RF Exposure Evaluation

FCC Limits

The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency (RF) radiation as specified in 1.1307(b)

Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz

Friis transmission formula: **$Pd = (Pout*G)/(4*pi*r^2)$**

Where

Pd = power density in mW/cm^2, **Pout** = output power to antenna in mW;

G = gain of antenna in linear scale, **Pi** = 3.1416;

R = distance between observation point and center of the radiator in cm

Pd id the limit of MPE, 1 mW/cm^2. If we know the maximum gain of the antenna and the total power input to the antenna, through the calculation, we will know the distance r where the MPE limit is reached.

Test Procedure

Software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel individually.

SISO:

Band	Antenna	Antenna Gain	max tune-up (dBm)	max tune-up (mW)	Power Density at R=20cm (mW/cm^2)	Limit (mW/cm^2)	Result
2.4G	1	3.04	17	50.119	0.02008	1.0	PASS
	2	2.99	17	50.119	0.01985		
5G	1	3.64	16	39.811	0.01831		
	2	3.14	16	39.811	0.01632		
5.8G	1	3.84	17	50.119	0.02414		
	2	3.69	15	31.623	0.01471		

MIMO:

Band	Antenna	Antenna Gain	max tune-up (dBm)	max tune-up (mW)	Power Density at R=20cm (mW/cm^2)	Limit (mW/cm^2)	Result
2.4G	1	3.04	17	50.119	0.02008	1.0	PASS
	2	2.99	17	50.119	0.01985		
5G	1	3.64	16	39.811	0.01831		
	2	3.14	16	39.811	0.01632		
5.8G	1	3.84	17	50.119	0.02414		
	2	3.69	17	50.119	0.02332		

802.11n could work in Synchronous transmitting mode.

The max power density is less than MPE exempt limit, so it is compliance.

IC Limits

Transmitters are exempt from routine SAR and RF exposure evaluations provided that they comply with the requirements of sections 2.5.1 or 2.5.2.

2.5.1

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance[4,5]

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

2.5.2

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

• below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);

• at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;

• at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);

• at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2}\ f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;

• at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

Test Result of RF Exposure Evaluation

According to RSS-102 RF exposure section 2.5.2 is calculated.

The minimum separation distance is 20cm declared by manufacturer

Test Result of RF Exposure Evaluation

SISO:

Band	Antenna	Antenna Gain	max tune-up(dBm)	EIRP(dBm)	EIRP(mW)	Limit (mW)	Result
2.4G	1	3.04	17	20.04	100.925	2684.034	PASS
	2	2.99	17	19.99	99.77	2684.034	
5G	1	3.64	16	19.64	92.045	4507.340	
	2	3.14	16	19.14	82.035	4507.340	
5.8G	1	3.84	17	20.84	121.339	4845.461	
	2	3.69	15	18.69	73.961	4845.461	

MIMO:

Band	Antenna	Antenna Gain	max tune-up(dBm)	EIRP(dBm)	EIRP(mW)	Limit (mW)	Result
2.4G	1	3.04	17	20.04	100.925	2684.034	PASS
	2	2.99	17	19.99	99.770	2684.034	
5G	1	3.64	16	19.64	92.045	4507.340	
	2	3.14	16	19.14	82.035	4507.340	
5.8G	1	3.84	17	20.84	121.339	4845.461	
	2	3.69	17	20.69	117.220	4845.461	

802.11n could work in Synchronous transmitting mode.

The max power density is less than MPE exempt limit, so it is compliance.