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Efficiency and Reliability Analysis of SiC-Based and Si-Based DC-DC Buck Converters in Thin-Film PV Systems

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Abstract : This research paper compares the efficiency and reliability (R(t)) of SiC-based and Si-based DC-DC buck converters in thin layer PV systems with an AI-based MPPT controller. Using Simplorer/Simulink simulations, the study assesses their performance under varying conditions. Results show that the SiC-based converter outperforms the Si-based one in efficiency and cost-effectiveness, especially in high temperature and low irradiance conditions. It also exhibits superior reliability, particularly at high temperature and voltage. Reliability calculation (R(t)) is analyzed to assess system performance over time. The SiC-based converter demonstrates better reliability, considering factors like component failure rates and system lifetime. The research focuses on the buck converter's role in charging a Lithium battery within the PV system. By combining the SiC-based converter and AI-based MPPT controller, higher charging efficiency, improved reliability, and cost-effectiveness are achieved. The SiC-based converter proves superior under challenging conditions, emphasizing its potential for optimizing PV system charging. These findings contribute insights into the efficiency, reliability, and reliability calculation of SiC-based and Si-based converters in PV systems. SiC technology's advantages, coupled with advanced control strategies, promote efficient and sustainable energy storage using Lithium batteries. The research supports PV system design and optimization for reliable renewable energy utilization.

Keywords : efficiency, reliability, artificial intelligence, sic device, thin layer, buck converter
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