

RF Exposure Calculations

From FCC 1.1310 table 1A, the maximum permissible RF exposure for an uncontrolled environment is $1\text{mW}/(\text{cm}^2)$. The electric field required to generate power density exposure (S) of $1\text{mW}/(\text{cm}^2)$ is calculated as follows:

$$S := \frac{E^2}{Z}$$

where S is Power Density (W/m^2), E is electric field (V/m) and Z is the impedance of free space (377Ω).

Thus the Electric Field allowable (E_a) to limit Power Density to $1\text{mW}/(\text{cm}^2)$, given that $1\text{mW}/(\text{cm}^2)$ is equivalent to $10\text{W}/\text{m}^2$, is given by:

$$E_a := \sqrt{S \cdot Z} \quad E_a := \sqrt{10 \cdot \left(\frac{\text{W}}{\text{m}^2} \right) \cdot 377 \cdot \Omega} \quad E_a = 61.4 \frac{\text{V}}{\text{m}}$$

Maximum conducted peak output power (P_{out}) from the OQ7OS2401 radio module without the amplifier is 16.1dBm. Given an antenna gain (G_{ant}) of 24dB, the maximum effective isotropic radiated power (EIRP) is 10.2W as shown below.

$$P_{\text{rad}} := 10^{\left(\frac{P_{\text{out}} + G_{\text{ant}}}{10} \right)} \cdot \text{mW} \quad P_{\text{rad}} = 10.2 \text{ W}$$

Since power density S (W/m^2) is related to effective radiated power P (watts) by the following equation,

$$S := \frac{P}{4 \cdot \pi \cdot D^2}$$

and using the relationship between S and E above, the following equation can be derived for the minimum safe separation distance to ensure exposure limits below $1\text{mW}/\text{cm}^2$.

$$D_{\text{min}} := \frac{\sqrt{P_{\text{rad}} \cdot \left(\frac{377 \cdot \Omega}{4 \cdot \pi} \right)}}{E_a} \quad D_{\text{min}} = 28.5 \text{ cm}$$

Repeating the calculations with the amplifier, the maximum output power of 19.5dBm and maximum antenna gain of 13dB result in a minimum safe separation distance of 11.9cm.