SPACE POWER SYMPOSIUM (C3)
Advanced Space Power Technologies and Concepts (3)

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ENHANCEMENT OF ENERGY-HARVESTING FROM RANDOM VIBRATION BY SWITCHED SHUNT CIRCUIT

Abstract

Many researchers have been trying to harvest electric energy from structural vibration for various self-powered small systems such as wireless measuring system, health monitoring system, and so on. Taking out and storing electrical energy from vibrating structural by using a piezoelectric transducer and a rectifier is one of these techniques. To enhance the performance of this technique, some researchers have invented self-powered switched shunt circuits. These switched shunt circuits automatically reverse the polarity of charge stored in the piezoelectric transducer at each moment when the voltage of piezoelectric transducer is at maxima. Both theoretically and experimentally, they have shown that the harvested energy can be increased drastically by using these shunt circuits. However, all of these studies have been limited to the energy harvesting form sinusoidal vibrations of a single-degree-of-freedom (SDOF) structure. However, in actual situation, vibrations are often more complex. The structure with multiple-degrees-of-freedom (MDOF) may be randomly excited. In this paper, therefore, we experimentally study if and how this kind of switched shunt circuit can enhance the ability of energy harvesting when a MDOF structure is randomly excited. In our study, a MDOF structure is randomly excited. By using a piezoelectric transducer and a rectifier, electric energy is taken out from this randomly vibrating structure and stored in a capacitor connected to an electric load. In various conditions, we study how much electric energy can be stored with and without our switched shunt circuit. Our switched shunt circuit is composed of coils, resistances, capacitances, diodes, thyristors, and programmable unijunction transistors (PUT), which was originally invented for semi-active vibration suppression. Experimental results show that the stored electrical energy can be increased more than twice by using our simple shunt circuit even when the structure is randomly vibrating.