

FCC-ID	AK8PCG31111L
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PREDICTION OF MPE AT A GIVEN DISTANCE

Calculations can be made to predict RF field strength and power density levels around typical RF sources using the general equations (3) and (4) on page 19 of the following FCC document:

“OET Bulletin 65, Edition 97-01 - Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”.

These equations are generally accurate in the far field of an antenna but will over predict power density in the near field, where they could be used for making a “worst case” prediction.

$$S = PG/4\pi R^2 \quad (3)$$

Where S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units e.g. mW)

G = power gain of the antenna in the direction of interest relative to the isotropic radiator

R = distance to the center of radiation of the antenna (appropriate units e.g. cm)

or,
$$S = EIRP/4\pi R^2 \quad (4)$$

Where EIRP = Equivalent Isotropically radiated power

General Limits:

§1.1307

Cellular Radiotelephone Service (subpart H of part 22)

Non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 1000 W ERP (1640 W EIRP)

§1.1307

Personal Communications Services (part 24)

Broadband PCS (subpart E): non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 2000 W ERP (3280 W EIRP)

§1.1310 LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

(B) Limits for General Population/Uncontrolled Exposure

300–1500 MHz: $f/1500$ mW/cm²

1500–100,000 MHz: 1.0 mW/cm²

§2.1091

No routine evaluation required when the device ...operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5 GHz and their ERP is 3 watts or more.

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§24.232

(a) Base stations are limited to 1640 watts peak equivalent isotropically radiated power (e.i.r.p.) with an antenna height up to 300 meters HAAT.

b) Mobile/portable stations are limited to 2 watts e.i.r.p. peak power, ...

§22.913

(a) Maximum ERP. The effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts. The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

The table below is excerpted from Table 1B of 47 CFR 1.1310 titled "Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure"

Frequency Range (MHz)	Power Density (mW/cm ²)
300 -1500	f/1500
1500 - 100000	1.0

Prediction for Part 22

Maximum radiated power EIRP: **26.026 dBm (400.50 mW) @848.8 MHz**

Lowest limit for 800 MHz fixed operations (@20cm) where no routine evaluation is required is § 1.1310: $(f/1500)\text{mW/cm}^2 = \mathbf{0.5659 \text{ mW/cm}^2}$

Calculated at distance of 20cm for reference antenna:

$$\text{Power density} = 400.50 / (4 \times \pi \times 20^2) = \mathbf{0.0797 \text{ mW/cm}^2}$$

Result: Configuration complies with rules as power density is below MPE limit.

Prediction for Part 24

Maximum radiated power EIRP: **31.901 dBm (1549.17 mW) @1880MHz**

Lowest limit for 1900 MHz fixed operations (@20cm) where no routine evaluation is required is § 1.1310: $\mathbf{1 \text{ mW/cm}^2}$

Calculated at distance of 20cm:

$$\text{Power density} = 1549.17 / (4 \times \pi \times 20^2) = \mathbf{0.3084 \text{ mW/cm}^2}$$

Result: Configuration complies with rules as power density is below MPE limit.

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Prediction for Part 15.247-FHSS

According to KDB 447498 D01 Mobile Portable RF Exposure v04:

If output power < (60/f(GHz)) mW then SAR evaluation is not required.

Maximum measured radiated power, **0.624 mW** < (60/2.402) mW

$$\mathbf{0.624\ mW} < (24.97)\ \text{mW}$$

Prediction for Part 15.247-DSSS

Maximum radiated power EIRP: **19.28 dBm (84.72 mW) @5785 MHz**

Lowest limit for 2400-2480MHz and 5725-5850MHz fixed operations (@20cm) where no routine evaluation is required is § 1.1310: **1 mW/cm²**

Calculated at distance of 20cm for reference antenna:

$$\text{Power density} = \mathbf{84.72 / (4 \times \pi \times 20^2) = 0.01686\ mW/cm^2}$$

Result: Configuration complies with rules as power density is below MPE limit.

Prediction for Part 15.407

Maximum radiated power EIRP: **21.76dBm (149.93mW) @5260MHz**

Lowest limit for 5180-5250MHz, 5250-5350MHz and 5470-5725MHz fixed operations (@20cm) where no routine evaluation is required is § 1.1310: **1 mW/cm²**

Calculated at distance of 20cm:

$$\text{Power density} = \mathbf{149.93 / (4 \times \pi \times 20^2) = 0.02984\ mW/cm^2}$$

Result: Configuration complies with rules as power density is below MPE limit.

Note: Below the Mobile Multi-transmitter MPE Estimation is provided. There are four cases that were investigated.

- 1. WWAN ANT in CDMA 800: WLAN TX1 & WLAN TX2 transmit in the 2.4GHz Band**
- 2. WWAN ANT in CDMA 1900: WLAN TX1 & WLAN TX2 transmit in the 2.4GHz Band**
- 3. WWAN ANT in CDMA 1900: WLAN TX1 & WLAN TX2 transmit in 5.725-5.8GHz Band**
- 4. WWAN ANT in CDMA 800: WLAN TX1 & WLAN TX2 transmit in 5.725-5.8GHz Band**

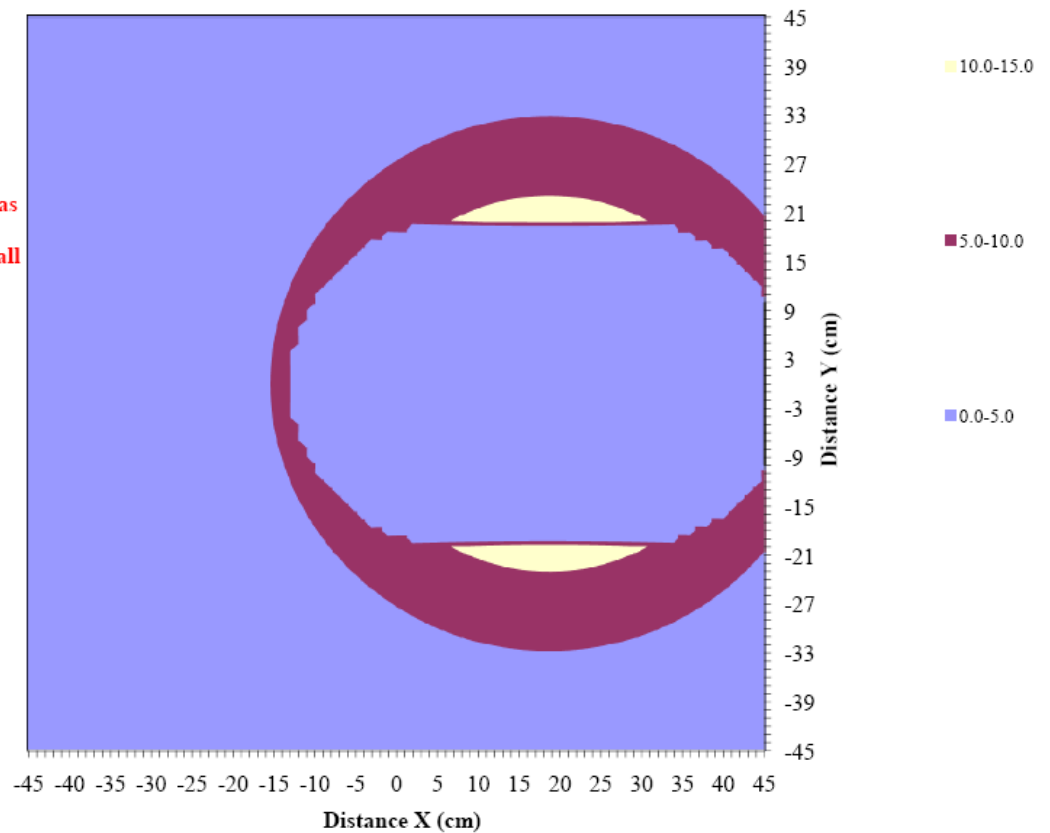
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Antenna No.		Total	1	2	3
Tx Status			On	On	On
Frequency	MHz		836.6	2437	2462
MPE Limit	mW/cm ²		0.56	1.00	1.00
Max % MPE	%	13.2	11.4	1.0	1.2
Power	(W)	0.386	0.290	0.048	0.048
Antenna Gain	dBi		0.42	0.36	1.10
EIRP	(W)	0.43	0.319	0.052	0.062
X	(cm)		18.7	7.5	28.1
Y	(cm)		0.0	0.0	0.0
Sector			FALSE	FALSE	FALSE
Arc			FALSE	FALSE	FALSE
θ_1	degs	input	-120	-120	-120
θ_2			60	60	60
θ_1		actual	-120	-120	-120
θ_2			60	60	60

% MPE Contour

Note: The 0% contour surrounding the antennas identifies a 20 cm perimeter surrounding all active antennas



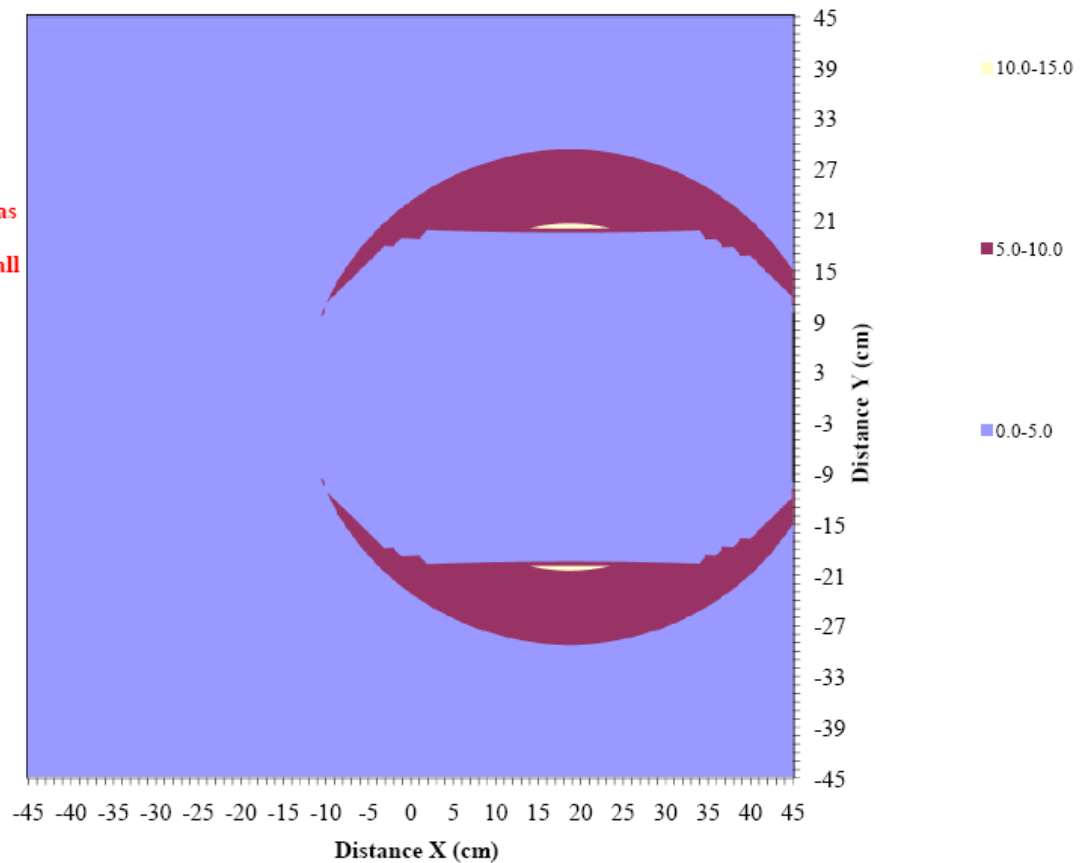
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Antenna No.		Total	1	2	3
Tx Status			On	On	On
Frequency	MHz		2437	1851.25	2462
MPE Limit	mW/cm ²		1.00	1.00	1.00
Max % MPE	%	10.5	1.0	8.7	1.2
Power	(W)	0.387	0.048	0.291	0.048
Antenna Gain	dBi		0.36	1.76	1.10
EIRP	(W)	0.55	0.052	0.436	0.062
X	(cm)		7.5	18.7	28.1
Y	(cm)		0.0	0.0	0.0
Sector			FALSE	FALSE	FALSE
Arc			FALSE	FALSE	FALSE
θ ₁	degs	input	-120	-120	-120
θ ₂			60	60	60
θ ₁		actual	-120	-120	-120
θ ₂			60	60	60

% MPE Contour

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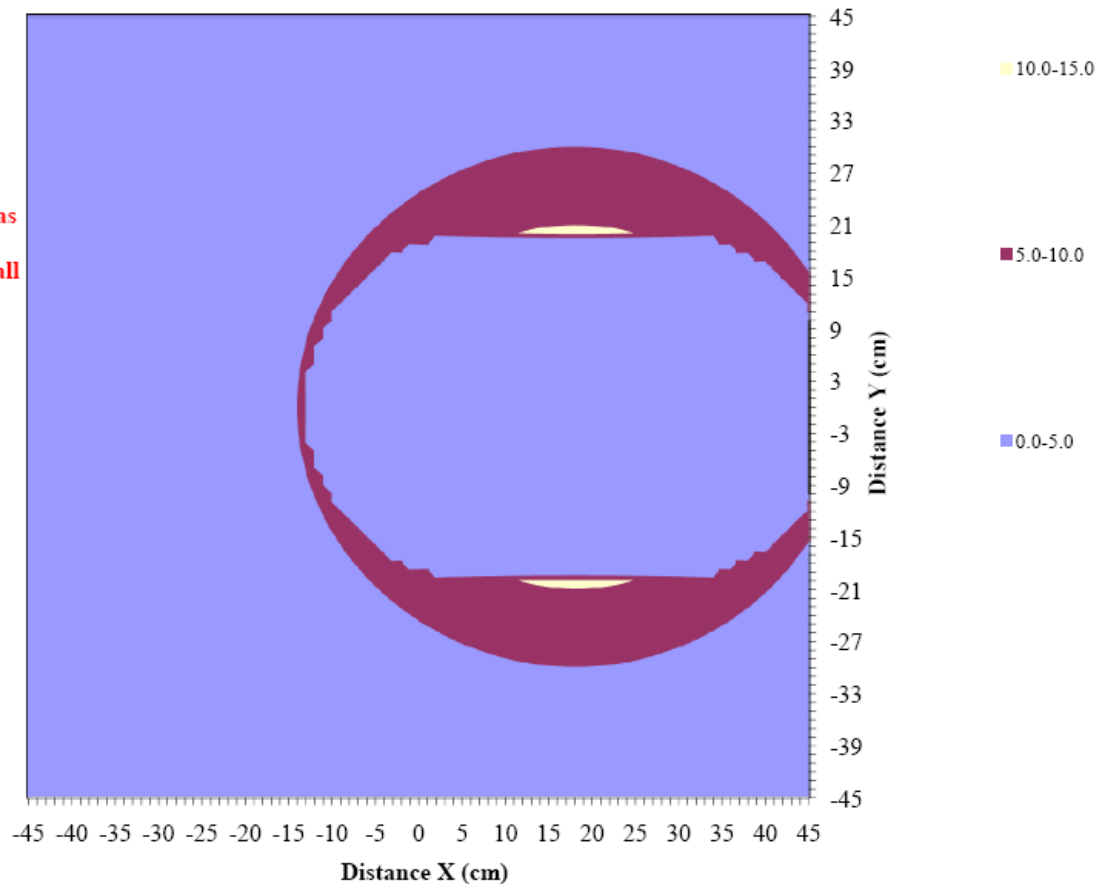
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Antenna No.		Total	1	2	3
Tx Status			On	On	On
Frequency	MHz		5785	1851.25	5825
MPE Limit	mW/cm ²		1.00	1.00	1.00
Max % MPE	%	10.9	1.7	8.7	1.1
Power	(W)	0.390	0.049	0.291	0.049
Antenna Gain	dBi		2.34	1.76	0.67
EIRP	(W)	0.58	0.085	0.436	0.058
X	(cm)		7.5	18.7	28.1
Y	(cm)		0.0	0.0	0.0
Sector			FALSE	FALSE	FALSE
Arc			FALSE	FALSE	FALSE
θ ₁	degs	input	-120	-120	-120
θ ₂			60	60	60
θ ₁		actual	-120	-120	-120
θ ₂			60	60	60

% MPE Contour

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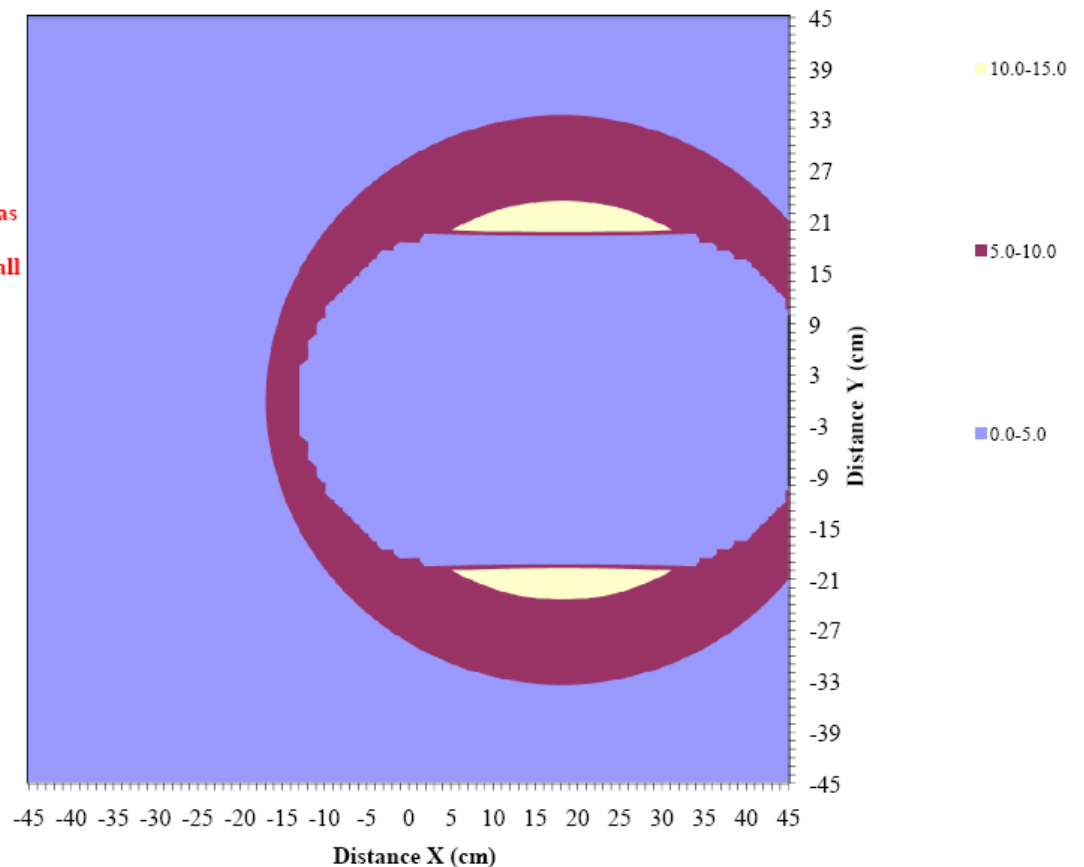
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Antenna No.		Total	1	2	3
Tx Status			On	On	On
Frequency	MHz		5785	836.6	5825
MPE Limit	mW/cm ²		1.00	0.56	1.00
Max % MPE	%	13.6	1.7	11.4	1.1
Power	(W)	0.389	0.049	0.290	0.049
Antenna Gain	dBi		2.34	0.42	0.67
EIRP	(W)	0.46	0.085	0.319	0.058
X	(cm)		7.5	18.7	28.1
Y	(cm)		0.0	0.0	0.0
Sector			FALSE	FALSE	FALSE
Arc			FALSE	FALSE	FALSE
θ ₁	degs	input	-120	-120	-120
θ ₂			60	60	60
θ ₁		actual	-120	-120	-120
θ ₂			60	60	60

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