14 RF EXPOSURE CALCULATIONS FOR HIGH GAIN ANTENNAS

From FCC 1.1310 table 1A, the maximum permissible RF exposure for an uncontrolled environment is 1mW/cm^2. The Electric field generated for a 1mW/cm^2 exposure (S) is calculated as follows:

$S = E^2/Z$

where:
S = Power density
E = Electric field
Z = Impedance.

$E = \sqrt{S \times Z}$

1mW/cm^2= 10 W/m^2

The impedance of free space is 337 ohms, where E and H fields are perpendicular.

Thus:

$E = \sqrt{10 \times 377} = 61.4$ V/m which is equivalent to 1mW/cm^2

Using the relationship between Electric field E, Power in watts P, and distance in meters d, the corresponding Antenna numeric gain G and the transmitter output power and solving for d,

$$d = \sqrt{\frac{P_{eak} \times 30 \times G}{E}}$$

Example using the Stub Omni-directional antenna

1. The Numeric gain G of antenna with a gain specified in dB is determined by:

$G = \text{Log}^{-1}(\text{dB gain}/10)$

$G = \text{Log}^{-1}\ 0.215 = 1.64$

Notice in Installation Manual:

While installing and operating this transmitter and antenna combination the radio frequency exposure limit of 1mW/cm^2 may be exceeded at distances close to the antennas installed. Therefore, the user must maintain a minimum distance of 5 cm from the antenna at all time.
The table below identifies the distances where the 1mW/cm^2 exposure limits may be exceeded during continuous transmission using the external antenna

TABLE 14-1: ANETNNA GAIN

Antenna Type	Gain (dBi)	Gain Numeric	Power Output (mW)	Calculated RF Exposure Separation Distance (cm)	Minimum RF Exposure Separation Distance (cm)
Internal	5.3	3.3	28	2.7	20