CHAPTER 1

INTRODUCTION

The sensor less control technique of Brushless DC motor powered from a photovoltaic source with Non inverting four switch buck-boost converter and Switched inductor quasi Z-source inverter. In order to improve the BLDC motor using sensor less vector control technique, the voltage profile is improved with a hysteresis band control which generates reference signal for sinusoidal pulse width modulation and it minimizes pulsation in output voltage ripple or noise and high starting torque is achieved. For speed regulation conventional PI controller, fuzzy logic controller and self tuning fuzzy PID controller are analyzed with different control schemes.

1.1 Need for the Study

Solar powered motor drives are recent trend for new research compared to conventional grid fed motor drives. Conventional motor control system involves two stage of power conversion, converting three phase ac supply from grid to DC and converting DC to AC using voltage source inverter. Interfacing a PV source for a BLDC motor drive is a challenging task that needs additional special converters and current limiting circuits. The objective of this research work is to extract efficient PV power for sensorless BLDC motor and to improve motor characteristic performance.

The BLDC motor drive is powered from a low voltage photovoltaic source through a boost converter and voltage source inverter. In the proposed system a speed estimation technique is used without speed sensors. The motor performance is observed with different pulse width modulation (PWM) control techniques. For extracting efficient and high power from PV source, different MPPT techniques were applied. Initial part of research is continued with two stages of power conversion viz. boost converter followed by an inverter. Later, the two stage power conversion methods are replaced with single stage power conversion using switched inductor

quasi Z-source inverter with voltage boosting capability. The proposed single stage power conversion system for PV power generation has reduced the total harmonic distortion in stator.

BLDC Motor voltage profile is improved with a hysteresis band control which generates reference signal for sinusoidal pulse width modulation and it minimizes pulsation in output voltage ripple or noise and high starting torque is achieved. Estimation of speed, flux and stator current of BLDC drive is done using current infusion technique. This method predicts the stator current of any phase of BLDC motor even under varying load conditions. Switched inductor quasi z-source inverter offers high power from PV without any active power conversion and a simple maximum boost pulse width modulation improves the dc link performance of the inverter. A self tuning fuzzy PID controller is employed which helps to achieve constant speed within small duration during starting. Further back EMF observer based speed estimation method is used which is based on machine mathematical model. It is a simple method that estimates the speed of BLDC Motor with high accuracy. The indirect field oriented control method is improved using switched inductor quasi Z source inverter for reducing the harmonics of stator current compared to other control method.

1.2 Problem Statement

The conventional vector controlled BLDC motor drive with a wide speed range are equipped with a speed sensor in addition to voltage and current sensors used in the control algorithm. This result in an increased cost and size of the system with additional electronic circuits involved for speed measurement. Idealistic characteristics of BLDC motor cannot be obtained with PWM inverters like trapezoidal shape of back-EMF and stator current. Ripple or pulsations in the torque also increase due to high switching frequencies involved in PWM technique. Since the BLDC motors current waveform is not sinusoidal, it adds harmonics in the current at stator side and due to the added harmonics the total harmonic distortion is high in stator current of BLDC motor. In solar fed motor drives, the quality of power supply from intermediate conversion stage influences the performance of the drive. Hence the

performance of the intermediate converter is highly important that leads to high torque ripple.

1.3 Objectives of the Study

The main objective of the research work is to improve the sensor less control technique of Brushless DC motor powered from a photovoltaic source and to minimize THD in stator current of BLDC motor. The following are also the objective of the study.

(i) To design and implement PV powered BLDC motor drive with intermediate non inverting buck boost converter and with different MPPT techniques.

(ii) To design and analyze the performance of different sensor less control techniques like hysteresis comparator based sine PWM technique and phase current infusion based space vector PWM technique.

(iii) To implement switched inductor quasi z source inverter fed BLDC motor drive using simple maximum boost PWM control.

(iv) To implement back EMF observer based speed estimation scheme for sensor less BLDC motor control and to analyze the performance of BLDC drive using Indirect Field Oriented Control (IFOC) technique.

1.4 Methodology of the Study

The first part of this research work is to design a standalone PV source that consists of PV panel, Non-inverting four switch buck-boost converter with perturb & observe MPPT algorithm for sensorless BLDC motor drive. Reference signal for sine PWM scheme is obtained from a single hysteresis band controller which removes the phase delay in back-EMF which limits the ripple in the output voltage to a lesser value. Further P&O algorithm is replaced by incremental conductance algorithm which improves the PV performance even under rapid changes of the solar parameters. A Hysteresis control technique is introduced to obtain a wide control over the developed torque and speed of the motor.

The second part of this research work is focused on a single stage power conversion system for solar power source fed BLDC motor drive. The Non inverting

four switch buck-boost converter is replaced with a switched inductor quasi z-source inverter network which can extract high power from PV source with voltage enhancing capacity. A self tuning fuzzy PID controller which gives approximate speed regulation with no manual tuning generates reference current. The error between actual and reference current is used as reference signal for PWM generation using Maximum boost PWM (MB-PWM) technique. Incremental conductance MPPT algorithm is applied on solar generation system that varies the modulation index of MB-PWM scheme. Simple Maximum boost PWM control is applied to a SLQZS inverter that can produce an output voltage higher than input voltage. A simplified indirect field oriented control (IFOC) with back-EMF observer that was used for speed estimation is replaced by MB-PWM control technique which results in reduction of torque ripple and to obtain a trapezoidal stator current waveform.

1.5 Limitations of the Study

The main limitation of this study is more computational process is involved in sensor less BLDC motor control in which speed is to be estimated and fed to controller section for producing switching pulses as per the speed reference command.

The limitation of this study is the space vector control for a sensorless BLDC drive cannot produce trapezoidal stator current and back-EMF for which hall position signal estimation scheme is introduced.

1.6 Organization of the Thesis

The thesis is organized with nine chapters as detailed below:

Chapter 1: Introduction. This chapter provides the overall composition of photovoltaic power fed Sensorless BLDC motor drive and the problems related to sensor less control of BLDC motor. Various methodologies to improve the performance of sensor less control of BLDC motor is also presented.

Chapter 2: Review of Literature. This chapter, the detailed review related to the research works in photovoltaic source fed motor control applications with sensor less control schemes is carried out.

Chapter 3: Non Inverting Four Switch Buck Boost Converter Fed Sensor Less BLDC Motor Using Hysteresis Controller. This chapter describes the design of non-inverting four switch buck-boost converter with perturb and observe MPPT algorithm as intermediate converter for PV fed inverter based drives. The hysteresis controller that generates a reference voltage of sine PWM which reduces ripple in the voltage developed for the BLDC motor.

Chapter 4: Non Inverting Four Switch Buck Boost Converter Fed Sensor Less BLDC Motor Using SVPWM. This chapter a new phase current infusion technique for indirect field oriented control using space vector modulation to control both speed and torque of motor and for continuously varying solar parameters incremental conductance MPPT algorithm is added to enhance efficiency of drive.

Chapter 5: SL-QZS Inverter Fed Sensorless BLDC Motor Using Fuzzy PID Controller. This chapter describes a Multi stage power conversion system that is replaced with single stage conversion system for PV fed motor control applications. A simple maximum boost PWM technique for improving the sensorless BLDC motor performance with self tuning fuzzy PID controller.

Chapter 6: SL-QZS Inverter Fed BLDC Motor Using IFOC and Back Emf Estimation Method. This chapter deals with a back-EMF observer scheme with sensor less speed estimation method and a simplified IFOC scheme with hysteresis current controller for torque ripple minimization and realizing BLDC motors wave shape with hall signal estimation.

Chapter 7: Design and Implementation. This chapter details with the design and implementation of sensor less BLDC drive in hardware setup.

Chapter 8: Results and Discussion. This chapter discussed the simulation and experimental results are carried out a sensor less BLDC motor control powered from photo voltaic source with buck-boost converter and switched inductor quasi z-source inverter with different control techniques.

Chapter 9: Conclusion and Scope for Further Study. This chapter, discuss the conclusion and the future scope of research work.