

國立陽明交通大學

電子研究所

碩士論文

應用於製造場所靜電放電控制的天線驅動
靜電放電事件偵測器設計

陽明交大

NYCU

**Design of Antenna-Driven ESD-Event Detector for
Manufacturing Field Control**

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摘要

近年來，IC 和半導體製造廠中的靜電放電監控受到許多關注。其中天線和示波器常被用來量測靜電放電發生時產生的輻射電磁場以此監測工廠中靜電放電事件的發生。這讓我們想要設計一個靜電放電事件偵測器，它可以從天線測量到的瞬態電壓波型中快速準確地識別靜電放電事件。

此論文中我們設計出一種由天線驅動的靜電放電事件偵測器並在單晶片中實現，此偵測器可以用於偵測和警報 IC 製造環境中的靜電放電事件。在設計此電路之前，我們對天線量測到的靜電放電事件訊號進行分析分析測量。實驗中得到靜電放電事件訊號的相關性質，並且測量結果顯示，在靜電放電事件中天線信號的峰對峰值電壓與其靜電放電的放電電壓呈顯著正相關。

本文中的靜電放電事件偵測器藉由檢測信號峰對峰值幅度和訊號持續時間來確定此天線信號是否為靜電放電所產生的脈衝。靜電放電事件偵測器包括對數放大器、比較器和時間鑑別器。偵測器電路中將對數放大器操作頻率設計在 DC 到 450 兆赫。對數放大器解調天線訊號的峰對峰值並與設定的參考電壓利用比較器對比判斷靜電放電事件的訊號強度。接著時間鑑別器通過訊號的持續時間識別靜電放電事件訊號。此靜電放電事件偵測器採用 0.18- μm CMOS 製程整合在單晶片中，總面積為 693 \times 563 平方微米，並在 1.8 伏特電源下操作耗能為 4.306 毫瓦。

經過實地測試，該偵測器可以檢測到由靜電槍、人體放電模式 (HBM) 測試儀或電場感應元件充電模式 (CDM) 測試儀產生的高頻瞬態信號。因此，此論文提出的靜電放電事件檢測器可以有效地在 IC 和半導體製造工廠中提供實時的靜電放電監控。

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Abstract

In recent years, more attention has been paid to the electrostatic discharge static monitoring and control in the IC and semiconductor manufacturing factories. Thus, antennas and oscilloscopes have been commonly used to measure ESD events in the factory by detecting the radiated fields generated during ESD events. This motivates us to design the ESD-event detector which can quickly and accurately identify ESD events from the antenna-measured transient voltage waveforms.

An antenna-driven ESD-event detector has been designed and fabricated in a single chip to detect and alarm the electrostatic discharge (ESD) events during the IC manufacturing environments. The ESD-event signal is characterized in the lab experiment. The experiment measured results also showed that the peak-to-peak

voltage (V_{pp}) of the antenna signal during the ESD event has a significantly positive correlation with its ESD-stress voltage level.

The proposed ESD-event detector can determine if that antenna signal falls within the ESD pulse by detecting signal amplitude and duration time. The proposed ESD-event detector includes a logarithmic amplifier, a comparator, and a time discriminator. A logarithmic amplifier operated at DC-450MHz is designed. The output of the logarithmic amplifier demodulating V_{pp} is compared to a reference voltage with the comparator. The time discriminator can identify the ESD pulse by its duration time afterward. The single chip of the ESD-event detector has been implemented in a 0.18- μm CMOS process with a total silicon area of only $693 \times 563 \mu\text{m}^2$ under a 1.8-V power supply.

The field tests verified that the detector could detect the high-frequency transient signals generated from the ESD generator, the human-body model (HBM) tester, or the field-induced charged-device model (CDM) tester. The proposed ESD-event detector can efficiently provide real-time ESD monitoring in the IC and semiconductor manufacturing factories.