شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

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جامعة عين شمس

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قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
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Ain Shams University
Faculty of Engineering
Electronics and Communications Engineering Department

Design of advanced synchronized DC\AC inverter

A Thesis
Submitted in partial fulfillment for the requirements for the degree of
Doctor of Philosophy in Communications Engineering
(Electronics and Communications Engineering)

By

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Ain Shams University
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"Design of advanced synchronized DC\AC inverter"

Name: Nancy Wadie Riad Saroufim
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Statement

This dissertation is submitted as a partial fulfillment of the degree of Doctor of Philosophy in Electrical Engineering (Electronics and Communications Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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List of Publications

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2. Riad N, Anis W, Elkassas A and Hassan AE-W "Three-Phase Multilevel Inverter Using Selective Harmonic Elimination with Marine Predator Algorithm" Electronics,MDPI, vol. 10, no. 4, pp.374, 2021, https://doi.org/10.3390/electronics10040374.

3. N. W. Riad, W. R. Anis and A. M. Elkassas, and A.Hassan, "Loss Model of Three-Phase Multilevel Inverter Based SiC MOSFET Using Selective Harmonic Elimination", IETE Journal of Research, Taylor & Francis. (Under Review).

Abstract

Because of the low harmonic distortion content and reduced voltage stress in switching devices, Multi-level Inverter (MLI) is of particular interest. The topologies of MLIs and modulation approaches are discussed elaborately. The inverter is evaluated using selective harmonic elimination (SHE) modulation.

The marine predator algorithm (MPA) is proposed for solving transcendental nonlinear equations in a selective harmonic elimination technique using an MLI. It proved its suitability and supremacy over the other selective harmonic (SHE) techniques used in recent research as it has good precision, high probability of convergence, and improving quality of output voltage. The optimum values of switching angles from MPA are applied to control a three phase 11-level MLI using cascaded H-bridge (CHB) topology to control the fundamental component and cancel the low order harmonics for all values of modulation index from 0 to 1. Analytical and simulation results demonstrate the robustness and consistency of the technique through the MATLAB simulation platform. The results obtained from simulation show that the MPA algorithm is more efficient and accurate than other algorithms such as teaching-learning-based optimization (TLBO), flower pollination algorithm (FPA), and hybrid particle swarm optimization with gray wolf optimization (PSOGWO). A prototype for a three-phase seven-level cascaded H-bridge

inverter (7L-MLI-CHB) experimental setup is carried out. The output of this experimental test validated and supported the results obtained from the simulation analysis.

The model of power loss of three phase 7L-MLI-CHB using the silicon metal-oxide-semiconductor field-effect transistor (MOSFET) is obtained according to the modulation technique. Conduction and switching losses are calculated based on the experimental manufacturer data from the Si-MOSFET using the thermal model of Piecewise Linear Electrical Circuit Simulation (PLECS). Losses and output power are measured at different modulation index values based on the MPA algorithm. Finally, a design of heatsink volume is presented for this design at different temperatures.

This thesis also includes a performance review of WBG semiconductor devices in the MLI. As a result, a contrast between WBG, Si-IGBT and silicon devices is made, and the power quality of the inverter in terms of power losses and overall efficiency is investigated.

A complete model of total power losses in inverter is presented and simulated based on manufacturing models. The operation of the inverter is simulated using different types of switching power devices.

This thesis also provides a complete analysis of photovoltaic (PV) inverter of 3kW output power by merging the design of PV array and DC-AC inverter; The design includes a PV module to configure a large array that agrees with the inverter power output, the DC-DC step-up (boost) converter, next the full-bridge using MOSFET switches controlled by Pulse Width Modulation(PWM) is used to generate three levels signal and the output LCL filter design, then to the load. Also studying the inverter parameters that affect the losses and inverter efficiency. The design is

verified using Matlab-Simulink simulation using parameters of a real PV module, switches, and passive elements to be close to practical.

Keywords: SiC-MOSFET, Cascaded H-Bridge, IGBT, MATLAB-Simulink, Multi-Level inverter, Marine Predator Algorithm, Power losses, PWM, Selective harmonic elimination.

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