

A LOW-PROFILE AND BROADBAND CONICAL ANTENNA

S. Zhou, J. Ma, J. Deng, and Q. Liu

National Key Laboratory of Antenna and Microwave Technology
Xidian University
Xi'an, Shaanxi, P. R. China

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

Corresponding author: S. Zhou (sgzhou@mail.xidian.edu.cn).

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

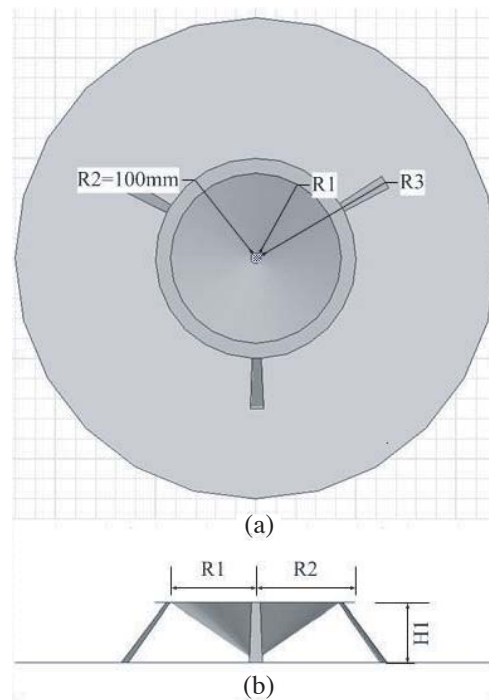


Figure 1. Geometry of the conical antenna. (a) Top view, (b) side view.

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, R_1 is the top radius of the cone and the inner radius of the ring; R_2 is the outer radius of the ring equal to 100 mm; R_3 is the distance between

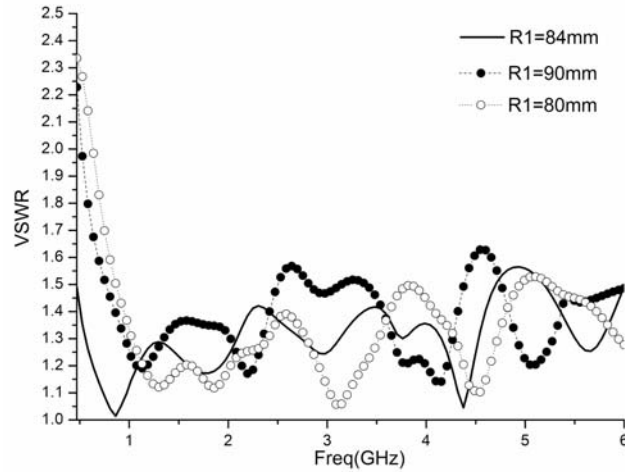


Figure 2. Simulated VSWR for various R_1 ($R_3 = 128$ mm).

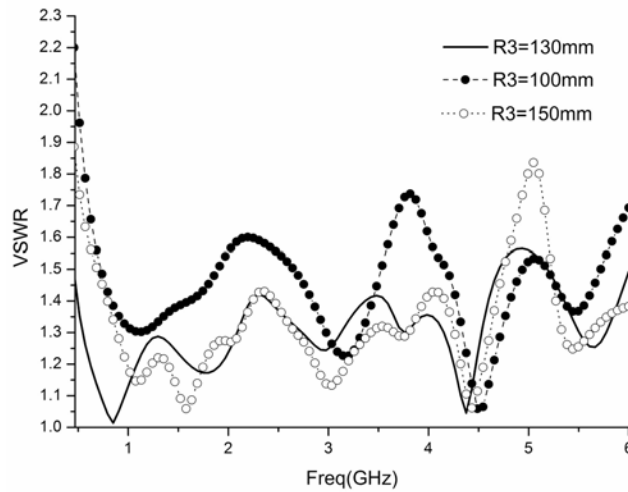


Figure 3. Simulated VSWR for various R_3 ($R_1 = 84$ mm).

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

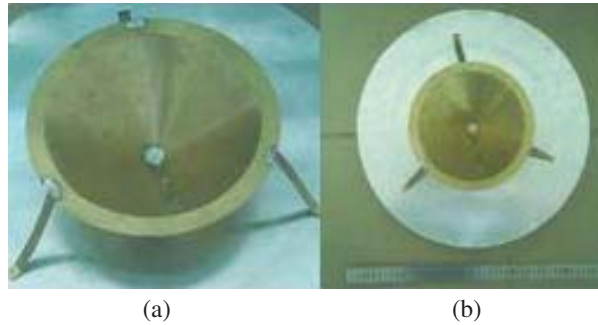


Figure 4. Photograph of the proposed antenna. (a) Without full ground, (b) with ground.

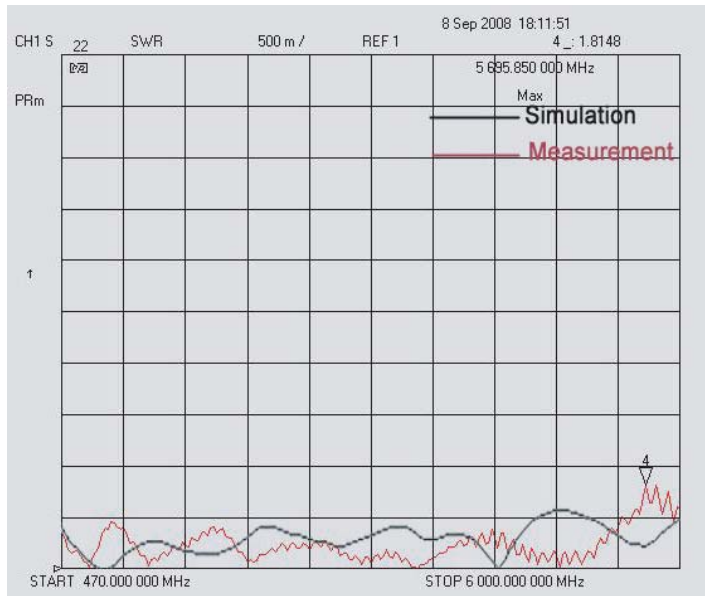


Figure 5. Measured and simulated VSWR.

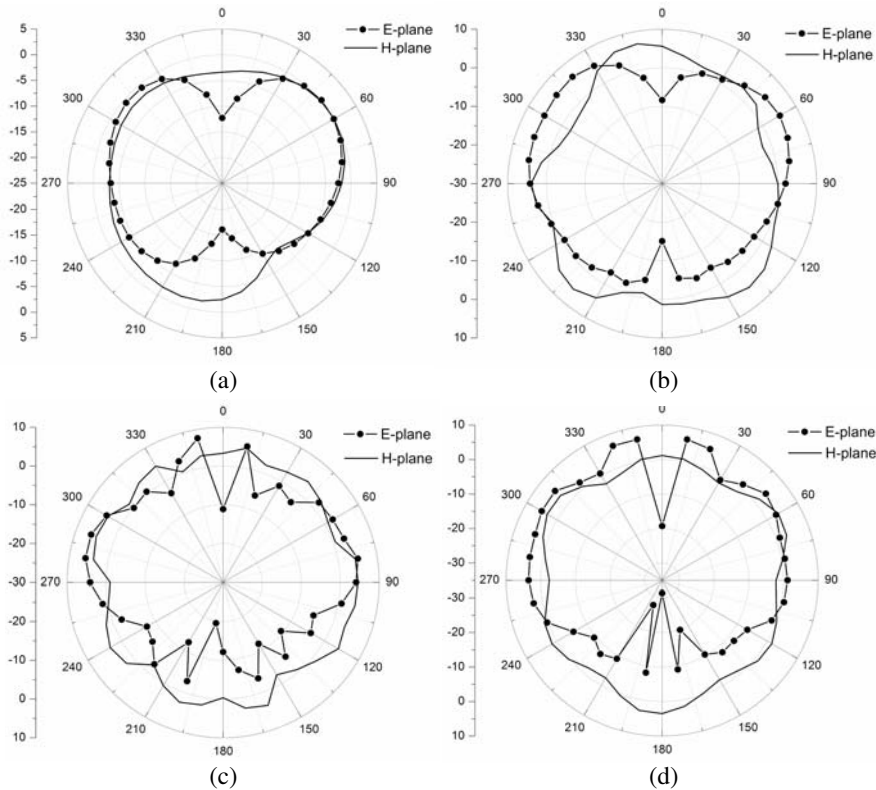


Figure 6. E -plane and H -plane radiation patterns. (a) 470 MHz; (b) 1.7 GHz; (c) 3.0 GHz; (d) 4.6 GHz.

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.

REFERENCES

1. Zhang, H.-T., Y.-Z. Yin, and X. Yang, "A wideband monopole with G type structure," *Progress In Electromagnetics Research*, PIER 76, 229–236, 2007.
2. Wang, F. J. and J.-S. Zhang, "Wideband cavity-backed patch antenna for PCS/IMT2000/2.4 GHz WLAN," *Progress In Electromagnetics Research*, PIER 74, 39–46, 2007.
3. Jiao, J.-J., G. Zhao, F.-S. Zhang, H.-W. Yuan, and Y.-C. Jiao, "A broadband CPW-FED T-shape slot antenna," *Progress In Electromagnetics Research*, PIER 76, 237–242, 2007.
4. Wang, F. J. and J.-S. Zhang, "Wideband cavity-backed patch antenna for PCS/IMT2000/2.4 GHz WLAN," *Progress In Electromagnetics Research*, PIER 74, 39–46, 2007.
5. Ammann, M. J. and Z. N. Chen, "Wideband monopole antennas for multi-band wireless systems," *IEEE Antennas Propag. Mag.*, Vol. 52, No. 2, 146–150, April 2003.
6. Ammann, M. J., "Control of the impedance bandwidth of wideband planar monopole antennas using a beveling technique," *Microw. Opt. Technol. Lett.*, Vol. 30, No. 4, 229–232, July 2001.
7. Suh, S. Y., W. L. Stutzman, and W. A. Davis, "A new ultra wideband printed monopole antenna: The planar inverted cone antenna (PICA)," *IEEE Transactions on Antennas and Propagation*, Vol. 52, No. 5, 1361–1364, May 2004.
8. Kim, K.-H. and S.-O. Park, "Analysis of the small band-rejected antenna with the parasitic strip for UWB," *IEEE Transactions on Antennas and Propagation*, Vol. 54, No. 6, 1688–1692, 2006.
9. King, R. W. P. and S. S. Sandler, "Compact conical antennas for wide-band coverage," *IEEE Transactions on Antennas and Propagation*, Vol. 42, No. 3, 436–439, 1994.

10. Palud, S., F. Colombel, M. Himdi, and C. Le Meins, "A novel broadband eighth-wave conical antenna," *IEEE Transactions on Antennas and Propagation*, Vol. 56, No. 7, July 2008.
11. Yu, Y. K. and J. Li, "Analysis of electrically small size conical antennas," *Progress In Electromagnetics Research Letters*, Vol. 1, 85–92, 2008.
12. Yu, Y. K., J. Y. Li, and Y. B. Gan, "Study of broadband small size conical antennas," *IEEE-APS*, 2006.
13. Palud, S., F. Colombel, M. Himdi, and C. Le Meins, "A novel reduced-height broadband monopole," *Proceedings of iWAT2008*, Chiba, Japan, 2008.
14. Nakano, H., H. Iwaoka, K. Morishita, and J. Yamauchi, "A wideband low-profile antenna composed of a conducting body of revolution and a shorted parasitic ring," *IEEE Transactions on Antennas and Propagation*, Vol. 56, No. 4, April 2008.