The application of the Proportional-Resonant controller in power electronic grid converters

The subject of the paper is the application of the Proportional-Resonant controller in power electronic grid converters. The problem considered is concerned specifically with how to implement such a controller in a digital structure, and the operation of this controller in the control system of the converter, which couples the energy source to the power grid.

In this paper, the analysis of P+R structures with infinite and limited gain was carried out. Thus, a structure was obtained that consists of basic functional blocks. To verify the performance of this structure, simulation tests were carried out in dedicated software. At this stage, a continuous description of the controller was used. The results obtained confirmed the usefulness of the regulator in the assumed application.

The next step described in the paper was the discretization of the developed P+R structure. The digital P+R controller, was characterized by the same properties as the one described in the continuous signal domain. Using digital models of power system components, the digital controller and control system, real-time tests were performed. The results of these tests once again confirmed the usefulness of the controller in such converters, as well as the correctness of the control system. The tests were carried out for a single-phase and a three-phase converter.

The final element of the dissertation is experimental tests. They were carried out for a single-phase and three-phase system. Different operating states of the power grid were taken into account. The system worked properly under all assumed conditions. Solutions were proposed to improve its operation under conditions of voltage fluctuations in terms of the stability of the power returned to the grid. Using a virtual phase loop, such a control algorithm for a single-phase system was developed that allowed the generation of a reactive component in addition to the active one. Experimental tests also included tests in a grid with an increased frequency of 400 Hz. The control system was not changed, only adjustments were made to the parameters of the structure. Also in such a network, the controller worked properly.