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A LOW-PROFILE AND BROADBAND CONICAL ANTENNA

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Abstract—A novel electric small conical antenna working on a very broad band, 0.47–6 GHz, with the height of only 60 mm, is presented. A capacitive ring on the top of the cone and three oblique shorted lines are used to expand the work band. By changing the width of the ring and the slope of the oblique line, the impedance of the antenna matches 50-ohm feed line commendably. Simulation and experiment results demonstrate that this antenna provides very broad band and low-profile characters, which exhibits a 12.8 : 1 impedance bandwidth with voltage standing wave ratio (VSWR) below 2 : 1 (the impedance bandwidth is 11.9 : 1 with the VSWR below 1.5 : 1) and with the height only 0.094 wavelength associated to the lowest frequency.

1. INTRODUCTION

Numerous multiband and wideband antennas [1–6] have been developed in response to the recent demand for wireless communication systems. Because of their electrically small size and essential broadband property conical antennas and their variations have been largely investigated for applications in broadband coverage [6–14]. Some of the antennas proposed in these papers have no low-profile characters and some of the antennas have no very broad band properties.

In this paper, a conical antenna composed of a capacitive ring and shorted lines placed above a ground plane is proposed. The capacitive ring is placed on the top of the cone and the shorted lines are between the ring's edge and ground. In addition, the lines are sloping which are very useful for the miniature and broadband of the

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antenna. By optimizing the width of the ring and the slope of the lines, this kind of antenna obtains very broad band and low-profile properties. Details of the antenna design are described in this paper, including simulation and measurement results. The antenna presented has a great advantage of 12.8 : 1 impedance bandwidth with VSWR below 2 : 1 and its height is only 0.094 wavelength relative to the lowest frequency.

2. ANTENNA DESIGN

The geometry and configuration of the proposed low-profile antenna is illustrated in Fig. 1. A conical monopole is placed on a circle ground plane with the radius of 400 mm, and the height of the antenna is 60 mm. The main radiation part is the cone whose base radius has been optimized to match the 50-ohm feed line. A circle ring is placed on top of the cone in order to make the match better. In addition, three oblique shorted lines which link the ring and ground are used for

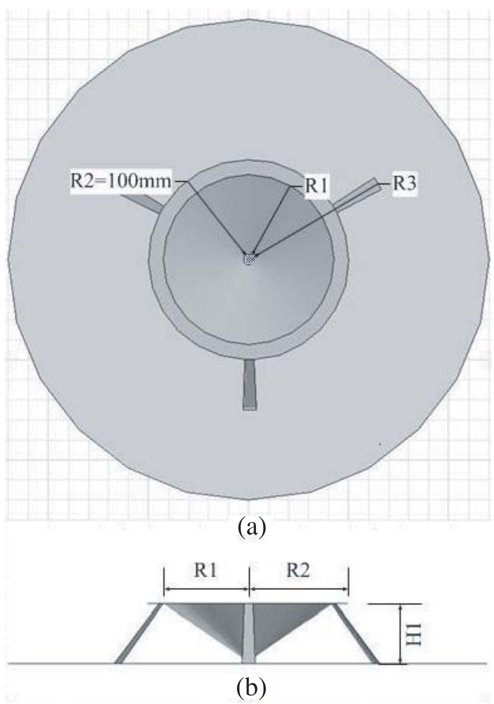

Figure 1. Geometry of the conical antenna. (a) Top view, (b) side view.

the further broadband and miniature of the antenna. The number of the lines is associated to the symmetry of the radiation pattern and without dramatic affection on the input impedance. As shown in Fig. 1, $R1$ is the top radius of the cone and the inner radius of the ring; $R2$ is the outer radius of the ringequal to 100 mm; $R3$ is the distance between

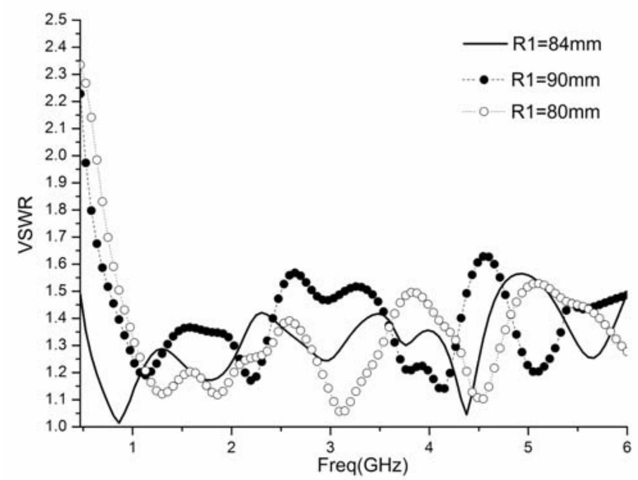

Figure 2. Simulated VSWR for various $R1$ ($R3 = 128\,\text{mm}$).

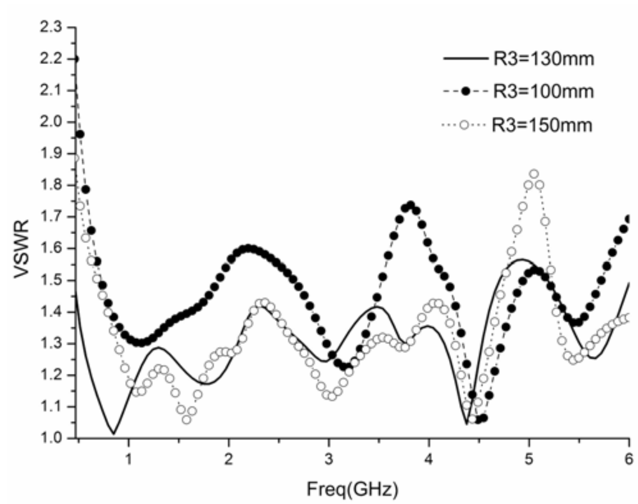

Figure 3. Simulated VSWR for various $R3$ ($R1 = 84\,\text{mm}$).

the base end point of the lines and the center point of the ground. By adjusting the width of the ring and the slope of the lines (adjusting $R1$ and $R3$), the antenna can obtain very broad band and low-profile properties. The variations of VSWR with the variations of $R1$ and $R3$ are showed in Fig. 2 and Fig. 3 respectively, which are simulated using Ansoft Frequency Structure Simulation 11.0 (HFSS 11.0).

By optimizing the values of $R1$ and $R3$, the antenna

(a) (b)

Figure 4. Photograph of the proposed antenna. (a) Without full ground, (b) with ground.

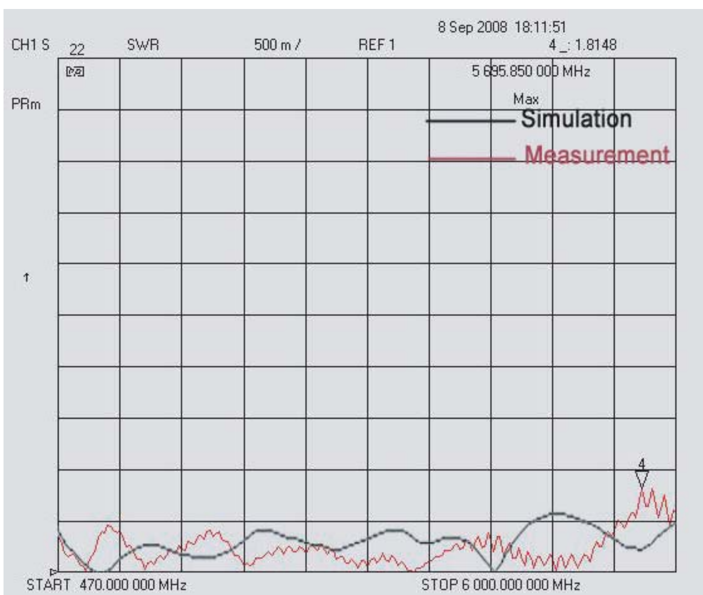

Figure 5. Measured and simulated VSWR.

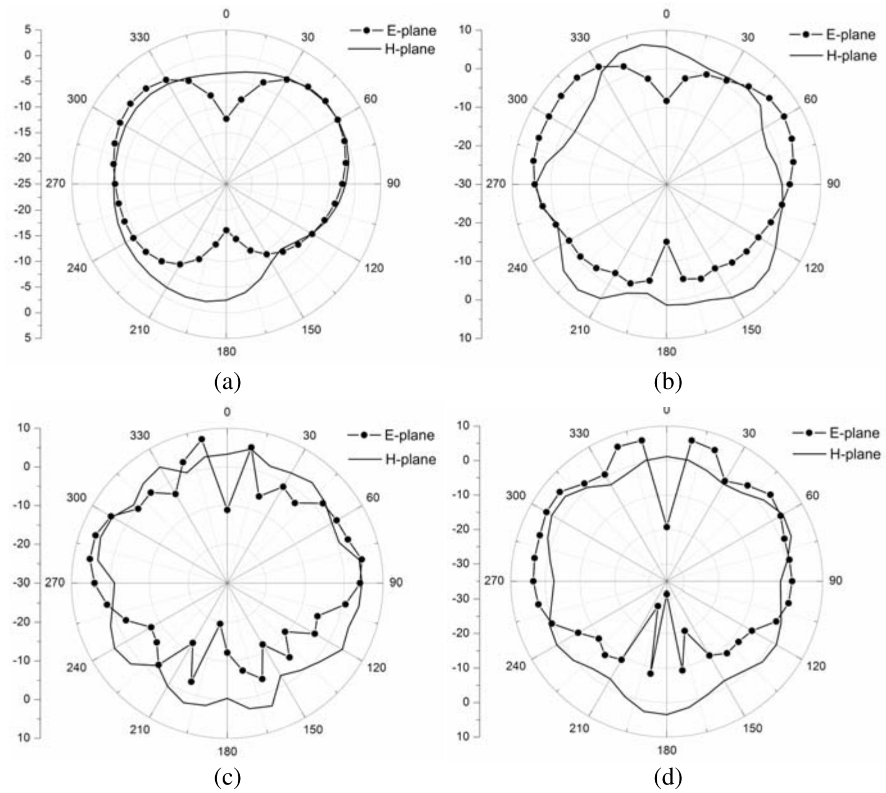

Figure 6. E-plane and H-plane radiation patterns. (a) 470 MHz; (b) 1.7 GHz; (c) 3.0 GHz; (d) 4.6 GHz.

with broadband and low-profile properties has been designed and manufactured. The photograph of the antenna is shown in Fig. 4.

3. PERFORMANCE

Both the simulated and the measured VSWR for the proposed antenna are presented in Fig. 5. Simulations were performed using ansoft HFSS software and measurements with HP8753D vector network analyzers. Although the results are in good agreement, there are some discrepancies and frequency shift between the simulated and measured substrate, which is because the band is too broad for the software to guarantee high accuracy and the fabrication of the antenna may bring some inaccuracy too. Fig. 6 gives the E- and H-plane radiation patterns of the antenna at several frequency points. It is obvious that the pattern of the antenna is like the pattern of a monopole on a finite ground.

4. CONCLUSION

A very short antenna with only 0.094 wavelength relative to the lowest frequency has been investigated, which shows a 12.8 : 1 impedance bandwidth. The antenna is based on a conical structure associated to a ring on the top and three oblique short lines attached to the ground. Simulated and measured results show that the performance of the antenna is very well.

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