Abstract

The work presented in this thesis is related to the design and performance evaluation of a three phase boost converter operated in the rectifier mode. The proposed three phase rectifier topology has been obtained by a cascade connection of three single phase H-bridge boost rectifiers. Initially, the characteristics of the H-bridge converter has been obtained by operating the H-bridge converter in the DC-DC boost mode. The various modes of operation of the converter when controlled by the bipolar and the unipolar PWM schemes have been derived and experimentally validated for the first time.

The state-space model of the converter has been derived and two control strategies have been designed for the indirect current control of the H-bridge converter. The control strategies have been tested by simulation for its performance under various transient disturbances. A PC-based experimental implementation of a suitable control strategy has been made for the operation of the converter in the DC-DC mode. After validating the performance of the designed scheme by simulation and experimentation for the DC-DC converter, the control scheme has been extended for the indirect current control of an AC-DC converter and the results obtained have been analysed to assess its performance. The implementation of the indirect current control by means of simple state-feedback principle has been shown to be quite effective for the current control of the H-bridge boost converter. This algorithm based on state variable feedback helps to analyse the steady state and transient performance characteristics of the H-bridge boost converter.

Extensive analysis of the single phase H-bridge converter in the rectifier mode of operation has been carried out and the various operating characteristics of the rectifier have been studied based on the phasor diagram analysis of the fundamental components of

the rectifier currents and voltages. The unity power factor (UPF) operation of the rectifier being the main motive of the study, has been given particular emphasis and the simulation studies and experimental analysis have been oriented extensively for this condition. The rectifier while operating at UPF is also been made to maintain a constant output voltage across the load terminals. The characteristics obtained by theoretical analysis for this operation has been presented along with the experimental responses.

The design and implementation of a control scheme has been presented for the UPF operation of the rectifier. The performance of the controller has been determined by experimental studies for various transient disturbances both at the supply and at the load terminals. A brief review of the existing three phase topologies has been made and a three phase topology obtained by a cascade connection of three single phase boost converters has been proposed. The advantages of the cascade topology arising from the reduction in the requirement of the reverse voltage ratings across the transistors has been experimentally validated. The proposed three phase converter has been operated in the rectifier mode maintaining UPF operation and maintaining a constant output voltage. The converter has also been analysed for its operation under certain types of open circuit and short circuit faults. The cascade three phase converter has finally been operated at a settable leading PF to compensate for existing lagging reactive loads on the supply transformer.

Key words : H-bridge converter, Boost converter, Pulse Width Modulation, State Variable technique, Linear Averaged Controller, Feedback Linearising Controller, Voltage Source Rectifier.