Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF AC MOTOR SPEED CONTROLLER USING MICRO CONTROLLER – BASED CYCLOCONVERTER

NUR TASNIM BINTI JOHARI

Bachelor of Electrical Engineering Technology with Honours

2022

DEVELOPMENT OF AC MOTOR SPEED CONTROLLER USING MICRO CONTROLLER – BASED CYCLOCONVERTER

NUR TASNIM BINTI JOHARI

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development of AC Motor Speed Controller Using Micro Controller – Based Cycloconverter

Sesi Pengajian : 2022/2023

Saya Nur Tasnim Binti Johari mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐ **SULIT*** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☐ **TIDAK TERHAD**

Disahkan oleh:

(TANDATANGAN PENULIS)
Alamat Tetap: 2456 LAHAR MINYAK, 13200 KEPALA BATAS, PULAU PINANG.

(COP DAN TANDATANGAN PENYELIA)
DR. MOHD BADRIL BIN NOR SHAH
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan
Universiti Teknikal Malaysia Melaka

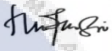
Tarikh: 13 JANUARI 2023

Tarikh: 13 JANUARI 2023

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this project report entitled "Development of AC Motor Speed Controller Using Micro Controller – Based Cycloconverter" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Student Name : NUR TASNIM BINTI JOHARI

Date : 13 JANUARI 2023

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honours.

Signature : 

Supervisor Name : DR MOHD BADRIL BIN NOR SHAH

Date : 13 JANUARI 2023

DEDICATION

This report is specially dedicated to all those who have supported, encouraged, challenged and inspired me and specially to my beloved family, honourable tutor and friends for all their guidance, love and attention which made it possible for me to make it up to this point.

ABSTRACT

In both the industrial and home sectors, the induction motor is the most extensively utilised machine. It is known as a constant-speed machine, and one of its key shortcomings is the difficulty of adjusting its speed with a cost-effective device. By synthesising the output waveform from parts of the AC supply without an intermediate DC link, a cycloconverter or cycloinverter converts a constant amplitude, constant frequency AC waveform to another AC waveform of a lower frequency. A cycloconverter-based speed controller is suitable to be used to control the speed of AC motor since it is low cost and low losses as compare to other type of speed controller. In this project, an AC motor speed controller developed using a microcontroller-based Cycloconverter circuit. The circuit consists of Arduino UNO microcontroller and SCRs that can change the frequency of AC voltage to the load. The circuit will be connected to a single phase AC motor to test the efficacy of the proposed gadget. It is found that the developed device can reduce the frequency of input AC voltage, subsequently can control the speed of AC motor.

ABSTRAK

Dalam kedua-dua sektor perindustrian dan rumah, motor aruhan adalah mesin yang paling banyak digunakan. Ia dikenali sebagai mesin berkelajuan malar, dan salah satu kelemahan utamanya ialah kesukaran melaraskan kelajuannya dengan peranti yang menjimatkan kos. Dengan mensintesis bentuk gelombang keluaran daripada bahagian bekalan AC tanpa pautan DC perantaraan, penukar siklon atau penukar sikloin menukar amplitud malar, bentuk gelombang AC frekuensi malar kepada bentuk gelombang AC lain dengan frekuensi yang lebih rendah. Pengawal kelajuan berasaskan cycloconverter sesuai digunakan untuk mengawal kelajuan motor AC kerana ia adalah kos rendah dan kerugian yang rendah berbanding dengan jenis pengawal kelajuan yang lain. Dalam projek ini, pengawal kelajuan motor AC dibangunkan menggunakan litar Cycloconverter berasaskan mikropengawal. Litar ini terdiri daripada mikropengawal Arduino UNO dan SCR yang boleh menukar frekuensi voltan AC kepada beban. Litar akan disambungkan kepada motor AC satu fasa untuk menguji keberkesanan gajet yang dicadangkan. Adalah didapati peranti yang dibangunkan ini boleh mengurangkan frekuensi voltan masukan AC, seterusnya boleh mengawal kelajuan motor AC.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Dr Mohd Badril Bin Nor Shah for his precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) for the financial support through to enables me to accomplish the project. Not forgetting my fellow colleague, for the willingness of sharing his thoughts and ideas regarding the project.

My highest appreciation goes to my parents, and family members for their love and prayer during the period of my study.

Finally, I would like to thank all the staffs at the Universiti Teknikal Malaysia Melaka (UTeM), fellow colleagues and classmates, the faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

f	-	Frequency
ms	-	Milisecond

LIST OF ABBREVIATIONS

V	-	Voltage
T	-	Time
rpm	-	Revolutions per minute

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

The method of controlling the current in an induction motor to control the speed is known as induction motor speed control. Although induction motors are normally employed in fixed frequency applications, they are popular for variable frequency applications such as industrial drives and electric cars. There are several methods to control the speed of an induction motor. We use a cycloconverter to control the speed of an induction motor using PWM approaches, among other methods. Traditionally, semiconductor switches have been used to convert ac to ac in one of two ways:

1. In two stages (ac-dc and then dc-ac) as in dc link converters
2. In one stage (ac-ac) cycloconverters.

A cycloconverter is a device that converts alternating current (AC) power at one frequency into alternating current (AC) power at a lower frequency with no direct current (DC) stage in between. It may also be used as a static recurrence charger because it contains silicon-regulated rectifiers. Cycloconverters are utilised in large variable frequency drives with power ratings ranging from a few megawatts to tens of megawatts. They are often phase-controlled, and thyristors have been used in the past because of their simplicity of phase commutation.

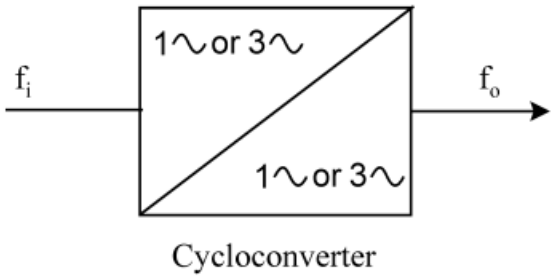


Figure 1.1 A cycolocnverter's Block Diagram

Other types of cycloconversion that use self-controlled switches are ac-ac matrix converters and high frequency ac-ac (hfac-ac) converters. However, these converters are not yet widely used.

The basic schematic diagram of cycloconverter is connectes to input 30 and 31 and for motor connection is between 25 and 26. Figure below show the basic schematic diagram.

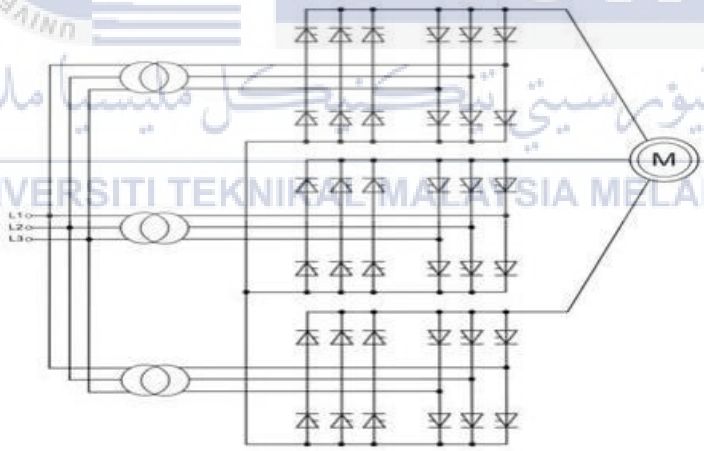


Figure 1.2 A Cycoloconverter's Basic Schematic Diagram

1.2 Problem Statement

Induction motor is a machine that is often used in various sectors especially the industrial sector. However, there are some drawbacks or disadvantages to be encountered when using or controlling induction motors. Among them is that the user will experience difficulty of difficulty to change especially during low-speed operation. Furthermore, the cost used for other types of speed controllers is also quite expensive as compared to using a cycloconverter. In addition to that, speed control of AC motor using cycloconverter is more efficient as compared to phase control angle or inverter technique.

1.3 Project Objective

The primary purpose of this research is to provide a way for controlling the speed of an AC motor using a microcontroller-based cycloconverter. The following are the specific objectives:

a) To design AC motor speed controller using a microcontroller - based Cycloconverter circuit.

b) To develop a hardware prototype of the designed cycloconverter circuit to verify the efficiency of the designed circuit.

1.4 Scope of Project

The explanation of the scopes in this project are consist of circuit design, program develop, software develops and hardware:

a) Type of Motor

A single-phase induction motor will be used in this project since it is widely used in many appliances such as fan, washing machine, air conditioning, to name a few.

b) Circuit Design

The fundamental theory of the cycloconverter will be used to design a circuit that consists of Arduino UNO microcontroller and SCRs that can change the frequency of AC voltage to the load.

c) Microcontroller Programming

To program algorithm for Arduino microcontroller in Arduino IDE Software to enable the speed control of AC motor using cycloconverter circuit.

d) Simulation

The developed circuit will be virtually simulated using proteus software.

e) Hardware

A prototype of the cycloconverter circuit designed combined with an Arduino microcontroller and another interfacing device will be developed in this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

To convert alternating current to mechanical power should use AC motor. This is called the electromagnetic induction phenomenon. there are two important components of an AC motor, namely the stator and the motor. The stator is the motor's stationary component, while the rotor is the motor's revolving component. Single-phase or three-phase AC motors are available.

In industrial, three-phase AC motors are utilised to transform bulk power from electrical to mechanical. For low-power conversion, single phase AC motors are typically employed. The single-phase AC motor is a small motor that can be used in a range of contexts, including the house, office, enterprise, factories, and other places. Refrigerators, fans, washing machines, hair dryers, mixers, and other household appliances all use single phase AC motors [1]

The AC motor is divided into two categories. The synchronous and induction motors are the two types.

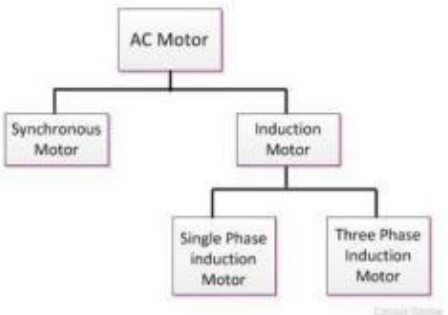


Figure 2.1 Type of AC Motor

2.2 Operation of AC Motor

The stator, or fixed outer drum, and the rotor, or revolving inner section coupled to the motor shaft, are the two primary components of an AC motorThe stator and rotor are surrounded by magnetic fields. The stator, which generates the rotating field, is wound with alternating current [2]

In an AC motor, the armature and field windings are combined. When an AC supply flux is linked to the stator, an air gap is created, which causes the flux to cycle at a fixed synchronous speed, resulting in voltages in the stator and rotor windings.

Single phase, three phase, braking, synchronous, asynchronous, customised two speed, and three speed single phase AC motors are all examples of this type of motor. The differentiation between the various categories is made depending on the job that must be done. Some AC motors are simple and designed for small jobs, while others are more complex and designed for larger, more demanding applications. The phase of the electrical feed differs for residential and industrial use, which is a significant distinction [2]

Residential power is either single or double phased, whereas industrial electricity is three phased. This divergence is responsible for the distinction between industrial and household AC motors [2]. Induction motors are a type of ac motor that uses electric current to generate torque, which is generated via electromagnetic induction from the magnetic field of the stator.

Figure 2.2 AC Motor

2.2.1 Star Up

An AC motor may be began with the aid of a simple on and stale switch, which can be a contactor or manual starter. A contactor allows the manage of toggle energy to an AC motor. Manual starters have a manual transfer that permits the operator to switch or change the power. This type of starting is known as a cross-road starter because it puts the engine under rapid stress from the power source. It links the motor's contacts directly to the entire voltage supply, which is usually six to eight times the rated current [2].

To reduce the value of the voltage supply during starting, a biting delta starter is used as the starter. The stator is connected in a star configuration, which switches to a delta configuration as soon as the motor reaches a certain speed. Thus, the line current drawn at the beginning is reduced.

A delta starting and an auto transformer starter both use the same mechanism. Again, the initial modern-day is constrained by the use of lower voltage in the stator. The torque and cutting-edge of a car transformer starter can be modified using the optimum tapping [2].

Through the slip rings and brushes, a rotor impedance starter is directly attached to the rotor. The rotor resistance is initially set to its maximum, but as the motor speed increases, it steadily declines. A rotor impedance starter is large and costly [2]

Soft starters are a more advanced type that provides for acceleration and deceleration control, as well as smooth and consistent motor stopping and starting, which is not possible with across-the-line variations [2]. The reduction of the wear on the motor and which device are connected is one of the advantages of soft starters.