

RF Exposure Info / MPE Sample Calculation

Model: CAP H 17E/17E/19/19

FCC-ID: XS5-CAPH17E19

INTRODUCTION

The ERA product is a digital distribution system with focus on flexibility, easy installing, commissioning and reliable operation. The system is designed in a way to satisfy all of today's needs as well as unknown future standards and requirements.

The ERA system comprises of two main parts. A base station interface (Master or Head End Unit) that takes RF signals as well as digital signals from the base stations, conditions the signals for the given application and assigns them to the coverage zones.

The coverage side is built of one or more Remote Units. The "Remote Unit" (hereinafter referred to as "**RU**") is connected via a 10GBASE SFP+ fiber optical link to the ERA Master Unit. This link gives a total RF bandwidth of up to 320 MHz. For higher bandwidth requirements, a secondary 10G link can be used in parallel.

RF signals between Master Unit and Remote Units are sent digitally over the fiber optical link. At the receiver side these signals are converted back to analog and amplified up to appropriate transmit levels.

The RU allows cascading of up to in total 4 RUs. This shall be done either in the optical domain by CWDM or digitally in the FPGA.

The unit is designed to support up to 4 RP21 type power amplifiers within one RU cabinet. Depending on the market needs the outputs of the PAs can be all combined to one common or multiple antenna ports.

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]

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

If we have more bands, than we have to calculated as a percentage:

The additional of the terms have to be lower than 1.

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

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

We are looking for a distance of ensures that the formula is satisfied.

$$R_1 = R_2 = R_3 = \dots = R_n$$

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

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

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

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

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

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

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

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

Limits for General Population / Uncontrolled Exposures

Frequency Range (MHz)

Power Density (mW/cm²)

300 – 1500

$S = f/1500$

1550 – 100000

$S = 1$

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

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

$$\sqrt{R_1^2 + R_2^2 + R_3^2 + \dots + R_n^2} < R \quad (\text{See previous page})$$

For example:

The EUT operates in 2 frequency bands: 1930-1995 MHz and 2110 -2180 MHz.

The max measured conducted output power is 43 dBm (20W) per antenna port. In MIMO application is the max output power 46 dBm (40W).

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]
1930	46	9	1,586
2110	46	9	1,586

The worst case would be if all bands were active:

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

$$R_{all} > 2,243\text{m}$$

(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.