ABSTRACT

Power Management Circuits for Energy Harvesting Applications

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Energy harvesting is the process of converting ambient available energy into usable electrical energy. Multiple types of sources are can be used to harness environmental energy: solar cells, kinetic transducers, thermal energy, and electromagnetic waves.

This dissertation proposal focuses on the design of high efficiency, ultra-low power, power management units for DC energy harvesting sources. New architectures and design techniques are introduced to achieve high efficiency and performance while achieving maximum power extraction from the sources. The first part of the dissertation focuses on the application of inductive switching regulators and their use in energy harvesting applications. The second implements capacitive switching regulators to minimize the use of external components and present a minimal footprint solution for energy harvesting power management. Analysis and theoretical background for all switching regulators and linear regulators are described in detail.

Both solutions demonstrate how low power, high efficiency design allows for a self-sustaining, operational device which can tackle the two main concerns for energy harvesting: maximum power extraction and voltage regulation. Furthermore, a practical demonstration with an Internet of Things type node is tested and positive results shown by a fully powered device from harvested energy. All system were designed, implemented and tested to demonstrate proof-of-concept prototypes.