REDUCED-SIZE SLOT ANTENNAS WITH LOW CROSS POLARIZATION

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Abstract

In this paper, small slot antennas with low cross polarization are investigated. We employ a symmetrical meander slot structure to design a reduced size slot antenna fed by a microstrip line. It acts as a multiple-folded slot loop antenna with an area reduction up to 50%, while the cross-polarization less than –30dB can be achieved. The analysis and design of the antennas are accomplished using a commercial full wave simulation software. The results compare quite well with the experiments.

I. Introduction

The development of small, conformal and low cost antennas have drawn much attention due to the miniaturization requirements of the mobile handset terminals. On the other hand, one of the major degradations for the performance of the modern mobile wireless communication is multi-path fading. Diversity reception techniques are well known methods to reduce the effects of multi-path fading. Implement of space diversity at the mobile requires physically small antenna elements, while, a cross-polarization less than –30dB is required to suppress the unwanted polarization in polarization diversity technique. In this paper, small slot antennas with low cross polarization will be designed and reported.

There have been many studies in the literatures to reduce the over size of slot antennas. A chip-capacitor is mounted on a annular slot to reduce the area by 23%[1]. Earlier work also showed that the length of a dipole slot can be reduced by 17% using a capacitor loading [2]. A more effective way to reduce the slot antenna is to use meander slot antenna structure [3]. In this case, the cross polarization is usually high due to the non-symmetry of the structure. In this paper, we employ a symmetrical meander slot structure to design a reduced size slot antenna with low cross polarization. It is fed by a microstrip line and acts as a multiple-folded slot loop antenna with a area reduction up to

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50%, while the cross-polarization less than −30dB can be achieved.

II. Antenna Structures and Characteristics

A. A typical slot loop antenna

The typical structure of a square slot loop antenna is shown in Fig.1. An LXL square slot loop with slot width W is cut in the ground plane, of which the microstrip feed line is on the opposite side of the substrate. The width W_f is set to form a 50 ohm feed line. As the fundamental mode of the antenna is excited, the total length of the slot is about one wavelength of the corresponding coplanar slotline guiding structure. The equivalent magnetic currents on the slot are shown in Fig.2, of which Jm1 and Jm2 are the contributors of the co-polarization. Because of the non-symmetry of the whole structure including the feed line the radiation due to the pair of (Jm3,Jm5) and (Jm4,Jm6) won't exactly cancel each other at the phi=0 plane. This leads to the increase of cross-polarization to about −19dB by numerical simulation.

B. 2-folded slot loop antenna

In order to reduce the cross-polarization from the pair of (Jm3,Jm5) and (Jm4,Jm6), the slot loop is bent to form a 2-fold slot loop structure as shown in Fig.3 such that the effective length of the cross-polarization source is reduced. The dimensions of slot and the microstrip fed open end stub length for the new structure are optimized to achieve the best performance. The analysis and design of the antennas are accomplished using a commercial full wave simulation software. The low cost FR4 board (h=1.6mm, epsilon=4.85) is used to implement the proposed antenna The dimensions of the antenna are listed below: W_f=3.05mm, L_f=2.63mm, W=16.16mm, W_1=0.74mm, W_2=1.89mm, L=17.48mm, L_1=2.9mm and L_2=0.9mm. The area reduction of the new antenna is about 50% as compared to the typical slot loop antenna. The equivalent magnetic currents on the slot are shown in Fig.4, of which the pair of (Jm3,Jm13) and (Jm4,Jm14) are now the main sources of the cross-polarization, which are shorter than (Jm3,Jm5) and (Jm4,Jm6) in Fig.2. This leads to the decrease of the cross-polarization to about −32dB by numerical simulation. The simulated reflection coefficient of the antenna compares quite well with the experiment as shown in Fig.5. The bandwidth is about 2.1% with center frequency at the ISM band f_o=2.45GHz. The radiation patterns of the E-plane and H-plane are shown in Figs.6 and 7. The experimental cross-polarization of −20dB is higher than the simulated result −30dB, which is due to the accuracy of the experimental setup.

Conclusion

A small slot antenna with low cross polarization is designed. The area reduction of the antenna is about 50%, while the cross-polarization is reduced from –19dB to –32dB. More results of various folded slot loop antennas, including 3-fold and 4-fold will be presented at the conference.

References:

[1] Cheng-Shong Hong, "Small annular slot antenna with capacitor loading, " Electronics Letters, pp.110 –111,Vol.36, no.2 , 2000

[2] Konno, K.; Wada, H.; Matsukawa, K., "Small-Sized Slot Antenna for Id-Card," AMPC '92, Vol.1, pp.141 –144, Aug 1992

[3] Wang, H.Y.; Taylor, S.; Simkin, J.; Oakley, J.M.; Emson, C.; Lancaster, M.J, "Simulation of microstrip small antennas," Antennas and Propagation 2001, Vol.2 , pp.611 -614

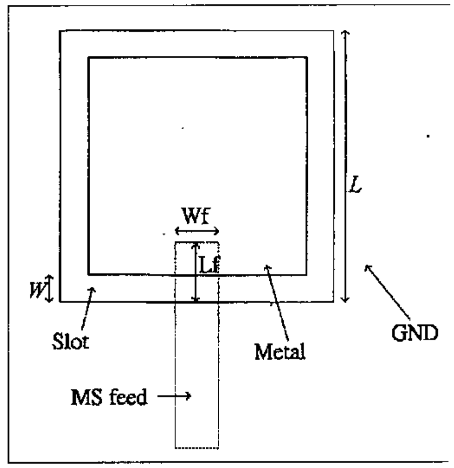

Fig.1 The antenna structure of a typical slot loop antenna

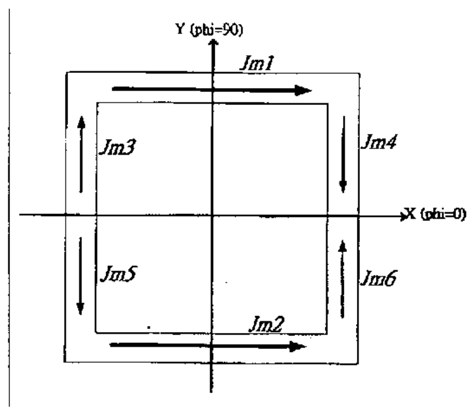

Fig.2 The equivalent magnetic current on a typical slot loop antenna

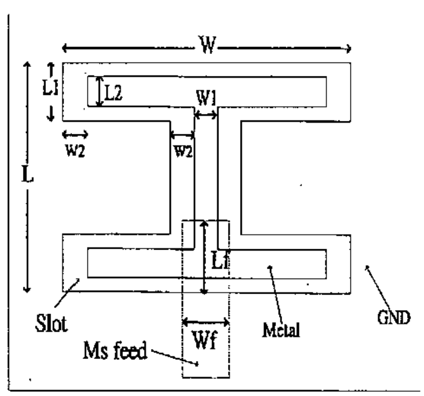

Fig.3 The antenna structure of the 2-folded slot loop antenna

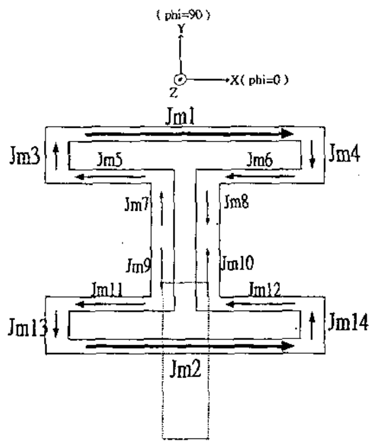

Fig.4 The equivalent magnetic current on the 2-folded slot loop antenna

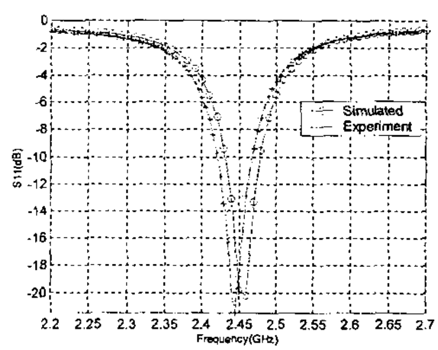

Fig.5 The reflection of the 2-folded slot loop antenna

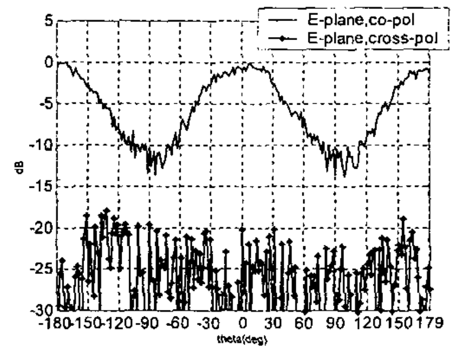

Fig.6 The E-plane radiation pattern of the 2-folded slot loop antenna

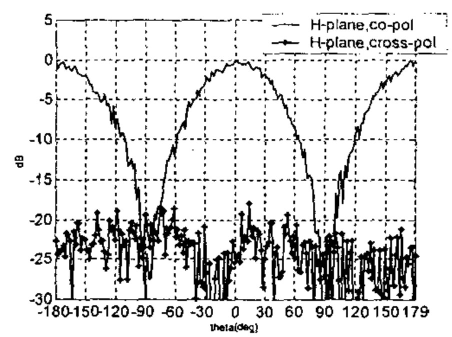

Fig.7 The H-plane radiation pattern of the 2-folded slot loop antenna