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Study on fault-tolerant control of open-winding brushless doubly-fed wind power generator

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Brushless doubly-fed generator (BDFG) has the advantages of reliable structure, easiness in implementing variable-speed constant-frequency, small converter capacity, and so on, which has a broad application prospect in large offshore wind power generation. There are two sets of windings with different pole numbers on the BDFG stator, which are respectively called the power winding for generation and the control winding for excitation. The coupling relationship between the two sets of stator windings is implemented by the special rotor. For the high reliability requirement of offshore wind power generation system, the control winding of BDFG being designed as open winding structure is proposed, that is, all the six terminals of control winding are drawn out to connect with dual converters. This topology structure can independently control each phase current of control winding, which can improve the fault redundancy capability of generation system, have more flexible control mode and further reduce the converter capacity to half of the original. For the special structure of open-winding BDFG, a novel fault-tolerant control strategy based on direct power control (DPC) is proposed. DPC derived from direct torque control can independently control the active and reactive powers of BDFG, and has simple structure, strong robustness and good real-time. From the DPC idea, the switching voltage vector selection table should be re-established according to the fault information of dual converters. This control method can enable the brushless doubly-fed wind power generator system to be normal operation under the fault of dual converters, and implement the maximum power tracking control at the same time. The feasibility and validity of the proposed fault-tolerant control strategy based on direct power control for the open-winding BDFG can be analyzed and verified by simulation and experiment. The work is supported by Key Project of National Natural Science Foundation of China (51537007).

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