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High-performance Cuk converter with turn-on switching at zero voltage and zero current

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ABSTRACT

The soft-switching technique has the potential to significantly enhance the performance of the power converter. This is primarily because it allows for an increase in the switching frequency, which ultimately leads to improved modulation quality. This raises extra concerns, particularly in high-power applications, because in a standard hard-switching converter structure, components can often not function at frequencies higher than a few hundred hertz. This paper presents a high-efficiency soft switching CUK converter. When the main and auxiliary switches are turned on and off at zero voltage, the proposed converter yields zero voltage and zero current. The suggested method is ideal for a DC-DC converter based on IGBTs or MOSFETs. The recommended systems are described using theoretical analysis, the results of computer simulations, and experimental data derived from a prototype. The design parameters of the inductance and capacitor circuit for edge-resonant soft switching were obtained using the output power and the switching duty ratio. In the end, soft-switching is better than hard-switching in terms of efficiency, particularly when operating under full load.

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1. INTRODUCTION

Power supply for personal computers, office equipment, spacecraft power systems, laptop computers, telecommunications equipment, as well as DC motor drives, all make use of DC-DC power converters. A soft-switched pulse-width modulation (PWM) converter, high-power applications-appropriate, has been presented [1]. High power density and high efficiency can be obtained from them, because the commutation takes place under zero-voltage or zero-current.

To lessen switching losses and electromagnetic (EM1) sounds, Cuk converters have been frequently employed as LED drivers [2]–[4]. In other words, a Cuk converter has substantially greater power handling requirements for its semiconductor components than a similar output power may be achieved using either a buck converter or a boost converter. A Cuk converter places a lot of emphasis on lowering the switching losses and increasing the EM1 sounds [5]. Designing a soft switching converter is extremely difficult because of the strict limitations on the permitted current/voltage stress and conduction losses. The fact that the converter is being fed with DC as an input just serves to increase the challenge of finding a solution. It is well known that, for soft switching, a non-zero product of the switch's voltage and current must accompany the switching transition, and that, to prevent the voltage and current from canceling each other out in a DC-DC converter, a sub-circuit containing active and passive switches and resonant devices must be specially