



# **A SELF-POWERED NEURAL RECORDING AND STIMULATION SOC FOR INTRACTABLE EPILEPSY TREATMENT**

By

Ali ElHussien Ali Hassan

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
in Partial Fulfilment of the  
Requirements for the Degree of  
**MASTER OF SCIENCE**  
in  
Electronics and Communications Engineering

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Under the Supervision of

**Prof. Ahmed M. Soliman**

Professor

Electronics and Communications Engineering  
Department

Faculty of Engineering, Cairo University

**Dr. Hassan Mostafa Hassan**

Assistant Professor

Electronics Communications Engineering  
Department

Faculty of Engineering, Cairo University

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Approved by the Examining Committee:

---

Prof. Ahmed M. Soliman, Thesis Main Advisor

---

Prof. Mohamed F. Abu-ElYazeed, Internal Examiner

---

Prof. Ahmed H. Madian, External Examiner  
(National Center for Radiation Research and Technology)

**FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
GIZA, EGYPT  
2018**

**Engineer's Name:** Ali ElHussien Ali Hassan  
**Date of Birth:** 26/04/1992  
**Nationality:** Egyptian  
**E-mail:** ali.h.hassan@ieee.org  
**Phone:** +201220487437  
**Address:** Electronics and Communications  
Engineering Department,  
Cairo University,  
Giza 12613, Egypt



**Registration Date:** 01/10/2015  
**Awarding Date:** / /yyyy  
**Degree:** Master of Science  
**Department:** Electronics and Communications Engineering

**Supervisors:**

Prof. Ahmed M. Soliman  
Dr. Hassan Mostafa Hassan

**Examiners:**

Prof. Ahmed M. Soliman (Thesis main advisor)  
Prof. Mohamed F. Abu-ElYazeed (Internal examiner)  
Prof. Ahmed H. Madian, National Center for Radiation Research and Techno (External examiner)

**Title of Thesis:**

A Self-Powered Neural Recording and Stimulation SoC for  
Intractable Epilepsy Treatment

**Key Words:**

Neural Implants; Neural Recording; Neural Stimulation; Wireless Powering; Biomedical circuits

**Summary:**

In this thesis, a self-powered neural recording and stimulation system-on-chip for intractable Epilepsy treatment. A prototype of the proposed SoC is implemented using 130 nm CMOS technology.

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Last but not least, the greatest debt and gratitude is for God who provided me with the capabilities to complete this project and achieve my goal.

# **Dedication**

I dedicate this dissertation to my family for the unceasing encouragement, support and attention. I want to thank them for the continuous supply of love and care. I own them every single achievement in my life.

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# List of Abbreviations

<b>Abbreviations</b>	<b>Description</b>
<b>ACC</b>	Anodic Current Controller.
<b>ADC</b>	Analog-to-Digital Converter.
<b>AVD</b>	Active Voltage Doubler.
<b>BGR</b>	Bandgap Reference.
<b>C-DAC</b>	capacitive Digital-to-Analog Converter.
<b>CCC</b>	Cathodic Current Controller.
<b>CMFB</b>	Common Mode FeedBack.
<b>CMOS</b>	Complementary Metal Oxide Semiconductor.
<b>CMS</b>	Current Mode Stimulation.
<b>DAC</b>	Digital-to-Analog Converter.
<b>DCO</b>	Digitally Controlled Oscillator.
<b>DNL</b>	Differential Non-Linearity.
<b>EA</b>	Error Amplifier.
<b>ECG</b>	Electrocardiographic.
<b>EEG</b>	electroencephalography.
<b>EMG</b>	Electromyography.
<b>ENOB</b>	Effective Number of Bits.
<b>EOC</b>	End Of Conversion.
<b>FFT</b>	Fast Fourier Transform.
<b>FIR</b>	Finite Impulse Response.
<b>FoM</b>	Figure-of-Merit.
<b>HPF</b>	High Pass Filter.
<b>ILPS</b>	Inductive link Power Supply.
<b>IMDs</b>	Implantable Medical Devices.
<b>INL</b>	Integral Non-Linearity.
<b>LDO</b>	Low-Dropout Regulator.

<b>LFPs</b>	Local Field Potentials.
<b>LNA</b>	Low-Noise Amplifier.
<b>LP-VTC</b>	Low-Power Voltage-to-Time Converter.
<b>LPF</b>	Low Pass Filter.
<b>LSB</b>	Least Significant Bit.
<b>MSAR</b>	Multiplying Successive Approximation Register.
<b>MSB</b>	Most Significant Bit.
<b>opamp</b>	Operational Amplifier.
<b>OTA</b>	Operational Transconductance Amplifier.
<b>PCE</b>	Power Conversion Efficiency.
<b>PPM</b>	Pulse Position Modulator.
<b>PSRR</b>	Power Supply Rejection Ratio.
<b>PVT</b>	Process, Voltage and Temperature.
<b>SAR-ADC</b>	Successive Approximation Register Analog-to-Digital Converter.
<b>SNR</b>	Signal-to-Noise Ratio.
<b>SoC</b>	System-on-Chip.
<b>T-ADC</b>	Time-Based Analog-to-Digital Converter.
<b>TC</b>	Temperature Coefficient.
<b>TDC</b>	Time-to-Voltage Converter.
<b>V/I</b>	Voltage-to-Current Converter.
<b>VTC</b>	Voltage-to-Time Converter.
<b>WPT</b>	Wireless Power Transfer.