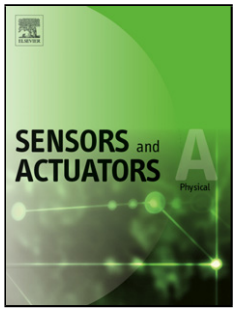

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Authors: Ammar Aldaoud[1], Artemio Soto-Breceda[2,6,7], Wei Tong[1,2,3], Greg Conductier[4], Mary A Tonta[4], Harold A. Coleman[4], Helena C. Parkington[4], Iain Clarke[4], Jean-Michel Redoute[5], David J. Garrett[1], Steven Prawer[1]

[1]School of Physics, University of Melbourne, Parkville, Victoria, Australia
[2]National Vision Research Institute, Australian College of Optometry, Carlton, Victoria, Australia
[3]Department of Optometry and Vision Sciences, University of Melbourne, Parkville, Victoria, Australia
[4]Department of Physiology and Biomedicine Discovery Institute, Monash University, Clayton, Victoria, Australia
[5]Electrical and Computer Systems Engineering, Monash University, Clayton, Victoria, Australia
[6]Department of Biomedical Engineering, University of Melbourne, Parkville, Victoria, Australia
[7]Data 61, CSIRO, Docklands, Victoria, Australia

Correspondence:

Name: Ammar Aldaoud
Email: ammar.ald.91@gmail.com
Alternate email: aaldaoud@student.unimelb.edu.au
Contact number: +61433 672 245

HIGHLIGHTS

- Up to 16 Individually addressable and wirelessly powered optogenetic channels
- Above 10mW of measured light output power
- Inductive multichannel resonant topology removes complex electronics from implant
- Ability to multiplex and pulse channels by modulating transmission signal
- Biological validation in porcine tissue, human embryonic kidney cells and retinal ganglion cells

Abstract

Optogenetic neuromodulation is a powerful technique used to study cells that form part of neuronal circuits. Light stimulation of neurons has led to a deeper understanding of autism, schizophrenia and depression. However, researchers are often limited to tethered systems involving percutaneous plugs, hence, wireless power transmission to an implantable device is desirable. This work details the design, fabrication and testing of multichannel wirelessly powered optogenetic devices. By employing several carefully tuned resonant tank circuits, this work demonstrates the ability to address a scalable number of light sources on a single device. Single channel, dual channel and 16 channel devices were fabricated, achieving light output readings of up to 15mW at 473nm, suitable for activating channelrhodopsin. Wireless power transmission was characterized in air and porcine tissue for implant depths up to 30mm, making device implantation feasible. The device was successful in activating endogenous (in retinal ganglion cells) and exogenously transfected channelrhodopsin in human embryonic kidney cells, providing biological validation. The significance of this approach is the removal of power-hungry and area-consuming electronics from the implant, while the ability to address and modulate individual light sources is maintained by shifting this complexity to the external wireless power transmitter.

Keywords: Optogenetics, Wireless power, Inductive, Multichannel, In-Vitro, Retinal Ganglion Cells, Human Embryonic Kidney Cells, Channelrhodopsin

1. Introduction