Impedance Based Characterization of a High-Coupled Screen Printed PZT Thick Film Unimorph Energy Harvester - DTU Orbit (27/10/2019)

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The single degree of freedom mass-spring-damper system is the most common approach for deriving a full electromechanical model for the piezoelectric vibration energy harvester. In this paper, we revisit this standard electromechanical model by focusing on the impedance of the piezoelectric device. This approach leads to simple closed form expressions for peak power frequency, optimal load, and output power without a tedious mathematical derivative approach. The closed form expressions are validated against the exact numerical solution. The electromechanical model contains a set of only five lumped parameters which, by means of the piezoelectric impedance expression, all can be determined accurately by electrical measurements. It is shown how four of five lumped parameters can be determined from a single impedance measurement scan, considerably reducing the characterization effort. The remaining parameter is determined from shaker measurements, and a highly accurate agreement is found between model and measurements on a unimorph MEMS-based screen printed PZT harvester. With a high coupling term K-2 Q similar or equal to 7, the harvester exhibits two optimum load points. The peak power performance of the harvester was measured to 11.7 nW at an acceleration of 10 mg with a load of 9 kΩ at 496.3 Hz corresponding to 117 μW/g^2.

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