Shielding Effect of Metallic Shielding on Antenna Mutual Coupling

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Abstract

This paper describes the shielding effects of the metallic structure on the antenna mutual coupling. Here, a rectangular pipe structure is proposed as the metallic shielding. It was shown by the simulation results that the shielding effect with the RBC_m of 17% was obtained by using the proposed rectangular pipe shielding.

Keywords : Mutual Coupling Metallic shielding Dipole antenna

1. Introduction

The radiation characteristics and the VSWR characteristics of the antenna have deteriorated because of the antenna mutual coupling. The suppression method of the antenna mutual coupling has been proposed and studied for these characteristics deterioration improvements [1]-[4].

This paper describes the shielding effects of the metallic structure on the mutual coupling between the dipole antennas. In Section 2, the rectangular pipe structure is proposed as the metallic shielding. In Section3, the shielding effects is shown by using the relative bandwidth characteristics of the normalized mutual coupling.

2. Analysis Model

Figure 1 shows the analysis model. The dipole antenna are located in the vertical direction, and the metallic shielding is set between the dipole antennas. The distance d_0 between the antenna elements is fixed at λ_0. Here, λ_0 is resonant wavelength of the dipole antenna.

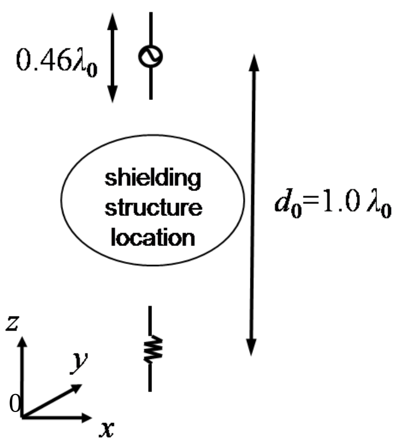


Figure 1: Analysis Model

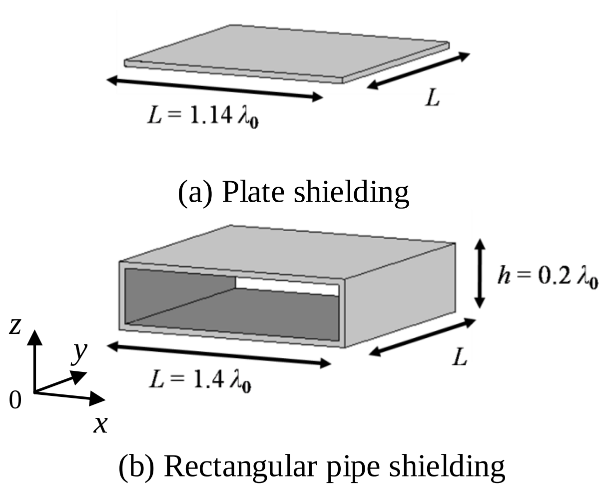


Figure 2: Shielding Models

Figure 2 shows the configuration of the metallic shielding structures. Figure 2(a) shows the plate shielding. The length is L=1.14λ_0. Figure 2(b) shows the proposed rectangular pipe shielding. The length and a height of the rectangular pipe shielding is L=1.4λ_0, h=0.2λ_0, respectively. The moment method (EEM-MOM) is used for the following calculation.

3. Effect of Shielding on Antenna Mutual Coupling

3.1 Evaluation Factor

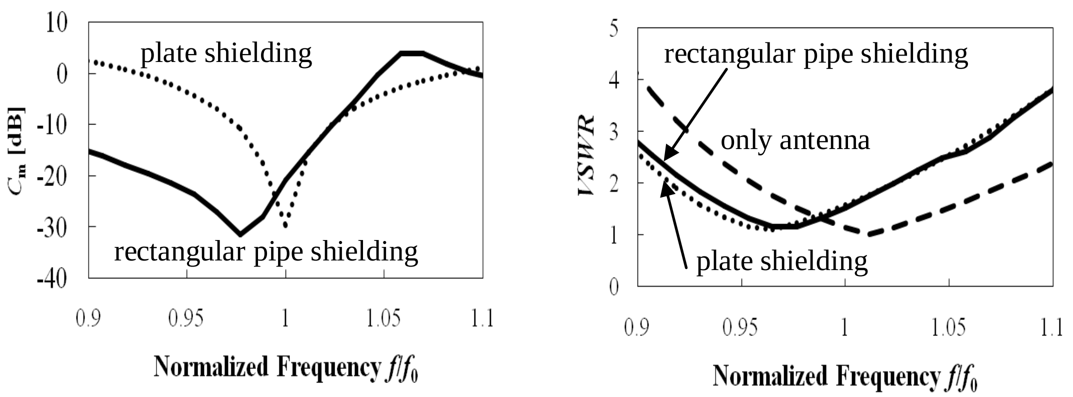
Here, the normalized mutual coupling (C_m) and the relative bandwidth (RBC_m) are defined for evaluation factor in this paper. C_m defined by Eq.(1). When this value is smaller than 1 (0dB), it means that the mutual coupling between antennas can be suppressed.

$$C_{\mathrm{m}} = \frac{\text{Antenna mutual coupling with shielding sturcture}}{\text{Antenna mutual coupling without shielding sturcture}} \quad (1)$$

RBC_m is the ratio of center frequency to bandwidth while C_m is less than the specific level.

3.2 Influence of Metallic Shielding on Mutual Coupling

Figure 3(a) shows the effects of metallic shielding structures on C_m. Figure 3(b) shows the effects of metallic shielding structures on *VSWR*. The horizontal axes of both figures are the frequency normalized by resonant frequency of the antennas, the vertical axis of Fig.3(a) is the normalized mutual coupling C_m. The solid line indicates the proposed rectangular pipe shielding, and the dotted line indicates the plate shielding.



(a) Effects of Metallic Shielding Structures on C_m (b) Effects of Metallic Shielding Structures on *VSWR*

Figure 3: Effects by the Metallic shielding structures

In Figure 3, as the value of C_m is lower than 0dB, it is shown that the metallic shielding structures can suppress C_m of antennas. Both metallic shielding structures can reduce C_m by about 30dB at the maximum. Furthermore, RBC_m of the proposed rectangular pipe shielding shown by a dotted line is wider than the plate shielding shown by a solid line. In addition, the effects of metallic shielding structures on *VSWR* is nearly same as shown in Fig. 3.

Figure 4 shows the effects of metallic shielding structures on RBC_m. In Fig. 4, the horizontal axis indicates the normalized C_m, and the vertical axis indicates the RBC_m. The solid line shows the case of plate shielding, and the dotted line shows the case of rectangular pipe shielding.

The plate shielding has about 5% of RBC_m while C_m is less than -10dB, and the rectangular pipe shielding has it about 17%. The rectangular pipe shielding is better than plate shielding for suppressing C_m of antennas.

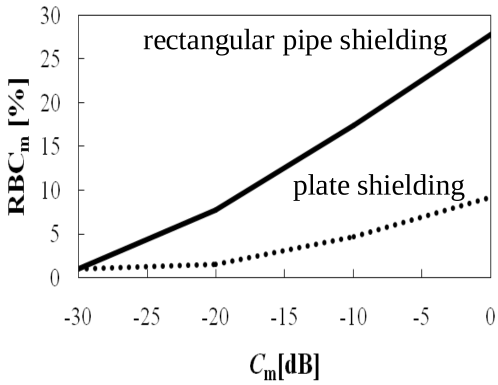
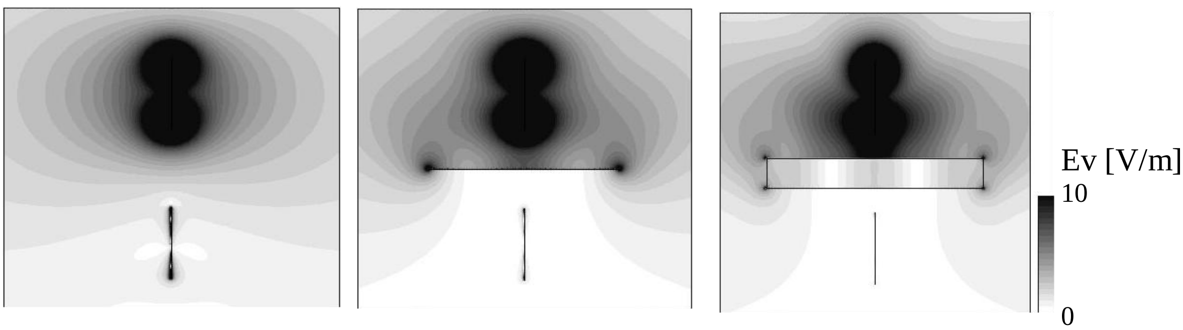


Figure 4: Effects of Metallic Shielding Structures on RBC_m

Figure 5 shows the effect of the metallic shielding structures on electric field. Figure 5(a), 5(b) and 5(c) show in case of the only antenna, with the metallic plate shielding, with the proposed rectangular pipe shielding. In Fig. 5, the strength of the electric field with the light and shade of the color. A bright color is used for a strong electric field strength, and a gloomy color is used to be a weak electric field strength.



(a) Only Antenna (b) with plate shielding structure (c) with proposed rectangular pipe shielding structure

Figure 5: Effect of the metallic Shielding Structures on Electric Field Distribution

In Fig. 5(b) and Fig. 5(c), it is found that the strength of the electric field around the dipole antenna which is attached resistance is lower than other antennas. As a result, It is confirmed that two metallic shielding structures act on the antenna mutual coupling. From results of Figs. 5(a) and 5(b), it is found that the strength of the electric field around antenna which is attached resistance is low.

3.3 Effects of Metallic Shielding Structures on Radiation Pattern of Antenna

Figure 6 shows the effects of metallic shielding structures on radiation patterns of the antenna. Figures 6(a) and 6(b) show the radiation patterns in the *y*-*z* plane and the *x*-*z* plane respectively. In Fig. 6, the solid line and the dotted line show the case of the proposed rectangular pipe shielding and the case of the plate shielding, respectively, the dashed line shows the case only for antennas.

In Figure 6, it is found that the effects of the plate shielding on radiation pattern of the antenna is weak and is the proposed rectangular pipe shielding structure's effect for it is strong. Therefore, it is necessary for the effects of the proposed rectangular pipe shielding on radiation patterns of the antenna to be made to weak.

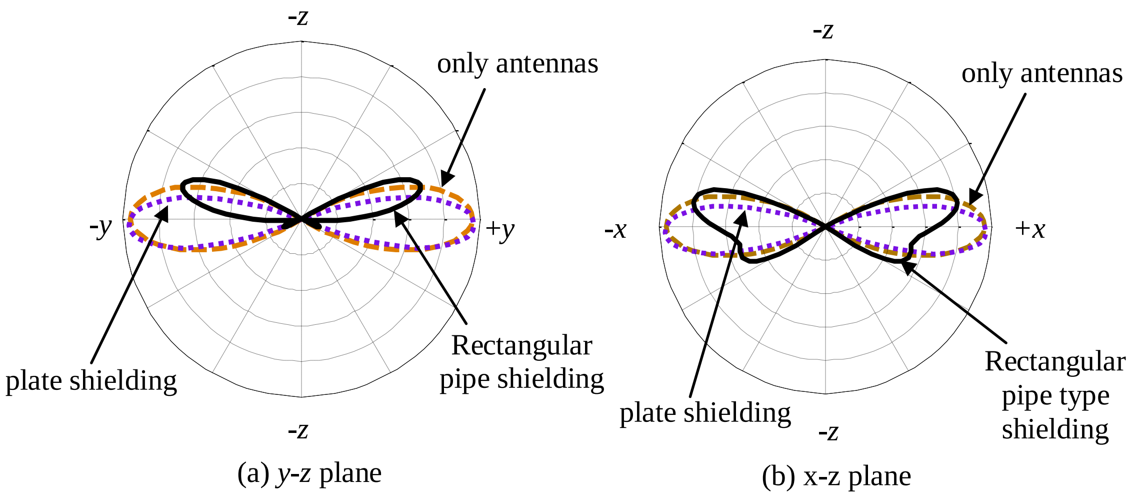


Figure 6: Influence of Metallic shielding structures on Antenna's Directivity

4. Conclusion

In order to suppress the antenna mutual coupling, the rectangular metallic pipe structure was proposed. Here, the relative bandwidth characteristics of the C_m were examined at the case of the rectangular metallic pipe structure in comparison with the metallic plate. By the simulation results, it was shown that the metallic structure could suppress the antenna mutual coupling with the effect of more than 30dB. And, it was also clarified that the shielding effects of the proposed rectangular pipe shielding was obtained as the RBC_m of 17% more than the case of the metallic plate.

References

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