Vibration Isolation and Shock Protection for MEMS

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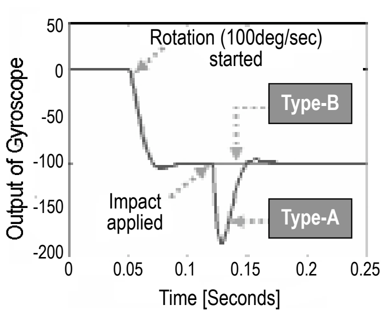
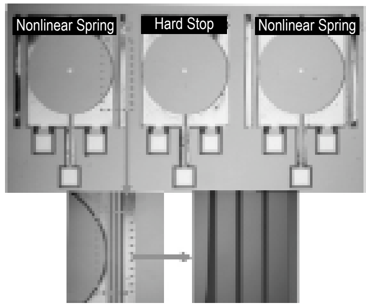


Simulated outputs for Type-A and Type-B gyroscopes after subjected to the same rectangular shaped impact.



Devices integrated with nonlinear spring shock stops. A hard stop device was also fabricated as a control.

External mechanical disturbances including vibration and shock have profound impact on the performance and reliability of MEMS devices. This project seeks to develop generic technologies that protect microsystems against them. Vibration produces undesirable outputs that cannot be corrected with electronics. Tuning fork gyroscopes (TFG), which are known to be relatively immune to linear vibrations, cannot completely eliminate linear vibrations in several special situations. Simulations were conducted using two commonly used TFG designs. Both designs have decoupled sense and drive masses; however, one is anchored at its sense mass (Type-A), whereas the other is anchored at its drive mass (Type-B). The results demonstrate that both designs are affected by linear vibrations. However, Type-B design is more resistant to vibration-induced errors than Type-A (>99% reduction). Shock permanently damages MEMS devices and hard shock stops have been conventionally used to limit the damage. However, hard stops can generate subsequent impacts, which should also be minimized. This goal can be achieved by two novel shock protection technologies using nonlinear springs and soft coatings. Devices integrated with nonlinear spring (silicon) stops and soft coating (Parylene) stops were fabricated and tested together with hard-stop devices. Test results show that both stops provide superior shock protection. The device survival rates of nonlinear spring stops (87%) and soft coating stops (94%) are more than 10x better than hard stops (4%). This project is supported by the Defense Advanced Research Projects Agency HERMIT program under contract number W31P4Q-04-1-R001.