

# 三端點與四端點的射頻金氧半電晶體模型參數萃取方法之建立及 等效電路模擬之驗證

研究生：葉致廷

指導教授：郭治群博士

國立交通大學

電子工程學系電子研究所

## 中文摘要

參數萃取方法之建立對於模擬的準確性相當重要，過去，晶圓廠所提供給客戶的元件樣本佈局(sample layout)中，Source 和 Body 是連接在一起的即三端電晶體(3T)，其所搭配的模式(model card)也是依據此而作出。但是電路設計者實際使用元件進行設計時，並不一定會將 S 和 B 兩端連在一起。因此，現在晶圓廠傾向於直接提供給客戶四端電晶體(4T)的樣本佈局，其所搭配的模式也是針對此情況而製作，以更符合電路設計者實際使用元件的方式。為了能夠提供準確無誤的模式給電路設計者使用，可靠的參數萃取方法的建立就更加被彰顯出其重要性。

本論文使用的 3T 與 4T NMOS 元件同樣置於雙埠(2-port)的 pad 上來進行 RF 量測與參數萃取的工作。本研究對於 2-port 量測的 de-embedding 方法以及參數萃取的方法作了一系列詳盡的探討，並且將所萃取出來的參數值代回小訊號模型加以驗證模型的可靠性與準確性，有了正確的小訊號模型表示我們能夠萃取出正確的參數值，正確的參數值可以提供我們方向與思維來製作更好的 model。

論文的最後再針對寄生電容作一連串詳細討論，分別從模擬(Raphael Simulator)與手算分析兩方面進行，結果顯示手算分析與模擬相當吻合，表示整個應用於計算過程中的想法相當正確，手算分析建立的成功讓我們可以準確地估算出特定結構的寄生電容，值得一提的是，本論文的手算電容分析的計算方式較其他參考文獻為直接也較為簡便。

# **Three Terminal and Four Terminal RF MOSFET Model Parameter Extraction Methods Development and Verification by Equivalent Circuit Simulation**

**Student : Chih-Ting Yeh**

**Adviser : Dr. Jyh-Chyurn Guo**

**Department of Electronics Engineering and Institute of Electronics  
National Chiao Tung University**

## **Abstract**

Parameter extraction method development is very important for accuracy of simulation. In the past, foundries always provide customers with the 3T sample layout, whose source and body terminals are connected together. But foundries tend to provide customers with 4T sample layout for circuit designers' purpose at present. And model card is constructed on 4T device to match the practical using way of circuit designers. In order to provide circuit designers with accurate model card, reliable parameter extraction method development is obviously important.

3T and 4T device in the thesis are put in 2-port pad to do RF measurement and parameters extraction. In this thesis, 2-port de-embedding and parameters extraction methods have been discussed in detail and used extracted parameters to verify the reliability and accuracy of small signal equivalent model. Obtaining correct small signal equivalent model represents that we can extract correct parameter values which could provide us with direction and thought to construct better model card.

The last part of this thesis is detailed discussion of parasitic capacitances. The results reveal that the simulation and analytical calculated are very matched. This represents the thought applied to calculating process is very correct. The success of analytical calculated model can accurately estimate the parasitic capacitances of specific structure. It is worthy to mention that the calculating method is more direct and simpler than other published references.