# Body Bias Control for Real-Time Systems

-Optimization and its Switching Parameters Analysis

for FD-SOI Technology-

Carlos Cesar Cortes Torres

May 2020

# Thesis Abstract

No.__________

| Registration Number | □ **“KOU”** □ “OTSU”<br>No. *Office use only | Name | CORTES TORRES Carlos Cesar |
|---|---|---|---|

Thesis Title

Body Bias Control for Real-Time Systems -Optimization and its Switching Parameters Analysis for FD-SOI Technology-

Thesis Summary


In the past decade, real-time systems (RTSs), which must maintain time constraints to avoid catastrophic consequences, have been widely introduced into various embedded systems and Internet of Things (IoTs). It is essential for any of these embedded systems be energy efficient due to battery life is important. Such systems tend to work intermittently and reducing leakage power in the idle state is essential. However, traditional energy models idealize overheads, they often require a significant amount of power since they must directly control the system supply voltage or cannot deal with the overhead of adjusting the BB voltage. Moreover, when the power supply is powered down the data in the memory element is lost, thus the models are not accurate.

Dynamic Body bias (BB) scaling is a promising approach to managing leakage energy and operational speed.
In this study, we investigated the RTS energy efficiency by analyzing the ability of BB, applying dynamic body bias control in providing a satisfying tradeoff between performance and energy. Although BB is an efficient technique to reduce the leakage power, it has not been commonly used dynamically because of the large timing and energy overhead when a conventional CMOS process is used. However, recent System On Insulator (SOI) technologies enabled to use dynamic body bias control with acceptable overhead. Here, we focus on Silicon On Thin Box (SOTB), a type of Fully Depleted (FD) SOI technology which can control BB widely with a small overhead.
For the BB control, we analyzed the timing and energy overhead of two simple microcontrollers and a dynamically reconfigurable processor with SOTB technology. We propose a practical energy and timing model that includes switching transition and idle regions analysis. It is based on extracted real-chip parameters.
First, we optimize VDD and BB voltages by using brute force coarse-grain method. Secondly, we propose a more accurate energy overhead model by using an analytical double exponential expression; we transform the real-chip physical parameters of the double exponential waveform into analytical function coefficients. Finally, we build an optimization model with a Non-Linear Programming.

The use of the proposed model resulted in an energy reduction of about 32% at lower frequencies as compared with the conventional model. Moreover, the energy overhead was reduced to approximately 14% of the total energy consumption. This methodology provides a framework and design guidelines for real-time systems and CAD.