國立陽明交通大學

電子研究所

碩 士 論 文

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National Yang Ming Chiao Tung University

Master Thesis

解決過壓問題之無線充電和雙向資料傳輸電路設計以供生醫裝置應用

The Design of Wireless Battery Charging and Bilateral Data Telemetry Circuits Solving Overvoltage Issues for Applications of Biomedical Devices

研 究 生：魏靖唐 (Wei, Ching-Tang)

指導教授：柯明道 (Ker, Ming-Dou)

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研 究 生：魏靖唐　　Student: Ching-Tang Wei

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摘要

近年來，因為鋰電池可作為可靠且持久的電源，具有可重複充電鋰電池的醫療元件被頻繁的使用，無線充電技術被用於對電池充電以減少更換電池的頻率。而無線資料傳輸技術則是被用於實現生醫裝置間的溝通。本論文中，無線充電和雙向資料傳輸電路採用台積電的 0.18-μm 高壓製程製作，包含了全波主動式整流器、線性電池充電器、二進制相位鍵移解調器和脈衝式負載鍵移調變器。電路的操作頻率為 13.56 MHz 的工業科學醫療頻帶。由於製程工藝的特性，此版電路能改善過壓問題。經由量測，全波主動式整流器在輸出功率為 225 mW 下的功率轉換效率為 84.2%，線性電池充電電路可以提供大約 50 mA 的充電電流，當功率放大器電路停止能量傳輸時，從電池到整流器的反向逆電流路徑能被終止。二進制相位鍵移解調器可以在正向資料傳輸時成功解調數據，與論文[1]的二進制相位鍵移調變器搭配量測，在正向資料傳輸速率為 211 kbps 下，位元錯誤率(BER)低於 3.2×10^{-8}。脈衝式負載鍵移調變器則能正常的調變反向資料傳輸訊號。當反向資料傳輸速率為 115.2 kbps 時，脈衝式負載鍵移調變器造成整流器輸出 18.1 mW 的功率耗損。

關鍵詞/字 ── 全波主動式整流器、無線電池充電、線性電池充電器、無線雙向資料傳輸、二進制相位鍵移、脈衝式附載鍵移

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Student: Ching-Tang Wei Advisor: Prof. Ming-Dou Ker

Institute of Electronics
National Yang Ming Chiao Tung University

Abstract

In recent years, medical devices with rechargeable Lithium-ion (Li-ion) batteries are frequently utilized because Li-ion batteries can be reliable and long-lasting power sources. Wireless charging technique is used for charging batteries to reduce the frequency of battery replacement. Wireless data telemetry is used to communicate between medical devices. In this work, the wireless battery charging and bilateral data telemetry circuits, including the full-wave active rectifier, linear battery charger, BPSK demodulator, and PLSK modulator are fabricated in TSMC 0.18-μm CMOS High Voltage Mixed Signal Based Generation II BCD 1P6M process. The operational carrier frequency of these circuits is 13.56 MHz, which is Industrial Scientific Medical (ISM) frequency band. Due to the process characteristic, the overvoltage issues in this circuit version can be improved. By the measurements, the power conversion efficiency (PCE) of the full-wave active rectifier is about 84.2% under the output power is 225 mW. The

linear battery charger can provide approximately 50 mA of charging current, and the reverse current flowing from the battery to the rectifier is prevented when the power amplifier stops transmitting power. The BPSK demodulator can demodulate data successfully when forward data telemetry is in operation. The bit error rate (BER) of the BPSK demodulator measured with the BPSK modulate in [1] under the data rate of 211 kbps is lower than 3.2×10^{-8}. The PLSK modulator can work normally for backward data telemetry. When the data rate of back telemetry is 115.2 kbps, the PLSK modulator causes about 18.1mW power loss at the output of the rectifier.

Keywords – full-wave active rectifier, wireless battery charging, linear battery charger, wireless data telemetry, BPSK, PLSK.