DESIGN OF RESONANCE FREQUENCY VARIABLE DIPOLE ANTENNA

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Abstract: Dipole antennas are resonant for the frequency of design. Its resonance frequency is dependent on its length which is a function of the wavelength of operation. Dipoles are usually designed for half the wavelength of its frequency of operation. Hence every dipole has its own resonance frequency of operation and to vary it is difficult. In this paper the author proposes a technique of adding two small circular rings to the elements of the dipoles. Varying the position of the ring shifts its resonance frequency. This type of dipole is very useful for operation over a band of frequencies than at single frequency and is not expensive.

Keywords: **Dipole, circular ring, frequency, resonance**

Introduction: The dipole is a fundamental wire antenna whose resonance frequency is dependent on the length of the dipole and is widely used as a receiving antenna in AM, FM radios and other portable devices [1-2]. It is low cost and light in weight. But to receive different frequencies we need to use dipoles of different lengths. This increases the volume and weight of the device. There are many types of wire antennas such as loop, rhombus, folded dipole, Yagi-Uda and so on. But many of these are resonant antennas and are efficient radiators or receivers only at the frequency of design and are not suitable for operation at other frequencies. Also it is not possible to vary their resonant frequency easily [3]. Wide band antennas such as biconical antennas operate for wide frequency range receives all the frequencies of any designated band which may cause interference. To prevent the interference of unwanted frequencies we have to design antennas with variable resonance frequencies so that only the desired frequency is received and others are rejected to reduce the interference [4-5].

In this paper a dipole with rings attached on the two wires is designed and its radiation characteristics are analyzed. Its radiation pattern is omnidirectional and is vertically polarized. But the reflection coefficient varies with the position of the rings on the elements. The resonant frequency of the dipole shifts with the change in the position of the rings on the wires. The dipole is designed at 600 MHz and the corresponding wave length is 500mm. All the dimensions are listed in the Table: 1.Two small rings are arranged on the wires and are moved from center feed position to the edges of the wires. The behavior of the return loss is analyzed and it is found there is a significant systematic shift in the resonance frequency with the position of the rings on the wires.

Table: 1 Dimensions of the Dipole Antenna

Name	Symbol	Dimensions
Frequency	f	600 MHz
Wavelength	λ	500mm
Gap between the wires	g	10mm
Length of the dipole	$0.475*\lambda=l$	237.5mm
Conductor length	Dipole length $-g/2$	113.75mm
Outer radius of the torus		18.52mm
Inner radius of the torus		5mm

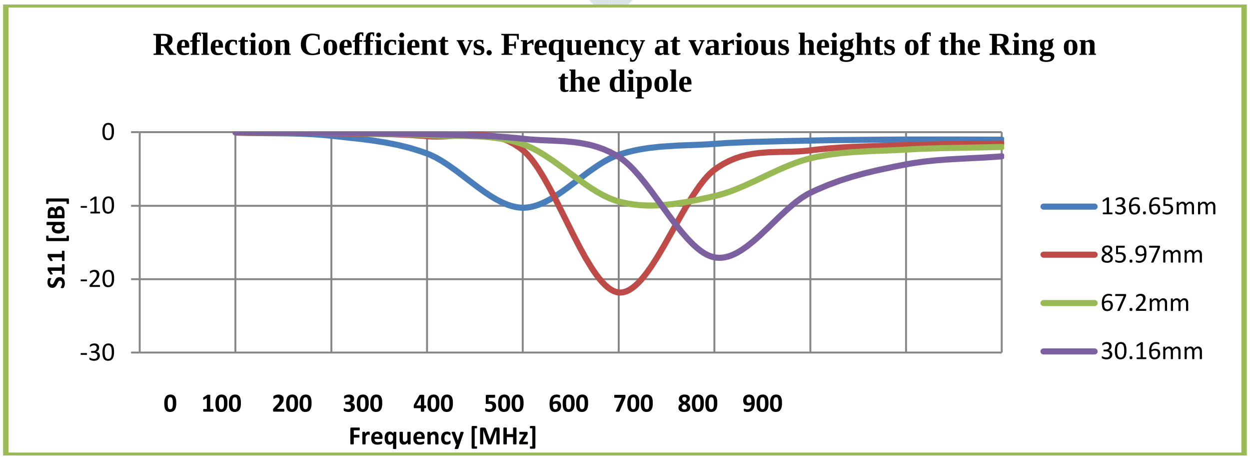

Fig.1: Reflection Coefficient Vs. Frequency

The reflection coefficient plot is shown in Fig. 1 for different positions of the ring on the wires. Four positions are considered for analysis. There are four resonant frequencies corresponding to positions- 136.65, 85.97, 67.2, 30.16mm. Four curves of

S_{11}correspond to the positions of the rings on the wires. It shows that the reflection is less that -10dB at the four positions. As the rings are close to the feed the resonant frequency is away from the center frequency. When the rings on both wires are moved to the edges the resonant frequency reduces below the center frequency of 500 MHz.On the other when the rings are moved towards the center of the dipole the resonance frequency shifts above the center frequency of 500MHz. This is because when the rings on the wire are close to the feed strong current flows in to the rings and the path length is more for the current to flow hence the actual electrical length on the main wire reduces and hence the frequency increases. But when the ring is on the edges the current has to flow on a longer path to reach the edge and hence the frequency reduces below the center frequency.

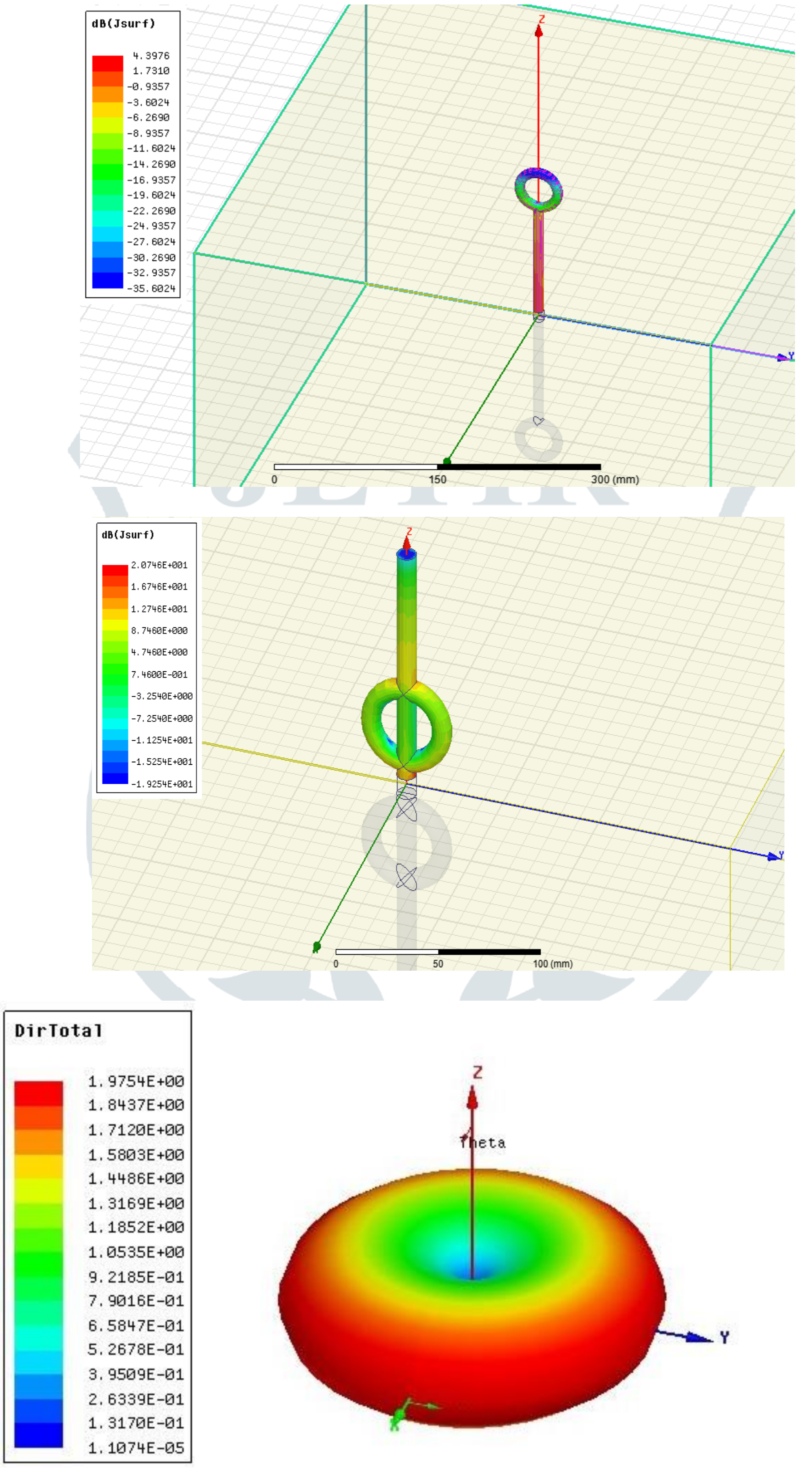

Fig.2: Radiation Pattern (3D)

The radiation pattern is omnidirectional and is not affected by the addition of the rings on the wires. It maintains the same shape at all the positions of the rings on the wires. Its polarization is also not affected due to the placement of the rings. Hence a notable shift is in the reflection coefficient shift with the position of the rings is presented.

ConclusionA novel method of shifting of resonance frequency of the dipole is presented in this paper. The resonance frequency is shifted from 400 MHz to 600 MHz as the rings are moved from the edges to the center of the dipole towards the feed point. At each position of the rings there is a predominant shift in the resonance frequency and with the return loss is below the 10 dB.The center frequency of the dipole for which it is designed is 500 MHz and the resonance is extending from below the center frequency to above the center frequency. When the ring is on the top edge the frequency is reduced as the actual physical length of the wires increases. When the ring is close to the feed the electrical length is reduced hence there is an increase in frequency.

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