

**Vibration Based Electromagnetic Energy Harvesting – Microgenerator,
Power Conversion and Control**

by

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ABSTRACT

Energy harvesting has been a research focus for many years. The idea that energy can be harvested from ambient environment and a device can operate without a battery is very attractive for low power electronic applications. The slow growth of battery technology and development of low power semiconductor technology has positioned energy harvesting as a feasible power source for low power applications.

The present work emphasizes on microgenerator design and power processing circuits for electromagnetic energy harvesting. The main objective is to develop a complete system for low voltage electromagnetic energy harvesting. The thesis work has been designed and developed in consecutive stages – (a) novel converter topologies for low voltage microgenerators, (b) unified design of microgenerators and converter topologies, (c) design of efficient auxiliary circuits, (d) optimal energy harvesting control.

A number of suitable converter topologies are first presented for low voltage, low power energy harvesting. Their operation, analysis and modeling are discussed in detail. The loss analysis is developed to properly characterize the performance of different converters developed in this thesis. Multiple methods to interface the microgenerator with the converters are presented. Based on the interface mechanism, a suitable unified design approach is also formulated for both the microgenerator and the converters.

To realize a self-sufficient energy harvesting system, design of auxiliary circuits like start-up circuits, controller and gate driver circuits is very important. In this work, they are fabricated to consume very low power while satisfying the converter requirements. Finally, a new low power control system is developed to maximize the output of the energy harvesting system. Two types of control are envisaged in this work. The first type is a simpler voltage regulation mechanism. The second, more interesting type of control is based on controlling the converter to maximize the harvested energy from the source.