Power Conversion Circuits for Microintegration

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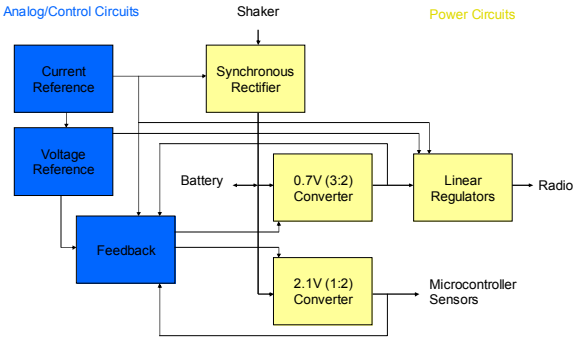
Vision

- Energy conservation is critical for energy-harvested wireless sensor nodes (WSNs)
- Nodes are heavily duty-cycled to achieve a standby power of 1-100 µW, peak powers can be 100x higher.
- Scavenger to load power efficiency critical at a wide range of power levels
- Efficient and small power conversion circuitry is the key to integrated power generation, storage and use!
- Goal: 1 cm^3 nodes and smaller



Research Questions

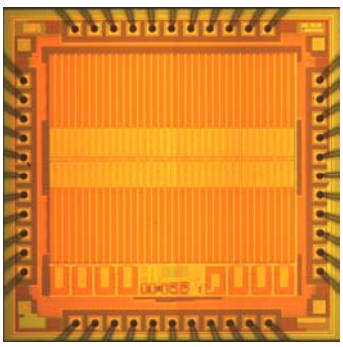
- How can we make an efficient converter at µW levels to supply all loads?
- Can we develop analog circuits that function at nW levels, such that they won't dominate circuit power loss?
- How can we efficiently capture the energy from a variety of energy-scavenging devices?
- Can we integrate all these circuits on a single IC?

Methods

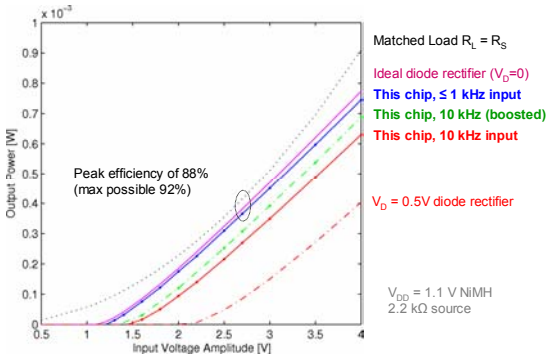
- Switched-capacitor (SC) power converters offer significant advantages to inductor-based converters:
  - Complete integration for sensor nodes
  - High efficiency over a wide range of power levels
- PicoCube chip uses two converters:
  - 1.2V – 0.8V: PicoRadio
  - 1.2V – 2.1V: Microcontroller, sensor
- A synchronous rectifier eliminates diode drops in the scavenger rectifier circuit

Findings

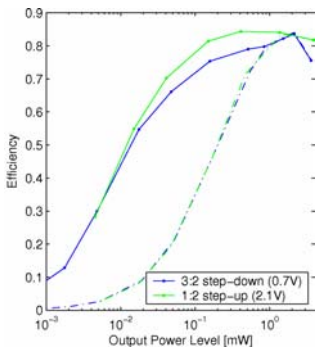
- Scavenger interface is 88% efficient: ~2x better than a diode rectifier
- Power converters are over 80% efficient, high efficiency at lower output powers
- Average system efficiency = 47% (duty cycled)



PicoCube power conversion IC
Fabricated May-Oct. 2007



Synchronous rectifier efficiency



Converter efficiency (w/ and w/o regulation)

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