Modeling of Mode Conversion Due to Asymmetry/Coating in Transmission Line System

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Mode conversion effects play an essential role in the radiated emission and susceptibility of transmission line systems [1, 2]. A special mode conversion effect is discovered in floating-ground three-conductor cables (FTC) with dielectric coatings and asymmetric structures. This effect partially conflicts with our perception of the field-to-wire coupling because there is a sizeable current [given by Method of Moments (MoM)] at the terminal load of the cables in free space under common-mode excitation which is quite different from the results predicted by multiconductor transmission line (MTL) theory, as shown in Figure 1. To effectively reveal the causes of this phenomenon, this paper studies the mode conversion effect of floating-ground multiconductor cables, which may support the comprehensive evaluation of the field-to-wire coupling of floating-ground cables. To this end, the characteristics of FTC are decomposed into the common-mode (CM) part and differential-mode (DM) part and the definition of CM and DM are given. The transfer inductance matrix characterizing the mode conversion from CM to DM is derived, and the factors that induce the mode conversion are discussed. The proposed model is verified by full-wave simulations (MoM) with the good agreement (as shown in Figure 1) and better efficiency. It should be noted that the common-mode excitation means the incident plane wave with the electric field in the y-direction and magnetic field in the x-direction. In this scenario (shown in Figure 1), the cable structure is asymmetrical since this cable structure causes non-equilibrium currents that induce mode conversion.

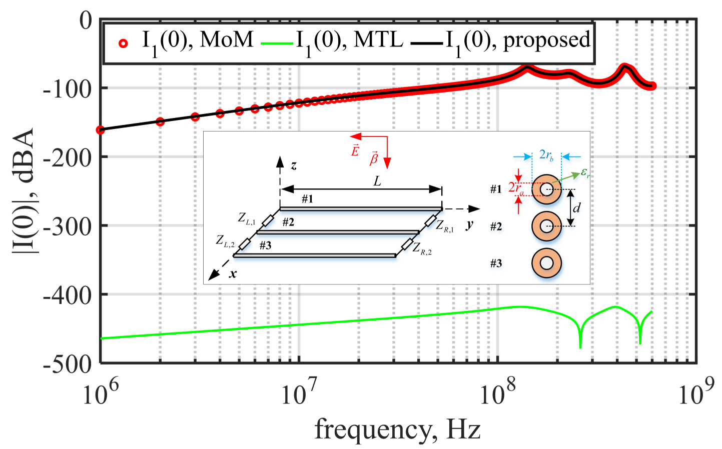

Figure 1. The induced currents at the left terminal load $Z_{L,1}$ obtained from MoM, MTL and the proposed method. (The scene parameters are as follows: $E = 1$ V/m, $r_a = 0.1$ mm, $r_b = 0.2$ mm, $\varepsilon_r = 5$, $\mu_r = 1$, $L = 1$ m, $d = 0.5$ mm, $Z_{X,i} = 50\ \Omega$ with $X = L, R$ and $i = 1, 2$.)

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References

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