

# IMPLEMENTATION OF NINE-SWITCH CONVERTER TO PV SOLAR ARRAY OPERATING WITH DIFFERENT LOADS

MOHAMMAD FIRZAN EIDLAN BIN MOHD TAUFIX

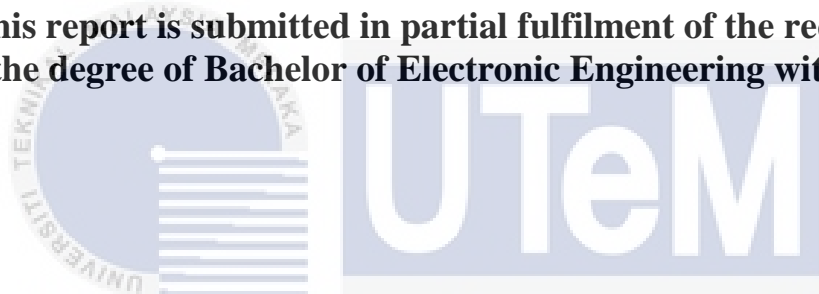


UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**IMPLEMENTATION OF NINE-SWITCH CONVERTER TO  
PV SOLAR ARRAY OPERATING WITH DIFFERENT LOADS**

**MOHAMMAD FIRZAN EIDLAN BIN MOHD TAUFIX**

**This report is submitted in partial fulfilment of the requirements  
for the degree of Bachelor of Electronic Engineering with Honours**



**Faculty of Electronic and Computer Engineering  
Universiti Teknikal Malaysia Melaka**

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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## DECLARATION

I declare that this report entitled “Implementation of Nine-Switch Converter to PV Solar Array Operating with Different Loads” is the result of my own work except for quotes as cited in the references.



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## APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.



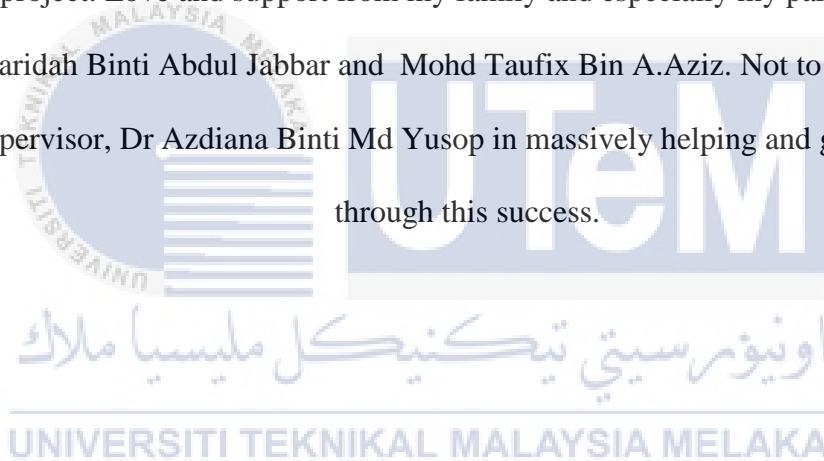
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Date : 1 JULY 2022 .....

## DEDICATION

Alhamdulillah, with the grace and strength from Allah in pursuing the completion of this project. Love and support from my family and especially my parents, Dr. Siti Faridah Binti Abdul Jabbar and Mohd Taufix Bin A.Aziz. Not to forget my supervisor, Dr Azdiana Binti Md Yusop in massively helping and guiding me through this success.



## ABSTRACT

Carbon free energy has always attracted worldwide attention to mitigate climate change. Its technological advancements and ability to create savings has always been greatly perceived by the people. However, with any technology there will always be shortcomings. Common inverters uses 12-Switch Converter to convert DC to AC, to supply three phase AC to two different loads. Thus, 12-Switch Converters has its weaknesses. During the conversion, power tends to lose between the switching phenomenon. It is bulky and require two converters to operate two loads independently. Therefore, to combat this limitation, the objectives of this project is to design a Nine-Switch Converter and analyze the difference in efficiency of power between the converters. It is required to design, simulate, built a prototype and compare the results. Design and simulation is done to ensure the system is correct and outlines the reference in building the prototype. In prototype, the components of the project are combined to create a system and the output of the system is measured and compared between the simulations to identify whether Nine-Switch Converter is more efficient than 12-Switch Converter. Hence, as discovered in the prototype testing, the Nine-Switch converter had 2.96% better efficiency in load 5.6ohms and 13.53% better efficiency in load 56ohms when compared to 12-Switch converter.

## ABSTRAK

*Tenaga bebas karbon sentiasa menarik perhatian dunia untuk mengurangkan perubahan iklim. Kemajuan teknologi dan keupayaannya untuk mencipta penjimatan sentiasa dilihat oleh orang ramai. Penyongsang biasa menggunakan Penukar 12 Suis untuk menukar DC kepada AC, untuk membekalkan tiga fasa AC kepada dua beban berbeza. Oleh itu, Penukar 12-Suis mempunyai kelemahan. Semasa penukaran, kuasa cenderung hilang antara fenomena pensuisan, ia bersaiz besar dan memerlukan dua penukar untuk mengendalikan dua beban. Bagi memerangi had ini, objektif projek ini adalah mereka bentuk Penukar 9-Suis dan menganalisis perbezaan kecekapan kuasa antara penukar tersebut. Projek memerlukan mereka bentuk, mensimulasi, membina prototaip dan membandingkan hasilnya. Reka bentuk dan simulasi dilakukan untuk memastikan sistem adalah betul dan menggariskan rujukan dalam membina prototaip. Manakala, dalam prototaip, komponen projek digabungkan untuk mencipta sistem dan keluaran sistem diukur dan dibandingkan dengan simulasi untuk mengenal pasti sama ada Penukar 9-Suis adalah lebih cekap daripada Penukar 12-Suis. Seperti dalam eksperimen prototaip, didapati bahawa Penukar 9-Suis mempunyai lebih 2.96% kecekapan dalam beban 5.6 ohms dan lebih 13.53% kecekapan dalam beban 56 ohms apabila dibanding dengan Penukar 12-Suis.*



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## LIST OF SYMBOLS AND ABBREVIATIONS

DC	:	Direct Current
AC	:	Alternating Current
PV	:	Photovoltaic
DAQ	:	Data Acquisition
W	:	Watt
Al	:	Aluminum
Sb	:	Antimony
In	:	Indium
P	:	Phosphorus اونيومر سیتی تیکنیکل ملیسیا ملاک
GaAs	:	Gallium Arsenide UNIVERSITI TEKNIKAL MALAYSIA MELAKA
I	:	Current
V	:	Volt
MOSFET	:	Metal Oxide Semiconductor Field Effect Transistor
IGBT	:	Insulated Gate Bipolar Transistor
PWM	:	Pulse Width Modulation
XOR	:	Exclusive OR
H	:	Henry
F	:	Farad
V <sub>pk</sub>	:	Peak Voltage

Vrms : Root Mean Square Voltage  
Ipk : Peak Current  
Irms : Root Mean Square Current  
P : Power  
LC : Inductor and Capacitor



# CHAPTER 1

## INTRODUCTION



This chapter introduces the basic idea structure of this project, starting with current faced problems and targets to achieve by the end of this project. Next, scope of work will layout the certain materials or components that will be used and highlights a few limitations of the project. Moreover, methodology synopsis shows processes on how the project will be handled, thus include expected outcomes. Finally, the thesis outline is included for better reference of each chapter in this project.

### 1.1 Project Overview

Common inverters uses 12-Switch converter to convert DC to AC, to supply three phase AC to two different loads. However, it is prone to switching losses during conversion. In addition, it is big in size and requires two converters for two loads. This is where the project is needed. To design a Nine-Switch converter, in order to analyze

the difference in efficiency of power between both converters. The first phase of this project is to design and simulate the 12 and Nine-Switch converter. Next, built a prototype according to the specifications of the simulated converters. Both simulation and prototype measurements are recorded for comparison. Finally, after plotting the measurements in graphs and table, calculations are made to verify whether Nine-Switch converter is better than 12-Switch converter.

## **1.2 Problem Statement**

Conventional sources of energy are continuously lessen in nature, so there is a paradigm shift in how people think about renewable energy. Renewable energy demands are increasing continuously due to technical advancements and growing technologies. However, the use of traditional 12-Switch Converters has its flaws, losing a large amount of its power in the switching phenomenon. Thus, considering a two load is required to operate by a single source, it would requires two different converters. This would not only build up the complexity and bulkiness of the system, but also steps up the switching and conduction losses. In order to improve the efficiency and output of the project, whilst reducing the switching and conduction losses, a new type of converter is required.

## **1.3 Objectives**

The target is set out to full-fill the project, analysis and demonstration of prototype based on these parameters:

- a) To design a Nine-Switch Converter with two loads.
- b) To analyze the difference in efficiency of power output between 12-Switch Converter and Nine-Switch Converter.

#### 1.4 Scope of Work

This project aims to demonstrate the efficiency gains of using Nine-Switch Converter compared to a 12-Switch Converter. Using MATLAB Simulink software the system is able to be verified and analyse the differences in power output and efficiency between the converters.

The software also allows the system to be thoroughly checked before constructing a prototype. Thus, the data gathered from simulation will be used for analyzing and comparison between prototype data.

In addition to the prototype, it will demonstrate a real world testing and obstacles. Connecting DAQ cards at important components in the prototype, i.e. PV panel, DC/DC booster, 12 or nine-switch converter and load allows the reading of voltage and current to be viewed. This is done by using LabVIEW, it enables the data gathered to be displayed and analyzed.



However, the limitations of this project are:

- Cloudy or rainy weather forecast may reduce the exposure of sunlight towards the solar panel.
- In the absence of battery in the system, it is only able to operate during sunny day.

## 1.5 Methodology Synopsis

Starting the development of this project is by research and comprehension of the system. It includes PV panel, DC/DC boost converter, 12 and Nine-switch converter, load and DAQ card. All the components are considered and chosen based on the desired output of the project.

Next is the design step of the system. To be created in MATLAB Simulink. Using the specifications chosen before, the components are placed into the system in order. First, PV panel, DC/DC boost converter, 12 or Nine-switch converter and load. DAQ card or sensors are inserted on the output of the following components. PV panel, DC/DC boost converter, 12 and Nine-switch converter and load to measure voltage and current.

Moving onto to the simulation, once the system is ready. Simulation plays a key role in determining whether the project is virtually successful or incomplete. Data of voltage and current are gathered at the components mentioned previously are to be used as comparison and guidelines.

After a successful design and simulation trial, the project is ready to be built into a prototype. With this, the project can be seen in its physical form and provide a real world testing scenario. Using DAQ card connected to the outputs of the components, the data of voltage and current are then gathered and analyzed using LabVIEW.

The final stage of the project is to analyze all the information gathered from simulation and prototype testing. This will give a clear view whether the project is a success and whether there is a significant difference in efficiency and power between using a 12-Switch Converter to a Nine-Switch Converter.