Analysis of Integrated Magnetics for Input Series Output Series DC-DC Converter

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Abstract

Multi module isolated converters (MMICs) find extensive application in various DC-DC applications due to their remarkable features of galvanic isolation, bi-directional power flow, high power density and enhanced efficiency. However, voltage and current sharing among the converter modules are the most significant issues in MMICs. This paper proposes Multi-port Integrated-Magnetics Transformers (MpIMTs) which address the input-output DC-link voltage imbalances within an ISOS converter. The proposed transformers ensure the input voltage sharing (IVS) and output voltage sharing (OVS) through balancing windings within their structures, thus substitutes the complicated active control scheme with the balancing winding. Besides, the input side and output side modules are decoupled from each other, thus the impact of parameters variation and inter-module energy transfer during a transient of one side does not reflect to the other side. These properties are achieved by proposing a custom-designed core and an off the shelf available U core assembled MpIMTs. The magnetic and electrical equivalent along with the design criteria of the balancing winding are also presented. Furthermore, the paper includes the comparative analysis of the proposed transformers which reveals that while the U-core MpIMT offers simplified construction, it comes at the expense of slightly reduced efficiency compared to the custom-designed MpIMT. Finally, the proposed U core MpIMT is validated through a laboratory prototype.

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