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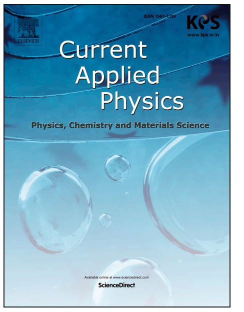

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Analysis of the energy extracted by a harvester based on a piezoelectric tile

Furio Cascetta[1], Alessandro Lo Schiavo[1], Aldo Minardo[1*], Marilena Musto[2], Giuseppe Rotondo[2], Alessio Calcagni[3]

In this paper, we analyze the maximum energy that can be extracted from a piezoelectric harvester subject to pulsed excitation, with an interface circuit composed by a standard bridge rectifier. We show that the optimal voltage of the DC load of the bridge rectifier is a fraction, comprised between 1/3 and ½, of the open-circuit voltage, depending on the piezoelectric losses and excitation time. A simple analytical model is provided, whose accuracy has been assessed against SPICE simulations. Furthermore, preliminary experimental tests carried out over a commercial piezoelectric tile confirm the validity of the proposed model.

Keywords: Energy harvesting, Piezoelectricity, Vibration

1. Introduction

Among the various energy harvesting technologies, piezoelectric vibration has emerged as a method for harvesting from to macro-to-micro scale [1-4]. Piezoelectric materials can be designed to handle a wide range of input frequencies and forces allowing for energy harvesting to occur. Although studies on piezoelectric energy harvesting systems have been extensively conducted over the past years [5-7], this application is still in development and therefore, its potential has not yet been fully exploited. Studies based on piezoelectric energy harvesting from human force include the energy harvested from the bending of elbow or finger joints [8], implants in the knee joints [9], piezoelectric modules inserted under the soles of shoes [10-12], or motion of the human limbs [13]. However, these cases cannot be considered as macro-sources because of their limited installation area, but independent units such as piezoelectric tiles can be planted over a wider area; thus, they can be used as macro-power sources [14]. Key aspects of the use of piezoelectric tiles on a large scale are cost reduction and quality of harvesting systems. The first aspect mainly depends on the efficient use of the system, the integration of various piezoelectric technologies, the reduced device break times by searching for new materials and designing appropriate energy transfer facilities. In this regard, Adnan M. Elhalwagy et al. [15] provided a guide to facilitate embedding piezoelectric tile technology in the designs as a part of the demanded low energy consumption in the buildings, while Xiaofeng Li et al [16] carried out an optimization of the piezoelectric tile deployment in according to the frequency of pedestrian mobility. Their study confirms that selecting high traffic areas is critical for the optimization of the energy harvesting efficiency; furthermore, the orientation of the tile pavement significantly affects the total amount of the harvested energy. The second aspect depends on the efficiency in transferring mechanical energy from the environment to the

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