A BACK-TO-BACK NARROW WIDTH MICROSTRIP ANTENNA WITH OMNIDIRECTIONAL PATTERN

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1. Introduction

Collinear array antennas constructed from coaxial elements such as sleeve dipoles or patch antennas using parastic cylinders are employed as omnidirectional antennas in mobile communication and wireless LAN systems[1],[2]. Furthermore, simple, small-size and low cost antennas are desired in such systems.

The purpose of this paper is to propose a back-to-back narrow width rectangular patch antenna fed by a CPW, and to clarify the characteristics of the our proposed patch antenna by using the finite-difference time-domain (FDTD) method[3]. The input impedances, radiation patterns and electric field distributions are calculated. The numerical results for the back-to-back patch antenna and a single patch antenna fed by a CPW are described. Good omnidirectional radiation pattern characteristics have been obtained.

2. Antenna configuration

The back to back patch fed by a CPW is shown in Fig.1. The single rectangular patch is the same configuration as the proposed antenna, but with a rectangular patch on only one side. Rectangular patches are formed on substrate with a dielectric constant εr, and thickness t. The length and width of the substrate are Ws and Ls, respectively. The length of the rectangular patch antenna is Lp and the width is Wp. The rectangular patches are arranged back-to-back, sandwiching a CPW on the ground plane. In proposed antenna, the Ws and Wp are same size. The characteristic impedance of the CPW is 50 Ω. The widths of the CPW are Wo and Wi, respectively. S is the distance between the edge of the patch and the edge of the CPW.

3. Analytical model

The FDTD algorithm based on the Yee's cell is applied to clarify the characteristics of the antennas as shown in Fig.1. The analytical model for FDTD is shown in Fig.2. The FDTD space was partitioned into 200 x 150 x 300 cells. The cell size was chosen as $\Delta x = \Delta y = 0.5$ mm and $\Delta z = 1.0$ mm. At the edge of the space, Mur's absorbing boundary condition[5] was applied. In order to ensure stability, the time increment was chosen as $\Delta t = 1$ picosecond.

The dielectric substrate is $40\Delta x$ and $100\Delta y$ in size, $1\Delta z$ in thickness, and has a dielectric constant of 10.0. The feed point of the CPW line is F, as shown in Fig.2, and this point is the reference plane for input impedance.

4.Numerical results

The input impedances, radiation patterns and electric field distributions of the narrow width rectangular patch were calculated at 1.9 GHz band. The parameters of the analytical model are shown in the Table.

The same characteristics of the single patch antenna fed by a CPW using the same parameters were calculated for comparison with the proposed antenna.

Fig.3 shows the calculated and measured input impedances as parameters of Wp and Ws. The resonance frequency of the back-to-back patch antenna is lower than that of the single patch antenna. And, the measured input impedances is lower than that of the calculated input impedances. The difference between the measured and calculated results is caused by the cell size of analytical model. The band width VSWR less than 2 is about 1%. These are the same experimental results shown in Reference [4].

Fig.4(a) shows the calculated H-plane (x-z plane) radiation patterns, and Fig.4(b) shows the calculated E-plane (y-z plane) radiation patterns. It was clear that an omnidirectional radiation pattern can be realized by using our proposed back to back narrow width rectangular patch antenna. Also our proposed antenna has almost the same radiation pattern as a dipole antenna. Fig.5(a) shows the calculated H-plane (x-z plane) radiation patterns, and Fig.5(b) shows the calculated E-plane (y-z plane) radiation patterns in case of the Ws =80 Δx and Wp = 48 Δy. Omnidirectional radiation pattern was not obtained. This result is also the same experimental results shown in Reference [4].

Fig.6(a) shows the calculated electric fields of the back-to-back patch antenna and Fig.6(b) the calculated electric fields of the single patch antenna. Ez is the electric fields between the patch and ground plane with a CPW. The electric fields of the edge of the substrate in the back-to-back patch was considerably different from that of the single patch.

5.Conclusion

This paper describes the calculated input impedance, radiation pattern and electric field distributions of the proposed back-to-back narrow width rectangular patch antenna fed by a CPW. From the results using the finite-difference time-domain (FDTD) method, the omnidirectional pattern can be obtained by using the narrow width rectangular patch

References

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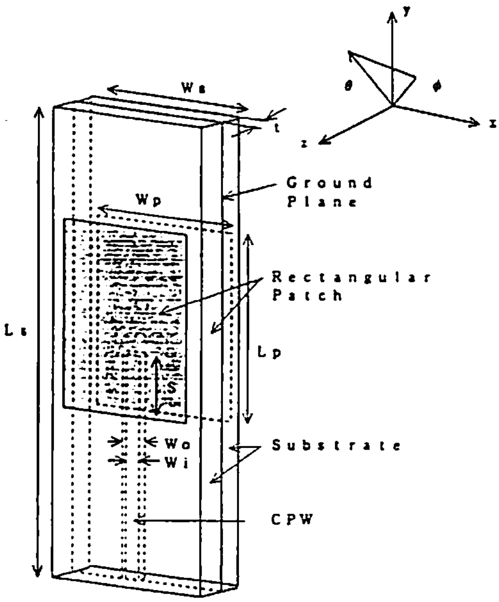


Fig.1 Configuration of a back to back rectangular patch antennas fed by a CPW.

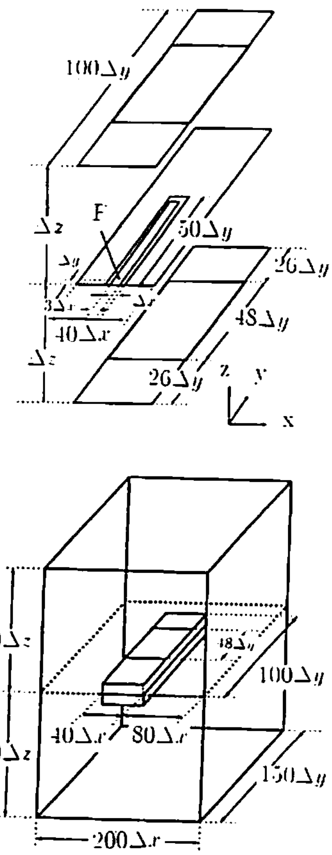
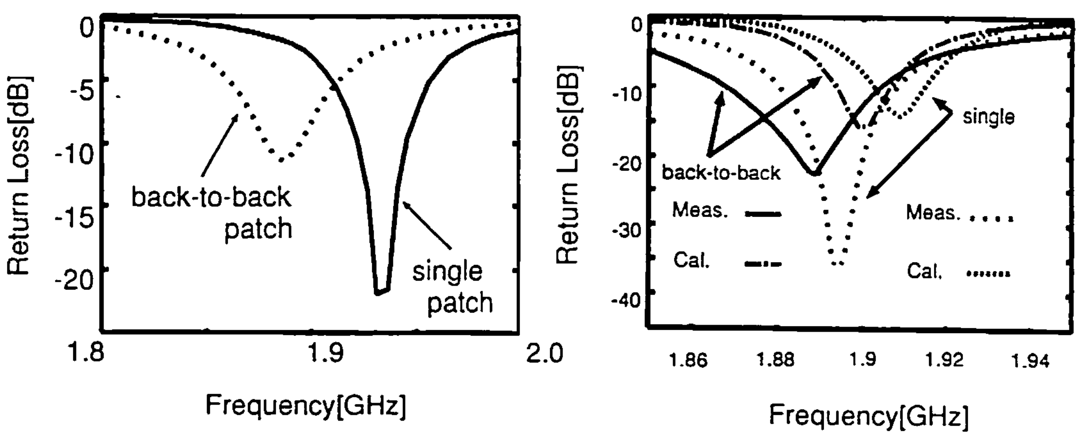


Fig.2 Analytical model.

Table ParameterS of analytical model.

($\Delta x, \Delta y = 0.5$mm. $\Delta z = 1.0$mm)

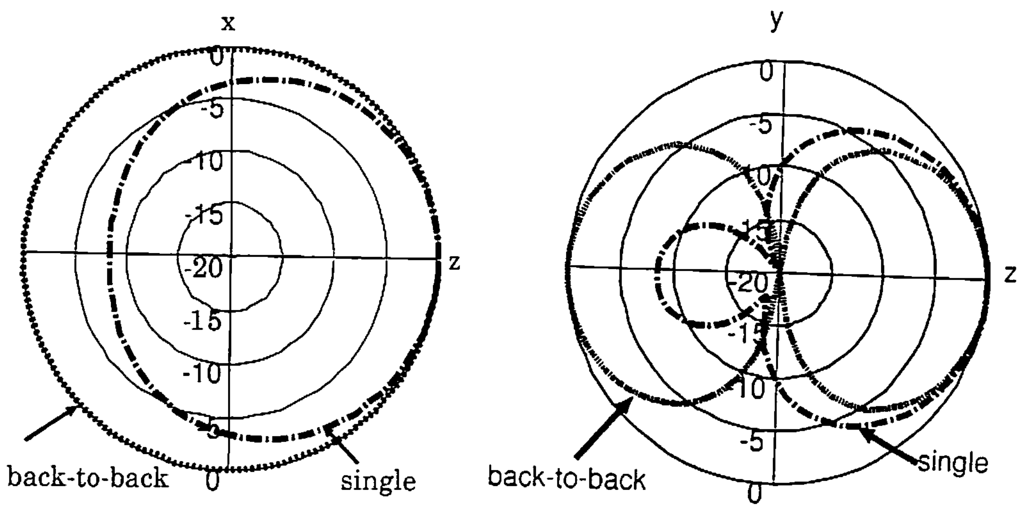
substrate	$40\Delta x \times 100\Delta y \times 2\Delta z$ ($W_s \times L_s \times 2t$)
patch	$40\Delta x \times 48\Delta y (W_p \times L_p)$
cpw	$3\Delta x (W_i)$ $5\Delta x (W_o)$
stub	$24\Delta y (S)$



(a) Wp = Ws = 40 Δx

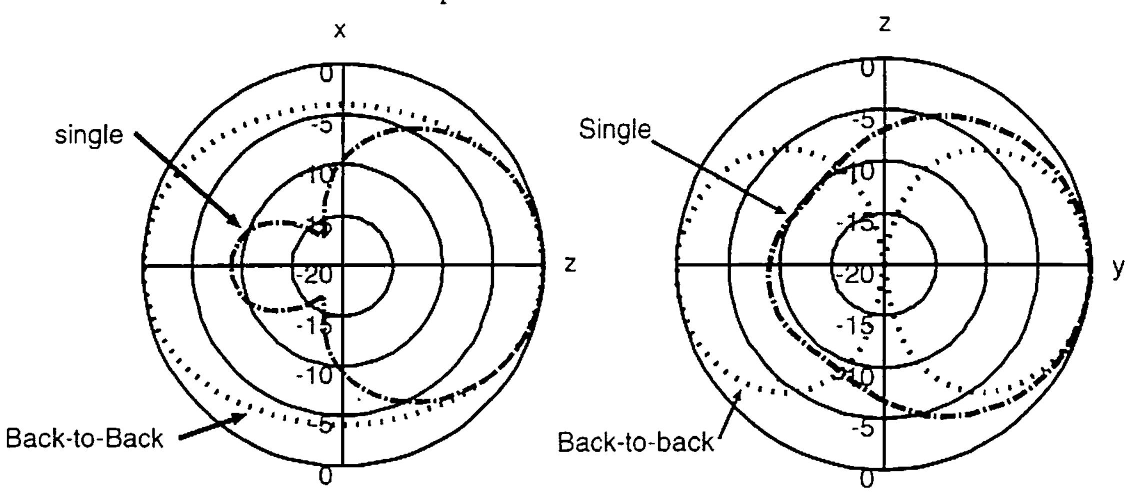
(b) Wp = 48 Δx, Ws = 80 Δx

Fig.3 Calculated and measured input impedances.



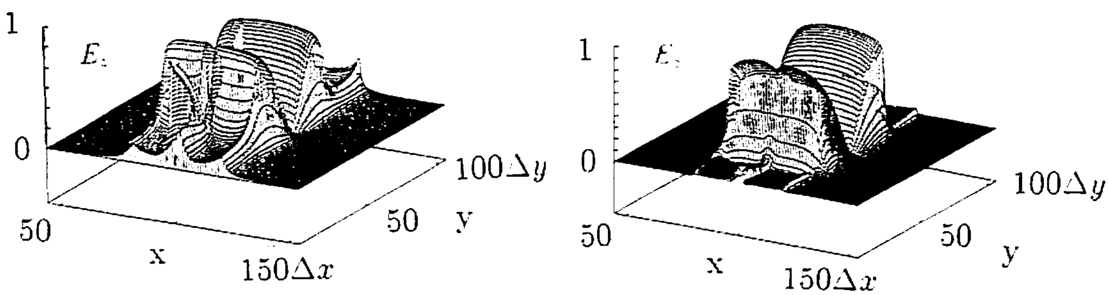
(a) H-plane (b) E-plane

Fig.4 Calculated radiation patterns.
Wp = Ws = 40 Δx



(a) H-plane (b) E-plane

Fig.5 Calculated radiation patterns.
Wp = 48 Δx, Ws = 120 Δx



(a)Back-to-back patch antenna (b)Single patch antenna

Fig.6 Calculated electric fields.