The effective of Radiation Pattern on Two Shape of Slot Antenna

W. Chanwattanapong*, N. Anantrasirichai*, and T. Wakabayachi**

*ReCCIT, Faculty of Engineering
King Mongkut's Institute of Technology Ladkrabang (KMITL)
Ladkrabang, Bangkok, 10520, Thailand
E-mail : kanoppin@kmitl.ac.th
**School of Information Technology and Electronics, Tokai University
Hiratsuka, Kanagawa, 259-1292, Japan
E-mail : wakaba@et.u-tokai.ac.jp

Abstract: This paper present the characteristics of radiation pattern of microstrip slot antenna on the ground plane fed by microstrip line. It is proposed for resonance frequency at 10 GHz. We will analysis two shape of slot antenna; double L-shape slot antenna and U–shape slot antenna. In this case, we will compare far-field radiation pattern of two shape slot antenna. Far-field radiation pattern of double L-shape slot antenna is bi-directional nevertheless U– shape slot antenna is uni-directional. The microstrip slot antenna is propose to analyze far-field radiation pattern for use in the wireless communication systems

Keywords: Double L-shape, U-shape, radiation pattern.

1. INTRODUCTION

In some communication system, the signals are sent through free space by antenna. There are many type of antennas can be used for transmit and receive signals. Microstrip or printed antenna is one type of antennas which is small size and light weight and widely used in wireless and mobile communications. The advantage of microstrip slot antenna are low-profile, light weight, small size, simple and inexpensive to fabricate by using modern printed-circuit technology. These are most suitable for wireless and mobile communication. Because of their low-power handling capability, these antenna can be used in low-power transmitting and receiving applications.

Analysis of radiation pattern on slot antenna, for desire resonance frequency 10 GHz, by using two shape of slot antennas double L- shape and U-shape slot antennas.

To describe the performance of an antenna, some parameters are necessary. Some of the parameters are interrelated and not all of them must be specified for complete description radiation pattern of the antenna performance. The parameters in characteristics of printed antenna for this analysis are radiation pattern, input impedance, S parameter and VSWR.

The parameter in characteristics of double-L shape and U-shape slot antenna for this analytical are radiation pattern at xy plane and xz plane. To avoid unwanted effects to reduce the return loss as much as possible by adjust matching impedance.

All of antenna simulation by using FDTD analysis. The Finite Difference Time Domain (FDTD) method is introduced to solve the complicated problems in electromagnetic field theory. The FDTD method is capable of computing electromagnetic interactions for geometric problems that it is extremely difficult to analyze by other methods. This technique is well-suited for handling complicate microstrip antenna configurations because it can conveniently model the numerous inhomogeneities encountered in these structures. Therefore, FDTD method is also use as a tool to obtain antennas characteristics various aspect.

2. FDTD METHOD AND ANTENNA STRUCTURE

FDTD method is a very powerful approach that can be used to calculate all the parameter for almost all types of antenna structures. Since all the near fields are available during the FDTD simulation, we can use near field to far field transformation to evaluate accurately the far field radiation properties of the antenna

We can obtain the radiating fields at far – field point as shown below:

$$E_\theta = \eta H_\phi = -j\frac{e^{-jkr}}{2\lambda r}(\eta N_\theta + L_\phi), \tag{1}$$

$$E_\phi = \eta H_\theta = j\frac{e^{-jkr}}{2\lambda r}(-\eta N_\theta + L_\theta). \tag{2}$$

To simulating double-L shape and U-shape slot antennas by using FDTD analysis. This software is a full wave electromagnetic simulation code for conventional three dimensional (3D) passive structures, particularly planar-oriented microwave circuits and antennas which are based on the FDTD algorithm. The algorithm of FDTD electromagnetic field analysis was introduced by Kane Yee. FDTD technique can be treats in transients conditions such as pulse in the time domain, and computational electromagnetic modeling which can predict and analysis of the electromagnetic responses of complex problems.

From, figure 3 as show analytical space in FDTD model are commonly for double-L shape and U-shape slot antenna. The analytical space in FDTD analysis 60x123x100 cells with the cell dimension $\Delta x = 0.152$ mm, $\Delta y = \Delta z = 0.15$ mm.

The structure of double L-shape and U-shape are shown in figure 1 and figure 2, respectively. Double L-shape and U-shape slot antenna on the ground plane are fed by a microstrip line. The length of each L-shape and U-shape slot are $\lambda g/2$.

The microstrip line is designed to be 50 ohms in order to match the measurement system and has the substrate of the thickness h = 1.52 mm and the dielectric constant $\varepsilon_r = 2.17$.

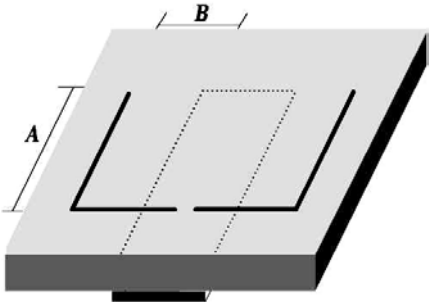

Figure 1. Double-L shape slot antenna structure.

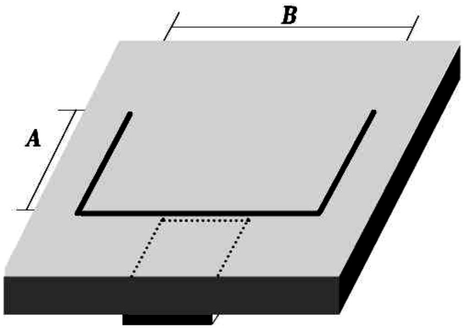

Figure 2. U-shape slot antenna structure.

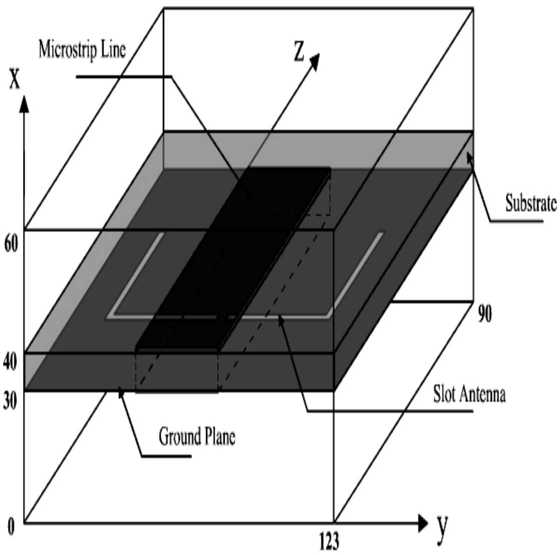

Figure 3. Antenna structure in analytical space of double L-shape and U-shape slot antenna.

3. SIMULATION RESULTS

3.1 Return Loss

The return loss S_{11} which is a parameter of antenna given as follows.

$$S_{11} = \frac{\Im\left[V_{ref}(t)\right]}{\Im\left[V_{inc}(t)\right]} e^{2\gamma L} \tag{3}$$

Where $\Im$ shows a Fourier transform and L is the length between an observing point and a reference point. The propagation constant γ can be define by

$$\gamma = \alpha + j\beta \tag{4}$$

Where α and β are attenuation and phase constants, respectively.

3.2 Characteristic of input impedance

The input impedance is the complex number. To find the input impedance, will be done after obtained the input return loss S_{11} . And input impedance of antenna is described by using an parameter S_{11} and characteristic impedance Z_o of a microstrip line.

$$Z_{in} = \left[\frac{(1 + S_{11})}{(1 + S_{11})}\right] Z_o \tag{5}$$

The observing point will be nearly the reference point when analyzing by FDTD method. By adjusting technique, real part and imaginary part of Zin are nearly 50 ohms and 0 ohm, respectively.

3.3 Characteristics of two shapes slot antenna.

Table 1 shown characteristic of double L-shape and U-shape slot antennas include resonance frequency, return loss and input impedance.

Table 1 Characteristics of two shapes slot antenna.

	(GHz)	S11 (dB)	Zin Real	Zin Imag	B/W
Double L-shape	**10.01**	**-39.18**	**43.45**	**0.87**	**3.5%**
U-shape	**10.08**	**-28.08**	**51.93**	**-3.43**	**4%**

Good matching of double-L shape can be obtained at resonance frequency 10.01 GHz which the return loss (S_{11}) = -39.18 dB, input impedance of real part (Zin real)=43.45 ohms, imaginary part (Zin imaginary) = 0.87 ohms.

And good matching of U-shape can be obtained at resonance frequency 10.08 GHz which the return loss (S_{11}) = -28.08 dB, input impedance of real part (Zin real) = 51.93 ohms and imaginary part (Zin imaginary) = -3.43 ohms.

3.4 VSWR

VSWR is a characteristic to show the performance of antenna which relate to reflected wave. In a properly designed system for impedance matching the value of VSWR is nearly 1. Figure 4 shown characteristics of VSWR of two shape slot antennas.

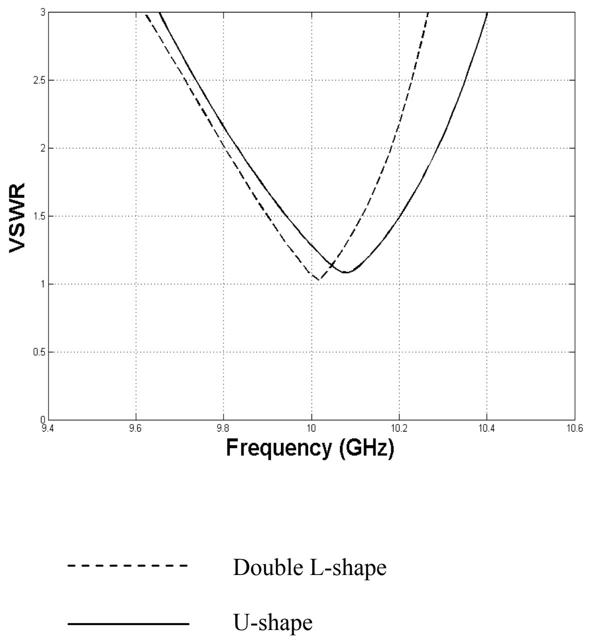

Figure 4. VSWR of two shape antennas.

The VSWR can be calculated from any of several bits of knowledge. Therefore, it is possible to determine value of VSWR by the ratio of the reflected voltage to incident voltage along the microstrip line. In this case, VSWR of double L-shape and U-shape slot antenna are nearly 1 at resonance frequency 10.01 GHz and 10.08GHz which calculated bandwidth at VSWR = 2.

3.5 Current Density

Generally, the directional electric field will orthogonal with the slot line plane. Then, high intensity of electric field in slot line will be increasing, the propagation effect can reachable to other side. The equivalent electric current density are related to the field component on the surface by

$$\vec{J}_s = \hat{n} \times \vec{H} \qquad (6)$$

where n is unit vector at boundary surface.

Characteristics of current density of double L-shape and U-shape slot antenna are shown in Fig. 5 and 6 .current density will be high at the end of slot.

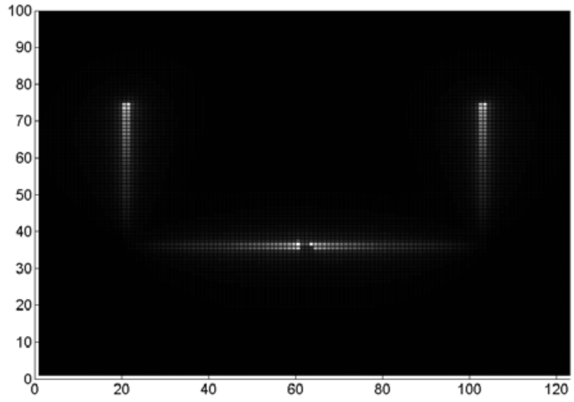

Figure 5. Characteristic of current density of double L-shape slot antenna at 10.01 GHz

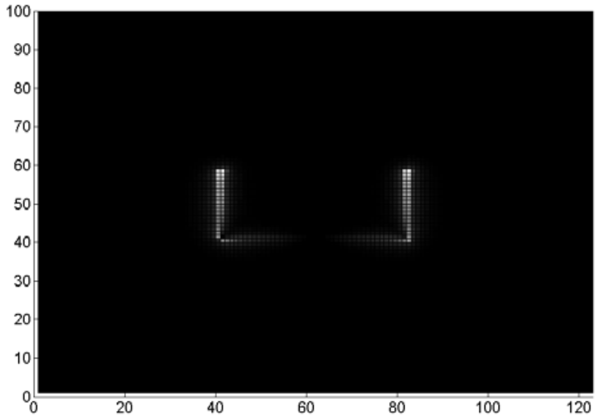

Figure 6 . Characteristic of current density of U-shape slot antenna at 10.08 GHz.

3.6 Far Field Pattern

By using FDTD method, it is possible to transform the near field to far field by discrete Fourier Transform to carry out for the equivalent electric and magnetic current densities during the FDTD iteration. So far fields are obtained by converting near field to far fields in the frequency domain. To consider the radiation pattern from the simulation of two shape slot antennas we can see the bidirectional and unidirectional radiation patterns of double L-shape and U-shape slot antennas, respectively.

The simulation results on radiation pattern of double L-shape and U-shape slot antenna are shown in figure 7; xy-plane and figure 8; xz-plane at resonance frequency about 10.01 GHz and 10.08 GHz, respectively. It seen that, high level of radiation pattern about 0 degree of U-shape slot antenna in figure 7 and 90 degree in figure 8. And far field radiation pattern of double L-shape slot antenna is bi-directional nevertheless U-shape slot antenna is uni-directional. Two sides of double L-shape made bi-directional pattern of double L-shape in figure 7.

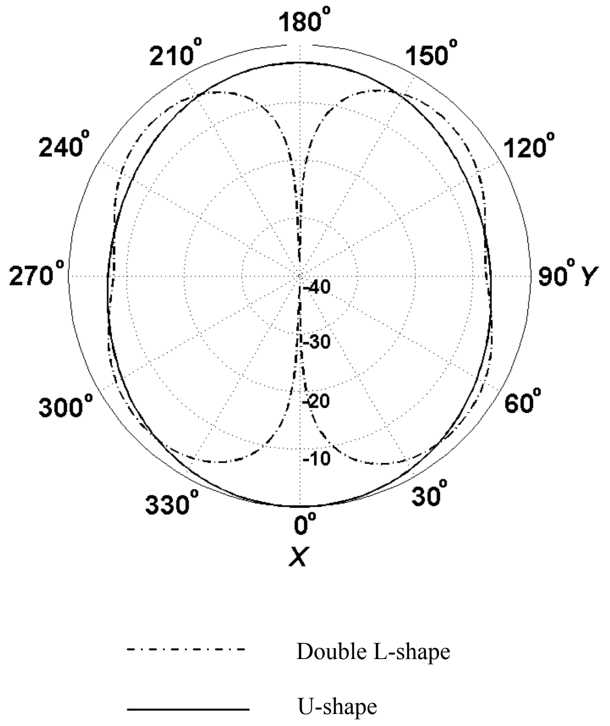

Figure 7. Far field pattern on the xy-plane of double-L shape and U-shape slot antenna

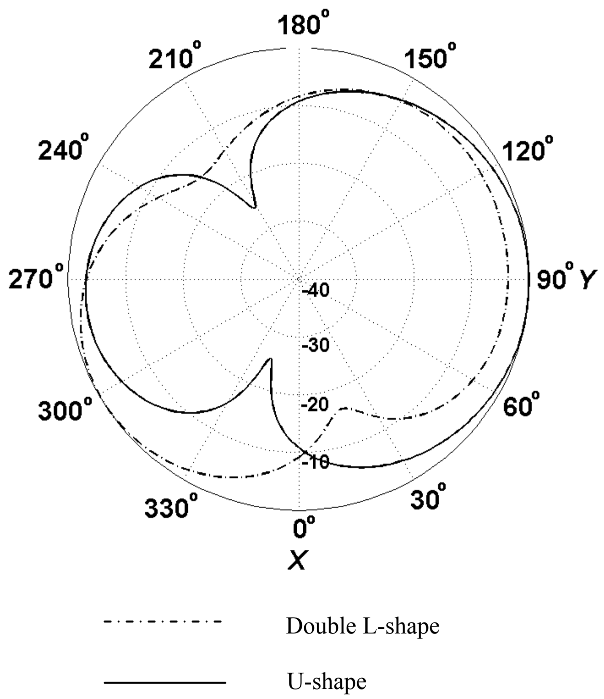

Figure 8. Far field pattern on the xz-plane of double-L shape and U-shape slot antenna.

4. CONCLUSION

The finite-difference time-domain method has been used to perform time-domain simulations of pulse propagation in several printed microstrip antenna. Double L-shape and U-shape have nearly length of slot at resonance frequency. The radiation pattern of double L-shape slot antenna is bi-dierectional pattern while U-shape slot antenna is uni-dierectional pattern, therefore, shaped of slot effect with radiation patterns of antenna

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