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Development of a coupled inductor SEPIC using a planar integrated structure for LED lighting applications.

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Abstract

The growing interest and use of LED lighting sources has resulted in a lot of effort being focused on developing LED driving circuits. In this dissertation the coupled inductor SEPIC is considered. The significance of the circuit in this work is that it is constructed from a new technology. The novelty in the construction is that all the passive components in the circuit are integrated in a planar structure. It is envisaged that the technology will eventually lead to cost reductions, improved reliability and an easier manufacturing process for the converter. In order to formulate some of the design specifications for the converter, namely the relative inductor sizes and coupling coefficient an analysis of the ripple in the converter for various coupling configurations is done. The analysis is facilitated by derived equations which describe the operation of the circuit in the time domain for steady state conditions. In order to be able to integrate the converter it is necessary to understand the operation and building elements of the planar structure. So a two conductor integrated passive is reviewed. A two conductor integrated passive essentially consists of two conductors which sandwich a dielectric, and all of which are enclosed by a magnetic core. The review entails a study of the various terminal uses of the structure and resulting equivalent circuits that can be obtained. The equivalent circuits are regarded as building blocks to constructing more complex circuits and examples of this are shown. The example circuits that are integrated include a custom network, a boost converter, and a flyback converter. Finally the complete design approach for developing a coupled inductor SEPIC using a planar structure is presented. From the design two different integrated assemblies are proposed. To validate the design, a 5W prototype for each assembly was built and tested. The prototypes' impedances were compared to the impedances of ideal conventional circuits in which agreement was observed into the high frequencies. Voltage waveforms during voltage conversion operation were also compared to that of built conventional circuits and general agreement was observed in all the waveforms. The efficiency was also measured where an average efficiency of 85.6% for the one prototype and 86.3% for the other prototype was observed for a 5W load.