

國立陽明交通大學

前瞻半導體研究所

碩 士 論 文

Institute of Pioneer Semiconductor Innovation

National Yang Ming Chiao Tung University

Master Thesis

自行阻斷逆電流路徑之線性電池充電器設計以供生醫裝置

應用

**The Design of the Linear Battery Charger with Self-  
Blocking Reverse Current Path for Applications of  
Biomedical Devices**

研 究 生：黃玟翔 (Huang, Wen-Hsiang)

指導教授：柯明道 (Ker, Ming-Dou)

中 華 民 國 一 一 三 年 六 月

June 2024

自行阻斷逆電流路徑之線性電池充電器設計以供生醫裝置應用

**The Design of the Linear Battery Charger with Self-Blocking**

**Reverse Current Path for Applications of Biomedical Devices**

研 究 生：黃玟翔

Student: Wen-Hsiang Huang

指導教授：柯明道 博士

Advisor: Dr. Ming-Dou Ker

國 立 陽 明 交 通 大 學

前瞻半導體研究所

碩 士 論 文

A Thesis

Submitted to Institute of Pioneer Semiconductor Innovation

Industry Academia Innovation School

National Yang Ming Chiao Tung University

in Partial Fulfillment of the Requirements

for the Degree of

Master of Science

in

Electrical, and Electronics Engineering

June 2024

Hsinchu, Taiwan, Republic of China

中 華 民 國 一 一 三 年 六 月

# 自行阻斷逆電流路徑之線性電池充電器設計以供生醫裝置 應用

研究生：黃玟翔

指導教授：柯明道 博士

國立陽明交通大學

前瞻半導體研究所

## 摘要

透過無線充電的方式對植入式生醫裝置充電可以避免病人頻繁地更替電池。線性電池充電器由於晶片面積小，適合當作植入式裝置的充電電路使用。由於充電電路與功率接收器的輸出相連，當功率發射器停止傳送功率或線圈遠離時，有逆向電流從電池流向功率接收器。在過去的逆向電流防護設計中，通常會使用開關阻斷逆電流路徑。

本論文提出的線性電池充電器採用了新的逆向電流防護電路。在防止逆向電流模式時，不須額外使用開關，可以自行阻斷逆電流路徑。實驗結果顯示，恆定電流充電模式下提供 50.2 mA 充電電流，電池電壓範圍為 3.3 V 至 4.21 V，在防止逆向電流模式時，電池漏電為 7.98  $\mu$ A。晶片面積和功耗是植入式晶片設計中的關鍵考慮因素。自行阻斷逆電流路徑之線性電池充電器設計為植入式生醫裝置節省不少晶片面積並延長電池放電週期。

關鍵詞/字 — 線性電池充電器、無線電池充電、逆向電流防護電路

# **The Design of the Linear Battery Charger with Self-Blocking Reverse Current Path for Applications of Biomedical Devices**

Student: Wen-Hsiang Huang

Advisor: Prof. Ming-Dou Ker

Institute of Pioneer Semiconductor Innovation  
National Yang Ming Chiao Tung University

## **Abstract**

By charging implantable biomedical devices wirelessly, the need for frequent battery replacements for patients can be eliminated. Because of the small chip area, linear battery chargers are suitable as charging circuits for implantable devices. Due to the connection between the charging circuit and the output of the power receiver, the reverse current flows from the battery to the power receiver when the power transmitter stops power transmission or the coils move apart. In past designs, switches were typically used to block the reverse current path.

The linear battery charger proposed in this paper applies a new reverse current prevention circuit. During reverse current prevention mode, the reverse current path is automatically blocked without the need for any additional switch. The experimental results showed that the charging current during constant current mode is 50.2 mA, with the battery voltage ranging from 3.3 V to 4.21 V. During the prevent reverse current mode, the battery standby current is measured to be 7.98  $\mu$ A. Chip area and power consumption are considered critical factors in the design of implantable biomedical devices. The design of the linear battery charger with a

self-blocking reverse current path saves chip area and extends battery discharge cycles for implantable biomedical devices.

Keywords –wireless battery charging, linear battery charger, reverse current prevention circuit.

