



**APPENDIX L**  
**: RF EXPOSURE EVALUATION**



## 1. RF Exposure Evaluation

### Radiofrequency radiation exposure limits.

Specific absorption rate (SAR) shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in § 1.1307(b) of this part within the frequency range of 100 kHz to 6 GHz (inclusive).

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*(900/f <sup>2</sup> )	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(ii) 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 <sup>2</sup> )	<30
30-300	27.5	0.073	0.2	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

f = frequency in MHz. \* = Plane-wave equivalent power density.

### Friis Formula

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

where

$P_d$  = power density in mW/cm<sup>2</sup>

$P_{out}$  = 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

If we know the maximum Gain of the antenna and the total power input to the antenna, through the calculation, we will know the MPE value at distance r.



## **Bluetooth Low Energy**

**Antenna Gain: 1.24 dBi**

Frequency (MHz)	Average Conducted Output Power (dBm)	Average Conducted Output Power (mW)	Power Density (mW/cm <sup>2</sup> )	Limit of Power Density (mW/cm <sup>2</sup> )
2 402	3.00	4.77	0.001 177	1.0
2 440	3.00	4.77	0.001 177	1.0
2 480	3.00	4.77	0.001 177	1.0

## **Wi-Fi**

**Antenna Gain: 1.23 dBi**

IEEE 802.11b

Frequency (MHz)	Average Conducted Output Power (dBm)	Average Conducted Output Power (mW)	Power Density (mW/cm <sup>2</sup> )	Limit of Power Density (mW/cm <sup>2</sup> )
2 412	15.00	11.76	0.008 750	1.0
2 442	14.30	11.55	0.008 594	1.0
2 462	14.70	11.67	0.008 683	1.0

IEEE 802.11g

Frequency (MHz)	Average Conducted Output Power (dBm)	Average Conducted Output Power (mW)	Power Density (mW/cm <sup>2</sup> )	Limit of Power Density (mW/cm <sup>2</sup> )
2 412	9.80	9.91	0.007 374	1.0
2 442	14.10	11.49	0.008 549	1.0
2 462	9.40	9.73	0.007 240	1.0

IEEE 802.11n

Frequency (MHz)	Average Conducted Output Power (dBm)	Average Conducted Output Power (mW)	Power Density (mW/cm <sup>2</sup> )	Limit of Power Density (mW/cm <sup>2</sup> )
2 412	9.80	9.91	0.007 374	1.0
2 442	13.10	11.17	0.008 311	1.0
2 462	9.30	9.68	0.007 202	1.0