AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics Engineering and Electrical Communications

Wake-up Receiver for Wireless Sensor Network Applications

A Thesis submitted in partial fulfillment of the requirements of
Master of Science in Electrical Engineering
(Electronics Engineering and Electrical Communications)

by

Samer Sayed Bahr Idres

Bachelor of Science in Electrical Engineering
(Electronics Engineering and Electrical Communications)
Faculty of Engineering, Ain Shams University, 2012

Supervised By

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Cairo - 2016

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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Date: 30 July 2016

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Thesis Summary

The realization of wireless sensor networks (WSN) demands ultra-low power wireless communication capability. Because the radio transceiver consumes power whenever it is active, it is more efficient to leave the receiver off and wake it up asynchronously only when needed. A dedicated wake-up receiver can continuously monitor the channel, listening for a wake-up signal from other nodes and activating the main receiver upon detection. This thesis aims to design a low power wake-up receiver targeting wireless sensor networks application. The main focusing is the design of low noise and low power architectures for the main building blocks of the wake-up receiver. The proposed wake-up receiver is designed and fabricated using CMOS technology. The measurement results show a good sensitivity performance (-59 dBm, -55 dBm, and - 49 dBm for 20 kbps, 100 kbps, and 200 kbps, respectively, and 57 GHz input frequency) that matched with the simulation results.

The thesis is divided into six chapters as described below.

Chapter 1
In this chapter, an introduction about the design of wireless sensor nodes and the importance of the wake-up receivers is presented. The thesis motivation, challenges, main contributions, and organization are then briefly discussed.

Chapter 2
This chapter includes the basic design consideration of wake-up receivers, and literature survey for the implemented wake-up receivers. Also, a concept background is introduced for the envelope detectors and its different topologies and architectures.

Chapter 3
Three sensitivity enhancement techniques are proposed in this chapter to increase the sensitivity performance of envelope detectors. Two of these techniques are based on noise cancelling of the envelope detector main devices. The other technique is based on the efficient current distribution between the envelope detector core itself and the baseband amplifier after the envelope detector.

Chapter 4
This chapter includes the proposed wake-up receiver system design and the system level simulations. This chapter also presents the circuit implementation of all system blocks, and the integration of the complete wake-up receiver. The wake-up receiver performance is checked using the circuit level simulations.

Chapter 5
Chapter five shows the post-layout and the measurement results of the fabricated wake-up receiver using CMOS technology. These results are analysed and compared with the performances of the state of the art wake-up receivers. Also, the main measurements setups are presented in this chapter.

Chapter 6
Chapter six concludes the thesis work with possible directions for future work.

Key words: wireless sensor networks, wireless body area network, wake-up receiver, envelope detectors, noise cancelling, low power, millimetre-wave, low noise amplifier, programmable gain amplifier, and analog to digital converter.

Acknowledgment

I am mostly grateful to ALLAH for bestowing upon me the chance, strength, and ability to complete this work. I wish to express my most gratitude to my supervisors, Dr. Mohamed El-Nozahi and Prof. Hani F. Ragai, for their guidance, encouragement, and useful discussions.

I am very grateful to Dr. Mohamed El-Nozahi who has been more than supervisor to me. I have learned from him both on technical and personal levels. I would like to thank Prof. Hani F. Ragai who taught me dedication in work.

Many thanks goes to Professor El-Sayed Mostafa and Professor Emad Hegazi for serving as my defense committee members and taking parts from their valuable time to read and judge my thesis work.

Many thanks to all my colleagues and friends for the many fruitful discussions and encouragement.

Last but not least, I would like to thank my parents, for their patience, care, and love that guided me through the whole journey.

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July 2016

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