RF Exposure Info / MPE Sample Calculation

Model: **DCM AF 1727E**
FCC-ID: **XS5-AF1727E**

INTRODUCTION

The DCM is a component of the Node A+/Node AM system which consists of a uplink and downlink path. Uplink and downlink are combined/divided by a duplexer at the mobile port and a duplexer at the BTS port.

In the uplink path, a signal originating from the mobile, is separated from the downlink signal via the UL IN duplexer, i.e duplexer at the Mobile port. It is then amplified by a low noise amplifier (LNA), which is - like the duplexer - part of the RF card. The RF card down-converts the signals to the IF and converts the analogue signal into a digital signal. Digital filtering / signal processing is done at the main board of the subrack. After the digital filtering / signal processing, the digital signal is converted into an analogue signal on the RF card, then up-converted and amplified on the RF card. Finally, the signal is sent to the PA (Power Amplifier) and combined with the downlink signal by the duplexer on the BTS port.

In the downlink path, a signal originating from the base station is separated from the uplink signal in the donor duplexer, i.e. duplexer at the BTS port. It is then amplified by a low noise amplifier (LNA), which is - like the duplexer - part of the RF card. The RF card down-converts the signals to the IF and converts the analogue signal into a digital signal. Digital filtering / signal processing is done at the main board of the subrack. Then, the digital signal is converted into an analogue signal, up-converted and amplified on the RF card. Finally, the signal is sent to the PA and combined with the uplink signal by the duplexer on the Mobile port.

The specific device generally will be professionally installed.
Hereby the gain of the finally installed antenna(s), cable attenuation and antenna height will be defined site specific at the time of licensing with the appropriate FCC Bureau(s).

The maximum permissible exposure limit is defined in **47 CFR 1.1310 (B).**

S = power density limit [W/m]
P = power [W]
R = distance [m]

$S_n = \frac{P_n G_n}{4\pi R_n^2}$ => $R_n = \sqrt{\frac{P_n G_n}{4\pi S_n}}$ (to calculate the distance at one frequency)

If we have more bands, than we have to calculated as a percentage:
The additional of the terms have to be lower than 1.

$$\frac{S_{cal1}}{S_1} + \frac{S_{cal2}}{S_2} + \frac{S_{cal3}}{S_3} + ... + \frac{S_{caln}}{S_n} < 1$$

$$\frac{\frac{P_1 G_1}{4\pi R_1^2}}{S_1} + \frac{\frac{P_2 G_2}{4\pi R_2^2}}{S_2} + \frac{\frac{P_3 G_3}{4\pi R_3^2}}{S_3} + ... + \frac{\frac{P_n G_n}{4\pi R_n^2}}{S_n} < 1$$

We are looking for a distance of ensures that the formula is satisfied.
$R_1 = R_2 = R_3 = ... = R_n$

$$\frac{P_1 G_1}{4\pi R^2 S_1} + \frac{P_2 G_2}{4\pi R^2 S_2} + \frac{P_3 G_3}{4\pi R^2 S_3} + ... + \frac{P_n G_n}{4\pi R^2 S_n} < 1$$

$$\frac{P_1 G_1}{4\pi S_1} + \frac{P_2 G_2}{4\pi S_2} + \frac{P_3 G_3}{4\pi S_3} + ... + \frac{P_n G_n}{4\pi S_n} < R^2$$

$$\sqrt{\frac{P_1 G_1}{4\pi S_1} + \frac{P_2 G_2}{4\pi S_2} + \frac{P_3 G_3}{4\pi S_3} + ... + \frac{P_n G_n}{4\pi S_n}} < R$$

With $R_n = \sqrt{\frac{P_n G_n}{4\pi S_n}}$ => $R_n^2 = \frac{P_n G_n}{4\pi S_n}$

$$\sqrt{R_1^2 + R_2^2 + R_3^2 + ... + R_n^2} < R$$

What you have to do for calculate the minimum distance were the power density limit is met:

1) If you have **<u>one path</u>**, you have to put you special values in the following formula.

$$R_n = \sqrt{\frac{P_n G_n}{4\pi S_n}}$$ (Distance for one carrier)

Limits for General Population / Uncontrolled Exposures

Frequency Range (MHz)	Power Density (mW/cm^2)
300 – 1500	S = f/1500
1550 – 100000	S = 1

2) If you have **<u>more than one path</u>**, you must add the individual terms quadratic.

$$R_n = \sqrt{\frac{P_n G_n}{4\pi S_n}}$$ (Distance for individual carrier)

$$\sqrt{R_1^{\,2} + R_2^{\,2} + R_3^{\,2} + \ldots + R_n^{\,2}} < R$$ (See previous page)

For example:

The EUT operates in 2 frequency bands:
1710-1780 MHz (UL), 2110 -2180 MHz (DL).
The max measured conducted output power is 30 dBm (1W) in UL and 27 dBm (0.5W) in DL.

Calculation for every path with maximum allowed antenna gain and without cable loss:

Frequency [MHz]	Max Power out [dBm]	Max. allowed antenna gain, **without** cable loss [dBi]	Min. Distance [m]
1710	30	9	0.251 m
2110	27	9	0.178 m

The worst case would be if all bands were active:

$$\sqrt{R_1^{\,2} + R_2^{\,2} + R_3^{\,2} + \ldots + R_n^{\,2}} < R$$

$R_{all} > 0.251$ m (see previous page for derivation)

For more accurate calculation, the cable loss and actual antenna gain have to be included in the finally system.
The antenna(s) used with device must be fixed-mounted on permanent structures with a distance to any human body to comply with the RF Exposure limit.