



Ain Shams University
Faculty of Engineering
Electrical Power and Machines Department

ON THE STUDY OF Z-SOURCE CONVERTERS

M.Sc. Thesis

Prepared by:

Eng. Mahmoud Ahmed Allam Sayed

Submitted in partial fulfillment of the requirements for the M.Sc. degree in
Electrical Engineering

Supervised by:

Prof. Dr. Ahmed Abdel-Sattar Abdel Fattah

Dr. Mostafa Ibrahim Mohammed Marei

Cairo, 2013

EXAMINERS COMMITTEE

Name: Mahmoud Ahmed Allam Sayed
Thesis title: On the study of Z-Source converters
Degree: Submitted in partial fulfillment of the requirements for the
M.Sc. degree in electrical engineering.

Name, title and affiliation

Signature

Prof. Dr. Osama Ahmed Mahgoub

Professor of Electric Power
Faculty of Engineering, Cairo University

Prof. Dr. Hamdy S. K. El Gohary

Professor of Electric Power
Faculty of Engineering, Ain Shams University

Prof. Dr. Ahmed Abdel Sattar Abdel Fattah

Professor of Electric Power
Faculty of Engineering, Ain Shams University

Dr. Mostafa Ibrahim Mohammed Marei

Associate Professor of Electric Power
Faculty of Engineering, Ain Shams University

SUPERVISORS COMMITTEE

Name: Mahmoud Ahmed Allam Sayed
Thesis title: On the study of Z-Source converters
Degree: Submitted in partial fulfillment of the requirements for the
M.Sc. degree in electrical engineering.

Name, title and affiliation

Signature

Prof. Dr. Ahmed Abdel Sattar Abdel Fattah

Professor of Electric Power
Electrical Power and Machines department
Faculty of Engineering, Ain Shams University

Dr. Mostafa Ibrahim Mohammed Marei

Associate Professor of Electric Power
Electrical Power and Machines department
Faculty of Engineering, Ain Shams University

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.

Name: Mahmoud Ahmed Allam Sayed

Signature:

Date: ... / ... / 2013

ACKNOWLEDGEMENT

I thank God, for wisdom and knowledge that He has blessed me. You made me strong. You gave me reasons to go and make the best out of me. You are the reason why I am here.

I would like to thank my supervisors: Professor Ahmed Abdel Sattar and Dr. Mostafa I. M. Marei for their continuous guidance, support, and encouragement throughout my research study. They have been wonderful advisors to me and major influence in my academic life. I could not possibly list all that I have learned from them.

I am grateful for my parents and my aunt, who helped me through all these. Thank you for supporting me in every way.

Mahmoud Ahmed Allam
Cairo, 2013

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

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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.

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