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Faculty of Engineering
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ON THE STUDY OF Z-SOURCE CONVERTERS

M.Sc. Thesis

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STATEMENT

This Thesis is submitted to Ain Shams University in partial fulfillment of the requirements for M.Sc. degree in Electrical Engineering.

The included work in this thesis has been carried out by the author at the department of electrical power and machines, Ain Shams University. No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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Mahmoud Ahmed Allam

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ABSTRACT

The importance of power electronic converters increased rapidly in the last years. They are necessary for most of modern power applications such as motor drives, VAR compensation, switched mode power supplies (SMPS), active filters, hybrid electric vehicles, integration of renewable energy resources to electricity grid... etc. Power conversion between different electricity forms (DC/AC) and levels (high voltage/low voltage) is a must for most of these applications.

Many topologies are recently introduced to allow power conversion with high efficiency and ease of control. In 2003, Fang Zheng Peng, introduced the Z-source inverter as a new topology with single stage buck/boost capability. Many developments and researches are made on the Z-source inverter till now.

This thesis discusses the theory of operation, different topologies, control techniques and applications of Z-source converters. In addition, the thesis presents three-phase and single-phase uninterruptable power supplies (UPSs) based on the high performance Z-source inverter (ZSI). The proposed control strategy is based on two loops. The first loop is dedicated to regulate the dc voltage of the Z-network capacitor and limiting the peak value of the dc link voltage by controlling the shoot-through duty cycle. The second loop employs the instantaneous voltage control technique to maintain the sinusoidal shape of the output voltage. Coordination between the two control loops is achieved by utilizing the simple boost control method to generate the PWM signals for the ZSI switches.

Simulations of the proposed UPS system are conducted using EMTDC/PSCAD package to evaluate the dynamic performance of the proposed control strategy. An experimental setup is built to verify the performance of single phase ZSI for both open loop and closed loop control. The experimental results are presented and they agree with the simulation results. This proves

the validity of the topology and the proposed control strategy for the single-phase UPS application.

The thesis consists of six chapters; they are summarized as follows:

Chapter (1): Gives an introduction about traditional converters and their limitations.

Chapter (2): Includes a literature review about the Z-source inverter topology, theory of operation, modes of operation, topologies, PWM control methods and applications.

Chapter (3): Discusses the proposed control strategy for the Z-source inverter based UPS application. Both three-phase and single-phase UPSs are presented.

Chapter (4): Investigates the simulation results of the proposed control strategy. The performance of the three-phase and single-phase UPSs systems based on the proposed Z-source inverter are studied under both dynamic and steady state operation.

Chapter (5): Describes the experimental setup. Moreover, the experimental results are analyzed and compared with the simulation results. Validity of the proposed system is proved.

Chapter (6): Concludes the thesis and recommends some directions for future research related to the subject of the thesis.

TABLE OF CONTENTS

Table of Contents

Table of Contents

LIST OF TABLES

LIST OF FIGURES

List of Figures

List of Figures

List of Figures