Rapid Communication

Indian J. Phys. **82** (7) 829-832 (2008)

IJP

Experimental investigation on single layer single-feed dual frequency (dual band) reduced sized slotted square microstrip patch antenna

S Bhunia[1], S Biswas[2], D Sarkar[2] and P P Sarkar[2*]

[1]Academy of Technology, Hooghly-712 121, West Bengal, India

[2]USIC, University of Kalyani, Kalyani, Nadia-741 235, West Bengal, India

E-mail : parthabe91@yahoo.co.in

Received 14 August 2007, accepted 13 May 2008

Abstract : A novel, compact, single probe-feed square microstrip patch antenna for operation in dual frequency can be achieved by cutting a circular slot having an inner square patch at its centre. From the experimental results obtained, the antenna size using the proposed design method can be reduced by about 70% compared to what is achieved in conventional design method using a simple square patch without the slot. This paper focuses about the typical results obtained experimentally.

Keywords : Dual frequency, dual band microstrip antenna.

PACS No. : 84.40.Ba

1. Introduction

In the designing of global positioning system and wireless communication, system miniaturization of the antenna has a vital role. Due to the lightness of microstrip antennas, they are well suited for systems to be mounted on airborne platforms, like synthetic-aperture radar (SAR). The broadening of total bandwidth can be achieved by using dual frequency patch antenna. Dual frequency antennas exhibit a dual resonant behavior in a single radiating structure. If any system requires two resonant frequencies, too far apart, dual frequency antenna with higher frequency ratio can be used instead of two different antenna arrays to reduce the area and weight. Different techniques have been reported to reduce the patch antenna size, such as a square-ring patch fed by a microstrip line, the use of cross and bend slots embedded in the radiating patch [1–3] and the use of a slot in the ground plane [4]. Another dual frequency antenna

*Corresponding Author

with square slot or rectangular slot loading have been reported in Refs. [5,6]. A compact dual-frequency microstrip antenna has been proposed in Ref. [7], which uses the rectangular microstrip patch loaded with one shorting pin. Characteristics of dual frequency compact rectangular microstrip patch antenna with a number of shorting pins have also been studied in Ref. [8]. A size reduction of the microstrip patch up to 51%, operating in dual-polarization mode by cutting symmetric pattern of cross slots from the square probe-fed patch has been reported in Ref. [9].

In this paper, we propose a single-feed antenna design by cutting a circular slot having an inner square patch at its centre. Results show that the proposed antenna is about 70% smaller compared to a traditional square patch antenna operating at the same frequency and we get the dual frequency operation in two different bands *i.e.* *S* and *C* bands having frequency ratio

2. Antenna design

The configuration of the compact-dual frequency antenna is shown in Figure 1. The antenna consists of a square microstrip patch of side L = 26 mm with a circular slot of diameter D = 20 mm having an inner square patch of side length W = 10 mm supported on a grounded dielectric sheet of thickness h = 1.5875 mm and dielectric constant ε_r = 2.4. The probe feed (radius r_p = 0.5 mm) is placed at the center of the square patch. Due to the additional slot perturbation for the horizontal patch surface current path as compared to the reference antenna without slot, surface current paths of the two resonant modes can be lengthened, which lowers the corresponding resonant frequencies.

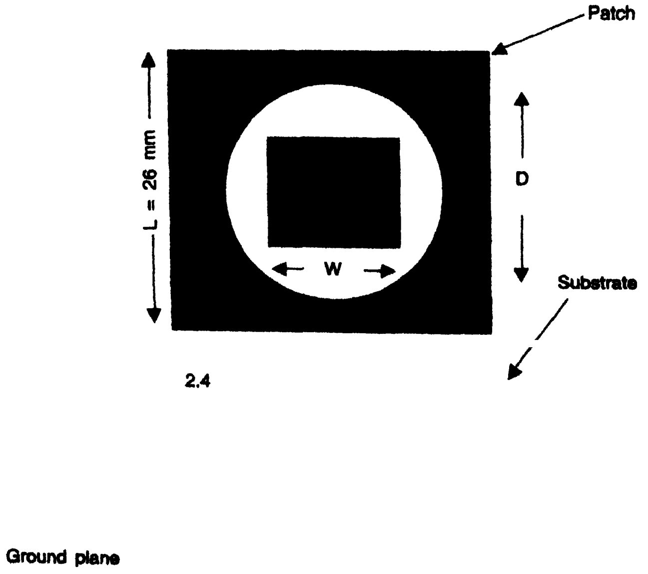

Figure 1. Geometry of square patch antenna with a slot.

3. Experimental results

Figure 2 shows the typical results of the measured return loss. The first two resonant frequencies are 2009 MHz and 6112.5 MHz. The corresponding return losses are –10.7 dB and –15.8 dB. The 10 dB bandwidth of the first resonant frequency is about 44 MHz, which is 2.19% of the resonant frequency. The 10 dB bandwidth of the second resonant frequency is about 150 MHz, which is 2.454% of the resonant frequency. The reference square patch antenna without slot resonating at 2009 MHz has the dimension L = 47.23 mm. However, the antenna proposed in this work has the dimension of L = 26 mm only. Hence, an antenna size reduction of about 69.69% can be easily achieved. Chen *et al.* has reported [5] 17% size reduction by cutting a square slot inside the rectangular patch. The 10 dB bandwidth of about 1.8% and of 2% have been reported for the two resonant frequencies 1932 MHz and 2475 MHz.

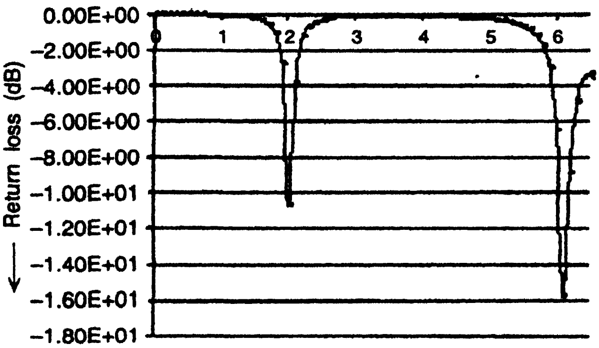

Figure 2. Return loss against frequency.

Figure 3 shows the radiation pattern of the proposed microstrip antenna in which the normalized amplitude (in dB) and radiation angle are plotted along Y axis and X axis, respectively. It is seen that the radiation pattern in H plane is better at higher frequency. The half-power beam width is about 100° and 120° for the 1st and 2nd resonant frequencies, respectively.

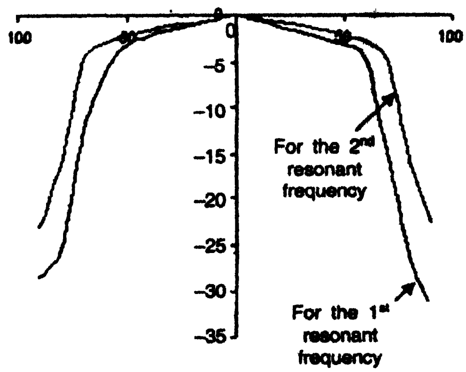

Figure 3. Radiation pattern.

4. Conclusion

In our designed slotted square microstrip patch antenna, we have two resonant frequencies. Considering 10 dB bandwidth, we have 2.19% and 2.45% bandwidth of the two resonant frequencies that are better than the experimental results reported in Refs. [5,9]. At the same time, we have achieved about 70% size reduction. The two frequencies in two different bands *i.e. S* and *C* bands are well separated having the frequency ratio ~3.04. The above results are encouraging. The proposed antenna may be used in synthetic-aperture radar (SAR) system.

References

[1] C Y Huang, J Y Wu and K L Wong *IEEE Trans. Antennas Propag.* **47** 605 (1999)

[2] H Iwasaki *IEEE Trans. Antennas Propag.* **44** 1399 (1996)

[3] W S Chen, C K Wu and K L Wong *Electron. Lett.* **34** 1278 (1998)

[4] J S Row and C Y Ai *Electron Lett.* **40** 1093 (2004)

[5] W S Chen *Electron Lett.* **34** 231 (1998)

[6] S C Gao and J Li *Progr. Electromagn. Res. PIER* **23** 59 (1999)

[7] K L Wong and W S Chen *Electron. Lett.* **33** 646 (1997)

[8] S C Gao and L W Li *IEEE Transaction on Vehicular Technology* **51** 8 (2002)

[9] K Gosalia and G Lazzi *IEEE Trans. Antenna Prop.* **51** 2182 (2003)