

1 RF Exposure Report

1.1 RF Exposure Measurement

The limit for Maximum Permissible Exposure (MPE) specified in FCC Part 1 Subpart I 1.1310 and RSS 102 Issue 5 Section 2.5 is followed. The gain of the antennas used in the product are 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.

1.2 RF Exposure Limit

According to FCC Part 1 Subpart I 1.1310 & RSS 102 Issue 5 Section 2.5 : 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)

Table 1: Limits for Maximum Permissible Exposure (MPE) as per FCC

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

Table 2: Limits for Maximum Permissible Exposure (MPE) as per ISED Canada

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (mW/cm ²)
Limits for Occupational / controlled Exposures			
100-6000	15.60 $f^{0.25}$	0.04138 $f^{0.25}$	-
Limits for General public / Uncontrolled Exposure			
300-6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	-

F or f = Frequency in MHz

1.2.1 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.

1.2.2 EUT Operation condition

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

1.2.3 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.

Note: ± 2 dB tune up value is considered for MPE calculation.

Protocol: WLAN (2.4GHz and 5GHz), Bluetooth, BLE, LTE, WCDMA

Test Results

Manufacturer has declared the tune-up value as ±2 dBm is considered in MPE calculation.

Antenna: Printed F Antenna

Antenna gain (G) : 3dBi for 2.4 GHz; Gain in Linear scale: 1.99;
6.5dBi for 5 GHz; Gain in Linear scale: 4.46;

Protocol	Data Rate	Antenna Gain in Linear Scale	Channel Frequency (MHz)	Pout (dBm)	Pout including Tuneup (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)	ISED Limit (mW/cm ²)
BLE	1Mbps	1.99	2402	5.50	5.62341	0.00223	1	0.53
BT	3Mbps	1.99	2402	9.47	14.02814	0.00557	1	0.53
WLAN (2.4GHz)	54Mbps	1.99	2412	14.66	46.34469	0.01839	1	0.53
WLAN (5GHz)	6Mbps	4.46	5320	13.43	34.91403	0.03102	1	0.90

Cellular: Antenna Gain: 2.14 dBi;

Gain in Linear scale: 1.63;

Mode	Channel Frequency (MHz)	Maximum average output power (dBm)	Maximum output power including Tune-up value (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)	ISED Limit (mW/cm ²)
WCDMA Band 2	1907.6	22.13	258.82129	0.08427	1.00000	0.45710
WCDMA Band 5	826.4	23.17	328.85163	0.10707	0.55093	0.25807
LTE band 2	1857.5	22.40	275.42287	0.08968	1.00000	0.45257
LTE band 4	1717.5	22.43	277.33201	0.09030	1.00000	0.42800
LTE band 5	848.3	22.96	313.32857	0.10202	0.56553	0.26272
LTE band 12	707.5	23.25	334.96544	0.10906	0.47166	0.23208
LTE band 13	779.5	23.75	375.83740	0.12236	0.51966	0.24797

Note: The product supports simultaneous transmission. Conducted output power measured with respect to each protocol.

Simultaneous mode Evaluation

1) FCC: Worst-case mode: LTE band 13 +5GHz WLAN
Sum (ratios)= $0.031/1+0.12236/0.51966=0.266<1.0$, Compliant

1) IC: Worst-case mode: LTE band 13 +2.4GHz WLAN
Sum (ratios)= $0.01839/0.53+0.12236/0.24797=0.528<1.0$, Compliant