Post-doctoral position offer

Subject : design of integrated conditioning circuit for a vibration energy harvester in high voltage CMOS technology

Laboratory: LIP6 (Computer science laboratory of Paris VI, University Pierre et Marie Curie)
Starting date: October 2010
Duration: 1 year, renewable
Salary: starting from 1950 euros net/month, depending on the experience
Location: Campus of Jussieu, 4, place Jussieu, 75005 Paris, France
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Context

This research topic involves the generation of electricity from energy of ambient vibrations for supplying autonomous embedded electronic systems. The electromechanical conversion is achieved with a capacitive (electrostatic) transducer. Such a transducer, in order to operate in mode of energy conversion, requires a complex, intelligent and adaptive command. A development of a vibration-to-electricity generator requires :

1) a development of a capacitive transducer with good characteristics. The transducer is generally implemented using silicon micromachining techniques (MEMS technologies). This activity concerns design, fabrication and test of a MEMS device.
2) A development of conditioning electronic circuit allowing the capacitive transducer to operate correctly. This activity concerns a design of analog mixed integrated circuits.*

Theses tho tasks are carried out by two teams working in close cooperation: ESYCOM (ESIEE) and LIP6. *This project is a part of the french national grant SESAM in which participate ESIEE, LIP6, TIMA and CEA-LETI.*

Project description

There exist numerous studies on generators of electricity from vibrations with use of a capacitive transducer. The particularity of our project is the sophistication of the conditioning circuit, which allows to optimize the power yield of generator, and to adapt its operation to the varying environment. Few studies address global operation of the generator, in particular, interaction between electrical and mechanical domains. Our work was preceded by a deep theoretical study whose results are presented in TCAS I (to be published).

The project started two years ago; an architecture of an adaptive conditioning circuit has been modeled in VHDL-AMD/Eldo language. The architecture of the conditioning circuit is inspired by those proposed in [1] based on a charge pump. The intelligence is introduced in the command of of the switch which cadences the cycle of energy conversion. The developed architecture of conditioning circuit is described in [2] (downloadable on our site).

Now the project is in the implementation phase. The developed architecture has to be implemented in 0.35 µm high voltage CMOS technology (AMD 035 HV). The main difficulty is to allow the transducer to operate at high voltage (tens of volts), which implies an implementation of a high voltage control circuit. The conditioning circuit includes a measurement block, an analog-to-digital converter

allowing to sense the current state of the circuit, a command generator, a comparator and a digital block. The main difficulty consists in ultra-low power consumption required for the conditioning circuit (microwatts).

Post-doc activities

The postdoctoral researcher will be involved in design of conditioning circuit IC in high voltage technology. He will participate in the coordination of the design carried out by two PhD students. The goal of the project is to have a designed, fabricated and tested chip, so to be able to interface it with the MEMS device developed by ESIEE.

Expected skills

- PhD in electroncis
- Practical experience in design of MOS integrated circuits (layout, Cadence, extraction/simulation, …)
- Knowledge of power (micro)electronics

References:

[1] B. C. Yen, H. L. Jeffery, “A variable capacitance vibration-to-electric energy harvester”, IEEE transactions on circuits and systems, vol. 53, no. 2, Feb. 2006, pp. 288-295

[2] VHDL-AMS modeling of adaptive electrostatic harvester of vibration energy with dual-output DC-DC converter, Andrii Dudka, Dimitri Galayko and Philippe Basset, *Proceeding of the 2009 IEEE International Behavioral Modeling and Simulation Conference (BMAS'2009)San José, USA, 2009*

[…] The publications of LIP6 related with the project can be found in this page.