Printed Microstrip-Line-Fed Compact Dual-Frequency Slot Antenna with an Open-Square Strip

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1. Introduction

There are many developments reported on dual-frequency slot antenna designs in [1-4]. However, it is found that the dimensions of slot used in [1-4] are large. In order to miniaturize the antenna size, a compact microstrip-line-fed dual-frequency slot antenna is proposed in this paper. With embedding an open-square strip along sides of slot, the dual-frequency slot antenna with a compact size can be obtained. Details of the proposed dual-frequency slot antenna are presented and discussed.

2. Antenna designs and experimental results

Figure 1 shows the geometry of the proposed microstrip-line-fed dual-frequency slot antenna. The square slot with the size of 25×25 mm^2 is printed on an inexpensive FR4 substrate which has the thickness of 1.6 mm and the relative permittivity of 4.4. The 50-Ω microstrip feed line has the length of Ls mm and the width of 3 mm. Especially, an open-square strip is embedded along sides of this square slot.

Without the use of open-square strip, it is noted that the fundamental mode at the center frequency 3760 MHz can be excited only. After using the open-square strip, the dual-frequency operation with various frequency ratios can be excited. When the length of this open-square strip is shorter as d_1 = 0 and d_2 = 10~22 mm, the dual-frequency operation can be excited with frequency ratio from 1.63 to 1.87. When the length is longer as d_2 = 22 mm and d_1 = 0~10 mm the frequency ratio can be excited from 1.87 to 1.95. In this design, different ground sizes are used by varying the length of G. When the parameter G is changed from 30 to 1 mm, it is found that BW_1 of lower band has the impedance bandwidth of from 6.35% to 11.06% and BW_2 of upper band from 21.07% to 27.27%. It means that the use of smaller ground plane can result in its larger impedance bandwidth. With the case of d_1 = 5mm, d_2 = 22 mm, G = 22.5mm and Ls = 36mm, the measured and simulated results of return loss are shown in Fig. 2. It is seen that the measured results can agree with the simulated ones very well. From measured results, the proposed dual-frequency antenna can be excited with the frequency ratio of 1.94% so that BW_1 for the lower band has the impedance bandwidth of 7% and BW_2 for the upper band has 22%.

From experimental results, it is found that by varying the lengths, d_1 and d_2, of open-square strip the beginning frequency of lower band can be excited from 2130 to 1770 MHz that makes the antenna size more compact. The compact ratio of size reduction is about 31% with respect to the beginning frequency at 2130 MHz as $d_1 = 0$ and $d_2 = 10$ mm. In Fig. 3, measured radiation patterns of the proposed antenna are presented by E- and H-planes. It is seen that the measured results of lower band at 1920 and 3590 MHz and upper band at 4050 MHz have the same polarization plane and broadside radiation patterns. In Fig. 4, measured antenna gains are shown. The gain variations in the lower and upper bands can be less than 2dBi.

3. Conclusions

In this paper, a printed microstrip-line-fed dual-frequency slot antenna has been demonstrated. With the use of an open-square strip, experimental results show that a compact dual-frequency slot antenna can be obtained. By varying the lengths of d_1 and d_2, the frequency ratio can be excited from 1.63 to 1.95. With the case of $d_1 = 5$mm, $d_2 = 22$ mm, G = 22.5mm and Ls = 36mm, the proposed dual-frequency antenna can be excited with the impedance bandwidth of 7% for lower band and 22% for upper band. In addition, the radiation patterns of lower and upper bands have been measured and presented by E- and H-planes. It is seen that they are similar to those of a conventional square-slot antenna. From measured results, antenna gain variation can be less than 2 dBi within both of lower and upper bands.

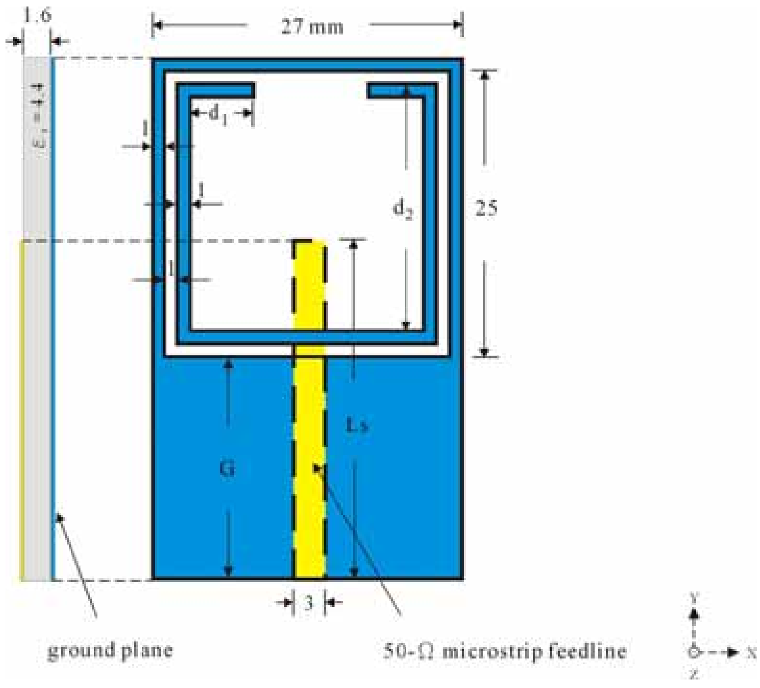


Fig. 1: Geometry and dimensions of the proposed dual-frequency slot antenna

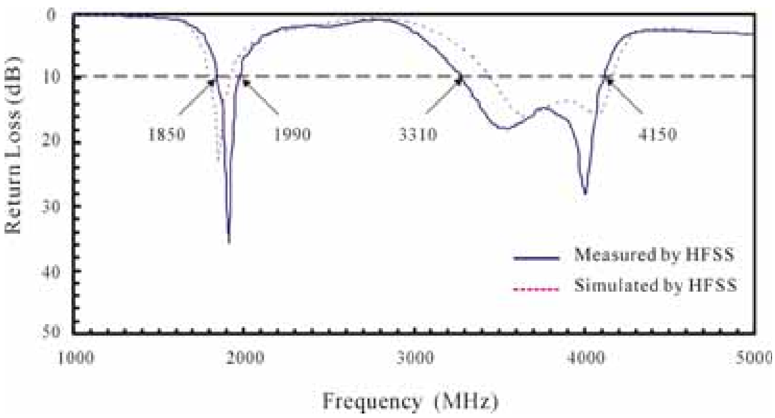


Fig. 2: Simulated and measured results of return loss against frequency as d_1 = 5mm, d_2 = 22 mm, G = 22.5mm and Ls = 36mm in Fig. 1

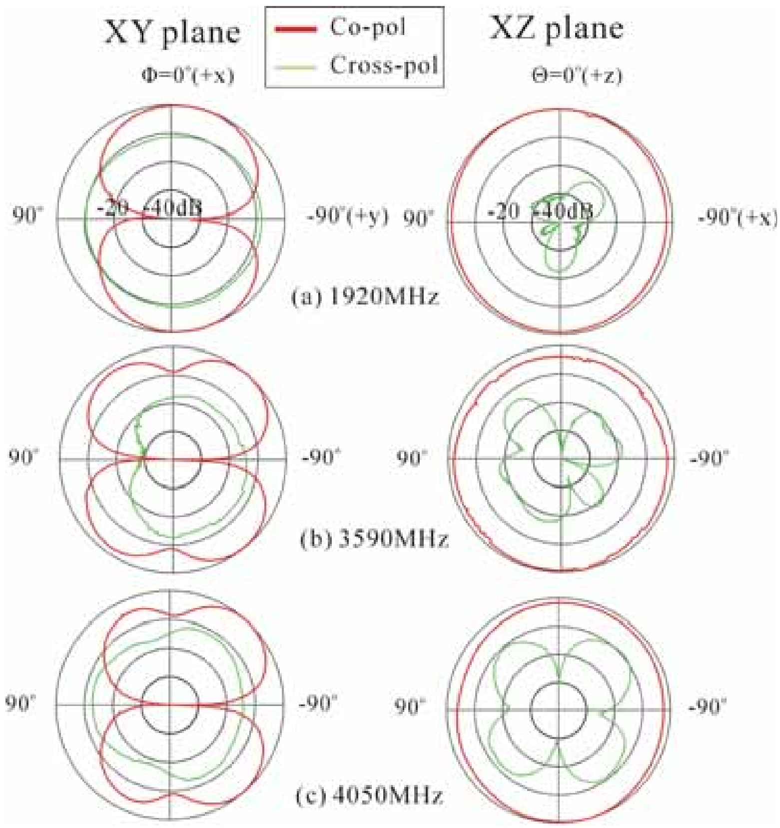
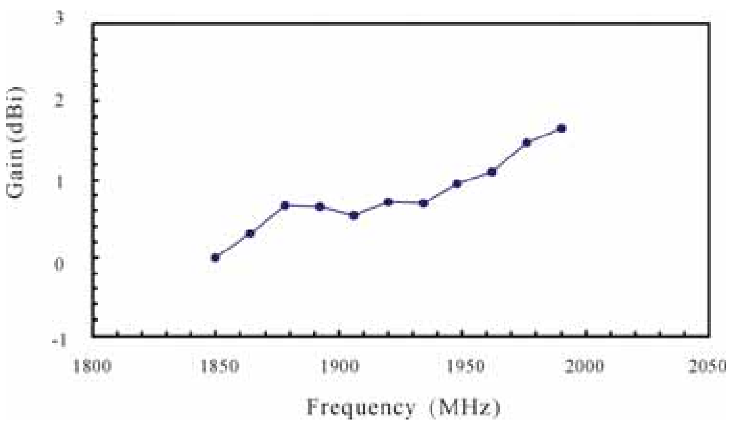
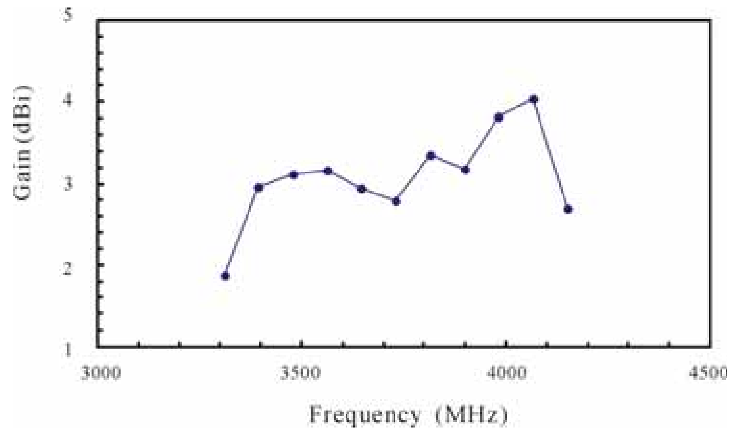


Fig. 3: Measured E- and H-plane radiation patterns at (a) 1920, (b) 3590, and (c) 4050 MHz



(a) Lower band



(b) Upper band

Fig. 4: Measured antenna gains against frequency of the proposed dual-frequency antenna

Acknowledgments

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References

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