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Original article

Design and optimization of buck and double buck converters by means of geometric programming

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Abstract

This paper describes a new method for determining the optimal components values and switching frequencies of buck DC–DC converters. First, we revisit some concepts of the optimization technique named geometric programming. Then, we observe that the problem of converter designing can be modeled by means of an objective function and certain constraints which can be written in a specific form known as the posynomial form. The constraints involve expressions that depend on magnitudes such as efficiency, bandwidth, and current and voltage ripples.

Specifically, we apply the design method in a synchronous buck converter and a synchronous cascade buck converter. This technique can efficiently determine the optimal sizing of the converter or the infeasibility of the set of design constraints in a quickly manner and, therefore, it can eases the cumbersome task of manually designing buck DC–DC converters.

As an additional result, we conclude that optimal design of the synchronous cascade buck converter performs more efficiently than the optimal design of the synchronous buck converter, given certain realistic set of specifications for wide-range voltage conversion.

Keywords: Synchronous buck converter; Synchronous cascade buckconverter; Geometric programming; Optimization; Switchingconverter design

1. Introduction

Many designers have noted that properly designing DC–DC converters is a time-consuming and costly process. Consequently, there is considerable interest in applying optimization methods to ease the burden of such a task. This paper introduces a new method to determine the optimal parameter values in a DC–DC converter design. The method, which is based on geometric programming (GP), allows designers to deal with a wide range of specifications and constraints, and is extremely fast. Moreover, the method either results in a globally optimal solution or conclusively determines infeasibility.

In recent years, the performance of buck DC–DC converters has improved. Some of the advances are related to energy-storing elements, which are now smaller and have fewer losses. Switches have also improved in that they are now faster, and have a smaller on-state resistance and a better blocking voltage. However, converter design parameters still have to be optimized to comply with dimension constraints and improve their efficiency.

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