

# A System for Efficient Neural Stimulation with Energy Recovery

by

Shawn Kevin Kelly

Submitted to the Department of Electrical Engineering and Computer Science

in partial fulfillment of the requirements for the degree of

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## Abstract

An analog VLSI-based low-power neural tissue stimulator is presented as a part of the MIT and Massachusetts Eye and Ear Infirmary Retinal Implant Project to develop a prosthesis for restoring some useful vision to patients blinded by retinal degeneration. Such a prosthesis would receive image data from an external camera and electrically stimulate surviving ganglion nerve cells. However, power consumption for this type of implant is dominated by the tissue and electrode-tissue interface, and the current source stimulators generally used are inefficient, limiting battery life and generating potentially damaging temperature increases at the retinal surface. A stimulation system has been developed which delivers the required stimulus charge to the electrodes, but uses far less power than typical stimulators. A traditional current source uses output transistors to limit current, but those transistors can drop substantial voltage, and therefore cost power. The aim of this system is to generate a step-ramp voltage waveform which mimics the electrode voltage (modeled as a series resistance and capacitance) during constant current stimulation. This is implemented with a series of voltage steps, each step a separate power supply. Electrodes are switched through a series of steps, and each step is maintained at its prescribed voltage by a controlled synchronous rectifier, which charges the supply capacitor from a single AC secondary power coil.

This novel architecture uses less than half of the power used by an aggressively designed current source stimulator with the same voltage rails, and about one-third of the power consumed by typical stimulators used for this function.

Thesis Supervisor: John L. Wyatt, Jr.

Title: Professor

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