Methods and Tools for the Design of Electrostatic Micromotors.

T.B. Johansson, K. Hameyer, R. Belmans

E.E. Dept., ESAT / ELEN
Katholieke Universiteit Leuven, Belgium
torb-johansson@esat.kuleuven.ac.be, kay.hameyer@esat.kuleuven.ac.be,
ronnie.belmans@esat.kuleuven.ac.be

Abstract.
In this paper the methodology of the design of electrostatic micro motors is discussed. Field computation is performed by the finite element method (FEM). Automated modeling and evaluation of the quantities of the electrostatic field in combination with an equivalent circuit technique leads to an efficient design tool.

Introduction.
Microengines i.e. micromotors and microactuators are energy converters with overall dimensions smaller than 1 mm. The conversion between electric and mechanical energy is always realised through a magnetic or an electric field. Therefore, for the design of micromotors, the exact calculation of such fields is of great importance in order to predict the operational behaviour. The paper focuses on the design of electrostatic variable capacitance micromotors.

Numerical technique.
The objective of any numerical method is to obtain a numerical solution of the defining equation or mathematical model. A defining equation is a continuous partial differential equation valid everywhere over the domain of the problem. Such a method requires that the physical model, including surrounding air is discretized by a mesh. The generation of the mesh must be flexible, fast and yet precise in order to be useful as a design tool. A meshgenerator has been developed which meet these requirements. This is combined with the derivation of an equivalent circuit model using the FEM solution [3]. This offers the opportunity to simulate the operational behaviour of an electrostatic micromotor fed by varying voltage cycles without repetitive use of the computational expensive FEM.

Automated 3D Meshgeneration.
The design tool is capable of generating precise 3D meshes by extruding the 2D mesh of a cross-section around the motor axis. The 2D mesh is generated from 8 geometric parameters, and the 3D mesh is completed after choosing the pole pitch and the polar arc of the stator and the rotor and choosing the rotor position. All 13 parameters may be chosen to arbitrary values which is essential for the purpose of optimization.

The development of a meshgeneration tool is based on extrusion rather then using commercially available and more general solid modelling techniques. The reason for this is speed and stability. The developed tool is up to 9 times faster when compared to commercially available tools and obtains a much higher confidence of producing a valid mesh for a valid combination of geometric parameters.

Results and Conclusion.
The complete design tool has successfully been used to optimise the average torque of various electrostatic micromotors. This has proved it to be an efficient tool for optimisation and design of electrostatic micromotors.

References.