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Abstract of PhD thesis:

"MODELING COMPONENTS OF PHOTOVOLTAIC SYSTEMS"

The theme of the work is modeling the components of photovoltaic systems in the SPICE program. Photovoltaic systems are increasingly and more commonly used in power systems. The basic components of the considered systems are photovoltaics cells. In addition, photovoltaic systems include accumulators and impulse electrical energy conversion systems. The constant improvment of photovoltaic cells constructions, batteries, DC-DC converters and inverters cause that the task of modeling properties of the components of photovoltaic systems is still equally important and valid.

In the literature you can find a lot of works on modeling photovoltaic cells or other components of the PV system. However, these models describe the considered elements in a very simplified way, i.e. by omitting thermal properties and dynamics of photovoltaic cells, batteries and power electronic converters (dc-dc converters or inverters). In turn, the methods of analyzing dc-dc converters known from the literature are limited to switching frequencies not exceeding 200 kHz and mainly concern the operation of these systems in the steady state.

The aim of the work was to develop electrothermal models of the components of photovoltaic installations, and in particular photovoltaic cells and panels and to verify these models in the real photovoltaic systems.

The following thesis was formulated: "Thermal phenomena significantly affect properties of the components of a photovoltaic power system, and this impact can be effectively modeled using concentrated electrothermal models of the components of the considered system operating in various weather conditions."

The paper proposes an electrothermal model of silicon photovoltaic cells and panels, an electrothermal model of power electronic converters and a model of a chain of photovoltaic panels in the form dedicated to the SPICE program. The method of estimating electrical, optical and thermal parameters of the developed models was presented. It was demonstrated that both the ambient temperature and the self-heating phenomenon, the changes in the radiation power density as well as the changes in the angle of incidence of the light illuminating the solar cells significantly affect the characteristics of individual components of the photovoltaic power supply system.

It was proved that it is possible to take into account thermal phenomena and insolation when modeling the components of a PV system and analyzing electrical and thermal parameters of these elements with the use of concentrated electrothermal models of the considered systems elements, which are dedicated to the SPICE program. The incorporation of changes in the power density of solar radiation and the temperature of the interior of the photovoltaic system components made it possible to determine the efficiency of both: the laboratory photovoltaic installation and the real photovoltaic installation. The experimentally veriied results of the simulation of the characteristics of alike individual system components and both the tested PV installations are also essential. The analysis of the conducted investigations enabled the assessment of the impact of daily and seasonal changes in temperature and insolation on the properties of the considered photovoltaic installations.

The obtained results of computer analyses and measurements prove the correctness of the thesis put forward in the paper. The formulated electrothermal models of photovoltaic system components can be useful for designers of photovoltaic power systems.