TSV 封装中互连结构的差分串扰建模研究

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摘　要：为了研究 TSV 封装中互连结构之间的串扰对差分信号传输特性的影响；针对硅通孔结构提出了一种改进型的“近邻硅通孔差分串扰”RLCG 寄生参数模型，进而提出了一种适用于描述接地硅通孔对近邻硅通孔串扰影响的“接地硅通孔”RLCG 寄生参数模型；针对层间互连线结构提出了一种改进型的 “近邻平行互连线差分串扰”RLCG 寄生参数模型，进而提出了一种 “近邻垂直互连线差分串扰” RLCG 寄生参数模型.在此基础之上，采用 HFSS 三维全波仿真方法对硅通孔和层间互连线的各种实际串扰状态进行了三维电磁场建模和分析.将 RLCG 模型的单端-单端串扰以及单端-差分串扰与 HFSS 模型的分析结果进行了对比，对比结果证明在 0.1~30 GHz 宽频段内本文提出的上述 4 种 RLCG 电路模型能够较为准确的描述 TSV 封装内互连结构之间的串扰特性.

关键词：TSV 封装；差分串扰；硅通孔；层间互连线；接地；耦合长度

Modeling of Differential Crosstalk Between Interconnects in the TSV Package

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Abstract：In order to research the transmission impact of differential crosstalk between interconnects within TSV package; in terms of the through silicon via structure， an improved RLCG parasitic parameter model of adjacent through silicon vias differential crosstalk is proposed，and another RLCG parasitic parameter model of grounding through silicon via is put forward to describe the crosstalk of grounding through silicon via upon adjacent through silicon via; in terms of inter-layer interconnects， the study comes up with an improved RLCG parasitic parameter model of differential crosstalk between adjacent and parallel inter-layer interconnects， as well as an RLCG parasitic parameter model of differential crosstalk between adjacent and vertical inter-layer interconnects. On that basis， the three-dimensional electromagnetic modeling and analysis of real crosstalk among through silicon vias and interconnects is conducted by a means of three-dimensional full-wave HFSS simulation. Single-ended to single-ended and single-ended to differential-ended crosstalk of the RLCG model and HFSS model are analyzed and compared. The results show that the four RLCG models mentioned above are able to describe features of crosstalk between interconnects in the TSV package properly.

Key words：TSV package； differential crosstalk; through silicon via; inter-layer interconnect; ground; coupling length

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