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Modelling Integrated Passive Structures For Power Converters

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A dissertation submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree Master of Science in Engineering.

Declaration

I declare that this dissertation is my own unaided work. It is being submitted for the degree of Master of Science in Engineering at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree nor examination at any other university.

Signed on _____ day of _____ 2013

_____

Adrian Floor

Abstract

Integrated architectures for power electronic circuits have been a subject of recent interest. Integration offers several benefits such as reliability, control on parasitic elements related to discrete components, and ease of manufacture. The main objective of this particular research has been to contribute towards effective modelling of integrated passive circuits operating in power electronic circuits.

Integrating passive components in one distributed space can be difficult to understand, and hence to design. Field electromagnetics is often unwieldy for a power electronics circuit designer, so a SPICE-like circuit simulator is often an effective design environment. This dissertation closely examines both lumped and distributed SPICE-compatible models.

Four SPICE-compatible models have been investigated by comparing them with an analytical distributed solution. This analytical solution is used to thoroughly derive the causes of all resonance points, as well as impedances at low/high frequencies; which are the important factors that characterize the integrated passive. This analytical solution is only implemented in a narrow range of boundary conditions; hence the SPICE-compatible methods must be developed, since SPICE then handles the algorithmic work of handling the more complicated boundary conditions found in power electronics.

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