Input Impedance Analysis for Cascaded GaN DC-DC Converter with Dead Time

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Abstract. This paper presents a modified small-signal model of GaN DC-DC converter with dead time, which improves the accuracy of converter input impedance for Cascaded system. The reverse voltage drop and reverse conducting resistance for e-GaN HEMTs are studied in the presented small-signal model. A schematic of presented model is derived based on the state-space averaging method for GaN DC-DC Converter with dead time, which provides the modified input impedance model. The dynamic input current of synchronous Buck converter shows a 8.85% increasement in the accuracy of modified input impedance model under a step variation of source voltage. A 120-W prototype is built to verify the feasibility of the proposed high-frequency.

Keywords: e-GaN HEMT converter · dead time · small-signal modeling · input impedance

1 Introduction

The scale of data center applications is constantly increasing, and the energy consumption of data centers has become an important energy consumption issue. To improve power density and efficiency to reduce energy loss, synchronous Buck converters using e-GAN HEMT power devices have become an important topology and solution for data center power supplies due to their higher performance compared to their silicon counterparts [1]. They are commonly used in load points and voltage regulator modules (VRMs) [2, 3].

Traditional data centers use AC bus architecture, where AC power from the utility grid is connected to the input of the Uninterrupted Power System (UPS) [4]. Typically, these subsystems are well designed to meet the performance specifications and stable operation individually. However, instability and oscillation may occur when cascading the converters, and the entire system may collapse in severe cases [5]. The optimized control parameters are able to avoid system oscillation, while the accurate model for cascaded system is prerequisite.

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