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Fuzzy Logic Based MPPT Control for a Thermoelectric Generator System

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Abstract
Thermoelectric generators (TEGs) are used in small power applications to generate electrical energy from waste heats. Maximum power is obtained when the connected load to the ends of TEGs matches their internal resistance. However, impedance matching cannot always be ensured. Therefore, TEGs operate at lower efficiency. For this reason, maximum power point tracking (MPPT) algorithms are utilized. In this study, both TEGs and a boost converter with MPPT were modeled together. Detailed modeling, simulation, and verification of TEGs depending on the Seebeck coefficient, the hot/cold side temperatures, and the number of modules in MATLAB/Simulink were carried out. In addition, a boost converter having a Fuzzy Logic Controller (FLC) based MPPT algorithm was added to the TEG modeling. After the TEG output equations were determined, the TEG modeling was performed based on manufacturer data sheets. Thanks to the TEG model and the boost converter with FLC MPPT, the maximum power was tracked with a value of 99.68% and the power derived from the TEG was nearly unaffected by the load changes. The power outputs obtained from the system with FLC MPPT were then compared with others MPPT algorithm which are the Perturb & Observe (P&O) and the Sliding Mode Control (SMC) to emphasize the power transfer efficiency of the TEG. Ultimately, the proposed modeling provides a system of TEGs and a boost converter having FLC MPPT.

Keywords: Thermoelectric generator (TEG); Modeling; MPPT; MATLAB/Simulink.