

## Abstract

Phase-shifting transformers (PSTs) have been widely used for many years. These devices influence on the power flows in the power systems by voltage phase angle regulation. Phase angle regulation is realized by introducing into the line additional voltage by series windings of the transformer. In this thesis asymmetrical PST with possibility of longitudinal voltage adjustment is investigated. Longitudinal voltage regulation allows to achieve higher flexibility comparing to classical PST solutions. In spite of the fact, that proposed PST construction is asymmetrical, there are possible to obtain different ways to control its work, even as symmetrical. Additionally, apart from power flow control, proposed PST can influence on the voltage regulation.

The doctoral thesis describes possible ways of PST control strategies and shows effects of the laboratory research. The PST was tested in the laboratorial power system prepared as the model of the real power system. Testing PST unit was designed as two transformer solution: longitudinal regulation was realized in first transformer, and the additional voltage introduced into the transmission line was realized in second, series one. Then, the Simulink model was built to compare laboratory tests with simulations and numerical calculations. Using Newton-Raphson power flow calculation method, in the IEEE 5-bus system were conducted calculations to compare influence of classical asymmetric PST with proposed unit working in two modes: quasi-symmetric and with lowered longitudinal voltage. The results show, that PST with longitudinal voltage regulation can be effective tool to control power flows, and additionally allow to control nodal voltage. During tests the same power flows for asymmetric and proposed PST were obtained, and the nodal voltage in proposed solution was lower about 9 kV. In this way the main disadvantage of asymmetric PST resulting in the output voltage growth is removed. All tests and simulations were conducted for steady-states.

The theory of PST with longitudinal voltage regulations shows, that this unit can operate in power systems with similar functions to unified power flow controller (UPFC) while being simple and cheaper solution.