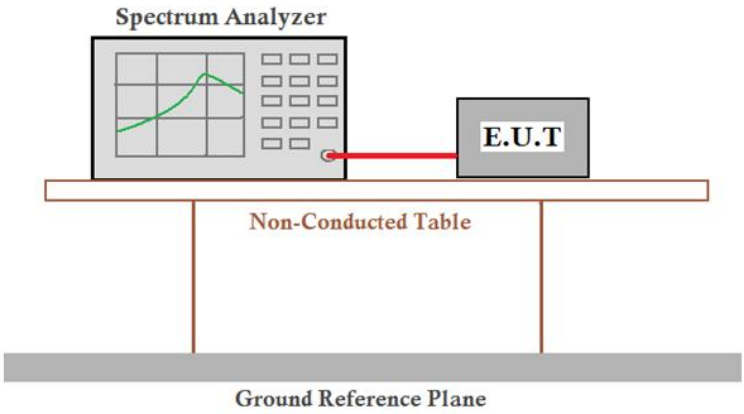
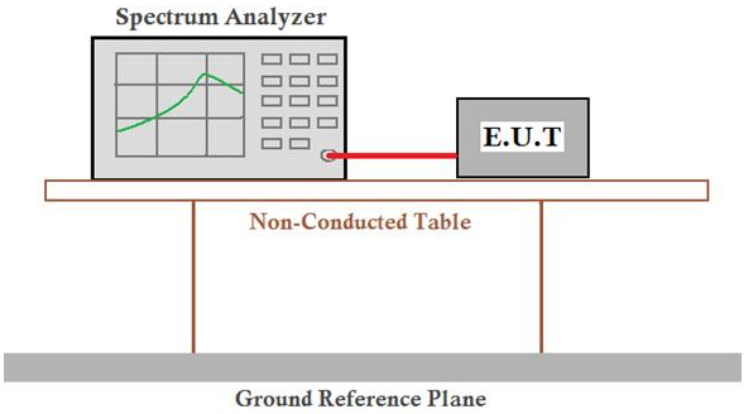
3.6 Hopping Channel Number

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10: 2013 Section 7.8.3
Test Setup:	
Instruments Used:	Refer to section 2.9 for details
Test Mode:	Hopping transmitting with all kind of modulation
Limit:	At least 15 channels
Test Results:	Pass

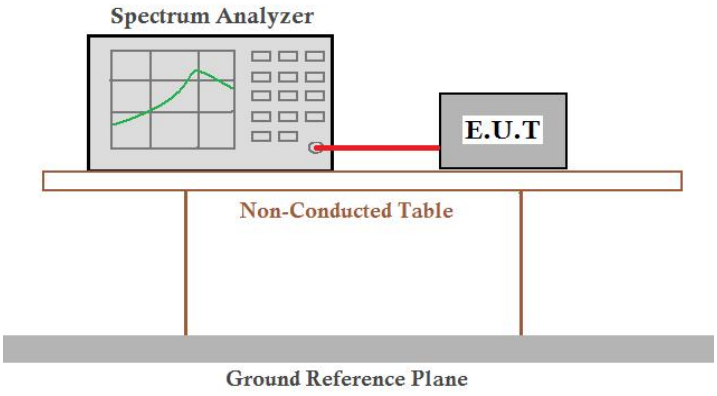
The detailed test data see: **Appendix E**

3.7 Band-edge for RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10: 2013 Section 7.8.6
Test Setup:	
Instruments Used:	Refer to section 2.9 for details
Exploratory Test Mode:	Hopping and Non-hopping transmitting with all kind of modulation and all kind of data type.
Final Test Mode:	Through Pre-scan, find the worst case of all modulation type.
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Test Results:	Pass

The detailed test data see: **Appendix F**

3.8 RF Conducted Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10: 2013 Section 11.11
Test Setup:	
Instruments Used:	Refer to section 2.9 for details
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Through Pre-scan, find the worst case of all modulation type.
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Test Results:	Pass

The detailed test data see: **Appendix G**

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:	

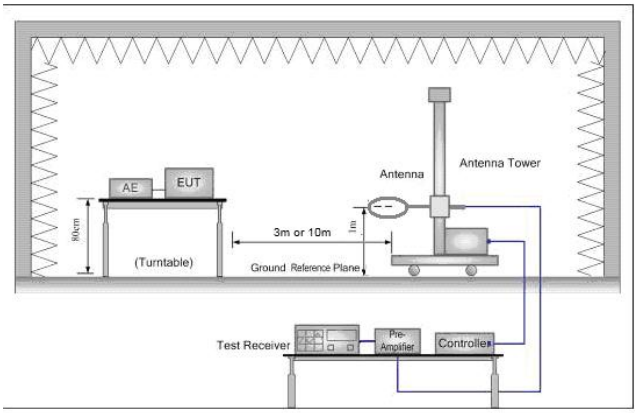


Figure 1. Below 30MHz

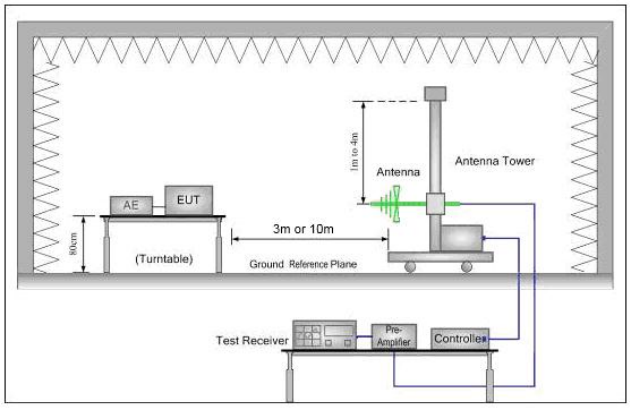


Figure 2. 30MHz to 1GHz

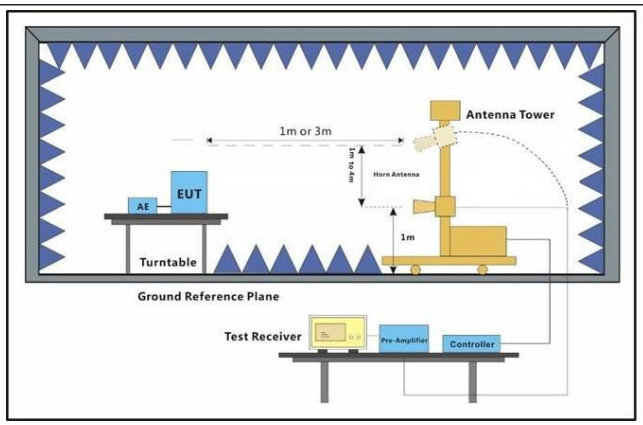


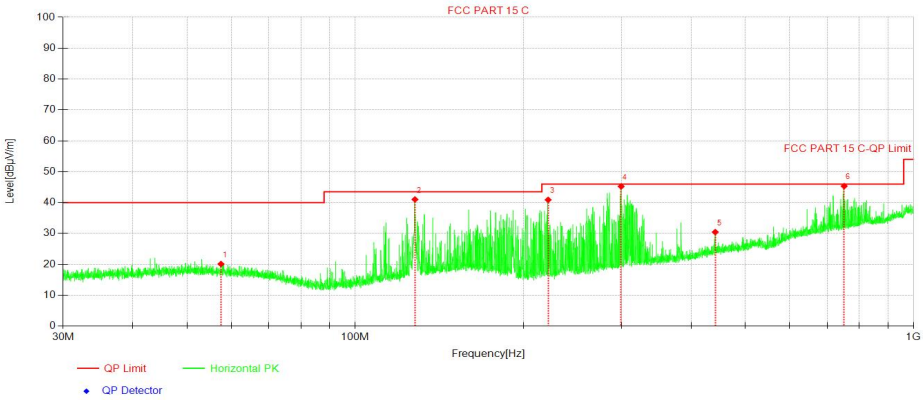
Figure 3. Above 1 GHz

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.

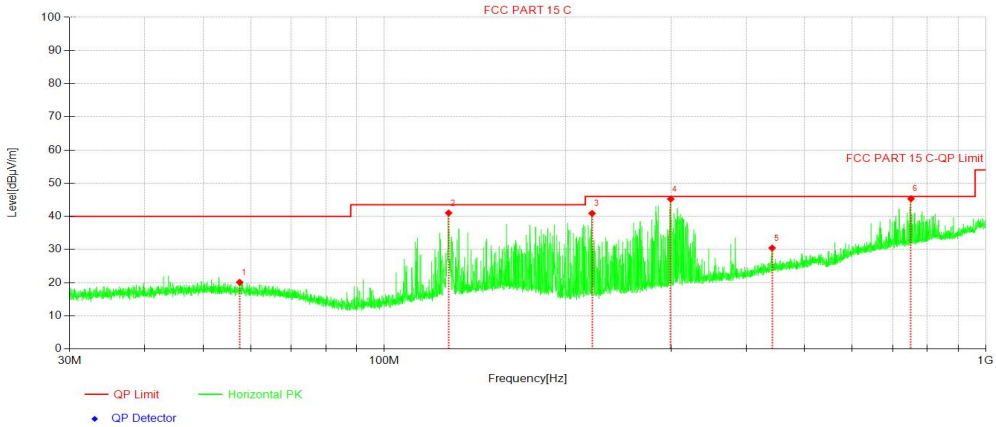
Test Configuration:	Measurements Below 1000MHz • RBW = 120 kHz • VBW = 300 kHz • Detector = Peak • Trace mode = max hold Peak Measurements Above 1000 MHz • RBW = 1 MHz • VBW ⩾ 3 MHz • Detector = Peak • Sweep time = auto • Trace mode = max hold Average Measurements Above 1000MHz • RBW = 1 MHz • VBW = 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 DH5 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



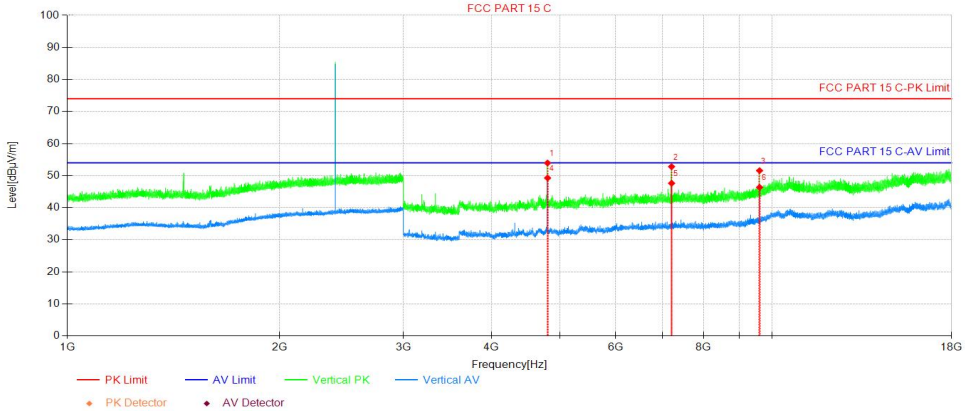
NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	66.40	40.80	-9.52	31.28	40.00	8.72	100	236	QP	Vertical
2	114.43	52.54	-10.76	41.78	43.50	1.72	100	0	QP	Vertical
3	154.98	48.92	-7.79	41.13	43.50	2.37	100	296	QP	Vertical
4	216.78	53.14	-11.06	42.08	46.00	3.92	100	256	QP	Vertical
5	496.80	43.49	-2.05	41.44	46.00	4.56	100	280	QP	Vertical
6	734.49	39.02	2.96	41.98	46.00	4.02	100	0	QP	Vertical



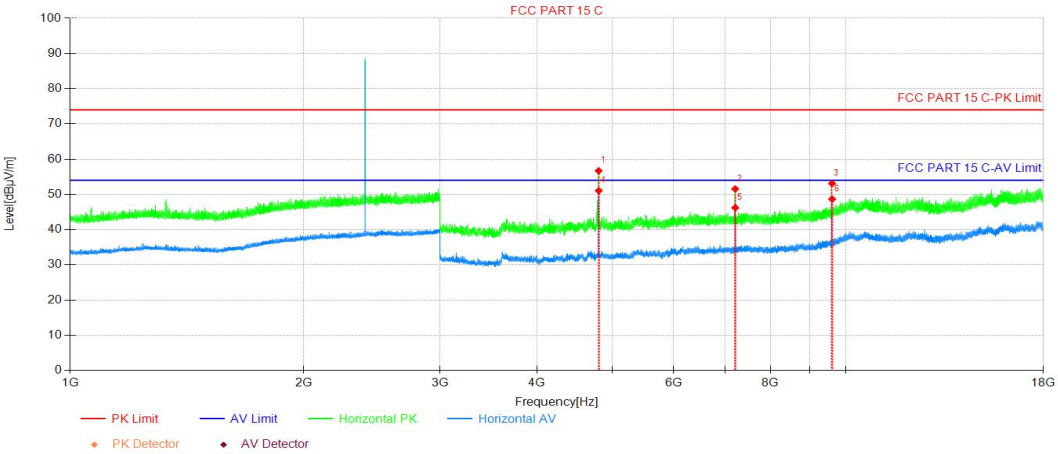
NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	57.51	28.63	-8.51	20.12	40.00	19.88	100	153	QP	Horizontal
2	127.97	50.64	-9.61	41.03	43.50	2.47	100	65	QP	Horizontal
3	221.62	51.95	-11.05	40.90	46.00	5.10	100	360	QP	Horizontal
4	299.52	52.24	-7.01	45.23	46.00	0.77	100	276	QP	Horizontal
5	441.43	33.47	-3.01	30.46	46.00	15.54	100	194	QP	Horizontal
6	751.16	41.90	3.43	45.33	46.00	0.67	100	70	QP	Horizontal

For above 1GHz

DH5 2402MHz

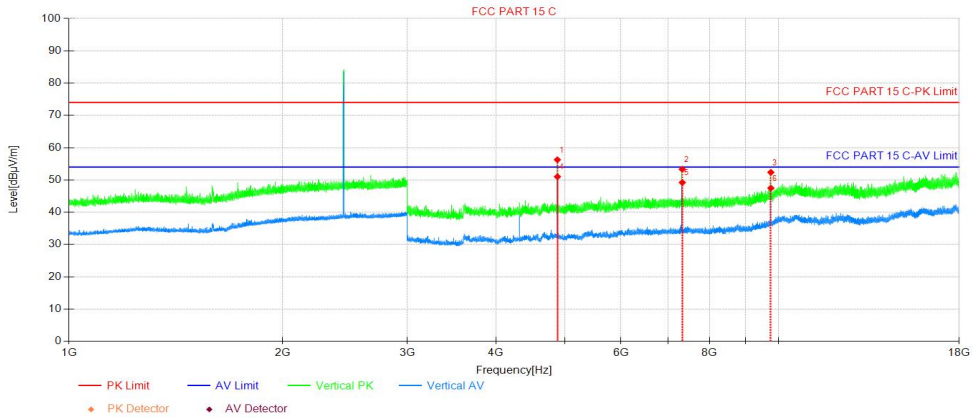


NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	4803.84	58.56	-4.61	53.95	74.00	20.05	150	340	Peak	Vertical
2	7206.21	54.58	-1.76	52.82	74.00	21.18	150	356	Peak	Vertical
3	9607.83	50.72	0.87	51.59	74.00	22.41	150	142	Peak	Vertical
4	4804.59	53.90	-4.61	49.29	54.00	4.71	150	340	AV	Vertical
5	7206.96	49.39	-1.76	47.63	54.00	6.37	150	15	AV	Vertical
6	9608.58	45.49	0.88	46.37	54.00	7.63	150	142	AV	Vertical

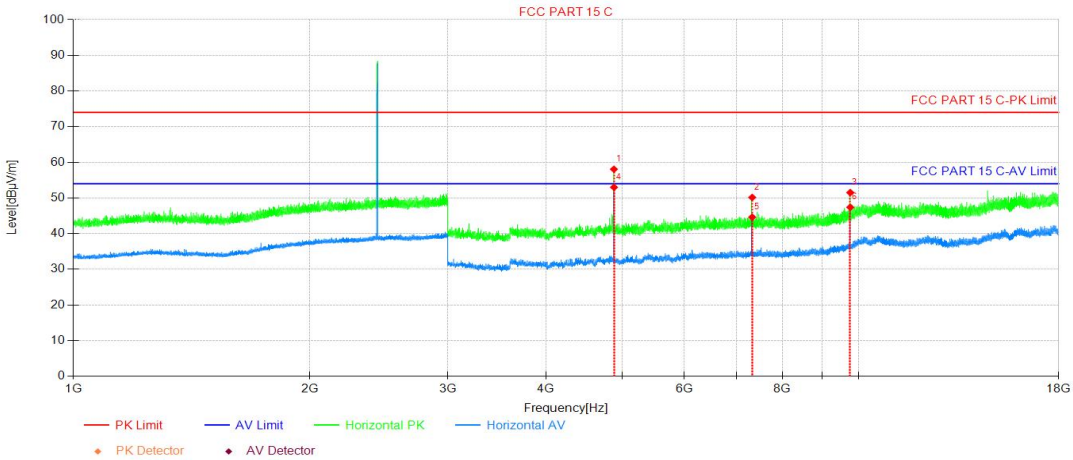


NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	4803.84	61.31	-4.61	56.70	74.00	17.30	150	17	Peak	Horizon
2	7206.21	53.31	-1.76	51.55	74.00	22.45	150	72	Peak	Horizon
3	9607.83	52.23	0.87	53.10	74.00	20.90	150	90	Peak	Horizon
4	4804.59	55.66	-4.61	51.05	54.00	2.95	150	0	AV	Horizon
5	7206.96	47.97	-1.76	46.21	54.00	7.79	150	72	AV	Horizon
6	9608.58	47.79	0.88	48.67	54.00	5.33	150	110	AV	Horizon

DH5 2441MHz

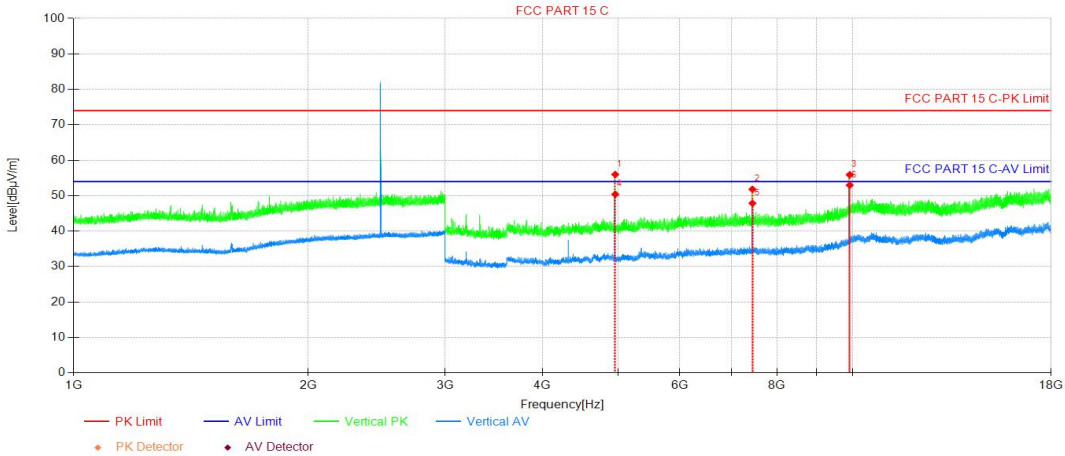


NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	4881.84	60.99	-4.72	56.27	74.00	17.73	150	342	Peak	Vertical
2	7323.21	54.83	-1.49	53.34	74.00	20.66	150	342	Peak	Vertical
3	9763.83	50.74	1.64	52.38	74.00	21.62	150	342	Peak	Vertical
4	4882.59	55.73	-4.72	51.01	54.00	2.99	150	357	AV	Vertical
5	7323.96	50.71	-1.49	49.22	54.00	4.78	150	4	AV	Vertical
6	9764.58	45.84	1.64	47.48	54.00	6.52	150	165	AV	Vertical

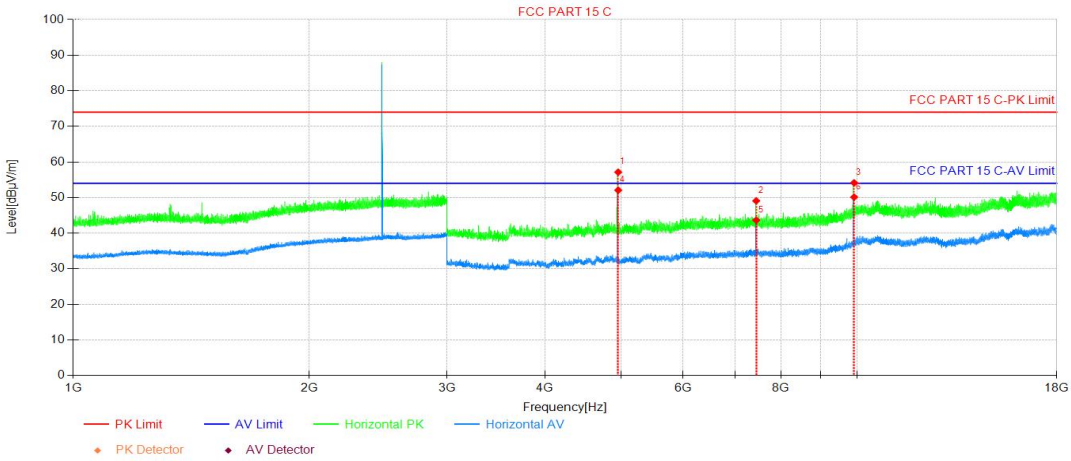


NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	4881.84	62.79	-4.72	58.07	74.00	15.93	150	15	Peak	Horizon
2	7323.21	51.65	-1.49	50.16	74.00	23.84	150	69	Peak	Horizon
3	9764.58	49.89	1.64	51.53	74.00	22.47	150	144	Peak	Horizon
4	4882.59	57.72	-4.72	53.00	54.00	1.00	150	15	AV	Horizon
5	7323.96	46.12	-1.49	44.63	54.00	9.37	150	90	AV	Horizon
6	9764.58	45.76	1.64	47.40	54.00	6.60	150	108	AV	Horizon

DH5 2480MHz



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	4959.84	60.85	-4.86	55.99	74.00	18.01	150	341	Peak	Vertical
2	7440.22	53.16	-1.34	51.82	74.00	22.18	150	341	Peak	Vertical
3	9919.84	53.66	2.26	55.92	74.00	18.08	150	341	Peak	Vertical
4	4960.59	55.26	-4.86	50.40	54.00	3.60	150	341	AV	Vertical
5	7440.97	49.21	-1.34	47.87	54.00	6.13	150	341	AV	Vertical
6	9920.59	50.69	2.27	52.96	54.00	1.04	150	357	AV	Vertical



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	4959.84	62.01	-4.86	57.15	74.00	16.85	150	19	Peak	Horizon
2	7440.22	50.42	-1.34	49.08	74.00	24.92	150	74	Peak	Horizon
3	9920.59	51.87	2.27	54.14	74.00	19.86	150	55	Peak	Horizon
4	4960.59	56.93	-4.86	52.07	54.00	1.93	150	3	AV	Horizon
5	7440.97	44.99	-1.34	43.65	54.00	10.35	150	74	AV	Horizon
6	9920.59	47.85	2.27	50.12	54.00	3.88	150	55	AV	Horizon

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,DH5 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:			

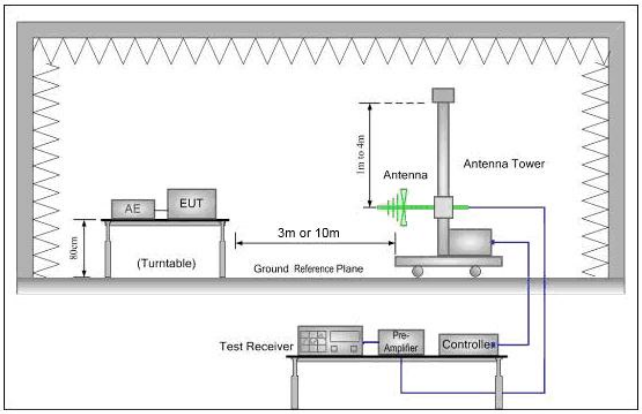


Figure 1. 30MHz to 1GHz

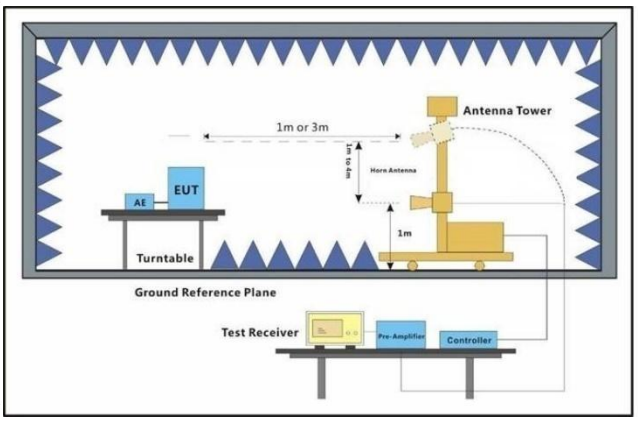


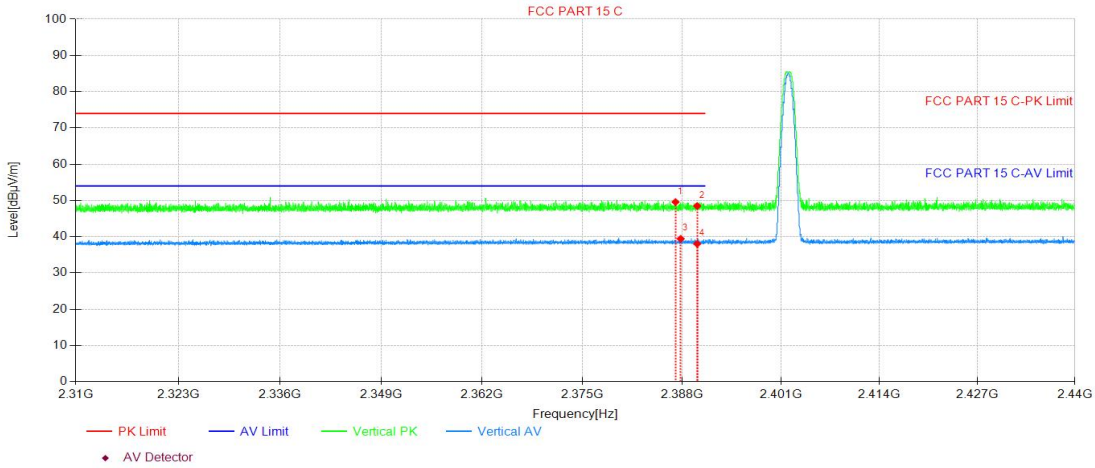
Figure 2. Above 1 GHz

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

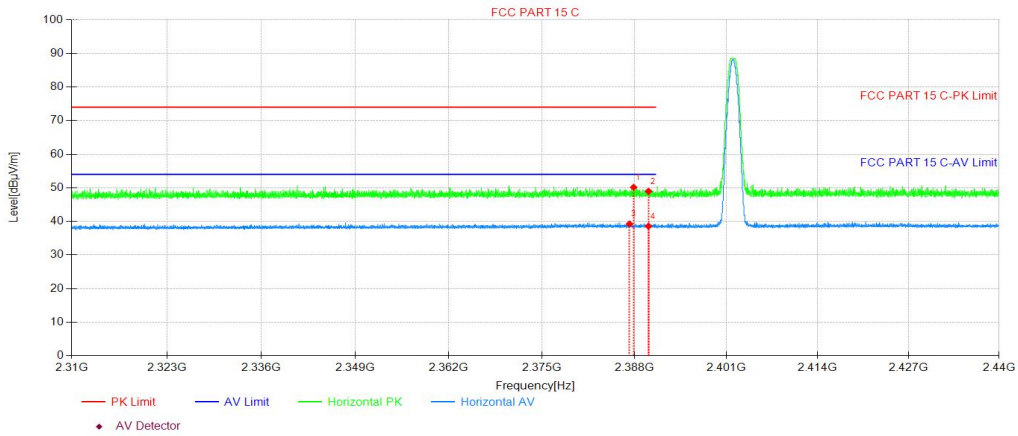
	• RBW = 120 kHz • VBW = 300 kHz • Detector = Peak • Trace mode = max hold Peak Measurements Above 1000 MHz • RBW = 1 MHz • VBW ⩾ 3 MHz • Detector = Peak • Sweep time = auto • Trace mode = max hold Average Measurements Above 1000MHz • RBW = 1 MHz • VBW = 10 Hz, when duty cycle is no less than 98 percent. • 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 DH5 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

DH5 2402MHz

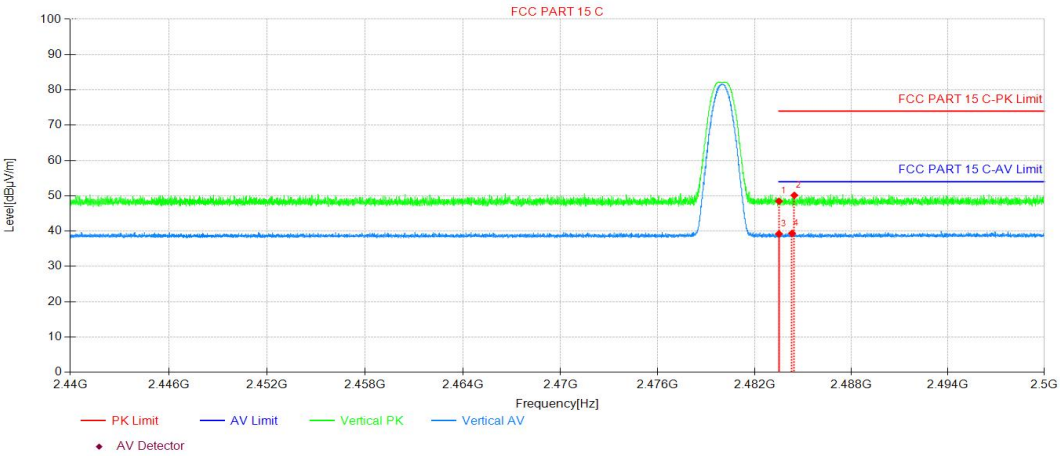


NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	AV Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	2387.17	50.38	-0.80	49.58	74.00	24.42	150	346	Peak	Vertical
2	2390.01	49.30	-0.80	48.50	74.00	25.50	150	97	Peak	Vertical
3	2387.85	40.24	-0.80	39.44	54.00	14.56	150	219	AV	Vertical
4	2390.01	38.84	-0.80	38.04	54.00	15.96	150	302	AV	Vertical

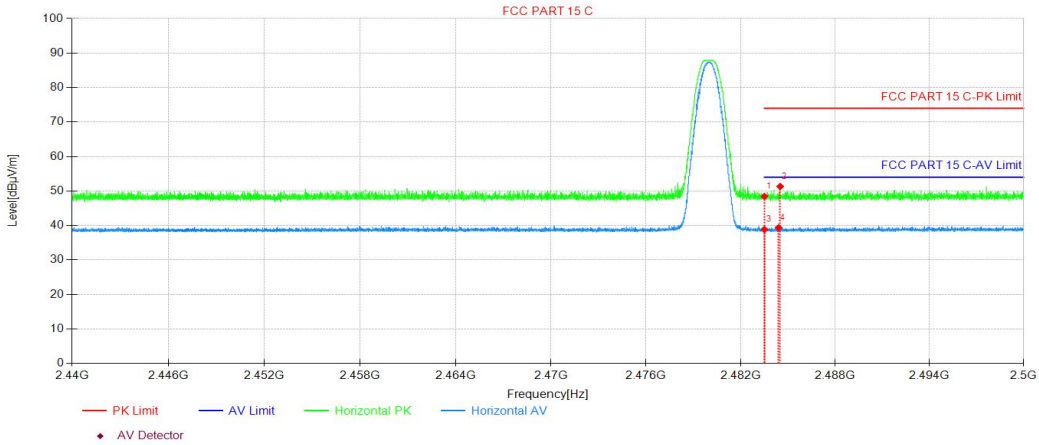


NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	AV Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	2387.91	50.95	-0.80	50.15	74.00	23.85	150	70	Peak	Horizon
2	2390.01	49.77	-0.80	48.97	74.00	25.03	150	117	Peak	Horizon
3	2387.33	40.05	-0.80	39.25	54.00	14.75	150	117	AV	Horizon
4	2390.01	39.37	-0.80	38.57	54.00	15.43	150	24	AV	Horizon

DH5 2480MHz



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	2483.50	48.77	-0.29	48.48	74.00	25.52	150	324	Peak	Vertical
2	2484.45	50.44	-0.28	50.16	74.00	23.84	150	88	Peak	Vertical
3	2483.50	39.50	-0.29	39.21	54.00	14.79	150	33	AV	Vertical
4	2484.31	39.65	-0.28	39.37	54.00	14.63	150	347	AV	Vertical



NO.	Freq. [MHz]	Reading Level [dBμV]	Correct Factor [dB/m]	Result Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Remark	Polarity
1	2483.50	48.73	-0.29	48.44	74.00	25.56	150	139	Peak	Horizon
2	2484.50	51.61	-0.28	51.33	74.00	22.67	150	313	Peak	Horizon
3	2483.50	39.15	-0.29	38.86	54.00	15.14	150	38	AV	Horizon
4	2484.40	39.68	-0.28	39.40	54.00	14.60	150	161	AV	Horizon

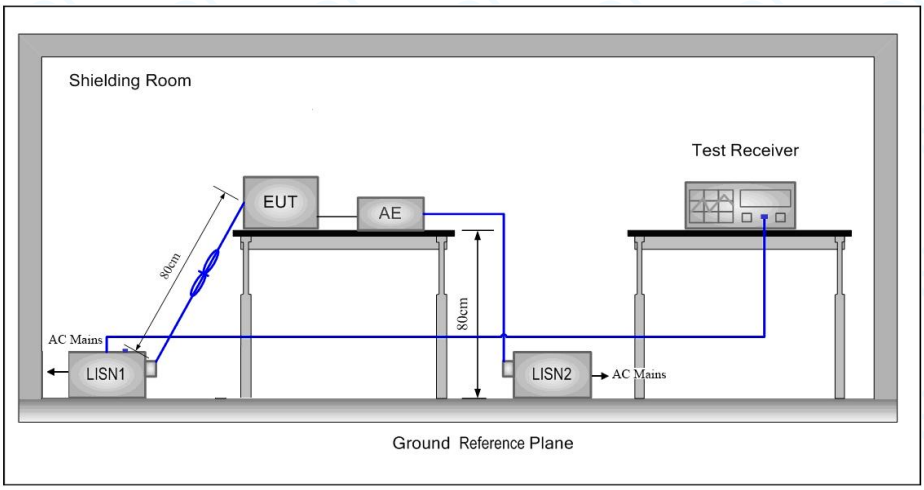
Note:

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, DH5 is the worst case, only the worst case was reported.

3.11 AC Power Line Conducted Emissions

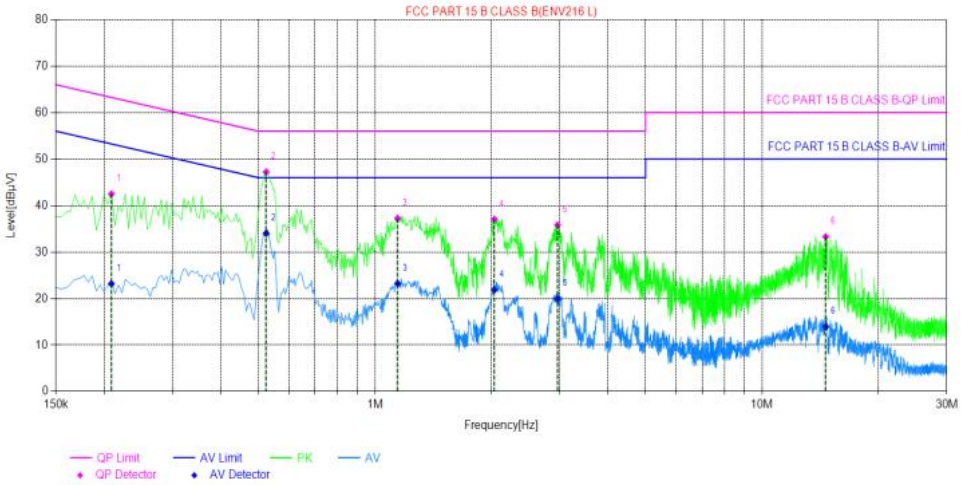
Test Requirement:	47 CFR Part 15C Section 15.207		
Test Method:	ANSI C63.10: 2013		
Test Frequency Range:	150kHz to 30MHz		
Limit:	Frequency range (MHz)	Limit (dBuV)	
		Quasi-peak	Average
	0.15-0.5	66 to 56*	56 to 46*
	0.5-5	56	46
	5-30	60	50
	* Decreases with the logarithm of the frequency.		
Test Procedure:	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:	PASS

Measurement Data

An initial pre-scan was performed on the live and neutral lines with peak detector.
Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

Live Line:



Final Data List									
NO.	Freq. [MHz]	Factor [dB]	QP Value [dBμV]	QP Limit [dBμV]	QP Margin [dB]	AV Value [dBμV]	AV Limit [dBμV]	AV Margin [dB]	Verdict
1	0.2085	9.93	42.48	63.26	20.78	23.18	53.26	30.08	PASS
2	0.5235	9.86	47.23	56.00	8.77	34.01	46.00	11.99	PASS
3	1.1445	9.72	37.26	56.00	18.74	23.23	46.00	22.77	PASS
4	2.0355	9.73	37.03	56.00	18.97	21.92	46.00	24.08	PASS
5	2.9625	9.74	35.82	56.00	20.18	19.90	46.00	26.10	PASS
6	14.6085	9.98	33.30	60.00	26.70	13.95	50.00	36.05	PASS