Common-Mode Voltage Reduction Pulsewidth Modulation Techniques for Three-Phase Grid-Connected Converters

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Abstract

This paper experimentally investigates the performance of three-phase voltage source pulsewidth modulation (PWM) converter, with the grid interfaced photovoltaic energy conversion system being the main application. In such applications the ground leakage current [common mode current (CMC)] should be much less than an ampere and this is difficult to obtain in transformerless (direct) connected systems. With the target being the reduction of the common mode voltage (CMV) and CMC, the converter performance is investigated thoroughly. Conventional PWM methods [space vector PWM (SVPWM) and discontinuous PWM (DPWM)] and recently developed reduced commonmode voltagePWM(RCMV-PWM) methods [active zero state PWM (AZSPWM) and near state PWM (NSPWM)] are considered. The performance of a 1-kW rated PWM rectifier with additional common-mode capacitor emulating a PV system has been experimentally investigated. It is shown that the CMV and CMC of the tested RCMV-PWM methods is significantly less than conventional methods. In particular, NSPWM yields the best overall performance including low ground leakage current, low inverter output (phase current) and input (dc-link current) ripple, and low switching losses. Accounting for the parasitic capacitance effect, the resonant frequency of the common-mode circuit is identified and it is used in the converter design for the purpose of avoiding resonances involving large CMV-CMC. This paper aims help the design engineer select the appropriate PWM method for gridconnected applications and provides some design rules of thumb.

Keyword：Common-mode current (CMC), common-mode voltage (CMV), leakage current, parasitic capacitance, photo-photovoltaic,