Maximum Permissible Exposure

1.1 Maximum Permissible Exposure

1.1.1 Test Methodology

In this document, we try to prove the safety of radiation harmfulness to the human body for the product under test. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 and Industry Canada RSS -102 were followed. The Gain of the antenna used in this calculation is declared by the manufacturer, and 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 a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

1.1.2 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental 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$_2$)	Average Time (minutes)
(A)Limits For Occupational / Control Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f^2)	6
30–300	…	…	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	0.037	0.2	30
300 - 1500	…	…	f/1500	30
1500 - 100,000	…	…	1.0	30

F = Frequency in MHz

* = Plane-wave equivalent power density

Limits per RSS-102 issue 5 March 2015

Table 4: RF Field Strength Limits for Devices Used by the General Public
(Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$
Note: f is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

1.1.3 EUT Operating Condition

The software provided by Manufacturer enabled the EUT to transmit data at lowest, middle and highest channel individually.

1.1.4 Classification

The antenna of the 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 with the antenna should be included in user's manual. So, this device is classified as a **Mobile Device**.

1.1.5 Test Results

1.1.5.1 Antenna Gain

The highest directional antenna gain for 2.4 GHz band was +11.5dBi or 14.12(numeric).

The highest directional antenna gain for 5 GHz band was +12.0dBi or 15.84(numeric).

1.1.5.2   Output Power into Antenna & RF Exposure value at distance 20cm:

MPE calculation for simultaneous Operation of BLE with 2.4 GHz band or 5GHz band

a)   Simultaneous operation of 2.4GHz, 5 GHz band and BLE

Highest Power 2.4 GHz band   24.39dBm

(From TUV Test Report 31560844.001)

Highest power in 5 GHz band   24.76dBm

(From TUV test report 31560848.001)

BLE mode power   3.81dBm

Simultaneous operation power   0.576 watts

(27.60dBm)

Calculations for this report are based on highest power measurement.

Limit for MPE (from FCC part 1.1310 table1) is 1.0 mW/cm^2

Limit for MPE (From IC RSS-102 Table 4) is 10W/m^2 is same as 1.0 mW/ cm^2

The highest measured total power is +27.60 dBm or 576mW

Using the Friss transmission formula, the EIRP is Pout*G, and R is 20cm.

Pd = (576*15.84) / (1600π) = 1.81 mW/cm^2, which is above the limit.

b)   Calculation of distance where Pd reaches 1mW/ cm^2

Using formula   R = $\sqrt{\text{P* G/4π Pd}}$

R = 26.19cm   **26.19cms is the safe distance from the unit**

1.1.6   Sample Calculation

The Friss transmission formula: $Pd = (Pout*G) / (4*\pi*R^2)$

Where;

Pd = power density in mW/ cm^2

Pout = output power to antenna in mW

G = gain of antenna in linear scale

$\pi \approx 3.1416$

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

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).