

RF EXPOSURE

FCC ID : 2BHL8-IRON-MD-RD
IC : 32779-IRONMDRD

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/f ²)	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 §5.3.2 The electric and magnetic field strength reference levels, power density reference levels, and associated reference period for devices employed by the general public (uncontrolled environment) and controlled-use devices (controlled environment) are specified in table 7 and table 8. Note that the power density limits specified in these tables apply to whole body exposure conditions.

Table 7: RF field strength and power density 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]
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 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616000/f ^{1.2}

Note: f is frequency in MHz.



MPE (Maximum Permissive Exposure) Prediction

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

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

S = power density [mW/cm²]

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 : FSK

- Frequency Range : 433.125 MHz ~ 434.375 MHz
- Measured RF Maximum Output Power : 3.67 dBm
- Target Power & Tolerance 3.00 dBm & \pm 1.00 dB

(Maximum : 4.00 dBm & Minimum : 2.00 dBm)
- Maximum Peak Antenna Gain : 0.87 dBi
- Maximum Output Power for the Calculation : 4.00 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.

$ \begin{aligned} - \text{EIRP} &= P + G \\ &= \underline{4.00} \text{ dBm} + \underline{0.87} \text{ dBi} \\ &= \underline{4.87} \text{ dBm} \\ &= \underline{3.07} \text{ mW} \end{aligned} $	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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Power Density at the specific separation

$ \begin{aligned} - S &= \text{EIRP} / (4 \times R^2 \pi) \\ &= 3.07 / (4 \times 20^2 \times \pi) \\ &= \underline{0.000\,611} \text{ mW/cm}^2 \text{ (Limit : 0.29) } \\ &= \underline{0.006\,106} \text{ W/m}^2 \text{ (Limit : 1.66) } \end{aligned} $	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm²)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna (<u>20</u> cm)</p>
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MPE Calculations : Bluetooth

- Frequency Range : 2402 MHz ~ 2480 MHz
- Measured RF Maximum Output Power : 13.07 dBm
- Target Power & Tolerance 13.00 dBm & \pm 1.00 dB
(Maximum : 14.00 dBm & Minimum : 12.00 dBm)
- Maximum Peak Antenna Gain : 0.00 dBi
- Maximum Output Power for the Calculation : 14.00 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.

$ \begin{aligned} - \text{EIRP} &= P + G \\ &= \underline{14.00} \text{ dBm} + \underline{0.00} \text{ dBi} \\ &= \underline{14.00} \text{ dBm} \\ &= \underline{25.12} \text{ mW} \end{aligned} $	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p>
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Power Density at the specific separation

$ \begin{aligned} - S &= \text{EIRP} / (4 \times R^2 \pi) \\ &= 25.12 / (4 \times 20^2 \times \pi) \\ &= \underline{0.004\ 997} \text{ mW/cm}^2 \text{ (Limit : 1.00) } \\ &= \underline{0.049\ 972} \text{ W/m}^2 \text{ (Limit : 5.35) } \end{aligned} $	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm²)</p> <p>EIRP : Equivalent Isotropic Radiated Power (mW)</p> <p>R : Distance to the center of the radiation of the antenna (<u>20</u> cm)</p>
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MPE Calculations : FSK + Bluetooth

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

<p>- Total (%) =</p> $[\text{Bluetooth LE Result(mW/cm}^2) / \text{Limit(mW/cm}^2)] +$ $[\text{24 GHz Radar Sensor Result(mW/cm}^2) / \text{Limit(mW/cm}^2)] * 100$ $= [\frac{\underline{0.000\ 611}}{0.29}] +$ $[\frac{\underline{0.004\ 997}}{1}] * 100$ $= \underline{0.561} \%$	<p>- NOTE</p> <p>FSK + Bluetooth</p> <p>FSK = <u>0.000 611</u> mW/cm²</p> <p>Bluetooth = <u>0.004 997</u> mW/cm²</p> <p>Distance to the center of the radiation of the antenna (<u>20</u> cm)</p> <p>Limit : $\leq 100 \%$</p>
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<p>- Total (%) =</p> $[\text{Bluetooth LE Result(W/m}^2) / \text{Limit(W/m}^2)] +$ $[\text{24 GHz Radar Sensor Result(W/m}^2) / \text{Limit(W/m}^2)] * 100$ $= [\frac{\underline{0.006\ 106}}{1.66}] +$ $[\frac{\underline{0.049\ 972}}{5.35}] * 100$ $= \underline{3.125} \%$	<p>- NOTE</p> <p>FSK + Bluetooth</p> <p>FSK = <u>0.006 106</u> W/m²</p> <p>Bluetooth = <u>0.049 972</u> W/m²</p> <p>Distance to the center of the radiation of the antenna (<u>20</u> cm)</p> <p>Limit : $\leq 100 \%$</p>
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