

AN ABSTRACT OF A THESIS

MODELING AND CONTROL OF A THREE-PHASE THREE-LEVEL DIODE CLAMPED CONVERTER

Srikanth Konduru

Master of Science in Electrical Engineering

The main concept of multilevel converters is to use low rating devices to achieve medium and high power by connecting these low rating devices in series. The three-level converter has several advantages of large capacity, large voltage, and low current waveform distortions when compared to two-level converters. The focus of this thesis was on three-level diode clamped converter and accordingly, this thesis dealt with the generalized discontinuous carrier-based PWM (GDPWM) scheme for controlling the neutral point voltage. An analytical technique was developed for determining the expressions for the modulation signals used in the carrier-based non-sinusoidal scheme. It also introduced a computationally efficient three-level GDPWM, which has been verified through simulation and as well as experimentally.

Novel techniques were developed to control three-level three-phase three-leg rectifiers using natural variables and the dq components of the system to regulate the dc-link voltage and to achieve unity power factor operation. In the control scheme using natural variables, all the control variables in the system were now represented as ac signals instead of the dc signals needed in the traditional control methods, eliminating the synchronous reference transformations of the currents, voltages, and the hardware (phase lock loop) or software required for voltage phase angle measurement. The approach developed a controller compensation technique and modulation signals required to turn on/switch off the switches to obtain the dc-link regulation under all load conditions. The modeling of the system and a detailed controller design methodology were set forth. The concept of natural variable utilization for control was extended to three-level, three-phase, two-leg rectifier to control the dc-link voltage and to achieve unity power factor operation. Simulation results using MATLAB/SIMULINK validated the proposed modulation schemes.

Based on the natural reference frame current regulators, a new high performance controller for a three-phase three-level rectifier, which is effective for both balance and unbalanced source voltages and source impedances, was developed. Another attractive advantage of this controller lied in the ability to be effective in yielding unity power factor operation with regulated DC voltage when the system was balanced while ensuring constant input power when unbalance occurred in the source voltage or/and source impedance. A novel technique was proposed to control the natural currents of an unbalanced/balanced, wye-connected three-phase load in the abc reference frame using carrier-based discontinuous pulse-width modulation (PWM) method for voltage source converters. The modeling of the unbalanced load system and a detailed controller design methodology were set forth. For unbalanced loads, the required impressed voltages for current regulation were unbalanced requiring a novel carrier-based PWM modulation scheme, which was presented in this thesis.