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

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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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

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

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