Performance Evaluation of a Multi-input Interleaved Boost Converter with a Tuned Proportional-integral Controller

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Abstract: The need for renewable energy access has led to the use of variable input converter approaches because renewable energy sources often generate electricity in an unpredictable manner. A high-performance multi-input boost converter is developed to provide the necessary output voltage and power while accommodating variations in input sources. This converter is specifically designed for the efficient usage of renewable energy. The proposed architecture integrates three separate unidirectional input power sources: photovoltaics, fuel cells, and storage system batteries. The architecture has five switches, and the implementation of each switch in the converter is achieved by applying the calculated duty ratios in various operating states. The closed-loop response of the converter with a proportional-integral (PI) controller-based switching system is examined by analyzing the Matlab-Simulink model utilizing a proportional-integral derivative (PID) tuner. The controller can deliver the desired output voltage of 400 V and an average power of 2 kW while exhibiting low switching transient effects. Therefore, the proposed multi-input interleaved boost converter demonstrates robust results for real-time applications by effectively harnessing renewable power sources.

Keywords: Multi-input converter, interleaved boost converter, pulse-width modulation, proportional-integral controller

1 Introduction

Renewable sources are most useful in the trailing trend of rising power demand. However, simply adding the sources is not a fundamental method for meeting this demand. Therefore, a controlled method for combining sources is required to maximize the benefits of renewable sources. A multi-input converter is necessary to enhance the utilization efficiency of renewable sources, as discussed by Navamani et al. [1]. The proposed converter is based on two interleaved and three input-boost converters that use five switches.

Different switching topologies were discussed, and a closed-loop controller was used in the topology to validate its performance. In comparison to a conventional boost converter, Dhople et al. [2], Prazenica et al. [3], and Lee et al. [4], have demonstrated the inherent advantages of an interleaved boost converter, such as reduced input current ripple, improved energy accuracy, improved transient performance, reduced electromagnetic emissions, and enhanced reliability. Furthermore, more than one energy source can be connected to electrically coupled multi-input converters in parallel or in series. This multi-input topology offers several advantages, including efficiency, compact size, reliability, and effective power management, as discussed by Tao [5], Kumar et al. [6], Majeed et al. [7], and Singirikonda et al. [8]. Owing to these benefits, multi-input converters are widely used in renewable energy systems. The multi-input converter compensates for electrical mismatches in the sources connected to the input

Manuscript received December 20, 2023; revised January 17, 2024; accepted February 19, 2024. Date of publication December 31, 2024; date of current version November 10, 2024.

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Digital Object Identifier: 10.23919/CJEE.2024.000094