Two by Two MIMO Antenna Composed of Inverted L Elements Printed on Dielectric Substrate

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Abstract - **Two by two MIMO antenna composed of two inverted L antennas is proposed and numerically analyzed. Inverted L antenna formed by coplanar waveguide is printed on the dielectric substrate. The thickness of dielectric substrate is 3 mm, its relative permittivity is 2.6 and the loss tangent is 0.0022. When the size of dielectric substrate is 41.5 mm by 40 mm, the S11 less than -10 dB is satisfied from 2.41 GHz to 2.49 GHz. The distance between two antennas is 36.1 mm. The S21 less than -20 dB and the correlation coefficient less than 0.005 are satisfied from 2.4 GHz to 2.5 GHz. The calculated directivity is 3.23 dBi at 2.45 GHz. In the numerical analysis, the electromagnetic simulator WIPL-D based on the Method of Moments is used.**

Index Terms — **MIMO antenna, inverted L antenna, coplanar waveguide, Method of Moments, WIPL-D.**

1. Introduction

By the demand for high data rate and large channel capacity of users in recent mobile communication systems, the MIMO systems became as the subject of investigation for several years [1]. A practical MIMO antenna should have a low signal correlation between antenna elements and good impedance matching characteristics [2, 3]. The mutual coupling is an important factor when antennas have been used for MIMO applications [4, 5].

One of authors has proposed an unbalanced fed ultra low profile inverted L antenna on a rectangular conducting plane. In this antenna, the electromagnetic field is strongly excited between the horizontal element of inverted L antenna and the ground plane [6]. Therefore even though two inverted L antennas are closely located, the mutual coupling may be weak. One of the authors has proposed the MIMO antenna composed of two unbalanced fed, ultra low profile inverted L antennas on a square conducting plane with its size of 55 mm by 55 mm [7]. In order to reduce the antenna height, the coplanar waveguide is printed on the dielectric substrate and realized the inverted L antenna [8].

In this paper, two by two MIMO antenna composed of two inverted L antennas printed on the dielectric substrate is proposed and numerically analyzed. In the numerical analysis, the electromagnetic simulator WIPL-D based on the Method of Moments is used [9].

2. Analytical Model

Figure 1 shows the structure of proposed MIMO antenna. The antenna is composed of two identical, inverted L antennas on the dielectric substrate. The coplanar waveguide is printed on the dielectric substrate. The planar elements *#1* and *#2* are printed on the rectangular dielectric substrate with size of (*pyp* + *pym*) by (*pxp* + *pxm*). The elements *#2* are short-circuited to the ground plane. The antenna is excited between the element *#1* and the ground plane. The length of horizontal element #1 is L and that of horizontal element #2 is L_1. The width of all element is w and the gap width between element *#1* and *#2* is g. The thickness of dielectric substrate is h = 3 mm. The relative permittivity and the loss tangent of the dielectric substrate are 2.6 and 0.0022, respectively. By adjusting the length of horizontal elements L and L_1, the input impedance is matched to 50 Ω. The distance d between the central axes of two antennas is 36.1 mm.

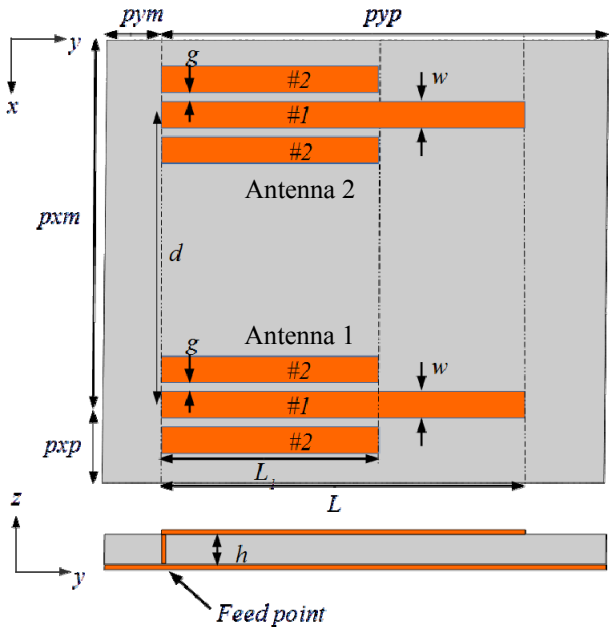


Fig. 1. Structure of proposed MIMO antenna.
L = 21.6 mm, L_1 = 16.8 mm, h = 3 mm, g = 0.25 mm, w = 1.5 mm, *pxp* = 2.7 mm, *pxm*=38.8mm, *pym* = 10 mm, *pyp* = 30 mm, d=36.1 mm

3. Results and Discussion

Fig. 2 show the calculated S11 and S21 parameters of the proposed MIMO antenna. The S11 less than -10 dB is satisfied from 2.41 GHz to 2.49 GHz. The S21 less than -20 dB is satisfied at this frequency band. The correlation coefficient ρ_e can be calculated as follows [10].

$$\rho_e = \frac{\left|S_{11}^* S_{12} + S_{21}^* S_{22}\right|^2}{\left(1-\left|S_{11}\right|^2-\left|S_{21}\right|^2\right)\left(1-\left|S_{22}\right|^2-\left|S_{12}\right|^2\right)} \quad (1)$$

Fig. 3 shows the calculated correlation coefficient of proposed MIMO antenna. The correlation coefficient becomes less than 0.005 at 2.4 GHz to 2.5 GHz. Fig. 4 shows the calculated electric field radiation patterns. Fig. 5 shows the electric field distribution on the surface of dielectric substrate. Due to the electric field along the top edge of dielectric substrate, the mutual coupling between two antennas becomes strong.

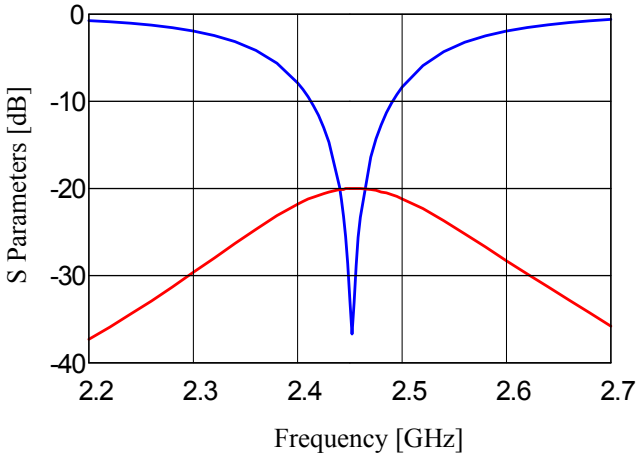


Fig. 2. S parameters of MIMO antenna.

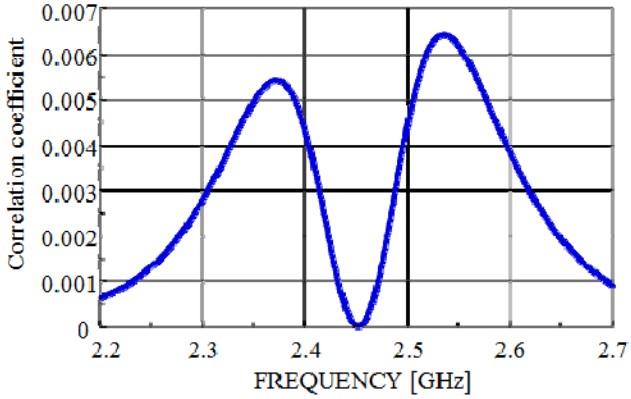
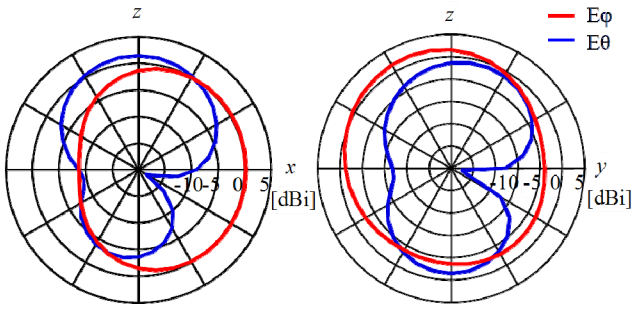


Fig. 3. Calculated correlation coefficient.

4. Conclusion

The MIMO antenna composed of the inverted L antennas printed on the dielectric substrate has been proposed. The size of propose antenna is 41.5 mm by 40 mm by 3 mm. Although the distance between two antenna elements is 36.1 mm, the mutual coupling between two antenna elements is very weak. The presented design is suitable for MIMO communication application.



(a) xz-plane (b) yz-plane

Fig. 4. Electric field radiation patterns.

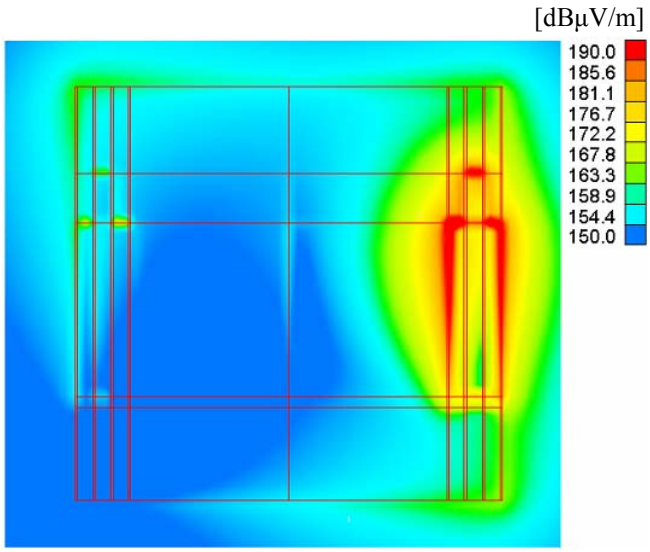


Fig. 5. Electric field distribution on dielectric substrate.

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