



**Ain Shams University**  
**Faculty of Engineering**  
**Electronics and Communications Department**

# **DC-DC Converter for Low-Energy Wireless Applications**

**A Thesis submitted in partial fulfillment for the  
requirements of a Master of Science degree in Electrical  
Engineering Electronics and Communications  
Engineering Department**

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B.Sc. of Electrical Engineering  
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Cairo 2019





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by

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Date: 30/01/2019

# Statement

This Thesis submitted in partial fulfillment for the requirements of a Master of Science degree in Electrical Engineering Electronics, and Communications Engineering Department.

The work included in this thesis was carried out by the author at the Electronics and Communications Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis was submitted for a degree or a qualification at any other university or institution.

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# Acknowledgments

First of all, all thank to Allah for giving the chance, strength and making me able to complete this work.

I would like to express my gratitude to my family. Many thanks to my supervisors Prof. Emad Hegazi and Prof. Mohamed El-Nozahi for their guidance, wise advice, useful suggestions, continuous motivation, and feedback.

I am very grateful to all the IC Lab professors and my first career mentor, Mohamed Abdelaal, ex-Staff Design Engineer at Si-Vision, who introduced me to the world of power management, as well as Mo'men Mansour, ex-Team Leader at Si-Vision, for his valuable ideas and comments to improve my work. I'd like also to thank Eng. Ahmed Helmy and Botros Iskandar for supervising my graduation project, as it was the first step to start my journey into IC design. I'd like also to thank Eng. Mohamed Samir, Eng. Ahmed Salah and Eng. Mohammed Tawfik for giving me the opportunity to work as an Analog/RF Design engineer at Si-Vision. This industrial experience and lab testing across different nodes greatly improve my knowledge and skills in the IC Design. Finally, I cannot forget to thank my dear colleagues Mohamed Ibrahim, Mahmoud Yousry, Mahmoud Mabrouk, Mahmoud Mohsen, Ahmed Farag, Sherif Diao, Nour-Eldin Hany, Ahmed El-Sayed, Amr Ahmed, Khalid Hafez and Anass Wanass for the many technical discussions and continuous support.

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January 2019

**Faculty of Engineering – Ain Shams University**

**Electronics and Communications Engineering Department**

**Thesis title: DC-DC Converter for Low-Energy Wireless Applications**

**Submitted by: Mahmoud Abdelwahab Ahmed Ahmed Khalil**

**Degree: Master of Science in Electrical Engineering**

# **Abstract**

**Mahmoud Abdelwab Ahmed Ahmed Khalil "DC-DC Converter for Low-Energy Wireless Applications", Master of Science dissertation, Ain Shams University, 2019.**

The demand on DC-DC converter increases as the scaling of CMOS technologies into the nanometer scale imposes lower supply voltage than the battery voltage which is defined by its electrochemical properties' limitations. High-efficiency DC-DC converters are needed to extend the battery life. This thesis aims to design a high efficiency and a low voltage ripple DC-DC Converter for low-energy wireless applications. The proposed converter is implemented using UMC130nm CMOS technology with a new design methodology and startup technique to reduce the power-up consumed energy and the startup time variations. The proposed buck inductor peak current is well-controlled at all inductance, input, and output voltage range using a simple replica circuit matched to the PMOS switch. An automatic background calibration is introduced to sustain converter stability and reduce the regulator voltage ripple across different load, supply and external components values. Simulation results show that the proposed converter minimizes ripple magnitude and variations especially at light loads while maintaining good efficiency results. Finally, a new FoM is introduced to compare all PFM buck designs.

**Keywords:** Low-Energy Transceivers, Inductor-based switching regulator, Pulse frequency modulation DC-DC converter, Adaptive on-time buck converter, Low-ripple DCM buck converter.

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# Summary

This thesis is divided into six chapters including the lists of contents, tables, figures and references as follows:

**Chapter 1** is an introduction highlighting the challenges and the main contributions of the thesis, followed by the outline of the thesis.

**Chapter 2** includes a survey between all the switching regulators' topologies in terms of voltage ripples, load current and power efficiency. This chapter describes the selected buck converter in-detail.

**Chapter 3** depicts the system design specifications resulting from supplying wide range of noise-sensitive loads and illustrates the voltage ripple briefly including its variations with load current, supply voltage and passives values. This chapter includes a survey for spurious noise reduction and different startup techniques. A new FoM is introduced to allow absolute comparison between PFM different designs through meaningful parameters.

**Chapter 4** shows the proposed converter circuit implementation. This chapter starts with BIAS top design and then illustrates the main operation of the final circuits design. Also, a new technique is adopted to generate a constant inductor peak current at all inductance, input and output voltage ranges. The chapter ends with a new background calibration technique to reduce the regulator ripple variations across different load, supply and external components values while maintaining converter stability.

**Chapter 5** shows all the simulation results for the proposed buck converter across different scenarios and PVT corners. It also depicts the achieved results summary, the proposed converter area estimate, and the initial floorplan.

**Chapter 6** is the conclusion of this work and the possible future work that needs to be added.



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