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Design Group

應用於三維晶片之靜電放電防護設計
ESD Protection Design for 3D ICs

隊伍名稱　積體電路可靠隊 / Reliabiliteam
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作品摘要

現今消費性電子產品的需求增加，為了提高電晶體的操作速度，閘極氧化層（Gate-oxide）的厚度也變得更薄，因此更容易遭受電性過壓（electrical overstress, EOS）與噪訊（noise）干擾，因而衍伸出可靠度的問題。

在尺寸微縮的同時，源極與汲極端的電場隨通道長度的縮減而增大，為克服短通道的熱載子效應和降低參雜接面的電阻值，LDD（Lightly-Doped Drain）和 Silicide、Policide 與 Salicide 的製程技術已被廣泛的使用，但此種技術會造成更嚴重的靜電放電（electrostatic discharge, ESD）問題。

3D-IC 設計已廣泛應用於各式消費性電子產品，但傳統的 ESD 箝位電路並沒有隨著電路整合而進步，本設計提出一具初始導通特性與低觸發電壓的箝位電路，可以應用於多電源系統的靜電放電防護，在多電源域系統，高電源至低電源的正常工作不會造成訊號失真且不會造成額外的功率消耗，本設計已於 180 奈米金氧半製程實踐並且驗證，實為一創新之 ESD 防護電路，本設計可提高電子產品的可靠度、增加產品的附加價值，未來可廣泛應用於各個三維整合電路

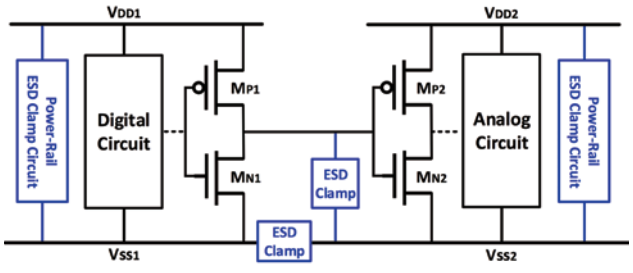

Fig 1. The ESD protection design for cross-power domains

Abstract

As technology improves and the manufacturing process of CMOS ICs moves towards nanoscale, gate oxides are manufactured with thinner and thinner oxide layers. Therefore, the gate oxide becomes more susceptible to the electrostatic discharge (ESD). ESD is the chief factor in the damage of electronic systems and devices. This kind of damage will cause permanent damage to semiconductor device.

The electric field of channel between drain and source becomes stronger with processes scaling. The process of Lightly-Doped Drain (LDD), Silicide, and Salicide which is widely used for overcoming hot-carrier effect and decreasing the resistance of junction causes electrostatic charge accumulated in the edge of channel. ESD becomes a serious reliability problem.

3D-IC is applied in all kinds of consumer electronic products, but traditional ESD clamp circuit doesn't improve as technology improves. This work proposes an initial turn-on characteristics and low trigger voltage ESD clamp circuit that applied in multi-power system. In multi-power system, the normal operation will not cause signal lose and additional power consumption. This design has been fabricated and verified in a 180-nm CMOS process. It is a novel ESD protection circuit. This design can improve the reliability of electronic products and increase the additional value of products. It can be widely used in various 3D-IC in the future.