
2	2484.02	48.06	1.86	49.92	74.00	24.08	150	223	Peak
3	2483.50	37.43	1.86	39.29	54.00	14.71	150	149	AV
4	2484.00	38.63	1.86	40.49	54.00	13.51	150	0	AV

Horizontal:



NO.	Freq. [MHz]	Reading Level [dBµV]	Correct Factor [dB/m]	Result Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark
1	2483.50	45.25	1.86	47.11	74.00	26.89	150	359	Peak
2	2484.03	47.64	1.86	49.50	74.00	24.50	140	196	Peak
3	2483.50	37.22	1.86	39.08	54.00	14.92	150	342	AV
4	2485.62	38.60	1.86	40.46	54.00	13.54	150	86	AV

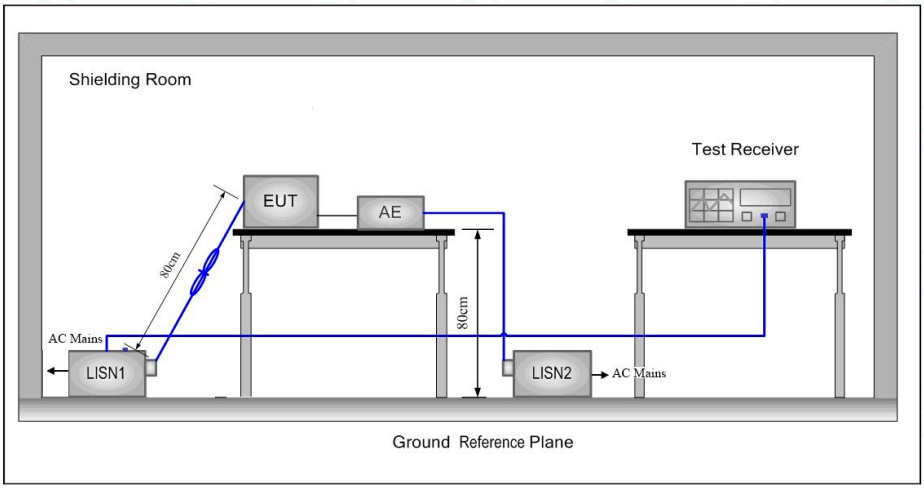
Note:

1. The Measurement (Result Level) is calculated by Reading Level adding the Correct Factor(maybe including Ant.Factor and the Cable Factor etc.), The basic equation is as follows:

Result Level= Reading Level + Correct Factor(including Ant.Factor ,Cable Factor etc.

2. All channels had been pre-test, 3DH5 is the worst case, only the worst case was reported.

3.11 AC Power Line Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.207		
Test Method:	ANSI C63.10: 2013		
Test Frequency Range:	150kHz to 30MHz		
Limit:	Frequency range (MHz)	Limit (dBuV)	
		Quasi-peak	Average
	0.15-0.5	66 to 56*	56 to 46*
	0.5-5	56	46
	5-30	60	50
	* Decreases with the logarithm of the frequency.		
Test Procedure:	1) The mains terminal disturbance voltage test was conducted in a shielded room. 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded. 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane, 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 2013 on conducted measurement.		
Test Setup:			

Exploratory Test Mode:	Transmitting with all kind of modulations, data rates at lowest, middle and highest channel. Charge + Transmitting mode.
Final Test Mode:	Through Pre-scan, find the the worst case.
Instruments Used:	Refer to section 2.9 for details
Test Results:	NA

Note:The wireless function does not work while the prototype is charging

4 Appendix

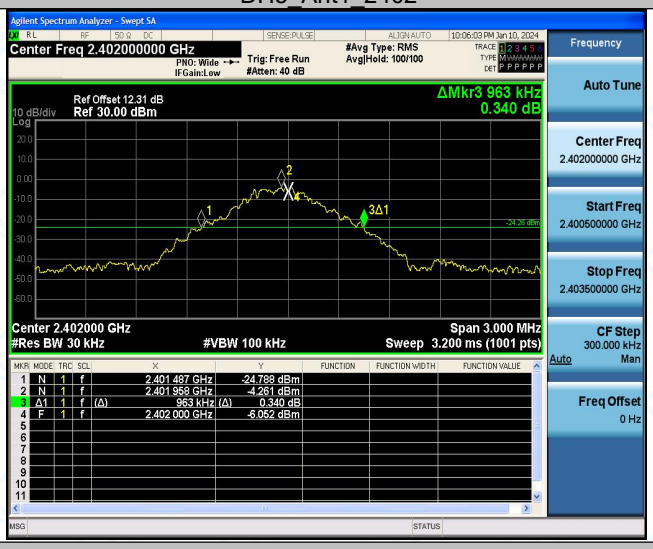
Appendix A: 20dB Emission Bandwidth

Test Result

Test Mode	Antenna	Freq(MHz)	20dB EBW[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.963	2401.487	2402.450	---	---
		2441	0.963	2440.490	2441.453	---	---
		2480	1.038	2479.430	2480.468	---	---
2DH5	Ant1	2402	1.314	2401.301	2402.615	---	---
		2441	1.341	2440.286	2441.627	---	---
		2480	1.284	2479.325	2480.609	---	---
3DH5	Ant1	2402	1.296	2401.310	2402.606	---	---
		2441	1.308	2440.310	2441.618	---	---
		2480	1.293	2479.307	2480.600	---	---

Test Graphs

DH5_Ant1_2402



DH5_Ant1_2441

DH5_Ant1_2480

2DH5_Ant1_2402

2DH5_Ant1_2441

2DH5_Ant1_2480

3DH5_Ant1_2402

3DH5_Ant1_2441

3DH5_Ant1_2480

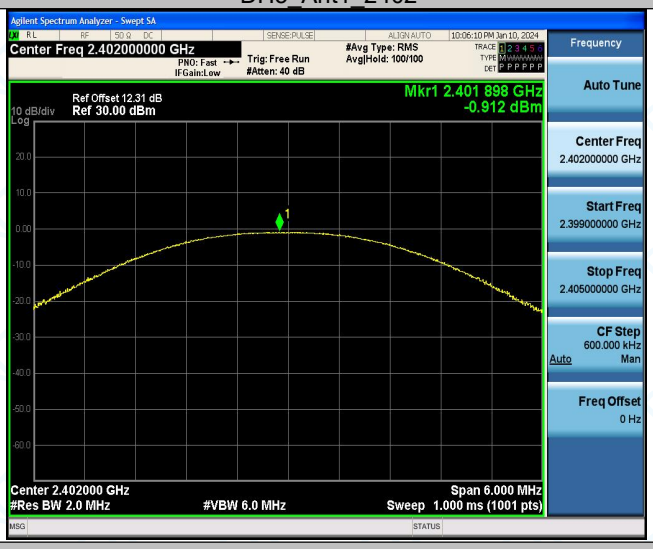
Appendix B: Maximum conducted output power

Test Result

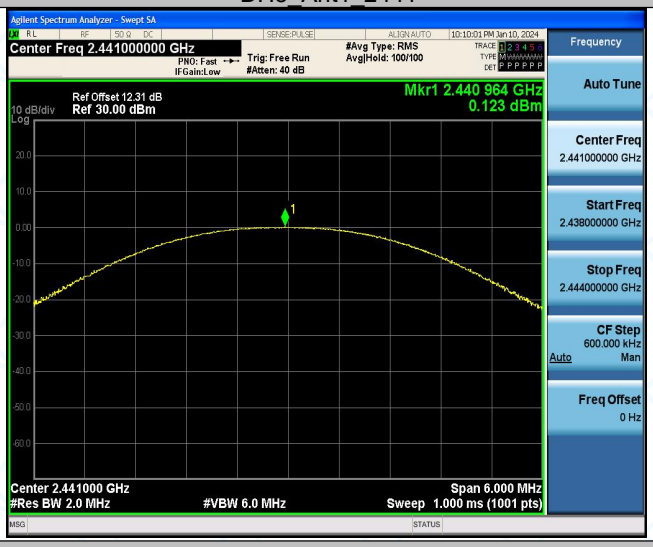
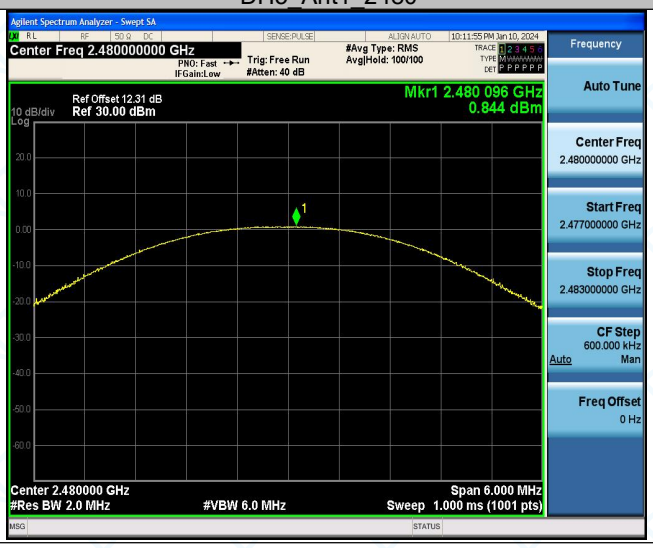
Test Mode	Antenna	Freq(MHz)	Conducted Peak Powert[dBm]	Conducted Limit[dBm]	Verdict
DH5	Ant1	2402	-0.91	≤20.97	PASS
		2441	0.12	≤20.97	PASS
		2480	0.84	≤20.97	PASS
2DH5	Ant1	2402	-0.14	≤20.97	PASS
		2441	0.88	≤20.97	PASS
		2480	1.66	≤20.97	PASS
3DH5	Ant1	2402	0.18	≤20.97	PASS
		2441	1.35	≤20.97	PASS
		2480	2.11	≤20.97	PASS

Test Graphs

DH5_Ant1_2402



DH5_Ant1_2441



DH5_Ant1_2480