ABSTRACT

Multilevel inverters are widely used in industrial power conversion systems both for utility and drives application. Multilevel inverter technologies are receiving increased attention recently in high voltage-high power applications, due to their ability to meet the increasing demand of power rating and power quality associated with reduced harmonic distortion and lower electromagnetic interference. The objective of this thesis is centered on minimizing the total harmonic distortion in the voltage output waveform.

The focus of this dissertation is a cascaded multilevel inverter with unequal or varying dc sources. Pulse width modulation (PWM) and space vector modulation (SVM) methods are used in power inverters applied to energy conversion systems. The traditional PWM methods, sinusoidal PWM method (SPWM) and space vector control (SVC) methods can only be applied to equal dc sources. Furthermore, complexity and computational cost of traditional SVM techniques increase with the number of levels of the inverter, and most of all use trigonometric functions or pre-computed tables. In addition, the existing three dimensional space vector modulation (3D-SVM) technique is applied to diode-clamped inverter and capacitor-clamped inverter. Also, the 3D-SVM method cannot be applied to multilevel inverters with unequal dc sources. Accordingly, this dissertation deals with the space vector modulation (SVM) of five-level inverters, especially two-dimensional space vector modulation schemes, optimized three-dimensional space vector...
pulse width modulation (3D-OSVPWM) schemes are proposed for multilevel inverters. The two-dimensional space vector modulation can be applied to multilevel inverter with equal dc sources whereas; optimized three-dimensional space vector modulation can be applied to both equal and unequal dc sources. The optimized three-dimensional space vector modulation scheme has a better DC link voltage utilization and result in a low harmonic distortion. It is an effective solution to handle zero sequence component caused by unbalanced or nonlinear loads.

Furthermore, the proposed SVM algorithm is generalized to allow efficient implementation of SVM to multilevel inverters with any number of levels. The most important advantage of the proposed concept is that the number of instructions required to implement the algorithm is almost independent from the number of levels in a multilevel inverter. Both the algorithms can be applied to any multilevel inverter topology. The computational complexity of the algorithm is very low and does not use trigonometric functions or look-up tables.

The simulations are carried out in MATLAB/Simulink to verify the performance of the algorithms. The simulation result validate that the algorithms can effectively minimize the harmonics as expected and experimental results indicate that the proposed technique is effective for the reduction of harmonics in multilevel inverters. The SVM algorithms are implemented in a computationally very efficient, low-cost Field-programmable gate arrays (FPGAs) and they are tested in laboratory with five-level inverter.