Mathematical Modeling and Numerical Simulation of the Detection Unit in a Miniaturized Capacitive Accelerometer

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Abstract— This paper presents a detection method used in a miniaturized capacitive accelerometer. Shown are: the structure of the accelerometer detection unit, and the complete mathematical model of this unit. At the level of the detection unit both mechanical and electrical parts are described. The chosen architecture for the capacitive sensor is a differential one. The ensemble includes three parallel plates, two fixed (external) and one mobile (placed centrally). It results two capacitors that allow the change of theirs capacities when an acceleration able to change the position of the movable plate is applied; the movable plate plays the role of the proof mass. As excitation signals, high frequency square wave signals with opposite signs are applied on the capacitors fixed electrodes. Given the small size of the accelerometer, the dynamic damping is provided by the air inside the housing. In this way, the damping coefficient is a strongly nonlinear function by the proof mass displacement and requires the accelerometer loop closing. To measure the proof mass displacements a charge amplifier is needed; its output voltage depends by the applied acceleration variations. The mathematical model includes the block schemes of both mechanical and electrical parts. It is finally validated through numerical simulations by using the Matlab - Simulink software.