Analysis and implementation of APWM power factor controlled bridge rectifier

Abstract

This thesis aims to analyze, simulate and implement a voltage oriented control (VOC) pulse width modulation (PWM) bridge rectifier system, with controllable power factor and sinusoidal supply current. The system is based on controlling the standard three-phase six-switch insulated-gate bipolar transistor (IGBT) bridge, by applying the voltage oriented control strategy using the space vector modulation (SVM)technique. This system introduces negligible harmonic pollution in supply current and has the capability of controlling the power factor with bidirectional power flow. This system can replace the conventional rectifier system in large number of applications, eliminating the problems normally associated with them. A detailed survey of the conventional converter topologies have been reviewed and different methods of harmonic reduction and power factor improvement is presented. A mathematical model of the selected converter topology is analyzed in detail and is investigated with three types of controllers . To study the different performance characteristics of the open-loop and the closed-loop system, using conventional PI controllers, hysteresis current controllers and fuzzy logic controllers, MATLAB/SIMULINK software package is used for the simulation of these subsystems. Effects of the system parameters namely: the amplitude modulation index (ma) and the power angle (δ) of the PWM rectifier and the hysteresis band width (HB) on the performance of both systems are investigated in both modes of operation; the rectifying mode and the inverting (regeneration) mode. Experimental verification is made using an IGBT bridge rectifier with a microcontroller based control system. Detailed of the experimental setup and the flowcharts of the different control algorithms are given. The experimental results of the open-loop system in the rectifying and inverting mode of operation, for different parameter variations, are presented to investigate the steady-state and dynamic performances of the system, for different types of disturbances. To validate the simulation results, based on the given mathematical model and analysis of the system, a comparison between the simulation and experimental results for both open-loop and closed-loop control systems have been presented.