Automated Clothesline System

by

Mohamad Ihsan b Ton Mohamad

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical & Electronics Engineering)

JUNE 2008

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Approved by,

(A.P. Dr. Josefina Barnachea Janier)

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHAMAD IHSAN B TON MOHAMAD

ABSTRACT

Automated Clothesline System is a system that can detect the rain and bring the clothes to a sheltered place automatically with the capability to pull the clothesline or washing line hand-free. This project uses sensors, microcontroller and motor. The sensor used for the system was water sensor. The microcontroller used was PIC16F877 and DC motor was used for the motor circuit. All circuits were constructed and tested and the microcontroller was programmed so that the motor control system can be implemented. The circuits were integrated and tested before the prototype was fabricated in a miniature model that represented the whole system. This project was found to be viable that it can detect rain and bring the clothes to sheltered place.

ACKNOWLEDGEMENT

First and foremost I would like to thank God Almighty for being my strength in times of needs and my place of comfort. With God, all things are possible.

With my deepest sense of gratitude, I would like to express my utmost and sincerest thanks to my supervisor, AP Dr. Josefina Barnachea Janier for her guidance, suggestions and feedbacks for the entire period of this project. She provided me with never ending encouragement and support to finish this project.

I also would like to name a few of the many for being very supportive to me; Kak Siti Hawa, Syed Qamarul Hidayat, Muhammad Nazri Arifuddin, Muhammad Zulkifli, Mohd Fariz Ikram, Muhammad Luqman, and many more people for being so kind and understanding in completing my project.

I also gratefully acknowledge the Electrical and Electronics Engineering Department of Universiti Teknologi Petronas for providing the sufficient guidance to complete this project smoothly. I also thank the department for the funding of the materials and equipments used for this project.

I will cherish the contributions, supports and encouragement of the above people in my heart forever. Without the contributions from any of these people, I believe that I would not have reached my objective. Again, thank you very much and all of you will always be remembered.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

A clothesline or washing line is any type of string, rope, cord, or twine that has been stretched between two points (i.e. two sticks), generally outside, above the level of the ground. Clothing that have been washed is hung along the line to dry, using clothes pegs or clothespins. Washing lines are attached either from a post or a wall. Longer washing lines often have poles holding up sections in the middle due to the weight of the clothing. [1]

The use of the clothesline is dependent upon fair weather and as the powered clothes dryer has become more affordable and included in home automation, especially in North America, external drying has declined in popularity. However, due to various concerns, pro-environment groups welcome the use of the clothes line. [1]

Washing lines are attached either from a post or a wall, and are frequently located in back gardens, or on balconies. Zoning regulations may prohibit their use as clothes lines are sometimes associated with poverty or considered not aesthetics. This is particularly true in California. But in Scotland, many tenement buildings have a drying green — a communal area which, while it may be used as a recreational space, is predominantly a place with many clothes lines. In Australia, one may see examples of the Hill Hoist, a type of rotary clothes line built in that country, although other countries have their own design of rotary.[1]

More elaborate rotary washing lines save space and are typically retractable and square or triangular in shape, with multiple lines being used. These can be folded up when not in use, although there is a hazard of getting fingers caught in the folded up version, so there is usually a safety button involved. [1]

1.2 Problem Statement

The present scenario is, it is hard to predict rain since the users will not be at their house all the time. If the users are available, they can bring the clothes to safe place when the rain comes by themselves. Despite the availability of the users at homes, it needs time for them to realize that the rain is coming and take the initial action to put the clothes at the safe place. If they are away from home, the clothes will become wet when the rain falls. It will be convenient if such an automation system exists which can provide assistant to the people in managing the laundries in everyday life. Therefore, an automation system that can detect the rain drops or incoming rain and bring the clothes to the safe place is needed so that daily routines can be done easier.

1.3 Objective and Scope of Study

The objectives of this project were to design and to build an automated clotheslines system for users by using the components such as water sensor, microcontroller and electric motor with the aim of achieving the following:

1. Detecting the presence of rain
2. Bringing the laundries to the sheltered place handfree.

The scope of the study covered only the design and modeling development of an automated clothesline system with sensory system and simple movement mechanism system. The main function of the automated clothesline system was the ability of detecting the presence of rain and bringing the laundries to the sheltered place independently without human intervention. The selection of materials, components, circuits and hardware used for the movement mechanism was done to produce a working model.

The sensory system was developed based on the application of water-resistant sensor. The water-resistant sensor for the automated clothesline system was constructed based on the existing water-resist sensors that are published on the internet website.

For the movement mechanism, the system utilized bi-directional DC motor to perform the movement of the loaded strings in both forward and reverse direction. The DC motor control system circuit was constructed based on the H-Bridge connection which was the general connection used for any kind of DC motor direction control. The movement mechanism was triggered by the important signal sent by the microcontroller as the microcontroller received the appropriate signals for the sensory system. Therefore, the microcontroller acted as the brain of the automated clothesline system and controlled the direction of the DC motor movement. The summarized scopes of project were:

1. Designing and constructing the sensor and motor circuit.
2. Programming the PIC microcontroller.
3. Build the automated clothesline system.

CHAPTER 2

LITERATURE REVIEW

2.1. Available Clothesline System

There are many types of clothesline available in the market. The basic type or the most popular type of clothesline is the T-shaped clothesline which is made by two T-shaped rod and strings. Figure 1 (a) shows the system of T-shaped clothesline. The other types of clothesline are rotary washing lines, retractable and triangular clothesline and clothesline with multiple lines. In order to make life easier, many inventors have tried to invent an automatic clothesline.

One type of automatic clothesline that are sold now is Cord-O-Clip automatic pulley. This clothesline consists of a rotary system and clothes clips and it was designed to ease the users to hang up their clothes on the washing line. The Cord-O-Clip is a revolutionary new product that makes drying laundry become the natural way simple for everyone. The user's only need to hang the clothes over the line, push the line along with their hand and their garment is clipped up securely to dry and the line is ready for your next article of laundry. Ultra strong clips ensure that all types of laundry are held securely and can withstand strong winds. The Cord-O-Clip is said to be the solution for the people, providing customer with fast ease of use and complete convenience that up until now has only been available from expensive, environmentally un-friendly clothes dryers. See Figure 1(b).

Figure 1 (b) shows the Cord-O-Clip automatic pulley. [2]

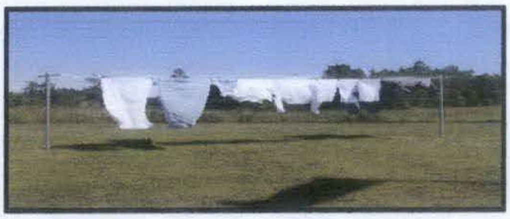


Figure 1(a): T-Shape Clothesline

Figure 1(b): Cord-O-Clip Automatic

2.2 Automated Clotheslines System

Automated clothesline system was a clothesline system designed to protect the laundry from the rain. This clothesline system detected the presence of rain and automatically brings the laundry to the sheltered place. The innovation of automated clothesline system was to provide a system embodied by a circuit consisting of sensors, microcontroller, electric motor device complete with a pulley system, with the capability of pulling the clothes-line hands free. The system was designed to provide the accommodation to the users so that they can perform their work peacefully and comfortably without worrying about their laundry.

Figure 2 shows the design concept of the automated clothesline system. The humidity or water sensor was used to detect the presence of rain and completed the electronics circuit so that it can give signal to the microcontroller. Then, the microcontroller gave the instruction to the motor to pull the clothesline into sheltered area where the clothes will be protected from the rain.

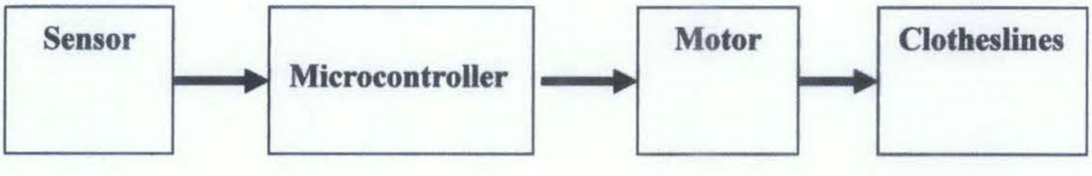


Figure 2: The design concept of automated clothesline system

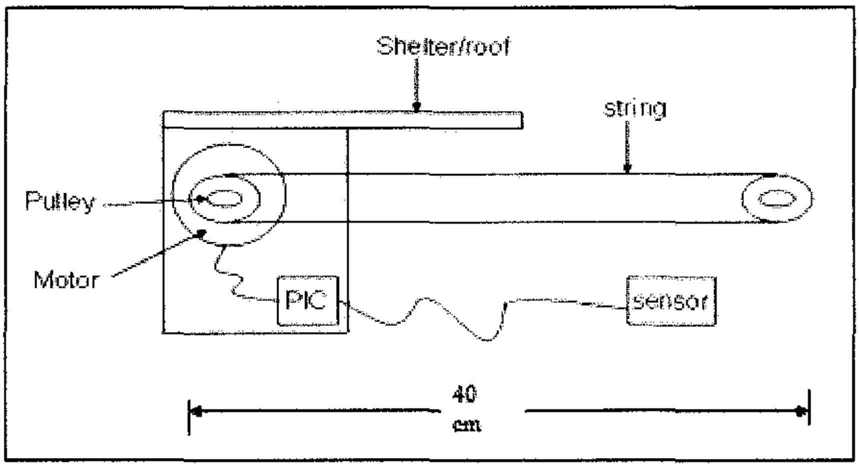


Figure 3: The design of automated clothesline system

2.3 Power Supply

Power supply from DC voltages was needed to power up the Automated Clothesline system. PIC needs 5V DC from the power supply so that it can run the system. Therefore, 12V DC power supply from battery needs to be converted to 5V in order to realize the system. This was achieved by using the voltage regulator to step the voltage down to 5V. In addition, voltage regulator circuit also provided circuit protection against voltage spikes.

2.3.1 Voltage Regulator

Voltage regulators are used to produce a stable power supply voltage (+Vs) from a higher (varying) DC voltage and to limit the current supply. Some electronic systems require a stable voltage supply. A varying input voltage can be converted to a stable DC voltage by using a voltage regulator as illustrated in Figure 4[3].

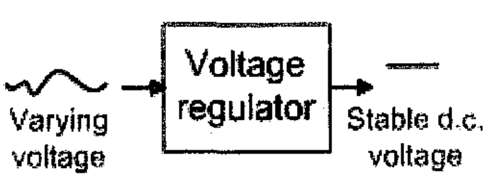


Figure 4: Voltage Regulator Operation [3]

LM78L05 voltage regulators can be used to produce an output voltage which is close to 5V (within the range 4.75V to 5.25V) .The voltage regulator will accept input voltages that vary anywhere in the range 7.5V to 35V. Voltage regulator provides protection to prevent the current drawn from input voltage source exceeding these limits. This can be useful in preventing excessive current being drawn from rechargeable batteries and also protects against accidental reverse connection of the input voltage source [3].

As stated in PICbasic Project by Ibrahim Dogan [6], a voltage regulator circuit is used to convert the 12V voltage to 5V, independent of the current drawn from the supply. A basic voltage regulator circuit consists of a regulator integrated circuit (IC) and filter capacitor. Figure 5 shows the low-cost voltage regulator circuit using LM78L05 IC with two filter capacitors. LM78LXX is a 3-pin IC with a maximum current capacity is 100mA [3].The input pins of the LM78LXX need to be connected to the +V terminal of the battery in parallel with a 0.33 μF capacitor while the ground pin is connected to the –V terminal of the battery. The third pin of LM78L09 which provides the output of 9V will be connected to the water level sensor circuits and LM78L05 which provides the 5V output will be connected to the microcontroller

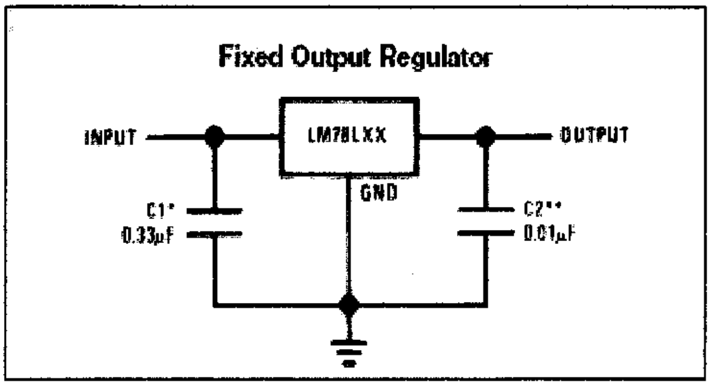


Figure 5: Circuit Diagram of the Voltage Regulator [3]

2.4 Water Sensor

Three sensors were considered to be used in the system consist from three different sensors. Through rigorous testing, the best suited sensor was chosen for the project. All three sensors received power from the battery. Each sensor completed a circuit in a unique way and allowed current to flow through it and to the microcontroller. The sensors that had been considered in this project were:

1. Infra red transmitter & detector circuit.
2. PC board sensor circuit.
3. Water detector circuit.

Considering the advantages and disadvantages of the above types of sensors, the water detector circuit has been chosen as the sensor circuit instead of the other two. Since this project is dealing with water, the infra red transmitter & detector circuit and the PC board sensor circuit were not quite suitable. The advantage of using the water detector circuit was that the sensor was not sensitive to the light. [4]

2.5 Microcontroller, PIC 16F877

Microcontrollers can be found in any products these days. For example modern washing machine in our house that consists of timer, button and LED contains a microcontroller. All modern cars also contain microcontroller. PIC is a family of Harward Architecture Microcontroller made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. PICs are popular with developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability. [5]

Microcontrollers are single-chip computer consisting of CPU (central processing unit), data and program memory, serial and parallel I/O (input/output), timers, external and internal interrupts, all integrated into a single chip that is very cheap in the market. Most microcontrollers operate with the standard logic voltage of +5V. Then, voltage regulators are needed to step the voltage down to 5V to supply the microcontroller [6].

In this project, the microcontroller module acquired inputs from water sensors. The output of the microcontroller was sent to the motor controller to control the motor movement. The microcontroller acted as the brain of the system and it will be programmed by using C language. The logic flow and motor running time will be programmed in this microcontroller.

The type of microcontroller that was used in this project is PIC16F877 which is one of the most popular PIC microcontrollers for a very long time. This type of microcontroller was chosen because PIC16F877 is readily available in market, easier to programmed and versatile. Besides, the functions of this microcontroller are suitable for the project. It consists of 40 pin devices and offers 8k x 14 words Flash Program Memory, 368 bytes RAM and 256 bytes EEPROM. There are 33 I/O pins where each pin can source or sink 25 mA current. Additionally, the device contains 3 timers with internal oscillator [7]. Other features of the PIC16F877 have been simplified in Table 1 and Table 2 shows the pin description of the PIC16F877 and Figure 6 shows the PIC16F877 pin configuration.

Table 1: Features of Microcontroller, PIC16F877 [7]

Key Features PICmicro™ Mid-Range Reference Manual (DS33023)	**PIC16F877**
Operating Frequency	DC - 20 MHz
FLASH Program Memory (14-bit words)	8K
RAM Data Memory (bytes)	368
EEPROM Data Memory (bytes)	256
Interrupts Capability	14 Source
I/O Ports	Ports A,B,C,D,E
I/O Pins	33
Timers	3
Serial Communications	MSSP, USART
Parallel Communications	PSP
Operating Voltage Range	2.0V to 5.5V
High Sink / Source Current	25 mA

Table 2: Microcontroller PIC16F877 Pin Description [7]

Pin	Description	Pin	Description
1	MCLR – Master clear	40	RB7 – PORT B bit 7
2	RA0 – PORT A bit 0	39	RB6 – PORT B bit 6
3	RA1 – PORT A bit 1	38	RB5 – PORT B bit 5
4	RA2 – PORT A bit 2	37	RB4 – PORT B bit 4
5	RA3 – PORT A bit 3	36	RB3 – PORT B bit 3
6	RA4/T0CK1 – PORTA bit 4/ Counter clk	35	RB2 – PORT B bit 2
7	RA5 – PORT A bit 5	34	RB1 – PORT B bit 1
8	RE0 – PORT E bit 0	33	RB0/INT – PORT B bit 0
9	RE1 – PORT E bit 1	32	Vdd - + V supply
10	RE2 – PORT E bit 2	31	Vss – Gnd
11	Vdd - + V supply	30	RD7 – PORT D bit 7
12	Vss – Gnd	29	RD6 – PORT D bit 6
13	OSC1 / CLK IN	28	RD5 – PORT D bit 5
14	OSC2 / CLK OUT	27	RD4 – PORT D bit 4
15	RC0 – PORT C bit 0	26	RC7 – PORT C bit 7
16	RC1 – PORT C bit 1	25	RC6 – PORT C bit 6
17	RC2 – PORT C bit 2	24	RC5 – PORT C bit 5
18	RC3 – PORT C bit 3	23	RC4 – PORT C bit 4
19	RD0 – PORT D bit 0	22	RD3 – PORT D bit 3
20	RD1 – PORT D bit 1	21	RD2 – PORT D bit 2

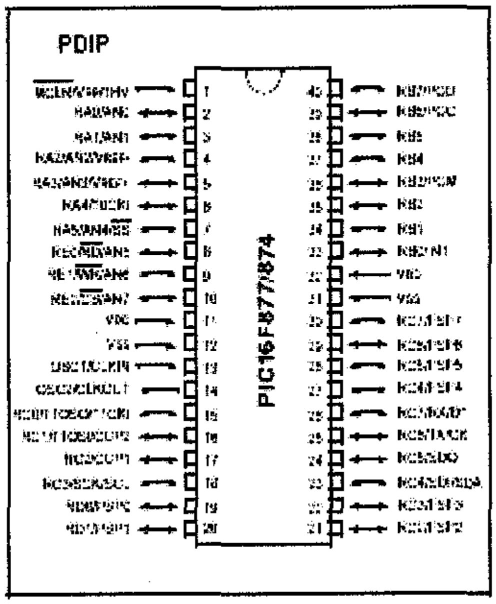


Figure 6: Microcontroller PIC16F877 Pin Configuration [7]

2.6 PIC Programmer Module

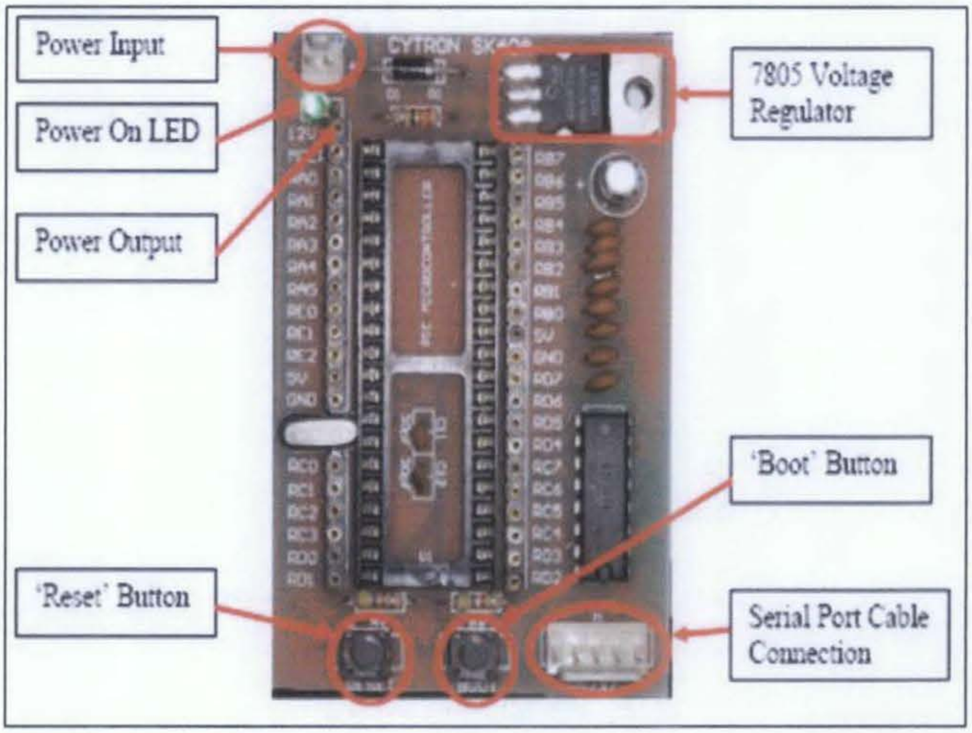
Programmers are traditionally used to get program code into the PIC. It is a hardware device that configures programmable non-volatile circuits such as EEPROM or programmable logic circuits.

Nowadays, there are many programmers for PIC microcontrollers ranging from the extremely simple designs which rely on ICSP (In Circuit Serial Programming) to allow direct download of code from a host computer, to intelligent programmers that can verify the device at several supply voltages. Many of these complex programmers use a pre-programmed PIC themselves to send the programming commands to the PIC that is to be programmed [8].

These are some common programmer types:

1. Simple serial port ICSP programmers
    - Generally rely on driving the PIC's Vss line negative to get the necessary voltage differences from programming. Hence they are compact and cheap but great care is needed if using them for in circuit programming [8].
2. Simple parallel port ICSP programmers
    - Simple to understand but often have much higher part counts and generally require external power supplies [8].
3. Intelligent programmers
    - Generally faster and more reliable (especially on laptops which tend to have idiosyncrasies in the way they implement their ports) but far more complex to build (in particular they tend to use a PIC in the programmer which must itself be programmed somehow) [8].

For this project, CYTRON SK40A was used as the PIC Programmer. SK40A have onboard voltage regulator, 7805 which will provide stable 5V output to PIC and other application. However, the maximum current of this regulator is only 1A, thus if higher current is needed, an additional voltage regulator is required. SK40A is ready with a protection diode to avoid damage to circuit if the Power Input polarity is connected wrongly. Once power is connected to Power Input, Power On LED will light up. If the LED does not light after power is connected, it might be caused by wrong polarity of power or no power from battery. SK40A also capable to accept the input voltage that range from 7V to 30V [9]. Figure 7 shows the CYTRON SK40A PIC Programmer and the schematic diagram for CYTRON SK40A PIC Programmer respectively.



2.7 Motor Controller Module

An H-bridge is an electronic circuit which enables DC electric motors to be run forwards or backwards. These circuits are often used in robotics. H-bridges are available as integrated circuits, or can be built from separate components. The term "H-bridge" is derived from the typical graphical representation of such a circuit.

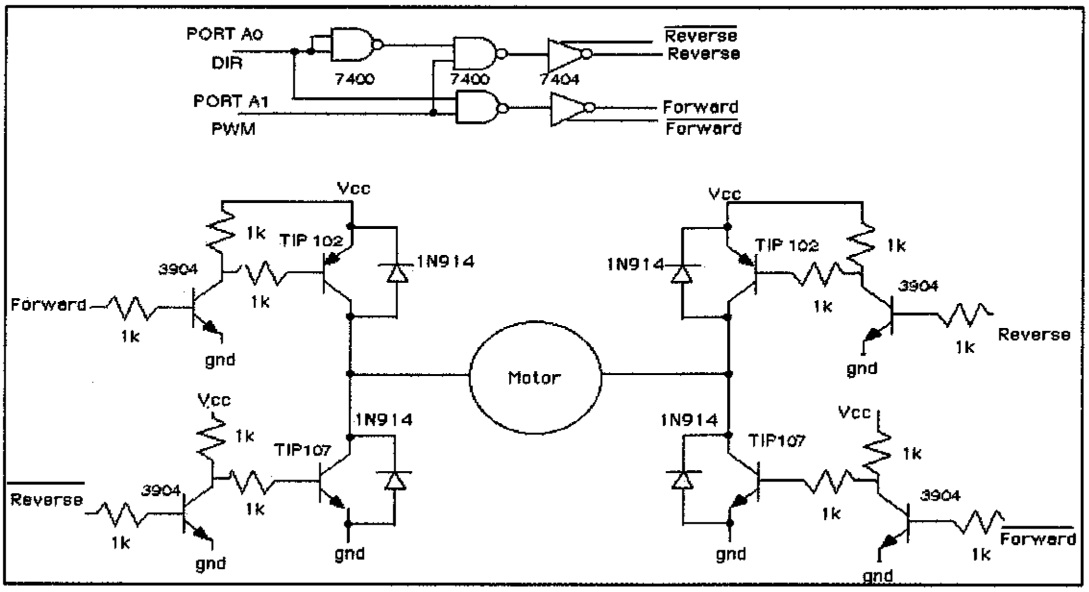


Figure 8: Structure of H-bridge Circuit [10]

As shown in the H-bridge switching in the Figure 8, there are four transistors used surrounding the motor (Q1, Q2, Q3 and Q4) which are the switching transistor to determine the direction of the current flow through the motor.

As input '0' is fed to the microcontroller, the base current flows into the base of the Q1 transistor to forward-bias the base-emitter junction, thus the current can flow from the collector to emitter to ON Q1 transistor. At the same time, Q4 is ON due to the flowing current to the base of Q1 which is allowing the collector current to flow to the emitter. Therefore, the potential at the emitter junction of Q1 is higher than the potential at the collector junction of Q3 to allow the current flow from positive terminal to negative terminal of the motor. Thus, the motor is rotating at the clockwise direction. When input '1' is fed, the motor will operate in anticlockwise direction with the same switching mechanism through the Q2 and Q4. [10]

Using the nomenclature above, the switches Q1 and Q2 should never be closed at the same time, as this would cause a short circuit on the input voltage source. The same applies to the switches Q3 and Q4. This condition is known as shoot-through [10].

In this project, the L293 H-bridge driver was used to drive the 12V dc motor either to be forward or reverse operation. Two enable inputs were provided to enable or disable the motor independently of the input signals [11]. These two inputs were droved by the signal from the microcontroller as to enable the changes of the direction of the motor movement. Figure 9 shows the L293 H-bridge IC and Figure 10 shows the L293 pin connections.

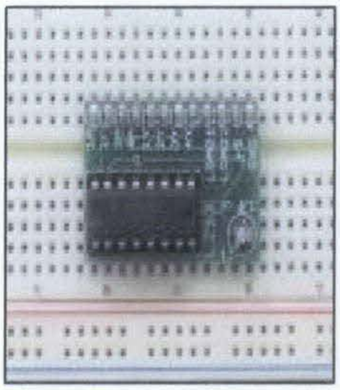


Figure 9: L293 H-bridge [11]

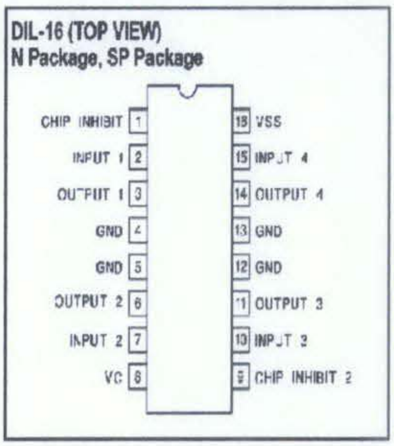


Figure 10: L293 Pin Connections [11]

2.8 DC Motor

The bi-directional DC was used in this project because it can provide continuous rotational to pull the string in either clockwise or anticlockwise direction.

The continuous rotational move was utilized to bring the clothes to the sheltered area fast enough so that the clothes will not get wet. The motor that was considered to be used was DC motor that will be supplied by 12 V dc voltage. [12]

Figure 11: DC motor [12]

2.9 Pulley and String

Two pulleys were used in this system. The pulleys have the internal diameter as the shaft of the power window motor since one of the pulleys will be attached to the shaft. The expected internal diameter of the pulley is about 1.5 centimeters. The string that was used will come from cord type of string. The lengths of the string will be around 7 meters.

For the model, track and gear were used instead of string and pulley. It was due to the difficulty to find the available pulley in small size.

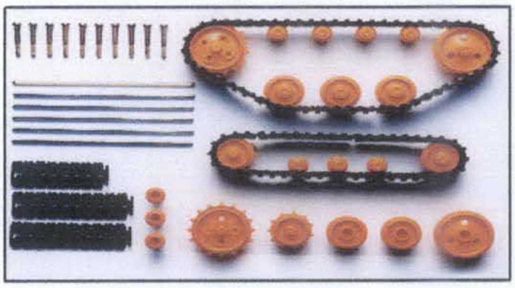


Figure 12: Track and gear [12]

CHAPTER 3

METHODOLOGY

For this project, Figure 2 shows the project workflow followed by the author.

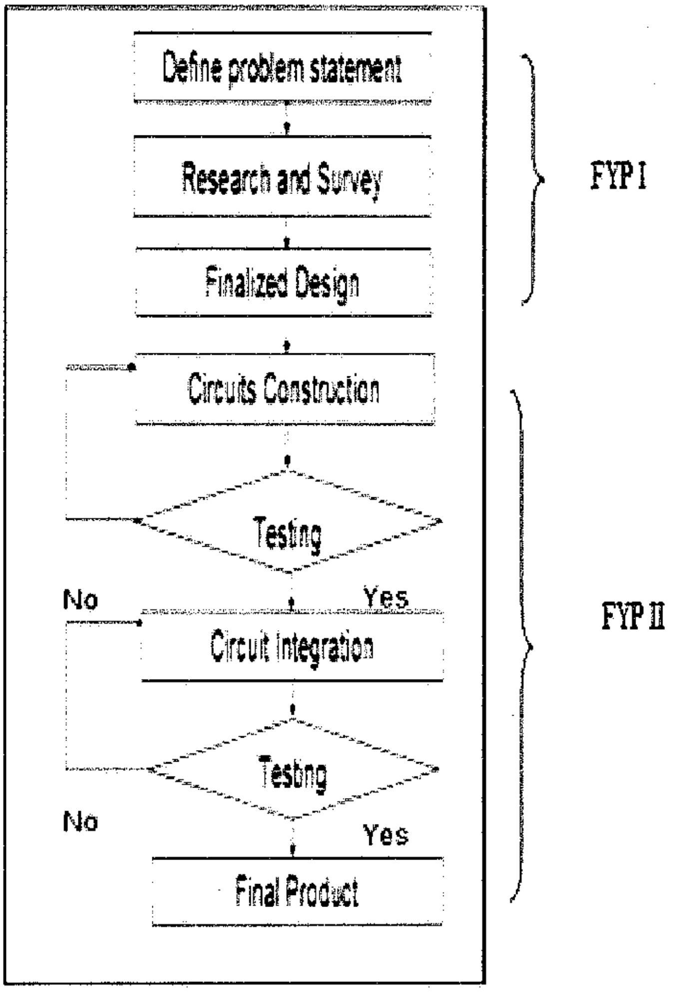


Figure 13: Project work flow

During Final Year Project I, the problem statement for the project was defined thoroughly to get the problem solutions. Then, research and studies was carried out to ensure the best ways to conduct the project. Research and studies regarding materials were including what suitable hardware, software and the cost of materials for the project were done. During the conducted studies, the final design was determined.

As for Final Year Project II, the designed circuit was drawn and simulated in suitable software and constructed on the breadboard. The circuits were tested and modified until the outcomes fulfilled the project objective. After that, all the circuit were integrated, tested and modified to ensure the prototype was working properly.

3.1 Tools Required

For the implementation of the project, several tools were required to be used to attain the goals.

Hardware

- Water level sensor circuit
- PIC Microcontroller
- Pulley and string (replaced by track and gear)
- 12V DC motor

Software

- PSpice software

  - To draw and simulate the designed circuit
- PIC C software

  - C language software for programming the PIC Microcontroller
- WARP 13

  - The burner software to burn the PIC Microcontroller
- Eagle Layout Editor

  - Schematic drawings and Gerber files creation to design the printed circuit board (PCB)

3.2 Project Activities

The part of the project work that was done in the first semester (FYP1) include the initial construction of the water level sensor circuits, construction of the voltage regulator circuits and circuits testing. Figure 13 shows the schematic diagram for voltage regulator circuits and Figure 14 shows the schematic diagram for water sensor circuit.

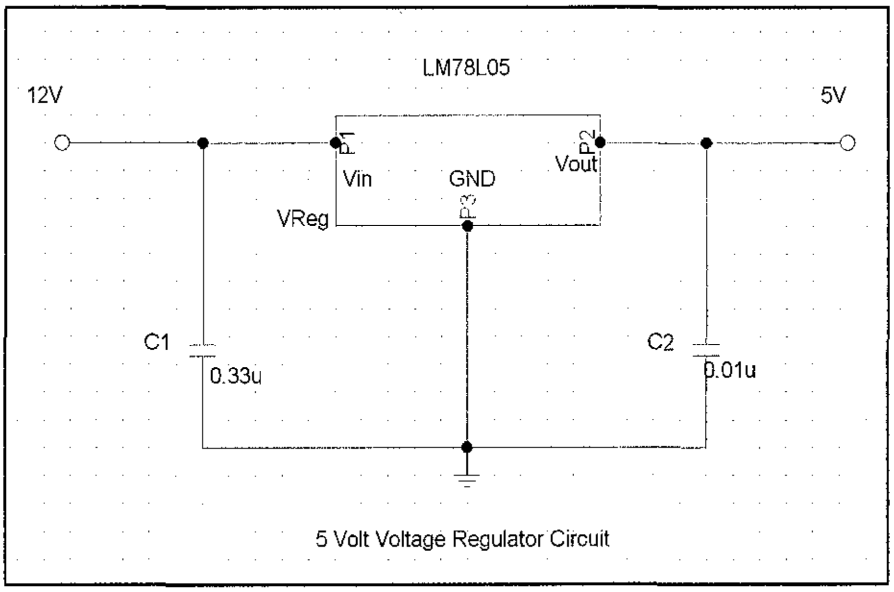


Figure 14: Voltage regulator schematic diagram

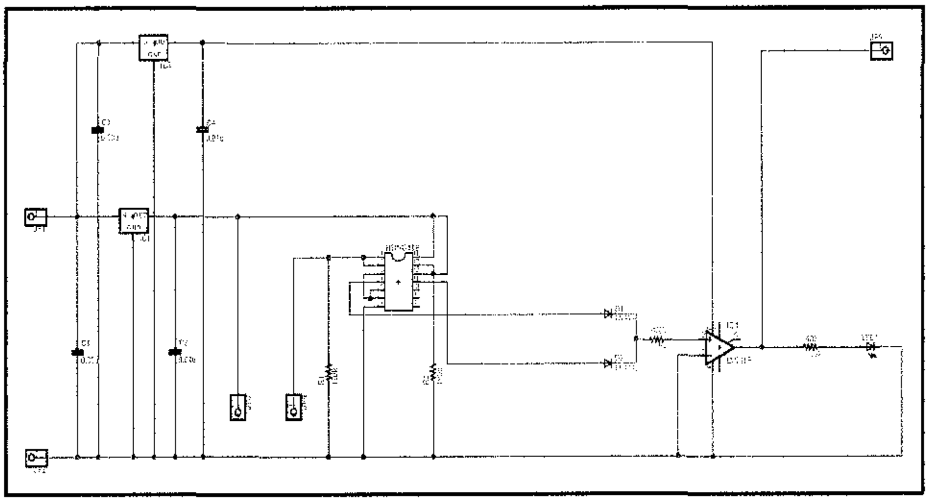


Figure 15: Water sensor schematic diagram

As for FYP II, the project was continued by creating Gerber Files to produce printed circuit board (PCB) for each circuits, constructed and tested the main controller circuit (PIC and H-Bridge circuit). Most of the construction of these circuits on a printed circuit board (PCB) was done and the prototype was integrated and constructed.

CHAPTER 4

RESULTS & DISCUSSION

4.1 Motor Specification

In order to ensure that the movement mechanism system performed as expected, the calculation for the energy needed to pull up the string and the power of the motor had been done. This calculation was made to guarantee that the chosen 12V DC motor was capable to pull up the string. In the actual system, it was expected that the system should be able to pull the string with weight up to 20 kilogram of laundries.

The power needed for motor given by:

$$P = E \div s$$

Where s was time taken to lift the load and E was energy needed given by;

$$E = F \times d$$
$$= M \times g \times d$$

Where;

F = Force needed to lift the load

d = Distance load to be lift up in meter

M= Total mass of the load

g = Gravity force

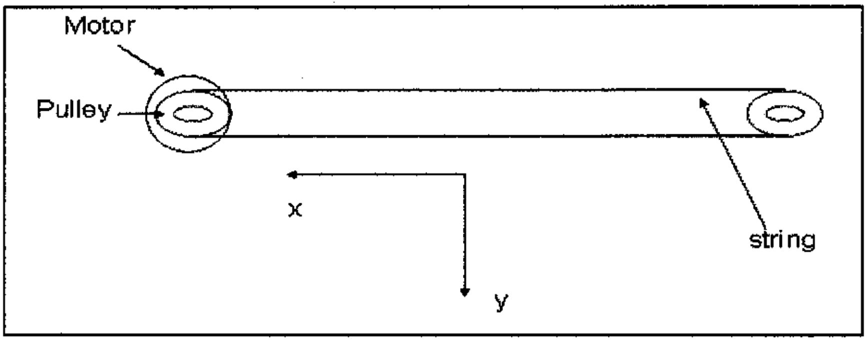


Figure 16: Illustration of clotheslines

x = force of motor

y = force of gravity and clothes weight

For actual system;

Neglecting the tension of the string:

Energy needed	=	F*d
	=	(M total) * (g) * (h)
	=	(20)*(9.81)*(0.10)
	=	19.62 Joule
Power motor needed	=	E/s
	=	(19.62) / (10s)
	=	1.962 W
	=	2.5801012×10^{-3} hp
12 V power window motor	=	I * V
	=	1.16 A * 12 V
	=	13.92 W
	=	1.8×10^{-2} hp

For this actual system, a motor with 2.5801012 x 10^{-3} hp was needed to run the whole system. Based on the calculation above, it was concluded that the power for 12 V power window motor was sufficient enough to drive motor and pull the 20 kg loaded string.

For model system;

Energy needed	=	F*d
	=	(M total) * (g) * (h)
	=	(1.6x10-4)*(9.81)*(0.10)
	=	1.5696 Joule

Power motor needed	=	E/s
	=	(1.5696x10-4) / (10s)
	=	1.5696x10^{-5} W

12 V DC motor	=	I * V
	=	0.05 A * 12 V
	=	0.6 W

For this actual system, a motor with 1.5696x10^{-5} W was needed to run the whole system. Based on the calculation above, it was concluded that the power for 12 V DC motor was sufficient enough to drive motor and pull the 1.6 x 10^{-4} kg loaded string.

4.2 Water Sensor Circuit

The water sensor circuit was constructed based on the schematic in Figure 15. This sensor circuit used 9 V battery as an input signal and the LED as the output. When both sensor pads were immersed in water, the water served as the current conductor that would closed the circuit to make a complete sensor circuit and lightened LED up. When the sensor pads were removed from the water, the connections was opened and the LED was turned off. The sensor circuit constructed on breadboard is shown in Figure 16.

Figure 17: Constructed water level sensor

The outputs measured from the circuit were maintained at 3.99V. The value measured was sufficient for signal voltage since only 2V was needed to trigger the PIC [6] so, by having the output voltage maintain at 3.99V, this sensor circuit was assumed can be used for the system.

4.3 Voltage Regulator Circuit

The voltage regulator was needed to convert 12 V DC supply to 5 Volt DC for PIC. In order to convert 12 Volt DC to 5Volt DC, voltage regulator circuit was constructed using LM78L05 voltage regulator IC. Figure 17 and Figure 18 shows the circuit diagram and constructed circuit for 5 Volt voltage regulator circuit using LM78L05. Table 3 shows the measured output for the circuit.

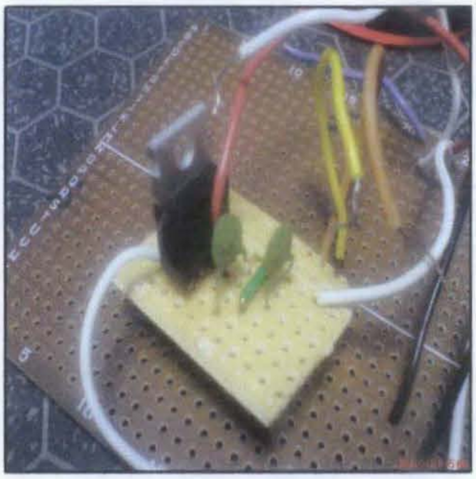


Figure 18: Constructed 5V Voltage Regulator Circuit

Table 3: Expected and measured output voltage for voltage regulator circuit LM78L05

Expected Output Voltage	Measured Output Voltage
5.0 V	4.99 V
5.0 V	4.99 V
5.0 V	4.96 V

The above table shows that the constructed voltage regulator circuit was able to produce 5 V output voltages from 12 Volt DC supply as expected but, further test were conducted to ensure that the outputs current were sufficient to supply power to the PIC circuit.

4.4 Motor Controller and PIC Circuit

This circuit was a circuit that was consisted of PIC circuit and H-Bridge circuit. PIC acted as the brain for the system. The PIC will send the output signal to the motor's circuit input to drive the motor. The H-bridge circuit was used to control the motor's forward and reverse movement respectively.

Figure 19 shows the constructed main control circuit.

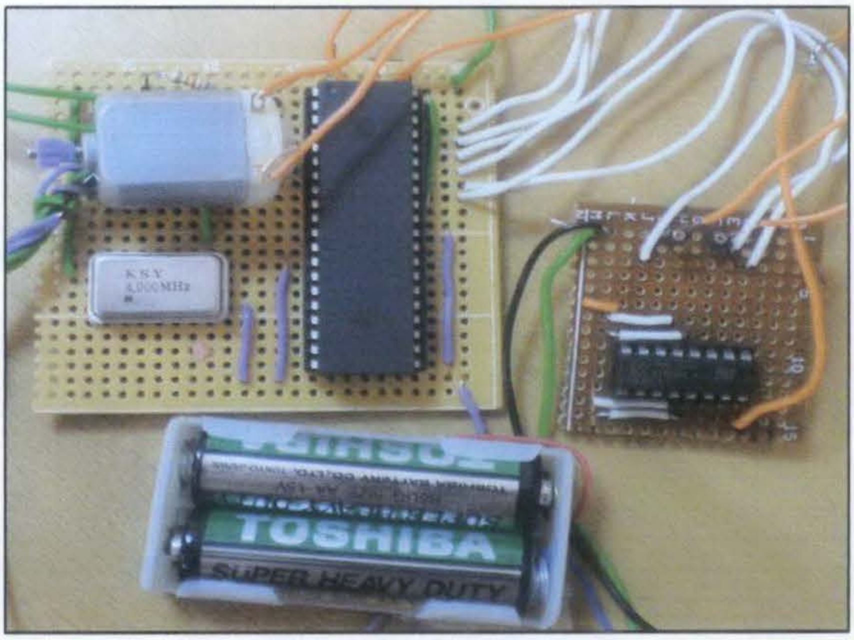


Figure 19: Motor control and PIC circuit

4.5 Gear and Track System

The gear and track system was one of the major parts of the system. This part, together with the motor pulled the clothes to the sheltered place. This part was consisted of 30 mm X 125 mm perspex with the gear and track. It was attached to the base through 1 mm shaft hole.

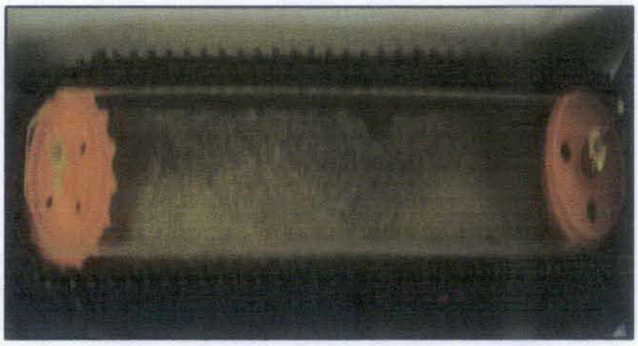


Figure 20: Automated Clothesline System Gear and track system

4.6 Base

The base for the model of clotheslines system was constructed from perspex which had 200mm in width and 445mm in length. The base acted as the support to system since the shaft of the motor can not be used as the poles to support the overall system.

Figure 21: Automated Clothesline System Base

4.7 Overall system

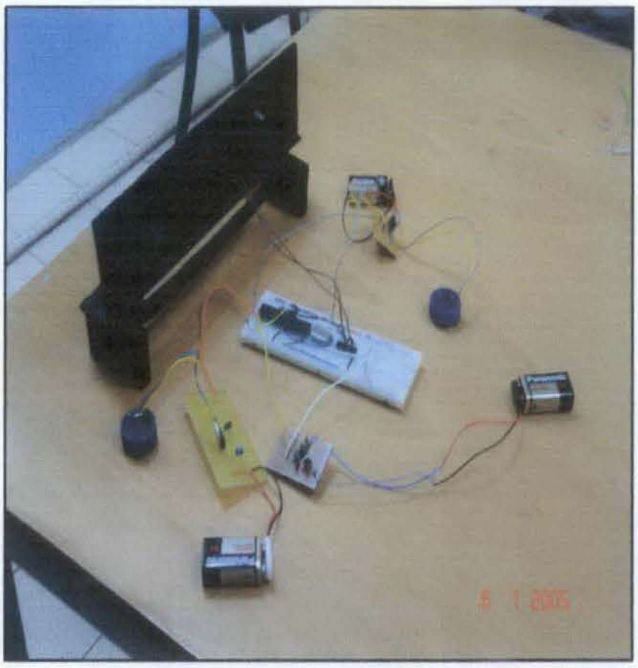


Figure 22: Automated Clothesline System

All the individual part of the system was assembled and integrated. When the sensor system detected the water, an output of 5 V has been given to PIC microcontroller. With this output, the microcontroller have triggered the motor system to move forward and pulled the track back to sheltered place by sending an output of 5V. But, the motor movement was not exactly as the expected result since the motor do not stop at the specified placed. It was believed that due to the distance of the poles were too short caused the time delay introduced cannot stop the motor at the exact place. Some tests or experiments have been conducted to determine the right time delay for the microcontroller. The data of the experiments that were conducted was shown in Table 4.

Table4: The relation between motor supply, time delays and location displacement.

Motor supply (V)	Time delay (s)	Displacement from exact location (cm)
5	10	100
5	7	79
5	5	60
5	1	35
2	10	65
2	7	48
2	5	37
2	1	31

The table shown that the time for the motor movement stopped was longer than expected. But as the motor supply power has been reduced to 2V, the displacements also have been reduced. Therefore, for this model, as long as the motor supply can reduced to the minimum requirement of the motor, the distance of displacement can be reduced significantly.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The objective of the project was to develop an automated clothesline system. The system made use of sensors, motor and microcontroller to enhance the process of clothes drying. After the system was integrated and constructed, it is concluded that this project is viable that it can detect rain and put the clothes to sheltered place hand-free.

5.2 Recommendation

For study, it is recommended that the motor can be operated in two directions (forward-reverse actions) so that the system can either put the clothes to the safe place when it is raining or put the clothes to the unsheltered area to dry the clothes back. Therefore, another sensor (light sensor, heat sensor, etc) are needed for this requirement. It was also recommended that limit switch were used to replace the time delay function so that the motor could be stopped at the requirement time and place.

REFERENCES

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http://en.wikipedia.org/wiki/H_bridge

[11] L293 Datasheet, Dual Full Bridge Driver, January 2000, STMicroelectronics

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http://en.wikipedia.org/wiki/Motor_controller

APPENDICES

APPENDIX A

LM78LXX DATASHEET

National Semiconductor

April 2006

LM78LXX Series
3-Terminal Positive Regulators

LM78LXX Series 3-Terminal Positive Regulators

General Description

The LM78LXX series of three terminal positive regulators is available with several fixed output voltages making them useful in a wide range of applications. When used as a zener diode/resistor combination replacement, the LM78LXX usually results in an effective output impedance improvement of two orders of magnitude, and lower quiescent current. These regulators can provide local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow the LM78LXX to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment.

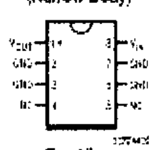
The LM78LXX is available in the plastic TO-92 (Z) package, the plastic SO-8 (M) package and a chip sized package (8-Bump micro SMD) using National's micro SMD package technology. With adequate heat sinking the regulator can deliver 100mA output current. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistors is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

Features

- LM78L05 in micro SMD package
- Output voltage tolerances of ±5% over the temperature range
- Output current of 100mA
- Internal thermal overload protection
- Output transistor safe area protection
- Internal short circuit current limit
- Available in plastic TO-92 and plastic SO-8 low profile packages
- No external components
- Output voltages of 5.0V, 6.2V, 8.2V, 9.0V, 12V, 15V
- See AN-1112 for micro SMD considerations

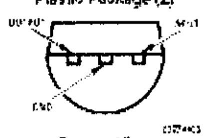
Connection Diagrams

SO-8 Plastic (M)
(Narrow Body)



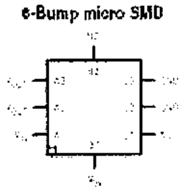
Top View

(TO-92)
Plastic Package (Z)



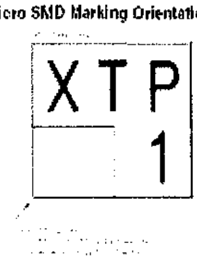
Bottom View

8-Bump micro SMD



Top View
(Bump Side Down)

micro SMD Marking Orientation



Top View

 www.national.com

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Power Dissipation (Note 5)	Internally Limited
Input Voltage	35V
Storage Temperature	−65°C to +150°C
ESD Susceptibility (Note 2)	1kV
Operating Junction Temperature	
SO-8, TO-92	0°C to 125°C
micro SMD	−40°C to 85°C
Soldering Information	
Infrared or Convection (20 sec.)	235°C
Wave Soldering (10 sec.)	260°C (lead time)

LM78LXX Electrical Characteristics

Limits in standard typeface are for $T_J = 25°C$, **Bold typeface applies over 0°C to 125°C for SO-8 and TO-92 packages, and −40°C to 85°C for micro SMD package.** Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. Unless otherwise specified: $I_O = 40mA$, $C_I = 0.33μF$, $C_O = 0.1μF$.

LM78L05

Unless otherwise specified, $V_{IN} = 10V$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_O	Output Voltage		4.8	5	5.2	V
		7V ≤ V_{IN} ≤ 20V 1mA ≤ I_O ≤ 40mA (Note 3)	4.75		5.25	
		1mA ≤ I_O ≤ 70mA (Note 3)	4.75		5.25	
ΔV_O	Line Regulation	7V ≤ V_{IN} ≤ 20V		18	75	mV
		8V ≤ V_{IN} ≤ 20V		10	54	
ΔV_O	Load Regulation	1mA ≤ I_O ≤ 100mA		20	60	
		1mA ≤ I_O ≤ 40mA		5	30	
I_Q	Quiescent Current			3	5	mA
ΔI_Q	Quiescent Current Change	8V ≤ V_{IN} ≤ 20V			1.0	
		1mA ≤ I_O ≤ 40mA			0.1	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz (Note 4)		40		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz 8V ≤ V_{IN} ≤ 18V	47	62		dB
I_{PK}	Peak Output Current			140		mA
$\frac{\Delta V_O}{\Delta T}$	Average Output Voltage Tempco	I_O = 5mA		−0.65		mV/°C
V_{IN} (Min)	Minimum Value of Input Voltage Required to Maintain Line Regulation			6.7	7	V
θ_{JA}	Thermal Resistance (8-Bump micro SMD)			230.9		°C/W

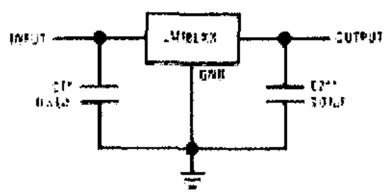
LM78L62AC

Unless otherwise specified, $V_{IN} = 12V$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_O	Output Voltage		5.95	6.2	6.45	V
		8.5V ≤ V_{IN} ≤ 20V 1mA ≤ I_O ≤ 40mA (Note 3)	5.9		6.5	
		1mA ≤ I_O ≤ 70mA (Note 3)	5.9		6.5	

Typical Applications

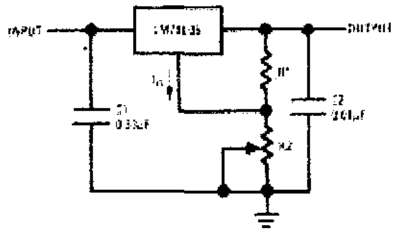
Fixed Output Regulator



*Required if the regulator is located more than 3" from the power supply filter.

**See (Note 4) in the electrical characteristics table.

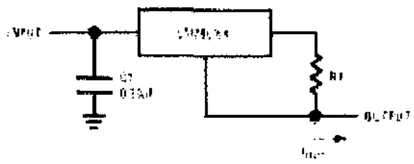
Adjustable Output Regulator



$V_{OUT} = 5V + (5V/R1 + I_Q) R2$

$5V/R1 > 3 I_Q$, load regulation $(L_r) \approx [(R1 + R2)/R1]$ (L_r of LM78L05)

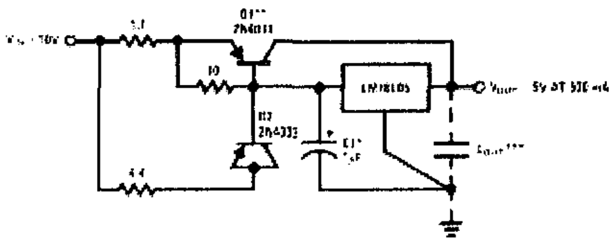
Current Regulator



$I_{OUT} = (V_{OUT}/R1) + I_Q$

$\Delta I_Q = 1.5mA$ over line and load changes

5V, 500mA Regulator with Short Circuit Protection



*Solid tantalum.

**Heat sink Q1.

***Optional: improves ripple rejection and transient response.

Load Regulation: 0.6% $0 \le I_L \le 250mA$ pulsed with $t_{ON} = 50ms$.

APPENDIX B

PIC16F87X DATASHEET

MICROCHIP

PIC16F87X

28/40-pin 8-Bit CMOS FLASH Microcontrollers

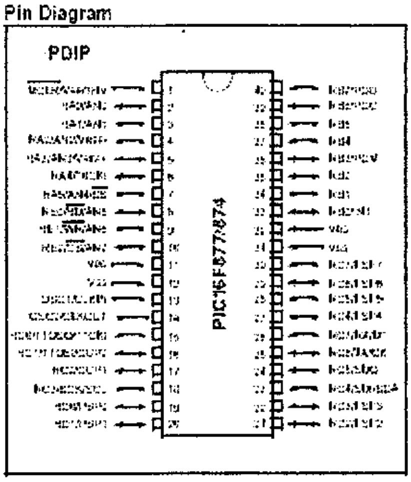
Devices Included in this Data Sheet:

- PIC16F873
- PIC16F874
- PIC16F876
- PIC16F877

Microcontroller Core Features:

- High-performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input
  DC - 200 ns instruction cycle
- Up to 8K x 14 words of FLASH Program Memory,
  Up to 368 x 8 bytes of Data Memory (RAM)
  Up to 256 x 8 bytes of EEPROM data memory
- Pinout compatible to the PIC16C73B/74B/76/77
- Interrupt capability (up to 14 sources)
- Eight level deep hardware stack
- Direct, indirect and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and
  Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code-protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low-power, high-speed CMOS FLASH/EEPROM technology
- Fully static design
- In-Circuit Serial Programming™ (ICSP) via two pins
- Single 5V In-Circuit Serial Programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial and Industrial temperature ranges
- Low-power consumption:
  - < 2 mA typical @ 5V, 4 MHz
  - 20 µA typical @ 3V, 32 kHz
  - < 1 µA typical standby current

Pin Diagram



Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI™ (Master Mode) and I²C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

Key Features PICmicro™ Mid-Range Reference Manual (DS33023)	PIC16F873	PIC16F874	PIC16F876	PIC16F877
Operating Frequency	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz
Resets (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
FLASH Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory	128	128	256	256
Interrupts	13	14	13	14
I/O Ports	Ports A,B,C	Ports A,B,C,D,E	Ports A,B,C	Ports A,B,C,D,E
Timers	3	3	3	3
Capture/Compare/PWM modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 input channels	8 input channels	5 input channels	8 input channels
Instruction Set	35 Instructions	35 Instructions	35 Instructions	35 Instructions

Pin	Description	Pin	Description
1	MCLR – Master clear	40	RB7 – PORT B bit 7
2	RA0 – PORT A bit 0	39	RB6 – PORT B bit 6
3	RA1 – PORT A bit 1	38	RB5 – PORT B bit 5
4	RA2 – PORT A bit 2	37	RB4 – PORT B bit 4
5	RA3 – PORT A bit 3	36	RB3 – PORT B bit 3
6	RA4/T0CK1 – PORTA bit 4/ Counter clk	35	RB2 – PORT B bit 2
7	RA5 – PORT A bit 5	34	RB1 – PORT B bit 1
8	RE0 – PORT E bit 0	33	RB0/INT – PORT B bit 0
9	RE1 – PORT E bit 1	32	Vdd - + V supply
10	RE2 – PORT E bit 2	31	Vss – Gnd
11	Vdd - + V supply	30	RD7 – PORT D bit 7
12	Vss – Gnd	29	RD6 – PORT D bit 6
13	OSC1 / CLK IN	28	RD5 – PORT D bit 5
14	OSC2 / CLK OUT	27	RD4 – PORT D bit 4
15	RC0 – PORT C bit 0	26	RC7 – PORT C bit 7
16	RC1 – PORT C bit 1	25	RC6 – PORT C bit 6
17	RC2 – PORT C bit 2	24	RC5 – PORT C bit 5
18	RC3 – PORT C bit 3	23	RC4 – PORT C bit 4
19	RD0 – PORT D bit 0	22	RD3 – PORT D bit 3
20	RD1 – PORT D bit 1	21	RD2 – PORT D bit 2

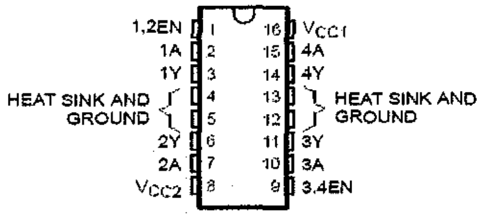
\

APPENDIX C

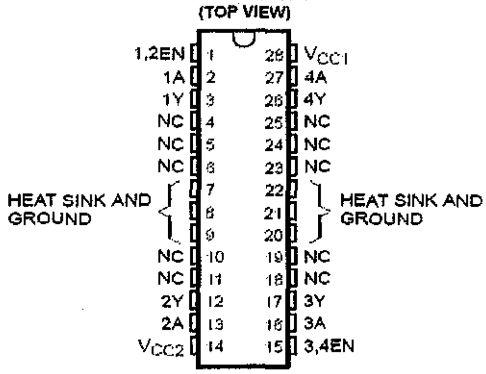
L293 DATAHEET

- **Featuring Unitrode L293 and L293D Products Now From Texas Instruments**
- **Wide Supply-Voltage Range: 4.5 V to 36 V**
- **Separate Input-Logic Supply**
- **Internal ESD Protection**
- **Thermal Shutdown**
- **High-Noise-Immunity Inputs**
- **Functional Replacements for SGS L293 and SGS L293D**
- **Output Current 1 A Per Channel (600 mA for L293D)**
- **Peak Output Current 2 A Per Channel (1.2 A for L293D)**
- **Output Clamp Diodes for Inductive Transient Suppression (L293D)**

N, NE PACKAGE
(TOP VIEW)



DWP PACKAGE
(TOP VIEW)



description

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

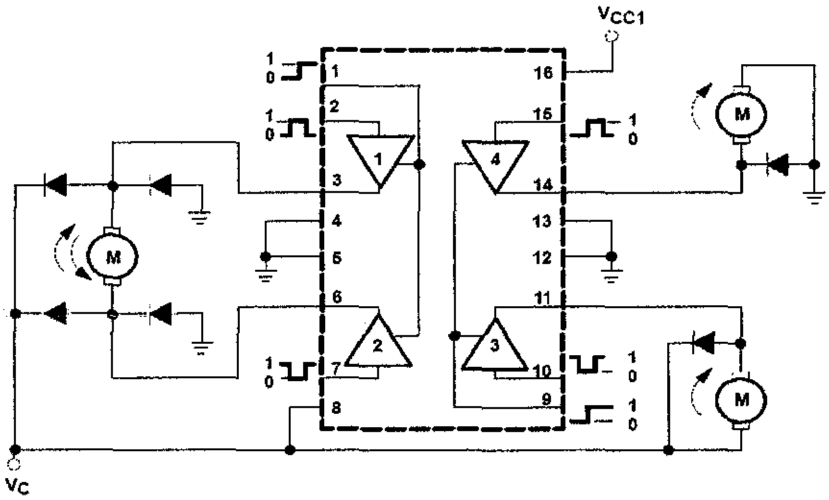
All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

On the L293, external high-speed output clamp diodes should be used for inductive transient suppression.

A V_{CC1} terminal, separate from V_{CC2}, is provided for the logic inputs to minimize device power dissipation.

The L293and L293D are characterized for operation from 0°C to 70°C.

block diagram



NOTE: Output diodes are internal in L293D.

TEXAS INSTRUMENTS
AVAILABLE OPTIONS

T_A	PACKAGE PLASTIC DIP (NE)
0°C to 70°C	L293NE L293DNE

Unitrode Products from Texas Instruments
AVAILABLE OPTIONS

T_A	PACKAGED DEVICES	
	SMALL OUTLINE (DWP)	PLASTIC DIP (N)
0°C to 70°C	L293DWP L293DDWP	L293N L293DN

The DWP package is available taped and reeled. Add the suffix TR to device type (e.g., L293DWPTR).

APPENDIX D

FYP II PROJECT GANTT CHART

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic														
	-Topic Proposal														
	-Topic assigned to students														
2	Preliminary Research Work														
	-Introduction														
	-Objective														
	-Literature review														
	-Project planning														
3	Submission of Preliminary Report				O										
4	Project Work														
	-Research : Sensor, Motor, Microcontroller														
	-Laboratory Work : Circuit Design														
5	Submission of Progress Report								O						
6	Project work continue														
	-Practical/Laboratory Work														
7	Submission of Interim Report Final Draft													O	
8	Oral Presentation														O
9	Submission of Interim Report														

APPENDIX E

FYP II PROJECT GANT CHART

No.	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Project Work Continue															
2	Submission of Progress Report 1															
3	Project Work Continue															
4	Submission of Progress Report 2															
5	Seminar (compulsory)															
5	Project work continue															
6	Poster Exhibition															
7	Submission of Dissertation (soft bound)															
8	Oral Presentation															
9	Submission of Project Dissertation (Hard Bound)															

Suggested milestone

Process