WIDEBAND OMNIDIRECTIONAL CYLINDRICAL METAL-PLATE MONOPOLE ANTENNA

Yung-Tao Liu and Kin-Lu Wong
Department of Electrical Engineering
National Sun Yat-Sen University, Kaohsiung 80424, Taiwan
E-Mail liuyt@ema.ee.nsysu.edu.tw

1. Introduction

Planar metal-plate monopole antennas have the attractive property of very wide impedance bandwidth. However, for higher operating frequencies, the planar monopole antenna usually suffers the drawback of showing poor omnidirectional radiation characteristics, which greatly limits its practical applications in the existing wireless communication systems [1]. This is largely owing to the path-length difference caused by large monopole width, and the antenna's radiated fields contributed from the excited surface currents near the two side edges of the planar monopole will be destructive in the direction parallel to the planar monopole [2]. To overcome this problem, the use of a tri-plate monopole [3] and a cross-plate monopole [4] have been recently reported, and improved omnidirectional radiation patterns have been obtained. However, due to the use of two or three metal-plate elements, this kind of crossed planar-monopole antenna needs to be welded together, which complicates the fabrication process. In this paper we present a novel wideband omnidirectional cylindrical metal-plate monopole antenna, which can be easily fabricated from folding a single metal plate, with no additional welding process required. Furthermore, the proposed antenna can provide good omnidirectional radiation over a wide bandwidth. A design example of the proposed antenna suitable for application in the new broadband wireless metropolitan area network (WiMAX) system with the IEEE 802.16a standard for fixed broadband wireless access in the 2-11 GHz band [5] is demonstrated. Details of the antenna design are described, and experimental results of the constructed prototype are presented.

2. Antenna Design

Fig. 1(a) shows the geometry of the proposed cylindrical metal-plate monopole antenna. The antenna is easily fabricated from folding a dumbbell-shaped metal plate shown in Fig. 1(b). A photo of the constructed prototype is shown in Fig. 2. The antenna shows a small cross-sectional area of 10×10 mm^2 and a length of 30 mm and is centered above a ground plane of 120×120 mm^2. In addition, a feed gap of 2.5 mm between the antenna and the ground plane is required for achieving optimal impedance matching over a wide bandwidth. The proposed antenna can be divided into two portions: one cylindrical metal-plate monopole and one input matching section. The cylindrical metal-plate monopole, formed by folding two widened ends of the metal plate to face each other with a small gap of 1 mm, shows a symmetrical structure, which makes omnidirectional radiation possible for the proposed antenna. For the input matching section, it is formed from bending the central portion of the

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metal plate. That is, with proper dimensions as given in Fig. 1, the input matching section can lead to good impedance matching for the proposed antenna over a wide bandwidth. Also note that, by viewing in the *y*-*z* plane in Fig. 1(a), the proposed monopole antenna has a configuration similar to that of a planar square monopole antenna with two notches cut in the antenna's two lower corners [6] (see Fig. 3), in which the two cut notches lead to improved impedance matching over a wide frequency band of larger than 10 GHz. For this reason, the proposed square cylindrical monopole antenna can be considered to have two three-dimensional notches formed in the antenna's input matching section, which makes possible a wide bandwidth for the antenna.

3. Experimental Results and Discussion

With the design dimensions shown in Fig. 1, the proposed antenna was constructed and studied. Fig. 4 shows the measured return loss for the constructed prototype. A very wide impedance bandwidth larger than 10 GHz with the lower edge frequency at 1.74 GHz is obtained, which makes the antenna easily cover the 2-11 GHz band for IEEE 802.16a operation. Fig. 5 shows the measured antenna gain against frequency. The antenna gain increases monotonically from about 2.0 to 7.8 dBi for frequencies up to about 8 GHz and then varies slightly in a range of 7.0 to 7.8 dBi. Radiation characteristics for operating frequencies over the 2-11 GHz band were also studied. Figs. 6 to 8 show the measured radiation patterns at 3, 7, and 11 GHz, respectively. The obtained radiation patterns all similar to that of a wire monopole antenna, and good omnidirectional radiation patterns in the azimuthal plane (*x*-*y* plane) are also observed, especially for the patterns at lower frequencies.

4. Conclusion

A cylindrical metal-plate monopole antenna fabricated using a single metal plate for achieving wideband omnidirectional operation has been proposed. A design example of the proposed antenna suitable for IEEE 802.16a operation in the 2-11 GHz band [5] has been successfully implemented, and the measured results indicate that good omnidirectional radiation characteristics over a wide frequency band of larger than 10 GHz have been obtained.

References:

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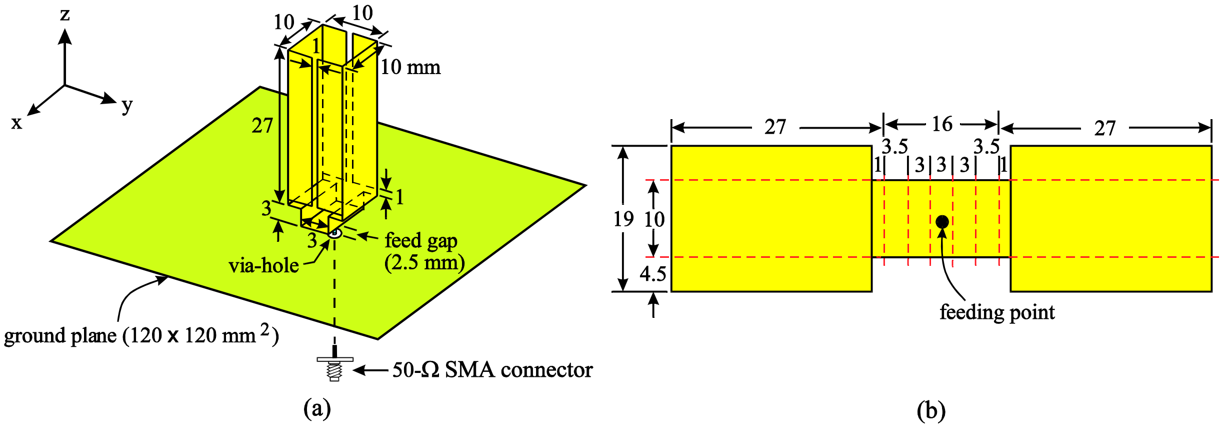

Fig. 1 (a) Geometry of the proposed wideband omnidirectional square cylindrical monopole antenna. (b) Dimensions of a dumbbell-shaped metal plate used for fabricating the antenna; the dashed lines are bending lines.

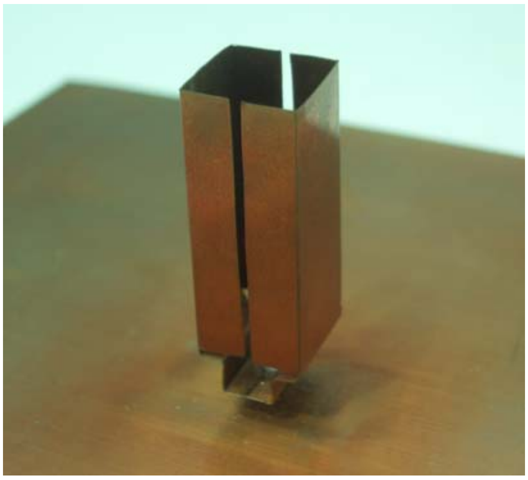

Fig. 2 Photo of a constructed prototype of the proposed antenna.

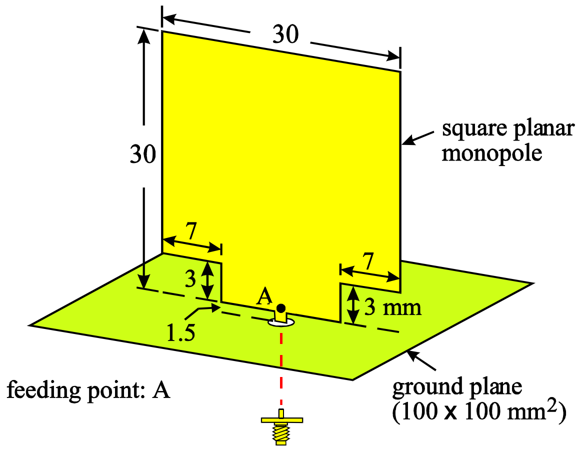

Fig. 3 Geometry of the planar square monopole antenna with notches in [6].

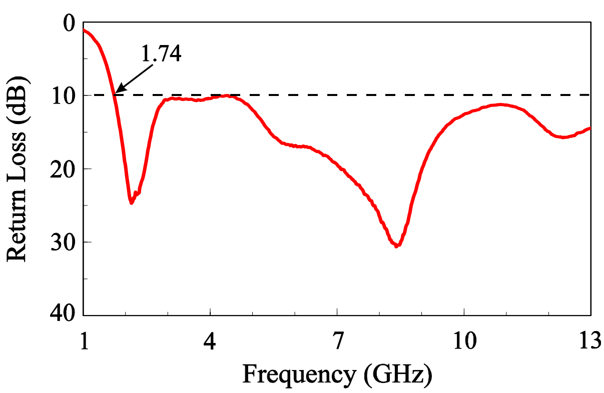

Fig. 4 Measured return loss against frequency.

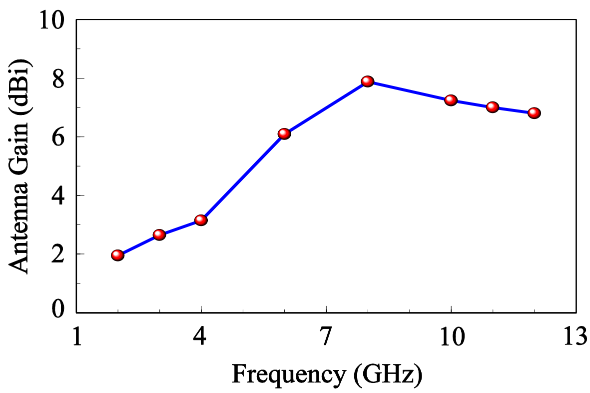

Fig. 5 Measured antenna gain against frequency.

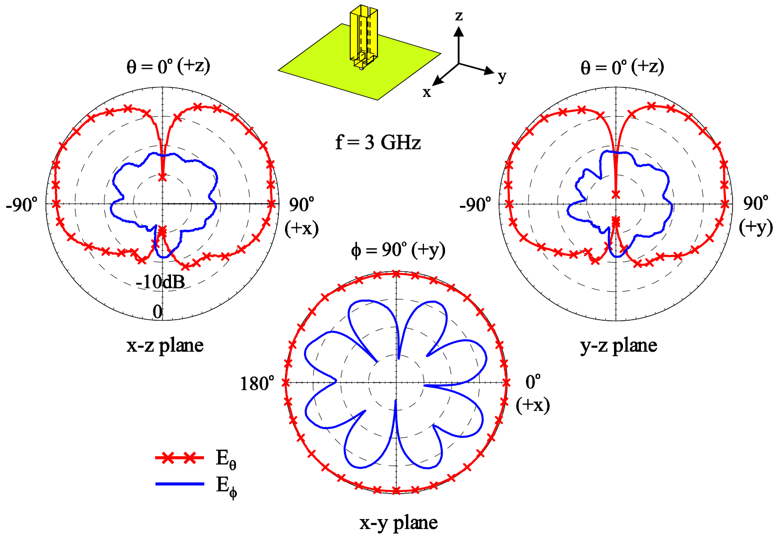

Fig. 6 Measured radiation patterns at 3 GHz.

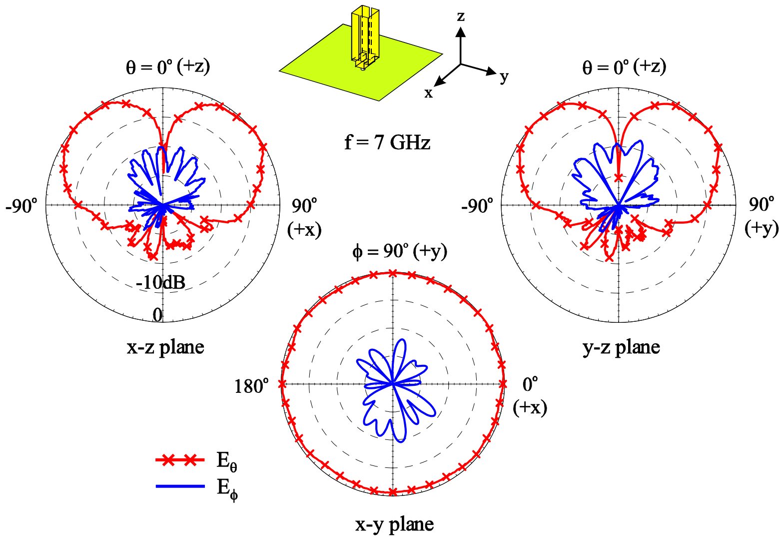

Fig. 7 Measured radiation patterns at 7 GHz.

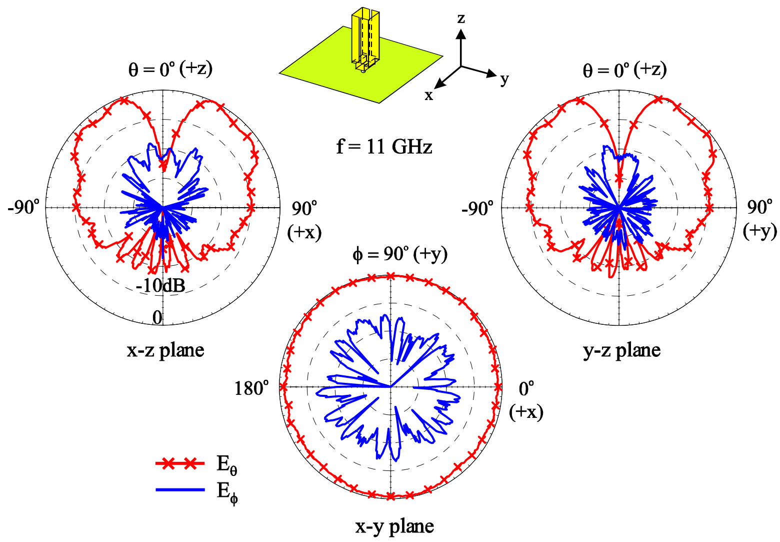

Fig. 8 Measured radiation patterns at 11 GHz.