

Public Abstract

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Title:Surface Micromachined MEMS Variable Capacitor with Two-cavity for Energy Harvesting

In this research, novel MEMS variable capacitors with two capacitive cavities for energy harvesting will be presented. The device scavenges the wasted energy associated with undesirable mechanical vibrations which can be used to power microelectronic sensors and actuators widely found in structures and systems surrounding us. The harvested power, though very small, can have a profound effect on the usage of micro sensors. For examples, the self-powered sensors will no longer require regular battery maintenance. The self-powered chip is a liberating technology. On a circuit board, it can simplify the connection. On a commercial jet, the sensors can greatly simplifying cabling.

The MEMS variable capacitors are unique in its two-cavity design and use of electroplated nickel as the main structural material. The device consists of 2×2 mm² movable proof mass plate suspended between two fixed plates forming two vertical capacitors. When the capacitance increases for one cavity, it decreases for the other. This allows using both up and down motion directions to generate energy. A single MEMS variable capacitor and 1×4 capacitors array with two capacitive cavities for energy harvesting from environmental vibration has been successfully fabricated using surface micromachining technology and experimentally characterized using a PCB test board mounted on a shaker. Comprehensive experimentations have been performed to characterize the fabricated devices. The comparison of the output performance between single capacitor and 1×4 capacitors array has been made. The devices were found with resonance frequency of 500 Hz and 290 Hz, respectively, for two different dimensions of movable plate and suspension beams. It is observed that the measured RMS voltage across the load resistors from capacitors array is 3.2 times in average of that from single capacitor under extensive excitation conditions. The measured power across the load resistors from the single capacitor and from the capacitors array achieved a maximum power around 220 nW and 2.5 μ W, respectively, under a high DC bias of 15 V and extremely intense excitation above 5g.