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Equivalent radiation source of 3D package for electromagnetic characteristics analysis

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Abstract: An equivalent radiation source method is proposed to characterize electromagnetic emission and interference of complex three dimensional integrated circuits (IC) in this paper. The method utilizes amplitude-only near-field scanning data to reconstruct an equivalent magnetic dipole array, and the differential evolution optimization algorithm is proposed to extract the locations, orientation and moments of those dipoles. By importing the equivalent dipoles model into a 3D full-wave simulator together with the victim circuit model, the electromagnetic interference issues in mixed RF/digital systems can be well predicted. A commercial IC is used to validate the accuracy and efficiency of this proposed method. The coupled power at the victim antenna port calculated by the equivalent radiation source is compared with the measured data. Good consistency is obtained which confirms the validity and efficiency of the method.

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1. Introduction

Three dimensional (3D) integration technology which offers high speed, high density, small size and enhanced performance is among the most promising solutions for future intelligent terminal and wireless communication equipment[1-3]. Different materials and functional devices are integrated into one package using through-silicon-vias (TSVs) technology, which may induce a deteriorated electromagnetic environment of an electronic system. Usually, the semiconductor devices (particularly MOS devices) in a 3D package are difficult to model in a commercial 3D full-wave simulator. For most cases, details of the 3D package are unknown due to the commercial confidentiality of the manufactures. Facing the enormous electromagnetic modeling problem of complex 3D packages, it is essential to exploit an accurate and efficient equivalent radiation source to characterize and analyze electromagnetic emission and interference of the 3D package without reference to the details of the structures.

Source reconstruction techniques based on near-field scanning represent a device under test (DUT) by simple equivalent currents or infinitesimal dipole array, which does not need internal structure information of the 3D package. The emission radiated by the equivalent radiation source is the same as that produced by the original DUT. Hence, an equivalent radiation source method can be used for modeling electromagnetic emissions and mutual interference of a complex 3D package with low computational burden and high efficiency. Some different equivalent radiation source methods based on near-field scanning have been proposed. Latticed equivalent dipoles are used to replace the DUT with