

# Abstract

With limited enhancement or expansion of the transmission infrastructure, the contemporary power systems are operating under more stressed conditions. It becomes important to fully utilize the existing transmission system to supply load demand as much as possible, thus eliminating or reducing the need for new transmission investment.

Flexible AC Transmission System (FACTS) technology provides an alternative to fully utilize the existing transmission lines as well as new and upgraded lines, by controlling power and also enhancing the power transfer capability of transmission lines. However, the implementation of FACTS controllers in the transmission system has introduced new power system dynamics that must be addressed in the area of power system protection, such as rapid changes in line impedance, power angle, line currents, transients introduced by the occurrence of fault and associated control action of the FACTS controller. Therefore, the performance of the protection system must be carefully analyzed in the presence of FACTS controllers.

The thesis aims at evaluating the performance of distance relays when different types of FACTS controllers, in particular Voltage Source Converter (VSC) based FACTS controllers, are incorporated at the midpoint of the transmission system to achieve voltage profile improvement and power transfer capability. The detailed models of these controllers and their control strategies are described. The presence of FACTS controllers in the loop affects both steady state and transient components of voltage and current signals. The rapid response of FACTS controllers to different power system configurations significantly affects the apparent impedance seen by distance relays. The apparent impedance seen by distance relays would be different from that of the system without FACTS controller. Due to this, the distance relay may malfunction, resulting in unreliable operation of the power system during faults. Furthermore, the effect of FACTS controllers on distance relay operation depends on the type of FACTS controller used, the application for which it has been installed and its location in the power system. The distance relay is evaluated for different loading conditions and for various fault conditions. Simulation studies are carried out using PSCAD/EMTDC based transient simulation package.