D12-042

作品名稱
應用於生醫裝置之低功率檢測與刺激晶片設計
Low power sensor and stimulator design for biomedical application

隊伍名稱
簡單生活，安全人生 / Live simply, Life safely

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作品摘要

隨著高齡人口的增長以及現今高壓力的生活環境中，造成不同疾病的人口日益上升；有鑑於此，若能對生理狀況即時掌握並回報，將可大大降低患病或疾病發作的機率；另一方面，還有許多需藉由電訊號輔助來達成生活功能正常化的民眾，如助聽器、電子眼、膀胱排尿刺激以及深層腦刺激等；因此本設計所提出的為一顆不僅包含檢測生理狀態，並擁有可程式化控制的刺激訊號來符合不同刺激部位需求的晶片，來達成多種醫療電子產品的開發，將可縮短由於晶片製作與醫療產品認證所需的漫長時間，以及降低開發所需的成本。

為使晶片具備所需功能，此系統包含五個區塊，分別為無線傳輸、電源管理、數位控制電路、刺激與檢測電路；在無線傳輸部分，採用線圈耦合方式，具備無線電源傳輸用以對內部電池進行充電，並可由外部對系統傳送控制訊號以及將檢測後的生理訊號數位化後在外部接收；在電源管理部分，本作品提出採用雙電池供電，可持續提供系統穩定供電，並具備自動選擇充電與供電的判斷機制；在刺激電路部分，本作品提出高轉換效率的電荷幫浦，採用交錯耦合方式並精簡電容的使用，整體轉換效益大於80%；而刺激電路所產生的刺激用電壓可藉由數位控制，調整刺激所需的電壓大小、頻率與時間長短，使其可根據不同部位與個體差異來調整。

本作品晶片使用台積電0.35-μm CMOS製程來實現，在工作電壓為1V時，整體晶片功率消耗為53 μW，晶片總面積為4.79 mm^2；並將晶片應用於體內與體外裝置，如Figure 1所示，以植入式心律調節器為例，可藉由此作品檢測心電訊號並在心律不整情況發生時提供刺激治療。經由本作品提出的整合晶片，將可使未來醫療電子產品開發更快速且微小化。

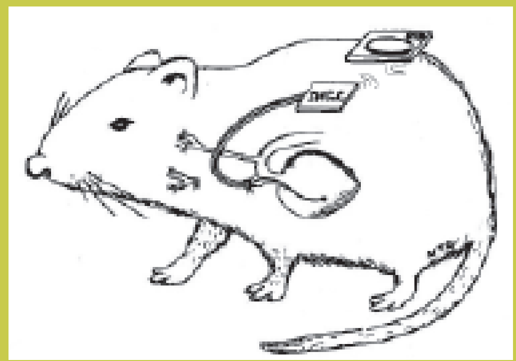


Fig.1 > 應用於植入式裝置示意圖與實際量測結果

Abstract

With the growth of the elderly population as well as today's high pressure living environment, caused by different diseases of the population rising. In view of this, if physical condition immediately grasp and return will greatly reduce the probability of illness or disease attack. On the other hand, there are many people need electrical stimulation to achieve the normal life, such as hearing aids, electronic eye, bladder stimulation and deep brain stimulation. So this design includes not only variety biosignal detection but also programmable stimulus for different site. To achieve a variety of medical electronics product development, will reduce the time cost of chip implementation and medical products certification.

To make chip with the desired function, this chip consists of five blocks for wireless transmission, power management, digital control circuits, stimulation and detection circuits. In the wireless transmission part, using the coils coupling to transmit power for the internal circuits, and also can transmit control signals from external as well as detection of biosignals outgoing. In the power management, this chip using dual batteries mode to supply a stable power to system. It processes with automatic choose mechanism for charging and supplying. In the stimulated part, this work proposed high conversion efficiency charge pump. It use mix-structure and streamline the number of capacitance. The overall conversion efficiency can greater than 80%. And the digital control circuits can adjust the voltage magnitude, frequency and length of time for stimulus. So that it can be adjusted according to the different parts and individual differences.

This chip was fabricated in TSMC 0.35-μm CMOS process. Under operating voltage of 1V, the overall chip power consumption of 53 μW. The total area is 4.79 mm^2. It used in vivo and vitro devices, such as Fig.2 work as a pacemaker. It detect Electrocardiography (ECG) signal and give stimulation therapy when arrhythmia happens. Through the integrated chip proposed in this work will enable the development of medical electronic products faster and miniaturization.

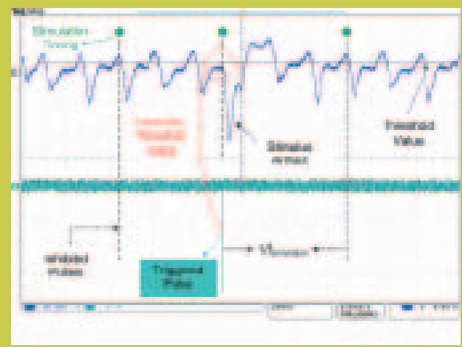
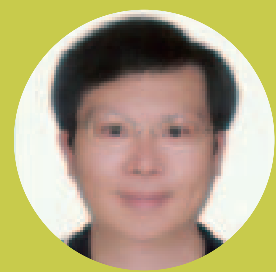


Fig.2 > in vivo experiment result

指導教授



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李順裕教授分別於1994年與1999年於成功大學電機所取得碩、博士學位。於2002年加入中正大學電機工程所任教至今，並於2011年升任正教授。

研究領域

混合信號積體電路與射頻通訊積體電路設計，並致力於生醫相關晶片之開發。