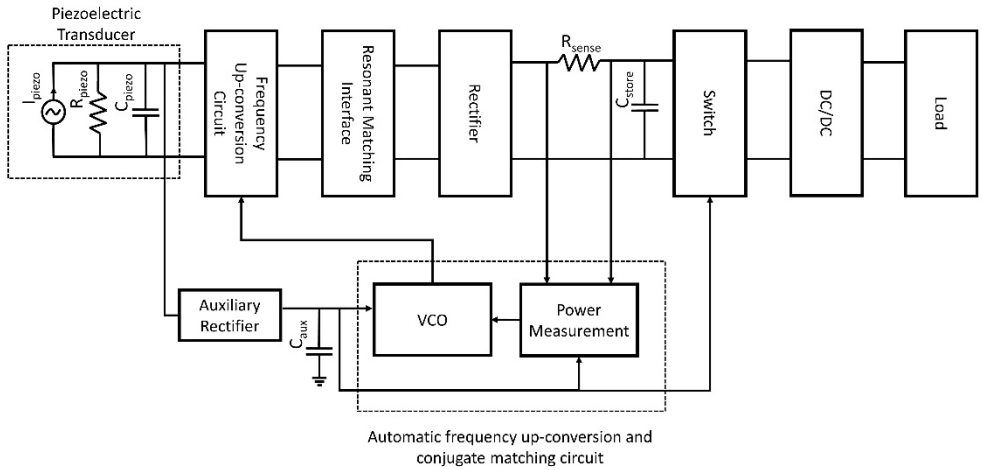
Master Thesis Proposal 2018

Dynamic frequency up-conversion technique for piezoelectric energy harvester

Keywords: Energy Harvesting, Integrated Circuit Design, Low Power Optimization



Background:

The thriving need for distribute self-powered sensors requires advanced technology to condition the power available from the surrounding environment. Piezoelectric energy harvesting is a promising technology commonly adopted to transduce mechanical stimuli into an ac signals, which cannot be used directly to power electronic devices. Hence, a harvesting interface has to be designed to rectify, store and regulate the available energy. The impedance characteristic of piezoelectric transducers is mainly capacitive over a wide frequency band. Therefore, to maximize the power conversion efficiency for multiple excitation frequencies, the harvesting interface should match dynamically the transducer impedance.

System Overview:

The aim of the research activity is to design and simulate an IC to scavenge efficiently energy from a random low-power input signal generated by a vibrating piezoelectric transducer. The harvesting architecture is based on an automatic frequency up-conversion technique [1,2], which will be designed to match dynamically the output impedance of the piezoelectric transducer by shifting the vibrational frequency of the piezoelectric element up to the resonant frequency of the harvesting interface. A switched transformer will be employed as the active component to implement the up-conversion technique. To control dynamically the switching frequency of the transformer, a feedback loop with on-chip power measurements and a voltage controlled oscillator will be adopted. The feedback loop is used to keep harvesting interface at the maximum output power point independently form the mechanical excitation frequency.

Tasks:

The student with background in electronics will be actively involved in the design of the IC for the harvesting interface. The research project comprises: (A) Circuit schematic optimization; (B) Physical layout design; (C) Parasitic extraction and validation of the physical design.

Partners and founding:

The research activity is founded by the National Natural Science Foundation of China (No. 61531008) and by the industrial cooperation partners of Sensovann AS. The activity will be conducted in cooperation with researchers at University of Southeast Norway (USN), Politecnico di Torino, Chongqing Technology and Business University (CTBU) and Shanghai Jiaotong University (SJTU).

Outcomes:

A good thesis project will encourage the candidate to join the Ph.D. program by continuing the research work on piezoelectric energy harvesting. A good master student will have the possibility of one publication on an IEEE conference or journal paper and will have the opportunity to visit CTBU in China.

Supervisors:
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[1] P. Li, et al. "An upconversion management circuit for low-frequency vibrating energy harvesting," IEEE Transactions on Industrial Electronics.
[2] P. Li et al, "A magnetoelectric composite energy harvester and power management circuit," IEEE Transactions on Industrial Electronics.