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Technical Note - TN14

Near field / far field

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1. Introduction

The radiation of the electromagnetic field in the vicinity of an antenna can be divided in 3 different zones:

- Very near field (Rayleigh zone)
- Near field (Fresnel zone)
- Far field (Frauenhoffer zone).

An intermediate zone (or transition zone) is sometimes used for the definition of the transition domain around the limit between the near and the far field zones.

It is important to notice that the limits between the zones are arbitrary and the transitions between the different zones are smooth and continuous. For instance, at the "far field limit", no dramatic change occurs.

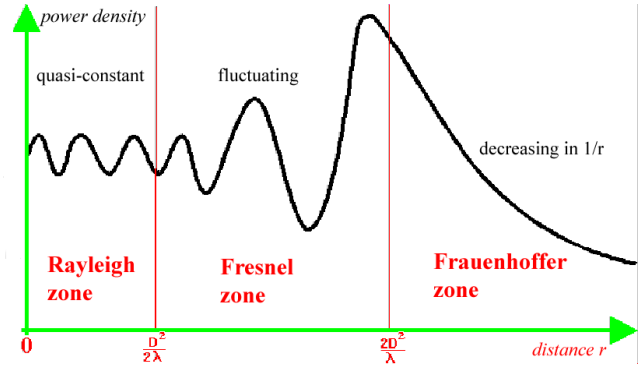

Fig. 1 : Diagram of the power density related to the distance from the antenna

2. Far field limit

This is the arbitrary limit between the far and near field regions.
The distance from the antenna to this limit depends on many factors, especially on the antenna type.
For a dipole, the distance r is:

$r = \frac{2D^2}{\lambda}$ where D is the dipole length.

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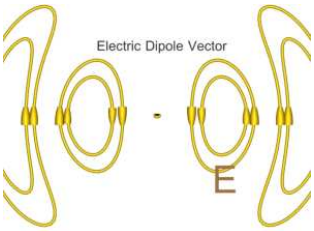
3. Characteristics of the near and far field regions

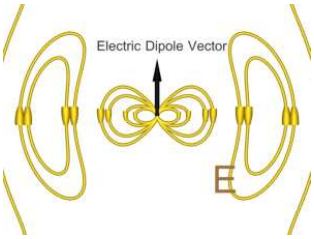
	near field	***far field***
Situation of the zone	close to the antenna	far from the antenna
Distance	$0 – 2D^2/\lambda$	$2D^2/\lambda$ - ∞
E perpendicular to H	no	yes
E and H perpendicular to S[1]	no	yes
Evolution of the field in 1/r	no	yes
Wave impedance (Z=E/H)	≠ 377 Ω	377 Ω
Field distribution	very complex and inhomogeneous	easy and monotone (spherical waves)

4. Propagation

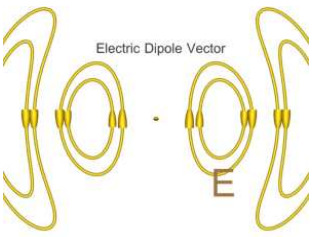
The following pictures show 4 phases of the radiation of an electric dipole. The complex field distribution in the vicinity of the antenna and the spherical waves in the far field region are clearly visible.



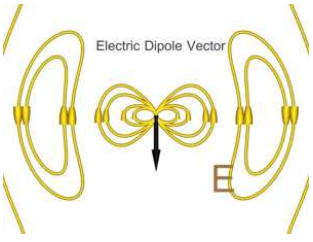
t = 0
i = 0 (i = instantaneous current in the dipole)



t = T/4
i = maximum (positive)



t = T/2
i = 0



t = 3T/4
i = maximum (negative)

[1] *S: Poynting vector (this vector is in the propagation direction, in the far field region)*

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