

Multiband Radio Frequency Energy Harvester

Li Bo¹, Xi Shao¹, Thomas Salter² and Neil Goldman^{1,3}

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/m^2 (100nW/m^2) and -10dBm/m^2 ($100\mu\text{W/m}^2$). 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 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.

Harvester Circuit Diagram

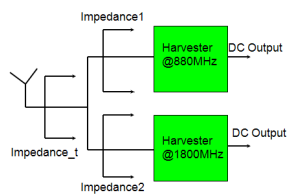


Fig. 1. The structure of the dual band energy harvester.

- Due to the weak available signal, each harvester is required to achieve low impedance on its harvesting frequency while achieving high impedance at other frequencies
- Requirement
- Impedance_t
 - $50\text{Ohms}@890\text{MHz}$
 - $14\text{Ohms}@1.8\text{GHz}$
- Impedance_1
 - $50\text{Ohms}@890\text{MHz}$
 - $1000\text{Ohms}@1.8\text{GHz}$
- Impedance_2
 - $1000\text{Ohms}@890\text{MHz}$
 - $14\text{Ohms}@1.8\text{GHz}$

Energy Harvester Circuit

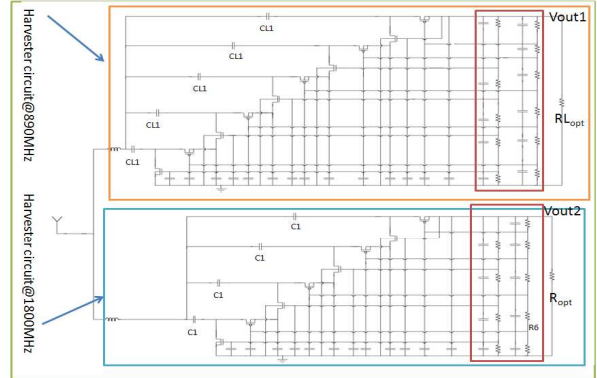


Fig 2. a) Circuit schematics of the dual band energy harvester.

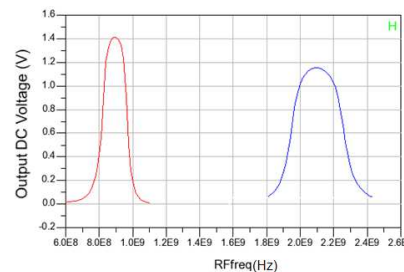


Fig. 2 b) Simulated DC output voltage at different frequency bands (the input power is -19dBm).

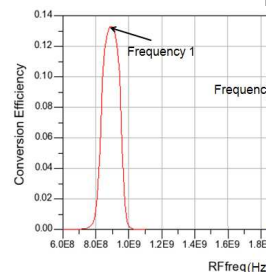


Fig. 2 c) Simulated energy harvest at different frequencies (the input power is -19dBm).

Dual-Band Antenna



Fig. 3 a) Fabricated printed circuit board antenna.

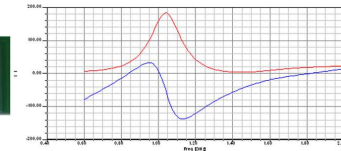


Fig. 3 b) Simulated antenna impedance at different frequencies. (The antenna has an impedance of 45 ohms at 890MHz while achieves 18ohms at 1800MHz.)

Achievements

- The energy harvester can generate more than 1V for an input power as low as -19dBm from mobile or TV towers.
- The generated energy can power low-power devices, which presents a new paradigm for energy harvesting.
- The energy harvesters can operate in multiple frequency bands.
- The conversion efficiency is high for a wide range of input power. The conversion efficiency increases as the input power increases.
- No external power source is required.

Intellectual Merit
 New paradigm for energy harvesting.

Broader Impacts
 Benefits to society: Clean energy, reduced battery usage, etc.