RF Exposure Calculations

From FCC 1.1310 table 1A, the maximum permissible RF exposure for an uncontrolled environment is $1mW/(cm^2)$. The electric field required to generate power density exposure (S) of $1mW/(cm^2)$ 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 $1mW/(cm^2)$, given that $1mW/(cm^2)$ is equivalent to $10W/m^2$, is given by:

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

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.

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

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 $1mW/cm^2$.

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

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.