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SUMMARY

"Impedance-differential protection for overhead lines"

This doctoral dissertation deals with a presently important issue of detection and location of transmission lines faults. In the first chapters, the topic of overhead line disturbances is presented, taking into account both the causes and the effects of short circuits. Initially, the classical current differential protection used to protect transmission lines is briefly described. Then, the effect of current transformers saturation on the operation of differential protection is analysed. The sensitivity of the classical differential protection to transformation errors has been demonstrated. This effect is manifested by, e.g., non-selective operation of the protection. Lastly, the methods for detection of the current transformers saturation have been also investigated thorough the scrutiny of the available literature.

The next chapter of the work presents the topic of fault location in the overhead lines. The basic line models used for fault location have been analysed and the problem of measurement synchronization from both ends of the line has been scrutinised. Moreover, the existing impedance-based fault location algorithms dedicated to overhead lines have been examined. The focus has been put on the algorithms that use measurements from both line ends, without any use of the pre-fault measurements.

The next section presents the algorithm of the impedance differential protection of transmission lines developed by the author. The algorithm is based on the measurement of currents and voltages from both ends of the protected line, combining the functions of the line protection and the fault locator. In order to ensure the selectivity of the protection operation – in case of short circuits, during which the current transformers could be saturated – the author proposes the use of a novel angular criterion. Furthermore, the dissertation describes a method aiming at improvement of the fault location accuracy by compensating the current transformers saturation, in the case of saturation occurring at one line end. For this purpose, the compensated current has been determined analytically by using voltages from both line ends and current from the unsaturated side. The developed impedance differential protection dedicated for double-circuit lines has been also introduced.

Using the models developed in the ATP-EMTP program, multi-variant simulations of short-circuits in a single- and double-circuit line have been carried out. The algorithm proposed in this dissertation has been implemented in Matlab software and tested for all generated fault cases. Test results indicate the correct operation of the developed protective algorithm and high accuracy of the fault location.

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