CHARACTERISTICS OF AN ELEMENT PRINTED ON DIELECTRIC SUBSTRATE WITH CONDUCTOR FRAME

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1. Introduction

In recent years, planner antennas such as microstrip and patch antennas have been focussed. It is important to develop new type antennas for mobile communications. Especially, conformal antennas are fitted on mobiles. On the other hand, FDTD method is used in order to analyze many kinds of antennas [1][2]. It is effective one to obtain fields and return loss of such antennas [3].

In this paper, we analyze screen antennas which are printed on a dielectric substrate with a conductor frame by using FDTD method, and describe characteristics of field patterns and return loss of screen antennas. This antenna is useful for the mobile communications and satellite communication.

2. Structure of antenna

Structure of a screen antenna is shown in Fig. 1. An antenna element is printed on a dielectric substrate with conductor frame as shown in Fig. 1(a). The conductor frame is shown in Fig. 1(b). Sizes of the frame, the dielectric substrate and position of the element are parameters of the screen antenna.

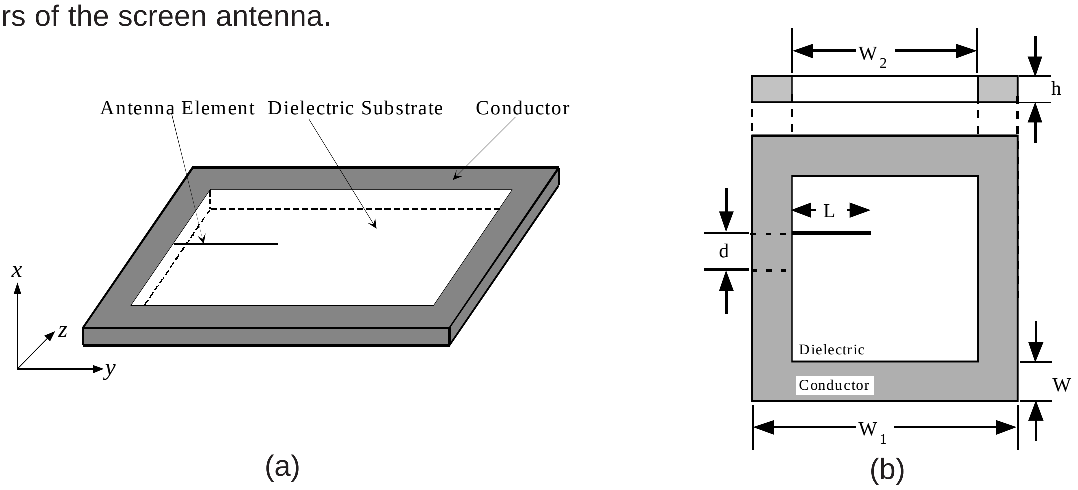

Fig. 1 Structure of a screen antenna

3. Numerical results

In our analysis, FDTD method is introduced. The analytical region consists of 100x310x310 cells and the cell size is 1 [mm]. The time step satisfies the Courant stability condition. The Mur second order absorbing boundary conditions are applied to boundaries. The input pulse is the Gaussian pulse.

3.1 Characteristics for antenna parameters

We calculated the far field patterns and return loss for a width W of a conductor frame as a parameter. Far field patterns in XY and XZ planes are shown in Figs. 2 and 3, respectively. In this case, the width of the substrate W_2 and the element length L are 120 [mm] and 37.5 [mm], respectively. The antenna element is located at the center of the dielectric substrate. A frequency of the antenna which is designed is 1 [GHz].

From Fig. 2, it is found that the far field patterns at the left hand side are changed for different values of W. It is clear from Fig. 3 that the far field patterns are influenced at angles of 90 and 270 degrees for various values of W. Especially, there is a difference of between field patterns around 240 and 300 degrees. Fig. 4 shows characteristics of the return loss. This

Table. 1 Sizes of antennas

L = 37.5 [mm], h = 3 [mm], ε_r = 6.68			
W_2	100	120	140
W_1 ( )in W	150 (25)	150 (15)	—
	170 (35)	170 (25)	170 (15)
	—	190 (35)	190 (25)
	—	—	210 (35)

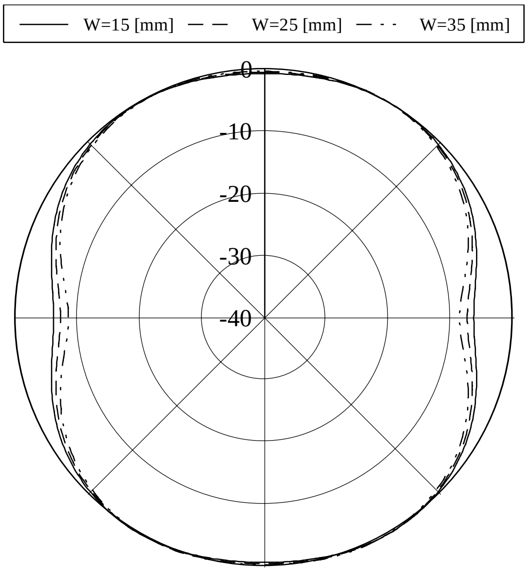

Fig. 3 Far Field Patterns (XZ plane)
W_2=120 [mm], f=1 [GHz]

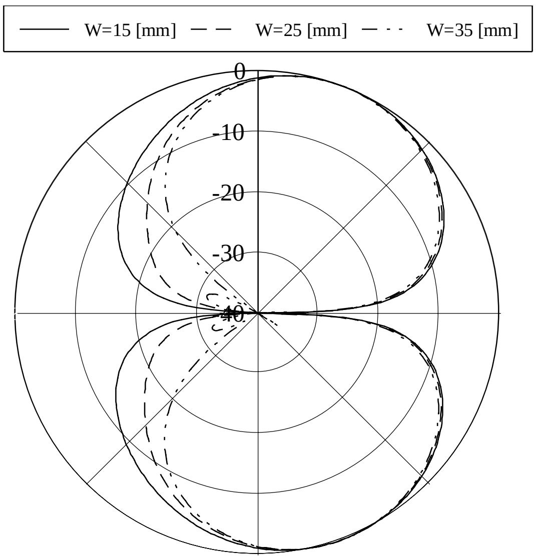

Fig. 2 Far Field Patterns (XY plane)
W_2=120 [mm], f=1 [GHz]

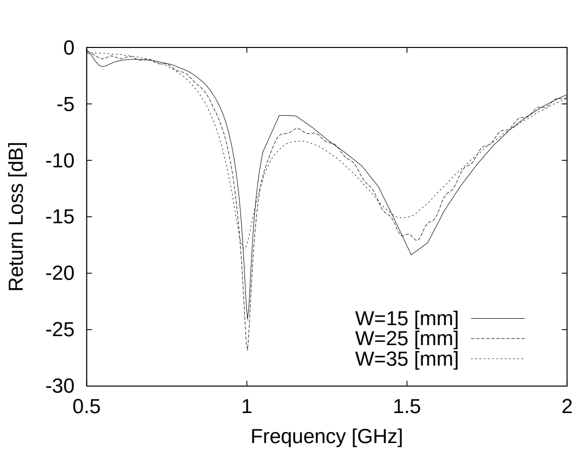

Fig. 4 Return Loss

antenna has two resonance frequencies 1[GHz] and 1.5 [GHz]. Even if the width of a conductor frame changes, the resonance frequencies don't change.

Next, we describe the characteristics for a size W_2 of the dielectric substrate as a parameter. The far field patterns and characteristics of the return loss are shown in Figs. 5, 6 and 7, respectively. The width of a conductor frame is W=35 [mm]. Fig. 5 shows far field patterns in XY plane. The far field patterns are influenced for changed values of W_2 from an angle of 180 degrees to an angle of 360 degrees. The far field patterns are influenced at angles of 90 degrees and 270 degrees for different values of W_2 as shown in Fig. 6.

Fig. 7 shows characteristics of the return loss. When the width of dielectric substrate is W_2=100 [mm], the resonance frequency is about 1[GHz]. However, when dielectric substrate becomes wide, a resonance frequency becomes low. This antenna has also a resonance frequency of 1.5[GHz]. The antenna has two resonance frequencies simultaneously.

3.2 A position of an antenna element

Fig. 8 shows far field patterns in XY plane. The far field patterns are influenced around 270 degrees for different positions of the element. Fig. 9 shows far field patterns in XZ plane. The far field patterns are changed at angles of 90 degrees and 270 degrees for different values of position.

Fig. 10 shows characteristics of return loss. When an antenna element is located at the center of the dielectric substrate, the antenna has two resonance frequencies. When an antenna element comes close to the conductor frame, two resonance frequencies approach each other. Then the antenna has a resonance frequency and the return loss increases.

4. Conclusion

We analyzed some characteristics of an antenna printed on the dielectric substrate using FDTD method. It is clear that characteristics are influenced by values of many parameters

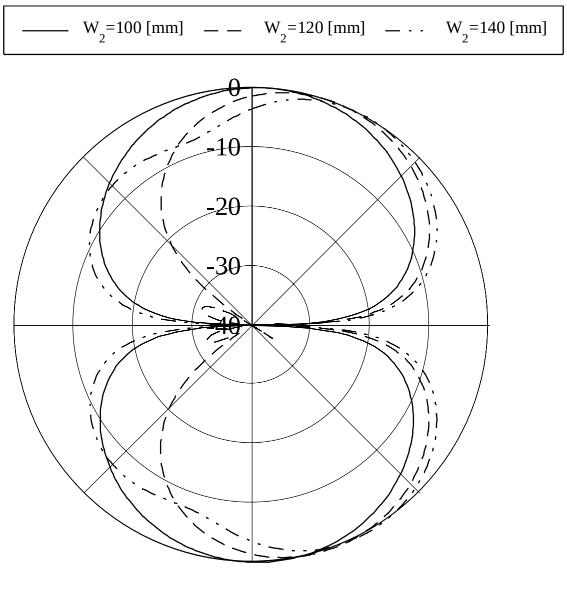

Fig. 5 Far Field Patterns (XY plane)
W=35 [mm], *f*=1 [GHz]

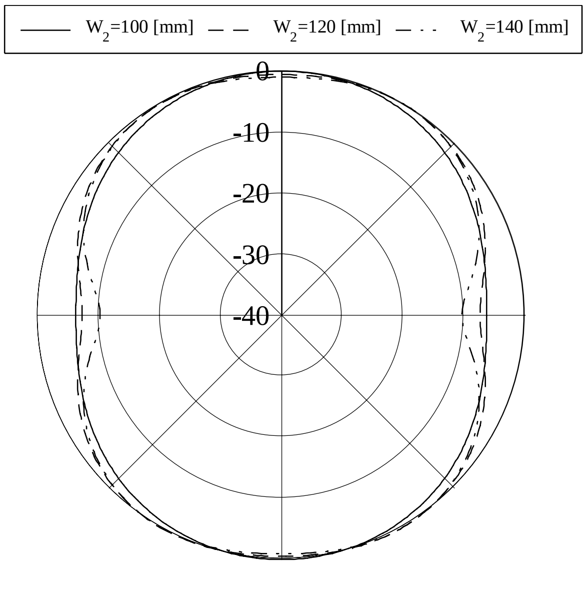

Fig. 6 Far Field Patterns (XZ plane)
W=35 [mm], *f*=1 [GHz]

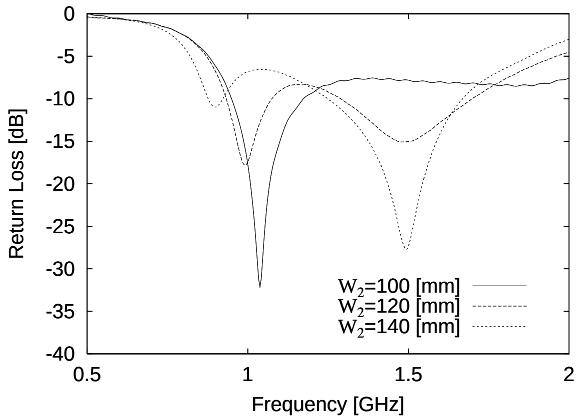

Fig. 7 Return Loss

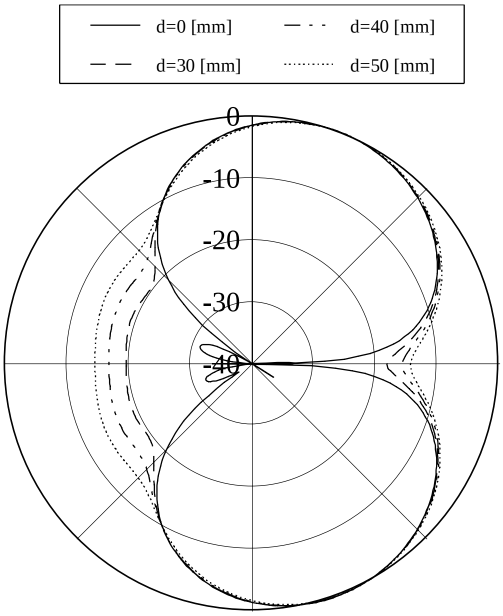

Fig. 8 Far Field Patterns (XY plane)
f=1 [GHz]

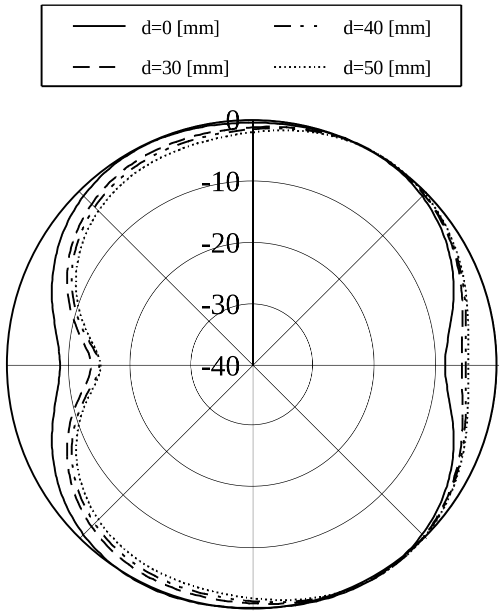

Fig. 9 Far Field Patterns (XZ plane)
f=1 [GHz]

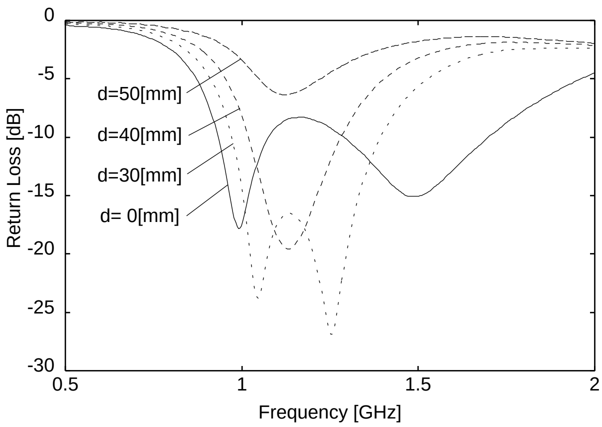

Fig. 10 Return Loss

such as the width of a conductor frame, a width of a dielectric substrate and a position of an antenna element. Although the antenna has an element, it is possible that the antenna has two resonance frequencies by changing parameters.

We will consider characteristics of the antenna for a length of an antenna element and shapes of element in future.

5. References

[1] Allen Taflove, “Computational Electro Dynamics The Finite-Difference Time-Domain Method”, Artech House Publishers, 1995

[2] E. Yamashita and Y. Qyan, “Microwave Planar Circuits and Antenna Analysis”, REALIZE INC., 1996.

[3] H. Matsui, T. Kunii, T. Wakabayasi, “Characteristics of Screen Antenna using FDTD Method”, IEEJ, EMT-98-142, pp. 19-23, Nov. 1998 (in Japanese)