Design Variability of a MEMS Resonator

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Abstract

It is important in designing micro-electromechanical systems (MEMS) to reduce the variability of design parameters caused by manufacturing tolerances and material properties. At NXP COMSOL has been used to investigate many aspects of the design, such as the Q-factor, anchor losses, thermal behavior, parasitic capacitance of the resonator and more. Quartz crystal resonators are used in many electronic oscillator packages since long times, due to their high Q-factor, low temperature drift and high stability. Recently, MEMS resonators have been developed to replace the quartz crystals in the timing market. The long built standard of the quartz crystals has resulted in a set of specifications which are hard to attain with the MEMS resonators. One of those for example is the temperature drift in the devices. The MEMS products can be used in the telecom and the automotive industry. It should be stressed that if the specs are met, and the design can operate stable over more than 20 years the MEMS are a serious candidate for replacing the quartz crystals. For example in Figure 1, an overview is given of the anchor losses of the device and simulations gave insight on how to design the resonator to reduce this. It is important to reduce the losses in favor of high Q-factors. In Figure 2 an overview is given of the fringing effect in the actuation gap, and should be taken into account for the performance. This aspect is also important in relation to the driving voltage and the non-linear behavior of the the electrical force. This presentation will cover these aspects, among others, and special attention will be given to the geometric parametric sweeps but also the static and time dependent simulations.

Figures used in the abstract

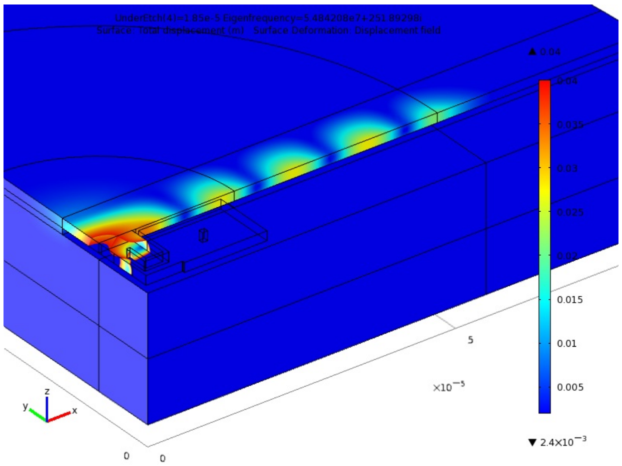

Figure 1: Acoustic losses in a MEMS device.

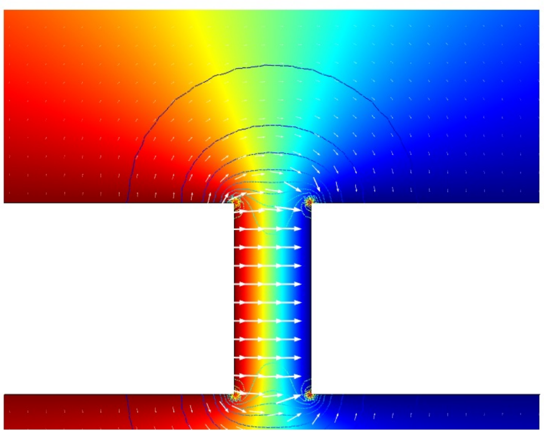

Figure 2: Fringing effect around the actuation gap.