Live Demo of A Vibration-Powered Bluetooth Sensor with Running PFC Power Conditioning

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I. System Overview

The energy harvesting technologies are going to replace the chemical batteries by providing an ever-lasting power solution for future dispersive devices in the Internet of Things (IoT), in particular, wireless sensor networs (WSN) and wearable electronics. The power conditioning circuit plays an crucial role for enhancing the energy harvesting capability [1]. This live demonstration shows a vibration-powered Bluetooth wireless sensor node with an emphasis on its running power factor correction (PFC) power conditioning design. The concurrent full paper has been submitted to the regular ISCAS track [2]. The self-powered sensor node is composed of three modules: the piezoelectric transducer, the self-powered synchronized switch harvesting on inductor (SP-SSHI) circuit for the running PFC power conditioning, and the Bluetooth module. These modules are enclosed by a 3D-printed frame. The sensor node assembly and disassembly are shown in Fig. 1(a) and (b).

The piezoelectric transducer is used to transform the kinetic energy into electricity. In this demonstration, the transducer is made of five low-cost stacked piezoelectric buzzers. It suspends the weight of other modules in the sensor node. In the power conditioning circuit, the SP-SSHI carries out the running PFC by dealing with the fluctuating and intermittent vibration. A commercialized rectifier LTC3588-1 (Linear Technology Co.) is used to regulate the output voltage for the digital electronics. A Bluetooth module is used here for showing the feasibility that the harvested power are large enough to power the wireless communication. The vibration is produced by a resonant speaker, which is excited by the vibration record from a real bridge. The excitation signal is downloaded from the EH Network Data Repository [3]. Fig. 2 compares the power harvesting performances of ordinary bridge rectifier and SP-SSHI. Under an vibration, whose amplitude is about 0.5 mm, the average harvested power of SP-SSHI (289 μW) is much larger than that of the ordinary bridge rectifier (49 μW), so it is large enough to power the Bluetooth module (79 μW) for transmitting the temperature information every five seconds.

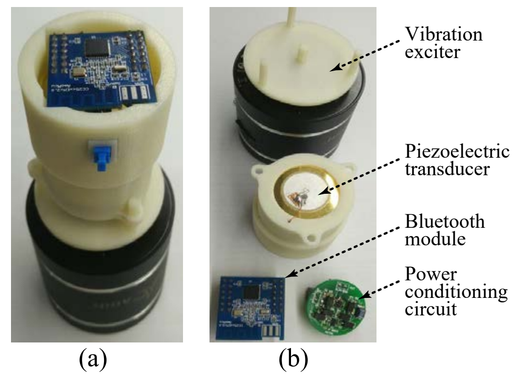

Fig. 1. Experimental setup of the vibration-powered Bluetooth sensor node. (a) The assembly. (b) The disassembly.

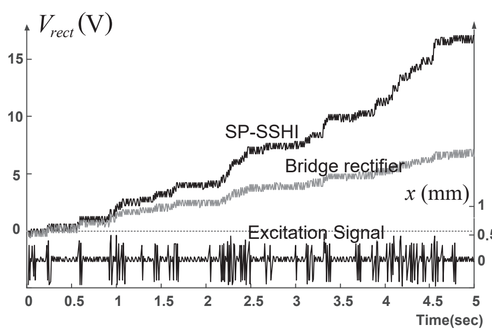

Fig. 2. Experimental comparison on the energy accumulation in the storage capacitor by using ordinary bridge rectification or SP-SSHI.

II. Visitor Experience

In this proposed demonstration, visitors will experienced the feasibility of batteryless operation of future WSN or IoT. They will also get to know the importance of power conditioning in the energy harvesting systems. As the fluctuating and intermittent vibration has brought in a new challenge to the conventional PFC, which mainly deals with periodic and regular source, the principle and implementation of the cutting-edge running-PFC solutions, as well as its live effect on harvesting capability enhancement will be illustrated to the visitors with an additional poster and live measurement.

References

[1] J. R. Liang and W. H. Liao, "Improved design and analysis of self-powered synchronized switch interface circuit for piezoelectric energy harvesting systems," *IEEE Trans. Ind. Electron.*, vol. 59, no. 4, pp. 1950-1960, 2012.

[2] K. Zhao, Y. H. Zhao and J. R. Liang, "A vibration-powered bluetooth wireless sensor node with running PFC power conditioning," submitted to ISCAS 2017 as a regular conference paper (paper ID: 2276).

[3] The Energy Harvesting Network Data Repository, URL: http://eh-network.org/data/index.php

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