

APPENDIX A: RF EXPOSURE CALCULATIONS FOR HIGH GAIN ANTENNAS

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 generated for a $1\text{mW}/\text{cm}^2$ exposure (S) is calculated as follows:

$$S = E^2/Z$$

where:

S = Power density

E = Electric field

Z = Impedance.

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

$$1\text{mW}/\text{cm}^2 = 10 \text{ W}/\text{m}^2$$

The impedance of free space is 377 ohms, where E and H fields are perpendicular.
Thus:

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

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,

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

Example using the Stub Omni-directional antenna

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

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

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

The following table represents the RF exposure separation distance. The values shown in Table 11-1 were calculated from the defacto EIRP (= antenna gain + power output - cable loss). The table represents the typical RF distance and the worst-case configuration based on the antenna specifications provided by the manufacturer.

TABLE 11-1: RF EXPOSURE SEPARATION DISTANCE FROM DEFACTIO EIRP

ANTENNA PART # & ANTENNA TYPE	MINIMUM CABLE LENGTH (DB LOSS) BETWEEN ANTENNA & POWER AMPLIFIER FOR LMR 600/LMR 400	EIRP (dBm)	ANTENNA GAIN (dBi)	CALCULATED RF EXPOSURE SEPARATION DISTANCE (cm)	MINIMUM RF EXPOSURE SEPARATION DISTANCE (cm)
ANT-O2412 Omni directional	150'/98' (6.6 dB)	35.0	12	15.9	20 cm
ANT-O2409 Omni directional	113'/74' (5.0 dB)	34.0	9	14.1	20 cm
ANT-O2408 Omni directional	100'/65' (4.4 dB)	34.0	8	14.1	20 cm
ANT-P2419 Patch	305'/197' (13.4 dB)	35.8	19	17.4	200cm
ANT-P2418 Patch	277'/179' (12.2 dB)	35.8	18	17.4	200cm
ANT-P2415 Patch	216'/140' (9.5 dB)	35.7	15	17.2	200cm
ANT-P2413 Patch	159'/103' (7.0 dB)	35.7	13	17.2	200cm
ANT-P2412 Patch	152'/99' (6.7 dB)	35.7	12	17.2	200cm
ANT-G2418 Grid-	150'/98' (6.6 dB)	41.0	18	31.7	200cm
ANT-G2424 Grid-	250'/162' (11.0 dB)	43.0	24	39.8	200cm
ANT-D2421 Dish	150'/98' (6.6 dB)	44.0	20.5	44.7	200cm