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A novel multiphase multilevel inverter topology for high power AC drives with open-end stator windings

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Realization of multilevel inverters for multiphase high power AC drives with open-end windings is presented in this paper, with a specific case of five-phase five-level inverter configurations. The five-level voltage profile is realized by feeding both ends of the stator windings using a three-level five-phase flying capacitor inverter on one side and a five-phase two-level inverter on the other side. The flying capacitors' voltages are effectively balanced by utilizing the switching state redundancies. The capacitor voltages can be balanced at any modulation index, irrespective of the operating power factor. The operation of a drive at a higher voltage is preferred in many applications due to the advantages such as higher efficiency and reduction in size and weight. However, this demands higher DC link voltage in many topologies. The DC voltage magnitude required in the proposed topology is half of that required in the conventional multilevel neutral point clamped (NPC) topology, for a given output voltage. Hence, the scheme proposed in this paper can be advantageous in such applications where there is a limitation in obtaining DC voltage sources of higher magnitudes, such as in electric and hybrid electric vehicles. Another attractive feature of this topology is the enhanced reliability, as it is possible to operate the drive with half power even if any one of the inverters completely fails. The number of active switches used in this topology is lesser than that in equivalent five-level NPC inverters. Unlike the NPC inverter, this topology does not require any clamping diodes and is also free from issues like neutral point fluctuations. A carrier based pulse width modulation (PWM) technique combined with a hysteresis controller for balancing of the capacitors' voltages is used for the control of the inverter. The proposed drive topology can be applied to high power AC drives such as in oil and gas industries, electric/hybrid electric vehicles, ship propulsion, traction etc. The simulation and experimental results support the proposed idea.