# Dynamic modeling for a mechatronic energy harvesting shock absorbers

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**Abstract**. This article analyses the dynamic performance of energy harvesting shock absorbers (EHSA), which contains overrun clutch, rack and pinion. The results show that the damping force of EHSA is composed of the inertia force and the electromagnetic damping force. The inertia force is produced by the motion of moving parts of EHSA, and the inertial mass of moving parts can be equivalent to the negative stiffness. The electromagnetic damping force is generated by the motor, and it is depended on the transmission efficiency and transmission ratio. Due to the change in transmission path, the dynamic performances of EHSA in compression stroke and rebound stroke are different. The dynamic stiffness in compression stroke is larger than that in rebound stroke, and the dynamic damping coefficient in rebound stoke is larger than that in compression stroke.

## Introduction

Traveling on roads, vehicles are subjected to different disturbances such as road irregularities, braking force, acceleration forces, and centrifugal forces on a curved road. Those disturbances not only cause discomfort to the driver and passengers, but also reduce the energy efficiency of vehicles. The shock absorber is widely used in vehicles, for vibration absorption and system stability [1]. The vibration energy dissipated by shock absorber is nearly 400 watts in the typical passenger vehicles traveling at 60 miles $h^{-1}$ on good and average roads [2]. The energy efficiency can reach 2.5% by harvesting the vibration energy in shock absorber, which can not only improve fuel economy of petrol vehicles but also increase the range of electric vehicle [3]. Recently, energy harvesting shock absorbers, composed of transmission structure and electromagnetic generator, have been analysed and tested to verify the capabilities of energy harvesting. However, most of the research are focused on the electrical characteristic, such as output voltage, output power, and power conversion efficiency at different excitation parameters [4]. In this paper, the design principle and the dynamic modeling of the energy harvesting shock absorbers have been presented, the dynamic performance of energy harvesting shock absorbers has been analysed, and some conclusions has been given.

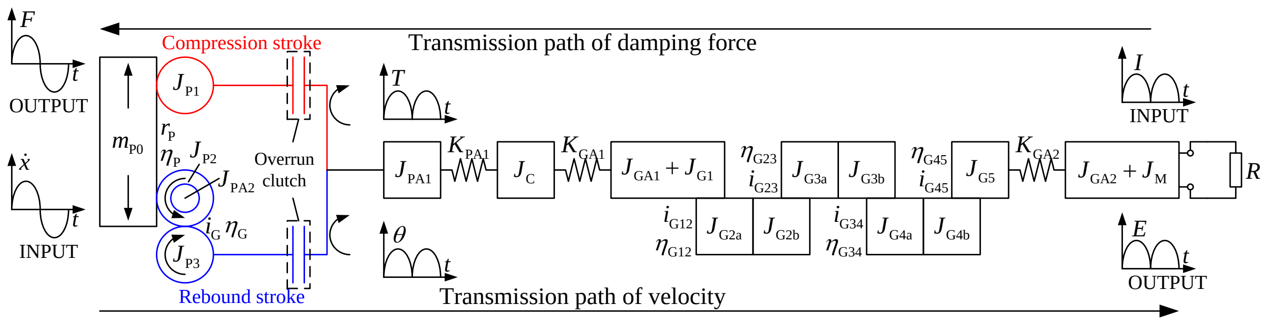


Figure 1: The Lumped modeling of EHSA

## Results and discussion

In this paper, the model of EHSA is established, and the dynamic performance of EHSA is presented and analysed. By using the overrun clutch and rack-and-pinion, the transmission paths in compression stroke and rebound stroke are difference. The total damping force of EHSA composed of the inertial force and electromagnetic damping force. And the dynamic damping coefficient and stiffness are calculated by using the electromagnetic damping force and inertial force. The results show that the electromagnetic damping force and dynamic damping coefficient are depended on the parameters of motor and transmission paths, and the inertial force and dynamic stiffness are depended on the frequency and efficient mass of moving parts of EHSA. Therefore, the electromagnetic damping force and dynamic damping coefficient in compression stroke are smaller than those in rebound stroke.

## References

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