1 RF Exposure Report

This report is part of main report no. ULR-TC568820300000020F

1.1 RF Exposure Measurement

The limit for Maximum Permissible Exposure (MPE) specified in FCC Part 1 Subpart I 1.1310 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.

Exemption limits for Routine Evaluation is applied according to RSS- 102 issue 5, section 2.5.2.

1.2 RF Exposure Limit

1) According to FCC Part 1 Subpart I 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)

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

F= Frequency in MHz

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 (W/m^2)
Limits for Occupational / controlled Exposures			
100-6000	$15.60f^{0.25}$	$0.04138f^{0.25}$	$0.6455f^{0.5}$
Limits for General population / Uncontrolled Exposure			
300-6000	$3.142\ f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$

F or f = Frequency in MHz

Friss Formula

Friss Transmission Formula: Pd = (Pout * G) / (4*pi*r²)

Where
Pd = power density in mW/cm²
Pout = output power to antenna in mW
G = gain of antenna in linear scale
Pi = 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.

2) According to RSS 102 Issue 5 Section 2.5.2 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 Section 2.5.2

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1.31 x 10-2 f^0.6834 W (adjusted for tune-up tolerance), where f is in MHz;

Table 2: Exemption Limits for Routine Evaluation – RSS 102 Issue 5 Section 2.5.2

Protocol: IEEE 802.15.4

Antenna Gain(dBi)	**Antenna Gain in linear scale**	**Channel (MHz)**	**Reletive power level setting configured in the software**	**Maximum Pout**	**Tune up Value in**	**Max e.i.r.p**	**Exclusion threshold as per RSS-102**
				(dBm)	**(dB)**	**(W)**	**(W)**
4	2.511886432	2440	18	16.41	1	0.1383	2.705287981
8	6.309573445	2440	18	16.41	1	0.3475	

Protocol: Radar operation

Antenna Gain (dBi)	**Channel Frequency**	**Maximum Pout including Tune up**	**Max**	**Max**	**Exclusion threshold as per RSS-102**
			e.i.r.p	**e.i.r.p**	
	(GHz)	**(dBm)**	**(dBm)**	**(W)**	**(W)**
26	9.538 to 10.56	-22.026	3.974	0.0024	5

Note:
1. Maximum EIRP value for Radar operation is taken from Radar test report with FCC ID :LOM990SRFL
2. Hence RF exposure evaluation is not required for ZigBee 2.4 GHz & 9.53 to 10.56GHz Radar operation.

1.2.1 EUT Operation condition

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

1.2.2 Assessment Condition

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: ± 1 dB tune up value is considered for MPE calculation, this value was declared by manufacturer

Table 3: Test Results for Maximum Permissible Exposure for standalone mode

Protocol: IEEE 802.15.4 Data Rate: 250 kbps

Antenna Gain	Antenna Gain in linear scale	Channel (MHz)	Reletive power level setting configured in the software	Maximum Pout	Tune up Value in	Maximum Power including tune up value	Power Density	FCC Limit	ISED Limit
(dBi)				(dBm)	(dB)	(mW)	(mW/cm²)	(mW/cm²)	(mW/cm²)
4	2.511886	2440	18	16.41	1	55.08077	0.027522	1	0.54085
8	6.309573	2440	18	16.41	1	55.08077	0.069131		

Protocol: 10GHz Radar operation Data Rate: NA

Antenna Gain	Antenna Gain in linear scale	Frequency (GHz)	Maximum Pout	Maximum Power	Power Density	FCC Limit	ISED Limit
(dBi)			(dBm)	(mW)	(mW/cm²)	(mW/cm²)	(mW/cm²)
26	398.1	9.538 to 10.56	-22.0206	0.00622	0.00049	1	1

Table 4: Test Results for Maximum Permissible Exposure for Simultaeous operating mode

RF Protocol	Calculated MPE	Final MPE	Limit
IEE 802.15.4 - 10GHz Radar operation	=(0.069131/1)+(0.00049/1)	0.069621	<1

Note :

1. For above table, to calculate MPE following formula is used

MPE RF 1 / Limit RF 1 + MPE RF2 / LIMIT RF 2 + ... +MPE RFn / Limit RFn < 1.

1.3 Conclusion

The product supports simultaneous transmission, Table 4 list possible combination; hence, the RF exposure analysis concluded that the RF exposure is compliant as per the limit specified in clause 1.2 of this report

******* END OF REPORT********