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A SYNCHRONIZED SWITCHING STRATEGY TO INCREASE ENERGY HARVESTING EFFICIENCY FROM MICRO-SCALE VIBRATION ENERGY

Abstract

Energy harvesting technology has recently received considerable attention owing to the increasing demand of energy in low-power-consuming microsystems used in daily applications and health-monitoring systems used in extremely isolated environments. Piezoelectric elements, in particular, have received considerable attention because of their high-power densities and promising integration potential as well as widely available vibratory energy sources. In line with increased attention to piezoelectric energy harvesting systems, various technical efforts to enhance their energy harvesting capability have been made. For example, Guyomar et al.(1) proposed a non-linear harvesting technique, called synchronized switch harvesting on inductor (SSHI). The proposed SSHI technique has been garnered significant attention on account of its practical applicability and superiority in harvesting performance, such that various spawned researches based on the SSHI technique have been reported. In this study, a modified synchronized switching strategy is proposed; this strategy is more powerful for micro-scale vibration energy harvesting compared to the conventional SSHI. This switching strategy induces a surge phenomenon to significantly boost the piezo-induced voltage, such that the voltage produced by the piezoelectric elements can easily overcome the threshold voltage accompanied by the forward voltage drop of the diode. The surge phenomenon occurs owing to a sudden current transit in the inductor right after the switching action. Its amplification can be further enhanced by adjusting the switching duration and parasitic capacitance value in the inductor itself. The effectiveness of the switching strategy proposed in this study was demonstrated by applying it to a simple cantilever beam-type piezoelectric harvester. Its superiority was assessed by comparing it with the conventional synchronized switching technique.

(1) D. Guyomar, A. Badel, E. Lefeuvre and C. Richard, "Toward energy harvesting using active materials and conversion improvement by nonlinear processing", IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control Vol. 52, No. 4, pp. 584–595 (2006)