

Wye-Connected Current Transformers Mathematical Model Implementation in Simulink – Simpowersystems Environment

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The reliability of power system operation depends on the correct relay operation.

Current transformers (CTs) are used to reduce the value of flowing currents in power system to values, which are convenient to measure and also to ensure the secondary device isolation from the primary system.

Properly selected CT supplies protection devices with undistorted secondary current. Otherwise, there is a CT iron core saturation, which can lead to protection device malfunction. Theoretically, the saturation can be avoided if all affecting the accuracy factors are taken into account during CT parameters selection. In practice, this leads to unacceptable CT dimension increasing.

Modern microprocessor-based protection relays can operate even at certain CT error level. Therefore, the complete CT saturation exclusion is not required, and the choice of CT parameters must be based on recommendations provided in instruction manual for the specific protection device.

Mathematical model of the wye-connected CT's based on the mathematical model of the single CT. The model is implemented in Simulink environment using SimPowerSystems block library, which contains a lot of electrical device models, however standard CT block is absent in it. This significantly limits the Simulink – SimPowerSystems environment usage for modeling a protection device, which obtain the information about the flowing current value from the CT secondary winding.

Wye-connected CT's model includes three models of the single CT, combined into a TA-Y block (fig. 1). Particular attention in the model was paid to the saturation characteristic of the current transformer core.

Studies were carried out using electrical network model (fig. 1).

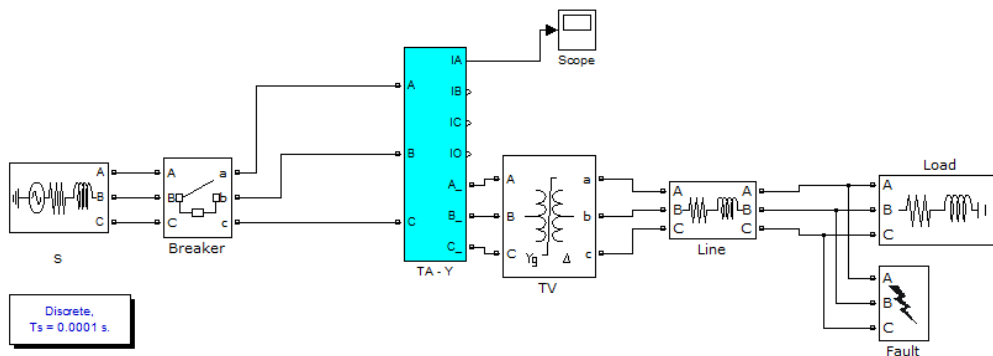


Fig. 1

10 km long 10.5 kV line is powered by a 115/10.5 kV, 16MVA transformer with the nonlinear magnetization characteristic.

As the result of calculations the distorted curve of the CT secondary current was obtained. This distorted secondary current shape is caused by the power transformer and wye-connected current transformers magnetic systems deep saturation. In the secondary current is clearly expressed the 2nd harmonic, which level decreasing with time.

Similar results were obtained during three-phase and phase-to-phase line faults simulations.

TPL-10 type current transformer case study confirmed the adequacy of the mathematical model implementation and the possibility of its usage for engineering analysis.