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REPORT TITLE:

Half-wave Antenna Modeling

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I. Introduction

An antenna is a transducer designed to transmit or receive electromagnetic waves. For transmission of a signal radio frequency electrical, energy from the transmitter is converted into electromagnetic energy by the antenna and radiated into the surrounding environment (atmosphere, space, water). For reception of a signal, electromagnetic energy impinging on the antenna is converted into radio frequency electrical energy and fed into the receiver.

A RF antenna is defined as a component that facilitates the transfer of a guided wave into, and the reception from, free space. In function, the antenna is essentially a transducer that converts alternating currents into electromagnetic fields or vice versa. The physical components that make up an antenna's structure are called elements. From a coat hanger to a tuned Yagi, there are literally hundreds of antenna styles and variations that may be employed.

Physically, an antenna is an arrangement of conductors that generate a radiating electromagnetic field in response to an applied alternating voltage and the associated alternating electric current, or can be placed in an electromagnetic field so that the field will induce an alternating current in the antenna and a voltage between its terminals.

An antenna is an integral part of a wireless system. Antennas are used in systems such as radio and television broadcasting, point-to-point radio communication, wireless LAN, radar and space exploration.

II. Half-Wave Antenna

a) Antenna description

The half wave antenna is an omni-directional antenna. Its radiates power equally well in all directions [2].

The half wave antenna consists of two straight collinear conductors of equal length, separated by a small gap [5] (figure. 1).

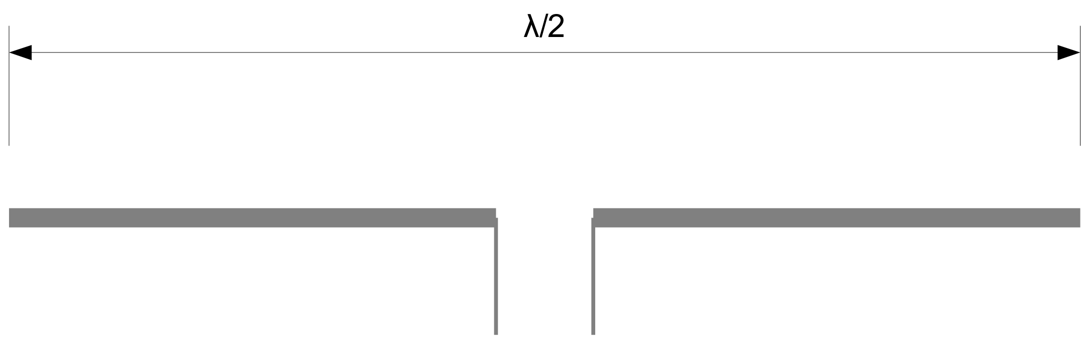

Figure 1. Half-Wave Antenna

The length of the antenna is one half the wavelength of the signal that can be translated most efficiently. A half wave antenna have a uniform or omni-directional radiation pattern in one dimension [2].

The electric and magnetic fields radiated from an antenna are an electromagnetic field (figure. 2). This field is responsible for the propagation and reception of RF energy.

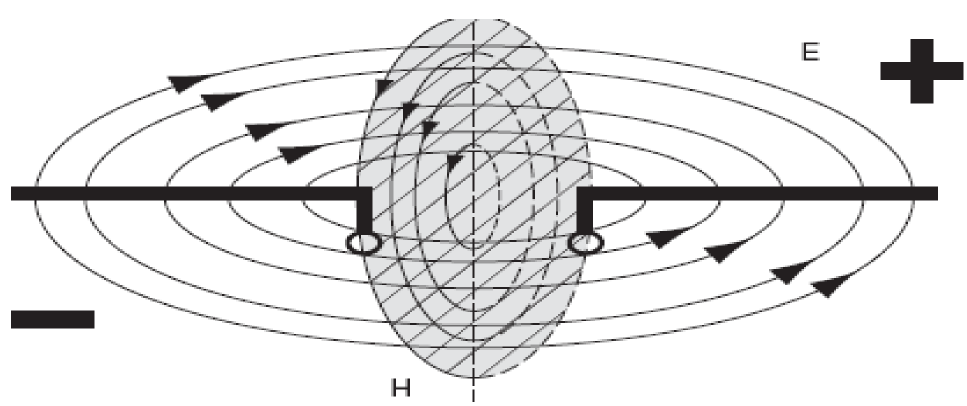

Figure 2. E and H Fields Surrounding An Antenna

b) Antenna Length Determination

Every frequency has a certain physical length that it occupies in space. That length is referred to as the wavelength and is determined by two factors [1]:

1) the frequency itself and

2) the speed of propagation.

The wavelength of the operational frequency determines antenna length. Since an antenna has a dielectric constant greater than that of free space, the velocity of a wave on the antenna is slower. This, along with several other factors, has led antenna designers to accept the following formula as accurate for all practical purposes to determine the physical length of a 1/4-wave antenna:

$$f = \frac{c}{\lambda\sqrt{\varepsilon}}$$

=>

$$\lambda = \frac{c}{f\sqrt{\varepsilon}}$$

where c is the light speed; *f* is the wave frequency and λ is the wave length.

In this paper, the frequency is fixed to 3 Ghz. The above formula give the wavelength ($\lambda = 0.1$m). In this case, the aluminum is used as conductor and its effective permittivity is equal to one.

C) Antenna electric model

Referring to the antenna layout (figure. 3), the one of the antenna impedance will be a capacitor. And the antenna arms have an inductance and this inductance will be in series with the capacitor. If the antenna radiates, some energy will be lost and this lost energy must accounted for in our model. The component which will dissipate power is the resistor. The equivalent antenna electric model is shown below (figure. 4).

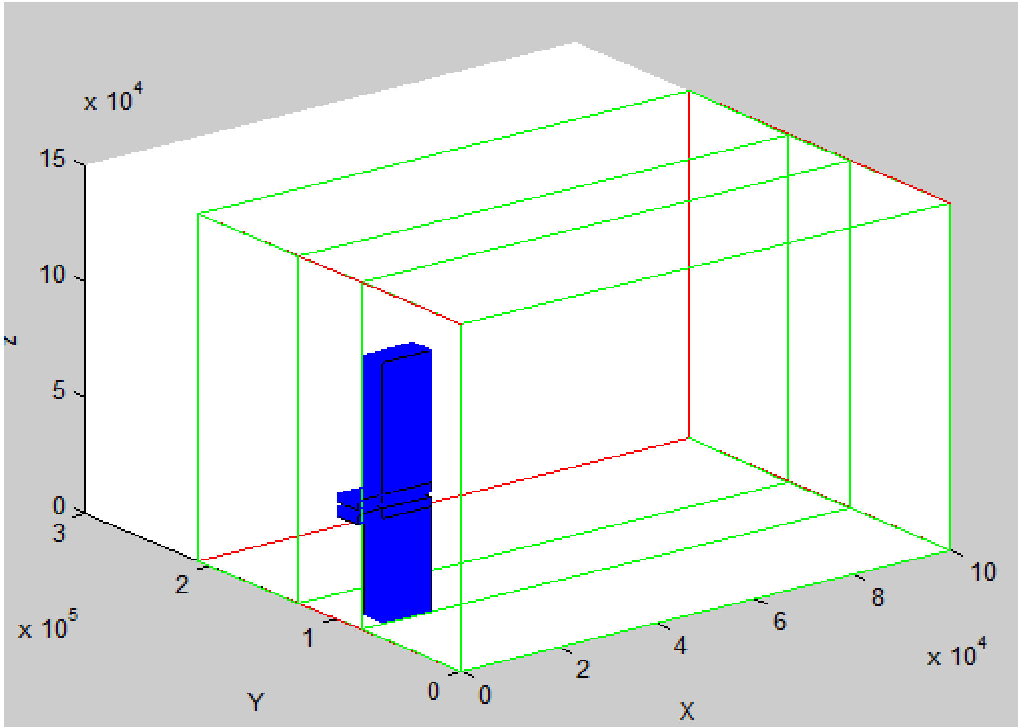

Figure. 3 Half-Wave antenna layout in three-dimensional

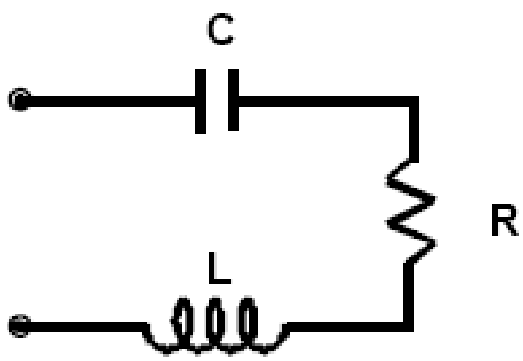

Figure. 4 Electric circuit equivalent

This figure above shown the RLC equivalent circuit of the antenna. At low frequencies, the dipole impedance will be a capacitive, at high frequencies it will be inductive, and at resonance it will be resistive.

By taking in account the gap between the two straight collinear conductors, the figure (figure. 5) is obtained. The inductance and resistance will be one half that of the dipole and the capacitance will be twice that of the dipole.

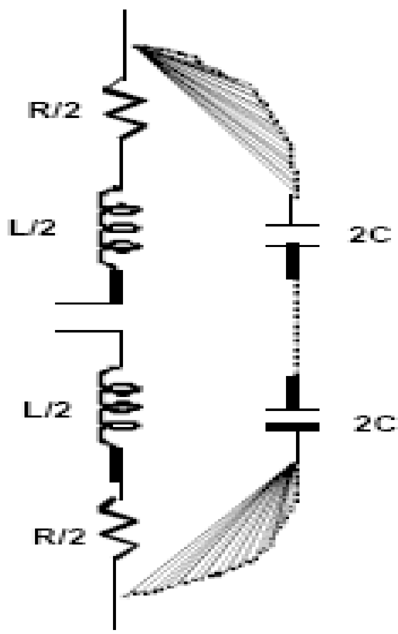

Figure. 5 Electric circuit equivalent with the gap

III. Simulation results

The simulation is performed with chamy software and the results are shown in the figures below.

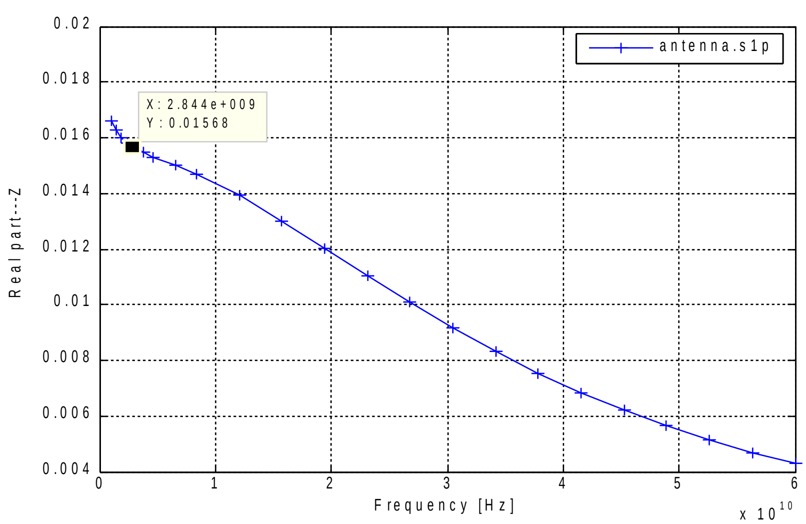

Figure. 6 Real part of the impedance

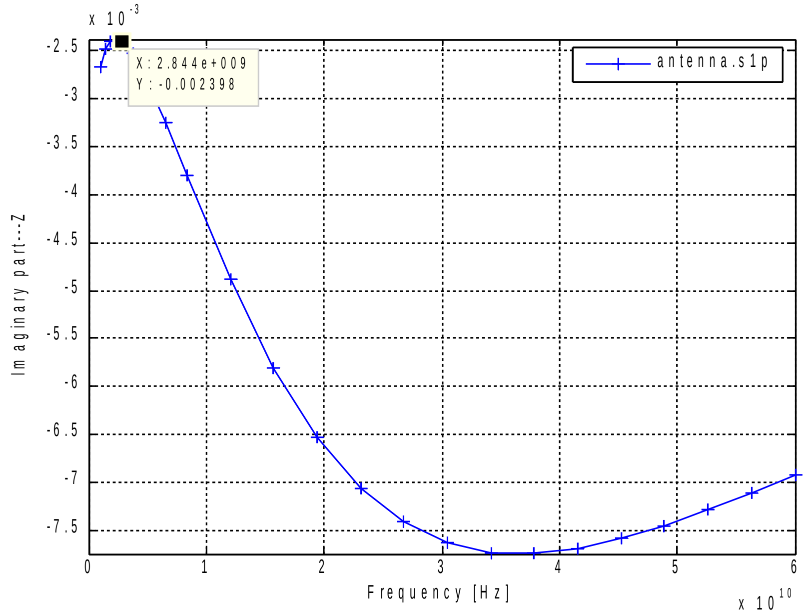

Figure. 7 Imaginary part of the impedance

Referring to the simulation results, at the resonance frequency (3 GHz) the imaginary part of the impedance is approximately null. The maximum efficiency is obtained at this frequency and the impedance is purely resistive.

IV. Conclusion

The half-wave antenna (dipole antenna) description has been performed. Its wavelength at 3 GHz and electric circuit has been determinated.

The antenna behavior using the variation of the entry impedance complex in function the frequency is evaluate with chamy software. The results obtained shown a good fit at resonance frequency. This antenna will be used for mobiles phones communication, radars detection.

The antenna will be simulated by using two ports to evaluate the input and output impedances, and its S parameters to obtain a good visibility of the behavior.

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