

## RF Exposure Evaluation

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:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than  $4.49/f^{0.5}$  W (adjusted for tune-up tolerance), where  $f$  is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- 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  $1.31 \times 10^{-2} f^{0.6834}$  W (adjusted for tune-up tolerance), where  $f$  is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

# RF EXPOSURE

## 1. 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 Permissible Exposure: RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm <sup>2</sup> ]	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 <sup>2</sup> )	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

## MPE (Maximum Permissible 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/cm<sup>2</sup>]

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]

## 2. 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 : 2402 MHz ~ 2480 MHz

- Measured RF Maximum Output Power (Avg.) : -7.58 dBm

- Target Power & Tolerance -8.00 dBm & ± 1.00 dB

( Maximum : -7.00 dBm & Minimum : -9.00 dBm )

- Maximum Peak Antenna Gain : 0.06 dBi

- **Maximum Output Power for the Calculation** : **-7.00** 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.

<p>- EIRP = P + G</p> <p>= <u>-7.00</u> dBm + <u>0.06</u> dBi</p> <p>= <u>-6.94</u> dBm</p> <p>= <u>0.20</u> mW</p>	<p>- NOTE</p> <p>P : Max tuneup Power (dBm)</p> <p>G : Maximum Peak Antenna Gain (dBi)</p> <p><math>EIRP \leq 1.31 \times 10^{-2} f^{0.6834} W</math></p> <p>= EIRP ≤ 2.736 W</p>
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### Power Density at the specific separation

<p>- S = EIRP / (4 X R<sup>2</sup>π)</p> <p>= 0.20 / (4 X 20<sup>2</sup> X π)</p> <p>= <u><b>0.000 04</b></u> mW/cm<sup>2</sup></p>	<p>- NOTE</p> <p>S : Maximum Power Density (mW/cm<sup>2</sup>)</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 LE+WLAN

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 for Bluetooth LE and WLAN

Bluetooth LE+WLAN

<p>-Total EIRP = Bluetooth LE Result(mW) + WLAN Result(mW)</p> <p>= <u>0.20</u> mW + <u>148.25</u> mW</p> <p>= <u>148.45</u> mW</p>	<p>- NOTE</p> <p>Bluetooth LE+WLAN</p> <p>Bluetooth LE = <u>0.20</u> mW</p> <p>WLAN = <u>148.25</u> mW</p> <p><math>EIRP \leq 1.31 \times 10^{-2} f^{0.6834} W</math></p> <p>= EIRP <math>\leq</math> 2.736 W</p> <p>*In the case of WLAN, EIRP value of the module report was used. IC ID : 21098-ESPWROOM32D</p>
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### simultaneous MPE for Bluetooth LE and WLAN

Bluetooth LE+WLAN

<p>- Total (%) =</p> <p>( [ Bluetooth LE Result(mW/cm2) / Limit(mW/cm2) ] + [ WLAN Result(mW/cm2) / Limit(mW/cm2) ] ) * 100</p> <p>= ( [ <u>0.000 040</u> / 1 ] + [ <u>0.029 493</u> / 1 ] ) * 100</p> <p>= <u>2.953</u> %</p>	<p>- NOTE</p> <p>Bluetooth LE+WLAN</p> <p>Bluetooth LE = <u>0.000 04</u> mW/cm2</p> <p>WLAN = <u>0.029 49</u> mW/cm2</p> <p>Distance to the center of the radiation of the antenna ( <u>20</u> cm )</p> <p>Limit : <math>\leq</math> 100 %</p> <p>*In the case of WLAN, Power Density value of the module report was used. FCC ID : 2AC7Z-ESPWROOM32D</p>
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