

Section 11. Maximum Permissible Exposure

MPE estimate is given per 2.1091 of FCC Rules:

Given

$$E_{\text{max}} = \sqrt{(30 * P * G) / d}$$

and

$$S = E^2 / 3770$$

where

E = Field Strength in Volts/meter

P = Power in Watts

G = Numeric antenna gain

d = Distance in meters

S = Power Density in milliwatts/square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$$d_{\text{max}} = \sqrt{((30 * P * G) / (3770 * S))}$$

Changing to units of Power to mW and Distance to cm, using:

$$P (\text{mW}) = P (\text{W}) / 1000 \text{ and}$$

$$d (\text{cm}) = 100 * d (\text{m})$$

yields

$$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$$

$$d = 0.282 * \sqrt{(P * G / S)}$$

where

d = distance in cm

P = Power in mW

G = Numeric antenna gain

S = Power Density in mW/cm²

Substituting the logarithmic form of power and gain using:

$$P (\text{mW}) = 10^{(P (\text{dBm}) / 10)} \text{ and}$$

$$G (\text{numeric}) = 10^{(G (\text{dBi}) / 10)}$$

yields

$$d = 0.282 * 10^{((P + G) / 20)} / \sqrt{S}$$

Equation (1)

$$S = 0.0796 * 10^{((P + G) / 10)} / d^2$$

Equation (2)

where

d = MPE distance in cm

P = Power in dBm

G = Antenna Gain in dBi

S = Power Density Limit in mW/cm²

Equation (1) and the measured peak power is used to calculate the MPE distance.

Equation (2) and the measured peak power is used to calculate the Power density.

Limit:

For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

The intended and expected application for this product is for installation in a commercial base station (restricted access).

For separation $\geq 20\text{cm}$, using the proper limit in FCC Part 1, Section 1.1310:

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	$^{*}(100)$	≥ 6
3.0-30	$1842/f$	$4.99/f$	$^{*}(900/f^2)$	≥ 6
30-300	61.4	0.163	1.0	≥ 6
300-1,500			$f/300$	≥ 6
1,500-100,000			5	≥ 6
(ii) 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			$f/1500$	< 30
1,500-100,000			1.0	< 30

*f = frequency in MHz; * = Plane wave oblique incident power density.*

Results:

In this case, applicable limit is for Occupational/Controlled Exposure per Table 1 above:

30-300MHz band, $S=1.0\text{mW}/\text{cm}^2$

300-1500MHz band, , most restricted limit is $f_{\text{low}}/300=406.1/300=1.353\text{mW}/\text{cm}^2$

No Antenna is included in this application. As reference, typical max. gain of antenna is $G=3\text{dBi}$. With $P=+23\text{dBm}$ (3dB over rated power), using formula (2) with $d=20\text{cm}$, yielding,

Frequency Band (MHz)	Power Density Limit (mW/cm^2)	Max. Output Power+ Antenna] Gain (dBm)	Calculated Power Density (mW/cm^2)	Meet the Limit
30-300	1.0	23	0.004	Yes
406.1-775	1.353	23	0.004	yes