The Near Field on the Ground Plane in Test Site

— Comparison between the Cases Horizontal and Vertical Polarization —

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1. Introduction

Measurement of site attenuation or electromagnetic noise from EUT (Equipment Under Test) is usually performed at the open field test site on the finite sized ground plane. The influence of the finite ground plane has been considered by some researchers concerning the site attenuation[1, 2]. The reflected wave on the ground plane was treated as it were on the infinite ground plane, in other words, the total reflection, and the diffracted wave was calculated by GTD (Geometrical Theory of Diffraction) in those calculations. However those calculations include some errors, as the ground plane and its edge have finite size.

So we calculated the electric field near the ground plane by the FDTD method to make clear the reflection and the diffraction of the finite sized ground plane for horizontal and vertical polarization.

2. Analyzed Model of Test Site

Fig.1 shows the model for measuring system of site attenuation for EMI measurements. Site attenuation is defined as the insertion loss from the transmitting antenna to the receiving antenna.

We consider about the antenna system of site attenuation as shown in Fig. 2. Fig. 2 (a) shows for the case of the horizontal polarization and (b) for the vertical polarization.

As the ground plane has finite size, we have to consider about the edge and the corner diffraction and the reflection to calculate the site attenuation. Generally, the site attenuation of the open field test site is measured and calculated from 30 to 1000 MHz. In rather low frequency range, we may not be able to adapted the GTD to calculate the diffraction wave from the edges of ground plane, we may not be able to treat the reflection wave as the total reflecting, because of the finite size of the ground plane.

So we calculate the electric filed radiated from transmitting antenna in time domain of this system with the FDTD method. The dimensions of region for calculation is 91 $\times$ 121 $\times$ 171 cells. The cell size of FDTD is 0.1 m $\times$ 0.1 m $\times$ 0.1 m, the time step of calculations is 192.6 times per sec. The wire radius of the transmitting and the receiving antenna is 5 mm.

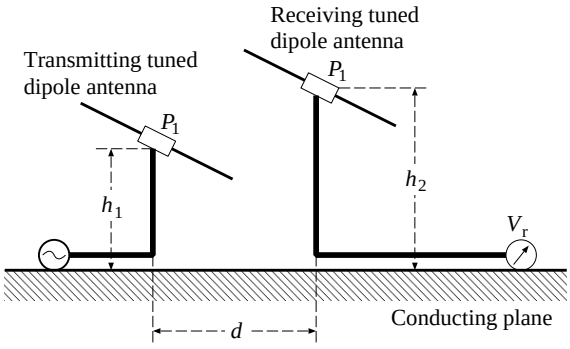


Fig. 1 The model of measuring system for site attenuation.

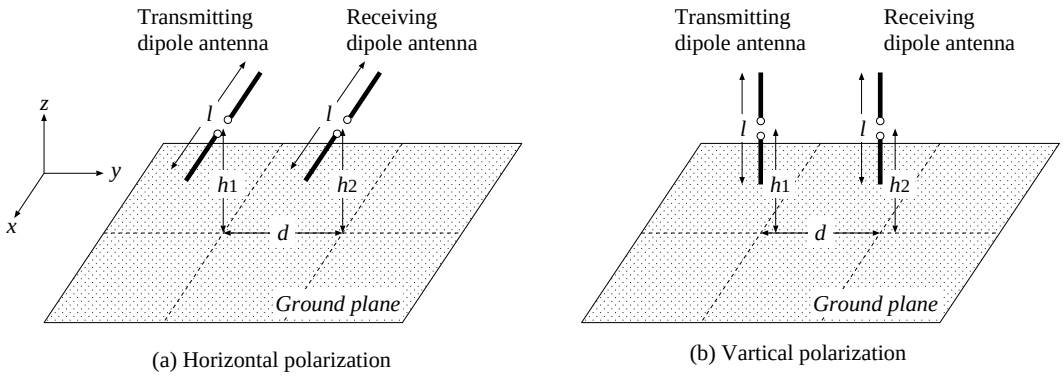


Fig. 2 Analyzed mode of test site.

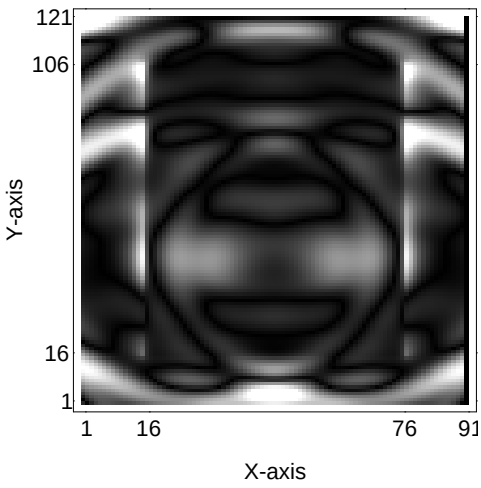
The number of additional 15 cells are used to separate the geometry from the outer boundary with free space.

3. Calculated Results

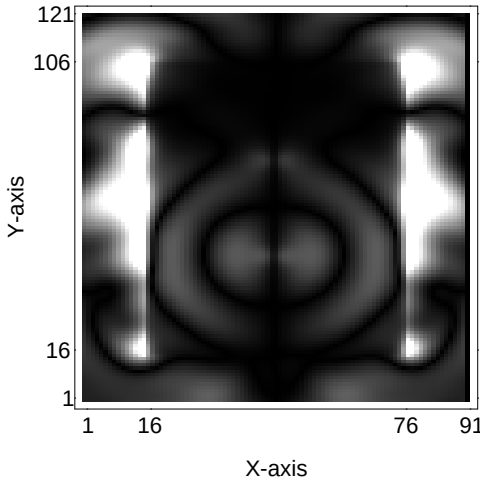
The parameters in Fig. 2 are $d = 3$ m, $l = 3$ m, $h_1 = 2$ m, $h_2 = 2$ m, where the l is corresponding to the half wavelength on 50 MHz.

Fig. 3 shows the calculated results of the typical distribution of electric field components in horizontal plane, 1 cell size (0.1 m) above the ground plane at 200 time steps after start time for horizontal and vertical polarization. The voltage source is Gaussian pulse which width is 32 time steps with source resistance 50 Ohms. White colored regions shows that the amplitude of the electric field is big, and black regions small. It is seen that the electric field is diffracted by the edge of ground plane. In the cases of E_x and E_y, the electric field near the edge crossed the directions of each electric field is strong and the field near the parallel to the edge is week, as well as we know. So it is found that the electric field diffracted from x-direction and y-direction edge of ground plane is negligible for horizontal and vertical polarization, respectively.

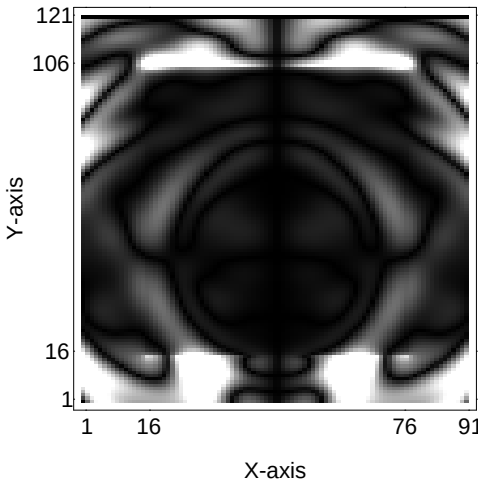
In the case of E_z, the direction of electric field is orthogonal to the all four edges of the ground plane. So it is found that the electric field from all edges is appeared. In



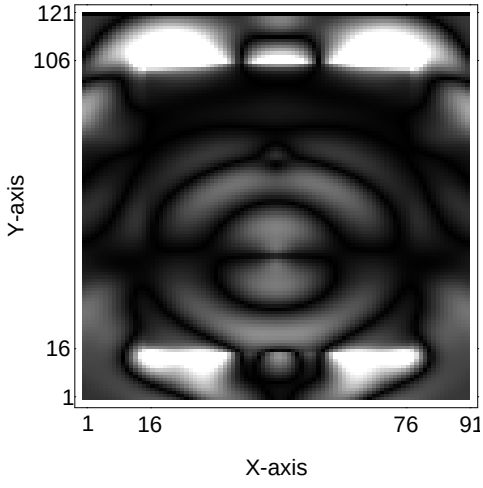
E_x



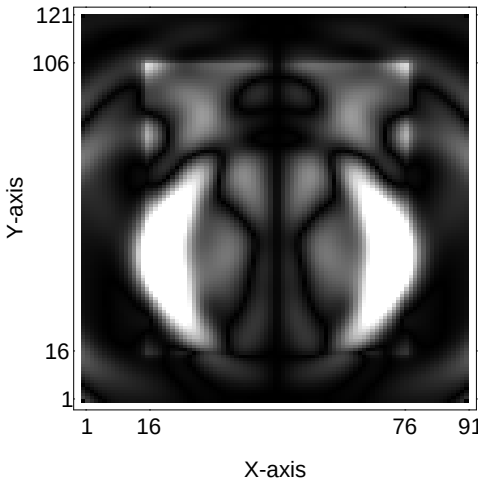
E_x



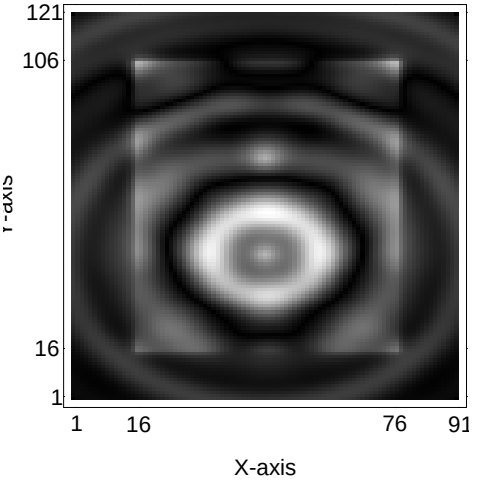
E_y



E_y



E_z



E_z

(a) For horizontal polarization (b) For vertical polarization

Fig. 3 Calculated electric field components above the ground plane.

addition, the field diffracted from the corner edge is appeared. So we think that we have to consider the corner diffraction of the E_z for the ground plane.

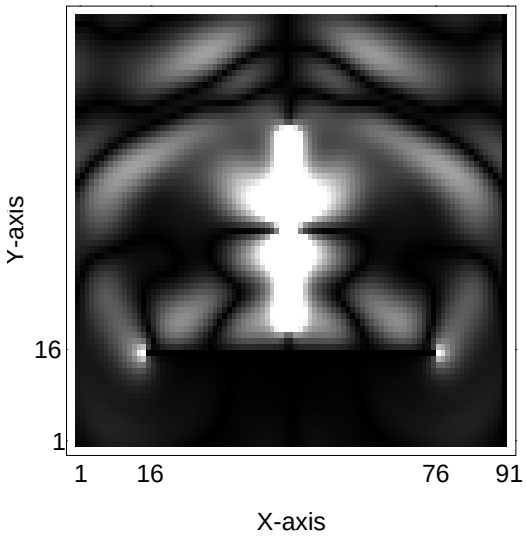


Fig. 4 Calculated electric field strength in x-z plane.

Fig. 4 shows the calculated electric field strength in x-z plane including the transmitting antenna after 200 time steps. It is found the electric field is diffracted by the edge of the ground plane from Fig. 4.

4. Conclusion

We calculated the electric field near the ground plane of test site. It became clear that the radiation from the edge of the ground plane.

In future, we will calculate the site attenuation by the FDTD method to convert the results of this paper from time domain to frequency domain.

References

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