

RF Exposure Report

RF Exposure Measurement

The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The gain of the antennas used in the product is extracted from the Antenna data sheets provided and also the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis Transmission formula is far field assumption, the calculated result of that is an over-prediction for near field power density. It is taken as worst case to specify the safety range.

RF Exposure Limit

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of the 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)
Limits for Occupational / controlled Exposures			
300 - 1500	--	--	F/300
1500 – 100000	--	--	5.0
Limits for General population / Uncontrolled Exposure			
300 - 1500	--	--	F/1500
1500 – 100000	--	--	1.0

F= Frequency in MHz

Friss Formula

Friss Transmission Formula: $P_d = (P_{out} * G) / (4 * \pi * r^2)$

Where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

R = Distance between observation point and the center of radiator in cm

If we know the maximum gain of the antenna and the total output power to the antenna, through calculation, we will know MPE value at distance 20cm.

EUT Operation condition

EUT was enabled to transmit and receive at lowest, middle and highest channels.

Classification

The antenna of this product, under normal use condition, is at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance from the antenna should be included in the User manual. So, this device is classified as Mobile device.

Test Results

2.4 GHz Band

Gain (G1) = 4.03 dBi = 2.51 (linear scale)

ZigBee 1	ZigBee 2	ZigBee 3	Wi-Fi (6Mbps) 2.4GHz	BLE	Sum	Sum
mW	mW	mW	mW	mW	mW	dBm
1.690	78.162	78.162	11.040	0.907	169.96	22.30
1.555	69.984	69.984	11.967	0.833	154.323	21.88
1.538	12.302	12.302	11.376	0.760	38.278	15.82

Maximum possible power value = 1.690 + 78.162 + 78.162 + 11.967 + 0.907 = **170.88 mW**

Manufacturer has declared the tune-up value as ±1 dB is considered in MPE calculation.

Maximum possible power value including tune up tolerance value = 170.88 + 1.25 = **172.13 mW** = Pout1

5 GHz Band
Gain (G2) = 4.32 dBi = 2.7 (linear scale)

 Maximum power value = **37.239 mW**

 Maximum power value including tune up tolerance value = $37.239 + 1.25 = \mathbf{38.48\ mW} = \text{Pout2}$

Frequency band	Worst Case Output Power to Antenna (mW)	Output Power including tune-up (mW)	Power Density (mW/cm ²)	Limit (mW/cm ²)
2.4 GHz	170.88	Pout1 = 172.13	Pd1 = 0.0859	1.000
5 GHz	37.239	Pout2 = 38.480	Pd2 = 0.0206	1.000

Friiss Transmission Formula:

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

$$Pd = [(Pout1 * G1) + (Pout2 * G2)] / [4 * \pi * r^2]$$

$$\mathbf{Pd = Pd1 + Pd2 = 0.1066\ mW / cm^2}$$