Multiband Radio Frequency Energy Harvester

Li Bo¹, Xi Shao¹, Thomas Salter² and Neil Goldsman¹,³

1. Dept. of Electrical & Computer Engineering, Univ. of Maryland, College Park MD
2. Laboratory for Physical Science, College Park MD
3. Institute for Systems Research, Affiliate, Univ. of Maryland, College Park MD

Introduction & Motivation

Wireless Electromagnetic energy is widely available in urban areas at power levels between -40dBm/m² (100nW/m²) and -10dBm/m² (100µW/m²). At the same time, the required digital energy per switch for 65nm CMOS technology is only 0.08fW. It is very promising to harvest ambient radio frequency (RF) energy and use it as a power source.

The energy strongly exists in different bands such as 890MHz, 1800MHz. In this poster, a multi-band RF energy harvester is presented. The energy harvester can generate more than 1V for an input RF power as low as -19dBm at two different frequency bands 890MHz and 1800MHz. Moreover, this work can be to extended into multi-band energy harvesting.

Applications

• Wireless bio-medical applications to remove the long wires from medical devices.
• To extend RFID tag range.
• To remove or reduce battery requirements on mobile devices such as wireless sensor networks.

Fig. 1. The structure of the dual band energy harvester.

Fig. 2 a) Circuit schematics of the dual band energy harvester.

Fig. 2 b) Simulated DC output voltage at different frequency bands (the input power is -19dBm).

Fig. 2 c) Simulated energy harvester AC to DC conversion efficiency at different frequencies (the input power is -19dBm).

Fig. 2 d) Chip layout of the dual band energy harvester.

Energy Harvester Circuit Design

• C1s, CL1s are AC decouple-couple capacitors.
• All the capacitors and resistors in the orange box are used for a DC self-bias purpose.
• Ropt, RLOpt are optimized to achieve the maximum output power efficiency.
• All remaining capacitors are bypass to work as ac short and dc block.
• The NMOS/PMOS connected diodes work in a similar way as regular pn diodes.
• Vout1 and Vout2 are the DC outputs.
• RFin is the AC input.

Fig. 3 a) Fabricated printed circuit board antenna.

Fig. 3 b) Simulated antenna impedance at different frequencies. (The antenna has an impedance of 45 ohms at 890MHz while achieves 160ohms at 1800MHz.)

Fig. 3 b) Simulated antenna impedance at different frequencies.

Dual-Band Antenna

Achievements

• The energy harvester can generate more than 1V DC voltage for an input power as low as -19dBm which is close to ambient RF energy from mobile or TV towers.
• The generated energy is enough to power the current digital devices, which presents promising battery-free mobile electronics.
• The energy harvesters can provider power from different frequency bands.
• The conversion efficiency can be as high as 14.4% for -19 dBm input power. The conversion efficiency increases as input power increases.
• No external power source is required.

Intellectual Merit

New paradigm for energy harvesting.

Broader Impact

Benefits to society: Clean energy, improved electronics.