DC AC MOTORS SWITCHING CONTOLLER

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Date : 24 NOVEMBER 2009

Special dedicated to

My beloved family and all my friends give a support and inspired me along my journey of education world.

ACKNOWLEDGEMENT

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To all our friends and course mates, thank you for believing in me and helping me. The experiences and knowledge I gained would prove invaluable to better equip me for the challenges lie ahead.

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ABSTRACT

This project is about controlling the switching of DC and AC motors. The DC motor has large starting torque compare to AC motors and therefore they always used as starting motor to move the electric vehicle. On the other hand the AC motors is consider maintenance free and suitable for electric vehicle as well. It is common practise to put these motor in an electric vehicle. This project applied how to operate electric train. The speed of the train is varied by moving the voltage control on the transformer panel. The higher the voltage, the greater the speed. Some transformers provide at least two different voltage ranges. The lower range is used for light trains the higher range for heavier trains. The problem is how to switch ON and OFF both motors when is required. This project will switch ON DC motor first and after certain speed which is will set by user and without considering the load AC motor is ON automatically. If the speed is lower than set value the DC motor will still ON. Both motors are running simultaneously once the temperature reached at certain value (set by user). The motors back to normal sequence of operation temperature of both motor back to normal. The controller also controls the forward and reverse direction of the motors.

ABSTRAK

Projek ini bertujuan mengawal pergerakan suis diantara motor DC dan motor AC. Secara umumnya motor DC mempunyai daya tujahan permulaan yang kuat berbanding motor AC, oleh itu ia selalu digunakan untuk mengerakkan kenderaan electric. Selain itu motor AC juga boleh dianngap sebagai kurang penyelengaraan dan sesuai digunakan untuk kenederaan electrik secara umumnya. Projek ini diambil bagaimana keretapi electrik berfungsi. Kelajuan keretapi bergantung kepada voltan yang dikawal oleh panel transformer.Voltan yang tinggi menyebabkan keretapi bergerak denagn lebih laju. Sesetengah transformer menyediakan sekurang-kurangnya 2 perbezaan voltan. Voltan yang rendah digunakan untuk megerakkan keretapi yang ringgan manakala untuk voltan yang tinggi digunakan untuk mengerakkan keretapi yang berat. Masalah utama dalam project ini bagaimana untuk suis On dan Off kedua-dua apabila diperlukan. Projek ini akan suiskan motor DC dahulu dan selepas kelajuan yang tertentu yang mana ditentukan oleh pengguna tanpa mempertimbangkan beban motor AC akan juga akan On secara automatik. Jika kelajuan rendah dari apa yang ditetapkan motor DC masih On. Kedua motor akan bergerak serentak jika suhu sampai pada angka yang ditetapkan. Motor akan kembali kepada keadaan asal mengikut turutan jika suhu dipertimbangkan. Projek ini juga akan mengawal pergerakan kehadapan dan kebelakang motor.

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CHAPTER 1

INTRODUCTION

1.1 Overview

The DC drive is relatively simple and cheap (compared to induction motor drives). But DC motor itself is more expensive. Due to the numerous disadvantage of DC motor(especially maintenance), it is getting less popular, particularly in high power applications. For lower power applications the cost of DC motor plus drives is still economical. For servo application, DC drives is still popular because of good dynamic response and ease of control.

This project is about controlling the switching of DC and AC motors. The DC motors has large torque compare to AC motors and therefore they always used as starting motor to move the electric vehicle. On the other hand the AC motors is consider maintenance free and suitable for electrical vehicle. The problem is how to switch ON and OFF both motors when is required.

This project will switch ON DC motor first and after certain speed which is will set by user and without considering the load AC motor is ON automatically. If the speed is lower than set value the DC motor will still ON. Both motors are running simultaneously once the temperature reached at certain value (set by user). The motors back to normal sequence of operation temperature of both motor back to normal. The controller also controls the forward and reverse direction of the motors.

1.2 Objective

The objective of this project is to:

i. Develop and implement DC and AC switch logic motor controller with following specification:

   a) Control circuit to run first the DC motor after certain speed (set by user and regardless the load) of DC motor, the AC motor will on automatically.
   b) If the speed is lower than we set DC motor will still ON again and will be repeating.
   c) The both motor are running on the temperature reached at certain value (set by user) and no switching is allowed but switching is allowed when once the temperature of both motor back to normal. Temperature will be simulated using 2 switches.
   d) Based on condition a, b, and c possible switching state are 1)Switch motor DC to motor AC or 2)Motor AC to motor DC 3)Both motor will ON 4) Both are OFF.

e) Required to demonstrate the project by 1) DC motors which is corresponding to the DC motor 2) LED which is corresponding to AC motor.

ii. To built the controller base on logic integrated circuit.

1.3 Scope of Project

Among of the scope of project are:

i. DC and AC switching motor controller.

ii. DC motor control.

iii. Truth table.

iv. Logic circuit to control the motors.

v. Simulation of logic switching motor controller.

1.4 Problem Statement

This project is about controlling the switching of DC and AC motors. The DC motor has large starting torque compare to AC motors and therefore they always used as starting motor to move the electric vehicle. On the other hand the AC motors is consider maintenance free and suitable for electric vehicle as well. It is common practice to put these motor in an electric vehicle. The problem is how to switch ON and OFF both motors when is required.

1.5 Thesis Organization

For this thesis consists of 5 chapter altogether. Chapter 1 explain about the actual concept which is guide to development DC AC motor controller switching. Other than that is contains objective and scope of this project. Chapter 2 is literature review, chapter 3 about the project methodology, it is about the flow of this project, step to follow and. also the how it’s manage. Chapter 4 present the result and lastly conclusions for chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

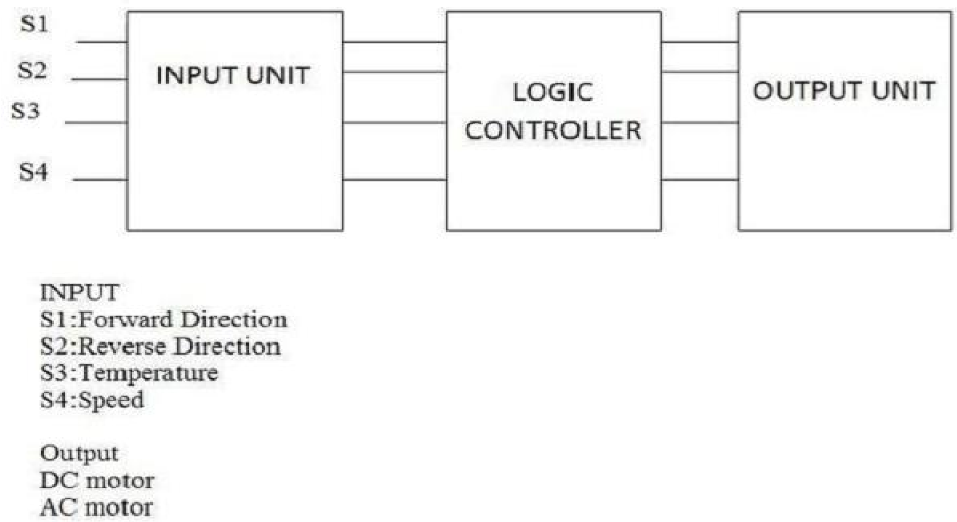
In this chapter, the researcher reviews articles and past research about the implementation of switch DC to AC controller via method which is logic circuit or integrated circuit, second using computer programming and lastly using microcontroller.

2.2 LOGIC CIRCUIT /INTEGRATED CIRCUIT

A logic gates is a circuit which uses digital signals as its inputs and outputs. What makes a circuit a gate is that each output depends entirely on the signals applied at the inputs. If these input signals change, then the output signal may also change. Digital circuits which use logic gates are usually arranged so that a logic 1 appears at an output only for some definite combination of input signals - for this reason these circuits are sometimes called combinational logic circuits. In theory, we could make i.c.s for each and every possible combination of input signals to produce a 1 output, but this would be wasteful of resources. In practice, what is done is to make i.c.s which accomplish a few standard logic operations. From these standard logic i.c.s any combinational logic circuit can be built up. The microprocessor is an extension of this idea - a circuit which can perform virtually any logic function.

The action of a standard combinational logic circuit, or of any circuit made up from these units, can be described in two ways. One way is by the use of a truth table. A truth table shows what output can be expected from each possible combination of inputs, so that the action of the circuit can be readily checked. Another method of describing the action of a circuit is by Boolean Algebra. This method is much more concise but less easy for the raw beginner to interpret, so both methods always be used together in this book. Boolean algebra, incidentally, was invented long before modern computers. It is named after George Boole (1815-1864) who devised it as a method of turning logical statements into algebraic expressions. Little use was made of this work until Shannon found in 1938 that Boolean algebra could be used to analysis relay circuits which carried out the sort of switching operations we now refer to as 'AND' and 'OR' gates.

2.2.1 FUNCTIONAL DIAGRAM CIRCUIT:



2.3 COMPUTER PROGRAMMING

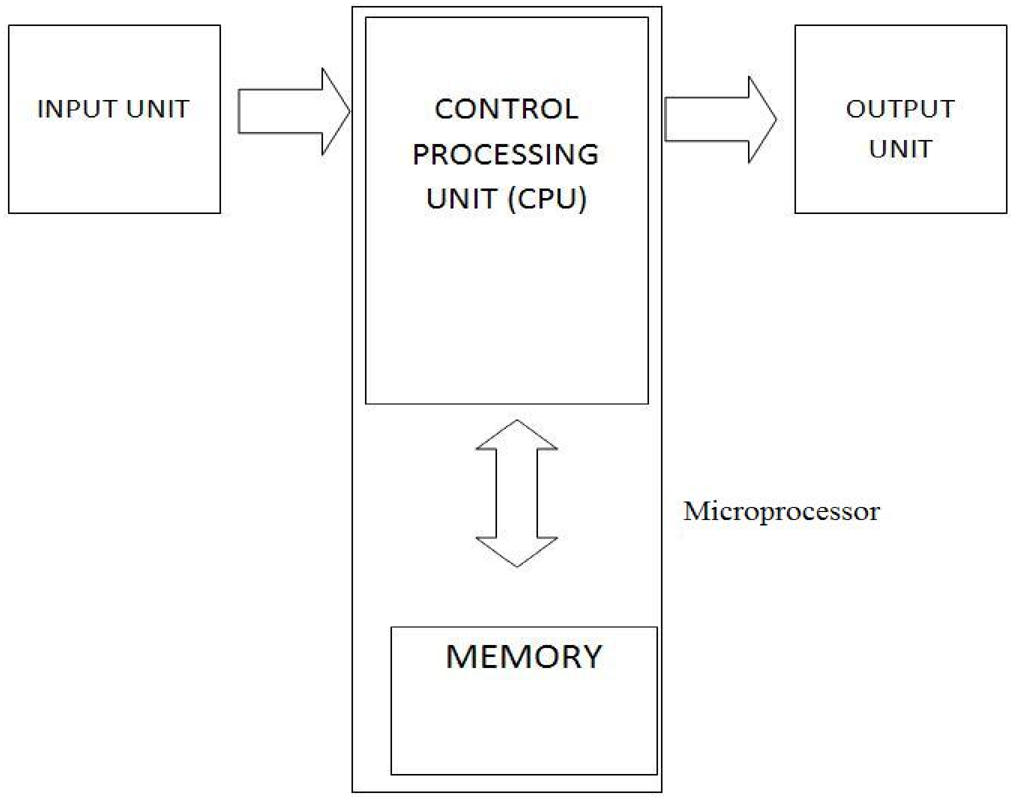
Computer programs (also software programs, or just programs) are instructions for a computer. A computer requires programs to function. Moreover, a computer program does not run unless its instructions are executed by a central processor however, a program may communicate an algorithm to people without running. Computer programs are usually executable programs or the source code from which executable programs are derived (e.g., compiled).

Computer source code is often written by professional computer programmers. Source code is written in a programming language that usually follows one of two main paradigms, imperative or declarative programming. Source code may be converted into an executable file (sometimes called an executable program or a binary) by a compiler. Alternatively, computer programs may be executed by a central processing unit with the aid of an interpreter, or may be embedded directly into hardware.

Computer programs may be categorized along functional lines: system software and application software. And many computer programs may run simultaneously on a single computer, a process known as multitasking.

Computer programming is the iterative process of writing or editing source code. Editing source code involves testing, analyzing, and refining, and sometimes coordinating with other programmers on a jointly developed program. A person who practices this skill is referred to as a computer programmer or software developer. The sometimes lengthy process of computer programming is usually referred to as software development. The term software engineering is becoming popular as the process is seen as an engineering discipline.

2.3.1 FUNCTIONAL DIAGRAM PC:



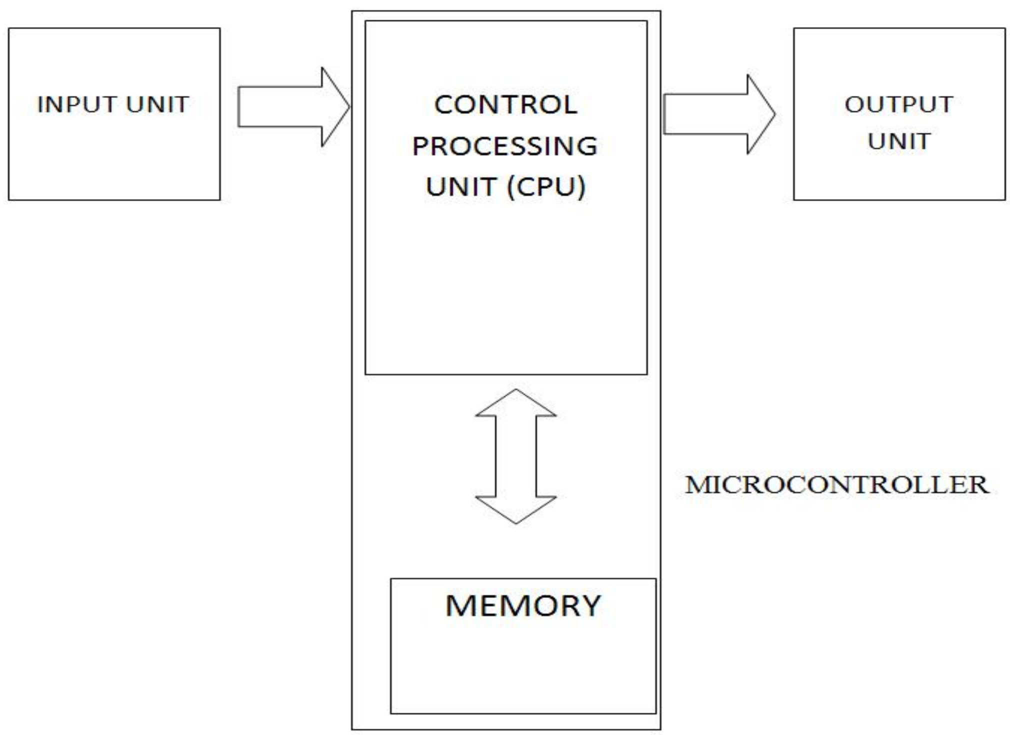
2.4 MICROCONTROLLER

A microcontroller is a highly integrated chip which performs controlling functions. A microcontroller, or embedded controller, is similar to a microprocessor as used in a personal computer, but with a great deal of additional functionality combined onto the same monolithic semiconductor substrate. Microcontrollers, sometimes referred to as one-chip microcomputers, are used to control a wide range of electrical and mechanical appliances.

Since they were first introduced, microcontrollers have evolved to the point where they can be used for increasingly complex applications. Some microcontrollers in use today are also programmable, expanding the number of applications in which they can be used. A modern microcontroller is basically a low-cost computer adapted to provide rapid solutions to external events after intensive computation. The microcontroller senses the happening of external events through signals received at input ports and transmits responses to the events through output ports. Modern microcontrollers are found in nearly every facet of modern life. More and more consumer and commercial products, such as for example but not limited to, appliances, telecommunications devices, automobiles, security systems, full-house instant hot water heaters, thermostats, and the like are being controlled by these integrated circuit microcontrollers.

Generally, a microcontroller has a standard hardware design that is customized for a particular implementation by programming the firmware for a specific application. Microcontrollers combine relatively inexpensive, generic hardware with specialized firmware to provide cost-effective custom designs for many different applications.

2.4.1 FUNCTIONAL DIAGRAM MICROCONTROLLER



CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will discuss on the methods that will be used to ensure the project could achieve the objective and scope of the project. Thus, all the methods need to be done as in in schedule so that this project could be complete within the time. There are several steps to be applied in designing a dc ac motor control switching.

Firstly before start this project we have classified a certain behavior and sensor as a input to the circuit sensor. Among of the behavior and sensor is the direction of motor have forward and reverse. Speed and temperature as a sensor that control the moving of motor. From this explanation we state 4 every each sensor have own characteristics that must be follow for this project. For this part we go to step by step flown the process of this project.

3.2 UNDERSTAND THE CONTROLLER BEHAVIOUR

For the motor that use consist 2 motors DC and AC but AC we substitute using LED because the scope of AC is very wide and connection is very complicated and need much time to spend. Only use DC motor and for the rotation just forward and reverse. For forward direction follow the clock wise and the reverse direction follow anti clock wise. From this direction we can distinguish the direction of motor.

3.2.1 FORWARD AND REVERSE DIRECTION

For the direction part have provided 2 button or switch to control the movement and easy to control among forward and reverse. For the forward direction just press the button forward we label as a logic 1 as active. For the reverse direction same with the instruction with forward direction just press the reverse button and known as a logic 0.With 2 button it become easy to control the direction of motor.

3.3 UNDERSTAND THE SENSOR BEHAVIOUR

For the sensor which is state previously consist of temperature and speed. Every each sensor have certain function that must be follow to run this motor. Actually for this project we apply from the electrical transport like train. Normally the motion or movement of train depend on the temperature and speed, from this knowledge we apply as a sensor to this motor.

3.3.1 TEMPERATURE AND SPEED SENSOR

Sensor of this motor we divide into 2 and every each sensor have own function that fixed. For temperature sensor state 2 condition here, first known as a normal temperature. Normal temperature here around 30-60 Celsius and label as a logic 0 and the high temperature around 60-90 Celsius and label as a logic 1. From this partition can know which temperature that need to control the motor and also the difference using normal temperature and high temperature. Speed sensor also have 2 part which is below set speed and above set speed. Set speed can be change and can be adjust. Logic 0 as a below set speed and logic 1 as a above set speed.

3.4 TRUTH TABLE

As well as a standard Boolean Expression, the input and output information of any Logic Gate or circuit can be plotted into a table to give a visual representation of the switching function of the system and this is commonly called a Truth Table. Logic gate truth tables shows each possible input to the gate or circuit and the resultant output depending upon the combination of the input.

For this part we have build the actual truth table base on this project consist 2 which is forward and reverse. From this truth table can see the all sensor base on logic that state previously.

3.4.1 FORWARD

AC	DC	TEMP	FORWARD	REVERSE	SPEED
0	0	X	0	0	0
0	1	0	1	0	0
1	0	0	1	0	1
1	1	1	1	0	X

3.4.2 REVERSE

AC	DC	TEMP	FORWARD	REVERSE	SPEED
0	0	X	0	0	0
0	1	0	0	1	0
1	0	0	0	1	1
1	1	1	0	1	X

3.5 SIMULATION

After got the truth table from forward and reverse compile to become 1 truth table like below It is easiest to do simulate using 1 truth table. Software that using to simulate is Max + plus II.

3.5.1 TRUTH TABLE

Temperature (A)	Forward(B)	Reverse(C)	Speed (D)	AC	DC
0	0	0	0	0	0
0	0	0	1	X	X
0	0	1	0	0	1
0	0	1	1	1	0
0	1	0	0	0	1
0	1	0	1	1	0
0	1	1	0	X	X
0	1	1	1	X	X
1	0	0	0	0	0
1	0	0	1	X	X
1	0	1	0	1	1
1	0	1	1	1	1
1	1	0	0	1	1
1	1	0	1	1	1
1	1	1	0	X	X
1	1	1	1	X	X

3.5.2 K-MAP

From the truth table above we can do Karnaugh maps. Function of Karnaugh maps is provides a systematic method for simplifying a Boolean expression or a truth table function. When used properly, the K map will produce the simplest SOP or POS expression possible. For this K maps we divide into 2 consist AC and DC.

3.5.2.1 AC

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	X	1	0
$\bar{A}B$	0	1	X	X
AB	1	1	X	X
$A\bar{B}$	0	X	1	1

AC =D + AB + AC

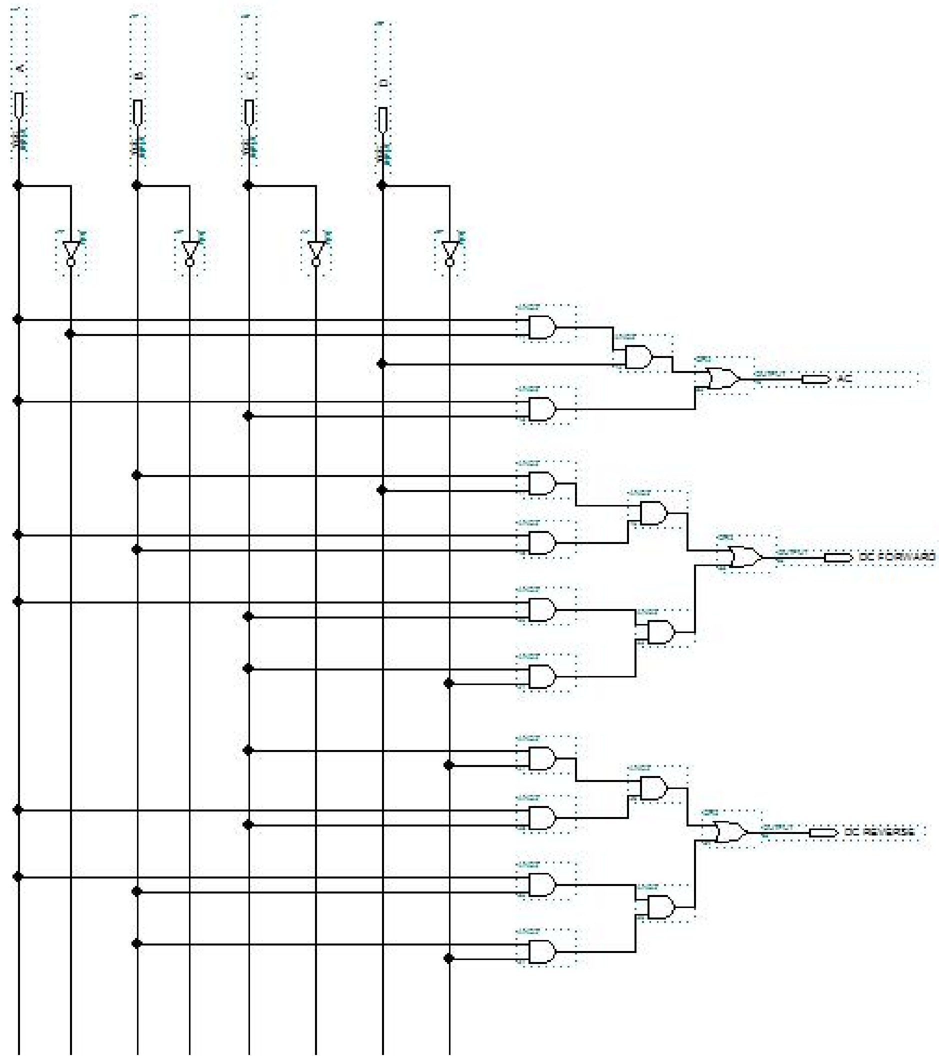
3.5.2.2 DC

	$\overline{C}\overline{D}$	$\overline{C}D$	CD	$C\overline{D}$
$\overline{A}\overline{B}$	0	X	0	1
$\overline{A}B$	1	0	X	X
AB	1	1	X	X
$A\overline{B}$	0	X	1	1

$DC = B\overline{D} + AB + AC + C\overline{D}$

3.5.3 LOGIC CIRCUIT

After K map from the truth table and got the AC and DC we get the result like above table. We construct the logic circuit using software Max plus II.



In this stage, we can create the logic circuit base on the K-map that we make before consist Ac and Dc. Using the software Max plus + II we can create the logic circuit using the symbol that given inside.

3.6 HARDWARE IMPLEMENTATION

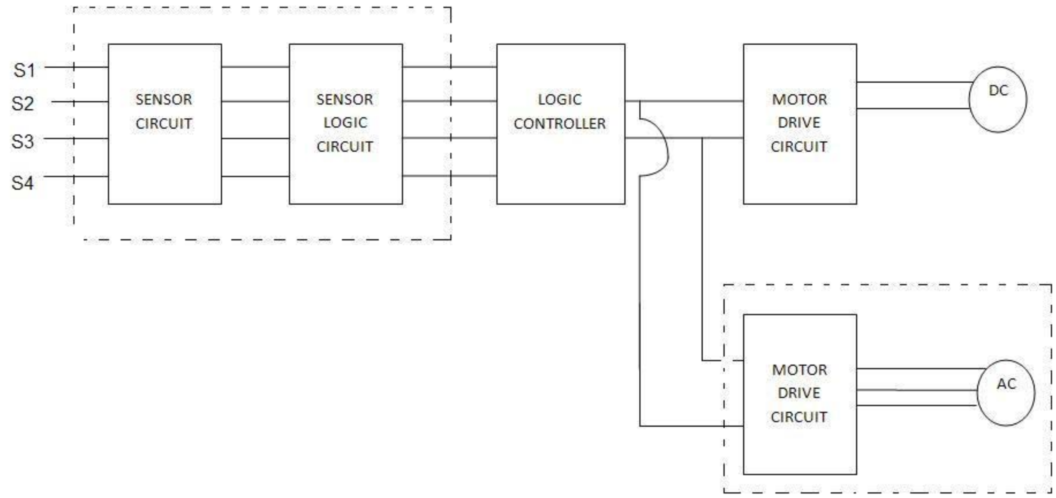


Figure 3.5: Block Diagram of Project

In this developing, hardware design will be constructed. From above figure, it shows each stage for the hardware design. Among of the stages are input, logic controller, and output consist dc motor. Input part consist sensors which is represented by the switches and also part motor drive that connected to ac motor we replace and represented by the LED because the connection of ac motor is very complicated. Other than that scope for ac motor very wide and need much time to study and solve it. The hardware development will be completed by following each stages of the block diagram.

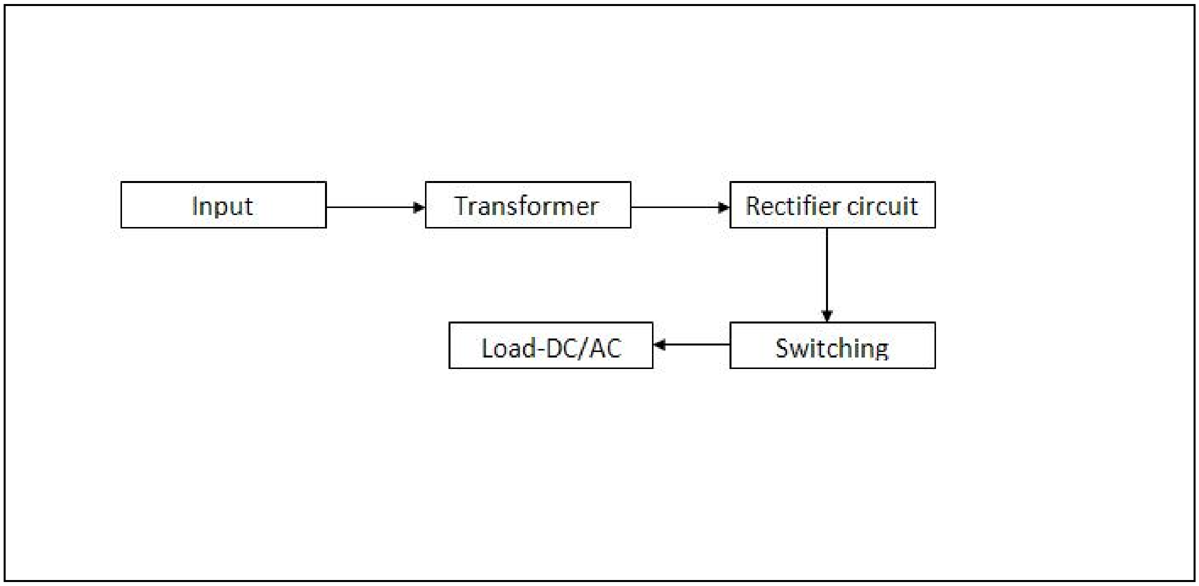


Figure 3.6:Flow chart Diagram

3.7 Input

To begin the design, there is an obviously need to convert the standard utility 240 AC voltage with frequency 50Hz to a useful DC voltage which would power the component within the rectifier. The 240 AC voltage power supply will step down by a power transformer then the output of the transformer will supply power to the rectifier circuit. Figure 3.7 below shows the 240AC voltage step down by using transformer.

Figure 3.7

3.8 Power Transformer

The transformer of the power converter circuit required an AC input. A basic three pin AC plug connector was connected to the transformer allowing it to be plugged into any standard wall plug. The transformer used in this project was step down controlled transformer. The specification of the power transformer is using 240V or 115V input voltage then will produced 12V output voltage and 0.25A output current. The transformer will produces output power about 6.0VA. Then the output of the transformer will connect to the rectifier circuit and the diode rectifier for controller circuit. The transformer is designed to connect in series for a single phase controlled rectifier. It is needed for input at 240VAC and output 12VAC. It is about 20:1 step down rate.

Figure 3.8:Power Transformer

3.9 Power Supply

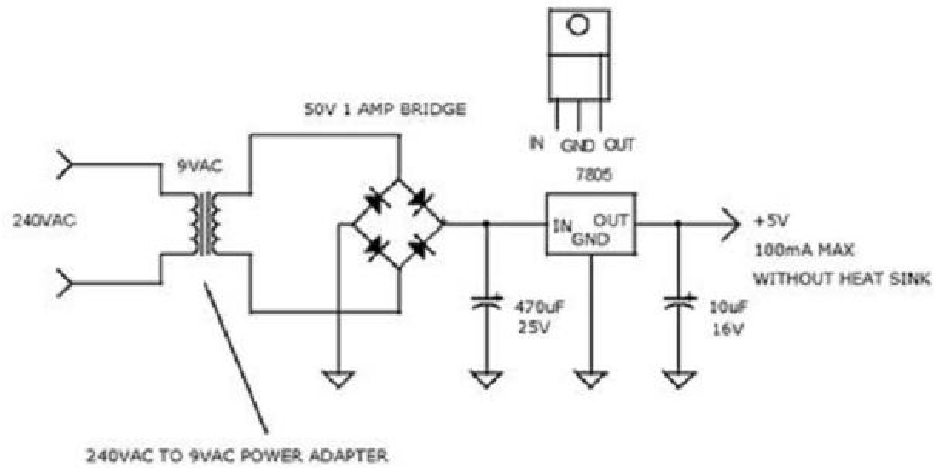


Figure 3.9

Voltage regulator comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device and overload protection all in a single IC. Although the internal construction of the IC is somewhat different from that described for discrete voltage regulator circuits the external operation is much the same. IC units provide regulation of either a fixed positive voltage a fix negative, voltage or an adjustably set voltage.

A power supply can be built using a transformer connected to the ac supply line to step the ac voltage to a desire amplitude then rectifying that ac voltage, filtering with a capacitor and RC filter, if desire and finally regulating the dc voltage using an IC regulator. The regulator can be selected for operation with load currents from hundreds of miliamperes to ten of amperes corresponding to power ratings from milliwatts to ten of watts.

3.10 Opto Isolator

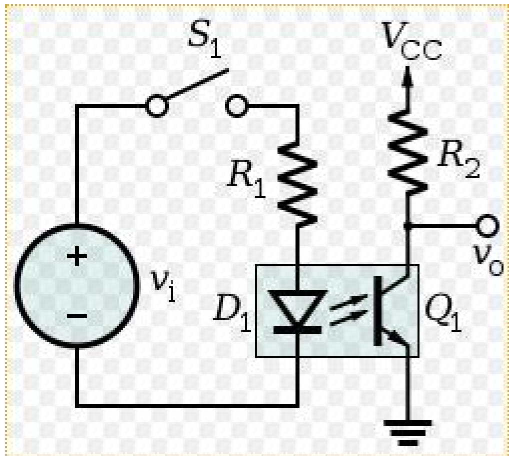


Figure 3.10

The opto-isolator is simply a package that contains both an infrared light-emitting diode (LED) and a photodetector such as a photosensitive silicon diode, transistor Darlington pair, or silicon controlled rectifier (SCR). The wave-length responses of the two devices are tailored to be as identical as possible to permit the highest measure of coupling possible. Other circuitry—for example an output amplifier—may be integrated into the package. An opto-isolator is usually thought of as a single integrated package, but opto-isolation can also be achieved by using separate devices.

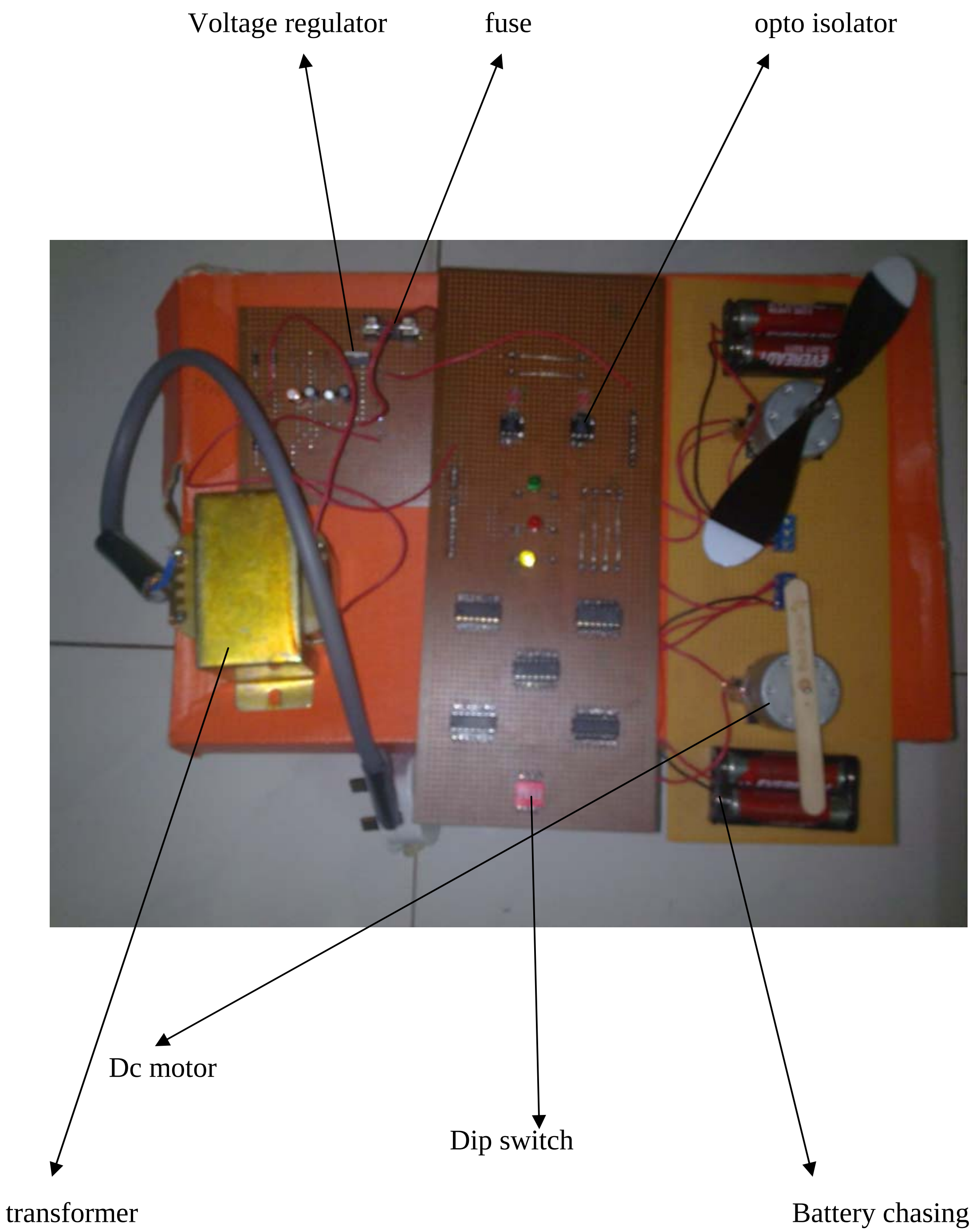


Figure 3.10:Picture dc ac motor controller switching

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The switching design of this project has been successful in achieving all objective. The switching have been successfully finished which all switches can operate with their own function. This chapter consists of the discussion on the result from the output and Max plus II is chosen to simulate the circuit designed. In this simulation, it will show the simulated output results. This simulation is very essential to keep all theoretical design and calculation is reliable to the project designed. Besides that, it can give clear view of the project according the obtained simulation output. Simulation of the dc ac motors switching controller unit has been done in determine the output that we creates before using truth table consists forward and reverse. After that we construct all the truth table and do K map consist ac and dc. Logic circuit have create base on the K map using the Max plus II and run the simulation base on the logic circuit which is explain previously.

4.2 RESULT OF EXPERIMENT

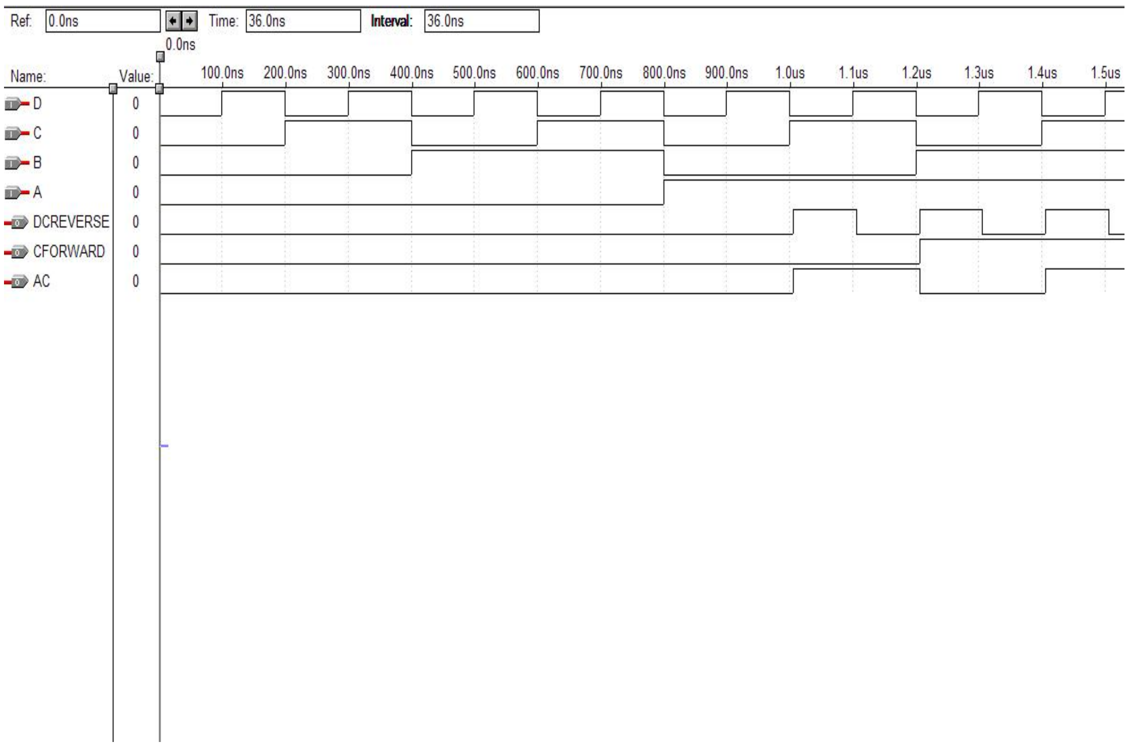


Figure 4.2.1

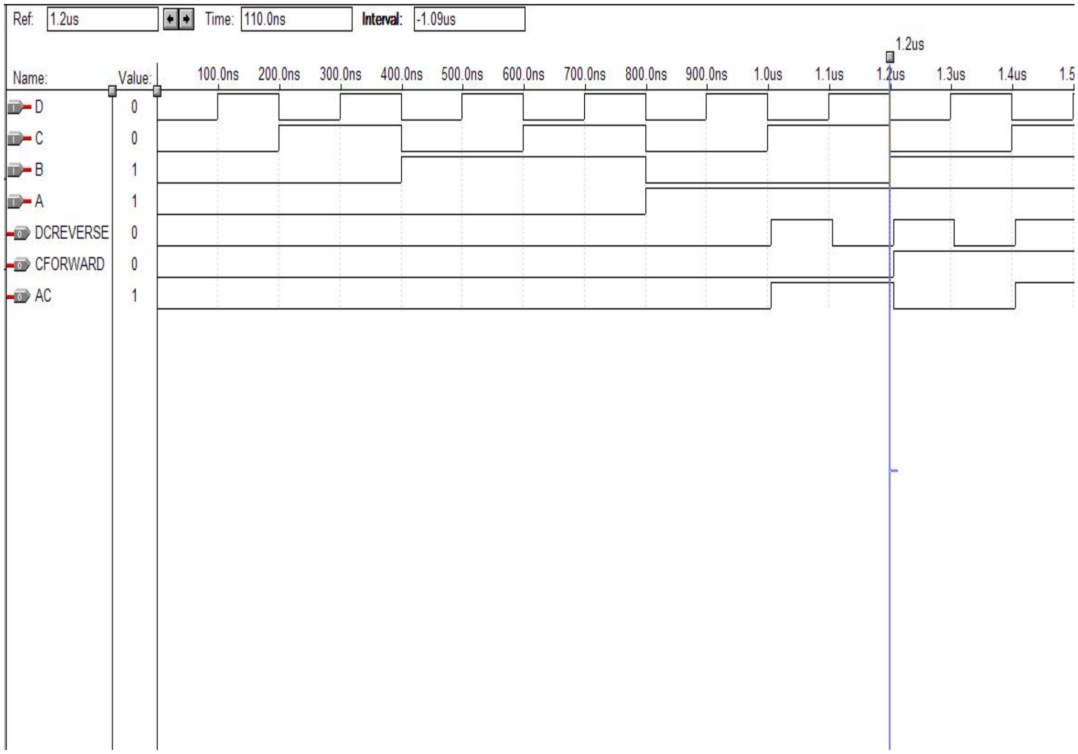


Figure 4.2.2

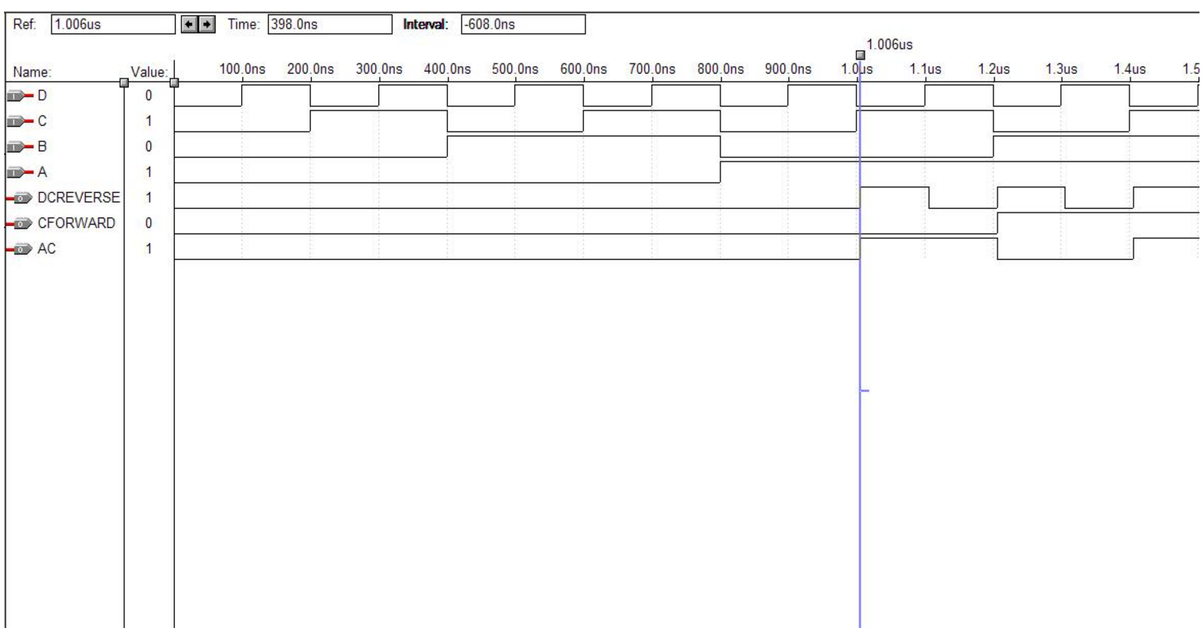


Figure 4.2.3

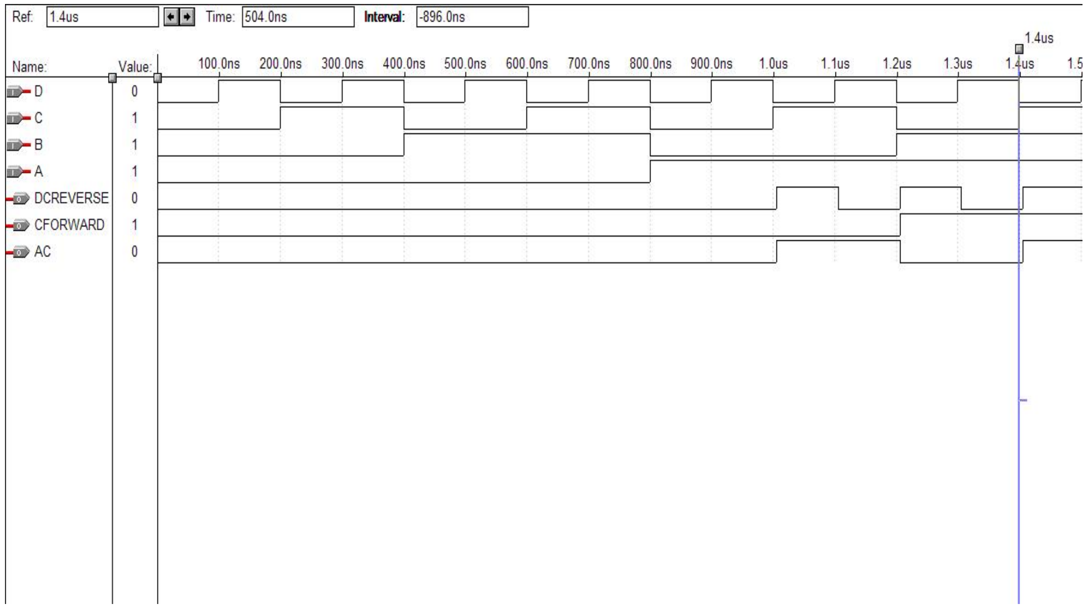


Figure 4.2.4

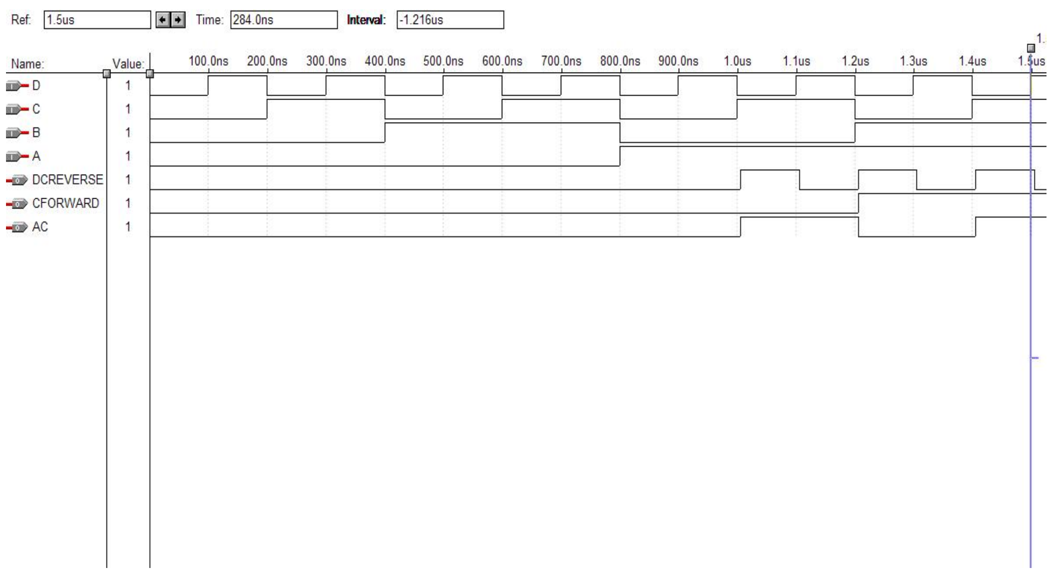


Figure 4.2.5

From the experiment every switches has been activate 0 or 1 to see the what the exact output which is created in our objective. The simulation using Max plus II is mostly same with the actual targeted.

4.3 PROBLEM AND SOLUTION

This chapter consist of discussion about the problem occur during before and after the process of making this switching project. The cause and effect will in this chapter and adding with the way to overcome the problem. The problem discuss on this chapter is categorized as a major problem that occur on the project and gives big effect to the project.

These problems occurs during checking the range of voltage that connected to the opto isolator at the pins 4 and 5 which connected to the dc motor. If supply voltage more than 7V,motor will do not stop properly conversely it became slow when we switch off. If use voltage around 3-4v it will stop properly when switch off. It is because the specification opto isolator which is need small voltage around 3-4v if more than that it will jump maybe it will be effect to the opto isolator and maybe break down and no long life.

To solve this problem the opto couplers need because it specification more that opto isolator which high voltage maybe have around 7V. All the component in this project need to change because previously all component using small voltage only such as basic IC such as 7404.7432.and 7408.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The report views the successfully design and implementation of the dc ac motor controller switching. The switching design consists only hardware implementation three parts.

For overall, processes to developed on this project have been successfully setup and all the objective and scope of the project is achieved.

5.2 Recommendation

Here are some recommendation for this project that should be added in future development:

1) Use microcontroller with more input/output to add and program more features to switching for make it more interesting and useable. For example adding buzzer sensor.

2) This project can be continue by interface the hardware into computer then develop software to analysis the process using graph or table. The suggestion software is visual basic.

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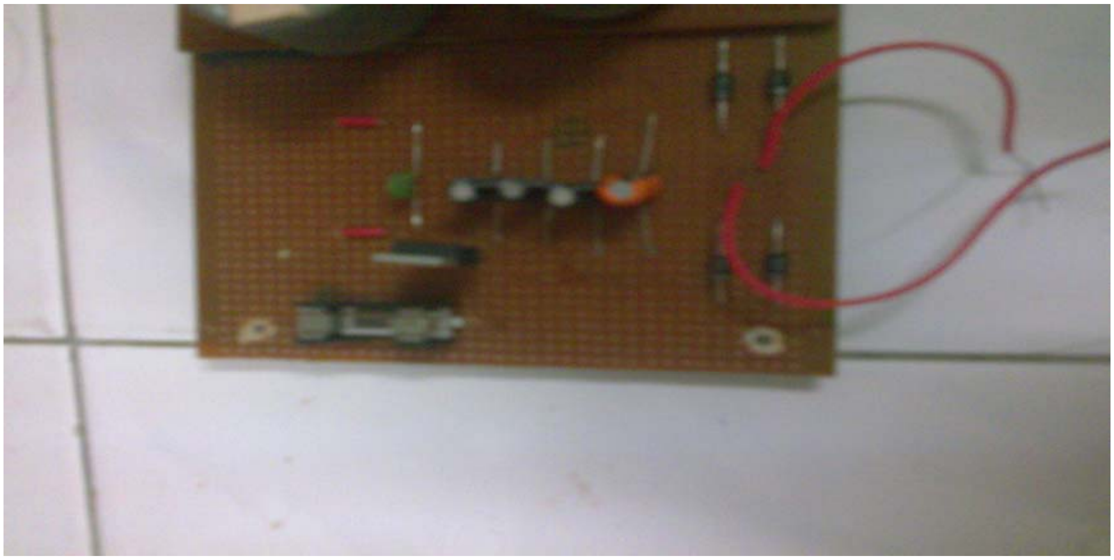
APPENDIX A

Result

Appendix A.1: Front view of a complete dc ac motor controller switching



Appendix A.2: Front view of a complete power supply 5V

Appendix A.3: Transformer connected to the plug 3 pin.

APPENDIX B

Data Sheets

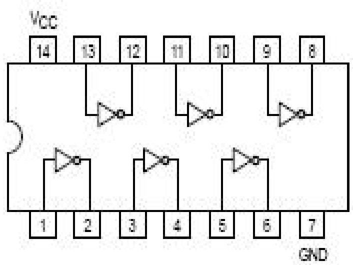
MOTOROLA

HEX INVERTER

SN54/74LS04

HEX INVERTER

LOW POWER SCHOTTKY



J SUFFIX
CERAMIC
CASE 632-08

N SUFFIX
PLASTIC
CASE 646-06

D SUFFIX
SOIC
CASE 751A-02

ORDERING INFORMATION

SN54LSXXJ Ceramic
SN74LSXXN Plastic
SN74LSXXD SOIC

GUARANTEED OPERATING RANGES

Symbol	Parameter		Min	Typ	Max	Unit
V_{CC}	Supply Voltage	54 74	4.5 4.75	5.0 5.0	5.5 5.25	V
T_A	Operating Ambient Temperature Range	54 74	−55 0	25 25	125 70	°C
I_{OH}	Output Current — High	54, 74			−0.4	mA
I_{OL}	Output Current — Low	54 74			4.0 8.0	mA

SN54/74LS04

DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)

Symbol	Parameter		Limits Min	Typ	Max	Unit	Test Conditions	
V_{IH}	Input HIGH Voltage		2.0			V	Guaranteed Input HIGH Voltage for All Inputs	
V_{IL}	Input LOW Voltage	54			0.7	V	Guaranteed Input LOW Voltage for All Inputs	
		74			0.8			
V_{IK}	Input Clamp Diode Voltage			−0.65	−1.5	V	V_{CC} = MIN, I_{IN} = −18 mA	
V_{OH}	Output HIGH Voltage	54	2.5	3.5		V	V_{CC} = MIN, I_{OH} = MAX, V_{IN} = V_{IH} or V_{IL} per Truth Table	
		74	2.7	3.5		V		
V_{OL}	Output LOW Voltage	54, 74		0.25	0.4	V	I_{OL} = 4.0 mA	V_{CC} = V_{CC} MIN, V_{IN} = V_{IL} or V_{IH} per Truth Table
		74		0.35	0.5	V	I_{OL} = 8.0 mA	
I_{IH}	Input HIGH Current				20	µA	V_{CC} = MAX, V_{IN} = 2.7 V	
					0.1	mA	V_{CC} = MAX, V_{IN} = 7.0 V	
I_{IL}	Input LOW Current				−0.4	mA	V_{CC} = MAX, V_{IN} = 0.4 V	
I_{OS}	Short Circuit Current (Note 1)		−20		−100	mA	V_{CC} = MAX	
I_{CC}	Power Supply Current Total, Output HIGH				2.4	mA	V_{CC} = MAX	
	Total, Output LOW				6.6			

Note 1: Not more than one output should be shorted at a time, nor for more than 1 second.

AC CHARACTERISTICS (T_A = 25°C)

Symbol	Parameter	Limits Min	Typ	Max	Unit	Test Conditions
t_{PLH}	Turn-Off Delay, Input to Output		9.0	15	ns	V_{CC} = 5.0 V C_L = 15 pF
t_{PHL}	Turn-On Delay, Input to Output		10	15	ns	

SN5408, SN54LS08, SN54S08
SN7408, SN74LS08, SN74S08
QUADRUPLE 2-INPUT POSITIVE-AND GATES

SDLS033 – DECEMBER 1983 – REVISED MARCH 1988

- **Package Options Include Plastic "Small Outline" Packages, Ceramic Chip Carriers and Flat Packages, and Plastic and Ceramic DIPs**
- **Dependable Texas Instruments Quality and Reliability**

description

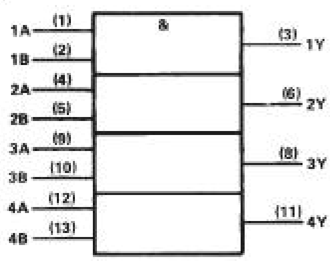
These devices contain four independent 2-input AND gates.

The SN5408, SN54LS08, and SN54S08 are characterized for operation over the full military temperature range of −55°C to 125°C. The SN7408, SN74LS08 and SN74S08 are characterized for operation from 0° to 70°C.

FUNCTION TABLE (each gate)

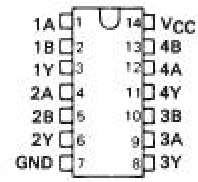
INPUTS		OUTPUT
A	B	Y
H	H	H
L	X	L
X	L	L

logic symbol†

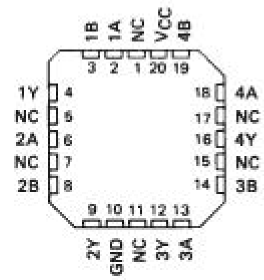


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for D, J, N, and W packages.

SN5408, SN54LS08, SN54S08 . . . J OR W PACKAGE
SN7408 . . . J OR N PACKAGE
SN74LS08, SN74S08 . . . D, J OR N PACKAGE
(TOP VIEW)

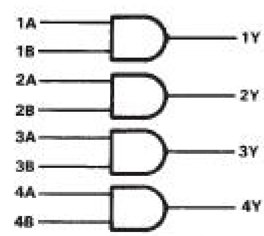


SN54LS08, SN54S08 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

logic diagram (positive logic)



$Y = A \cdot B$ or $Y = \overline{\overline{A} + \overline{B}}$

recommended operating conditions

		SN5408			SN7408			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			– 0.8			– 0.8	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature	– 55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS †	SN5408			SN7408			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN, I_I = – 12 mA			– 1.5			– 1.5	V
V_{OH}	V_{CC} = MIN, V_{IH} = 2 V, I_{OH} = – 0.8 mA	2.4	3.4		2.4	3.4		V
V_{OL}	V_{CC} = MIN, V_{IL} = 0.8 V, I_{OL} = 16 mA		0.2	0.4		0.2	0.4	V
I_I	V_{CC} = MAX, V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX, V_I = 2.4 V			40			40	μA
I_{IL}	V_{CC} = MAX, V_I = 0.4 V			– 1.6			– 1.6	mA
I_{OS}§	V_{CC} = MAX	– 20		– 55	– 18		– 55	mA
I_{CCH}	V_{CC} = MAX, V_I = 4.5 V		11	21		11	21	mA
I_{CCL}	V_{CC} = MAX, V_I = 0 V		20	33		20	33	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see note 2)

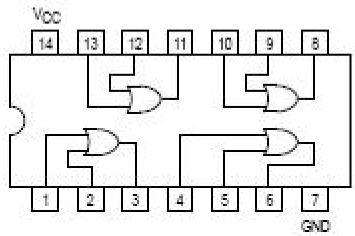
PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	A or B	Y	R_L = 400 Ω, C_L = 15 pF		17.5	27	ns
t_{PHL}					12	19	ns

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.

MOTOROLA

QUAD 2-INPUT OR GATE

SN54/74LS32



QUAD 2-INPUT OR GATE

LOW POWER SCHOTTKY

J SUFFIX
CERAMIC
CASE 632-08

N SUFFIX
PLASTIC
CASE 646-06

D SUFFIX
SOIC
CASE 751A-02

ORDERING INFORMATION

SN54LSXXJ	Ceramic
SN74LSXXN	Plastic
SN74LSXXD	SOIC

GUARANTEED OPERATING RANGES

Symbol	Parameter		Min	Typ	Max	Unit
V_{CC}	Supply Voltage	54 74	4.5 4.75	5.0 5.0	5.5 5.25	V
T_A	Operating Ambient Temperature Range	54 74	−55 0	25 25	125 70	°C
I_{OH}	Output Current — High	54, 74			−0.4	mA
I_{OL}	Output Current — Low	54 74			4.0 8.0	mA

DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)

Symbol	Parameter		Limits Min	Typ	Max	Unit	Test Conditions	
V_{IH}	Input HIGH Voltage		2.0			V	Guaranteed Input HIGH Voltage for All Inputs	
V_{IL}	Input LOW Voltage	54			0.7	V	Guaranteed Input LOW Voltage for All Inputs	
		74			0.8			
V_{IK}	Input Clamp Diode Voltage			−0.65	−1.5	V	V_{CC} = MIN, I_{IN} = −18 mA	
V_{OH}	Output HIGH Voltage	54	2.5	3.5		V	V_{CC} = MIN, I_{OH} = MAX, V_{IN} = V_{IH} or V_{IL} per Truth Table	
		74	2.7	3.5		V		
V_{OL}	Output LOW Voltage	54, 74		0.25	0.4	V	I_{OL} = 4.0 mA	V_{CC} = V_{CC} MIN, V_{IN} = V_{IL} or V_{IH} per Truth Table
		74		0.35	0.5	V	I_{OL} = 8.0 mA	
I_{IH}	Input HIGH Current				20	µA	V_{CC} = MAX, V_{IN} = 2.7 V	
					0.1	mA	V_{CC} = MAX, V_{IN} = 7.0 V	
I_{IL}	Input LOW Current				−0.4	mA	V_{CC} = MAX, V_{IN} = 0.4 V	
I_{OS}	Short Circuit Current (Note 1)		−20		−100	mA	V_{CC} = MAX	
I_{CC}	Power Supply Current Total, Output HIGH				6.2	mA	V_{CC} = MAX	
	Total, Output LOW				9.8			

Note 1: Not more than one output should be shorted at a time, nor for more than 1 second.

AC CHARACTERISTICS (T_A = 25°C)

Symbol	Parameter	Limits Min	Typ	Max	Unit	Test Conditions
t_{PLH}	Turn-Off Delay, Input to Output		14	22	ns	V_{CC} = 5.0 V C_L = 15 pF
t_{PHL}	Turn-On Delay, Input to Output		14	22	ns	

NTE3083
Optoisolator
NPN Darlington Transistor Output

Description:
The NTE3083 contains a gallium arsenide infrared emitter optically coupled to a silicon planer photo–darlington in a 6–Lead DIP type package.

Features:
- High Sensitivity: 1mA on the Input will Sink a TTL gate
- High Isolation: 3550VDC, $10^{12}\Omega$, 0.5pF

Absolute Maximum Ratings:
Storage Temperature Range, T_{stg} . . . . . –65° to +150°C
Operating Temperature Range, T_{opr} . . . . . –55° to +100°C
Lead Temperature (During Soldering, 10sec), T_L . . . . . +260°C
Total Power Dissipation (T_A = +25°C), P_D 250mW
Derate Linearly to 100°C . . . . . 3.3mW/°C
Input to Output Isolation Voltage (1sec), V_{ISOL} 3550VDC

Input Diode
Forward Current, I_F 60mA
Reverse Voltage, V_R 3V
Peak Forward Current (1µs pulse, 300pps), $I_F$peak 3A

Output Darlington
Collector–Emitter Voltage, V_{CEO} 30V
Collector–Base Voltage, V_{CBO} 30V
Emitter–Base Voltage, V_{EBO} 6V
Collector Current, I_C 125mA

Electro–Optical Characteristics: (T_A = +25°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Isolation Between Emitter and Detector						
Capacitance	C_{iso}	f = 1MHz	–	0.5	–	pF
Resistance	R_{iso}	V = 500VDC	10^{11}	10^{12}	–	Ω
Voltage Breakdown	V_{iso}	t = 1sec	3550	–	–	VDC

Electro–Optical Characteristics (Cont'd): (T_A = +25°C unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Emitter (GaAs LED)						
Forward Voltage	V_F	I_F = 20mA	–	1.15	1.50	V
Reverse Voltage	V_R	I_R = 10μA	3.0	25.0	–	V
Junction Capacitance	C_J	V_R = 0V	–	50	–	pF
Detector (Silicon Photo–Darlington)						
Collector Breakdown Voltage	$V_{(BR)CEO}$	I_C = 1mA	30	60	–	V
Base Breakdown Voltage	$V_{(BR)CBO}$	I_C = 10μA	30	60	–	V
Emitter Breakdown Voltage	$V_{(BR)EBO}$	I_E = 10μA	6	8	–	V
Collector Leakage Current	I_{CEO}	V_{CE} = 10V	–	1	100	nA
Saturation Voltage	$V_{CE(sat)}$	I_C = 2mA, I_F = 1mA	–	0.8	1.0	V
		I_C = 10mA, I_F = 5mA	–	0.8	1.0	V
		I_C = 50mA, I_F = 10mA	–	0.9	1.2	V
Base Photo–Current	I_B	V_{CB} = 5V, I_F = 10mA	–	2	–	μA
Darlington Gain	h_{FE}	I_B = 1μA, V_{CE} = 1V	–	50k	–	
Collector–Emitter Capacitance	C_{CE}	V_{CE} = 10V	–	6	–	pF
Switching Times, Coupled						
Rise Time, Fall Time	t_r, t_f	V_{CC} = 10V, I_C = 10mA, R_L = 100Ω	–	80	–	μs
TTL Gate Turn–On Time	t_{ON}	I_F = 1mA	–	200	–	μs
TTL Gate Turn–Off Time	t_{OFF}	I_F = 1mA	–	400	–	μs
DC Collector Current Transfer Ratio	CTR	I_F = 10mA, V_{CE} = 5V	200	400	–	%