Performance Verification of Chain Link Converter Based Interconnection System

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Abstract

Small scale back-to-back (BTB) and/or HVDC systems based on voltage source converters (VSCs) are used world-wide for the reason that they supply electrical power to small islands without AC power systems, are easily connected to wind power facilities or fuel battery sources, etc. VSCs consisting of self-commutated devices such as IGBTs (insulated gate bipolar transistors) have the features that they can control active and reactive power rapidly and independently [1] and they generate small AC harmonics. To extend applications of the VSC-BTB and VSC-HVDC systems, further research and improvements to decrease their losses, harmonics and volume are needed, as well as cost. The application of the chain link converter (CLC) which consists of multiple single-phase VSCs (SP-VSCs) connected in parallel or series to an AC power system is attractive because the harmonic contents of output currents are relatively small, irrespective of low PWM carrier frequency. As a result, high efficiency operation can be obtained [2]. In this paper, CLC application to AC system interconnection (CLC-interconnection) is proposed. Digital simulation is used to study the performance of the system and analogue simulator tests with prototype model of the system, for confirmation.

We propose a DC voltage balancing control (DVBC) method between series converters for the CLC-interconnection system with high DC voltage, which connects SP-VSCs in series on the DC side to make losses low. The DC voltage of each converter should be controlled to the same voltage to get a reasonable capacity from the view point of design. In the DVBC circuits, DC voltage difference is divided into active and reactive control components and added to controller output signals so as to balance the DC voltage. From the digital simulation studies on symmetrical and even unsymmetrical AC system faults, we confirmed the DC voltages of each converter are balanced in steady and transient states by the DVBC.

For high reliable operation, we also propose a continuous operation method. If fault of one SP-VSC occurs, the system can operate continuously by removing the faulted VSC. In the case of series connection of SP-VSCs, the faulted VSC and its corresponding SP-VSCs are bypassed and DC voltage reference of the DC voltage controller is decreased. In the case of parallel connection of SP-VSCs, the faulted VSC and its corresponding SP-VSCs are removed. Thus the continuous operation in VSC faults can be realized. This is confirmed by digital simulation, too.

Finally, viability of CLC-interconnection systems is confirmed through performance evaluation tests by interfacing the prototype model with an analogue simulator.

[1] H.Stemmler, "State of the Art and Future Trends in High Power Electronics", IPEC-Tokyo 2000, Plenary session, April 2000
[2] H.Konishi, et. al., "Performance Study of a Chain Link Converter Application in BTB and HVDC Systems", ICEE2001, pp.606-609, Xi'an, China,2001.7

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