A Shorted-End Curved Strip Dipole on Dielectric and Conducting Plane for Wireless LANs

[#]N. Fhafhiem, P. Krachodnok, M. Uthansakul, and R. Wongsan
School of Telecommunication Engineering, Suranaree University of Technology
Nakhon Ratchasima, 30000, Thailand, Email: m5140732@g.sut.ac.th

1. Introduction

Wireless local area network (WLAN) system has been extensively used for communications in wide range of the service area. The antenna is important for develop WLANs, it applied for high frequency 2.45 GHz. In addition the antenna has been sufficient gain, it required either unidirectional or omnidirectional beam coverage abroad area and high power handing. Moreover, the antennas are relatively simple in concept, structure easy, and inexpensive. The dipole antenna has some qualification that prominent point, its shape could be change easy and variety. This antenna will be usually placed at the wall of rooms or buildings. However, most kinds of this antennas has omnidirectional pattern, therefore, they are not suitable for field radiating in the large room because of power loss in unnecessary directions such as outside of room. Also, this paper is interested that qualification. This argues, if we can design an antenna to illuminate a predefined wide coverage area, it will have more efficient for field radiating.

The related literatures to the shape or curved dipole structure have been reported by several authors. Krishnan et al. [1] presented a V-shape wire loop that structure liked butterfly, it had elliptically radiation pattern. Dubost [2] presented the antenna which is shorted-circuited dipole parallel on perfect reflector plane. Tumvichit et al. [3] presented a half-wave dipole with a conductor plane at a distance much smaller than a quarter wavelength, the operating frequency is 2 GHz. Feed point of the antenna is fed though the coaxial cable on the backside of the conductor plane, it had the half power beamwidth is $85.5°$ in the E-plane and $87°$ in the H-plane. Besides these, Pimpol and Wongsan [4] presented the impedance analysis of a shorted-end curved dipole on reflector plane. A curved dipole consists of curved wire dipole and shorted their both end on metallic reflector plane applied for the broadcasting station (UHF TV). As far as we know, there is no information about curved strip dipole which is necessary for the structure that requires the simple in concept, simple feeder high power handing, small structure, and used for high frequency that is required. Since impedance is the important characteristic that determines efficiency of antenna. Therefore, this paper focuses on the impedance and parameter that used for design of a shorted-ends curve strip dipole. Numerical result of this antenna will be simulated by Computer Simulation Technology (CST) Software.

At first, we present about configuration geometry of propose curved strip antenna (Sect. 2). Next, current distributions, input impedance, return loss, and radiation patterns are introduced with computational results in Sect. 3. Finally, the conclusions are given in Sect. 4.

2. Configuration of the Proposed Antenna

A shorted-end curved dipole antenna is constructed of a curved strip dipole that it is mounted over a dielectric which has permittivity (ε_r) is 3.6. The both ends of curve strip dipole are welded connection on a metallic conductor plane as shown in Figs. 1 and 2. The parameters of antenna consist of the total length and wide of curved strip dipole expressed by L_d and w, respectively, and the radius a is aligned along ϕ-direction at which the feed center of this curved strip is connected at $\phi = \pi/2$. In addition, the dimension of the square reflector plane is $L \times W$. The length L_d is half-wavelength structure at curved strip dipole.

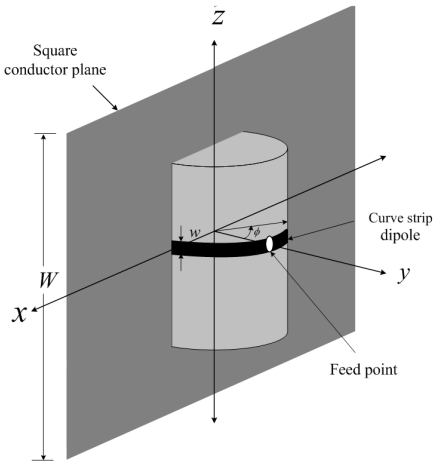

Figure 1: Configuration of the Curved Strip Dipole on Dielectric and Conductor Plane

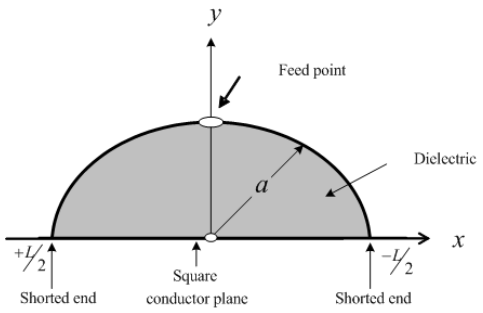

Figure 2: Model of a Horizontal Curved Strip Dipole on Dielectric and Conductor Plane

3. Numerical Results

The objective of this paper is to match the constructed antenna with a 50 ohms coaxial feed at a desired frequency. The curved strip dipole antenna was designed for 2.45 GHz (λ = 8 cm). From calculations, it is found that the half-wavelength of curved strip dipole is $L_d = \pi a$. In order to tune the center frequency of the constructed antenna to 2.45 GHz, we analyze the antenna model by using the CST software. In the computation, L_d, w, L, and W are varied. From optimize analysis, the good matching and the proper gain of this antenna could be obtained. The data of the antenna geometry is summarized in Table 1.

3.1 Current Distribution, Input Impedance, and Return Loss

For illustrated in Fig. 3, it found that the appropriate length of this curved strip dipole should be 0.47 λ because a dielectric is affected to decrease a few length of curve strip dipole. Also, the current magnitude at the both ends is zero and at the feed point current is most. As shown in Fig. 4, the length of curved strip dipole and size of conductor plane is the important parameter to characterize the impedance characteristic. After optimize analysis, we have obtained good impedance matching with 50 ohms at 2.45 GHz, and the excellent return loss is -15.42 dB as illustrated in Fig. 5.

Table 1: The Data of the Antenna Geometry

Parameters	Electrical Size
w	0.04 λ
Ld	0.47 λ
W	0.42 λ
L	0.50 λ
a	0.17 λ

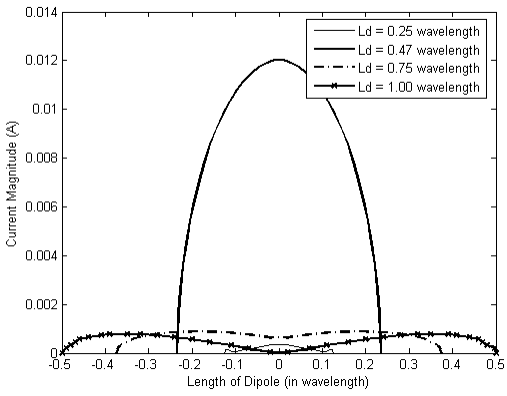

Figure 3: Current Distribution of Curved Strip Dipole on Dielectric and Conductor Plane

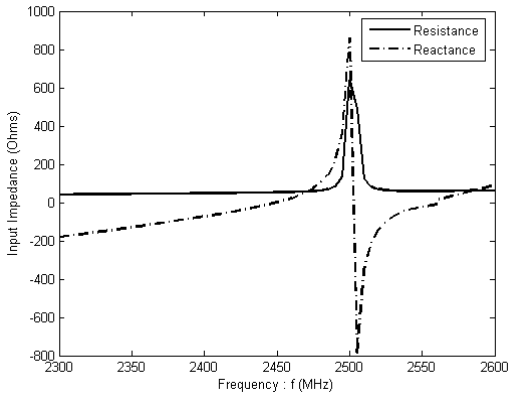

Figure 4: Input Impedance of Curved Strip Dipole on Dielectric and Conductor Plane

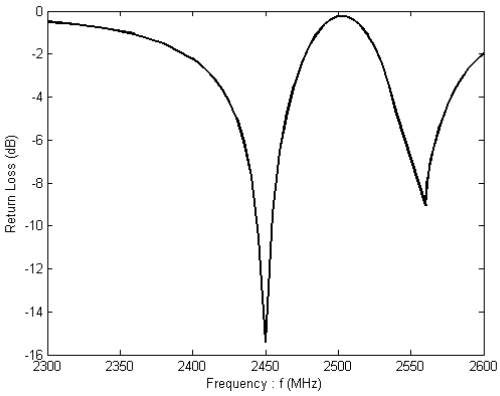

Figure 5: Return Loss of Curved Strip Dipole on Dielectric and Conductor Plane

3.2 Radiation Patterns

The radiation patterns are shown in Figs. 6 and 7 which E- and H-plane of the antenna correspond to the xy-plane and yz-plane, respectively. The maximum radiation occurs in the normal direction to a reflector plane. We have achieved a maximum gain of 6.21 dB which is higher than that of a traditional half-wave dipole. Moreover, it had the half power beamwidth E- and H-plane are 80° and 90° , respectively, that is wide because the antenna is bended to curved and also sideward along the plane in a small amount. The results of gain, HPBW, and patterns are well agreement of antenna for wireless local area (WLAN) system. In application that wanted unidirectional beam and high gain, which is wider than straight dipole.

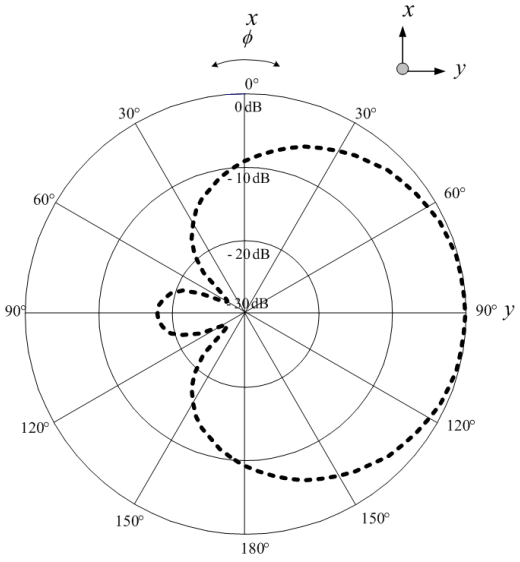

Figure 6: Radiation Pattern in *xy* -Plane

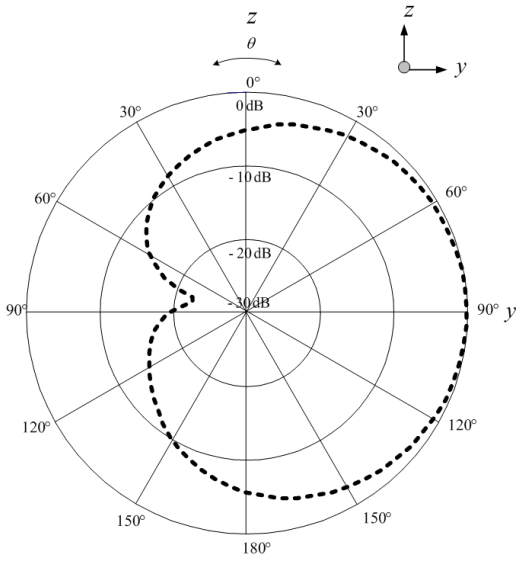

Figure 7: Radiation Pattern in *yz* -Plane

4. Conclusion

This paper proposes curved strip dipole on dielectric and reflector plane antenna which is utilized to usually placed at the wall and ceiling for wireless communication system at 2.45 GHz. Design and analysis of propose antenna use Computer Simulation Technology (CST) Software. It has been structure uncomplicated and in expensive that was demand on equipment for communication system. In addition, it has been enough beamwidth for wireless local area network (WLAN) system and high directive gain and then, it had developed simple dipole to curved dipole feed point at center of curved. This antenna obviated back lobe by conductor plane and have a small size due to permittivity of dielectric.

References

[1] Krishnan, L.-W. Li, and M.-S. Leong, "A V-Shaped Structure for Improving the Directional Properties of the Loop Antenna," IEEE Trans. Antennas Propag., vol.53. pp. 2114-2117, June 2005.

[2] G. Dubost, " Flat Radiating Dipoles and Applications to Arrays," RESEARCH STUDIES PRESS A DIVISION OF JOHN WILEY & SONS LTD. pp. 28-36.1981.

[3] Thumvichit , Takano, "Ultra Low Profile Dipole Antenna with a Simplified Feeding Structure and a Parasitic Element", IEICE Trans. Commun., vol.E89-B, No.2, pp. 576-580, 2006.

[4] Pimpol, Wongsan, "Impedance Analysis of a Shorted-End Curved Dipole on Reflector Plane using Method of Moment ,"The 2007 ECTI International Conference, Thailand, Vol. 2, pp. 667-670, 2007.