Abstract

The main purpose of the dissertation was to investigate possibilities of reducing power losses in the process of converting electrical energy in isolated DC/DC boost converters powered with low voltage energy source. To do that topological analysis of isolated DC/DC boost converters was performed in order to compare their physical parameters with the parameters of the proposed converters. The results of the comparative analysis are included in the dissertation and the hypotheses formulated in the research were verified in the six analytical chapters of the monograph.

The first chapter presents the architecture of isolated DC/DC boost converters and describes their basic topologies. Next, in order to choose optimal hypothetical technical parameters of the converters, topologies with best characteristics have been considered.

The second chapter, in turn, focuses on the operating principle of a two-inductor half bridge DC/DC converter (an L-type half-bridge). Laboratory tests of the converter model are presented in order to compare them with the results described in further chapters.

Chapter three deals with the test results of a half-bridge isolated DC/DC boost converter. The half-bridge structure combines some features of high efficiency and a small number of semiconductor components. This topology is a modification of the converter described in the second chapter. Here, the two input inductors have been replaced with a single, integrated inductor magnetically coupled with a balancing transformer. Original design algorithms of magnetic components and a method of selecting an optimal number of winding layers are described. The use of both planar magnetics (PM) and integrated magnetics (IM) technologies ensure higher efficiency of the converter when compared with similar solutions within this power range. The maximum reported efficiency for half-bridge converter is 96.3%. The chapter also contains the budget of power losses in both the passive and semiconductor components. The estimated and measured losses have shown slight differences.

The quasi-parallel converter described in chapter four is, in fact, a two half-bridge converters connected in parallel on the primary, and in series, on the secondary side of the isolation transformers. Parallel connection of the converters has made it possible to increase the gain in the system along with an increase of the number of sections. The efficiency in these circuits is not significantly smaller than in single circuits. The difference is about 0.5% for peak efficiency values and it is maintained in the predominantly power range of the half-bridge system. The maximum reported efficiency for quasi-parallel converter is 95.2%.

Chapter five is concerned with comparison of the three isolated boost DC/DC converters described in the dissertation. The original converters showed about 4% higher efficiency than the classic type L-type converter.

The research results are presented in chapter six. They demonstrate that the main purpose of the dissertation has been achieved.