

**國立陽明交通大學**

**電子研究所**

**碩士論文**

**Institute of Electronics**

**National Yang Ming Chiao Tung University**

**Master Thesis**

**應用於植入式生醫元件13.56百萬赫茲功率與雙向數  
據傳輸電路之改良設計**

**Improved Design on 13.56-MHz Power and Bilateral  
Data Telemetry Circuits for Implantable Biomedical  
Applications**

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# 應用於植入式生醫元件 13.56 百萬赫茲功率與雙向數據傳輸電路之改良設計

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## 摘要

近年來，植入式醫療元件被廣泛用於治療神經系統疾病。因為晶片須植入於人體內，體內能量的和資料傳輸需要一組近場線圈進行傳遞。本論文中，功率和雙向資料傳輸電路採用台積電的 0.18- $\mu\text{m}$  CMOS 工藝製作，其中整合了電源控制電路、脈衝式負載鍵移反向遙測電路和二進制相位鍵移正向遙測電路。電路的操作頻率為 13.56 MHz 的工業科學醫療頻帶。控制電路有 7 種不同的功率大小可以輸出，由 3bit 控制信號 Ctr[2:0] 控制。脈衝式負載鍵移比傳統的負載鍵移調製方式具有更好的功率轉換效率，並可以正常接收並正確解調出資料。傳輸數據在 105.9kbps 的數據傳輸速率下，脈衝式負載鍵移的 BER 小於  $3.2 \times 10^{-8}$ 。而最大數據傳輸速率可達 500kbps。修改二進制相位鍵調製器解決過壓問題，可以在正向資料傳輸時成功解調資料，在 211kbps 的數據傳輸速率下 BER 僅  $9 \times 10^{-4}$ 。而最大數據傳輸速率可達 500kbps。

**關鍵詞：**植入式裝置、神經調控系統、功率與雙向數據傳輸電路、二進制相位鍵移、脈衝式負載鍵移。

# **Improved Design on 13.56-MHz Power and Bilateral Data Telemetry Circuits for Implantable Biomedical Applications**

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## **Abstract**

In recent years, implantable medical devices have been widely used to treat neurological diseases. Since the chip is implanted into the human body, energy and data transmission within the body require a set of near-field coils for wireless transmission. In this work, the power and bilateral data telemetry system is fabricated in TSMC 0.18- $\mu\text{m}$  CMOS technology, which integrates the power control circuit, Pulsed Load-Shift Keying (PLSK) backward telemetry circuit, and Binary Phase-Shift Keying (BPSK) forward telemetry circuit. The operating carrier frequency is 13.56 MHz in the Industrial Scientific Medical (ISM) frequency band. The power control circuit can generate seven different power levels, controlled by a 3-bit control signal Ctr[2:0]. PLSK modulation has better power conversion efficiency than traditional load key shift (LSK) modulation, and can correctly demodulate data. The bit error rate (BER) of the PLSK demodulator is less than  $3.2 \times 10^{-8}$  under the data rate of 105.9 kbps. The maximum data rate can reach 500 kbps. The BPSK modulator is modified to solve

voltage overstress. The BER of the BPSK demodulator is  $9 \times 10^{-4}$  under the data rate of 211 kbps. The maximum data rate can reach 500 kbps.

**Keywords:** Implantable device, Neuro-modulation system, Power and bilateral data telemetry circuits, BPSK, PLSK.

