CHAPTER 1

Multilevel converters for utility applications such as static var compensation, voltage sag support, HVDC intertie, large variable speed drives.

Harmonics, power quality, and power filter design.

Hybrid electric vehicle (HEV) applications such as motor drives or dc-dc converters.

Soft switching inverters and dc-dc converters.

Areas like transportation and utility applications.

There have been new trends in the AC/DC and DC/AC power conversion. The pulse width modulated two-level converters have been the dominant topology in the low power and some selected medium power applications. There has been on-going research on these power converters and as technology evolves and matures various new trends and performance of the converter can be identified. Several important issues play a key role in new trends. Factors like increasing the power density, improving performance of the converter, reducing the cost of the converter, and also increasing the VA ratings of the converter. There are several ways in which these factors can be achieved such as in case of the increasing the power density; this can be realized by reducing the switching losses due to the devices by using soft-switching techniques, efficient power devices, and improving the thermal management. Next issue is increasing the performance of the system, which is achieved by reducing the total harmonic distortions, reducing the EMI problems, and by increasing the dynamics of the system.

The important criterion, which plays a major role, is the cost of the converters. Tremendous amount of research work is going in an attempt to reduce the cost of the converters by reducing number of devices (Sparse converters)[1-3]. Sparse converters are

Better synthesizing of the output waveforms which reduces the output filters and the rating of the passive components;

Many possible connections are available such as single-phase, three-phase, and multi phase connections;

Low switching frequency yields high efficiency.

When series connected capacitors are used to divide the dc-link voltage, three-level inverters (multilevel converters in general) have a dc-link voltage problem due to the following reasons:

Unequal capacitor values due to manufacture tolerances.

Unequal loading of the capacitors due to unintended switching delays.

Unequal loading of the capacitors due to nonlinear loads containing even order harmonics.

Dead-time implementation, which is always necessary in voltage source converters.

Transformer-secondary leakage inductance or voltage imbalance due to manufacturing tolerances.

Unbalanced load due to imbalances between the phases of the three-phase load.

Dynamic operating conditions such as acceleration or deceleration of a motor.

Imbalances in the parameters of the power semiconductors switching devices.

This is an important problem associated with the multilevel converters. Under certain conditions, the dc-link neutral point potential can significantly fluctuate or continuously drift to unacceptable levels. As a result, the switching devices may fail due to over stress on the devices. Though it is possible to reduce the neutral point voltage deviation by excessively increasing the dc-li the single carrier modulation scheme. Next part of the chapter deals with the discontinuous modulation scheme. Also included are detailed and step-by-step procedure of analyzing and deriving the discontinuous modulation scheme. The chapter also provides the hardware implementation and experimental results to validate the proposed control scheme.

Chapter 5 presents the control of the neutral point voltage using the generalized carrier-based discontinuous pulse width modulation. Also the chapter includes the control of neutral currents based on the concept of sharing functions.

Chapter 6 presents the development of the control scheme based on the natural variable utilization. The chapter includes the control of a three-phase voltage source inverter and rectifier under unbalanced load conditions using a natural reference frame controller. Also it provides a detailed analysis of the control methodology and the selection of parameters. Simulation results will be provided to validate the methodology.

Chapter 7 presents the detailed analysis and control of a three-phase three-leg three-level rectifier. This chapter begins with a brief introduction to the multilevel rectifiers and provides the objectives of the control schem

Chapter 9 presents the control of an unbalanced three-phase three-level rectifier. This chapter provides the causes for unbalance operations and the control methodology to achieve the regulation of the dc voltage and constant power transfer. Simulation results are provided.

Chapter 10 presents the hardware implementation of the three-level diode clamped inverter. A detailed procedure of selection of the components and a step-by-step procedure in building the inverter are explained. The carrier-based implementation using the TMS320LF2407 DSP is detailed in this chapter.

Chapter 11 presents the contributions of the work with some conclusions. Also it provides some future extension of the present work.