Multiband Monopole Antenna for Wireless Communication

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This article describes a lossy magnetic-material coated monopole antenna that can be dynamically retuned to different frequencies of operation

Multiband antennas are attractive for many military and commercial applications where it is required to have a single antenna that can be dynamically reconfigured on multiple frequency bands. Such antennas result in considerable savings in size and weight, as well as cost.

Recent development of modern wireless and mobile communication has suggested increasing demands for novel antennas with a multiband operation for cellular and WLAN applications. For instance, wireless local area networks (WLAN) for the IEEE 802.11b and IEEE 802.11a operate in 2.4-2.48 GHz, 5.15-5.35 GHz and 5.725-5.825 GHz. Many novel antenna structures for single, dual or multiple bands have been proposed by [2-16], however, most of these antenna configurations suggest complicated design in the antenna structures.

In this article, a lossy magnetic-material coated monopole antenna on a conducting box is simulated by using FDTD. Multiband operation and good radiation performance suitable for the WLAN and cellular systems can be achieved. Details of the antenna design are described, and simulated results such as return loss, input resistance and reactance, radiation patterns are presented and discussed.

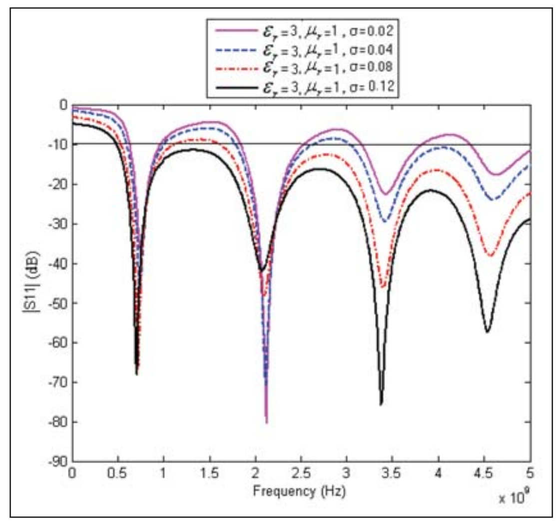

Figure 1 · Return loss versus frequency for different conductivity values.

Problem Description

The basic configuration and structure is similar to that used in [1], which is an approximation to a small hand-held portable device with an attached antenna. The wire monopole antenna is placed at the top side of the conducting box representing the body of the device and fed at the junction between the wire and the box. The "frill" source method was used to implement the source. The conducting box has a width of 10 mm, a length of 60 mm and a height of 50 mm. The wire antenna has a radius of 0.5 mm. No dielectric coating on the box is considered. However, the wire antenna is surrounded by a 5 mm lossy magnetic coating.

The FDTD method is used to numerically investigate the antenna performance. First, the FDTD algorithm was validated by comparison to the measured values published in [1] for the case of no antenna coating. The FDTD algorithm was then modified to include the dielectric layer surrounding the antenna. It was also validated by comparing the calcu-

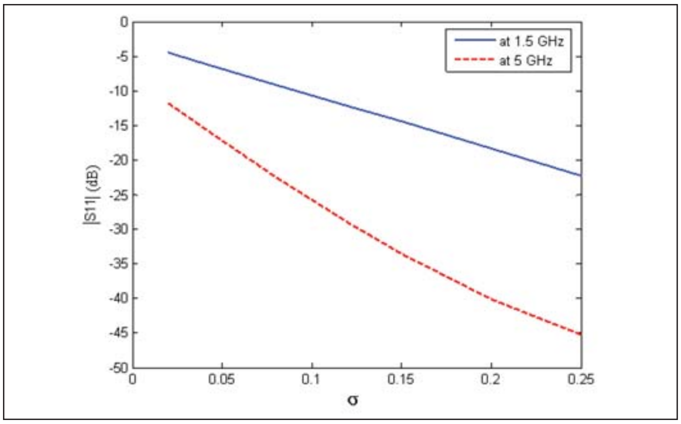

Figure 2 · Return loss versus σ at *f* = 1.5 GHz and *f* = 5 GHz.

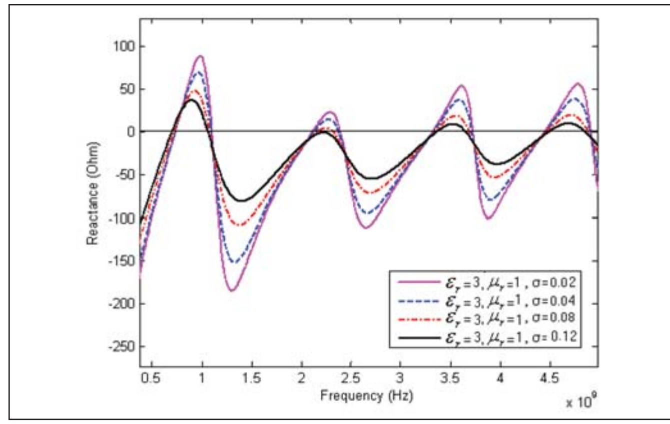

Figure 3 · The input reactance versus frequency at various values of σ.

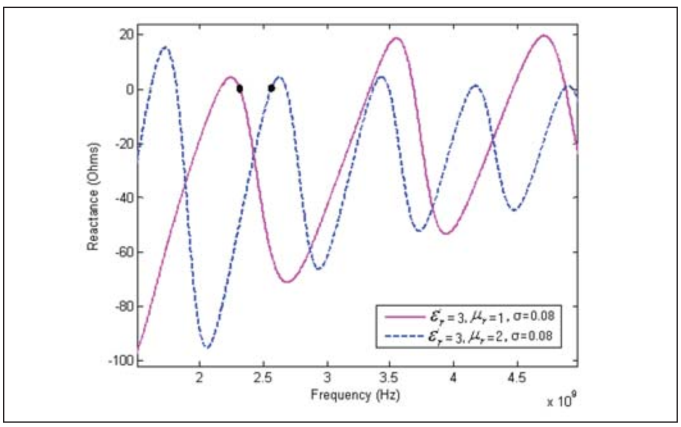

Figure 5 · The input reactance versus frequency for μ_r values of 1 and 2.

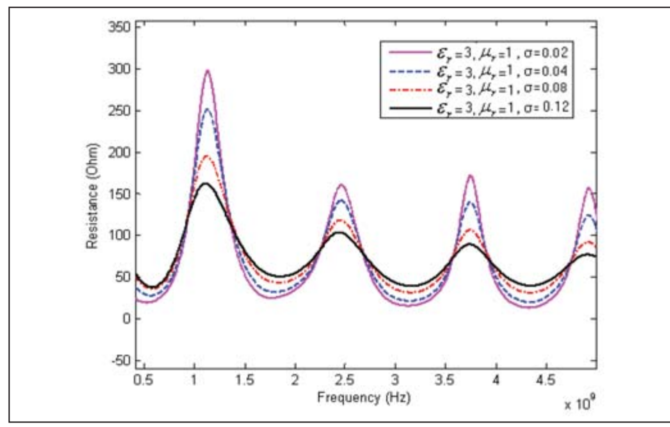

Figure 4 · The input resistance versus frequency at various values of σ.

lated values published in for the case of changing permittivity while keeping the permeability unchanged [18].

In the simulation, all sides of the computation domain were terminated by PML layers [19] to enhance the accuracy of the results [19]. The structure is excited by a Gaussian pulse to obtain results over a wide bandwidth.

Numerical Results

Several FDTD simulation runs were performed for the characterization of the antenna performance. In Figure 1, the return loss versus frequency curves for various conductivity values are presented. From the given values, it can be noticed that the return loss decreases with increasing σ. This result is convincing because as we increase σ, the resistance will decrease and the lost power will also decrease. This creates an easy and simple way to enhance the reception conditions, while many recent papers try to enhance the reception conditions by implementing complicated antenna structures [3-6, 9-10].

Figure 2 shows the return loss versus σ at a given frequency. For the given values, it can be seen that the return loss versus σ at frequency (1.5 GHz) is totally linear, however, for higher frequencies (i.e., 5 GHz), the magnitude of the return loss tends to be more exponantially decaying as we increase σ. Further, the return loss at higher frequencies seems to be lower than at lower frequencies.

Figure 3 shows the simulated input reactance versus frequency for different conductivity values. It shows that increasing σ will decrease the input reactance values closer to zero, as a result, this will enable the device to operate on many center frequencies.

Figure 4 shows the simulated input resistance versus frequency for different conductivity values. It can be seen that increasing σ, the input resistance tends to decrease to 50 Ω, which is the practical impdance of a coaxial cable.

The antenna center frequency can be shifted to bands commonly used for practical applications in cellular or WLAN by changing the permeability of the antenna coating material.

This case is presented in Figure 5, where the center frequency is changed from 2.3 to 2.6 GHz by increasing

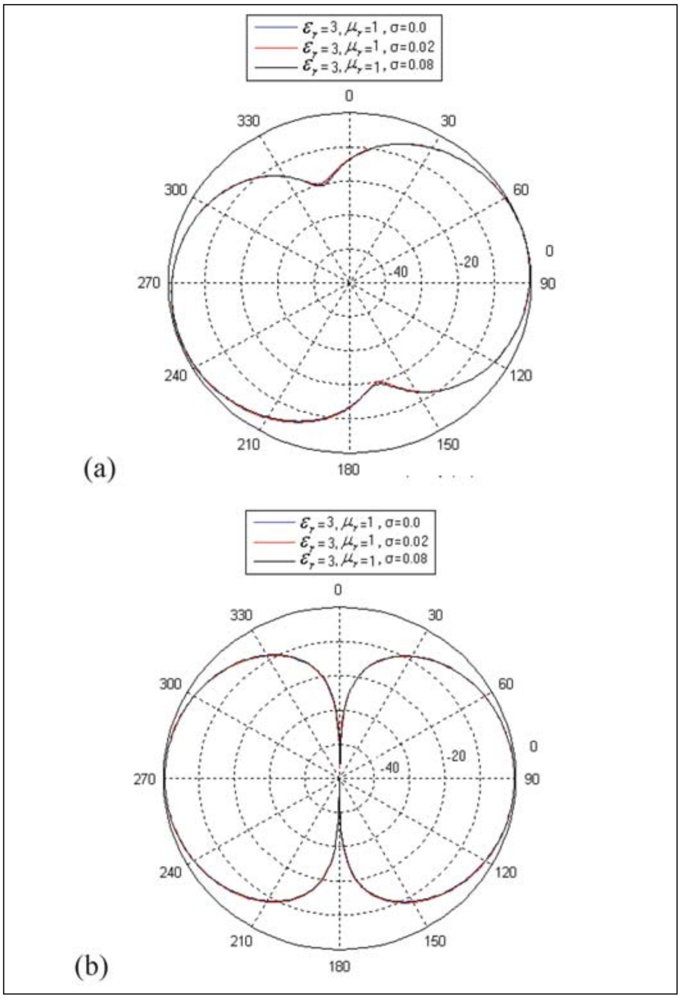

Figure 6 · (a) Simulation results of the *E*-plane radiation patterns of the antenna at 900 MHz for various values of σ. (b) Simulation results of the *H*-plane radiation patterns of the antenna at 900 MHz for various values of σ.

the relative permeability of the coating from 1 to 2.

Conclusions

A study of the effects of lossy magnetic coating on a monopole antenna performance is presented. In particular, it has been shown that a monopole antenna can operate in multiband cellular and WLAN applications by changing the conductivity of the coating material with excellent radiation properties.

Acknowledgments

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