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Wideband Electrically Small Monopole antenna

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Abstract

An electrically small monopole antenna operating in the WLAN frequency band is proposed in this paper. The antenna operates in 3.45-5.45 GHz WLAN frequency bands. Compact size, simple design and low cost make the antenna an attractive candidate for future wireless applications.

1 Introduction

Nowadays RF front ends are becoming smarter, smaller and lightweight. Higher performance wireless systems demanded the developments of antenna systems that are electrically small in size, light weight and suitable to the physical and electromagnetic environments in which they operate. Moreover wideband antennas are preferred more in the communication scenario since they have multiple applications [1,2]. A wideband monopolar patch antenna with dual ring couplers is presented in [3]. A monopole-like radiation pattern and a wide band from 5.45 GHz to 7.16 GHz is obtained, when the two annular rings are properly coupled. A different antenna solution for a wideband coverage, consisting of a compact perturbed E-shaped patch antenna has been presented in [4]. Two rectangular notches and two zig-zag slots have been inserted in the patch to achieve a wider impedance bandwidth and better return loss levels. For exciting the antenna, a probe is inserted between the first teeth of the zig-zag slots. A wideband patch antenna consisting of two metal rings coupled to a circular patch radiator is reported in [5]. The antenna is printed on a circular grounded dielectric substrate while a coaxial probe, located at the center of the circular patch, is used for antenna excitation. Full-wave FEM based HFSS is used to analyze the antenna. The measured impedance bandwidth covers the 5.45–7.16 GHz frequency band making the antenna a suitable candidate for wireless communication standards (WLAN, WiMAX).

The propagation path loss of the vertical polarization is far less than that of the horizontal polarization for unattended ground sensors or land mobile systems in vehicles which are used for near ground applications[6]. Monopoles are commonly preferred in such applications due to their simple structures and capability to provide an omnidirectional vertically polarized radiation pattern. However, the height of a conventional $\lambda0/4$ monopole is very large at these frequencies. This necessitated the development of miniaturized low-profile monopole antennas [7]–[11].

A capacitive loading technique is used to reduce the height of monopoles in [7] and [8]. Eventhough these type of antenna has a height of around $\lambda0/10$ and a relatively large lateral dimension, it can provide high gain and bandwidth, A short monopole based on a quarterwave microstrip resonator is reported in [9]. The antenna have less than $\lambda0/40$ in height and $\lambda0/10$ in lateral dimensions.

In addition to difficulties above mentioned in designing small antennas, measuring a monopole antenna with an electrically small ground plane is also a challenging task due to the cable effects on the antenna performance [12]. Errors in measurement results are caused by the strong near-field coupling between the coaxial-feeding cable and antenna. Ferrite chokes or baluns are used to suppress cable currents and reduce the measurement errors in [13] and [14]. However, the effectiveness of this method is quite limited. A balanced version of the proposed monopole is fabricated to indirectly examine the antenna performance In [10]. In [11], a small source module is employed to avoid using a long coaxial cable, but the reflection coefficients of the antenna can be calculated only by observing the variation of received power versus frequency.

In the present work, we propose a compact and simple design that is wideband as well as electrically small. Compact size, low cost and simple profile make the antenna a promising candidate for future wireless applications.

2 Antenna Geometry

Figure.1 shows the geometry of the proposed antenna structure. The prototype of the antenna is fabricated on a substrate having dielectric constant (ε_r) 4.4, and thickness (h) 1.6 mm and dielectric loss tangent 0.02. Other dimensions of the antenna is given as L=15, W=3, L1=15, W1=9, Lg=25, Wg=10, S=0.5 (All dimensions are in mm).

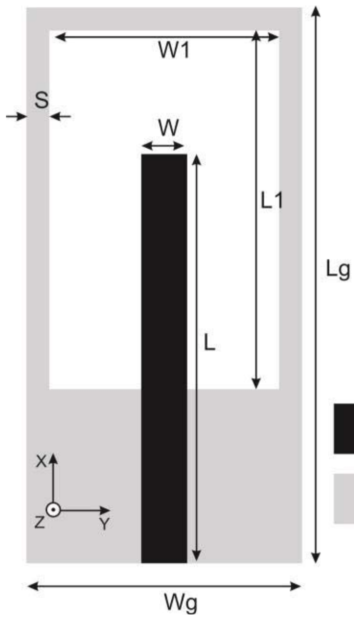

Figure. 1. Geometry of the proposed antenna. Dimensions: L=15, W=3, L1=15, W1=9, Lg=25, Wg=10, S=0.5.

3 Results and Analysis

All simulations are carried out with Ansoft HFSS simulation software. Fabrication of the antenna is performed using photolithography technique. The simulated reflection parameter S11 of antenna is shown in Figure.2. The simulated results show that the antenna has a -10 dB band width of 2 GHz ranging from 3.45 GHz to 5.45 GHz with resonances centered at 3.75 GHz an 4.9 GHz respectively which is wide enough to cover the 3.6GHz and 5GHz WLAN frequency bands.

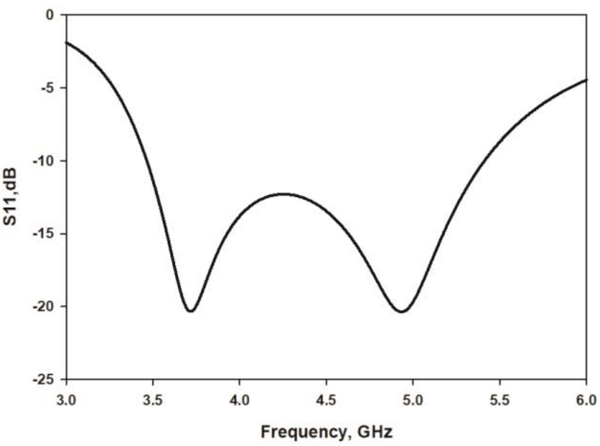

Figure.2. Return loss characteristics of the wideband electrically small antenna.

Photograph of the fabricated antenna is given in Figure.3.

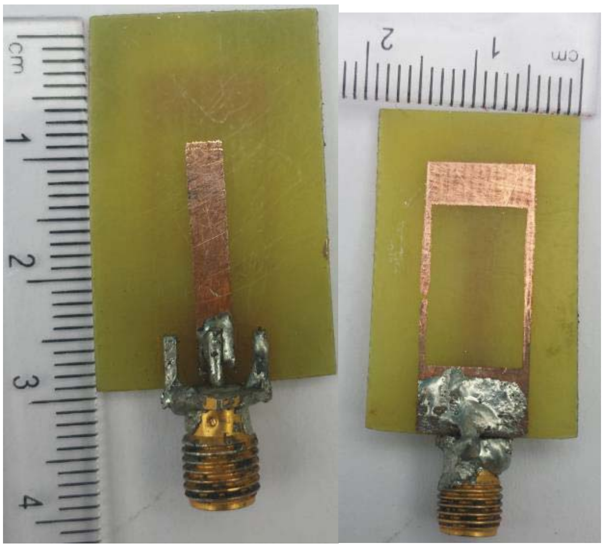

Figure.3. Photograph of the fabricated antenna (a) Front view (b) Back view.

4 Conclusion

A simple electrically small, wideband ground modified monopole antenna for WLAN application is presented. The antenna has simple structure with less geometrical parameters and is fabricated on a low cost substrate. All these features make the proposed antenna a good and efficient candidate for emerging wideband wireless applications.

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6 References

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