

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 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

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/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]

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 & $\pm$ 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.

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

- S = EIRP / (4 X R²π) = 0.20 / (4 X 20² X π) = <u>0.000 04</u> mW/cm²	- 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)
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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

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

Bluetooth LE+WLAN

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