Abstract of the doctorate thesis by Kalina Detka

**Modelling inductors for electrothermal analyses of dc – dc converters.**

The subject of the paper are inductors dedicated to dc – dc converters. In literature there are relatively few positions devoted to modelling passive components, such as inductors used in dc - dc converters, taking into account thermal phenomena. These elements have non-linear dependents L(i), and their characteristics strongly depend on temperature. The aim of this paper was to develop and verify experimentally the electrothermal model of an inductor dedicated for SPICE, useful for the analysis of dc-dc converters.

The following thesis was posed: “It is possible to formulate a compact electrothermal model of an inductor containing cores made of different ferromagnetic materials that is implementable in SPICE and witch takes into account, beside the influence of thermal effects on properties of the element, the non-linear characteristics of this inductor and improves the accuracy of calculating the characteristics of dc-dc converters, compared to classical models”.

The paper describes the magnetic properties of the materials used to build the core of the inductor and compares properties of the cores made of different magnetic materials on the basis of their data sheets.

The methods and measurement systems to measure the characteristics and parameters of the inductor are described and the results of measurements are presented. First of all, the author’s method to measure thermal parameters of the inductor is discussed.

In addition, in the paper literature models of the ferromagnetic core and inductors are analysed. Based on the current state of literature, the principles for formulating electrothermal models of electronic components are described and the examples of their implementation for SPICE are shown. An important component of the work are the author’s electrothermal models of the ferromagnetic core and inductors dedicated to the program SPICE and the author’s algorithm of parameters estimation such as: electric, magnetic and thermal parameters. Experimental verification of the electrothermal model of the inductor based on measurements of the characteristics L(i) and Z(f) is carried out. Then the results of simulation and measurement of boost and buck converters comprising inductors with the cores made of different materials are compared.

An important outcome of the implementation of the work are the results of calculations and measurements. The results show that depending on the choice of the core material different courses of the characteristics L(i) are obtained as well as the characteristics of temperature changes. From the point of view of usefulness of various magnetic materials used in dc-dc converters is their low core losses and constant L(i) characteristics are important.

The new methods for measuring parameters of the inductor is an important part of research work, in particular methods of measuring, the inductors own and mutual thermal parameters, which are subject to national and European patent application.

The results of calculations and measurements of characteristics of inductors containing the cores made of different materials shown that the proposed electrothermal model of the inductor correctly describes the characteristics of the examined elements, and the course of these characteristics significantly depends on the material of the ferromagnetic core and their geometric size. The accuracy of the description of the characteristics of the measured converters used in the new model is much higher than the one used in the classical linear model of the inductor.