

SAR evaluation
FCC ID: 2BWWI-TJ1097S1

Test Standards

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.

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
3.0-30	1842/f	4.89/f	*(900/f ²)
1500 - 100000	--	--	5.0
Limits for General population / Uncontrolled Exposure			
300 - 1500	--	--	f/1500
1.34-30	824/f	2.19/f	*(180f ²)
1500 - 100000	--	--	1.0

f= Frequency in MHz

MPE Calculation Method

$$E \text{ (V/m)} = (30 \cdot P \cdot G)^{0.5} / d$$

$$\text{Power Density: } P_d \text{ (W/m}^2\text{)} = E^2 / 377$$

E = Electric Field (V/m)

P = Peak RF output Power (W)

G = EUT Antenna numeric gain (numeric)

d = Separation distance between radiator and human body (m)

The formula can be changed to

$$P_d = (30 \cdot P \cdot G) / (377 \cdot d^2)$$

From the peak EUT RF output power, the minimum mobile separation distance, $d=0.2\text{m}$, as well as the gain of the used antenna, the RF power density can be obtained.

Calculated WIFI Result and Limit (WORSE CASE IS AS BELOW)

Antenna Gain (Numeric)	Peak Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
4.91 (3.097)	50.35 (17.02dBm)	0.031021	1	Compiles

Note:

Antenna Gain: 4.91dBi (2.4G Band)

$$\text{ERP} = 17.02 + 4.91 - 2.15 = 19.79\text{dBm} (95.28\text{mW})$$

WIFI 2.4G band and 5G band cannot transmit Simultaneously

Calculated Bluetooth Result and Limit (WORSE CASE IS AS BELOW)

Antenna Gain (Numeric)	Peak Output Power (mW)	Power Density (S) (mW/cm ²)	Limit of Power Density (S) (mW/cm ²)	Test Result
3.39 (2.183)	0.998 (-0.01dBm)	0.000433	1	Compiles

Note:

Antenna Gain: 3.39dBi (2.4G Band)

ERP=3.39-0.01-2.15=1.23dBm(1.327mW)

BT BDR/EDR and BLE cannot transmit Simultaneously

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} = 50.35/3060 + 0.998/3060 = 0.016780$$

$$\sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} = (95.28 + 1.327) / 3060 = 0.031571$$

$$\sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} = (0.031021 + 0.000433) / 1 = 0.031454$$

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

$$0.016780 + 0.031571 + 0.031454 = 0.079805 < 1$$