High Efficiency Ultralow Voltage CMOS Rectifier for Wireless Power or Energy Harvesting Applications

Background
In power management system, the voltage converting element (diode) provides a unidirectional path for the current flowing from the source toward the load. The popular diodes are constrained by their forward bias drop of almost 400 mV. In a chip, one replaces the diodes by diode-tied MOS transistors, but the channel resistances of the transistor-based switches limit the overall power efficiency and reduce the output voltage. The structure is increasingly inefficient in advanced low-voltage µm processes. Passive rectifiers use diode-connected, bootstrapped and floating-gate MOS transistors in various configurations, while active rectifiers employ controlled MOS switches. Despite their higher power efficiencies, active rectifiers generally need some additional static power for their internal circuitry and their performance is still affected by dynamic losses within the switches.

Technology
To improve the power conversion chain performances of an integrated circuit and increase the output voltage for a given input source amplitude, here is a new full-wave CMOS rectifier. It employs a pair of bootstrapped pMOS switches with very low effective threshold voltage formed in the gate cross-coupled structure whose bulk is dynamically biased to reduce the leakages. This structure is combined with a single charge reservoir to reduce the effective threshold voltage of selected MOS switches in the positive and negative input source cycles. It is fully compatible with advanced sub-micron CMOS technologies (e.g. 0.18 µm) and is based on a simple circuit designs. Voltage conversion ratio larger than 70% for an AC input source with 0.8V peak amplitude have been measured on the prototype.

Application
This technology targets applications where energy efficiency is critical and offers to enhance the power management chain of the chip, like wireless sensors or wirelessly powered devices using ultralow voltage sources for energy harvesting or scavenging systems. It is also applicable for smart biomedical implants or RFIDs.

Competitive Advantages
The proposed technology offers:
- High efficiency: voltage conversion ratio>70% for an AC input with 0.8V peak amplitude,
- Full compatibility with advanced sub-micron CMOS technologies, like 0.18 µm,
- No complex circuit design.

Patent
US Provisional Patent Application “SINGLE RESERVOIR FULL-WAVE RECTIFIER”

Next Steps
This technology is available for a licence. A first collaborative step could be customizing the design for a dedicated application.

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