

## MAXIMUM PERMISSIBLE EXPOSURE

### Standard Applicable

Section 15.247 (b)(5) : Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Section 1.1310: The criteria listed in the following table shall be used to evaluate the environment impact of human exposure to radio frequency radiation as specified in 1.1307(b) LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

| Frequency Range<br>(MHz)                                 | Electric Field<br>Strength (V/m) | Magnetic Field<br>Strength (A/m) | Power Density<br>(nW/cm <sup>2</sup> ) | Average Time<br>(Minutes) |
|----------------------------------------------------------|----------------------------------|----------------------------------|----------------------------------------|---------------------------|
| (A) Limits for Occupational/control Exposures            |                                  |                                  |                                        |                           |
| 300-1500                                                 | --                               | --                               | F/300                                  | 6                         |
| 1500-100,000                                             | --                               | --                               | 5                                      | 6                         |
| (B) Limits for General Population/Uncontrolled Exposures |                                  |                                  |                                        |                           |
| 300-1500                                                 | --                               | --                               | F/300                                  | 6                         |
| 1500-100,000                                             | --                               | --                               | 1                                      | 30                        |

F = Frequency in MHz

### Calculations

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

Where

**P<sub>d</sub>** = power density in mW/cm<sup>2</sup>

**P<sub>out</sub>** = output power to antenna in mW

**G** = gain of antenna in linear scale

**π** = 3.1416

**r** = distance between observation point and center of the radiator in cm

The limit of **P<sub>d</sub>** is 1 mW/cm<sup>2</sup>. 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 where the **P<sub>d</sub>** at 20 cm is meet the limit of MPE.

**Result (Worse case mode)**

| Radio Technology | Operation Frequency (MHz) | Distance (cm) | Maximum Peak Output Power (dBm) | Antenna Gain (dBi) | Power Density (mW/cm <sup>2</sup> ) | Limit (mW/cm <sup>2</sup> ) |
|------------------|---------------------------|---------------|---------------------------------|--------------------|-------------------------------------|-----------------------------|
| WiFi             | 2462                      | 20            | 20.54                           | 1.18               | 0.0266                              | 1                           |
| Bluetooth        | 2480                      | 20            | 1.46                            | 4.67               | 0.0013                              | 1                           |

The **P<sub>d</sub>** at 20 cm distance calculated from the Friis transmission formula is much smaller than the limit requirement 1 mW/cm<sup>2</sup> or 10W/m<sup>2</sup>.

The **Installation Manual** instructs the user to install the device such that it has a separation of at least 20 cm from persons to comply with the FCC's requirements. This separation of 20 cm more than meets the FCC's and Industry Canada RF exposure requirements.

**Simultaneous Evaluation:**

Both of WLAN 2.4GHz and Bluetooth radio can transmit simultaneously.

The formula of calculated MPE is:

$$\text{CPD1/LPD1} + \text{CPD2/LPD2} + \dots \text{etc.} < 1$$

CPD=Calculated Power Density

LPD=Limit of Power Density

The MPE evaluation is  $0.0266/1 + 0.0013/1 = 0.0279 < 1$ , which confirms the device complies with the MPE limit.