

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: $Pd = (Pout \cdot G) / (4 \cdot \pi \cdot r^2)$

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

BLE

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
2440MHz	3.91	2.46	0.0006	1.0	PASS

Antenna gain=1.19dBi

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
802.11ac(HT40) 2422MHz SISO(ANT 2)	15.00	31.62	0.0083	1.0	PASS
802.11n(HT20) 2412MHz MIMO	19.28	84.72	0.0490	1.0	PASS

Antenna gain: ANT 1: 1.19dBi, ANT 2: 2.04dBi

Directional gain=10log [(10^{ANT1/20}+10^{ANT2/20})²/2]dBi=4.64dBi

UNII-Band I

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
802.11ac(HT80) 5210 SISO(ANT 1)	15.25	33.50	0.0090	1.0	PASS
802.11ac(HT20) 5180MHz MIMO	15.06	32.06	0.0188	1.0	PASS

Antenna gain:ANT 1: 1.31dBi, ANT 2: 2.03dBi

Directional gain=10log [(10^{ANT1/20}+10^{ANT2/20})²/2]dBi=4.69dBi

UNII-Band III

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
802.11ac(HT80) 5775MHz SISO(ANT 1)	15.35	34.28	0.0098	1.0	PASS
802.11ac(HT80) 5775MHz MIMO	15.05	31.99	0.0197	1.0	PASS

Antenna gain: ANT 1: 1.58dBi, ANT 2: 2.18dBi

Directional gain=10log [(10^{ANT1/20}+10^{ANT2/20})²/2]dBi=4.90dBi

BT and WIFI Simultaneous Transmission:

$$\sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k}$$

BLE + 2.4G WIFI MIMO+5G WIFI SISO=(0.0006/1)+(0.0490/1) +(0.0197/1)= 0.0006+0.0490+0.0197=0.0693<1

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