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PSPICE Computer Model of a Nonlinear Three-Phase Three-Legged Transformer

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Abstract: This paper proposes a simple, practical PSPICE model of a three-phase, three-legged, saturated transformer with an accurate performance. The transformer is modeled with its electric and magnetic equivalent circuits and a simple but reliable characterization of its nonlinear magnetic behavior. Two three-phase transformers of 380/220 V, 7.5 kVA and 60 kVA, respectively, are studied in order to verify the goodness of the model. The parameters of these transformers are measured in the laboratory, and comparison of the PSPICE model with real measurements has been successful.

Keywords: Transformer model, saturation curve, magnetizing current, nonlinear model.

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Thermal Problems Caused by Harmonic Frequency Leakage Fluxes in Three-Phase, Three-Winding Converter Transformers

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Abstract: Harmonic frequency leakage flux can be a limiting factor in three-phase, 3-winding HVDC converter transformers. Investigation of a three-phase, three-winding, 240 MVA converter transformer failure indicated the failure was caused by harmonic fluxes. Calculations indicated that the magnitudes of these harmonic fluxes to be approximately 45% of the power frequency leakage flux for the transformer, and are little affected by the transformer impedance or the converter firing angle. A study of the failed transformer loading during its life was made and a calculation made of the hot-spot temperature considering various insulation half-life factors. Based on published information on insulation half life factors it was estimated that at full load the hot spot temperature of the transformer was about 159oC. From examination of the insulation in the hot spot area, this estimate of hot spot temperature was considered reasonable.

Keywords: Transformer, converter, harmonic, thermal, leakage, fluxes.

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Transmission and Distribution

Control Schemes for Equalization of Capacitor Voltages in a Neutral Clamped Shunt Compensator

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Abstract: Voltage imbalance in capacitors is a well-known problem in compensator topologies that use two or more capacitors. This imbalance may exist even if the load does not contain any dc component, due to practical factors. However, when the load contains a dc part, the voltage imbalance problem becomes critical. In this paper, a two-quadrant chopper is used to regulate the capacitor voltages in a two-capacitor compensator structure. Two different control strategies for the two-quadrant chopper to equalize the voltage of the capacitors are proposed. The strategies are validated through detailed simulation studies. Experiments were carried out to validate the hysteresis control of the chopper.

Keywords: Active shunt compensators, dc load, voltage imbalance, voltage equalization, chopper control.

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Fuzzy-Based Reactive Power and Voltage Control in a Distribution System

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Abstract: This paper presents fuzzy-based reactive power and voltage control in a distribution system. The main purpose is to find the combination of main transformer load tap changer (LTC) positions and capacitor on/off switching operations in a day, such that the voltage deviations at the secondary bus of main transformer become as small as possible, while the reactive power flows through the main transformer and the real power losses at feeders become as little as possible. To minimize system repair cost, the total number of switching operations of LTC and capacitors in a day must be kept as few as possible. The linguistic expressions such as "as small as possible," "as little as possible," and "as few possible" are not close. In this paper, the reactive power and voltage control problem is first formulated with fuzzy sets, and then an annealing search technique is used to find a proper combination of LTC positions and capacitors on/off switching operations in a day. To demonstrate the effectiveness of the proposed method, reactive power and voltage control in a distribution system within the service arm of Yumlin District Office of Taiwan Power Company (TPC) is analyzed. It is found that a proper dispatching schedule for LTC positions and capacitors switching operations can be reached by the proposed method.

Keywords: Distribution system, LTC, capacitor, feeder, fuzzy sets, simulated annealing.

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GMPC Enables Energy Transmission Over Interconnected the SAPP Grid

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Abstract: The Grid Master Power Controller (GMPC) controls the generation at the Cahora Bassa hydro power station in Mozambique and its dispatch through parallel ac and dc interconnections. The bulk dc power flows directly to South Africa, while ac power is delivered to Zimbabwe, which is also interconnected with the South African ac grid. This paper describes the GMPC functions in its various control modes that are required for the different system configurations. It features adaptive gain and offset compensation for precision open-loop control of the HVDC and the turbines; robust control strategies for non-responsive generation or transmission; fast GPS-based angle measurement for damping control; robust automatic control-mode-selection independent of remote signaling; controls for proposed braking resistors; and smooth and safe control transfers between the GMPC and its emergency standby controller (EC). The success of the GMPC is evident from the fact that the angle-control mode, in which the high power HVDC system operates parallel with the weak ac interconnection, has become the unreserved and preferred choice ever since its commissioning in October 1999.

Keywords: Cahora Bassa HVDC, Grid Master Power Controller (GMPC), parallel ac/dc operation, ac/dc interconnection, braking resistors, frequency control, angle control.

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