# Radiation Pattern and Directivity of an Antenna Array

This application calculates the array factor and directivity of a uniform linear antenna array, and then plots the radiation pattern.

Number of elements in the uniform array

$$N := 15$$

Design frequency

$$f_d := 1 \text{ GHz}$$

Permittivity and permeability of free space

$$\epsilon_0 = 8.854 \times 10^{-12} \frac{A^2 \cdot s^4}{m^3 \cdot kg}$$

$$\mu_0 = 1.257 \times 10^{-6} \frac{m \cdot kg}{A^2 \cdot s^2}$$

Phase constant

$$\beta_0 := 2 \cdot \pi \cdot f_d \cdot \sqrt{\mu_0 \cdot \epsilon_0} = 20.958 \frac{1}{m}$$

Wavelength

$$\lambda_d := 2 \cdot \frac{\pi}{\beta_0} = 0.300 \text{ m}$$

For a maximum at

$$\phi_m := \frac{\pi}{3}$$

Inter-element spacing

$$d := \frac{\lambda_d}{3} = 0.100 \text{ m}$$

Progressive phase shift between elements

$$\psi := \beta_0 \cdot d \cdot \cos(\phi_m) = 1.047$$

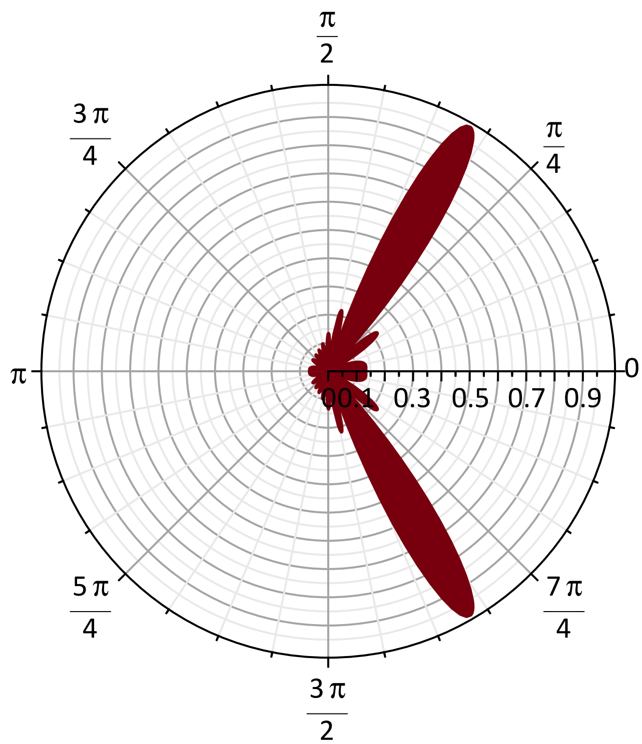
Array factor

$$AF := \left| \frac{1}{N} \cdot \frac{\sin\left(\frac{N}{2} \cdot \left(\beta_0 \cdot d \cdot \cos(\phi) - \psi\right)\right)}{\sin\left(\frac{1}{2} \cdot \left(\beta_0 \cdot d \cdot \cos(\phi) - \psi\right)\right)} \right|$$

$$AF = 0.067 \cdot \left| \frac{\sin(15.708 \cdot \cos(\phi) - 7.854)}{\sin(1.047 \cdot \cos(\phi) - 0.524)} \right|$$

$\text{plots:-polarplot}\left(AF(\phi), \phi = 0..2 \cdot \pi, \text{filled}, \text{transparency} = 0, \text{title} = \text{"Array Factor"}, \text{titlefont} = [\textit{Calibri}], \text{axesfont} = [\text{Calibri}]\right) =$

Array Factor




The directivity for this array is calculated from the total power radiated.

$$P_{tot} := 2 \cdot \text{int}\left(AF^2, \phi = 0..2 \cdot \pi, \text{numeric}\right) = 0.942$$

$$D_0 := \frac{4 \cdot \pi}{P_{tot}} = 13.343$$

which in dB is

$$10 \cdot \log10\left(D_0\right) = 11.252$$