

## Efficient Energy Extraction Circuit for Impact Harvesting from High Impedance Sources

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**Abstract :** Harvesting mechanical energy from footsteps or other impacts is a possibility to enable wireless autonomous sensor nodes. These can be used for a highly efficient control of connected devices such as lights, security systems, air conditioning systems or other smart home applications. They can also be used for accurate location or occupancy monitoring. Converting the mechanical energy into useful electrical energy can be achieved using the piezoelectric effect offering simple harvesting setups and low deflections. The challenge facing piezoelectric transducers is the achievable amount of energy per impact in the lower mJ range and the management of such low energies. Simple setups for energy extraction such as a full wave bridge connected directly to a capacitor are problematic due to the mismatch between high impedance sources and low impedance storage elements. Efficient energy circuits for piezoelectric harvesters are commonly designed for vibration harvesters and require periodic input energies with predictable frequencies. Due to the sporadic nature of impact harvesters, such circuits are not well suited. This paper presents a self-powered circuit that avoids the impedance mismatch during energy extraction by disconnecting the load until the source reaches its charge peak. The switch is implemented with passive components and works independent from the input frequency. Therefore, this circuit is suited for impact harvesting and sporadic inputs. For the same input energy, this circuit stores 150% of the energy in comparison to a directly connected capacitor to a bridge rectifier. The total efficiency, defined as the ratio of stored energy on a capacitor to available energy measured across a matched resistive load, is 63%. Although the resulting energy is already sufficient to power certain autonomous applications, further optimization of the circuit are still under investigation in order to improve the overall efficiency.

**Keywords :** autonomous sensors, circuit design, energy harvesting, energy management, impact harvester, piezoelectricity

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