Mutual Coupling Reduction Using Resistive Sheets

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***Abstract* – This paper proposes an array antenna that uses resistive sheets to reduce mutual coupling between array antennas. Similar to 1D TCDA, a PEC wall was set up to satisfy PEC boundary conditions between dipole antennas to realize wideband. Additionally, this wall alleviates mutual coupling. To reduce mutual coupling between antennas at a specific frequency, resistive sheets were attached to the edge of the PEC wall. The proposed antenna is a 1 × 64 array antenna operating at 11.3 ~ 18GHz. Mutual coupling within the band satisfies -19dB or less.**

***Index Terms* — Array antenna, mutual coupling, resistive sheets, 1D TCDA.**

1. Introduction

In the field of radar research, array antennas require a low mutual coupling characteristic, to facilitate the clear detection of the target image [1]–[4] and match the self-impedance of the antenna in any array location [5].

There have been many attempts to reduce mutual coupling. In microstrip antennas, mutual coupling occurs frequently through the ground plane. To prevent this, one can isolate the ground plane or insert a resonant structure so that it cannot be transmitted at a specific frequency [6]–[11]. Another commonly used technique is polarization rotation [12]–[13].

In this study, to create a broadband antenna with low mutual coupling, a dipole array antenna similar to 1D TCDA [14] was used, and we propose a simple means of reducing mutual coupling.

2. Mutual Coupling Reduction Technique

Fig. 1 shows the full array antenna and its unit cell configuration. By arranging the dipole antennas arranged in the E-plane, a PEC boundary condition is formed between the dipoles [14]. Therefore, even if the PEC wall were set up between the dipoles (as in Fig. 1), the boundary condition is virtually unchanged. However, the reason for setting the PEC wall is to reduce concurrent mutual coupling.

Fig. 2 shows the electric field profile of a unit cell at 12GHz and 18GHz, and without resistive sheets. At 12GHz (where mutual coupling is strong), coupling occurs through diffraction at the edge of the PEC wall. Obviously, more diffraction occurs at the edge at 12GHz than at 18GHz.

However, coupling can be reduced by appropriately positioning 377ohm resistive sheets along the edge. Fig. 3 shows the profile with sheets. As one can see, less diffraction occurs at the edge of the PEC wall with the sheets at 12GHz, because the resistive sheets dissipate the coupling energy through diffraction.

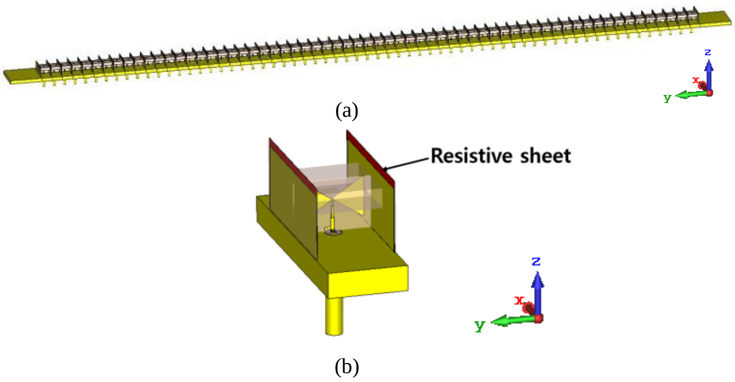


Fig. 1. (a) Proposed 1 × 64 full array antenna and (b) its unit cell configuration.

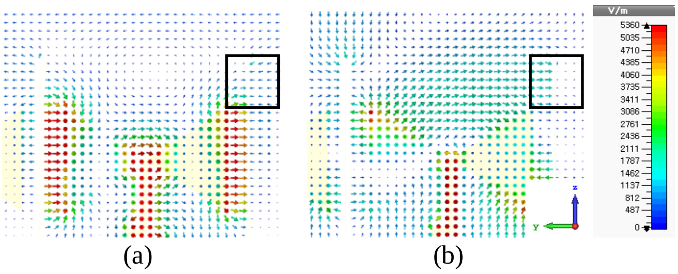


Fig. 2. Electric field profile in the unit cell at (a) 12GHz and (b) 18GHz, without resistive sheets.

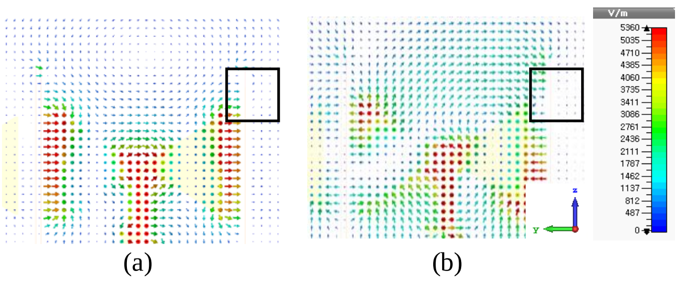


Fig. 3. Electric field profile in the unit cell at (a) 12GHz and (b) 18GHz, with resistive sheets.

Fig. 4 shows the S-parameter with/without the resistive sheets, where the number of the excited port is 1 and that of the adjacent port is 2. The results show that the mutual coupling is reduced from -12.5dB to -23dB at 12GHz when the resistive sheets are attached, and the impedance is well matched at 11.3 ~ 18GHz. It can be noted that the

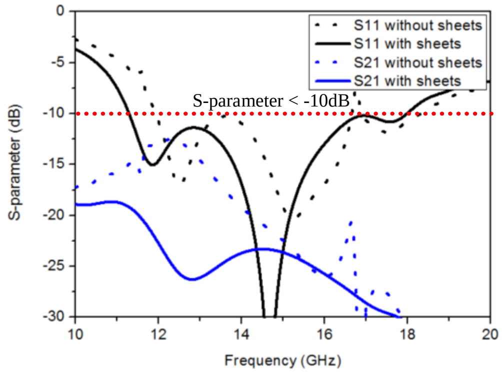
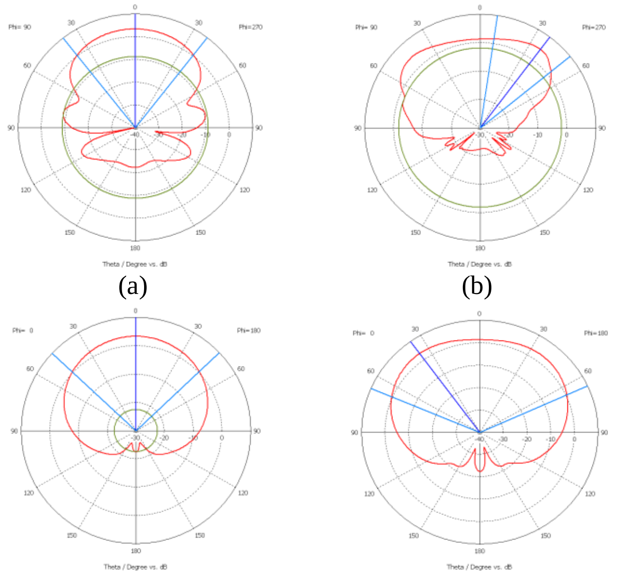


Fig. 4. S-parameter with/without resistive sheets.



(a) (b) (c) (d)

Fig. 5. Active element gain pattern on the E-plane at (a) 12GHz and (b) 18GHz, and on the H-plane at (c) 12GHz and (d) 18GHz.

results of the S-parameter are almost the same—regardless of the unit cell and the position in the full array antenna—since the mutual coupling is quite low [5]. However, there is a trade-off for radiation efficiency: radiation efficiency without resistive sheets is more than 88% within the bandwidth, but it is more than 53% with the sheets. In fact, radiation efficiency at 12GHz decreases by about 35%, while there is no significant decrease at the other frequencies. This is evidence that the resistive sheets nearly dissipate the diffracted fields. Fig. 5 shows the active element gain patterns of the center antenna of a 1 × 64 full array at 12GHz and 18GHz. On the E, H-plane, the 3dB beamwidth exceeds 75 degrees and the maximum gain exceeds 2dB.

3. Conclusion

We proposed a wideband array antenna with a very low mutual coupling characteristic. The design is based on the energy absorption by small resistive sheets between two antennas. The sheets significantly reduced the mutual coupling by effectively dissipating the diffracted fields. However, the radiation efficiency decreased with a decrease in coupling. Finally, the radiation patterns have a wide beamwidth on both planes and the maximum gain exceeds 2dB.

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