CHAPTER 1

INTRODUCTION

Variable speed drive systems are essential in many industrial applications. In the past, DC motors were used extensively in areas where variable speed operation was required, since their flux and torque could be controlled easily by the field and armature current. DC motors have certain disadvantages, which are due to the existence of the commutator and the brushes. That is, they require periodic maintenance; they cannot be used in explosive or corrosive environments and they have limited commutator capability under high speed, high voltage operational conditions. These problems can be overcome by the application of alternating current motors, which can have simple and rugged structure, high maintainability and economy.

AC drives are mainly classified into direct and indirect converter drives. In direct converters (cycloconverters), the AC power is fed directly to the AC motor. The maximum output frequency of the cycloconverter is about one third of the supply frequency. It has principally been used for applications in which motor size is large and the speed of the operation is low. In indirect converters the AC power variation process is carried out in two stages. In the first stage, the AC power, using either a diode or SCR bridge rectifier, is rectified and then inverted to a variable AC power by means of an inverter. This connection between the converters is known as a DC link. DC link AC converters are divided into VSI and CSI. They are in fact duals of each other. CSI supplies a controlled current to the motor whereas VSI

controls voltage at the motor terminals. The Alternating Current (AC) motor, especially asynchronous three phase Induction Motor (IM) has been the motor of choice in industrial settings for about the past half century as power electronics can be used to control its output behavior. Thus, IM and its drive system have been gaining market share in industry and even in alternative applications such as hybrid electric vehicles. The IM is a rugged structure motor because it is brushless and has very fewer internal parts that need maintenance or replacement.

For variable speed electric motor applications in low to moderate power, Pulse Width Modulation (PWM) with Voltage Source Inverter (VSI) is usually used. However, the switched voltages produce high voltage slopes over the stator windings, which stress the insulations and causes bearing current problems. A possible solution is to use PWM with Current Source Inverter (CSI). For ac motor (especially IM) variable speed drives fed by Current Source will have both stator current and voltage waveforms are close to the sinusoidal waveform, the above problems are reduced. Further, CSI can be used for high power applications. In the recent years, the high performance CSI fed variable speed drives, especially IM drives has been dominated by various control methods.

The vector-based V/F control method is used to study and verify system performance that is related to the scalar control concept. This method is also useful in real-time control applications. The vector-based V/F control is valid for both steady and transient states. In this work, IOL control uses an optimal control law that is designed to achieve pre-assigned eigenvalues with minimum possible magnitudes for the feedback gain elements and improved control performance. A new RFO control system in IFOC is implemented for

the CSI-fed IM drive, whereas DTC provides simple control architecture with a similar dynamic performance as that of IFOC. A modular Simulink implementation of the IM model is also developed, and the DTC concept is applied to the developed IM model.

Nowadays, most of the research works which are carried out for a variable speed drive on a steady state basis only. To achieve better results in dynamic states there is a need for specially designed computer simulation programs. This Research work is concerned with the Modeling and Dynamic Performance analysis of Vector Controlled CSI fed IM drives. The main objectives are to compare the dynamic performance of the vector control methods which have been applied to solve our research problems. All these control methods are analyzed for the dynamic characteristics of a Current Source Inverter (CSI) fed IM drives using Matlab simulation procedures.

The major objectives of this research work are:

1. To model a modest control algorithm for the entire drive systems components and to enhance the simplicity in their simulation procedures and to have experimental verification using a laboratory prototype hardware.
2. To obtain the dynamic performance characteristics of the drive system using different control techniques in order to track the given speed and torque references with respect to the load torque changes
3. To analyze and find the suitable control technique for dynamic changes in references using simulation results from Matlab software and experimental results from a Laboratory Prototype Hardware.