Abstract

Transmission lines are often subjected to faults due to storms, lightning, snow, freezing rain, insulation breakdown etc. Accurate fault location is required to expedite maintenance and quick restoration of the line and saves financial loss for the utilities. An accuracy of the classical TW based FL methods depends on data synchronization, IED processing delays, and secondary cable delays etc. Proposed three FL methods (i) a method using single-ended data (ii) a method using unsynchronized data, and (ii) a model-free method for series compensated line using synchronized data using TW technology. The proposed methods tested using PSCAD/EMTDC simulations and results are compared with commercially available methods and found to be accurate. These methods will give a freedom to customers to choose a particular method based on the availability of communication infrastructure.

The dependability and security of the protection are compromised due to the integration of the series capacitors and CIRPPs into power grid. The presence of series capacitors in the fault loop affects transient components of voltage and current signals. As a result, widely used impedance-based protection (distance protection) finds limitation for lines with series capacitors. A hybrid time-domain protection scheme for series compensated lines using incremental quantity combined with traveling wave principle is proposed, aimed to improve the reliability and speed of protection.

Available distance protection methods have limitations in special situations such as acceleration of the Zone 2 decision, fault classification for lines connected with converter interfaced renewable power plants and auto-reclosing for mixed lines. Proposed an accelerated Zone 2 protection scheme using single-ended data and it is used for back up acceleration scheme in case of communication channel failure. The phase selection is key module in the distance protection and integration of the inverter-interfaced generation to the grid poses challenge in phase selection. A method for phase selection is developed using TWs information. The auto-reclosing becomes more challenging in the case of mixed lines (combined overhead lines with underground cables) where the auto-reclosing shall be enabled for a fault in the OHL section or block for a fault in the UGC section. Selective auto-reclosing scheme is proposed using traveling waves for mixed lines.

These methods are tested using PSCAD/EMTDC simulations for various test situations. Numerous test results are presented to highlight the superior performance of the techniques over available methods. These methods can be implemented in available IEDs with a sampling frequency of 1MHz.

Keywords: *Transmission line, fault location, faulted section identification, series compensated lines, transmission line protection, fault classification, mixed lines, auto-reclosing, traveling waves, incremental quantity, and time-domain protection.*