RF EXPOSURE

1. FCC Regulation

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissive Exposure: RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm^2]	Averaging Time [minute]
Limits for General Population / Uncontrolled Exposure				
0.3 ~ 1.34	614	1.63	*(100)	30
1.34 ~ 30	824/f	2.19/f	*(180/f2)	30
30 ~ 300	27.5	0.073	0.2	30
300 ~ 1 500	/	/	f/1 500	30
1 500 ~ 15 000	/	/	1	30

f=frequency in MHz, *= plane-wave equivalent power density

2. ISED Regulation

According to RSS-102 §4 Exposure Limits, For the purpose of this standard, Industry Canada has adopted the SAR and RF field strength limits established in Health Canada's RF exposure guideline, Safety Code 6.[18]

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

Frequency Range	Electric Field Strength [V/m rms]	Magnetic Field Strength [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 $f^{0.25}$	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 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000/$f^{1.2}$

Note: f is frequency in MHz.

*Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).

MPE (Maximum Permissive Exposure) Prediction

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2 \quad \left(\Rightarrow R = \sqrt{PG/4\pi S}\right)$$

S = power density [mW/cm^2]
P = Power input to antenna [mW]
G = Power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna [cm]

3. RF Exposure Compliance Issue

The information should be included in the user's manual:

This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter. A minimum separation distance of 20 cm must be maintained between the antenna and the person for this appliance to satisfy the RF exposure requirements.

MPE Calculations : Bluetooth LE

- Frequency Range : <u>2402</u> MHz ~ <u>2480</u> MHz

- Measured RF Maximum Output Power : <u>3.22</u> dBm

- Target Power & Tolerance <u>3.00</u> dBm & ± <u>1.00</u> dB

(Maximum : <u>4.00</u> dBm & Minimum : <u>2.00</u> dBm)

- Maximum Peak Antenna Gain : <u>2.50</u> dBi

- Maximum Output Power for the Calculation : <u>4.00</u> dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the The MPE Calculations for this exposure is shown below.

- EIRP	=	P + G				- NOTE
	=	<u>4.00</u>	dBm	+	<u>2.50</u> dBi	P : Max tuneup Power (dBm)
	=	<u>6.50</u>	dBm			G : Maximum Peak Antenna Gain (dBi)
	=	<u>4.47</u>	mW			

Power Density at the specific separation

- S	= EIRP / (4 X $R^2\pi$)	- NOTE
	= 4.47 / (4 X 20^2 X π)	S : Maximum Power Density (mW/cm^2)
	= **0.000 889** mW/cm^2 (Limit : 1.00)	EIRP : Equivalent Isotropic Radiated Power (mW)
	= **0.008 886** W/m^2 (Limit : 5.35)	R : Distance to the center of the radiation of the antenna (<u>20</u> cm)

MPE Calculations : 24 GHz Radar Sensor

- Frequency Range :   <u>24150</u>   MHz

- Measured RF Maximum Output Power :   <u>10.00</u>   dBm

- Target Power & Tolerance   <u>9.50</u>   dBm   &   ±   <u>1.00</u>   dB

                                        (Maximum :   <u>10.50</u>   dBm   &   Minimum :   <u>8.50</u>   dBm   )

- Maximum Peak Antenna Gain :   <u>9.23</u>   dBi

- Maximum Output Power for the Calculation :   <u>10.50</u>   dBm

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the The MPE Calculations for this exposure is shown below.

- EIRP   =   P + G
 	
       =   <u>10.50</u>   dBm   +   <u>9.23</u>   dBi
 	
       =   <u>19.73</u>   dBm
 	
       =   <u>93.97</u>   mW
	- NOTE
	
	 P : Max tuneup Power (dBm)
	
	 G : Maximum Peak Antenna Gain (dBi)

Power Density at the specific separation

- S   =   EIRP / ($4 \times R^2 \pi$)
 	
   =   93.97   /   (4 X 20^2 X π)
 	
   =   **<u>0.018 695</u>**   mW/cm² (Limit :   1.00   )
 	
   =   **<u>0.186 952</u>**   W/m² (Limit :   10.00   )
	- NOTE
	
	 S : Maximum Power Density (mW/cm²)
	
	 EIRP : Equivalent Isotropic Radiated Power (mW)
	
	 R : Distance to the center of the radiation of the
	      antenna (<u>20</u> cm)

MPE Calculations : Bluetooth LE + 24 GHz Radar Sensor

The EUT will only be used with a separation of 20 centimeters or greater between the antenna and the body of the
The MPE Calculations for this exposure is shown below.

simultaneous MPE for Bluetooth LE and 24 GHz Radar Sensor

Bluetooth LE + 24 GHz Radar Sensor

- Total (%) =	- NOTE
[Bluetooth LE Result(mW/cm2) / Limit(mW/cm2)] +	Bluetooth LE + 24 GHz Radar Sensor
[24 GHz Rada Sensor Result(mW/cm2) / Limit(mW/cm2)] * 100	Bluetooth LE = **0.000 889** mW/cm2
	24 GHz Radar Sensor = **0.018 695** mW/cm2
= [**0.000 889** / 1] +	
[**0.018 695** / 1] * 100	
= **1.958** %	Distance to the center of the radiation of the antenna (**20** cm)
	Limit : $\leq$ 100 %

- Total (%) =	- NOTE
[Bluetooth LE Result(W/m2) / Limit(W/m2)] +	Bluetooth LE + 24 GHz Radar Sensor
[24 GHz Rada Sensor Result(W/m2) / Limit(W/m2)] * 100	Bluetooth LE = **0.008 886** W/m2
	24 GHz Radar Sensor = **0.186 952** W/m2
= [**0.008 886** / 5.35] +	
[**0.186 952** / 10.00] * 100	
= **3.583** %	Distance to the center of the radiation of the antenna (**20** cm)
	Limit : $\leq$ 100 %