

國立交通大學

電子工程學系 電子研究所

博 士 論 文

無線網路應用之互補金氧半射頻接收器設計

CMOS RF Receiver Design for  
Wireless LAN Applications



研 究 生：溫 文 燊

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本論文針對應用至無線區域網路之互補式金氧半(CMOS)射頻接收器提出系統化設計。設計考量涵蓋了通訊標準規格、電路的行為模式、電路設計到封裝模型以及射頻/基頻共同驗證的方法。對於各種無線區域網路之標準提出2.4/5-GHz雙頻直接轉換接收器架構之系統分析，並針對部分關鍵電路進行設計實做。首先以0.25- $\mu\text{m}$ 互補式金氧半製程技術設計之5-GHz頻段低雜訊放大器。此低雜訊放大器配有雙頻可切換負載，能夠操作於5-GHz無線區域網路應用之低頻段與高頻段；其頻段的切換特性並不因溫度改變而影響。此外，本文提出一個低閃爍雜訊、電流折疊(Current-Folded)之混波器結構應用於低電壓直接轉換接收器。提出的混波器分離了傳統Gilbert-Cell混波器結構在雜訊指數、轉換增益以及交互調變失真之間的設計取舍，並且比「注射電流復用」(Current-Reused Injection)的架構展現更佳的效能。並以0.18- $\mu\text{m}$ 互補式金氧半製程進行電路實作，實驗結果驗證此混波器電路架構的優點。再者，提出射頻/基頻共同驗證的方法，得以在接收器進行實作前確認接收器之系統EVM表現，並以0.25- $\mu\text{m}$ 互補式金氧半製程技術實做2.4-GHz直接轉換前端接收器，實驗結果與射頻/基頻共同模擬的結果相當吻合。

# CMOS RF Receiver Design for Wireless LAN Applications

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The dissertation presents the systematic design of a direct conversion CMOS radio receiver for wireless LAN applications. The design considerations cover from standard specifications, circuit behaviors, schematic designs to package models as well as the RF/Baseband co-verification method. A 2.4/5 GHz dual-band receiver architecture is proposed and analyzed for various wireless LAN applications and some of the key circuits are designed and implemented. First a 5-GHz low noise amplifier designed in 0.25- $\mu\text{m}$  CMOS technology is presented. The LNA equips with a dual-band switchable load and is capable to operate in the upper and lower bands in the 5-GHz WLAN band. The switching ability is not affected by the temperature variation. In addition, a low flicker noise current-folded mixer topology for low voltage direct conversion receiver is also proposed. The proposed mixer decouples the design tradeoffs between noise figure, conversion gain and third order intermodulation distortion in Gilbert-cell mixers and exhibits much

better performance compared with the conventional current-reused injection mixers. Moreover, an RF/Baseband co-verification methodology has been proposed to verify system EVM performance of the receiver prior to chip fabrication. A 2.4-GHz direct conversion front-end receiver has been implemented in 0.25- $\mu\text{m}$  CMOS technology as a part of the dual-band receiver and the measurement result shows agreement with the RF/Baseband co-simulation result.



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93年6月

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