

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, * = Plane-wave equivalent power density.

Friis transmission formula: $P_d = (P_{out} * G) / (4 * \pi * r^2)$

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

For BLE

Mode	Output power to antenna (dBm)	Tune-up Power(dBm)	Max Tune-up Power(dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
GFSK	1.17	1(±1)	2	1.58	0.0006	1.0	PASS

For 2.4GHz

Mode	Output power to antenna (dBm)	Tune-up Power(dBm)	Max Tune-up Power(dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
802.11n20	12.63	12(±1)	13	19.95	0.0073	1.0	PASS

For 5.2GHz

Mode	Output power to antenna (dBm)	Tune-up Power(dBm)	Max Tune-up Power(dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
802.11n40	12.74	12(±1)	13	19.95	0.0074	1.0	PASS

For 5.8GHz

Mode	Output power to antenna (dBm)	Tune-up Power(dBm)	Max Tune-up Power(dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
802.11a	13.44	13(±1)	14	25.12	0.0093	1.0	PASS

For 13.56MHz

Mode	Output power to antenna (dBm)	Tune-up Power(dBm)	Max Tune-up Power(dBm)	Output power to antenna (mW)	Power Density at R=20cm (mW/cm ²)	Limit (mW/cm ²)	Result
13.56MHz	-33.57	-33(±1)	-32	0.000631	0.00000013	0.9789333	PASS

Field Strength: 61.63dBuV/m @3m

61.63dBuV/m -95.2=-33.57 dBm

Remark: antenna gain= BLE: 2.62dBi, 2.4GHz: 2.62dBi, 5.2GHz: 2.69dBi, 5.8GHz: 2.69dBi, 13.56MHz: 0dBi

The device cannot transmit with 2.4G WI-FI and 5.2, 5.8G WI-FI simultaneously, can transmit with



2.4G WI-FI, 5.2, 5.8G WI-FI and Bluetooth BLE and NFC_13.56MHz simultaneously.

Calculations for simultaneously transmit

Mode	Ratios	Result	Limit	Result
BLE	0.0006	0.00790013	1	PASS
2.4G Wi-Fi	0.0073			
13.56	0.00000013			

Mode	Ratios	Result	Limit	Result
BLE	0.0006	0.00800013	1	PASS
5.2G Wi-Fi	0.0074			
13.56	0.00000013			

Mode	Ratios	Result	Limit	Result
BLE	0.0006	0.00990013	1	PASS
5.8G Wi-Fi	0.0093			
13.56	0.00000013			

Ratios = Power Density / Power density Limit