

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

BT EDR

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
2480MHz	5.67	3.69	0.0028	1.0	PASS

Antenna gain=5.8dBi

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
2480MHz	2.86	1.93	0.0015	1.0	PASS

Antenna gain=5.8dBi

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
2412MHz MIMO 802.11n(HT20)	15.56	35.97	0.0384	1.0	PASS
2462MHz ANT 2 802.11n(HT20)	16.39	43.55	0.0228	1.0	PASS

ANT 1: 4.4dBi

ANT 2: 4.2dBi

MIMO: 7.3dBi

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
5230 MHz MIMO 802.11n(HT40)	16.57	45.39	0.0377	1.0	PASS
5240MHz ANT 2 802.11a	16.64	46.13	0.0201	1.0	PASS

ANT 1: 3.0dBi

ANT 2: 3.4dBi

MIMO: 6.21dBi

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 MIMO 802.11ac (HT40)	17.10	51.29	0.0408	1.0	PASS
5290MHz ANT 2 802.11ac (HT80)	16.85	48.42	0.0179	1.0	PASS

ANT 1: 3.3dBi

ANT 2: 2.7dBi

MIMO: 6.02dBi

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
5510MHz MIMO 802.11n (HT40)	16.99	50.00	0.0448	1.0	PASS
5500MHz ANT 2 802.11ac(HT20)	17.28	53.46	0.0207	1.0	PASS

ANT 1: 4.1dBi

ANT 2: 2.9dBi

MIMO: 6.53dBi

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
5755MHz MIMO 802.11ac(HT40)	17.13	51.64	0.0401	1.0	PASS
5775MHz ANT 2 802.11ac(HT80)	16.91	49.09	0.0190	1.0	PASS

ANT 1: 2.9dBi

ANT 2: 2.9dBi

MIMO: 5.91dBi

BT and WIFI Simultaneous Transmission:

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

$$\begin{aligned} \text{BT EDR} + 2.4\text{G WIFI MIMO} + 5.6\text{G WIFI MIMO} &= (0.0028/1) + (0.0384/1) + (0.0448/1) \\ &= 0.0028 + 0.0384 + 0.0448 = 0.1336 < 1 \end{aligned}$$

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