Embedded Tutorial

Path Toward Future CAD Environments for MEMS

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ABSTRACT

As MEMS technology is inserted into more and more embedded systems, the drive to lower cost will push integration of digital and analog electronics with micromechanical sensors and actuators. There is a related market push to deliver reliable MEMS from concept to product with design cycle times comparable to mixed-signal ICs. The unique requirement of MEMS to integrate electronics with mechanics, electrostatics and other physical processes translates into new challenges and opportunities for CAD. Application engineers from industry and emerging MEMS CAD vendors are beginning to successfully blend traditional electronics IC CAD concepts with new tools tailored to MEMS. MEMS design requires simultaneous evaluation of system architecture to describe functionality, of device topology to describe geometric interactions, and of process flow to determine material properties and other mechanical characteristics. A handful of foundries now provide access to fixed MEMS processes that are capable of fabricating an important variety of systems. The foundries eliminate the need for custom process design and have motivated formation of hierarchical design methodologies and supporting representations that apply to a majority of MEMS applications and processes. Such a structured approach will lead to design reuse and core-based design of complex mixed-domain systems on a chip.

In this tutorial, we will introduce design techniques for microelectromechanical devices and systems that are compatible with VLSI design methodologies. We will describe micromechanical design tools implemented in existing frameworks having links between physical form and function. Examples of inertial sensors and micromechanical filters will be used to demonstrate a design flow consisting of mixed electrical and mechanical schematic design entry, behavioral simulation using analog HDL, micromechanical layout synthesis, extraction and verification. We will highlight design issues specific to MEMS that have drive tool development, including mixed-domain modeling, device geometry, layout position, design rules and manufacturing variations. Our goal is to overview MEMS application areas, and enable CAD engineers to understand the primary issues involved in integrating MEMS design with traditional electronics design flows.