Design and Study of Multiband Microstrip Antenna

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Abstract— A multiband antenna which is fed by a SMA coaxial probe is investigated in this paper. The proposed antenna is composed of a circular patch and a loop microstrip line. By introducing a loop microstrip line and three probes feeding for the circular patch, the proposed antenna delivers the multiband impedance matching performance. The simulated result shows that the antenna has three frequency bands covering 1.254–1.404 GHz, 1.653–1.746 GHz and 2.142–10.752 GHz for VSWR < 3. Details of the antenna design and results are presented.

1. INTRODUCTION

With the rapid developments in wireless communication technology, multiband antennas are increasingly demanded in many wireless systems. Many printed multiband antennas can be achieved by microstrip line feed [1–6]. By adding extra resonant elements to the main patch, a microstrip-fed multi-band planar antenna was presented in [1]. In [2], two resonant radiating parts were used for a dual-band antenna. In [3], a dual-band slot antenna was proposed for wireless local area network (WLAN) applications. A multiband antenna consisting of a set of printed frame dipoles was proposed in [4]. A dual-band dipole antenna with an integrated balun feed was given in [5]. In [6], a dual-band planar antenna design using a dual-feed monopole slot was proposed for WLAN applications.

Multiband antennas can also be designed by using a coaxial probe feed [7, 8]. A dual-band antenna was proposed in [7], which consisted of a longer dipole for the lower band and a pair of shorter dipoles for the upper band. In [8], a dual-band patch antenna was achieved by using a double SRR on a grounded dielectric slab.

In this paper, we propose a new simple multiband antenna. The tri-band antenna consists of a circular patch and a loop microstrip line, which is fed by a SMA coaxial probe. The circular patch is fed by three probes connected to the loop microstrip line. The proposed antenna is designed

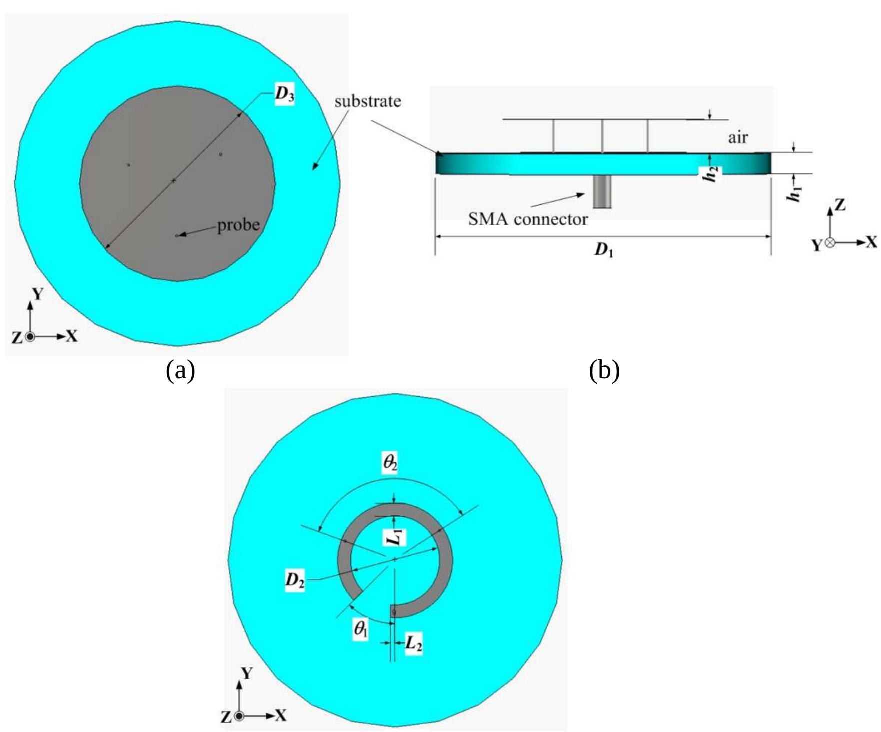

Figure 1: Geometry of the proposed antenna.

to cover three bands of 1.254–1.404 GHz, 1.653–1.746 GHz and 2.142–10.752 GHz with acceptable performance in terms of gain, and impedance matching. Radiation patterns at different frequencies, and the gain across the operating bandwidth are studied.

2. ANTENNA DESIGN

The configuration of the proposed antenna is illustrated in Figure 1. The antenna comprises three layers of conductor, which include a circular radiating patch, a loop microstrip feed line, and a circular ground plane. The loop microstrip line is fabricated on a FR4 substrate with diameter $D_1 = 150$ mm, thickness $h_1 = 3$ mm, relative permittivity $\varepsilon_r = 4.4$. The inner diameter and width of the loop microstrip line are $D_2 = 40$ mm and $L_1 = 5.8$ mm, respectively. The loop microstrip line has a cut with $\theta_1 = 46°$, and is connected with a rectangular metal ($L_1 \times L_2 = 5.8\,\text{mm} \times 2\,\text{mm}$). The antenna is fed by SMA coaxial probe which places at a distance of 22.9 mm away from the center along y-axis, and connected to the loop microstrip line. The circular radiating patch of diameter $D_3 = 90$ mm is placed above the feed line at spacing of $h_2 = 5$ mm. The circular radiating patch

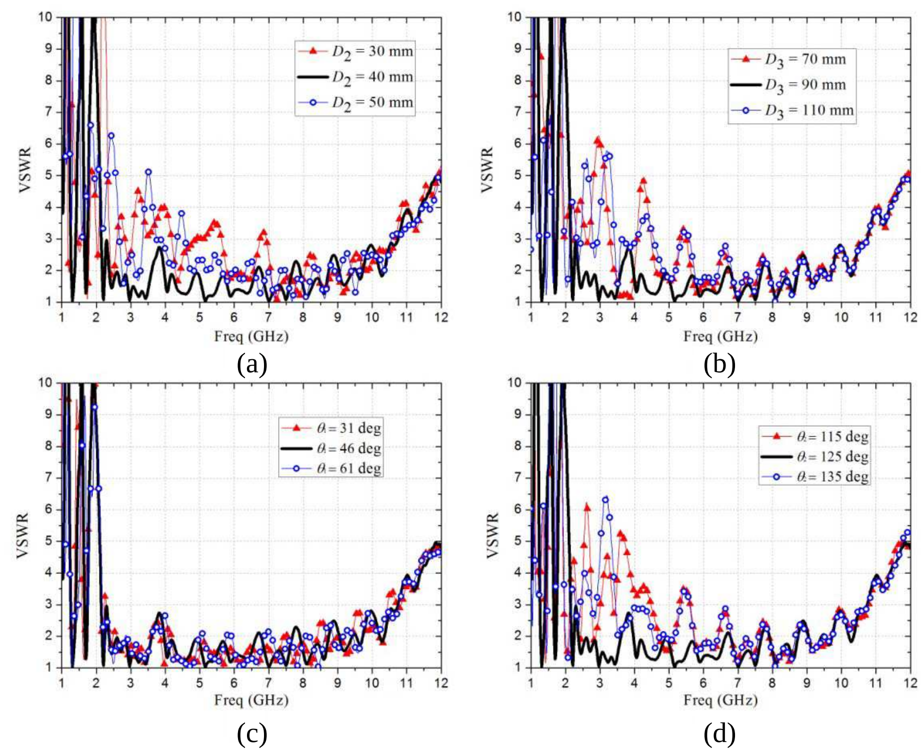

Figure 2: VSWR variation for different (a) D_2, (b) D_3, (c) θ_1, and (d) θ_2.

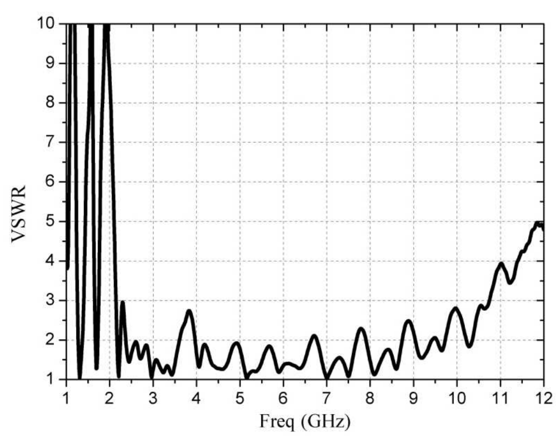

Figure 3: Simulated VSWR of the proposed antenna.

is fed by three probes. The diameter of probes is 1 mm. These three probes are placed along the microstrip feed line with 24 mm away from the center and sequentially rotated 125° (θ_2).

The performance of the proposed antenna is analyzed and optimized by full-wave electromagnetic simulation software based on FITD.

3. RESULTS AND DISCUSSIONS

A series of simulations are conducted in order to provide more detailed information about the antenna design. The diameters of the loop microstrip line and circular radiating patch have effects on impedance matching. From Figures 2(a) and (b), it is observed that the impedance bandwidth greatly depends on D_2 and D_3. Narrowing or increasing these two diameters, respectively, makes the impedance bandwidth reduce. Figure 2(c) shows the effects of the angle θ_1 on the impedance matching. It is shown that the angle θ_1 mainly affect the performance on the low frequency band.

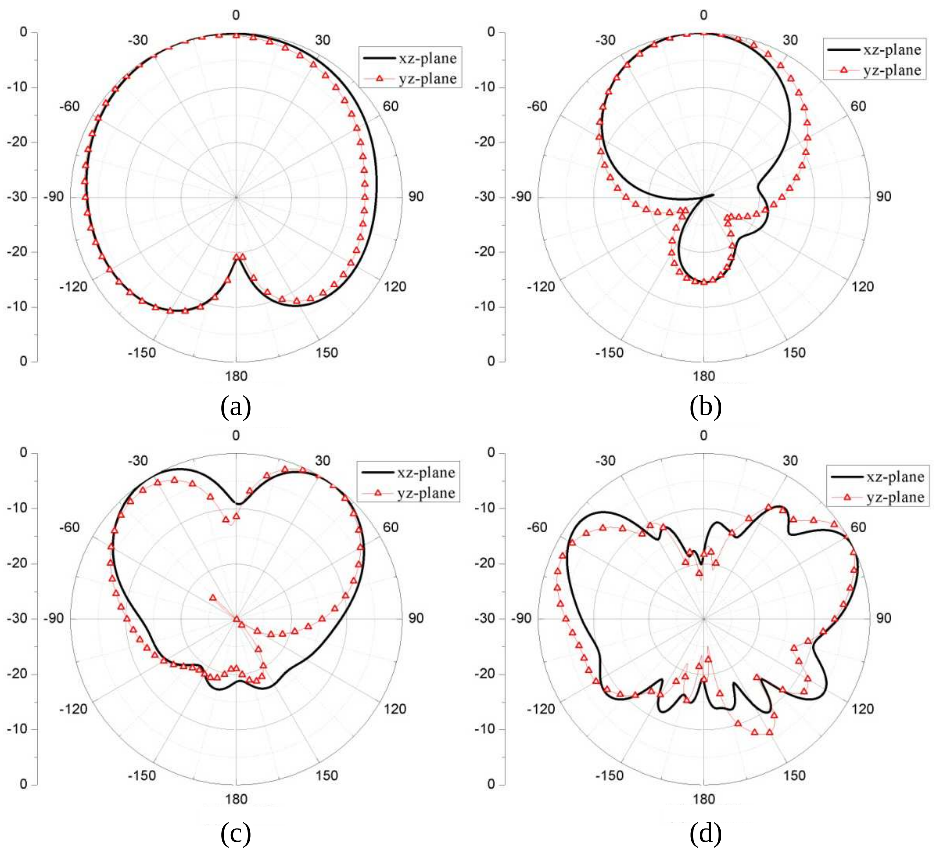

Figure 4: Radiation patterns of the proposed antenna at (a) 1.3 GHz, (b) 1.69 GHz, (c) 2.5 GHz, and (d) 8.5 GHz.

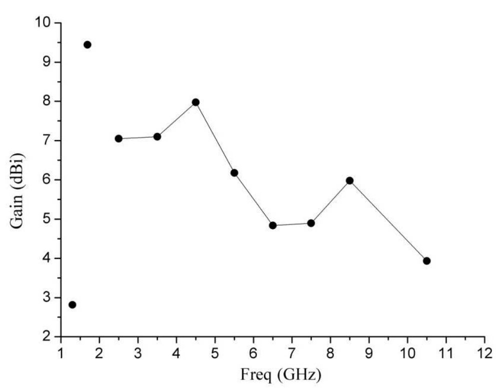

Figure 5: Gain of the proposed antenna.

The effect of the angle θ_2 is also very remarkable, shown in Figure 2(d). The impedance matching can be obtained by tuning angle θ_2. The VSWR based on the optimal parameters are given in Figure 3.

The radiation patterns of the proposed antenna in the two principle planes are shown in Figure 4. It can be seen that the proposed antenna has good directional radiation patterns at 1.3 and 1.69 GHz. However, at 2.5 and 8.5 GHz, the antenna exhibits conical beam patterns. The gains of the proposed multiband antenna are respectively about 2.8 dBi for the 1.3-GHz band, 9.4 dBi for the 1.69-GHz band and 3.9–8.0 dBi for the third band as shown in Figure 5.

4. CONCLUSION

A novel multiband antenna, fed by a SMA coaxial probe, is successfully implemented with good impedance matching characteristic. The diameter and height of the proposed antenna is 150 mm and 8 mm, respectively. The 3 : 1 VSWR bandwidths are ranging from 1.254 to 1.404 GHz, from 1.653 to 1.746 GHz, and from 2.142 to 10.752 GHz. Besides, the antenna exhibits a good and stable radiation performance across the whole band. The proposed antenna is suitable in many wireless systems.

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