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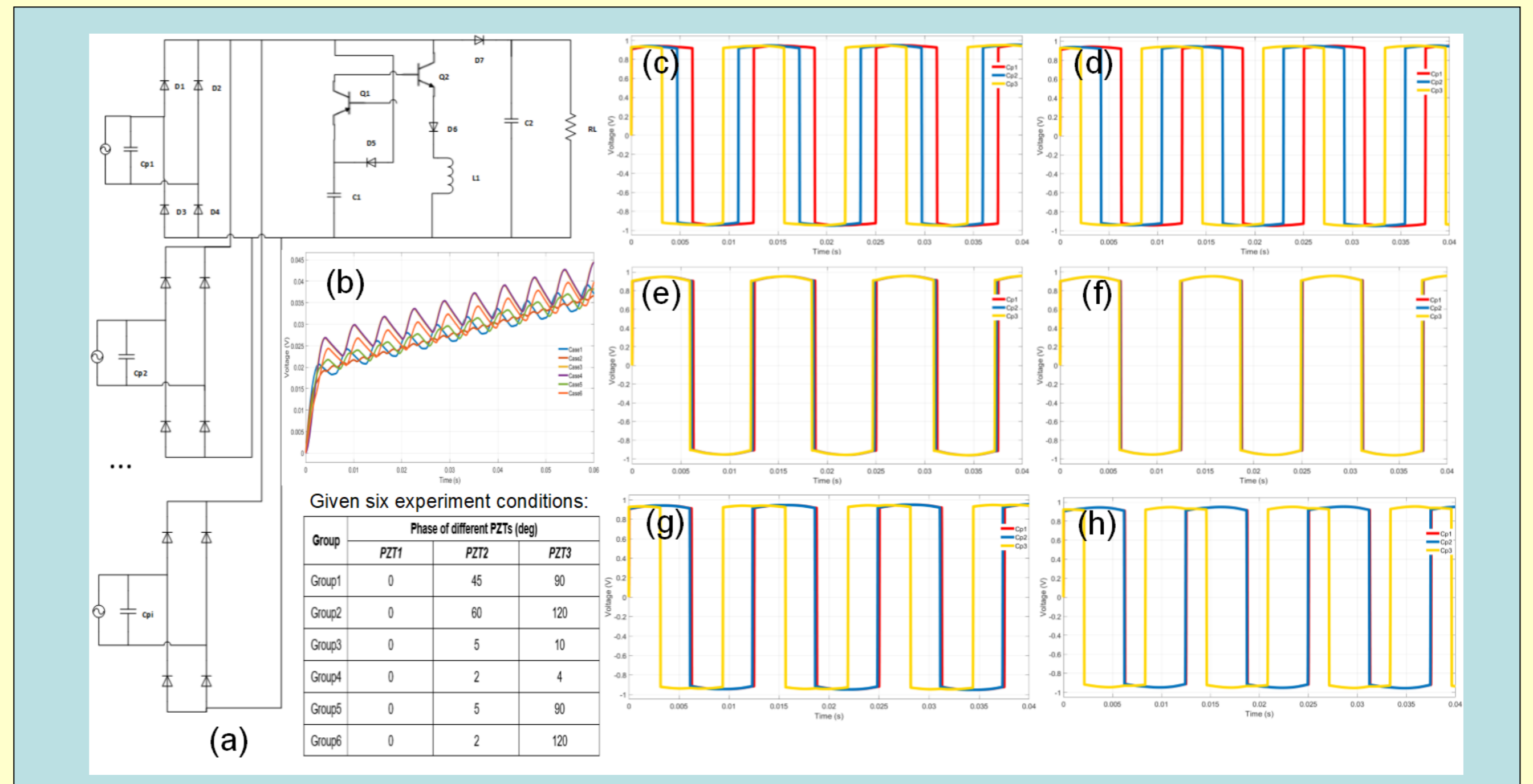
A Self-powered Multi-input P-SSHI Interface Circuit for Piezoelectric Energy Harvesting with Arbitrary Phase Difference

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Abstract

In this paper, a novel interface circuit based on P-SSHI which can be utilized for multi-input piezoelectric energy harvesting is presented. When it comes to the arbitrary phase difference between different piezoelectric transducers (PZT), traditional power conditioning circuit can hardly solve the phase mismatch of multiple sources. However, the proposed circuit can solve this problem with the improved circuit topology of the rectifier. Moreover, self-powered strategy which is designed for the proposed multi-input parallel synchronized switching harvesting on inductor (P-SSHI) circuit is applied as well. When the voltage reaches the peak, the switch is on and the parallel inductor branch access the circuit. Comparing with those based on serial synchronized switching harvesting on inductor (S-SSHI), the energy harvesting efficiency is improved. The proposed circuit shows a good compatibility in different cases of the input sources with arbitrary phase difference within $(0, 2\pi)$.

Circuit and result



(a): proposed circuit with multi-input; (b): output voltage of the six groups; (c)~(h): voltage of the equivalent piezoelectric capacitor V_p in group 1~6;

In group 1 and 2, When the input cells are PZTs with relatively large phase difference, the DC pulsation after rectification is larger than the single input PZTs. Meanwhile, the frequency of the pulsating DC is increased and the number of peaks increases as well.

In group 3 and 4, When the input cells are PZTs with relatively small phase difference, the waveform is similar to each voltage waveform of the PZTs after rectification and the number of peaks is not changed.

In group 5 and 6, When the input cells are PZTs contains both large phase difference and small difference. Despite the waveform changes to a large extent and multiple peak appears, the number of the effective peaks is still limited.

the proposed circuit topology can realize the multi-input. Especially, when the change of phase difference of different PZTs is average or the number of input cells is large, the output of the circuit shall be much more stable and show a good performance.

Summary

We proposed a novel self-powered piezoelectric energy harvesting circuit in view of multi-input condition based on P-SSHI. In this circuit topology, the number of shared inductor and the switch which applied with self-powered strategy is not increased with the increasing number of input cells. As a result, the topology is simplified. Furthermore, the problem of existing arbitrary phase difference in different input PZTs is solved effectively by the full bridge rectifier structure, thus, the possible power loss resulting from the phase difference is eliminated. Especially in the case of large number of input cells and average changes in the phase different of input PZTs, this circuit have a better performance.