TSV 封装中阻抗不连续差分互连结宽频寄生参数建模研究

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摘　要：为了研究 TSV 封装内除差分对硅通孔外在硅基片的层间和层下存在的微凸点、平面互连线、倒装焊球等互连结构对差分信号传输特性的影响，提出了一种改进型的适用于描述 TSV 封装内“串连型差分互连阻抗”的差分对硅通孔结构的 RLCG 电路模型，进而提出了一种采用“阻抗不连续系数”来描述串行连接的微凸点、平面互连线、倒装焊球等结构的 “串连式阻抗不连续结构” RLCG 电路模型.在此基础之上，采用 HFSS 三维全波仿真方法对 TSV 封装中的硅通孔、微凸点、平面互连线、倒装焊球等差分对互连结构的各种串行连接方式进行了三维电磁场建模和分析.将 RLCG 模型的差模正向传输系数与 HFSS 模型的分析结果进行了对比，对比结果证明在 0.1~30 GHz 特别是 3~25 GHz 宽频段内本文提出的上述 2 种 RLCG 电路模型能够较为准确的描述出差分互连结构的差模信号宽频传输特性.

关键词：TSV 封装；差分对 TSV 结构；串连型差分互连阻抗；串连式阻抗不连续结构；阻抗不连续系数；RLCG 电路模型；HFSS 模型

Broadband Parasitic Parameters Modeling of Impedance Discontinuous Differential Pair Interconnect Structure in the TSV Package

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Abstract：In order to research the influence on the differential transmission characteristics caused by micro-bump， planar interconnector， flip-chip solder ball and other interconnect structures except for the through silicon via in the TSV package， an improved RLCG circuit model of the differential TSV， which is suitable for describing the "impedance of the differential interconnect structures connected in series" is proposed. Then， a RLCG circuit model of the “impedance discontinuity structure connected in series” which is suitable to describe the micro-bump， planar interconnector， flip-chip solder ball and other interconnect structures used “impedance discontinuity coefficient” is proposed. On this basis， 3D full wave simulation method of HFSS is used to simulate the structure made up of the micro-bump， planar interconnector， flip-chip solder ball and other interconnect structures connected in series. The differential mode forward transmission coefficient of the RLCG model and HFSS model are analyzed and compared. The results show that two RLCG models proposed above can describe the wideband transmission characteristics of differential mode signals accurately in the 0.1~30 GHz， especially in the 3~25 GHz wave band.

Key words： TSV package； differential TSV structure； impedance of the differential interconnect structures connected in series； impedance discontinuity structure connected in series； impedance discontinuity coefficient； RLCG circuit model； HFSS model

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