DESIGN GROUP

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作品名稱

以CMOS 0.18微米製程實現400 MHz植入式醫療通訊系統之數位校正超再生接收機

A 400-MHz Super-Regenerative Receiver with Digital Calibration for MICS Applications in 0.18-μm CMOS Process

隊伍名稱

吞了就對 Swallow!!

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作品摘要

現今老年化人口驅使先進醫療儀器的需求，例如使用無線植入式裝置監控及收集病人健康資訊。新的低功率射頻技術正推進創新的醫療儀器能以無線方式傳送病人資訊。

以往這種體內的通訊裝置多是利用電感式的磁場耦合來提供無線連結，通常操作頻率約為數十到數百kHz。其主要的優點是具有穩定的傳輸品質，但最大的缺點是傳輸量只有約1~30 kbps，且外部儀器必須直接接觸病患皮膚，傳輸距離較短。為了克服以上傳輸量及傳輸距離的限制，新的超低功率主動式無線傳輸技術目前正在發展，利用更高的操作頻率，如最近才制定的植入式醫療通訊MICS (Medical Implant Communications Service，從402 MHz到405 MHz)頻段，提供更高的傳輸量，此外利用主動式的無線通訊裝置可以提供更長的傳輸距離(約> 2公尺)。

此創作主要在於應用於植入式醫療通訊的接收器，此接收器必須操作在MICS頻段，並具有消耗功率低，且滿足所需接收的data rate。其採用超再生接收器，具有低雜訊放大器(LNA)、Balun、數位控制震盪器(Digitally-controlled oscillator)、包絡偵測器(Envelope detector)、解調器(Demodulator)。並加入三個數位校正電路分別為Q-enhancement loop、Frequency calibration、以及Pulse-width adjustment loop。Q-enhancement loop(QL)在於增加震盪器的quality factor，使得接收器有較佳的selectivity。Frequency calibration(FC)校正震盪器頻率至MICS頻帶。Pulse-width adjustment loop (PAL)則調整quench signal使得解調器能正確解調OOK訊號。對於super-regenerative receiver需要的quench訊號，可藉由Q-enhancement loop以及Pulse-width adjustment loop來達成，而不需要外部訊號源提供，藉此減少外部元件。傳統上，鎖相迴路能鎖定頻率，卻需要較長鎖定時間造成接收器校正時間較長。在這個創作中，採用開迴路數位電路，frequency calibration，以減少校正時間。

指導教授

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Abstract

Today's aging population is driving the demand for more-advanced healthcare devices, such as wireless implant devices that can monitor and collect a patient's health information. New low-power radio-frequency (RF) technologies are helping the development of innovative medical tools which are capable of wirelessly transmitting patient health data.

Conventionally, low-frequency inductive links are the prevalent method of communication with data rates of 1-30 kbps. However, inductive links usually need an external programmer to contact the skin of the patient over the implanted devices. In order to overcome the limitation of inductive links, such as short range and low data rate, medical implant communications service (MICS) band allocated in 402 MHz to 405 MHz are recently adopted. The allocation of this band supports the use of longer-range and high-speed wireless links.

In this work, a receiver for the medical implant application is designed. It is operated in the MICS band, consumes lower power, and meets the requirement of the data rate. The proposed architecture of the super-regenerative receiver, is composed of a low-noise amplifier (LNA), a balun, a digitally-controlled oscillator (DCO), an envelope detector, a demodulator, and three calibration loops. Three calibration loops (Q-enhancement loop, frequency calibration, and pulse-width adjustment loop) are added to facilitate the function of the super-regenerative receiver. Q-enhancement loop improves the quality factor of the DCO to acquire a better selectivity. Frequency calibration adjusts the DCO frequency to the MICS band. Pulse-width adjustment loop adjusts the quench signal to help the demodulator demodulate the on-off keying signal. With the Q-enhancement loop and the pulse-width adjustment loop, the quench current can be generated inside the chip instead of the off-chip quench signal, and the number of the external components is reduced. Conventionally, a phase-locked loop is employed to acquire the initial frequency locking, but the PLL closed-loop settling time will prolong the turn-on time of the RX. In this work, an open-loop digital circuit, frequency calibration, is proposed to reduce the turn-on time.