COMPACT CPW-FED DUAL FOLDED-STRIP MONOPOLE ANTENNA FOR 5.8-GHz RFID APPLICATION

Wen-Chung Liu[1] and Ping-Chi Kao[2]
[1] Department of Aeronautical Engineering
National Formosa University
64 Wenhua Road
Huwei, Yunlin 632, Taiwan, Republic of China
[2] Institute of Electro-Optical and Materials Science
National Formosa University
64 Wenhua Road
Huwei, Yunlin 632, Taiwan, Republic of China

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ABSTRACT: *A coplanar waveguide (CPW)-fed monopole antenna with dual folded strips for the radio frequency identification (RFID) application is presented. The proposed antenna has a very compact size, with, including ground plane, only 14 × 8 mm², and can operate at the 5.8-GHz band with measured impedance bandwidth and average antenna gain of 450 MHz and ≥5.5 dBi, respectively, and also monopolelike radiation patterns.* © 2006 Wiley Periodicals, Inc. Microwave Opt Technol Lett 48: 1614–1615, 2006; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.21686

Key words: *CPW-fed; monopole antenna; compact antenna; RFID*

1. INTRODUCTION

Recently, the radio frequency identification (RFID) technology, a means for effectively tracking and managing goods, has been wildly investigated. The basic elements of a RFID system include a read/write device and a tag, and data is transferred between the tag and the read/write device wirelessly by means of electromagnetic waves at the assigned bands of 125 kHz; 13.56, 869, and 902–928 MHz; and 2.45 and 5.8 GHz. Thus, design of an antenna with a low profile, low cost, and especially compact size for valuable and easy use in a RFID tag becomes pressingly necessary. In the literature, several related antenna designs have been proposed [1–3]. However, these designs are either complex in antenna structure or still large in antenna size for practical applications.

In this paper, a novel design of a compact planar monopole antenna consisting of dual folded strips and a CPW feeding structure is presented. By properly selecting each length of the two folded strips to be about one-quarter wavelength, compact antenna size, good impedance matching condition, and good radiation characteristics suitable for the RFID application, even the wireless local area network (WLAN) system, at 5.8 GHz can be achieved. Details of the antenna design and both analytical and experimental results are presented and discussed.

2. ANTENNA CONFIGURATION

Figure 1 shows the configuration of the proposed compact CPW-fed monopole antenna design. The antenna was etched on one side of an FR4 microwave substrate with dielectric constant of 4.4 (ε_γ) and substrate thickness of 1.6 mm (h). Two equal inwardly folded strips were situated symmetrically with respect to the longitudinal direction (that is, the z-direction) and fed by a CPW feeding line to form a CPW-fed two-arm monopole antenna prototype. The geometrical parameters of the antenna were studied by analysis with the aid of the IE3D™ electromagnetic software. Finally, as shown in Figure 1, the strip widths for the two folded strips were both chosen to be 1 mm and each strip was constructed by two horizontal sections with equal length of 1.5 mm, and two vertical sections with lengths of 9 mm and (ℓ + 1) mm for the longer and shorter sections, respectively. The bottom ends of two folded strips were appropriately connected to the top two sides of a CPW feeding line with a signal strip of width 3 mm and length 6 mm. In addition, a gap distance of 0.5 mm between the signal strip and the two equal finite coplanar ground plane, each with length 4 mm and width 2 mm, and a vertical spacing of 1 mm from the bottom of the folded strip to the ground plane were also used. Using this design, we constructed the folded strip to provide a resonant path having a length of about 10 + ℓ mm (that is, 1.5 + 7 + 1.5 + ℓ) and thus the length ℓ may effectively tune the location of the resonant frequency. Moreover, the total size of the proposed antenna, including the ground planes, is only 14 × 8 mm², which provides an antenna size reduction of more than 20% and 87%, compared to that in [2] and [3], respectively.

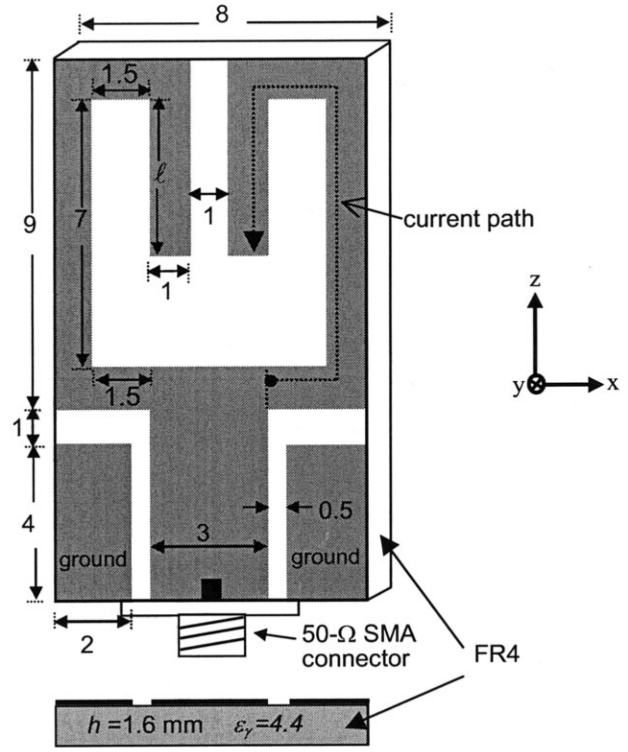

Figure 1 Configuration of the proposed compact CPW-fed dual folded-strip monopole antenna for 5.8-GHz RFID application (dimensions: mm)

3. RESULTS AND DISCUSSION

The effects of the strip length ℓ on the resonant frequency of the proposed antenna are firstly studied. Figure 2 shows the typical calculated return losses against frequencies for the cases of strip length ℓ = 2, 3, 4, 5, and 6 mm. From the plot, it is clearly seen that the resonant frequency is obviously moved towards the higher bands as the length ℓ is decreased. This can be explained in that the effective current path is shortened as ℓ decreases. Considering the bandwidth requirement for covering 5.8-GHz RFID applications, the case of ℓ = 4 mm, which excites a resonant mode at 5.75 GHz, was selected as the constructed prototype. Also note that this case has current length of about 14 mm or about 0.27λ, which is very close to one-quarter wavelength, at 5.75 GHz. Figure 3 shows the measured and calculated return losses for the proposed design with ℓ = 4 mm. It is seen that the proposed antenna has resonant-mode excitation at 5.79 GHz and simultaneously has a good matching condition. The measured 10-dB return loss bandwidth is 450 MHz,

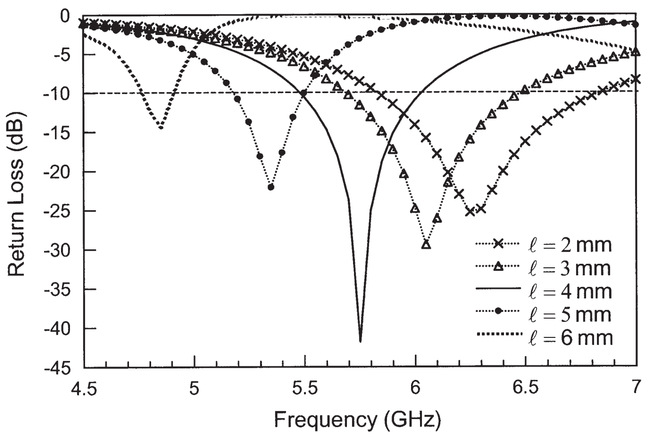

Figure 2 Calculated frequency responses of input return loss for the proposed antenna with various ℓ

ranging from 5.53 to 5.98 GHz. Also, agreement between the calculation and measurement clearly seems good.

The far-field radiation patterns at 5.79 GHz for the proposed antenna was also measured and shown in Figure 4. Monopolelike radiation patterns in the E-planes (x–z and y–z planes) and almost omnidirectional pattern in the H-plane (x–y plane) are observed. In addition, the radiation characteristic of this design has been found to be stable, since similar patterns have also been measured at other operating frequencies across the band. The peak antenna gain for frequencies across the operating band has also been measured. The antenna provides a very stable peak gain within the range of about 5.2–5.7 dBi.

4. CONCLUSIONS

A CPW-fed folded-strip monopole antenna with a compact size has been proposed, and a constructed prototype suitable for RFID and even WLAN applications in the 5.8-GHz band has been demonstrated. The proposed antenna can be designed to have bandwidth of 450 MHz, monopolelike radiation performance, and peak antenna gain of more than 5.5 dBi in average, but has only 14×8 mm^2 in antenna size. The antenna is mechanically robust and easy to fabricate and integrate with application-specific circuits.

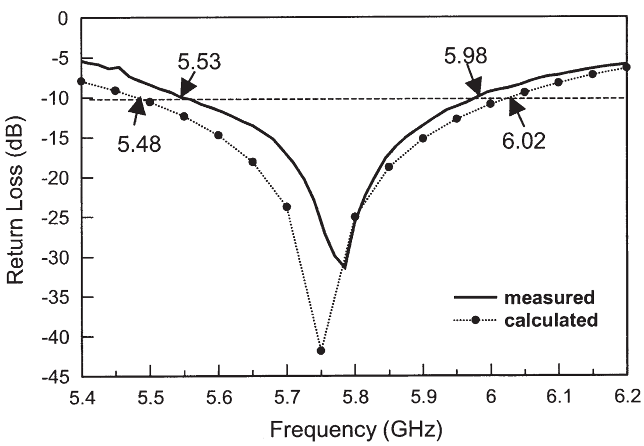

Figure 3 Measured and calculated frequency responses of input return loss for the proposed antenna with ℓ = 4 mm

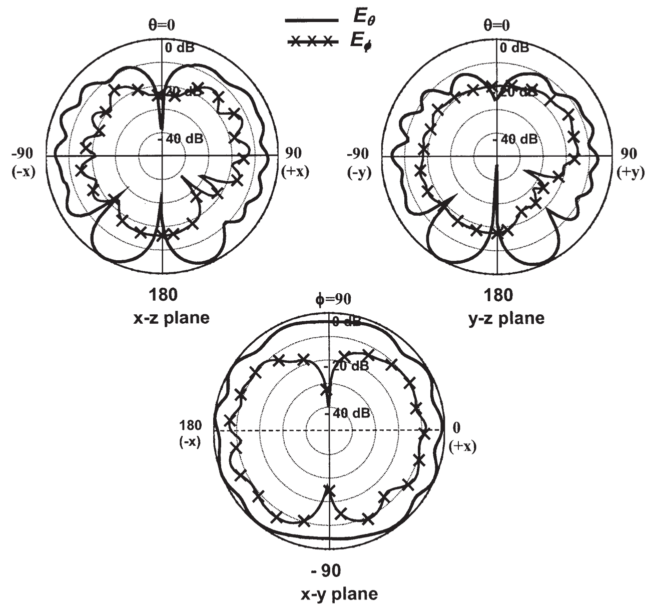

Figure 4 Measured far-field radiation patterns at 5.79 GHz for the proposed antenna with ℓ = 4 mm

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USING UV TECHNIQUE TO ACCELERATE THE MM-PO METHOD FOR THREE-DIMENSIONAL RADIATION AND SCATTERING PROBLEM

Hai Tao Chen,[1,2] Jian Xin Luo,[2] and Guo Qiang Zhu[1]
[1] College of Electronic Information
Wuhan University
Wuhan 430079, China
[2] Wuhan Maritime Communication Research Institute
Wuhan 430079, China

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ABSTRACT: *An UV method, method of moments (MoM), physic-optic method (UV-MM-PO) hybrid technique is proposed to analyze the large-scale electromagnetic problems. In this new method, the UV decomposition technique is used to accelerate the conventional MM-PO hybrid method. With this hybrid technique, the problem is divided to MM region and PO region, and the currents are all expanded by RWG functions. The expression of interaction matrix between MM region and PO region are reformulated as a combination of two matrices: one is only related to the direction of basis functions and another is only related to the distance between source and field. The elements of the latter are smooth, and this matrix propitiously dealt with by using the UV technique. With the sampling process of the UV technique, only a few elements of the interaction matrix should be calculated, and the computational efficiency can be improved evidently. Calculated examples show that the results of this method approach those of the MM-PO method,*