4.4 Unwanted Emissions Measurement

This section is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement.

4.4.1 Limit of Unwanted Emissions

(1) For transmitters operating in the 5150-5250 MHz band: all emissions outside of the 5150-5350 MHz band shall not exceed an EIRP of -27dBm/MHz.

For transmitters operating in the 5250-5350 MHz band: all emissions outside of the 5150-5350 MHz band shall not exceed an EIRP of-27 dBm/MHz. Devices operating in the 5250-5350 MHz band that generate emissions in the 5150-5250 MHz band must meet all applicable technical requirements for operation in the 5150-5250 MHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of -27 dBm/MHz in the 5150-5250 MHz band.

For transmitters operating in the 5470-5725 MHz band: all emissions outside of the 5470-5725MHz band shall not exceed an EIRP of -27 dBm/MHz.

For transmitters operating in the 5.725-5.85 GHz band:
15.407(b)(4)(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 15.6dBm/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.

(2) Unwanted spurious emissions fallen in restricted bands shall comply with the general field strength limits as below table.

Frequency (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

EIRP (dBm)	Field Strength at 3m (dB μ V/m)
- 27	68.2

Note: The following formula is used to convert the EIRP to field strength.

$$EIRP = E_{Meas} + 20\log(d_{Meas}) - 104.7$$

where

EIRP is the equivalent isotropically radiated power, in dBm

E_{Meas} is the field strength of the emission at the measurement distance, in dBμV/m

d_{Meas} is the measurement distance, in m

4.4.2 Measuring Instruments

The measuring equipment is listed in the section 3.3 of this test report.

4.4.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNll Test Procedures New Rules v02r01 Section G) Unwanted emissions measurement.

   (1)Procedure for Unwanted Emissions Measurements Below 1000MHz
   - RBW = 120 kHz
   - VBW = 300 kHz
   - Detector = Peak
   - Trace mode = max hold

   (2)Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz
   - RBW= 1 MHz
   - VBW ≥ 3 MHz
   - Detector = Peak
   - Sweep time = auto
   - Trace mode = max hold

   (3)Procedures for Average Unwanted Emissions 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.
2. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.

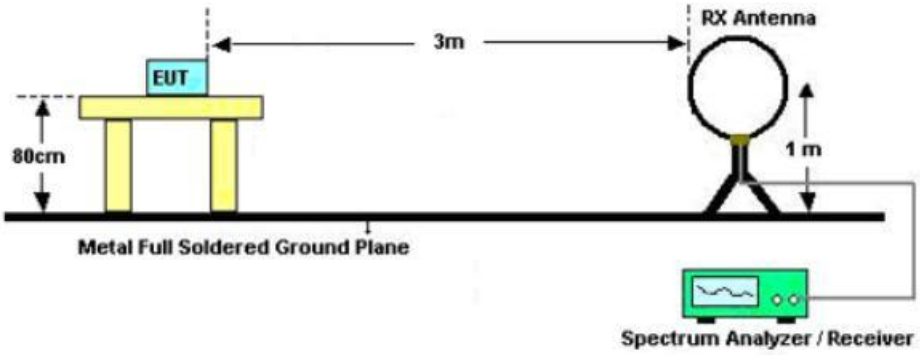
4.. The antenna is a broadband antenna and its height is adjusted between one meter and four.

meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.

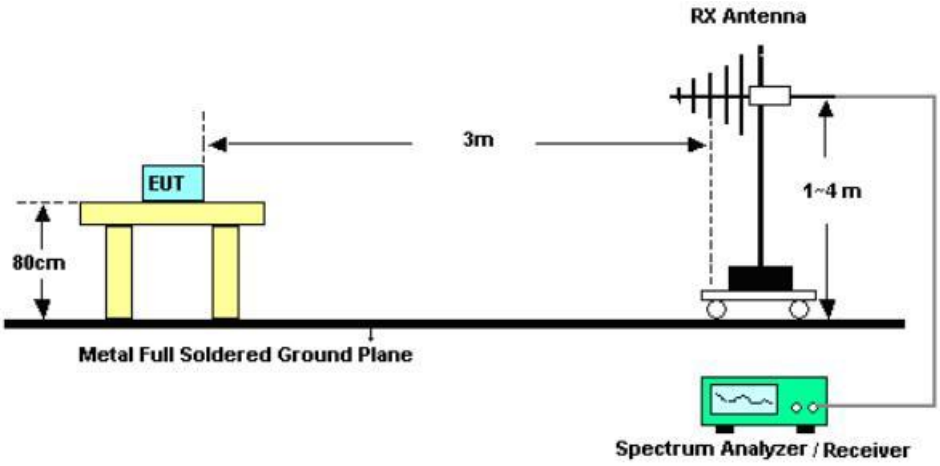
5. For each suspected emission, the EUT was arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than peak limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

4.4.4 Test Setup

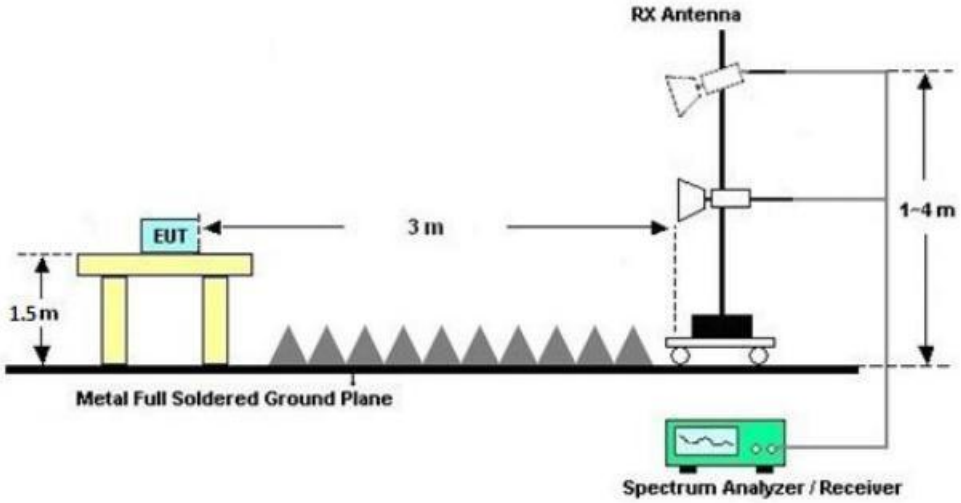
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



4.4.5Test Results of Radiated Spurious Emissions (9 kHz - 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

4.4.6 Test Result of Radiated Spurious at Band Edges

Please refer to ANNEX B.1.

4.4.7 Test Result of Radiated Spurious Emissions (30MHz - 10th Harmonic or 40GHz whichever is lower)

Please refer to ANNEX B.1

4.4.8 Duty Cycle

Please refer to ANNEX A.4.

4.5 AC Conducted Emission Measurement

4.5.1 Limit of AC Conducted Emission

For equipment that 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 the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	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.

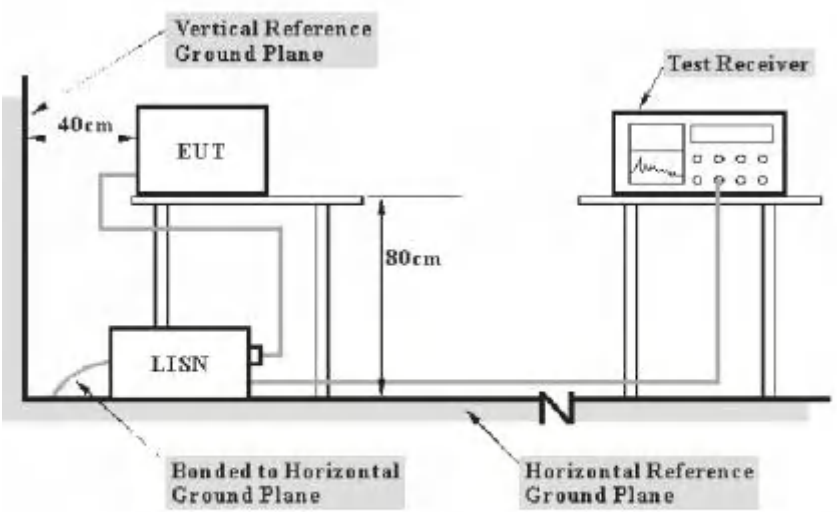
4.5.2 Measuring Instruments

The section 3.3 of List of Measuring Equipment of this test report is used for test.

4.5.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth =9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

4.5.4 Test Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

4.5.5 Uncertainty Measurement

Where relevant,the following measurement uncertainty levels have been estimated for tests performed on the EUT. The listed uncertainties are the worst case uncertainty for the entire range of measurement. Please note that the uncertainty values are provided for informational purposes only and are not used in determining the PASS/FAIL results.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

CASE	Uncertainty
Continuous Emission (AC port)	2.92 dB

4.5.6 Test Result

Remark: The product is DC powered, this test item is not applicable.

4.6 Antenna Requirements

4.6.1 Standard Applicable

15.203 requirement: 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.

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

4.6.2 Antenna Anti-Replacement Construction

The antenna is External on the main PCB and no consideration of replacement. The best case gain of the antenna is -0.70dBi.

-------- THE END --------

ANNEX A: Test Results of Conducted Test

A.1 6dB and 26dB and 99% Occupied Bandwidth Measurement

Test Result_26dB Bandwidth

Test Mode	Antenna	Frequency[MHz]	26db EBW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11A-CDD	Ant1	5180	18.760	5170.400	5189.160	---	---
11A-CDD	Ant2	5180	19.480	5170.280	5189.760	---	---
11A-CDD	Ant1	5220	19.120	5210.200	5229.320	---	---
11A-CDD	Ant2	5220	19.880	5210.320	5230.200	---	---
11A-CDD	Ant1	5240	19.240	5230.160	5249.400	---	---
11A-CDD	Ant2	5240	19.240	5230.320	5249.560	---	---
11A-CDD	Ant1	5260	19.200	5250.480	5269.680	---	---
11A-CDD	Ant2	5260	19.440	5249.920	5269.360	---	---
11A-CDD	Ant1	5300	19.320	5290.440	5309.760	---	---
11A-CDD	Ant2	5300	19.760	5289.840	5309.600	---	---
11A-CDD	Ant1	5320	19.600	5310.200	5329.800	---	---
11A-CDD	Ant2	5320	19.880	5310.280	5330.160	---	---
11A-CDD	Ant1	5500	19.520	5490.200	5509.720	---	---
11A-CDD	Ant2	5500	19.280	5490.080	5509.360	---	---
11A-CDD	Ant1	5580	18.840	5570.560	5589.400	---	---
11A-CDD	Ant2	5580	19.000	5570.480	5589.480	---	---
11A-CDD	Ant1	5700	20.000	5690.040	5710.040	---	---
11A-CDD	Ant2	5700	19.120	5690.400	5709.520	---	---
11A-CDD	Ant1	5720	19.280	5710.360	5729.640	---	---
11A-CDD	Ant2	5720	19.000	5710.400	5729.400	---	---
11A-CDD	Ant1	5720_UNII-2C	14.64	5710.360	5725	---	---
11A-CDD	Ant2	5720_UNII-2C	14.6	5710.400	5725	---	---
11A-CDD	Ant1	5720_UNII-3	4.64	5725	5729.640	---	---
11A-CDD	Ant2	5720_UNII-3	4.4	5725	5729.400	---	---
11A-CDD	Ant1	5745	19.680	5735.200	5754.880	---	---
11A-CDD	Ant2	5745	19.280	5735.320	5754.600	---	---
11A-CDD	Ant2	5785	19.600	5775.080	5794.680	---	---
11A-CDD	Ant1	5785	19.280	5775.240	5794.520	---	---
11A-CDD	Ant1	5825	19.120	5815.240	5834.360	---	---
11A-CDD	Ant2	5825	19.240	5815.240	5834.480	---	---
11N20MIMO	Ant1	5180	20.920	5169.600	5190.520	---	---
11N20MIMO	Ant2	5180	20.040	5170.120	5190.160	---	---

11N20MIMO	Ant1	5220	20.840	5209.480	5230.320	---	---
11N20MIMO	Ant2	5220	22.240	5209.280	5231.520	---	---
11N20MIMO	Ant1	5240	20.640	5229.520	5250.160	---	---
11N20MIMO	Ant2	5240	20.280	5229.400	5249.680	---	---
11N20MIMO	Ant1	5260	20.280	5249.640	5269.920	---	---
11N20MIMO	Ant2	5260	20.960	5248.960	5269.920	---	---
11N20MIMO	Ant1	5300	19.960	5289.760	5309.720	---	---
11N20MIMO	Ant2	5300	20.360	5289.720	5310.080	---	---
11N20MIMO	Ant1	5320	20.480	5309.600	5330.080	---	---
11N20MIMO	Ant2	5320	20.120	5309.880	5330.000	---	---
11N20MIMO	Ant1	5500	20.000	5489.960	5509.960	---	---
11N20MIMO	Ant2	5500	22.240	5489.800	5512.040	---	---
11N20MIMO	Ant1	5580	21.520	5569.160	5590.680	---	---
11N20MIMO	Ant2	5580	21.960	5568.120	5590.080	---	---
11N20MIMO	Ant1	5700	20.400	5689.520	5709.920	---	---
11N20MIMO	Ant2	5700	20.400	5689.520	5709.920	---	---
11N20MIMO	Ant1	5720	20.040	5709.760	5729.800	---	---
11N20MIMO	Ant2	5720	20.080	5709.880	5729.960	---	---
11N20MIMO	Ant1	5720_UNII-2C	15.24	5709.760	5725	---	---
11N20MIMO	Ant2	5720_UNII-2C	15.12	5709.880	5725	---	---
11N20MIMO	Ant1	5720_UNII-3	4.8	5725	5729.800	---	---
11N20MIMO	Ant2	5720_UNII-3	4.96	5725	5729.960	---	---
11N20MIMO	Ant1	5745	20.000	5734.920	5754.920	---	---
11N20MIMO	Ant2	5745	19.880	5734.920	5754.800	---	---
11N20MIMO	Ant1	5785	20.040	5774.920	5794.960	---	---
11N20MIMO	Ant2	5785	20.440	5774.800	5795.240	---	---
11N20MIMO	Ant1	5825	21.280	5814.080	5835.360	---	---
11N20MIMO	Ant2	5825	20.840	5815.080	5835.920	---	---
11N40MIMO	Ant1	5190	39.120	5170.240	5209.360	---	---
11N40MIMO	Ant2	5190	38.880	5170.720	5209.600	---	---
11N40MIMO	Ant1	5230	39.360	5210.320	5249.680	---	---
11N40MIMO	Ant2	5230	38.880	5210.320	5249.200	---	---
11N40MIMO	Ant1	5270	39.520	5250.160	5289.680	---	---
11N40MIMO	Ant2	5270	38.880	5250.240	5289.120	---	---
11N40MIMO	Ant1	5310	40.000	5289.920	5329.920	---	---
11N40MIMO	Ant2	5310	52.880	5284.400	5337.280	---	---
11N40MIMO	Ant1	5510	40.000	5489.840	5529.840	---	---
11N40MIMO	Ant2	5510	39.600	5490.480	5530.080	---	---
11N40MIMO	Ant1	5550	39.280	5530.240	5569.520	---	---