Modern power electronics devices typically include DC-DC converters, which designing requires reliable methods of computer simulations. Work on methods of modelling and simulation models of components of DC-DC converters have been conducted since the appearance of the programs in the seventies dedicated to computer simulations of electronic circuits such as for example SPICE. Also since the publication of the first articles about simulation of DC-DC converters, work on the method, which allows fast computing of their DC and frequency characteristics and time waveforms can be observed. Due to the fact that DC-DC converters require to their correct operation a trapezoidal signal, which is time-dependent, it is impossible to compute correctly DC and AC analysis of these circuits. The points required to compute these characteristics can be obtained only using a transient analysis, but every single analysis carried out allows reaching only one point for DC or frequency characteristic. Therefore, that way of computing characteristics of DC-DC converters is time-consuming – time of computations of one point can be equal even to a few days. The solution to this problem is the use for the analysis an averaged model of the diode-transistor switch which is included in the DC-DC converter. Such models can be used for DC, frequency and a transient analysis. This way of modeling is based on the conception that the DC-DC converter can be analysed separately in two states of operation: when transistor is turned-on and simultaneously diode is turned-off (1^{st} state) and when the transistor is turned-off and simultaneously the diode is turned-on (2^{nd} state). Both these states are described using separate sub-circuits that depend on each other. Voltage and currents in these sub-circuits are average values of these quantities occurring in the actual converter.

The scientific goal of the project is elaboration of an electrothermal model of a diode-transistor switch which include IGBT (Insulated Gate Bipolar Transistor), which allows performing fast and reliable computer simulation of DC-DC converters with these transistors. The elaborated model will be reliable in all three modes of operation: continuous (CCM), discontinuous (DCM) and boundary mode (BCM). A key problem that the applicant is going to solve is elaboration of an electrothermal averaged model, which ensures satisfactory accuracy of computations of characteristics of the DC-DC converter in the steady state.

As part of the project, an average model of a diode-transistor switch with an IGBT will be formulated and a method for determining the value of its parameters will be developed. The model will be verified experimentally in a boost DC-DC converter. The last stage of works will be an analysis of the influence of selected external factors, such as e.g. ambient temperature, attached load or input voltage value on the accuracy and duration of calculations using this model.

The result of the project will be the averaged electrothermal model of the diode-transistor switch with the IGBT transistor for SPICE program, valid in a wide range of DC-DC converter voltages and currents with this switch along with the algorithm for determining values of its parameters. The model elaborated under this project will allow optimization of the DC-DC converters design process, especially in the area of power loss management in semiconductor devices contained in such a converter. The calculations made using this model will allow you to design the optimal cooling system of the transistor and the diodes contained in the considered converter at the design stage.