

RF Exposure Evaluation

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/cm², **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 is the limit of MPE, 1 mW/cm². 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.

Test Result of RF Exposure Evaluation

Wifi 2.4G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
2462MHz	14.93	31.12	0.00780	1.0	PASS

Wifi 5.2G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
5180MHz	14.95	31.26	0.00784	1.0	PASS

Wifi 5.3G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
5310MHz	14.80	30.20	0.00757	1.0	PASS

Wifi 5.6G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
5500 MHz	14.96	31.33	0.00785	1.0	PASS

Wifi 5.8G

Channel	Max output power to antenna (dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
5825MHz	12.76	18.88	0.00473	1.0	PASS

Antenna gain: 1dBi

According to 447498 D01 General RF Exposure Guidance v05

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

--f(GHz) is the RF channel transmit frequency in GHz

--Power and distance are rounded to the nearest mW and mm before calculation

--The result is rounded to one decimal place for comparison

$$\text{eirp} = \text{pt} \times \text{gt} = (\text{EXd})^{2/30}$$

where:

pt = transmitter output power in watts,

gt = numeric gain of the transmitting antenna (unitless),

E = electric field strength in V/m, --- $10^{((\text{dBuV/m})/20)}/10^6$

d = measurement distance in meters (m) ---3m

$$\text{So pt} = (\text{EXd})^{2/30} \times \text{gt}$$

For BT mode

Field strength = 90.68dBuV/m @3m

Ant gain =1dBi, so Ant numeric gain=1.259

$$\text{So pt} = \{ [10^{(90.68/20)}/10^6 \times 3]^2 / 30 \times 1.259 \} \times 1000 \text{ mW} = 0.28 \text{ mW}$$

$$\text{So } (0.28 \text{ mW} / 5 \text{ mm}) \times \sqrt{2.480} = 0.088 < 3$$

For BLE mode

Field strength =90.49dBuV/m @3m

Ant gain =1dBi, so Ant numeric gain= 1.259

$$\text{So pt} = \{ [10^{(90.49/20)}/10^6 \times 3]^2 / 30 \times 1.259 \} \times 1000 \text{ mW} = 0.27 \text{ mW}$$

$$\text{So } (0.27 \text{ mW} / 5 \text{ mm}) \times \sqrt{2.440} = 0.084 < 3$$

802.11n/ac could work in Synchronous transmitting mode.

The maximum simultaneously power density were as below

BT+2.4G WIFI+5.2G WIFI: 0.0371 <1.

BT+2.4G WIFI+5.3G WIFI: 0.0372 <1

BT+2.4G WIFI+5.6G WIFI: 0.0369 <1

BT+2.4G WIFI+5.8G WIFI: 0.0372 <1

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