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Design and Optimization of an Electromagnetic Vibration Energy Converter

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Abstract : Vibration provides an interesting source of energy since it is available in many indoor and outdoor applications. Nevertheless, in order to have an efficient design of the harvesting system, vibration converters have to satisfy some criterion in terms of robustness, compactness and energy outcome. In this work, an electromagnetic converter based on mechanical spring principle is proposed. The designed harvester is formed by a coil oscillating around ten ring magnets using a mechanical spring. The proposed design overcomes one of the main limitation of the moving coil by avoiding the contact between the coil wires with the mechanical spring which leads to a better robustness for the converter. In addition, the whole system can be implemented in a cavity of a screw. Different parameters in the harvester were investigated by finite element method including the magnet size, the coil winding number and diameter and the excitation frequency and amplitude. A prototype was realized and tested. Experiments were performed for 0.5 g to 1 g acceleration. The used experimental setup consists of an electrodynamic shaker as an external artificial vibration source controlled by a laser sensor to measure the applied displacement and frequency excitation. Together with the laser sensor, a controller unit, and an amplifier, the shaker is operated in a closed loop which allows controlling the vibration amplitude. The resonance frequency of the proposed designs is in the range of 24 Hz. Results indicate that the harvester can generate 612 mV and 1150 mV maximum open circuit peak to peak voltage at resonance for 0.5 g and 1 g acceleration respectively which correspond to 4.75 mW and 1.34 mW output power. Tuning the frequency to other values is also possible due to the possibility to add mass to the moving part of the or by changing the mechanical spring stiffness.

Keywords : energy harvesting, electromagnetic principle, vibration converter, moving coil
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