Ain Shams University
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Design of Low Power Readout Circuit using FinFET Technology

A Thesis
Submitted in partial fulfillment of the requirements of a Master of Science degree in Electrical Engineering

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Statement

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for the degree of Master of Science in Electrical Engineering.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or qualification at any other scientific entity

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Summary

FinFET technology has been born as a result of the relentless increase in the levels of integration. The basic tenet of Moore's law has held true for many years from the earliest years of integrated circuit technology. Essentially it states that the number of transistors on a given area of silicon doubles every two years. FinFET technology takes its name from the fact that the FET structure used looks like a set of fins when viewed. The FinFET is a technology that is used in IC implementation. FinFETs are not available as discrete devices. However FinFET technology is becoming more widespread as feature sizes within integrated circuits shrink down and there is a growing need to provide very much higher levels of integration with less power consumption.

This thesis focuses on design of a capacitive pressure sensor readout circuit using the FinFET technology and comparing it with that based on traditional CMOS technology. FinFET-based design shows less power consumption in the proposed circuits.

The first chapter is an introductory chapter for the whole thesis, presenting the main concept and developing the thesis organization.

The second chapter gives a background on the sensor used in the thesis. It also present many architectures for the readout circuit allowing to choose a suitable circuit for the proposed readout circuit. A survey on low power techniques is also presented, as it is our main goal in the thesis; designing low power circuits.

The third chapter introduces the new FinFET device, it declares the need for a new technology, highlighting the advantages of using FinFET device in next technology generations. The FinFET technology is a good choice for low power circuits.

The fourth chapter proposes the readout circuit design, using two architecture to convert the capacitance of the sensor into frequency; LC and ring oscillators. The design of a counter stage needed to detect the resulting frequency is given in this chapter. Simulation of circuits using FinFET and CMOS 0.13 μm technology are presented with emphasis on the power dissipation in each technology.

The last chapter gives a comparative study between the results in this thesis and previous published work. Also a discussion is given and a conclusion is drawn.

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Chapter 1

Introduction

Among the different techniques usually used to reduce power consumption in custom circuits is to replace the conventional CMOS MOSFETs by FinFETs. Basically FinFETs have low leakage current and negligible short channel effects leading to low power consumption.

1.1 Motivation

Down-scaling of MOS devices is continuously attempted aiming to achieve faster circuit speed, smaller area, and lower power dissipation. Multi-gate MOSFET is one of the most promising semiconductor devices that was proven to be the best choice for future ICs, so, it has become an intense subject of scientific research. Sensor application usually dont need high speed, but requires low power consumption which is the most important issue in the design of battery operated ubiquitous applications. In this work the technology route rather than architectural or power management routes has been chosen to design a low power readout circuit for a capacitive pressure sensor.

1.2 Organization

The organization of the thesis is as follow: chapter 1 presents an introduction on the main idea behind this work, chapter 2 introduces a background on the sensor used, architectures for readout circuit, and low power techniques found in the literature. Chapter 3 is devoted to FinFET its advantage, Chapter 4 gives the proposed design of the readout circuit with its simulation. Finally a discussion is given and a conclusion is drawn in chapter 5.