Design CPW Fed Slot Antenna for Wideband Applications

K. Nithisopa[1,2], J. Nakasuwan[1], N. Songthanapitak[1]
N. Anantrasirichai[3], and T. Wakabayashi[4]
[1]Department of Electronic and Telecommunication Engineering, Faculty of Engineering
Rajamangala University of Technology Thanyaburi (RMUTT)
Klong 6, Thanyaburi, Pathumthanee, Thailand
[2]Department of Electronic and Telecommunication Engineering, Faculty of Engineering
Rajamangala University of Technology Phra Nakhon (RMUTP)
North Bangkok, Bangkok, Thailand
[3]ReCCIT, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang
Ladkrabang, Bangkok, 10520, Thailand
[4]School of Information Science and Engineering, Tokai University
Hiratsuka, Kanagawa, 256-1292, Japan

Abstract— In this paper, a CPW-fed slot antenna for wideband application was designed and simulated. In order to examine the performances of this antenna, a prototype was designed at frequency 2.4 GHz and simulated with various width of slot antenna in both sides for input impedances matching and simulated by IE3D software package of Zeland. The simulation result of bandwidth is 1.65 GHz (2.1–3.75 GHz) which covers the standard frequency of IEEE 802.11 b/g (2.4–2.4835 GHz) and Wimax (2.3–3.6 GHz). With these performances, the proposed antenna can be used in wideband applications.

DOI: 10.2529/PIERS061009084055

1. INTRODUCTION

Microstrip antenna is one type of antennas which can be used for transmitting and receiving signals. Microstrip or printed antennas are low profile, small size, light weight and widely used in wireless and mobile communications, as well as radar applications. Microstrip antennas can be divided into two basic types by structure, namely microstrip patch antenna and microstrip slot antenna [1, 2]. The slot antennas can be fed by microstrip line, slot line and CPW [3, 4]. The CPW is the feeding which side-plane conductor is ground and center strip carries the signal. The advantage of CPW fed slot antenna is wideband antenna which many research introduce the several shape of slot antenna for use in WLAN applications. In this paper, we proposed the slot antenna fed by CPW at a designed frequency of 2.4 GHz and coverage frequency range from 2.1–3.75 GHz.

2. ANTENNA STRUCTURE

The CPW fed slot antenna is designed at 2.4 GHz with the symmetrical structure, as shown in Figure 1(a). This antenna is designed on RT/Duroid 5880, the substrate with thickness (h) of 1.575 mm and dielectric constant (ε_r) of 2.2. The coplanar waveguide (CPW) is designed to be 50 ohms in order to match the characteristic impedance of transmission line. The dimension of the slot antenna is referred to the guide wavelength (λ_g) which given by

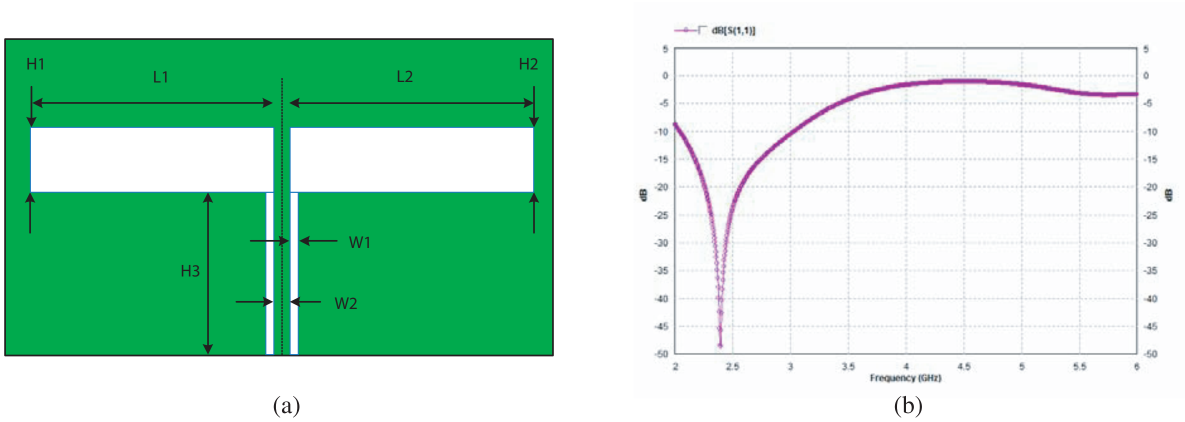
$$\lambda_g = \frac{c/f}{\sqrt{\varepsilon_{eff}}} \tag{1}$$

where ε_{eff} is an effective dielectric constant.

$$\varepsilon_{eff} \approx \frac{\varepsilon_r + 1}{2} \tag{2}$$

In this case, λ_g at frequency 2.4 GHz is 98.81 mm.

The total length of slot antenna ($L_1 + L_2 + W_2$) is $0.81\lambda_g$ (80.0 mm) and width of slot (H_1, H_2) is $0.1\lambda_g$ (10.5 mm). For match impedance with characteristic impedance of transmission line 50 ohms, the gap (W_1), width of the center strip (W_2) and length of CPW line (H_3) are 0.5 mm, 2.4 mm and 23 mm, respectively.



(a) (b)

Figure 1: CPW-fed slot antenna and S_{11} in case of same slot. (a) Configuration of CPW fed slot antenna. (b) Characteristic of return loss (S_{11}).

3. DESIGN PROCEDURE

In this paper, we proposed the concept of the designing CPW fed slot antenna for wideband which has three design procedures. This slot antenna composed of two small slots on the ground plane that are left and right slots. For every case of designing, we will fix the gap (W_1), width of the center strip (W_2) and length of CPW line (H_3) to 0.5 mm, 2.4 mm and 23 mm, respectively.

Design 1: Same length and same width of two slot (left slot and right slot).

The parameters of this structure are as following:

$$L_1 = L_2 = 38.8\,\text{mm} \qquad \text{(total length of slot antenna} = 80.0\,\text{mm)}$$
$$H_1 = H_2 = 10.5\,\text{mm}$$

Figure 1(b) show the characteristic of return loss S_{11} of Design 1. The simulation results of bandwidth and its return loss are shown in Table 1.

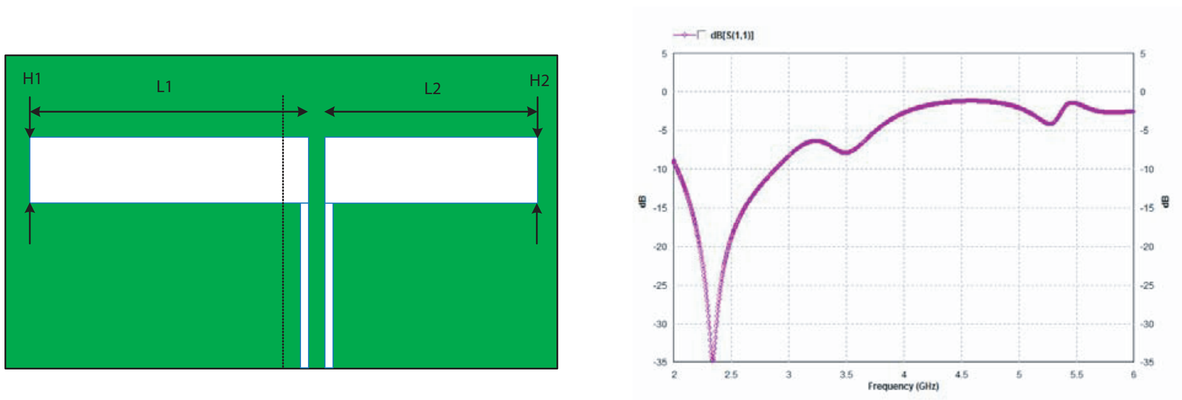
Design 2: Different length and same width of two slots.

The parameters of this structure are as following:

$$L_1 = 43.8\,\text{mm},\ L_2 = 33.8\,\text{mm} \qquad \text{(total length of slot antenna} = 80.0\,\text{mm)}$$
$$H_1 = H_2 = 9.5\,\text{mm}$$

The simulation results are shown in Table 1, and the return loss S_{11} is shown in Figure 2(b).

Design 3 : Different length and different width of two slots.

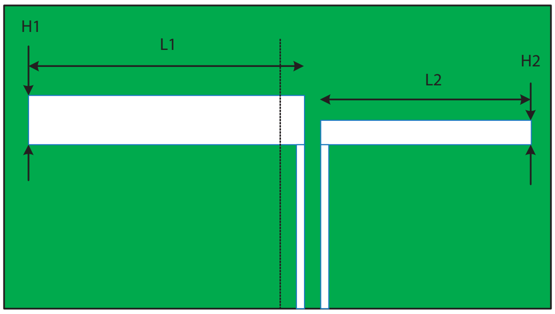


(a) (b)

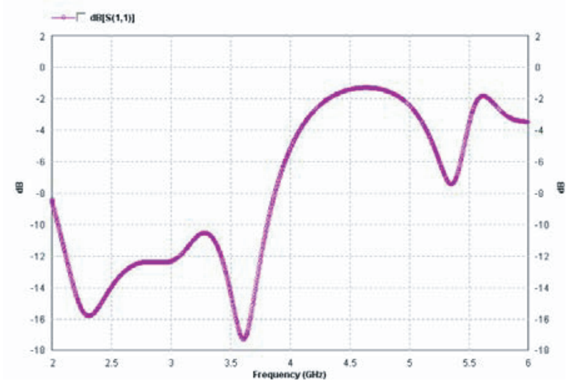
Figure 2: CPW-fed slot antenna in case of difference length and same width of slot. (a) Configuration of CPW fed slot antenna. (b) Characteristic of return loss (S_{11}).

The parameters of this structure are as following:

$$L_1 = 43.8\,\text{mm},\ L_2 = 33.8\,\text{mm} \qquad \text{(total length of slot antenna} = 80.0\,\text{mm)}$$
$$H_1 = 7.8, \qquad H_2 = 4.1\,\text{mm}$$



(a)



(b)

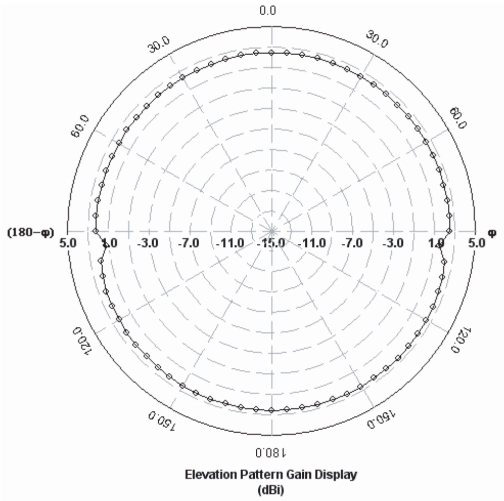
Figure 3: CPW-fed slot antenna in case of difference length and difference width of slot. (a) Configuration of CPW fed slot antenna. (b) Characteristic of return loss (S_{11}).

4. SIMULATE RESULTS

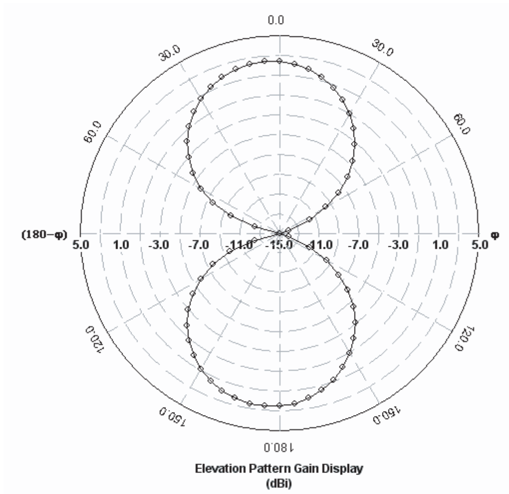
The basic slot antenna fed by CPW is shown in Figure 1(a). When varying the length of slot, it will affect on bandwidth and return loss as shown in Figure 2. When we increase width of slot, the bandwidth is increasing, as shown in Figure 3. The dimension and some parameters are listed in Table 1.

Table 1: The value of parameters and the characteristics of CPW-fed slot antenna.

L1 (mm)	L2 (mm)	H1 (mm)	H2 (mm)	Bandwidth (−10 dB) (GHz)	Return Loss (dB) ≅ 2.4 GHz
38.8	38.8	10.5	10.5	1.0	−48
43.8	33.8	9.5	9.5	0.8	−35
43.8	33.8	7.8	4.1	1.65	−15.5

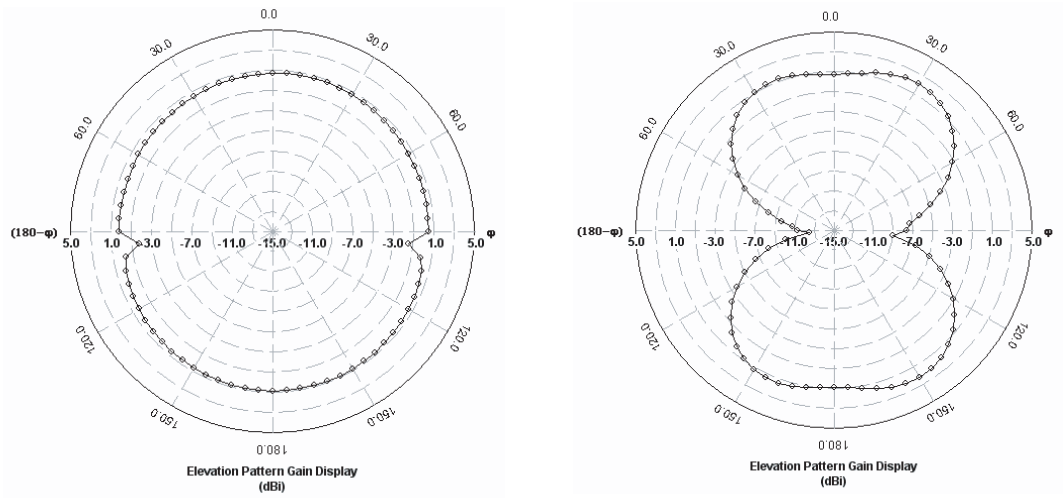


(a)



(b)

Figure 4: Radiation pattern at frequency 2.45 GHz. (a) yz-plane. (b) xz-plane.



(a) (b)

Figure 5: Radiation pattern at frequency 3.65 GHz. (a) yz-plane. (b) xz-plane.

The radiation pattern of y-z plane and x-z plane at frequency 2.45 GHz and 3.65 GHz are shown in Figure 4 and Figure 5.

5. CONCLUSION

The design of slot antenna fed by CPW is considered on the basic structure. It is proved by varying the length and the width of the slot for achieving the wideband for use in WLAN applications. This paper shows the maximum bandwidth of 1.65 GHz at design frequency of 2.4 GHz. The wideband is created with the different length and the different width of the slot antenna.

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