Abstract

The dissertation includes eight chapters divided into the introduction, literature review of selected power theories, purpose, scope and thesis, two chapters describing the decomposition of currents of the load supplied with asymmetric sinusoidal and non-sinusoidal voltage source and expressions describing balancing compensators with star and delta structures and minimizing balancing compensator for non-sinusoidal asymmetrical supplying voltage. The sixth to eighth chapters present theoretical and simulation calculations as well as, in the eighth chapter, laboratory measurements of the real system.

The second chapter includes an overview of selected power theories from the first, which is the Budeanu's power theory - the domain of frequency - and the first theory of power in the time domain – the Fryze's power theory. In the further part of the chapter, the theories most often used for practical purposes (control of active power filter) or theories through which it is possible to improve the power conditions are described. At the very end, the Currents' Physical Components Theory is presented in more detail.

The third chapter presents the aim of this doctoral thesis, which is the correct mathematical description of three-phase four-wire systems supplied with an asymmetrical voltage source and the capability of improving, by balancing compensation, power conditions. In the further part of the chapter, the scope of the entire work and thesis of the work are given.

The fourth chapter includes a mathematical description of the currents' components of the linear time-invariant (LTI) unbalanced load powered with asymmetrical sinusoidal voltage in a three-phase four-wire system without and including the impedance of the neutral conductor. In subsection 4.2, mathematical relations are presented that allow to calculate the ideal reactive balancing compensator parameters in the star configuration and to extend the description of the ideal balancing compensator with delta structure that must be connected to the star structure compensator for full, ideal balancing compensation.

The fifth chapter also includes a mathematical description of the currents' components of the LTI unbalanced load and the possibility of balancing compensation by balancing compensators in both configurations for the fundamental harmonics and higher order harmonics. In addition, in this chapter, expressions describing the minimizing balancing compensation are added, which allows the number of passive elements in one branch to be limited to a maximum of two, at the expense of the balancing compensation accuracy.

The sixth chapter presents theoretical calculations and simulation calculations verifying the proposed mathematical description in Chapter 4. Theoretical calculations are made in Matlab, Mathcad and Microsoft Excel programs. Each of the programs allowed to accomplish results differing only in the value of numerical errors. Simulation models are built in the Matlab/Simulink program on the basis of the values of the original load, admittances and substitute sources determined on the basis of the expressions from Chapter 4 and with the balancing compensators included.

The seventh chapter includes identical theoretical and simulation calculations as in Chapter 6 but extended to systems with a source of non-sinusoidal asymmetrical voltage. The end of the

chapter is devoted to theoretical and simulation calculations of minimizing balancing compensation.

In the last chapter of the dissertation (Chapter 8), theoretical calculations of the real LTI unbalanced load, supplied with an asymmetrical sinusoidal voltage source, constructed resistors in the form of resistance heaters and a three-phase compensating reactor are presented. After the theoretical calculation of the balancing compensators in both configurations, the Matlab/Simulink model was built and simulations with ideal balancing compensators were performed. The last part of the chapter presents measured values with balancing compensators included, which are compared with theoretical and simulation values.

At the end of the work, the conclusions from previous chapters are presented.