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## Design and characterization of an electromagnetic energy harvester for vehicle suspensions

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Some more information concerning the harvesting of shock absorber energy.

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## Abstract

During the everyday usage of an automobile, only 10–16% of the fuel energy is used to drive the car —to overcome the resistance from road friction and air drag. One important loss is the dissipation of vibration energy by shock absorbers in the vehicle suspension under the excitation of road irregularity and vehicle acceleration or deceleration. In this paper we design, characterize and test a retrofit regenerative shock absorber which can efficiently recover the vibration energy in a compact space. Rare-earth permanent magnets and high permeable magnetic loops are used to configure a four-phase linear generator with increased efficiency and reduced weight. The finite element method is used to analyze the magnetic field and guide the design optimization. A theoretical model is created to analytically characterize the waveforms and regenerated power of the harvester at various vibration amplitudes, frequencies, equilibrium positions and design parameters. It was found that the waveform and RMS voltage of the individual coils will depend on the equilibrium position but the total energy will not. Experimental studies of a 1:2 scale prototype are conducted and the results agree very well with the theoretical predictions. Such a regenerative shock absorber will be able to harvest 16–64 W power at  $0.25\text{--}0.5\text{ m s}^{-1}$  RMS suspension velocity.

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