# PIC PWM CONTROLLER

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"I hereby declared that this report is a result of my own work except for the excepts that have been cited clearly in the references."

Signature : ..................................................................
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Date : 06/05/2008

To my parents, my brothers, my sisters and my lover

# ACKNOWLEDGEMENT

First of all, I am grateful because I was given a chance to take part in this project. This is a wonderful opportunity for me to harness my skills in both the programming and hardware area.

In this acknowledgement segment, I wanted to thank is my project supervisor, Encik Azziddin Bin Mohamad Razali for allowing me to do this project. He had given me some idea on how to do my project and also on writing this dissertation. He has taught and has guided us along the way in doing this project. He also had given some inner idea in completing this project. Through his guidance, I was able to complete this project as expected.

And for the person that I forgot to mention in the segment, I would like to say a big thank you to you all. Without the support and help that you all gave me, this project would not be so faster to accomplish.

# ABSTRACT

Nowadays, Microchip PIC has become one of the popular tools in the area of controller especially in robotics and motor control. The main objective of this project is to control the speed of low power DC motor by varying the duty ratio of Pulse Width Modulation (PWM) waveform, produced by PIC16F877A microcontroller. In addition, observation of the DC motor performance has been made by investigating the relationship between PWM frequency and the DC motor performances. MIKRO C software is used to write and verify the PIC source code in C language. Finally, the simulation of the controller circuit and the PIC programming has been performed by using PROTEUS 6 LIFE software. The results show that the speed of the DC motor is proportional to the PWM duty ratio. The speed of the DC motor will increase if the duty ratio is increase within a certain limit. Further more, the voltage spike at the DC motor input terminal can be decrease by increasing the frequency of PWM pulse.

# ABSTRAK

Hari ini, Microchip PIC sudah menjadi salah satu peralatan yang popular dalam aplikasi pengawal terutamanya robotic dan kawalan motor. Objektif utama projek ini adalah mengawal kelajuan DC motor yang mempunyai kuasa yang rendah dengan mengubah gelombang-gelombang Pulse Width Modulation (PWM) duty ratio yang dihasilkan oleh PIC16F877A microcontroller. Tambahan pula, pemerhatian daripada DC motor akan dibuat dengan mengkaji hubungan antara PWM frekuensi dan DC motor. MIKRO C software akan digunakan untuk menulis dan membuktikan pengaturcaraan PIC dalam Bahasa C. Akhirnya, persimulasian litar pengawal dan pengaturcaraan PIC dapat ditonjolkan dengan menggunakan PROTEUS 6 LIFE software. Keputusan yang didapati menunjukkan kelajuan DC motor adalah berkadar langsung dengan PWM duty ratio. Kelajuan DC motor akan meningkat apabila duty ratio akan meningkat dengan beberapa sekatan. Sehubungan dengan itu, voltan spike pada masukan terminal dapat dikurangkan dengan meningkatkan frekuensi PWM pulse.

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# LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| PIC | - | Programmable Interface Controller |
| PWM | - | Pulse Width Modulation |
| DC | - | Direct Current |
| IC | - | Integrated Circuit |
| I/O | - | Input and Output |
| AC | - | Alternating Current |
| LED | - | Light Emitting Diode |

## LIST OF APPENDIXES

# CHAPTER 1

# INTRODUCTION

## 1.1 Project Synopsis

This project attempts to investigate the effect of the PWM frequency and duty ratio to the speed and performance of the DC motor. Two set of experiment are constructed in order to the investigation. In the first experiment, the duty ratio will be varied while the frequency is fixed with a certain value. Mean while in the second experiment, the PWM frequency will be varied while the duty ratio is fixed.

C programming is used to write the source code for producing PWM waveform. MIKRO C software is used to compile the source code and compile it to hex file which is downloaded to the PIC chip.

There are five push buttons in the designed circuit. The first push button is a reset button which is used to interrupt or stop the motor rotation. The second and third push buttons are used to change the duty ratio while the frequency is in fix condition. The second push button is used to produce 20% or 0.2 of duty cycle with 5 KHz PWM frequency. The third push button is used to produce 80% or 0.8 of duty cycle with 5 KHz PWM frequency. The fourth and fifth push buttons are used to change the frequency while the duty ratio is in fix condition. The fourth push button is used to produce 1.5 KHz frequency with 40% or 0.4 duty cycle. The fifth push button is used to produce 100 KHz frequency with 40% or 0.4 duty cycle.

The waveform at the pin 17 (RC2) from PIC16F877A microcontroller, outputs of L298 motor driver and DC motor will be measured by the oscilloscope.

## 1.2 Project Objectives

Firstly, these project objectives research the relationship between the duty cycle and frequency for the DC motor control.

Secondly, the waveform of output PWM PIC16F877A microcontroller L298 motor driver and DC motor will be researched to analyze the ripple effects and turns off spike.

Thirdly, the source code must be written down and simulation must be made.

Fourthly, comparison waveform between hardware and simulation will be made to analyze and observe the different or effects at both waveform.

Lastly, the effects of fast recovery diode will be researched to analyze the effects to the output waveform of DC motor.

## 1.3 Scopes Of Work

To investigate the high duty ratio and low duty ratio at the same frequency, two set of push buttons will be set up in the inputs of PIC16F877A microcontroller with 20% duty ratio and 80 % duty ratio at 5 KHz frequency. To investigate the high frequency and low frequency at the same duty ratio, two set of push buttons will be set up in the inputs of PIC16F877A microcontroller with 1.5 KHz frequency and 100 KHz frequency at 40 % duty ratio. Observation will be analyzed in the output waveform of PIC16F877A microcontroller, L298 motor driver and DC motor in both conditions. In addition, ripple effects and turn off spike also can be observed from this waveform.

The source code can be written down by using MIKRO C software and simulation can be made by PROTEUS 6 LIFE software. All the waveforms are taken from output of PIC16F877A microcontroller, outputs of L298 motor driver and DC motor.

The comparison waveform between hardware and simulation will be analyzed and discussed. In addition, the output waveforms of DC motor will be taken and observed when the adding fast recovery diode in the DC motor and no adding fast recovery diode in the DC motor conditions.

**1.4 Problem Statement**

Commonly, the variable resistor is used to adjust the resistance to control the speed of DC motor. This is because it can reduce and increase the flowing of the current to the DC motor and prevent the DC motor rotating slowly or quickly until DC motor burn. If the PIC microcontroller is used to control the speed of DC motor, the exactly frequency and duty cycle can be set and not need to adjust the resistance to reduce or increase frequency or duty cycle.

In a power electronic application, not all the IC can produce the range of duty cycle from 0 to 1.0. But using the PIC microcontroller, the range of duty cycle can be longer or shorter exactly from 0 to 1.0. For example, the SG3524 IC only has the minimum duty cycle about 0.45 even though it can produce PWM signal.

**1.5 Expected Result**

Firstly, the speed of DC motor of 20% full speed of duty cycle must be slower than 80% full speed of duty cycle at the 5 KHz frequency. This is because the speed will increase when the duty cycle will increase.

Secondly, the speed of DC motor of 100 KHz frequency will be less turn off spike than the speed of DC motor of 1.5 KHz at the 40% duty ratio. [1] The DC motor will run smoother when the frequency will increase.

Thirdly, there are no any ripple effects and turns off spike appear at the output waveform of DC motor from the simulation. The speed of DC motor can be researched from simulation when the duty cycle is varied. In addition, there are no any distortions appear in the waveforms.

Lastly, adding the fast recovery diode to the DC motor can reduce ripple effects in the output waveform of DC motor. When the frequency is higher, the ripple effects can be reduced. From simulation, there are no any ripple effects to the output waveform of DC motor.

## 1.6 Advantage Of PIC PWM Controller

1. Speed
   The speed of DC motor can be increased or reduced by setting source code to PIC microcontroller.

2. Decrease harmonic
   PWM signal which are produced by PIC16F877A microcontroller can make the reduction in filter requirement to decrease the harmonic.

3. Output Voltage amplitude
   This controller is easier to control the output voltage amplitude because it can maintain the DC supply voltage at the full speed.

4. Duty cycle
   This controller can longer or shorter the range of duty cycle from 0 to 1.0

5. Electronic device
   This controller can be used to control the supply of electrical power to another device such as in speed control of electric motors, volume control of Class D audio amplifiers or brightness control of light sources and many other power electronics applications.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction To Microcontroller

### 2.1.1 Microcontroller

Microcontroller is an essential electronic device that change the electronics design topology since its inception few decades ago. Basically, microcontroller is a computer system that is fabricated in a single integrated chip. A microcontroller chip consists of a Central Processing Unit (CPU) memory modules, and several input/ output peripherals.

**Figure 2.1: Different Types of PIC**

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**Figure 2.1: Different Types of PIC**

### 2.1.2 Variation of Microcontroller

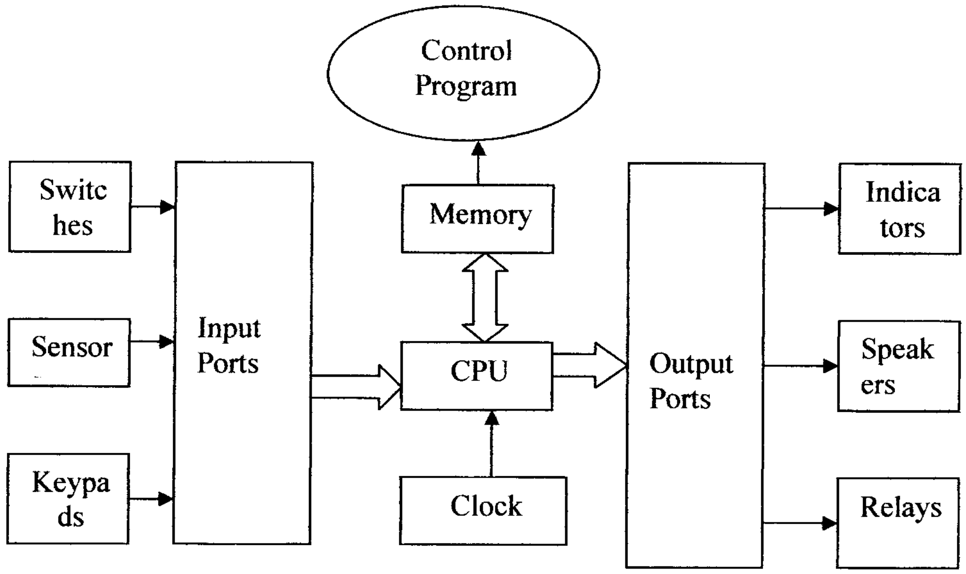


**Figure 2.2: Block Diagram for Microcontroller**

The microcontroller is used as a device that can form the basis of an embedded system for electronics applications. It provides a flexible low cost solution to bridge the gap between single chip computers and the use of large numbers of discrete logic chips.

Depending on various manufacturers, microcontroller is divided into several categories. For examples, 8 bit, 16 bit, 32 bit and so on. Most commonly used microcontroller is 8 bit microcontroller. It is simple, small in size, and capable of doing most things related with control and input or output devices.

As for the manufacturers, the competitiveness of the microcontroller market has encouraged several big name companies to share a piece of the pie. Those companies are:

a. Motorola ( 68HC11,68HC12)
b. Intel ( 8051)
c. Atmel ( AVR)

d. Microchip (PICmicro)

### 2.1.3 PIC Microcontrollers

The PIC microcontrollers are based on RISC (Reduced Instruction Set Computer) architecture; therefore use a relatively small number of instructions. Most PIC used 35 instructions compared to some general purpose microprocessors (like Motorola 68000 and Intel 8085) that may have several hundred.

Important feature of modern PIC devices is the use of electrically erasable and programmable Flash memory for program storage. These Flash memory devices are often denoted by the use of the letter "F" as part of the device coding ( example: PIC16F84). Flash devices are much easier to work with for one-off prototyping because erasure and reprogramming is greatly simplified.

### 2.1.4 Choosing PIC Device

When choosing which PIC is suitable for a particular project, it is important to select a device that is well supported. Supported mean the chips is widely available off the shelves and also in programming environment that intended to use on software development.

In this country, the most popular PIC chips that are widely available are PIC16F84A and its so called "big-brother" PIC16F877A. However, Microchip Inc, the company that produces and manufactures PIC, has already stop the production for PIC16F84A and offer few alternative as the replacements such as 16F88 and 16F628A ( which are more powerful and feature-packed chip compare to its predecessor).

Other than that, you also must ensure that the PIC incorporates all of the peripheral I/O facilities that you will need.

**Table 2.1: The difference of common tasks and features needed**

| Common tasks | Features needed |
|---|---|
| Multiple display devices such as LCD and LED | Adequate number I/O ports are needed to accommodate the devices. |
| PC-based project | Communication interface ( UART,RS232/RS485, USB etc) |
| Analog sensors, such as temperature sensor | Built-in A/D converter can make the project easier to construct and implement. |

### 2.1.5 Development Languages

There are several development languages developed to program a microcontroller to perform its specific application. Three main languages that been used are Assembly Language (ASM), BASIC and C.

**Assembly Language (ASM)**

Many people still use assembly code because of inertia. Its have been used for years since the microcontroller inception. Assembly language is considered as low level language and closely related to machine code. In ASM, the users need to be hardware oriented as the programming need the user to know in detail the hardware registers and configuration.

**BASIC**

In computer programming, **BASIC** (an acronym for Beginner's All purpose Symbolic Instruction Code) is a simple programming language that is very easy to learn. The instruction is simple and straight forward, hence its simplicity.