Hindawi Publishing Corporation
International Journal of Antennas and Propagation
Volume 2008, Article ID 379247, 4 pages
doi:10.1155/2008/379247

Research Article

CPW-Fed Slot Antenna for Wideband Applications

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Received 7 July 2007; Accepted 28 February 2008

Recommended by Karu Esselle

A new coplanar waveguide (CPW)-fed wideband printed slot antenna is presented, and the impedance characteristics of this antenna with different sizes of tapers are discussed. The effect of tapering angle with the resonant frequency is also observed. The fundamental parameters of the antenna such as bandwidth, return loss, gain, radiation pattern, and polarization are obtained. All meets the acceptable antenna standards. The measured input impedance bandwidth (return loss < -10 dB) of the prototype antenna is 52% (4.27–7.58 GHz). The radiation patterns are bidirectional in both planes. This antenna can be part of various wireless communication systems.

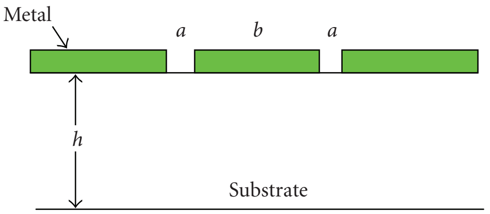
1. INTRODUCTION

Recently, the market for wireless local area network (WLAN) products is booming rapidly with the roll out of IEEE 802.11b products into the home, public, and office environments. With the increasing consumer demand for wireless multimedia, even higher throughput will be required. Hence, the IEEE 802.11a and the HIPERLAN/2 standards are designed and finalized to accommodate this demand by providing transmission data rates up to 54 Mbps in the 5-GHz ISM band [1, 2]. The IEEE 802.11a defines three frequency hands that can be used. The first band extends from 5.15 to 5.25 GHz, the second from 5.25 to 5.35 GHz, and the third from 5.725 to 5.825 GHz [3]. On the other hand, the HIPERLAN/2 specifies two bands: from 5.15 to 5.35 GHz and from 5.470 to 5.725 GHz [2, 4]. In addition, radio frequency identification (RFID) systems have been widely used recently in supply chain management by retailers and manufacturers to identify and track goods. Several frequency bands have been assigned to the RFID applications, such as 125 KHz, 13.56, 869, 902–928 MHz, 2.45, and 5.8 GHz. Moreover, public safety application is allocated around 4.9 GHz. To cover plenty of applications, single antenna with wider bandwidth is desirable.

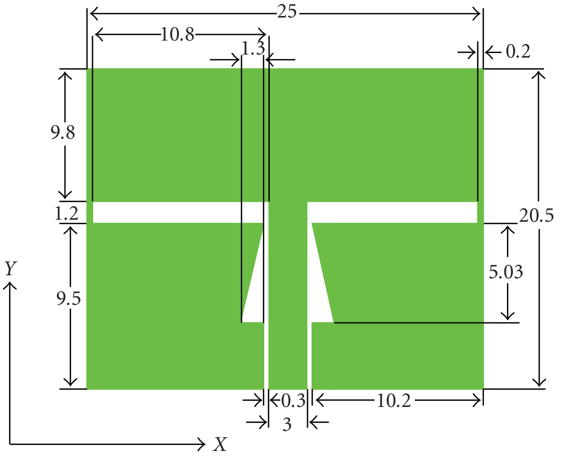
In applications where size, weight, cost, performance, ease of installation, and aerodynamic profile are constrains, low-profile antennas like microstrip and printed slot antennas are required. Because microstrip antennas inherently have narrow bandwidths and, in general, are half-wavelength structures operating at the fundamental resonant mode [5], researchers have made efforts to overcome the problem of narrow bandwidth, and various configurations have been presented to extend the bandwidth [6–10] by introducing slots in the microstrip patch. On the other hand, printed slot antennas fed by coplanar waveguide (CPW) have several advantages over microstrip patch antennas. Slot antennas exhibit wider bandwidth, lower dispersion, and lower radiation loss than microstrip antennas, and CPW also provides an easy means of parallel and series connection with active and passive elements that are required for matching and gain improvement, and with ease of integration with monolithic microwave integrated circuits (MMIC) [11]. A coplanar waveguide-fed broadband printed slot antenna with linear taper is presented in [12] to increase the impedance bandwidth. The bow tie slot antenna [13] has been studied and has shown a wide bandwidth approaching 40%. In this present work, the antenna is designed using a new type of tapering structure with CPW-fed to achieve wide bandwidth. The analysis is performed numerically using method of moments from the Zeland- IE3D.

2. ANTENNA STRUCTURE AND DESIGN

The geometry of the proposed coplanar waveguide (CPW)-fed slot antenna is shown in Figure 1 with all dimensions in mm. This antenna has a simple structure with only one



(a) Front view



(b) Top view

Figure 1

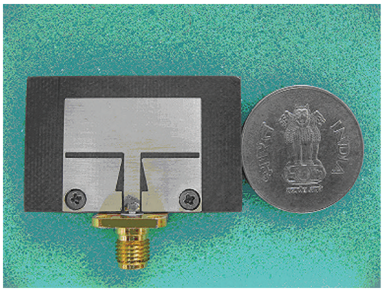


Figure 2: Photograph of the proposed antenna.

layer of dielectric substrate (RT/duroid 5880 PTFE glass fiber substrate) and metallization. There is no ground below the substrate, that is, ungrounded CPW.

Substrate details: dielectric constant $\varepsilon_r = 2.2$, $h = 3.175$ mm.

CPW dimensions: $a = 0.3$ mm, $b = 3$ mm.

The dimension of the slot antenna is referred to the guide wavelength (λ_g) which given by

$$\lambda_g = \frac{c/f}{\sqrt{\varepsilon_{\text{eff}}}}, \tag{1}$$

where ε_{eff} is an effective constant $\varepsilon_{\text{eff}} \approx (\varepsilon_r + 1)/2$.

In this case,

$$\begin{gathered} \varepsilon_{\text{eff}} \approx \frac{2.2+1}{2} \approx 1.6, \\ \lambda_g = 39.68\,\text{mm} \quad (\text{for } f = 6\,\text{GHz}). \end{gathered} \tag{2}$$

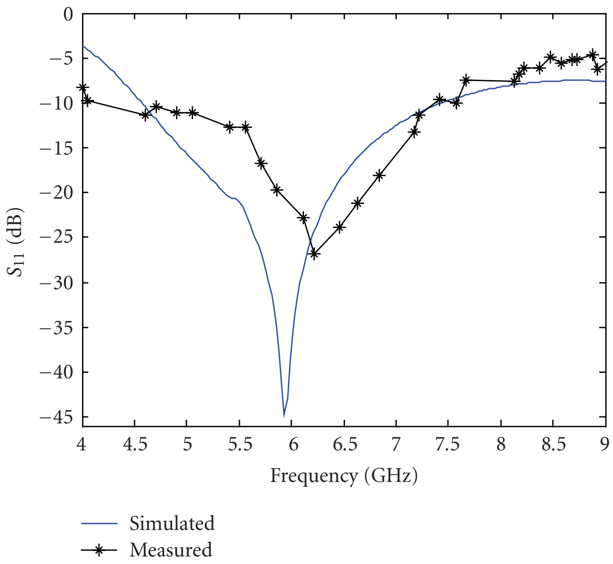


Figure 3: Return loss versus frequency.

Finally, the dimensions of the antenna by simulation with the aid of IE3D electromagnetic software were studied and then adjusted by experiment. To make the accepted antenna parameters, the length and width of the structure are reduced to 25 mm (W) and 20.5 mm (L) after many observations. The widths of the center strip and slot of the 50 ohm CPW feed line are chosen to be 3 mm and 0.3 mm, respectively. In general, the input return loss level and the resonant frequency of the proposed design will vary with total length L and width W of the structure. The better impedance matching can be obtained by varying the angle of tapering and the distance from the center strip.

A photograph of this prototype antenna is shown in Figure 2.

3. RESULTS AND DISCUSSION

Simulated and measured input return losses are shown and compared in Figure 3. The measured input impedance bandwidth (return loss < -10 dB) of the prototype antenna is 3.31 GHz (4.27–7.58 GHz), while the simulated bandwidth is 2.85 GHz (4.73–7.58 GHz). Though the simulated and measured results are in good agreement, it can be made still better if fabrication precision is increased. Due to limited testing facilities, only simulated radiation patterns are presented. The E- and H-plane radiation patterns simulated at 6.06 GHz are shown in Figures 4(a) and 4(b), respectively. The radiation patterns are bidirectional in the E-plane and H-plane. It should be noted that cross polarization levels are well controlled in E-plane and H-plane. Moreover, antenna is linearly polarized. The simulated peak antenna gain is 4.39 dBi at 8 GHz. The gain-versus-frequency characteristics are given in Figure 5.

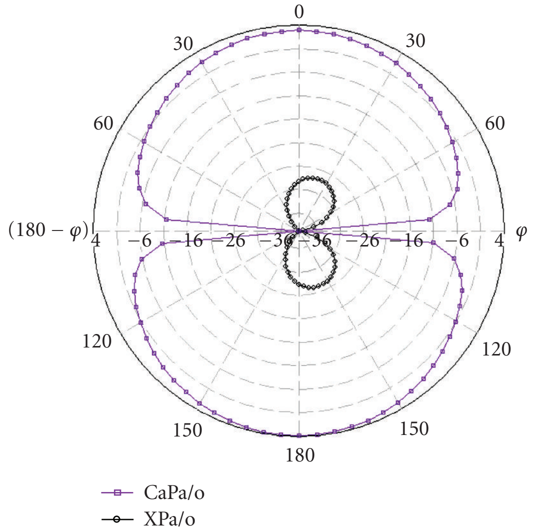
It is observed that increment in tapering angle with constant distance X (refer to Figure 6) results in shifting the resonating frequency with slight reduction in return loss.

Table 1: Effect of tapering angle with $x = 0.3$ mm.

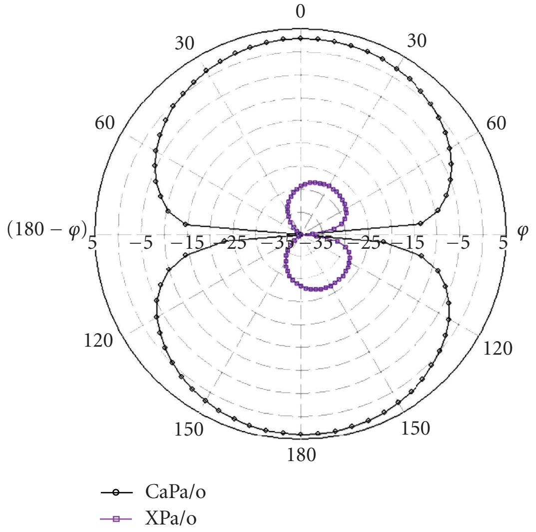
S.No	Angle θ (deg)	Resonating frequency (GHz)	Return loss (dB)
1	77	5.9	− 44.7
2	82	6.2	− 37.2
3	86	6.26	− 32.49
4	88	6.41	− 31.06

Table 2: Effect of taper distance and angle.

S.No	Distance X (mm)	Angle θ (deg)	Return loss (dB) @ 5.9 GHz
1	0.3	77	− 44.77
2	0.5	82	− 33.41
3	0.7	86	− 28.10
4	0.9	88	− 19.89



(a) E-plane pattern (dBi)



(b) H-plane pattern (dBi)

Figure 4

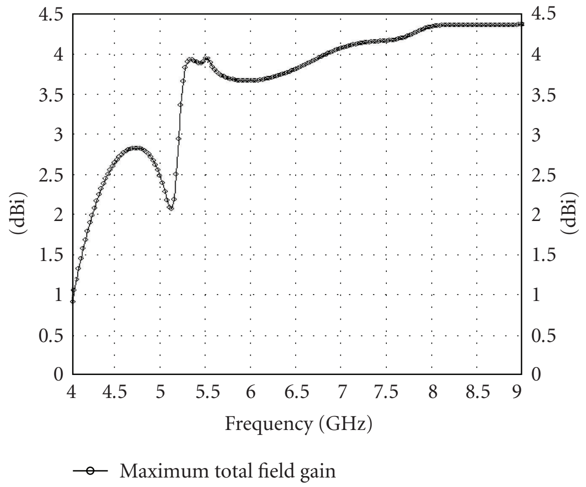


Figure 5: Gain versus frequency.

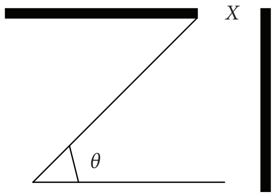


Figure 6: Tapering angle and distance illustration.

Table 1 gives the effect of tapering angle on frequency. If the distance X varies, then angle θ also varies. Changes in both the distance X and angle do not affect the resonating frequency but the return loss. Table 2 shows the effects of tapering angle with different distance X on the return loss performance.

4. CONCLUSION

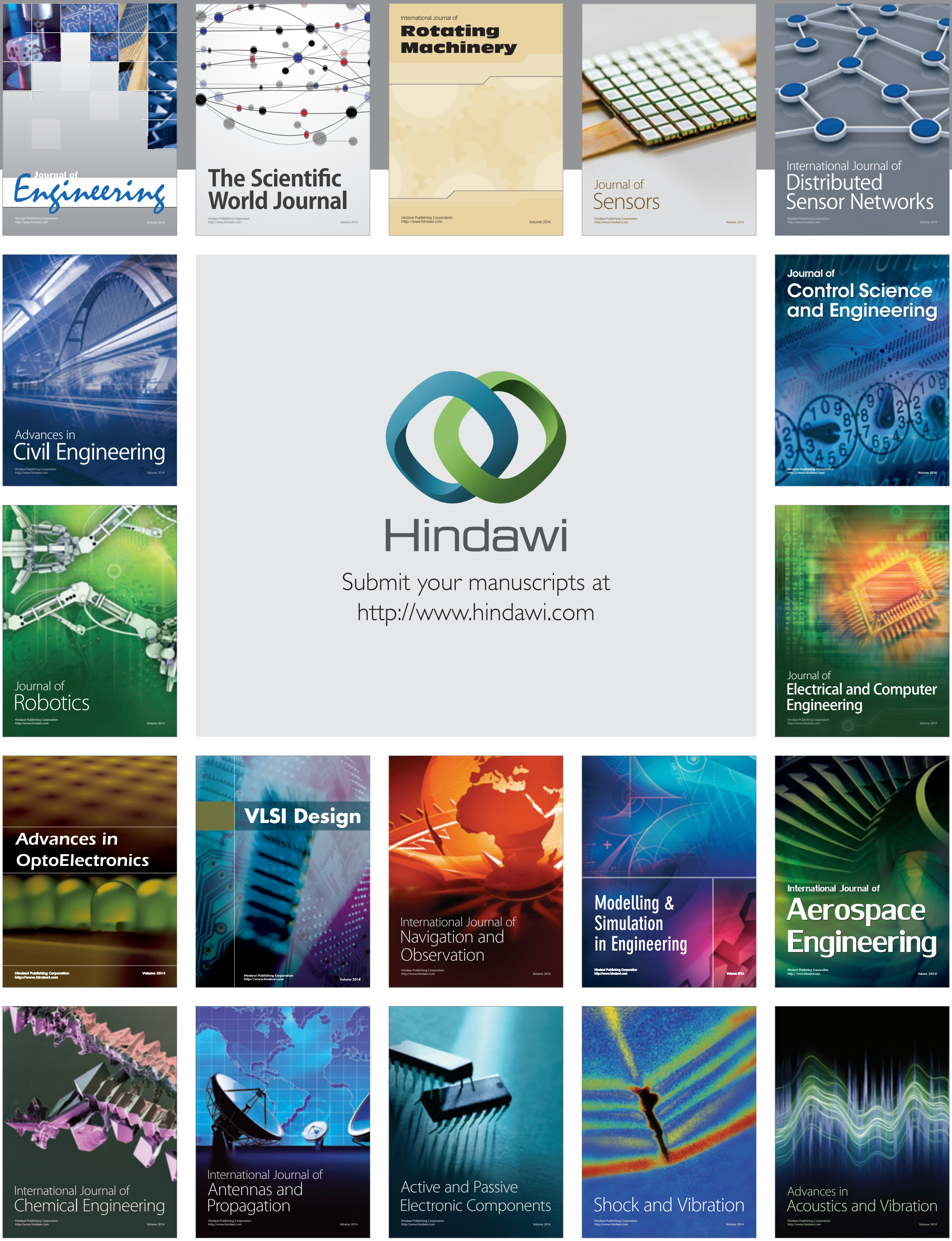
The antenna shows no significant variations in radiation pattern characteristics over the bandwidth of operation. The designed antenna is well suited for domestic wireless networks because of its low profile and mass production possibility. Moreover, the simple and uniplanar structure makes it ease of design and mass production. By changing the tapering angle and size, the antenna can be made to work for UWB band. It can be predicted that this taper technique, which will be studied further, will be useful for other slot antennas.

ACKNOWLEDGMENT

The authors would like to acknowledge the useful comments by Professor Bharati Bhat, Professor (Rtd), CARE, Indian Institute of Technology, Delhi.

REFERENCES

[1] B. O'Hara and A. Petrick, *The IEEE 802.11 Handbook: A Designer's Companion*, IEEE Press, New York, NY, USA, 1999.
[2] ETSI, "Broadband radio access networks (BRAN); HIPERLAN type 2 technical specifications; physical layer (PHY)," Tech. Rep. DTS/BRAN-0023003, European Telecommunications Standards Institute, Sophia Antipolis, France, October 1999.
[3] IEEE 802.11, "Wireless access method and physical layer specifications," New York, NY, USA, Sepember 1994.
[4] W. Diels, K. Vaesen, P. Wambacq, et al., "Single-package integration of RF blocks for a 5 GHz WLAN application," *IEEE Transactions on Advanced Packaging*, vol. 24, no. 3, pp. 384–391, 2001.
[5] K.-L. Wong, *Compact and Broadband Microstrip Antennas*, John Wiley & Sons, New York, NY, USA, 2002.
[6] T. Huynh and K.-F. Lee, "Single-layer single-patch wideband microstrip antenna," *Electronics Letters*, vol. 31, no. 16, pp. 1310–1312, 1995.
[7] K.-L. Wong and W.-H. Hsu, "Broadband triangular microstrip antenna with U-shaped slot," *Electronics Letters*, vol. 33, no. 25, pp. 2085–2087, 1997.
[8] Y.-X. Guo, K.-M. Luk, K.-F. Lee, and R. Chair, "A quarter-wave U-shaped patch antenna with two unequal arms for wideband and dual-frequency operation," *IEEE Transactions on Antennas and Propagation*, vol. 50, no. 8, pp. 1082–1087, 2002.
[9] K. F. Tong, K. M. Luk, K. F. Lee, and R. Q. Lee, "A broad-band U-slot rectangular patch antenna on a microwave substrate," *IEEE Transactions on Antennas and Propagation*, vol. 48, no. 6, pp. 954–960, 2000.
[10] Y. X. Guo, K. M. Luk, and K. F. Lee, "L-probe proximity-fed short-circuited patch antennas," *Electronics Letters*, vol. 35, no. 24, pp. 2069–2070, 1999.
[11] R. N. Simons, *Coplanar Waveguide Circuits, Components, and Systems*, John Wiley & Sons, New York, NY, USA, 2001.
[12] J.-W. Niu and S.-S. Zhong, "A CPW-fed broadband slot antenna with linear taper," *Microwave and Optical Technology Letters*, vol. 41, no. 3, pp. 218–221, 2004.
[13] E. A. Soliman, S. Brebels, P. Delmotte, G. A. E. Vandenbosch, and E. Beyne, "Bow-tie slot antenna fed by CPW," *Electronics Letters*, vol. 35, no. 7, pp. 514–515, 1999.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