Energy-Harvesting Battery Charger for Self-Sustaining Portable Microelectronic Applications

By: Erick O. Torres ◆ Advisor: Prof. Rincon-Mora
Georgia Tech Analog and Power IC Design Lab

Abstract

As microelectronic portable devices continue to shrink and incorporate numerous functions in a single device, power availability becomes a major constraint. Because of their compact size, the amount of available, stored energy in the battery is limited, resulting in short lifespan. It is necessary to prolong battery life, and thus device life, by continuously replenishing energy consumed. Energy is extracted and harnessed from the surrounding environment by using current MEMS scavenger technology. Through very efficient management, this energy is utilized to charge an integrated battery, resulting in a self-sustaining battery charger capable of significantly extending the lifetime of any portable microelectronic device.

Introduction

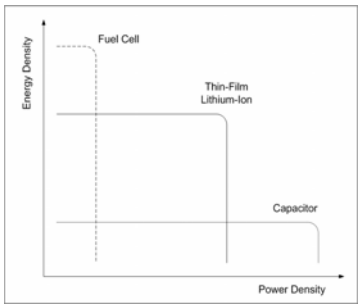
Application: Microsensors

- Available stored energy in battery limited by small dimensions
- Battery cannot be recharged or replaced
- PROBLEM: Short device lifetime

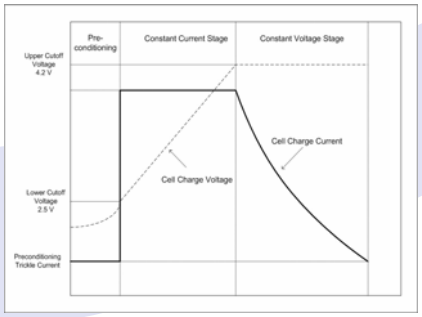
- SOLUTION:
  Continually add and replace consumed energy by using energy from the surrounding environment

Thin-Film Lithium-Ion Battery

- High energy density
- High cell voltage
- No “memory” effect
- Very long cycle life
- On-chip integration
- Charging characteristics:
  - Preconditioning
  - Constant-Current
  - Constant-Voltage



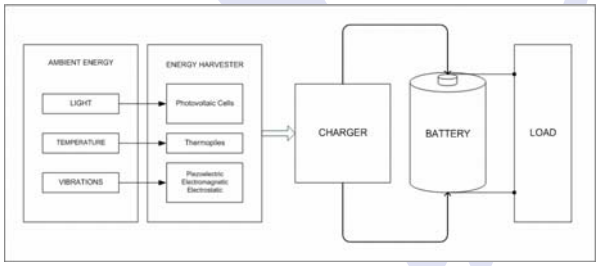
Thin-Film Lithium-Ion Battery: Charging Characteristics

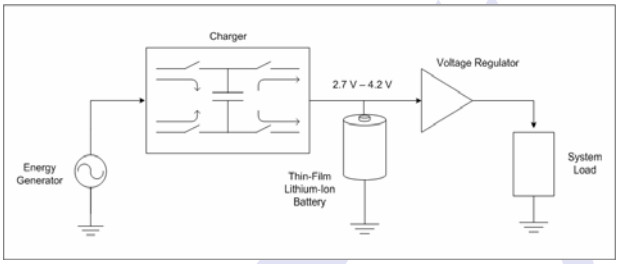


Environment Energy Sources

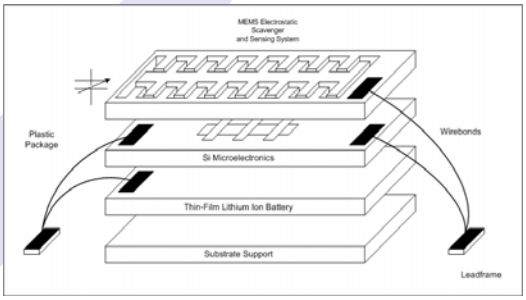
Energy Sources	Energy Density	Environmental Considerations	Physical Implications
Light Outdoors (sunny) Indoors	 Very high Very low	Depends on weather and shade Constant intensity	Small surface area available
Vibrations Piezoelectric Electromagnetic Electrostatic	 High High Moderate	Plentiful, but dependant on exact application	Available MEMS technology
Thermal Gradients	Low	Depends on application	Small gradients over small distances

System Level Approach





System-in-Package Vision



Future Plans

- Currently gathering information through literature search
- Develop one energy harvester at a time
- Efficient charger design capable of utilizing energy “bursts” from harvester

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