

5.2.1.1 Dipole Antenna Input Impedance Canonical Validation Problem

The dipole antenna is one of the simplest structures in electromagnetic compatibility problems. The values of the real and imaginary input impedance are well known for a dipole antenna. The impedance varies vs. frequency (wavelength compared to the antenna physical length). The half wavelength resonant frequency real part of the impedance should be 73 ohms, and the imaginary part should be 42.5 ohms.

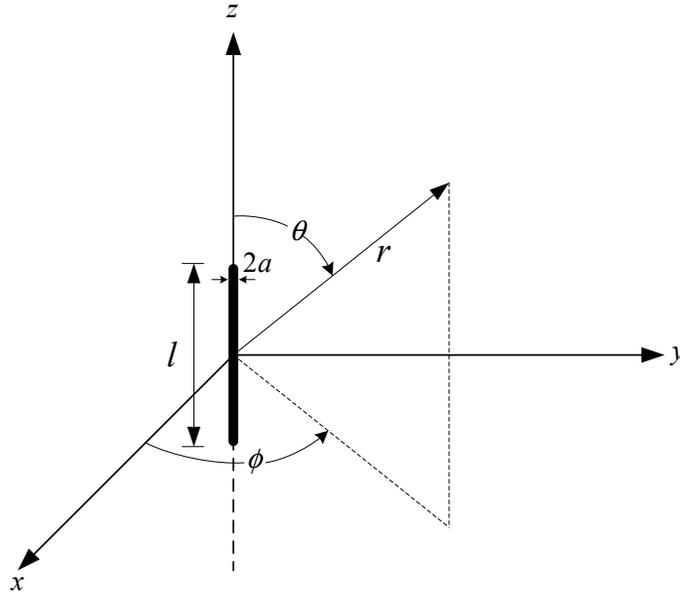


Figure 1. Dipole Antenna Geometry

Real and imaginary part of input impedance at the input terminals are given by equation 5.2.1.1.1 from [1]

$$R_{in} = \frac{R_r}{\text{Sin}^2(kl/2)} \quad (5.2.1.1.1)$$

$$X_{in} = \frac{X_m}{\text{Sin}^2(kl/2)}$$

Where l is the length of the antenna and a is the diameter. It is assumed that $a \ll l$

R_{in} = real part of the radiation resistance at the input (feed) terminals

X_{in} = imaginary part of the radiation resistance at the input (feed) terminals

R_r , is the radiation resistance at current maximum

Note: The radiation resistance and the input resistance are based on ideal current distribution and do not account for finite radius of the wire or the gap spacing at the feed.

The radiation resistance is also the antenna input impedance since the current maximum for a half wavelength dipole occurs at the input terminals. The imaginary part associated with the input impedance of

a dipole is a function of its length. Thus, the total input impedance for $l = \lambda/2$ is equal to $Z_{in} = 73 + j42.5$ Ohms.

The input impedance of a dipole for varying lengths (in wavelengths) has been computed and provided in a file "***Dipole_Input_Impedance.xls***". The radius of the dipole is assumed to be very small compared to the length. From the results the input impedance of a half wave dipole can be verified to be $Z_{in} = 73 + j42.5$ Ohms and when the overall length of the dipole is a multiple of λ , (i.e., $l = n\lambda$, $n = 1, 2, 3, \dots$), the current at the input terminals is zero which indicates the radiation resistance at the input terminals is infinite.

Reference:

[1] Constantine A. Balanis "*Antenna Theory Analysis and Design*" second edition, John Wiley Sons and Inc.