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JUDUL: **NIGHT LAMP BRIGHTNESS CONTROLLER SYSTEM**

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(HURUF BESAR)

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LOT 6880 JALAN PERMATANG 5
KEMPAS BARU 81200 JOHOR BAHRU
JOHOR DARUL TAKZIM

FAIRUZ RIZAL MOHAMAD RASHIDI
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NIGHT LAMP BRIGHTNESS CONTROLLER SYSTEM

SITI HANUM SURYA BINTI IBRAHIM

This thesis is submitted as partial fulfillment of the requirement for the
Award of the Bachelor Degree of Electrical Engineering (Electronic)

Faculty of Electrical & Electronic Engineering
University Malaysia Pahang

NOVEMBER 2009

"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Electronics)"

Signature : ________________________________

Name : FAIRUZ RIZAL MOHAMAD RASHIDI

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DEDICATION

Special dedicated to

To my beloved family, lecturer and friends who always give supports and helping me to pass through all the obstacles while doing this project.

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ABSTRACT

Night Lamp Brightness Controller System is designed as an intelligent street light. This is because this system can sense day or night, sense if there is any motion or not and can control the brightness of the lamp in two condition, dim or full brightness. The brain for this system is PIC16F877. Firstly, Light Dependent Resistor (LDR) sensor will sense day or night. If the sensor sense night, PIC microcontroller will switch on the Passive Infrared (PIR) sensor and lamp in dim condition and but if it day, there is nothing happen towards the system. Next, when PIR sensor senses the motion or movement, PIC microcontroller will switch the condition of lamp from dim to full brightness. The lamp will be in full brightness condition until the PIR sensor did not sense any movement anymore and it will back to dim conditon. Next when LDR sensor senses the intensity of light from sun, the system will turn the lamp and PIR sensor off. Lastly, this system will loop to the initial condition.

ABSTRAK

'Night Lamp Brightness Controller System' dicipta sebagai lampu jalan pintar. Ini kerana sistem ini boleh mengesan siang dan malam, mengesan jika ada pergerakan atau tidak dan boleh mengawal kecerahan lampu dalam dua keadaan iaitu malap dan terang sepenuhnya. Pengawal penuh untuk system ini adalah PIC16F877. Pertama, 'Light Dependent Resistor (LDR) sensor' akan mengesan sama ada keadaan pada waktu itu siang atau malam. Jika sensor tersebut dapat mengesan keadaan waktu itu adalah malam, PIC pengawal mikro akan mengaktifkan 'Passive Infrared (PIR) sensor' dan lampu dalam keadaan malap tetapi jika sensor mengesan hari masih siang, tidak ada apa-apa perubahan yang akan berlaku terhadap sistem. Seterusnya, apabila PIR sensor dapat mengesan pergerakan, PIC pengawal mikro akan mengubah kecerahan lampu dari malap kepada kecerahan yang penuh. Lampu tersebut akan berada dalam keadaan kecerahan yang penuh sehingga PIR sensor tidak lagi dapat mengesan sebarang pergerakan dan ia akan kembali kepada keadaan malap. Seterusnya, jika LDR sensor dapat mengesan cahaya matahari, sistem tersebut akan mematikan lampu dan PIR sensor. Dan yang terakhir adalah system ini akan kembali kepada keadaan asal.

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LIST OF SYMBOL

I/O	-	Input Output
RAM	-	Random Access Memory
ROM	-	Read Only Memory
PROM	-	Programmable Read Only Memory
EPROM	-	Erasable Programmable Read Only Memory
IC	-	Integrated Circuit
R	-	Resistor
LED	-	Light Emitter Diode
k	-	kilo
V	-	volt
mA	-	mili ampere
LDR	-	Light Dependant Resistor
PIR	-	Passive Infrared
Ω	-	ohm

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Nowadays, street light are an important component when a night is coming. It is because street light will be a component that replaces sun at night. It also will help a living creature to continue their activity at night. But, there are many highways that did not have a street light and sometimes, some place that has a street light are rarely use by the road user. Both of situations can cause a negative effect. When there is no street light at certain area that some people use, it maybe can give big chances to a robbery or other criminal activities. And when there is a street light at area that people rarely use can cause a wasting current. This also would not give any profit to the government. Others, as we can see, nowadays street light is used concept of timer. For example, the timer is set the street light will turn on at 7.00 pm and turn off at 7.00 am. This condition is not flexible because the day turn to night is not constantly. Sometimes, 7.00 pm is still in day but the street light is already switched on. And sometimes, at 7.00 am is still in the dark but the street light is already turn off.

This Night Lamp Brightness Controller System is an intelligence system. It will overcome this problem with the very flexible system. The system that to be develop with LDR sensor and Motion Detector to control the brightness of the street lamp. This system only operates at night. It will be two condition of lamp. When there is any movement is detected, the lamp will be in full brightness condition. But, if there is no motion is detected, lamp is still in dim condition. This is system is save the current that used when the lamp is in dim condition. And it can be installed at deserted area.

The advantage of this system is it did not need high current to support the lamp when it is in dim condition. Others, it is also would not cause a high cost to develop this system and when the system operating.

1.2 OBJECTIVE OF THE PROJECT

The objective of this project is to;

1. To create system that can detect day or night time according to sun's intensity.
2. At night, to control a lamp in dimmed condition when no motion has detected and full brightness when motion is detected.
3. To develop a night lamp system that can detect day or night and control the brightness of a lamp.

1.3 PROJECT SCOPE

a. Assembly the hardware and do programming for the microcontroller (PIC).

PIC that has been using in this project is PIC16F877. This is because the entire feature that content in this type of PIC microcontroller is suitable and preferable for this project. The application that has been using is ADC, PWM, and other.

b. Detect motion in 5 meters.

The sensor that has been installed in this project that function as a motion detector is Passive Infrared (PIR) sensor. The PIR Sensor has a range of approximately 5 meters. The PIR sensor can sense object up to120° within 1 meter range. The sensitivity can vary with environmental conditions. The sensor is designed to adjust to slowly changing conditions that would happen normally as the day progresses and the environmental conditions change, but responds by making its output high when sudden changes occur, such as when there is motion.

c. 2 condition of lamp is dimmed and full brightness.

According to the objective that have stated above, the lamp has to be controlled based on the situation. If there is a motion has detected, the lamp will be in full brightness, but when no motion has detected, the lamp exactly will be in dim condition. These two conditions of lamp will be controlled by PIC microcontroller by using PWM application.

d. This system can sense day or night by using LDR sensor

Light Dependent Resistor (LDR) sensor is very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically.

1.4 PROBLEM STATEMENT

As we know, there are many problems can happen when there is no street light with a well function at the highway at night. This happen because this street light is a replacement with sun at night besides a moon. People can continue their business safely at night with this street light such as walking to go back home from the bus stop and others. But when there is no street light, the dangerous thing can happen easily because these bad people cannot be see clearly in a dark night. But, if there is a street light also gives us a drawback when this street light is placed at a highway that is been seldom used. This is because the voltage that is supply to support the street light is wasting just like that because of no people driving their vehicle through this way.

1.5 THESIS ORGANIZATION

This thesis consists of seven chapters. This chapter discuss about overview of project, objective research, project scope, problem statement and thesis organization.

Chapter 2 contains a detailed description of night lamp brightness controller system. It will explain about the concept of night lamp brightness controller system, the application of this system and the involved component in this project.

Chapter 3 includes the project methodology. It will explain how the project is organized and the flow of process in completing this project. Also in this topic discusses the methodology of the system, circuit design, software design and the mechanical design.

Chapter 4 contained detailed description about hardware development. It will explain more detail about the electronic component that had been used and the method used to develop hardware.

Chapter 5 includes the software methodology. This will discuss more about the software that had been use to design a programming for the whole project.

Chapter 6 will discuss more about the result and discussion. This chapter will show the result of this project step by step.

The last chapter contained the detailed description about conclusion and recommendation. This chapter will conclude the whole project and give a future recommendation to make this project perfect.

CHAPTER 2

LITERATURE REVIEW

2.1 OVERVIEW

Street light are the device that help human continue their activities at night. Street light as known as lamppost is placed everywhere especially at a place that is at a strategic location where many people use stay or do their activity at that place.

A street light, lamppost, street lamp, light standard, or lamp standard is a raised source of light on the edge of a road, which is turned on or lit at a certain time every night. The concept that has been using for street light nowadays is timer concept.

2.1.1 Main use of Street Light

There are three distinct main uses of street lights, each requiring different types of lights and placement. The different types of lights can make the situation worse by compromising visibility or safety.

First is beacon light. A modest steady light at the intersection of two roads is an aid to navigation because it helps a driver see the location of a side road as he comes closer to it and he can adjust his braking and know exactly where to turn if he intends to leave the main road or see vehicles or pedestrians. A beacon light's function is to say "here I am" and even a dim light provides enough contrast against the dark night to serve the purpose. To prevent the dangers caused by a car driving through a pool of light, a beacon light must never shine onto the main road, and not brightly onto the side road. In residential areas, this is usually the only appropriate lighting, and it has the bonus side effect of providing spill lighting onto any sidewalk there for the benefit of pedestrians. On highways, this purpose is commonly served by placing reflectors at the sides of the road.

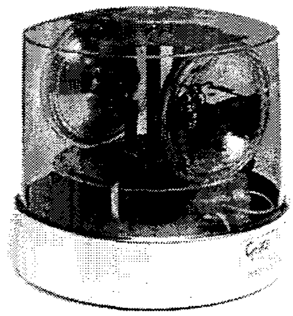


Figure 2.1: Beacon light

The second light is roadway lights. Street lights are not normally intended to illuminate the driving route, but to reveal signs and hazards outside of the headlights' beam. Roadway lights are properly used sparingly and only when a particular situation justifies increasing the risk. This usually involves an intersection with several turning movements, situations where drivers must take in much information quickly that is not in the headlights' beam. In these situations, at freeway junction or exit ramp, the intersection may be lit so that drivers can quickly see all hazards, and a well designed plan will have gradually increasing lighting for approximately a quarter of a minute before the intersection and gradually decreasing lighting after it. The main stretches of highways remain unlighted to preserve the driver's night vision and increase the visibility of oncoming headlights. If there is a sharp curve where headlights will not illuminate the road, a light on the outside of the curve is often justified. If it is desired to light a roadway, perhaps due to heavy and fast multilane traffic, to avoid the dangers of casual placement of street lights it should not be lit intermittently, as this requires repeated eye readjustment which implies eyestrain and temporary blindness when entering and leaving light pools. In this case the system is designed to eliminate the need for headlights. This is usually achieved with bright lights placed on high poles at close regular intervals so that there is consistent light along the route. The lighting goes from curb to curb.

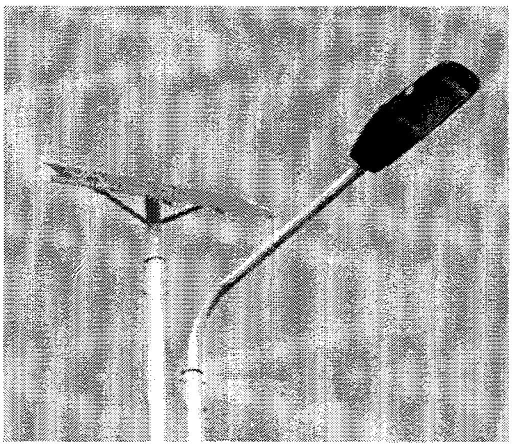


Figure 2.2: Solar street light

The last light is security lighting. Security lighting is similar to high-intensity lighting on a busy major street, with no pools of light and dark, but with the lighted area extending onto people's property, at least to their front door. This requires a different type of fixture and lens. The increased glare experienced by drivers going through the area might be considered a trade-off for increased security. This is what would normally be used along sidewalks in dense areas of cities. Often unappreciated is that the light from a full moon is brighter than most security lighting.

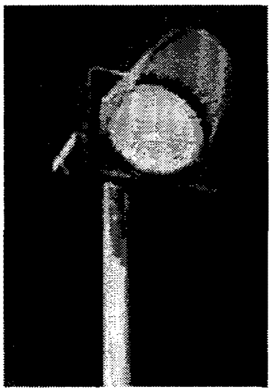


Figure 2.3: Security light

2.2 Night Lamp Controller System.

Time goes by and the technologies are more and more by passes of time. In this subtopic, the technology that we want to discuss is about technologies of street light. Nowadays, a latest controller system of street light that has been using in Malaysia is timer. The timer has been set when the light have to on and off. For example, the timer is been set at 7p.m to turn on and when 12 hours later, the lights will turn off. In this situation, this kind of system is not very practical because the dusk at the dawn not always fix at 7p.m and 7a.m. sometimes we can see that the street light is turn on but there is still in a day and other situation is the street is still in the dark because that time is not at 7p.m yet. And these two situations will make a little difficulty toward our human being.

Others, nowadays street light is just have one condition of light. So the current that has been used can be a wasted if there is no person driving their vehicles used this highway.

Next is solar street light. This kind of street light is stored the energy in the morning when there is a sunlight and will use the energy at night to lighting the street light. This system is quite practical and a good system because solar power is pollution free during use. Production end wastes and emissions are manageable using existing pollution controls. End-of-use recycling technologies are under development. And the facilities also operate with little maintenance or intervention after initial setup. But, there are also a several disadvantages while been using this solar system, such as solar electricity is almost always more expensive than electricity generated by other sources. Others, solar electricity is not available at night and is less available in cloudy weather conditions. Therefore, a storage or complementary power system is required.

Night Lamp Brightness Controller System has been develop as an intelligent street light where this system can be turn on and off at the right time. There are 2 sensors has been installed in this system which is LDR sensor and PIR sensor. LDR sensor is function to detect day and night. While PIR sensor is function to detect motion or movement.

The advantage of this system is the lamp has two condition lighting which is dim and full brightness. The condition is function when there is a motion has detected or no motion detect. When there is a motion has been detected, the lamp will be in full brightness condition, while, when there is no motion detected the lamp will stay in dim condition. Other advantages are this system is turn off and on according to light detection at LDR sensor. When the LDR detect that is a night, lamp will be turn on in dim condition if there is no motion and vice versa.

The disadvantage of this system is PIR sensor is sensitive with all movement such as a movement of tree.

2.3 PIC 16F877 Microcontroller

PIC (Peripheral Interface Controller) is the IC which was developed to control peripheral devices, alleviating the load from the main CPU. It is also family of Harvard Architecture microcontroller. It is made by Microchip Technology, derived from the PIC1640 originally developed by General Instrument's Microelectronics Division. The PIC16F877/874 devices come in 40-pin packages. PIC16F877 is PIC which is placed in the higher rank of PIC16F873 and the capacity of the program memory and so on is big capacity compared with 873. The function which is in 877, not being in 873 is the function of the parallel communication. It is called PSP (Parallel Slave Port).

The core features is this PIC is high performance RISC (Reduced Instruction Set Computer) TPU (Time Processing Unit). This RISC is fixed microcode size with normally one clock cycle for each instruction. It is also easy to operate as less transistor is required and faster execution time. And it prefers high level language. Other features are 35 single word instructions, all single cycle instruction except for program branches which are two cycles, pinout compatible to the PIC16C73B/74B/76/77, interrupt capability (up to 14 sources), eight levels deep hardware stack, programmable code protection, processor read/write access to program memory and etc.

The peripheral features are:

- 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)

2.4 HALOGEN LAMP

A halogen lamp is an incandescent lamp in which a tungsten filament is sealed into a compact transparent envelope filled with an inert gas and a small amount of halogen such as iodine or bromine. The combination of the halogen gas and the tungsten filament produces a chemical reaction known as a halogen cycle that increases the lifetime of the bulb and prevents its darkening by redepositing tungsten from the inside of the bulb back onto the filament. The halogen lamp can operate its filament at a higher temperature than a standard gas filled lamp of similar power without loss of operating life. This gives it a higher efficacy (10-30 lm/W). It also gives light of a higher color temperature compared to a non-halogen incandescent lamp. Alternatively, it may be designed to have perhaps twice the life with the same or slightly higher efficacy. Because of their smaller size, halogen lamps can advantageously be used with optical systems that are more efficient.

Halogen lamps get hotter than regular incandescent lamps because the heat is concentrated on a smaller envelope surface, and because the surface is closer to the filament. This high temperature is essential to their operation. Because the halogen lamp operates at very high temperatures, it can pose fire and burn hazards. Some safety codes now require halogen bulbs to be protected by a grid or grille, especially for high power (1-2 kW) bulbs used in commercial theatre, or by the glass and metal housing of the fixture to prevent ignition of draperies or flammable objects in contact with the lamp. Similarly, in some areas halogen bulbs over a certain power are banned from residential use.

Any surface contamination, notably fingerprints, can damage the quartz envelope when it is heated. Contaminants will create a hot spot on the bulb surface when the bulb is turned on. This extreme, localized heat causes the quartz to change from its vitreous form into a weaker, crystalline form which leaks gas. This weakening may also cause the bulb to rapidly form a bubble, thereby weakening the bulb and leading to its failure or explosion, and creating a serious safety hazard. Consequently, manufacturers recommend that quartz lamps should be handled without touching the clear quartz, either by using a clean paper towel or carefully holding the porcelain base. If the quartz is contaminated in any way, it must be thoroughly cleaned with rubbing alcohol and dried before use.

Halogen headlamps were widely implemented in many automobiles. Halogen floodlights for home outdoor lighting systems as well as for watercraft are also manufactured for commercial and recreational use. They are now also used in desktop lamps. Halogen headlamps were widely implemented in many automobiles. Halogen floodlights for home outdoor lighting systems as well as for watercraft are also manufactured for commercial and recreational use. They are now also used in desktop lamps.

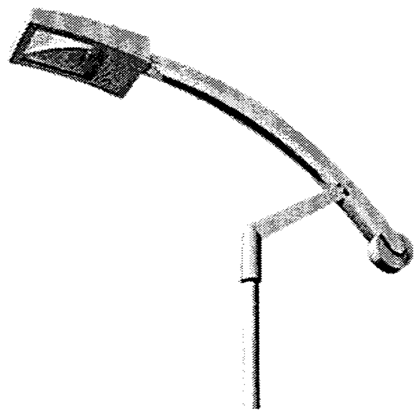


Figure 2.4: Halogen lamppost

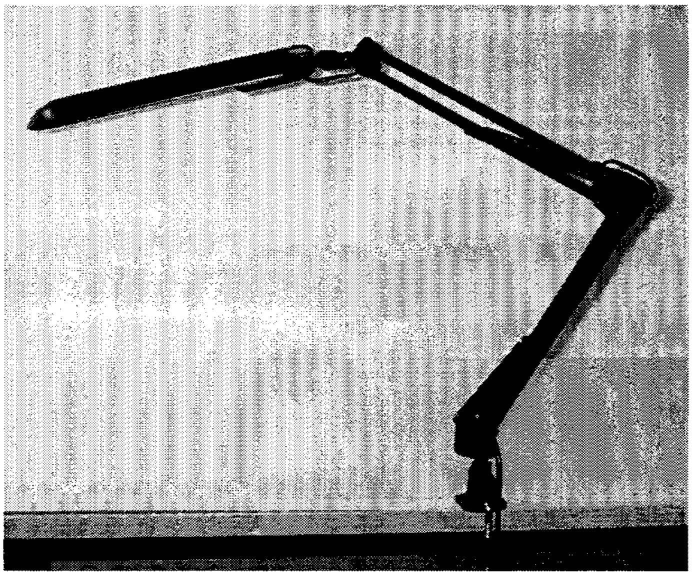


Figure 2.5: Halogen lamp desk

CHAPTER 3

METHODOLOGY

3.1 OVERVIEW

This chapter 3 will discuss and explains the detail about the methodology of the whole system and flow of project that used in "Night Lamp Brightness Controller System". This chapter also describes further about the planning of the whole project that is included about software and hardware development.

Besides, in this chapter, I also will discuss about the whole planning for Projek Sarjana Muda (PSM).

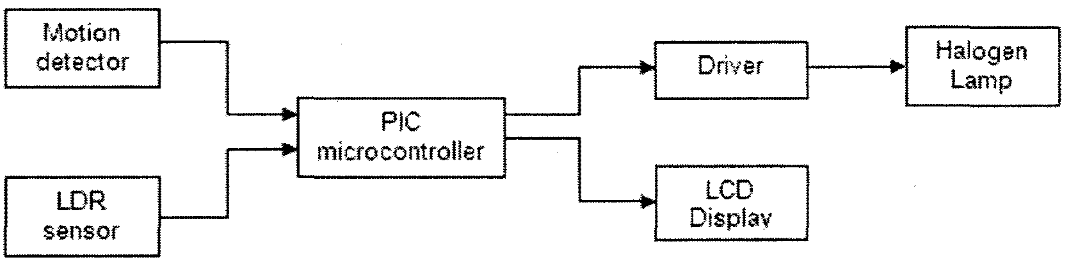
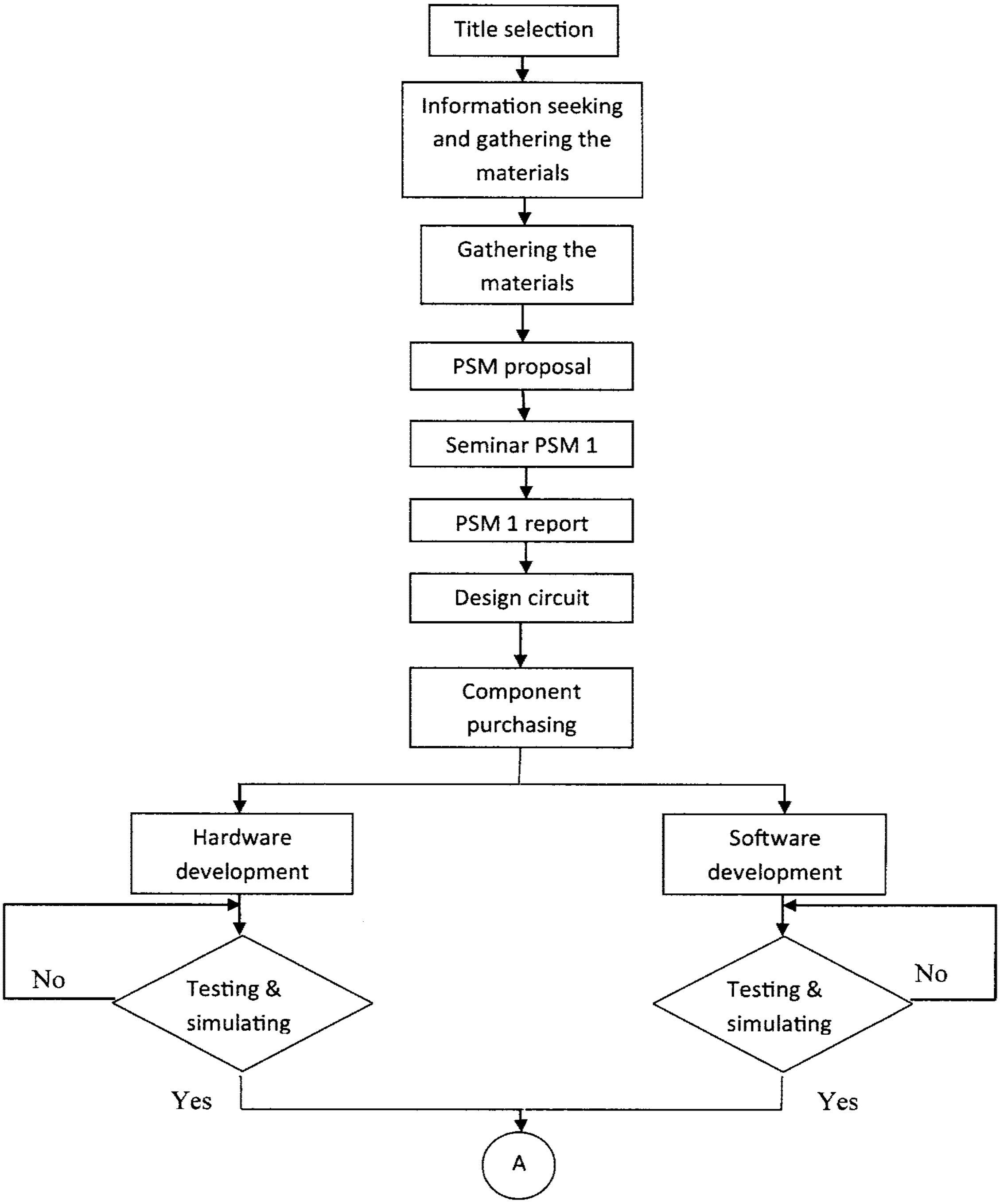


Figure 3.1: Block diagram for Night Lamp Brightness Controller System

3.2 WHOLE PLANNING



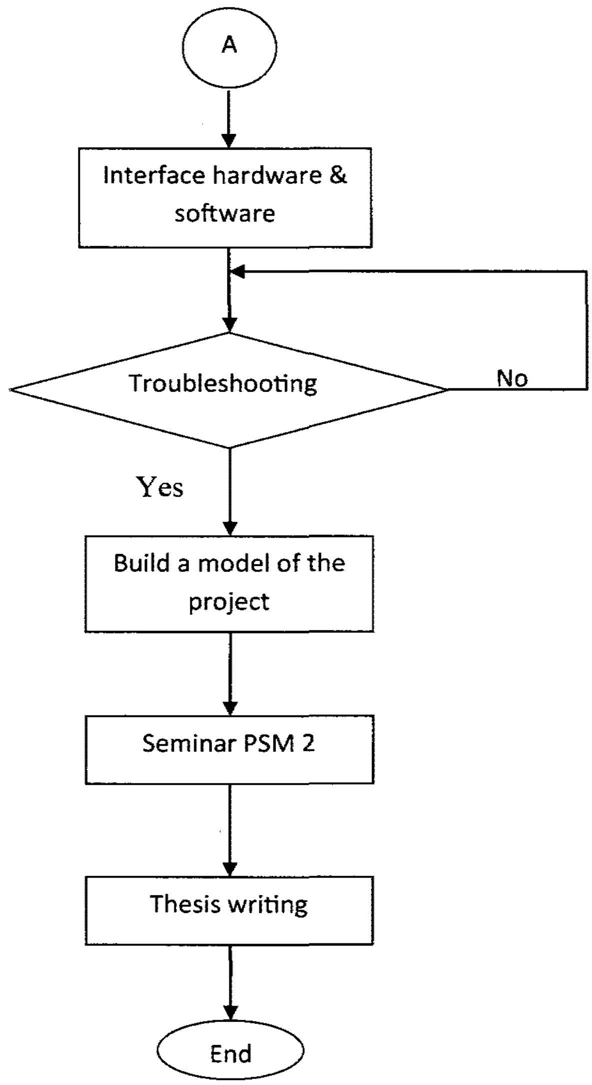


Figure 3.2: Flowchart of the whole planning

This flowchart is the flow work to build "Night Lamp Brightness Controller System". After the selection title is done, all the information such as article that related to this system and datasheet of the components that will be used in the project. All this information will be combine to make a literature review.

Next is design the circuit and start to select the appropriate component due to the datasheet and purchasing them.

At this stage is call development process. This process has 2 parts which is hardware development and software development. For the hardware development part, the circuit is build module by module. The module is the input for the circuit, LDR sensor and Motion Detector. Next module is the driver for power LED. After the module is done, it will be test and simulate. It also same goes to software development.

After the testing and simulating process, the hardware and software will be interface together. Troubleshooting process will be the next process after the interfacing software and hardware is done.

If there is no problems occur, the model of this project is starting to build. Final stages are preparing for Seminar PSM 2 and complete the thesis writing.

3.3 PROJECT FLOWCHART

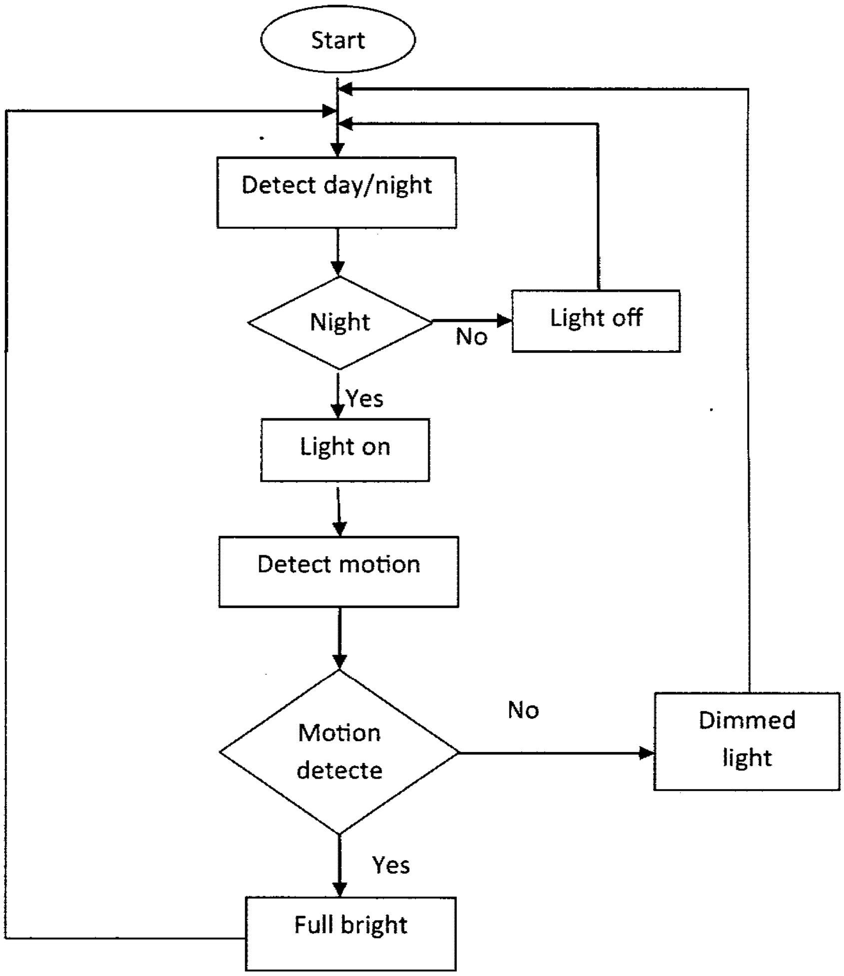


Figure 3.3: Project flowchart of the Night Lamp Brightness Controller System

This system is invented to detect day and night according to the level that have been set. Others, it is also sense a motion to control a brightness of the street light. Firstly, this system will start to operate when the LDR sensor sense that there no emitting light from sun. It will set the street light in dim condition. On the other hand, this system will set full brightness condition when there is a motion has been sense by Passive Infrared (PIR) sensor. In this case, the nature motion such as a movement of tree and others has been neglected.

Next, this system will be in dim condition when PIR sensor senses no movement of car or human.

Lastly, when LDR sensor senses the emitting light from the sun, this system will be hibernate.

3.4 PROGRESS PLANNING

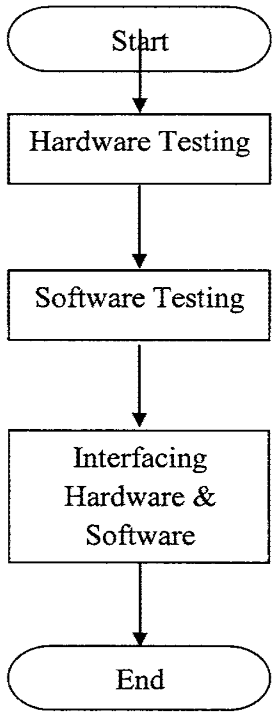


Figure 3.4: Progress flowchart of the "Night Lamp Controller Brightness System"

According in figure 3.3, the first progress planning that I have been done is hardware testing. This testing is important because to make sure that all the component in a good condition and can function well.

The next progress is software testing. It is to test the coding that has been designed based on the system.

Lastly, after the hardware and software has been successfully tested, the next progress is to interface both of hardware and software.

3.4.1 Hardware Testing

Firstly, the very basic circuit we need to construct is voltage regulator circuit. This is very important because the function of voltage regulator is fixing the voltage supply form 9V to 5V. We have to convert the 9V to 5V because PIC microcontroller only needs 4.75V to 5.25V to be function. This 5V will be supply to PIC microcontroller to make this PIC function and supply to input and output ports. If this circuit construction is function well, we can move to the next step or else we have to continue this stage until it is done.

Next step is crystal oscillator circuit construction. This circuit is also important to PIC microcontroller. This is because the crystal will create an electrical signal with a very precise frequency. The function of the frequency is to keep track of time and to provide a stable clock signal for digital integrated circuit. . The crystal also will set the frequency of the PIC microcontroller.

Next is combination of voltage regulator and crystal oscillator circuit with PIC16F877. An additional, reset circuit will be also combined with the basic circuit. This is because when there is occur or error happens towards the circuit, PIC microcontroller can be reset to the initial condition.

Next, to sense day or night based on intensity of light, the Light Dependant Resistor (LDR) sensor will be use. This component will be connected is series with resistor. It will be using the concept of voltage divider. The value of the voltage is depends on the intensity of light that the Light Dependant Resistor (LDR) sense. We can conclude that the higher intensity of light, the higher the value of voltage.

Next, the Passive Infrared (PIR) sensor is used to detect a motion. This sensor has 3-pin header where the minus pin (-) have to be connected to ground, plus pin (+) connects to Vcc and OUT pin connects to PIC16F877 microcontroller's I/O pin.

Next, the lamp that has been use in this project is Philip halogen. Base on the specification, this lamp need 12V and 20W. As we know, PIC microcontroller just can supply up to 5V only so that, the lamp cannot be connected directly to the PIC. The driver is needed to convert 5V to 12V. As a solution, relay 5V is been using as a driver. The relay will be function as a 'middleman' between PIC and lamp. When the 5V is supplied to relay, it will tap 12V and supply it to the lamp.

Lastly, after all the circuit is combined with PIC microcontroller, once again, the troubleshooting will be doing to all components.

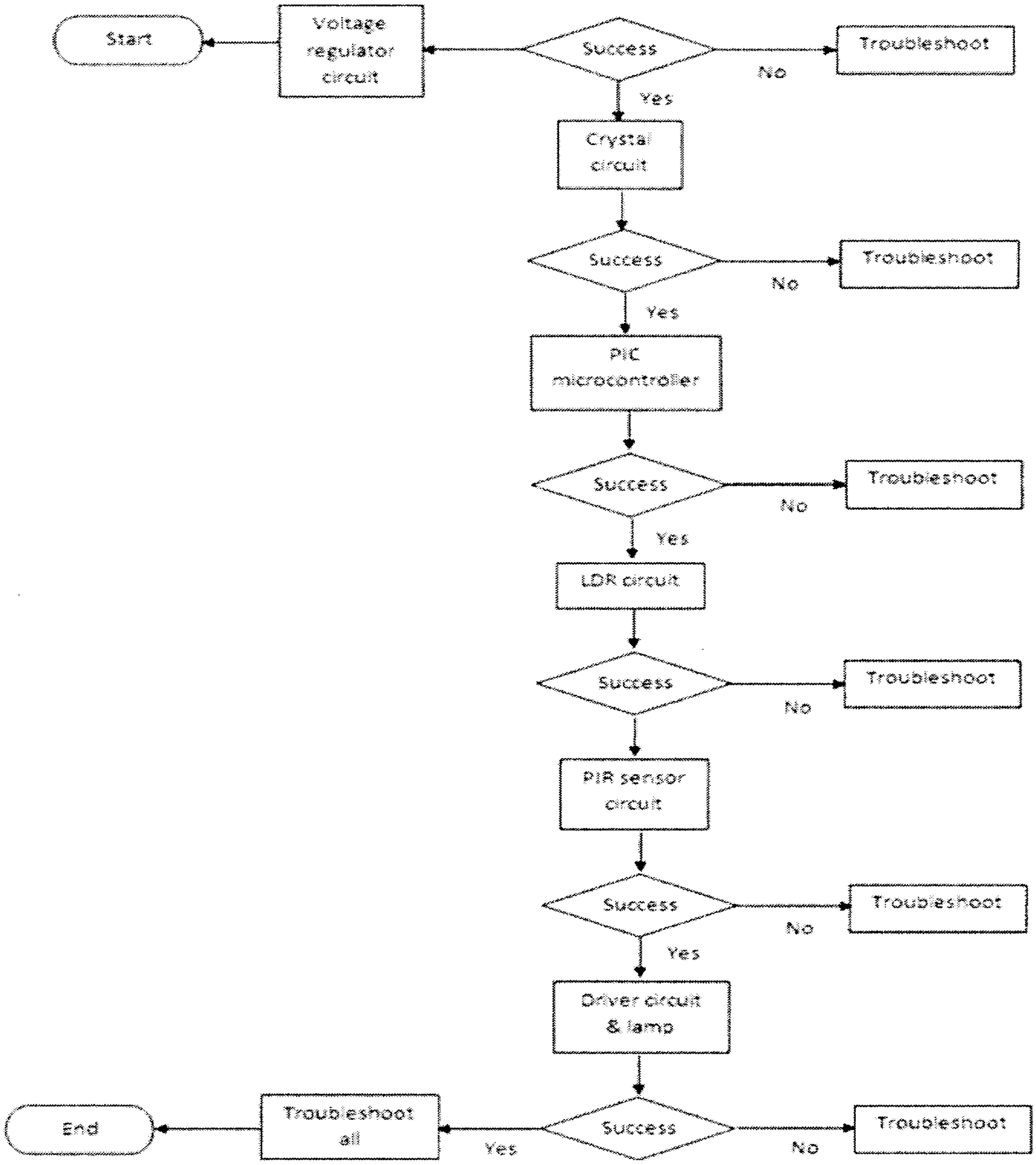


Figure 3.5: flowchart of hardware testing

3.4.2 Hardware implementing

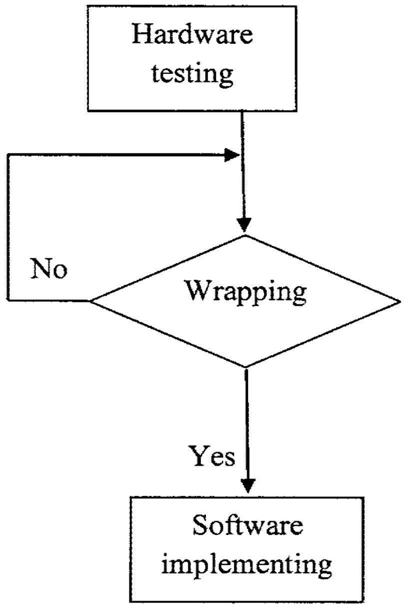


Figure 3.6: flowchart of hardware implementing

According to figure above, there is one method that has been used to implement the hardware. The method is wrapping technique. The thing that we need to do this method is wrapping wire and wrapping tool. We have to do this wrapping technique to connect all the components at the strip board base on the circuit without using a jumper wire. This kind of method also will reduce a space that we used compare to 'wire jumper' method. Lastly, after finished to implement the hardware, we move to software implementing.

3.4.3 Software implementing

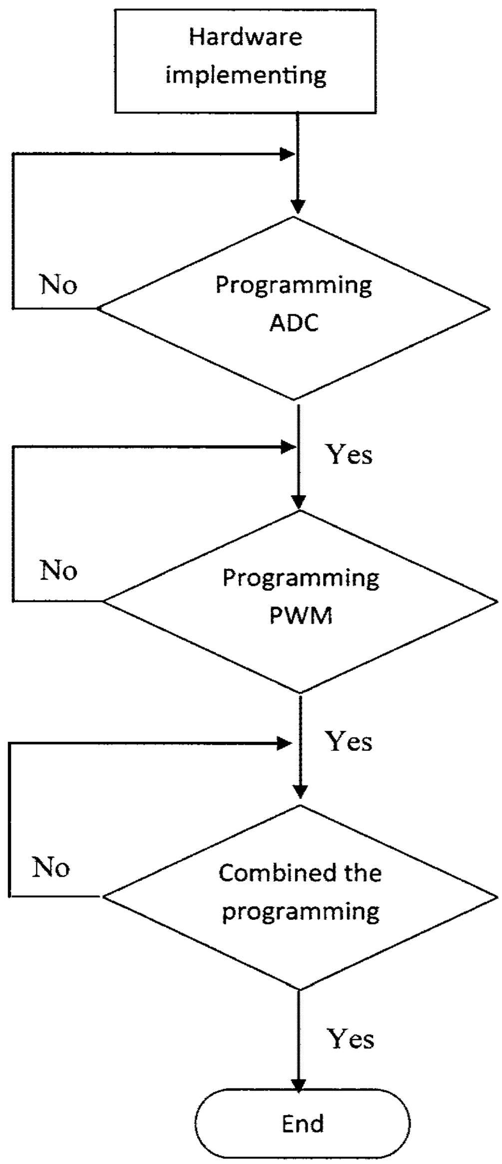


Figure 3.7: flowchart of software implementing

From the figure above, the first step that has to be done after finishing the hardware implemented is programming ADC for sensors. The sensor that has been using in this system is Light Dependant Resistor (LDR) sensor and Passive Infrared (PIR) sensor. Both of these sensors are using ADC application to function where we have to convert the analogue input to digital so that the PIC microcontroller can read the value.

Next is PWM programming. PWM application has been using to control the brightness of a lamp. For this application, we have to decide the duty cycle and the frequency that suitable with the two condition of brightness dim and full brightness.

Lastly, after both of the ADC and PWM programming is success, we have to combine the programming together and make sure the output is the same as we expected.

CHAPTER 4

HARDWARE DEVELOPMENT

4.1 OVERVIEW

This chapter will discuss more detail about hardware part that involved in "Night Lamp Brightness Controller System". The component that had been using is LCD, LDR sensor, PIR sensor, halogen lamp, resistor, capacitor, bipolar junction transistor, crystal, voltage regulator, potentiometer and switch.

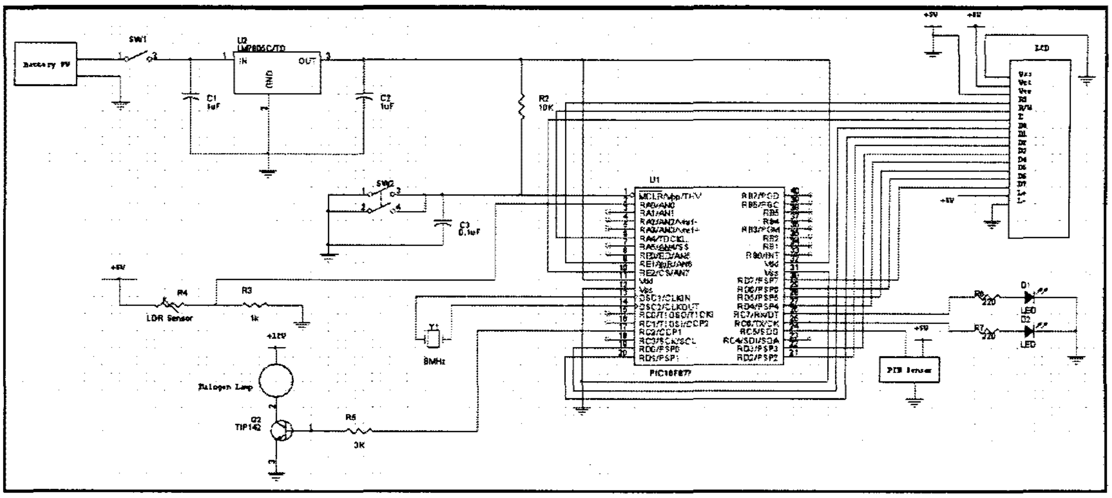


Figure 4.1: Circuit Design

4.2 PIC16F877 MICROCONTROLLER

PIC16F877 microcontroller is one of the important components in this project. This is because PIC microcontroller is function as a 'brain' to this project. Without it, it is impossible to this circuit to function same like what we want.

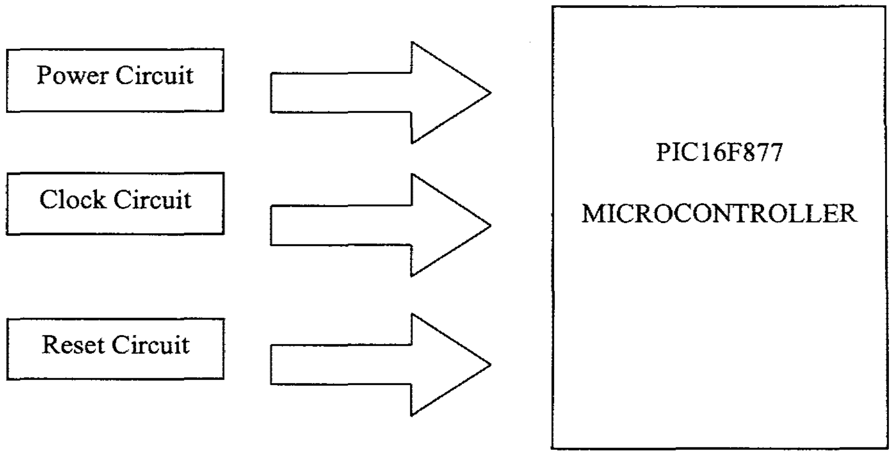


Figure 4.2: Block Diagram of PIC16f877 basic circuit

According to figure above, to make this PIC function, 3 basic circuits is needed which are Power Circuit, Clock Circuit and Reset Circuit.

4.2.1 Pin configuration

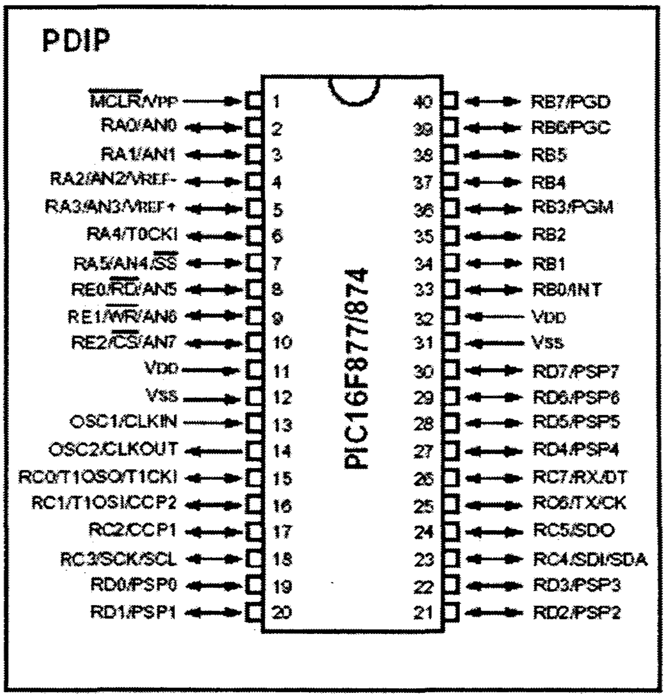


Figure 4.3: PIC16F877 Microcontroller

From the figure above, we can see that PIC16F877 has 40 pins including 5 input and output ports where each of the pin has their own function. The port is Port A, Port B, Port C, Port D and Port E. Every pin in the port can be either input or output pin depend on declaration that we have made earlier in the coding.

4.2.1.1 Power Supply and Ground

PIC 16F877 operates in voltage with the range of 4.75V to 5.25 V. The pin V_{DD} (pin 11 and pin 32) is connected to power supply. The pin V_{SS} (pin 12, pin 31) is connected to ground. If voltage supply is connected to LM7805, pin 3 of the voltage will produce an output voltage, 5V. Instead of that, the pin 3 is connected to pin 11 and 32 PIC16F877.

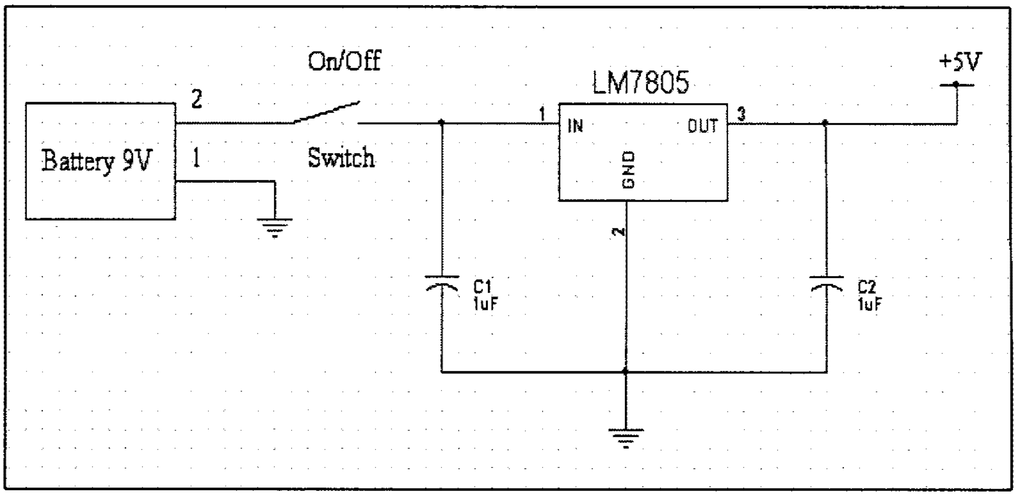


Figure 4.4: Voltage regulator connection

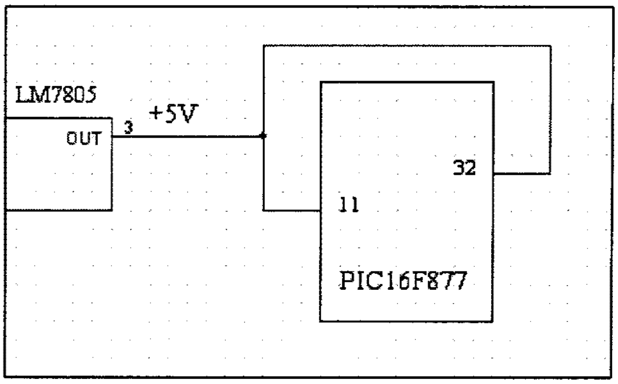


Figure 4.5: V_{DD} connection

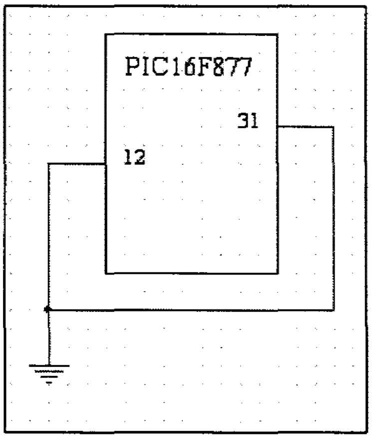


Figure 4.6: V_{SS} connection

4.2.1.2 Oscillator/Clock

The OSC1 or CLKIN (pin 13) and OSC2 or CLKOUT (pin 14) used to provide the internal clock. In this project, the crystal that has been used is crystal with value of 8 MHz.

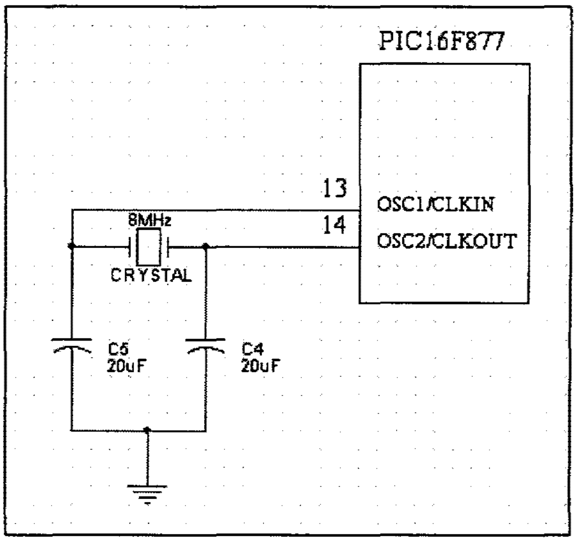


Figure 4.7: Oscillator connection

4.2.1.3 Reset Circuit

Reset is a power-on reset signal. The 10K pull-up resistor will keep the signal high when the reset button is not pressed. Pressing the push button causes the pin to be pulled low, thus forcing to reset. Reset also known as bidirectional control signal is acts as an input to initialize the microcontroller to a known startup state. It also acts as an open-drain output indicator that an internal failure has been detected in either the clock monitor or computer operating properly (COP) watchdog circuit.

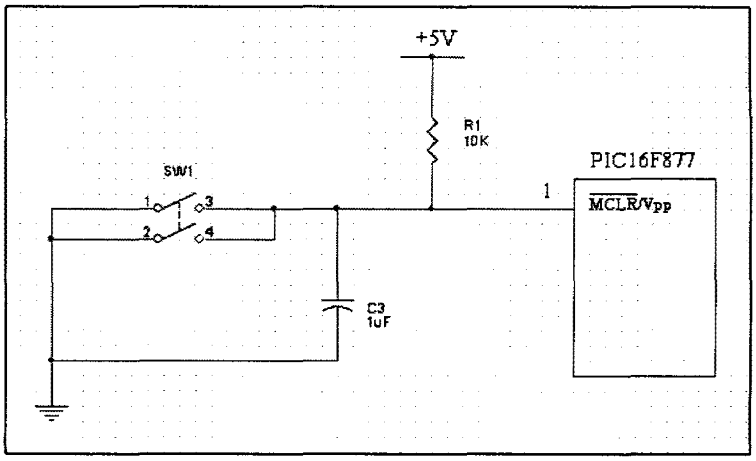


Figure 4.8: Reset Circuit

4.2.1.4 INPUT/OUTPUT Ports

In this project, three input/output ports have been used. One pin from port A is declared as an input to LDR sensor. Two pin from port C has been declare as an input to PIR sensor and the other one as an output to driver that has been connected to halogen lamp. Then, 8 pins from port D is used to control LCD. 2 pins from port E is used to control RS and Enable port of LCD.

Description	Port	Pin
LDR sensor	Port A.0	2
PIR sensor	Port C.5	24
RESET	-	1
LCD	Port D.0-D.3 Port D.4-D.7 Port E.1-E.2 Port A.4	19-22 27-30 9-10(RS & Enable) 6(read/write)
Crystal Oscillator	-	13 & 14
Lamp's driver	Port C.2	17
Vcc	-	11 & 32
Ground	-	12 & 31

Table 4.1: Description of Port

4.2.2 CIRCUIT DESIGN

This part is explained about how the circuit has been constructed. Firstly, the very basic circuit that need to be developed is voltage regulator circuit. This circuit is important because it function to fix all the high value voltage input to 5V. It is needs to avoid the PIC microcontroller from burn because of receiving a high value of voltage at V_{DD} pin (pin 11 and 32). From the datasheet, we have been informed that the range of input voltage for PIC16F877 is around 4.75-5.25V only. There is a consequence that will be happen if the voltage supply is below or greater than the range.

Figure below is showing us the connection of the basic circuit for PIC microcontroller.

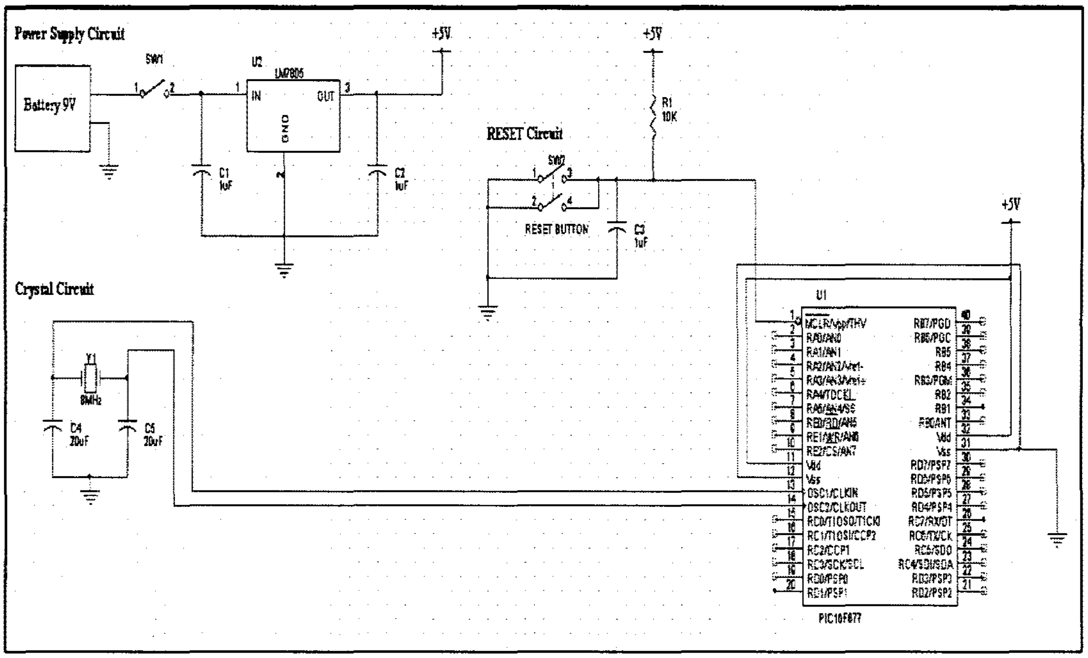


Figure 4.9: The basic connection on PIC16F877A

4.3 HALOGEN LAMP

Halogen lamp is been using in this project as a street light. 12V and 20W is a maximum demand that this halogen lamp need to make it function well. As we know, PIC16F877 is only supply 5V and 220mA to all the input and output pin. So that, to make it function as we want, a driver to control the current is needed to be design first.

According to the lamp characteristic, current is set to control the brightness of the lamp. Instead of that, the driver that we need to designed have to be able to convert a small input current to a high output current that can support this lamp. The suitable component that can convert the current is NPN power transistor. This transistor is amplify the current, for example in this project, this transistor is used to amplify the small output current from a PIC so that it can operate a lamp. In many circuits a resistor is used to convert the changing current to a changing voltage, so the transistor is being used to amplify voltage. To choose the right value of resistor, some calculation that related to the lamp has to be done. A transistor may be used as a switch (either fully on with maximum current, or fully off with no current) and as an amplifier (always partly on).

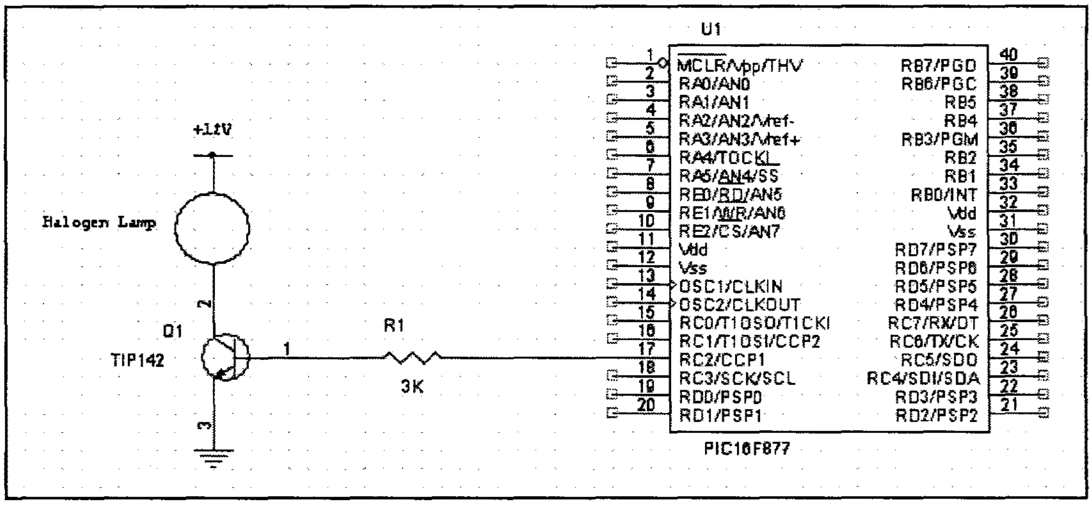


Figure 4.10: Circuit Diagram of halogen lamp and the driver.

As we can see at the figure above, a 3KΩ resistor has been chosen after do a little calculation that related to current that needed to support lamp, the value of hfe as known as β, the current and voltage from the PIC microcontroller. And the calculation is as below:

I_C (current that support lamp) = 1.5A

hfe = β = 1000

$I_C = \beta I_B$

$I_B = \frac{I_C}{\beta}$

$= \frac{1.5}{1000}$

= 0.0015A @ 1.5mA

$R_B = \frac{V}{I_B}$

$$= \frac{5}{0.0015}$$

$$= 3.33K\Omega$$

The voltage output from the PIC microcontroller is not always fixed 5V. Sometimes, it can be drop to 4.7V because other output from other pin is also need the voltage. To be safe, we pick 3KΩ resistor to convert the changing to a changing voltage.

Sometimes, transistor is becoming too hot to touch due to a waste heat is produced in transistors while the current flowing through them. Heat sinks are needed for power transistors because they pass large currents. The heat sink helps to dissipate the heat by transferring it to the surrounding air.

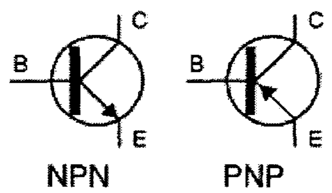


Figure 4.11: Symbols of the transistor.

4.4 Liquid Crystal Display (LCD)

The LCD is been using to display the condition of lamp and PIR sensor. It also informs the viewer if the lamp were ON or OFF. A 14-pin access is provided having eight data lines, three control lines and three power lines. The connections are laid out in one or two common configuration either two row of seven pins or single rows of 14 pin.

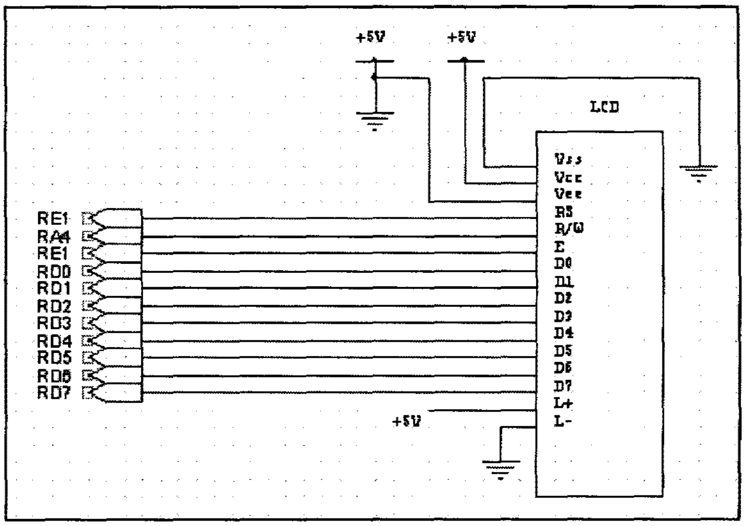


Figure 4.12: Connection of LCD.

As we can see in the figure above, LCD has 16 pins. Pin 1 and 2 are the power supply lines, Vss and Vdd. The Vdd pin is connected to the positive supply and Vss to the ground. Pin 3 called V_{EE} is connected to potentiometer 10KΩ. This pin is function to alter the contrast of the display. Pin 4 is the Register Select (RS) line, the first of the three command control input. When RS line is low, data bytes transfer to the display are treated as command, and the bytes read from the display indicates its status. By setting the RS line high, character data can be transferred to and from the LCD.

Pin 5 is the Read/Write line and it connected to port A.4, pin 6 in PIC microcontroller. There are two condition lines for this pin which is LOW and HIGH. When the R/W is pulled LOW, it is for to write the commands or character to the LCD, while when the R/W is pulled high, is to read character data or status information from its register. For this project, R/W is connected to ground as it only to use for transmit data from PIC microcontroller to LCD. Pin 6 is Enable (E) pin for LCD. This pin is used to initiate the actual transfer commands or character data between the LCD and data lines. When writing to the display, data is transferred only on the high to low transition of this signal. However, when reading from the display, data will become available shortly after the low to high transition and remain available until the signal falls to low again. Pin7 to pin 14 are the eight data bus lines (D0 to D7). Data can be transferred to and from the display, either as a single 8-bit byte or as two 4-bit "nibbles". For this project, the entire pin data bus line is connected to Port C.

4.5 Sensor

There are two types of sensors that has been using in this project. LDR sensor is used to detect day or night and PIR sensor is used to detect motion.

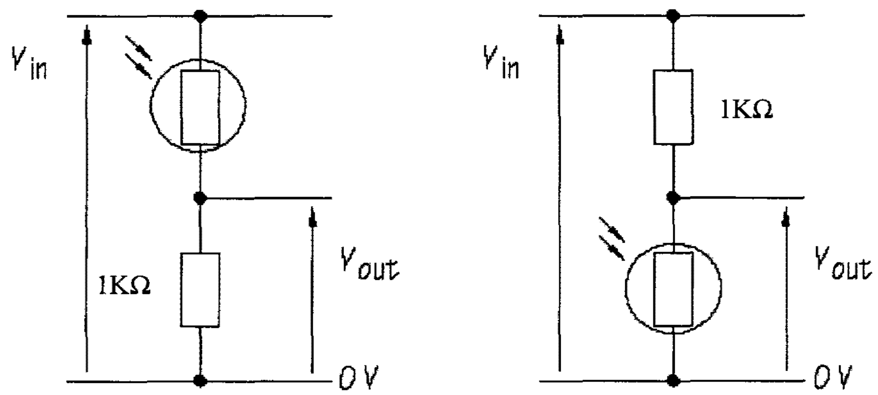


Figure 4.13: Circuit diagram for LDR sensor.

As we can see the figure above, the LDR sensor is connected series with 1KΩ resistor. In this project, we use a left circuit. This is because the LDR sensor will sense lightness and the lightness can be measured with tap a multimeter at the resistor.

An LDR is an input transducer (sensor) which converts brightness (light) to resistance. It is made from cadmium sulphide (CdS) and the resistance decreases as the brightness of light falling on the LDR increases. The LDR sensor is connected to port A.0, pin 2. This component also has no polarity, so that, we can choose any 2 pin of the LDR to connect them at 5V or resistor. Next, the other pin of resistor is connected to ground. Lastly, the pin LDR sensor and resistor that has been connected together, is connected again at PIC16F877.

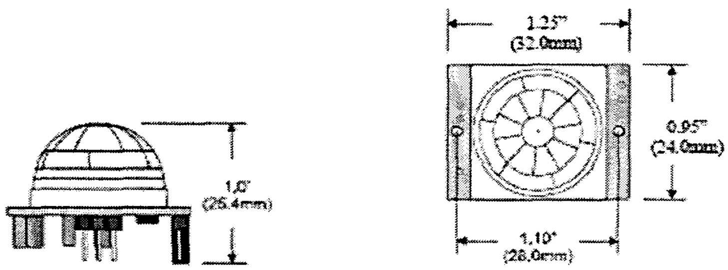


Figure 4.14: Dimensions of PIR sensor

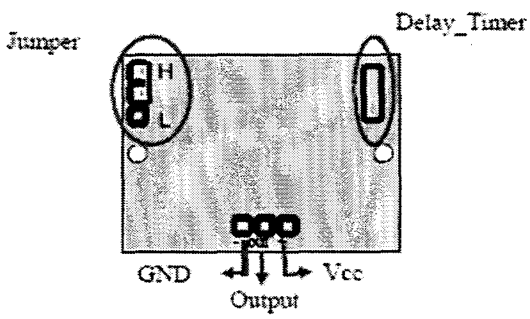


Figure 4.15: PIR sensor's pin

According to figure 4.13, PIR sensor has three pin, which is GND, Output and V_{CC}. GND pin is connected to ground, output pin is connected to PIC16F877 and V_{CC} is connected to 5V. There are two positions for jumper. The first position is L, and the mode for position L is 'retrigger' means the output is remain HIGH when sensor is triggered repeatedly. The output is LOW when idle (not triggered). The other one position is L for normal mode. In this mode, output HIGH then LOW when triggered. Continuous result in repeated HIGH/LOW pulses. And lastly, the output is LOW when idle. For this project, the PIR is in position L and in normal mode.

CHAPTER 5

SOFTWARE DEVELOPMENT

5.1 OVERVIEW

In this chapter, we will briefly discuss about software development. PIC16F877 microcontroller is used to control all elements in this project. This PIC microcontroller only understand machine code, programming through assembly language need to be develops and then converted to machine code. The software that had been used to design a programming is called PICBasic Pro Compiler and the software that converted the assembly language to machine language.

5.2 HALOGEN LAMP

Halogen lamp is been used in this project as a street light. A halogen lamp is only has 2 pin and there is no polarity. We can simply connect any other two pin at ground and voltage supply. The halogen lamp that has been chosen is from Philip brand and the specification is 12V, 20W and 1.67A. That is the maximum voltage, power and current that this halogen lamp needs to be turn on. This halogen lamp need a driver to be operating because of PIC microcontroller cannot support the lamp.

DESCRIPTION

To control brightness of this halogen lamp is by using Pulse Modulation Width (PWM). According to the PIC16F877 datasheet, to use this PWM, there is one pin that specially made to operate the PWM application the pin is called CCP1 pin 17 port C.2. Full duty cycle is equal to 255 bit. The brightness of the system is depends on duty cycle that has been set. For halogen lamp, if we set 100% duty cycle means that is a maximum brightness for the lamp, but the brightness is not suitable for street lamp. After several try, we able to get the right brightness of halogen lamp for condition full brightness. That is 180 bits equal to 70.58% duty cycle. And for dim condition is 80 bit means 31.37%.

```
DEFINE CCP1_REG PORTC
DEFINE CCP1_BIT2

main:

HPWM 1,180,30000      ;    full brightness condition
PAUSE 1000

HPWM 1,80,30000       ;    dim condition
PAUSE 1000

GOTO main
```

Figure 5.1: Programming for halogen lamp

As we can see at figure 5.1, the coding for PWM is like this, "HPWM 1,80,30000". '1' that has been state at the coding means that we use channel 1 of CCP. '80' is bit that we choose for adjustment of lamp brightness. Lastly, '30000' is the frequency that we choose to run the PWM.

5.3 SENSOR

There is type of sensor that has been installed in this project which is PIR sensor and LDR sensor. LDR sensor will be used to sense the intensity of light and send the data to the PIC microcontroller. Programming for sensor is quite complex, compare to the other part. This sensor will use Analogue to Digital Converter (ADC). Basically, there are several steps before the ADC port can be use. In this project, port A.0 is declare as analogue port and has been connected to LDR sensor.

DESCRIPTION

Before we use an ADC port, we must first define and initialize the port. Define ADC_BITS 8 means we set the number of bit in result is 8 bit. Define ADC_CLOCK 3 means we set the clock sources 3MhZ. Define ADC_SAMPLEUS 50 means we set the sampling time 50 microseconds. Coding for LDR VAR WORD means we define the variable size in word (16bit). adconl=%00001001 means we define the certain port A and E is analogue port; and the certain port of A and E is digital. Refer table 5.1 for more details. LDR means the PIC microcontroller will read the data at the ADC channel (port A0) and store the data in word size (16 bit). LDR<20 means if the input voltage at port A0 is lower than 0.4V ($\left(\frac{20}{255}\right) X5V = 0.4V$), the programming will jump to next line programming.

```
DEFINE ADC_BITS 8
DEFINE ADC_CLOCK 3
DEFINE ADC_SAMPLEUS 50

LDR VAR WORD

adcon1=%00001001

OUTPUT portc.6

LED1 VAR PORTC.6


 main:

 ADCIN 0, LDR
 PAUSE 100

 IF LDR<20 THEN
    LED1=1
 ELSE
    LED1=0
 ENDIF
```

Figure 5.2: Sample programming for sensor

PCFG3: PCFG0	AN7[1] RE2	AN6[1] RE1	AN5[1] RE0	AN4 RA5	AN3 RA3	AN2 RA2	AN1 RA1	AN0 RA0	VREF+	VREF-	CHAN/ Refs[2]
0000	A	A	A	A	A	A	A	A	VDD	VSS	8/0
0001	A	A	A	A	VREF+	A	A	A	RA3	VSS	7/1
0010	D	D	D	A	A	A	A	A	VDD	VSS	5/0
0011	D	D	D	A	VREF+	A	A	A	RA3	VSS	4/1
0100	D	D	D	D	A	D	A	A	VDD	VSS	3/0
0101	D	D	D	D	VREF+	D	A	A	RA3	VSS	2/1
011x	D	D	D	D	D	D	D	D	VDD	VSS	0/0
1000	A	A	A	A	VREF+	VREF-	A	A	RA3	RA2	6/2
1001	D	D	A	A	A	A	A	A	VDD	VSS	6/0
1010	D	D	A	A	VREF+	A	A	A	RA3	VSS	5/1
1011	D	D	A	A	VREF+	VREF-	A	A	RA3	RA2	4/2
1100	D	D	D	A	VREF+	VREF-	A	A	RA3	RA2	3/2
1101	D	D	D	D	VREF+	VREF-	A	A	RA3	RA2	2/2
1110	D	D	D	D	D	D	D	A	VDD	VSS	1/0
1111	D	D	D	D	VREF+	VREF-	D	A	RA3	RA2	1/2

A = Analog input D = Digital I/O

Table 5.1: ADCON1 register table

For PIR sensor, this sensor is connected to pin 24, port C.5. This sensor will function when detect a movement.

```
DEFINE osc 8

TRISC.6=0
TRISC.5=1
TRISC.7=0

LED1 VAR portc.6
LED2 VAR portc.7
PIR VAR portc.5

 main:

 IF PIR=1 THEN
    HIGH LED1
    HIGH LED2

 ELSE
    LOW LED1
    HIGH LED2
 ENDIF
```

Figure 5.3: Sample programming for PIR sensor

5.4 LCD

Basically, there are several steps before LCD can display character correctly. Pin RS and E need to be configuring correctly. Otherwise, the LCD won't work. However LCD needs to be initializing once before it can be used.

DESCRIPTION

```
DEFINE LCD_DREG      PORTD   ;   line 1
DEFINE LCD_DBIT      4       ;   line 2
DEFINE LCD_RSREG     PORTE   ;   line 3
DEFINE LCD_RSBIT     1       ;   line 4
DEFINE LCD_EREG      PORTE   ;   line 5
DEFINE LCD_EBIT      2       ;   line 6
DEFINE LCD_BITS      4       ;   line 7
DEFINE LCD_LINES     2       ;   line 8
DEFINE LCD_COMMANDUS 2000    ;   line 9
DEFINE LCD_DATAUS    50      ;   line 10
```

Figure 5.4: Define data for programming LCD

Figure 5.4 is shown a define data programming for LCD. The purpose to define this data is to set the setup in PIC microcontroller. Line 1 is to set LCD data port, line 2 is to set starting data bit (0 or 4) if 4-bit bus, line 3 is to set LCD Register Select port, line 4 is to set LCD Register Select bit. Line 5 is to set LCD Enable port, line 6 is to set LCD Enable bit, line 7 is to set LCD bus size (4 or 8 bit), line 8 is to set number of line on LCD, line 9 is to set command delay time is micro second and line 10 is to set data delay time in micro second.

According to figure 5.5, that is the programming for LCD. From this programming, the LCD will display “SITI HANUM SURYA BT IBRAHIM“ and “EN. FAIRUZ RIZAL MOHD RASHIDI” repeatedly.

```
trisa.4=0
trisd=0
trise.1=0
trise.2=0
adcon1=%00001001

main:

    LOW porta.4

    LCDOUT $FE,1
    PAUSE 2000

    LCDOUT $fe,$80+2, "SITI HANUM"
    LCDOUT $fe,$c0, "SURYA BT IBRAHIM"
    PAUSE 3000

    LCDOUT $FE,1
    PAUSE 2000

    LCDOUT $fe,$80, "EN. FAIRUZ RIZAL"
    LCDOUT $fe,$c0, "MOHAMAD RASHIDI"
    PAUSE 3000

RETURN
```

Figure 5.5: Programming for LCD

Firstly, we define data port is starting at port D4, RS port is located at port E1 and enable port is located at port E.2. We also defined that the data that had been used is 4 bit, lines that had been used to show the text is 2 lines display, which means up and down display lines. Port A4, all port D, port E1 and E1 are all set as an output port. Adconl %00001001 means that we set 2 port from port e is digital (E1 and E2. First, R/W port for LCD is pulled low in order to write to write commands or character to the LCD.

According to the figure 5.5, port A.4 is set as LOW. This is because lined is pulled low in order to write commands or character to the LCD, or pulled high to read character data or status information from its register. Command 'LCDOUT $FE,1' is a operation to clear the display at screen LCD. 'LCDOUT $fe,$80' is a operation to move cursor to the beginning of first line and 'LCDOUT $fe,$c0' is a operation to move cursor to beginning of second line.

LCDOUT $fe,$80+2, "SITI HANUM" means that the text in " " will be appeared at the first lines, starting two character from left. For LCDOUT $fe,$C0, "SURYA BT IBRAHIM", it means that the sentence will be appeared at the second lines, starting at the beginning character from left.

5.5 OVERALL PROGRAMMING

In this subtopic, we will discuss the overall programming from start until how to upload the programming into PIC16F877. The overall programming can be referred at APPENDIX A. Figure below is shown the arrangement of the programming.

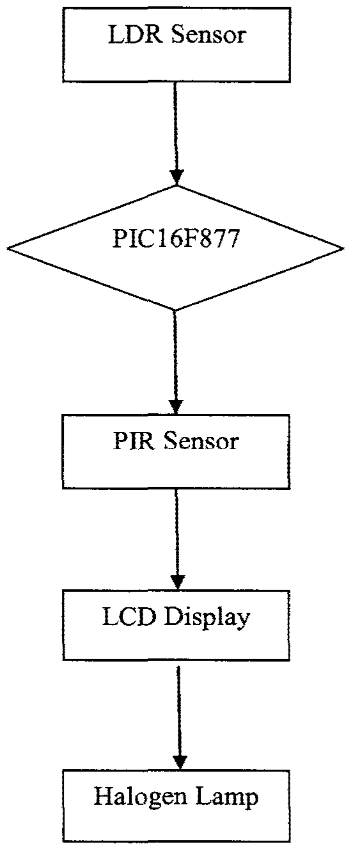


Figure 5.6: Arrangement of the programming

5.5.1 DESCRIPTION

Program can be divided into 3 parts which is initialization, body and subroutine. The particular parts are assembled in Microcode Studio.

All the port or command that will be use has to be define. This is because to tell the PIC microcontroller the command and port is used to what function. (Refer appendix A).

From the figure above, we can see that LDR sensor is function as a switch to this system. If the LDR sensor senses the intensity of light, PIC microcontroller will compare the voltage that has convert to bit with the bit that we has choose. For example:

```
IF LDR<10 THEN
    IF PIR=1 THEN
        GOSUB lcd1
        HPWM 1,150,30000
        PAUSE 2000
    ELSE
        GOSUB lcd2
        HPWM 1,50,30000
        PAUSE 2000
    ENDIF
ELSE
    GOSUB lcd3
    HPWM 1,0,30000
    PAUSE 2000
ENDIF
```

Figure 5.7: Programming for LDR sensor, PIR sensor, LCD and lamp

This coding means PIC microcontroller will compare the voltage the LDR sense with 0.4 ($\left(\frac{20}{255}\right)X5V = 0.4V$) voltage where this voltage is been set as night. If the voltage is lower than 0.4V, PIC microcontroller will compared a data for PIR sensor. If PIR is equal to 1 means the sensor is sense the motion and it will go to subroutine lcd1.

Next, at the subroutine lcd1, PIC microcontroller will clear the LCD display and after pause "MOTION DETECTED" will be display at line 1 LCD and "LAMP:FULL BRIGHT" will be displayed at second line in LCD. After that, it w will return back to main coding and move to the next line programming.

Next, the halogen will turn on in full brightness because in the previous, the PIR sensor is senses a motion. But lamp will change to dim condition when PIR sensor is at a LOW state and will turn off when LDR sensor sense the intensity of light and when the comparison is done the voltage is greater the 0.4V.

```
lcd1:
    PAUSE 100
    LCDOUT $FE,1
    PAUSE 100
    LCDOUT $fe,$80, "MOTION DETECTED"
    LCDOUT $fe,$c0, "LAMP:FULL BRIGHT"
    RETURN

lcd2:
    PAUSE 100
    LCDOUT $FE,1
    PAUSE 100
    LCDOUT $fe,$80+3, "NO MOTION"
    LCDOUT $fe,$c0+3, "LAMP: DIM"
    RETURN

lcd3:
    PAUSE 100
    LCDOUT $FE,1
    PAUSE 100
    LCDOUT $fe,$80+1, "PIR SENSOR OFF"
    LCDOUT $fe,$c0+4, "LAMP OFF"
    RETURN
```

Figure 5.8: Programming for subroutine LCD

5.5.2 PICBasic Pro Compiler

The compilation has to be done to make the PIC microcontroller function as we want. First, the program has to build with MicroCode Studio. When the program is done it will be complied in .HEX file. This type of file is in machine language and this language is needed to make the PIC microcontroller run the system. Other, the simulator also need this .HEX file to simulate the system. To compile the PICBASIC language into machine language, firstly, the type of microcontroller should be choose in the PIC microcontroller dropdown list next to the download program button that shown in figure 5.9. Next, click the compile button or F9 from the key board that shown in figure 5.10.

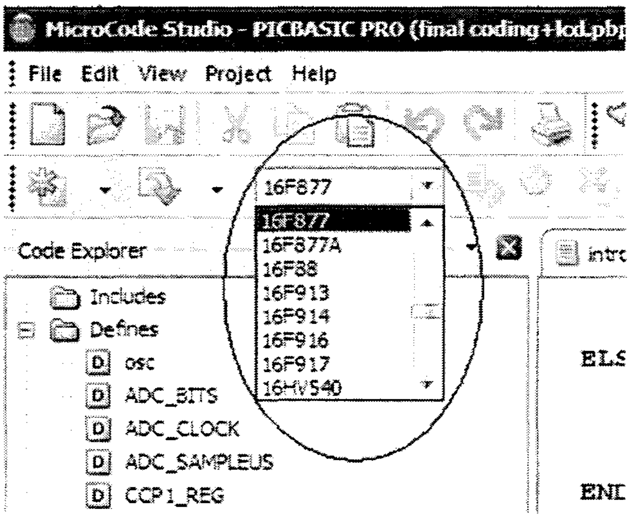


Figure 5.9: PIC Microcontroller Dropdown List

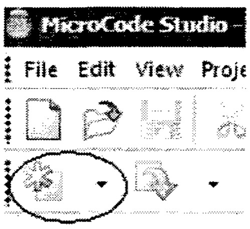


Figure 5.10: Compiler Button

5.5.3 melabs Programmer

After the compilation is done, .HEX file will be generated and automatically will be saved at the same folder. To burn the program into PIC microcontroller, firstly, same as PICBasic, the type of microcontroller should be choose in the PIC microcontroller dropdown list. Next, the file must be choosing by melabs Programmer as shown in figure 5.11 and figure 5.12. After that, the configuration has to change because the type of PIC microcontroller that we used which is PIC16F877 is a high speed type. Thing that has to change is Oscillator change to HS and disabled Watchdog timer, Power-up Timer, Brown-out Reset, Low Voltage Programming and Flash Program Memory Write. For Code Protect is set to off and Data EEPROM is set to Not Protected as shown in figure 5.12. After we set the configuration, the melabs Programmer is ready to program our PIC microcontroller with just clicking Program button as shown in figure 5.11.

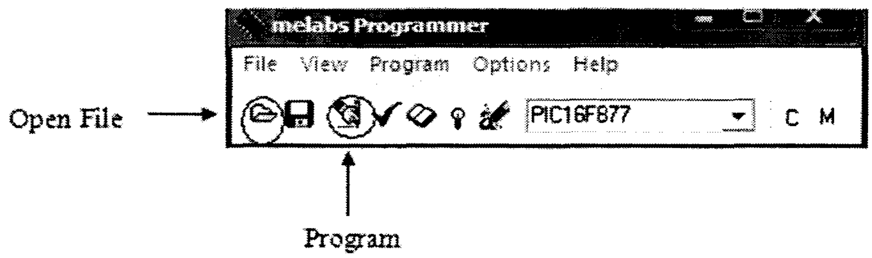


Figure 5.11: melabs Programmer

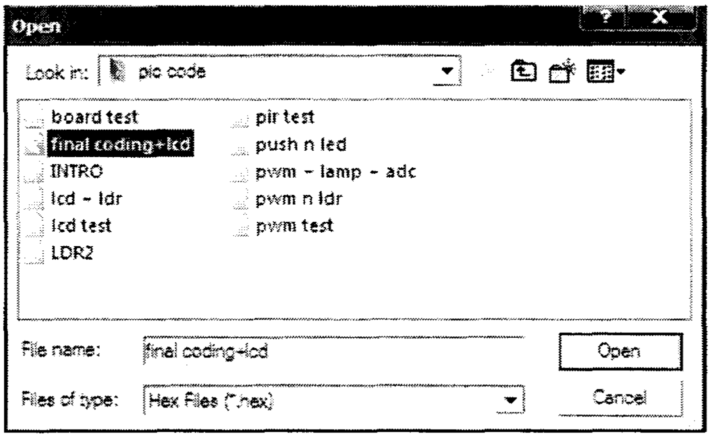


Figure 5.12: Open file to choose the program

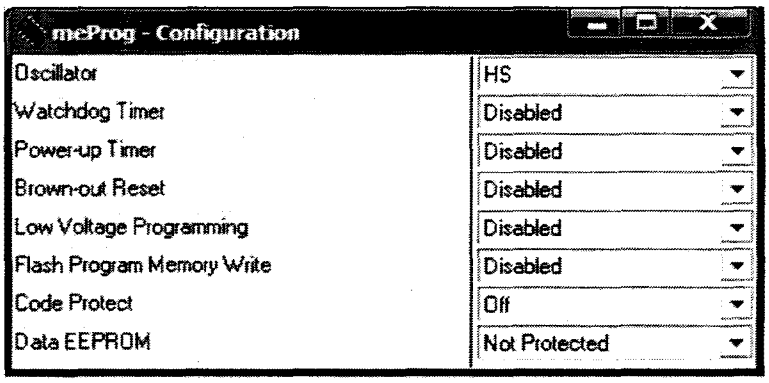


Figure 5.13: meprog Configuration

When the melabs Programmer had done program the PIC microcontroller, the notifications will appear as shown in figure 5.15.

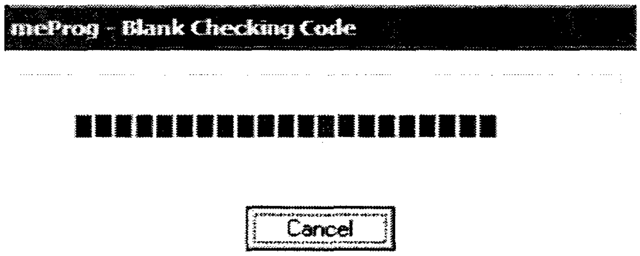


Figure 5.14: Download Program in Progress

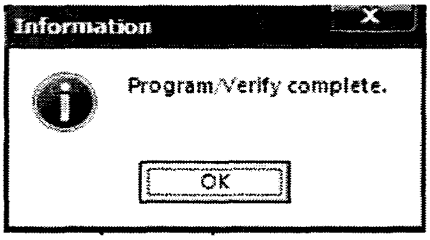


Figure 5.15: Download Program is Complete

CHAPTER 6

RESULT & DISCUSSION

6.1 OVERVIEW

This chapter will discuss about the final result of the project. Finally, all the component is constructed and integrated into stripped board to developing a project called "Night Lamp Brightness Controller System" by using PIC16F877 as a brain of the project. A combination of programming for each module were developed a complete and successfully system. Everything that related to this final result of the system will be discussed in this chapter.

After completing this project, including all part of the devices and complete programming, the result almost the same as expected result and fulfil the objective and scope of the project. The photoresistor or LDR will collect the data and the microcontroller will compare the data and switch on the PIR sensor and lamp. The system flows smoothly as expected inside the methodology. The complete programming can be referred at the appendix.

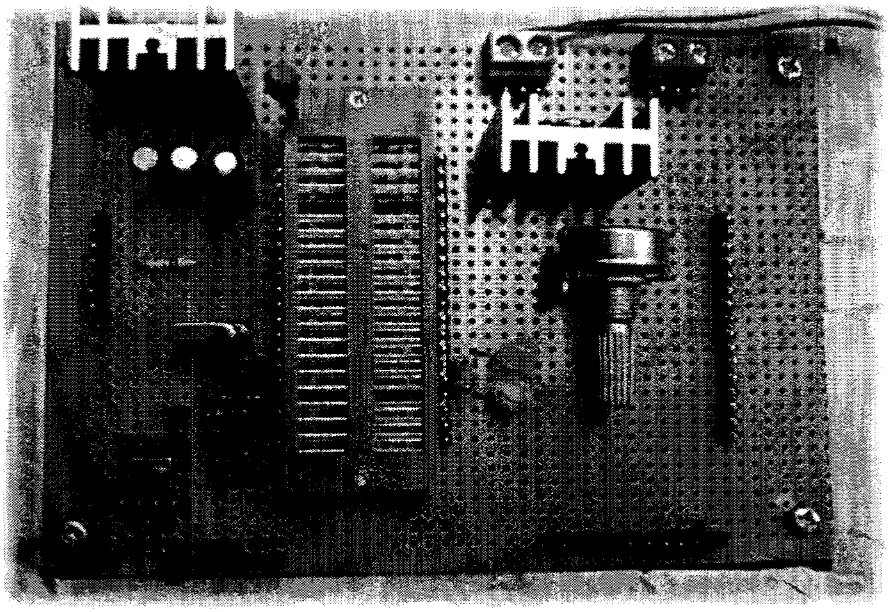


Figure 6.1: Complete circuit for "Night Lamp Brightness Controller System"

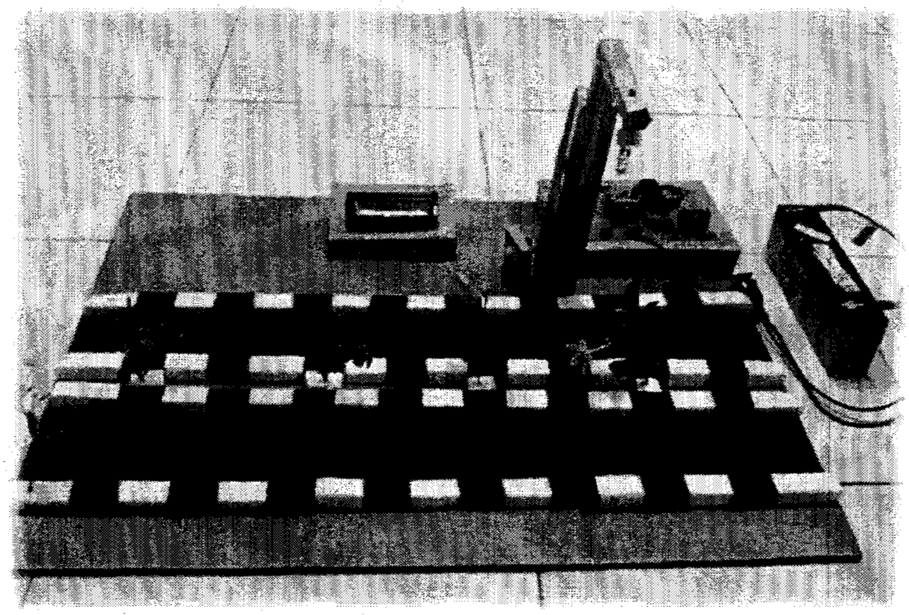


Figure 6.2: Complete model for "Night Lamp Brightness Controller System"

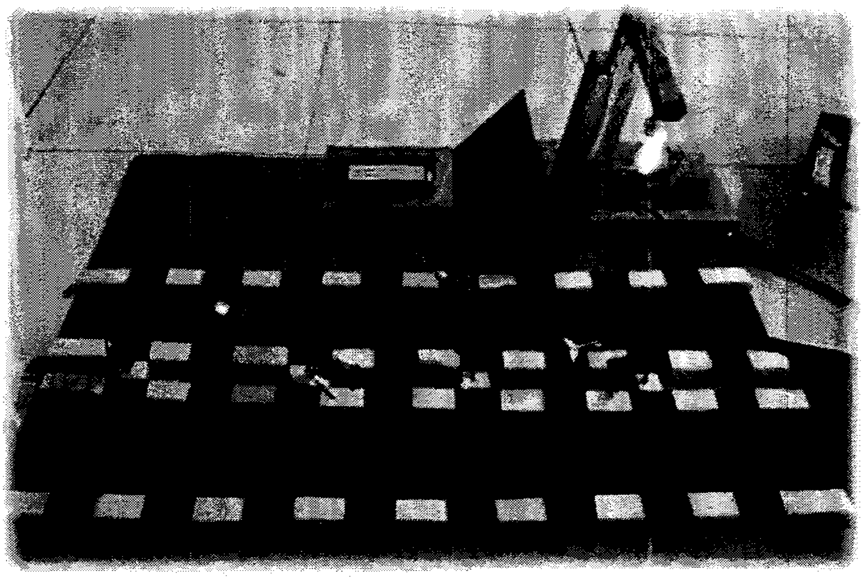


Figure 6.3: Complete model for "Night Lamp Brightness Controller System" (lamp in dim condition)

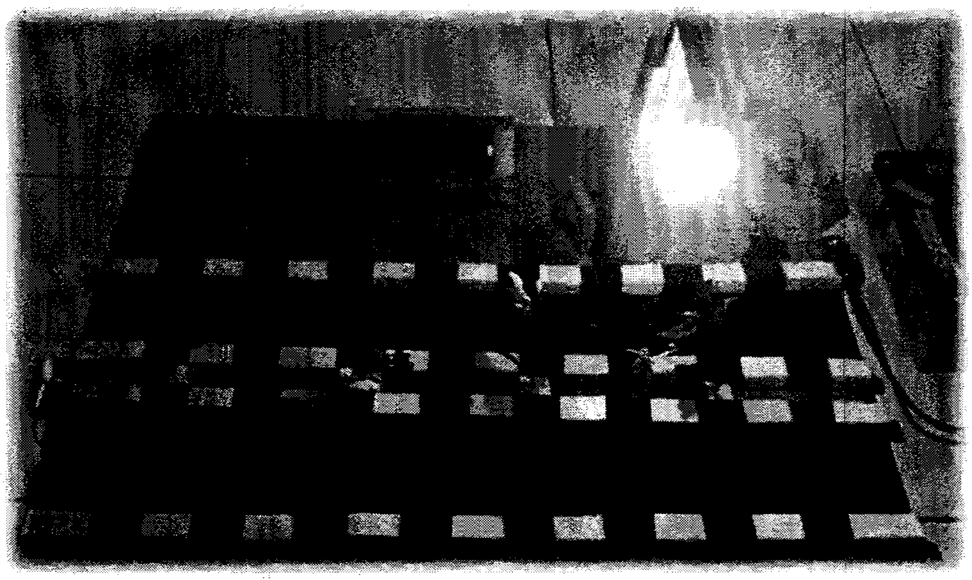


Figure 6.4: Complete model for "Night Lamp Brightness Controller System" (lamp in full brightness condition)

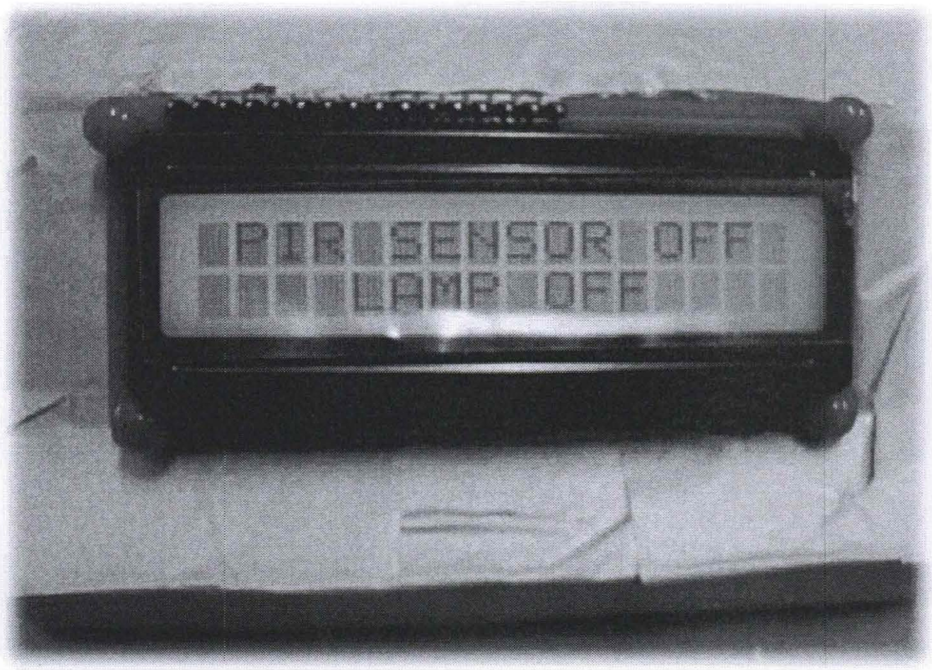


Figure 6.5: LCD screen display when LDR sensor sense intensity of light greater than 0.4V

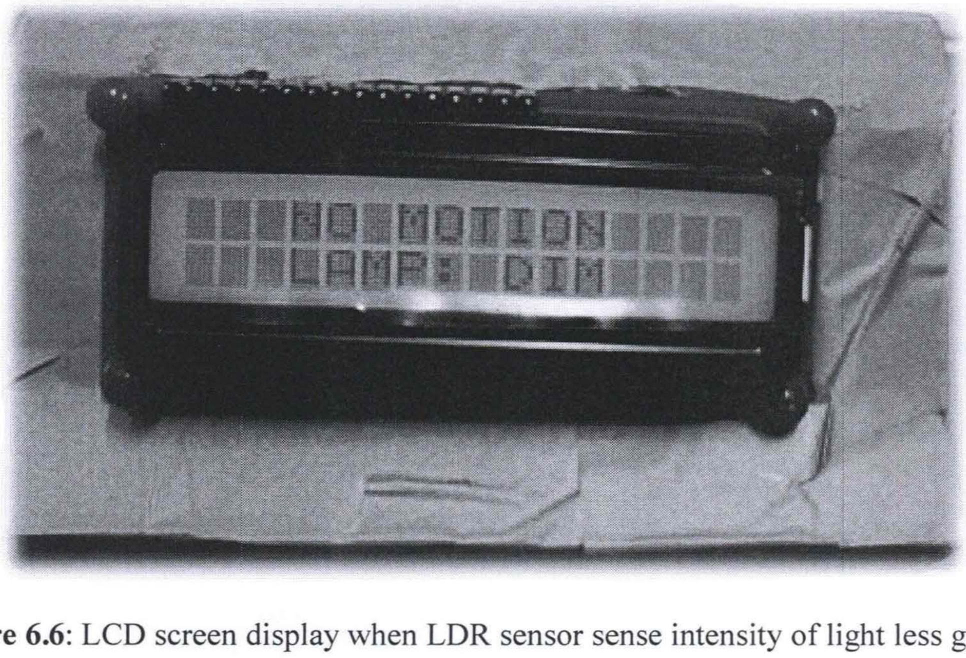


Figure 6.6: LCD screen display when LDR sensor sense intensity of light less greater than 0.4V and no motion detected

Figure 6.6: LCD screen display when LDR sensor sense intensity of light less than 0.4V and a motion has been detected

6.2 RESULT OF THE NIGHT LAMP CONTROLLER BRIGHTNESS SYSTEM

All the results that we obtained in this project will be discussed briefly in this subtopic. The system will run sequence by sequence smoothly and will remain looping at certain level.

When the system is turn on, LDR sensor will automatically on and sense the intensity of light and LCD will display "PIR SENSOR OFF" at line 1 and "LAMP OFF" at line 2.

After that, PIC microcontroller will compare the input voltage from LDR sensor. If the input voltage is higher than 0.4V, LCD will display as the same at initial state and nothing is change. But when the input voltage is lower than 0.4V means there is a little intensity of light is sense by LDR sensor and night will appeared. So that, the PIR sensor is turn on to sense a movement and lamp also turn on in dim condition. At this time, LCD will display "NO MOTION" in line 1 and "LAMP: DIM" line 2.

Next, if the PIR sensor is detect a motion, it will give HIGH to PIC microcontroller, and the LCD will display "MOTION DETECTED" in line 1 and "LAMP:FULL BRIGHT" in line 2. At the same time, the lamp will change to full brightness condition.

The system will always loop and compare the input voltage at LDR sensor and PIR sensor. The halogen lamp and LCD will change according to the input of LDR sensor and PIR sensor as shown in table 6.1.

<table>
<tr><th colspan="2">INPUT</th><th colspan="2">OUTPUT</th></tr>
<tr><th>LDR Sensor</th><th>PIR Sensor</th><th>Halogen Lamp</th><th>LCD Display</th></tr>
<tr><td>>0.4V</td><td>Off</td><td>Off</td><td>LDR SENSOR OFF
LAMP OFF</td></tr>
<tr><td rowspan="2"><0.4V</td><td>0</td><td>On</td><td>NO MOTION
LAMP: DIM</td></tr>
<tr><td>1</td><td>On</td><td>MOTION DETECTED
LAMP:FULL BRIGHT</td></tr>
</table>

Table 6.1: Table of the Changing Halogen Lamp and LCD Display

CHAPTER 7

CONCLUSION & RECOMMENDATION

7.1 OVERVIEW

As we know that the sun is the ideal source of light. The intensity of sunlight is helpful for living creature to continue their daily life. When the night has come, it can be told by the missing of the intensity of sunlight. With this concept that we applied into our intelligent street lamp called "Night Lamp Brightness Controller System", the system will be more accurate to sense day and night and to estimate the right time to turn on the lamp.

The goal of this project is to design a program and hardware to control the brightness of the lamp based on the motion that will sense by PIR sensor. The PIC16F877 microcontroller that been used as a brain system so that the brightness of lamp can be control based on the movement or motion detection.

Generally, this project is complete and achieves the entire objective within the scope of project given. This system also can be implemented in our daily life with a little adjustment and modification at the system. By using the LDR sensor, this system is able to sense the intensity of sunlight to differentiate day and night. With the intelligent PIC16F877 microcontroller, this project has been done successfully without any serious problem.

7.2 Problem & Solution

While doing this project, there is many problems has occur and the problems are:

a. In PSM 1, power LED has been suggested to be lamp to this project, but then, this component is very hard to find, to solve this; the lamp has been changed to halogen lamp that has almost same specification as power LED.

b. The halogen lamp is a current control component but the driver that has been used to convert the 5V to 12V is relay. Relay is kind of driver that control the voltage. Others, to control the brightness of lamp is use PWM command and relay is not suitable with this command because it has a delay time to tap the coil to let 12V flow to the lamp. To solve this, the driver is change to current control circuit. TIP142 NPN transistor has been used to control the current. This type of transistor is been chosen because this component is able to handle the PWM command.

7.3 Recommendation

Even though this system is achieve the objective within the scope that has been stated, a several additional is needed to make this project more stable and to improve the performance of the system. The suggestion is:

a. PIR sensor that has been used is too sensitive with any movement that the sensor sense. In real life, if this sensor has been used, even the movement of the tree will be change the condition of lamp into full brightness. As recommendation, this project needs to replace this PIR sensor with temperature sensor and metal sensor. This because temperature sensor will sense the present of human or animal while metal sensor will sense the present of vehicles.

b. Change the BJT NPN to TTL. This is because TTL is a multiple transistor system, so that the output from this process is more accurate. Other, TTL is particularly well suited IC package the input of a gate may all be integrated into a single base region to form a multiple emitter transistor. TTL also can reduce a cost because it is a combining a several small on-chip components and become one larger device.

7.4 Costing & Commercialization

Total cost for this project is about RM154. The detail about the item can be referring at APPENDIX D. Generally at this price, it can be categorize cheap since it included several extra electronic component such as halogen lamp, LCD etc.

Besides this project has potential to be commercialized. Street light is a important thing for the road user. With the additional of the new function, the street light will be more practical and functional.

7.5 Conclusion

At the end of this project, this system able sense day and night. Other, the lamp also function in two condition which is full brightness and dim condition according to the objectives. Lastly, the model also successfully builds. As a conclusion, this project is done very well and all the objectives are achieved.

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[1] Buie, J. *Coupling Transistor Logic and Other Circuits.* U.S. Patent 3,283,170. 1966.

[2] *Stray Voltage Still on the Loose*, Retrieved on October 13, 2009 from http://scienceline.org/2006/08/04/physics-grant-manholes/.

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[4] Petro Koblyuk ,*Light Dimmer with Capsense Brightness Control*, Retrieved on March 4, 2009 from ftp://ftp.efo.ru/pub/cypress/psoc/capsense/app/TDAN_LampDimmerAppNote.pdf

[5] Ryun Huff, *Versatile High Power LED Driver Controller Simplifies Design*, Retrieved on March 10, 2009 from www.techonline.com/learning/techpaper/208808699

APPENDIX A

SOFTWARE DEVELOPMENT

Program of "Night Lamp Brightness Controller System" Project

```
'**************************************************************
'* Name       : SITI HANUM SURYA BINTI IBRAHIM                *
'* Supervisor : FAIRUZ RIZAL MOHAMAD RASHIDI                  *
'* University : UNIVERSITI MALAYSIA PAHANG                    *
'* Date       : 19/11/2009                                    *
'* Version    : 1.0                                           *
'* Notes      : NIGHT LAMP BRIGHTNESS CONTROLLER SYSTEM       *
'**************************************************************
DEFINE osc 8
DEFINE ADC_BITS 8
DEFINE ADC_CLOCK 3
DEFINE ADC_SAMPLEUS 50
DEFINE CCP1_REG PORTC
DEFINE CCP1_BIT2
DEFINE LCD_DREG    PORTD
DEFINE LCD_DBIT    4
DEFINE LCD_RSREG   PORTE
DEFINE LCD_RSBIT   1
DEFINE LCD_EREG    PORTE
DEFINE LCD_EBIT    2
DEFINE LCD_BITS    4
DEFINE LCD_LINES   2
DEFINE LCD_COMMNDUS 2000
DEFINE LCD_DATAUS  50

trisa.4=0                    'port a4 is not an analog port. Define port like other port'
trisd=0                      'define output port for LCD'
trise.1=0
trise.2=0

LDR var word

adcon1=%00001001             ' port e1 & e2 is digital, & another ADC port = analog'

TRISC.5=1

PIR var portc.5

main:
low porta.4                  ' to write the LCD'

adcin 0, LDR
pause 100
```

```
if LDR<10 then                          'LDR sense night'
   if PIR=1 then                        'motion has been detected'
      gosub lcd1
      hpwm 1,150,30000                  'lamp is fullbrightness'
      pause 2000
   else                          'no motion detected'
      gosub lcd2
      hpwm 1,50,30000                   'lamp in dim condition'
      pause 2000
   endif
else                             'LDR sense a day'
   gosub lcd3
   hpwm 1,0,30000                'lamp is off'
   pause 2000
endif
 goto main

 lcd1:
   pause 100
   lcdout $FE,1
   pause 100
   lcdout $fe,$80, "MOTION DETECTED"
   lcdout $fe,$c0, "LAMP:FULL BRIGHT"
   return

 lcd2:
   pause 100
   lcdout $FE,1
   pause 100
   lcdout $fe,$80+3, "NO MOTION"
   lcdout $fe,$c0+3, "LAMP: DIM"
   return

 lcd3:
   pause 100
   lcdout $FE,1
   pause 100
   LCDout $fe,$80+1, "PIR SENSOR OFF"
   lcdout $fe,$c0+4, "LAMP OFF"
   return
```

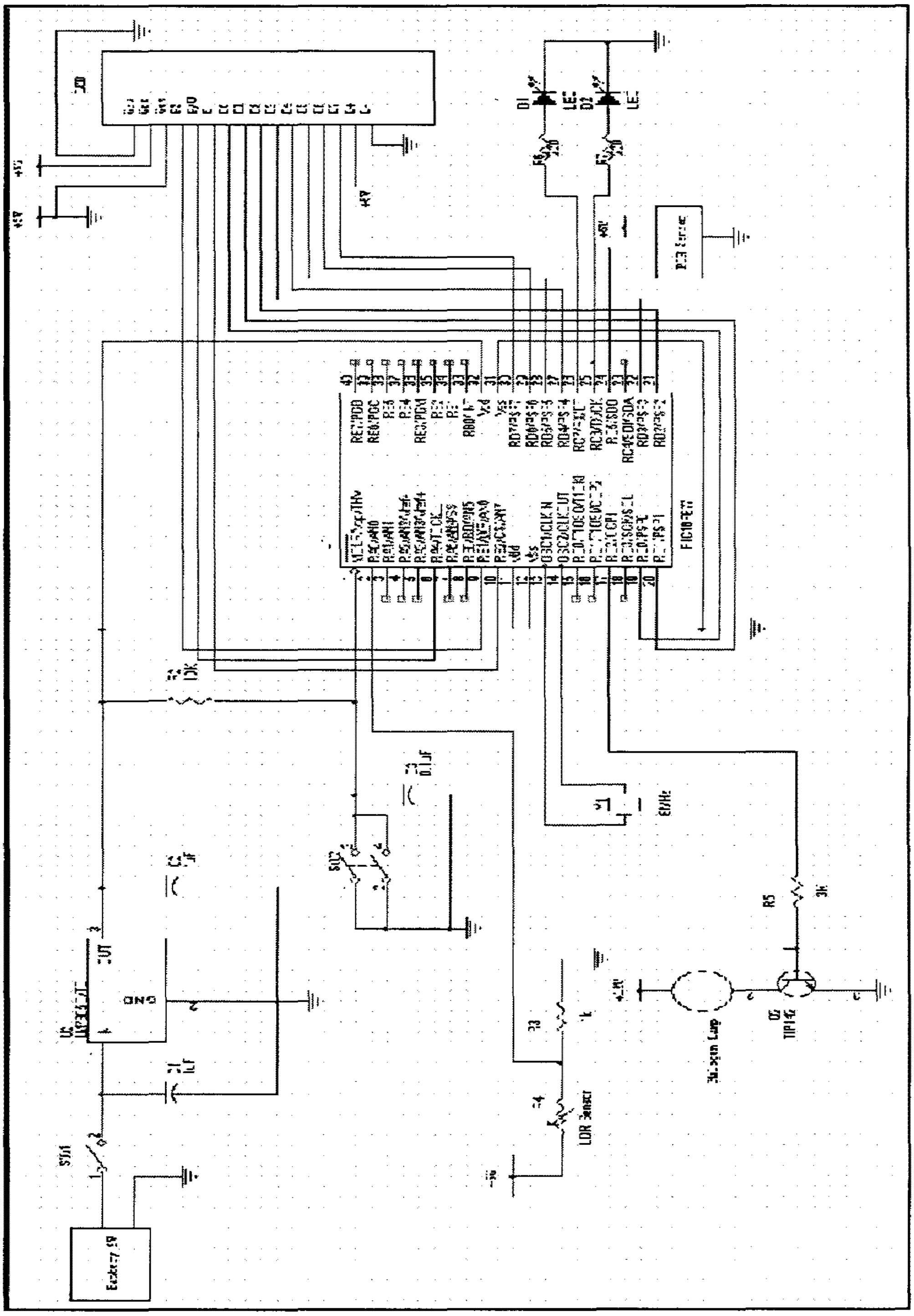
APPENDIX B

HARDWARE DEVELOPMENT

Full schematic circuit of the project

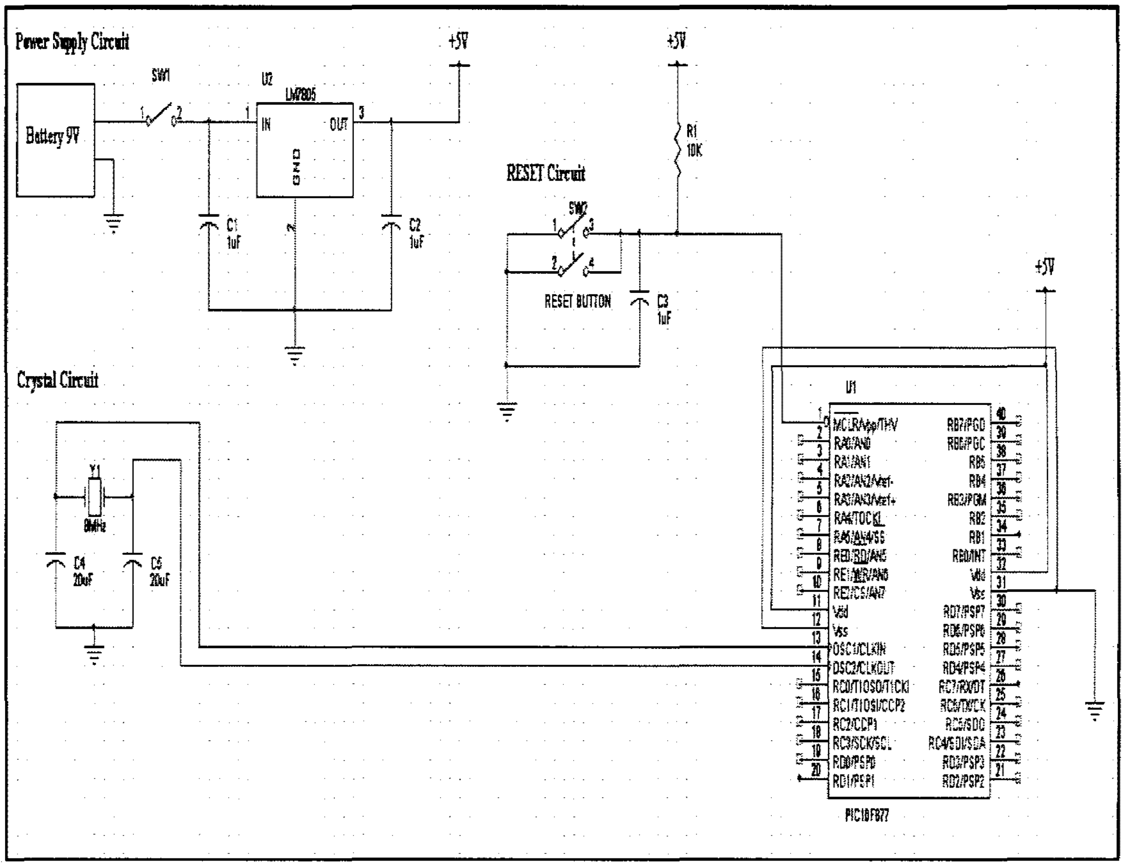
CIRCUIT I

Complete circuit



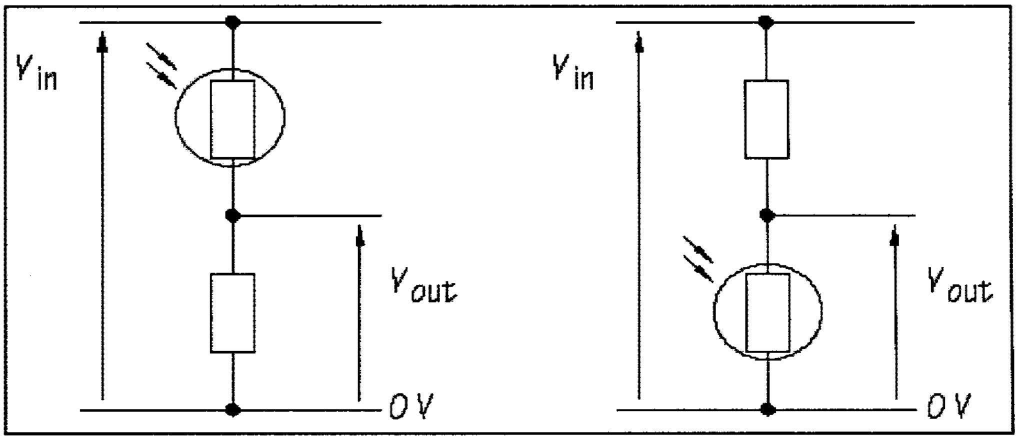
CIRCUIT II

PIC16F877A Basic Circuit

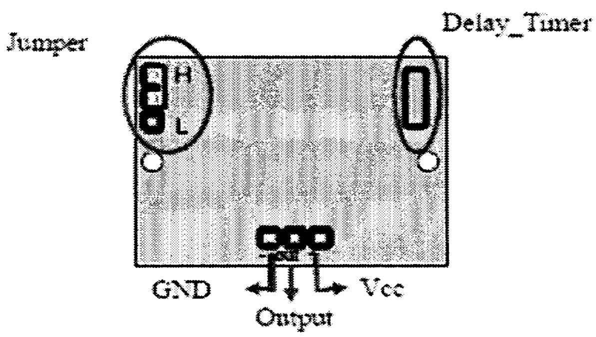


CIRCUIT III

Sensor Circuit



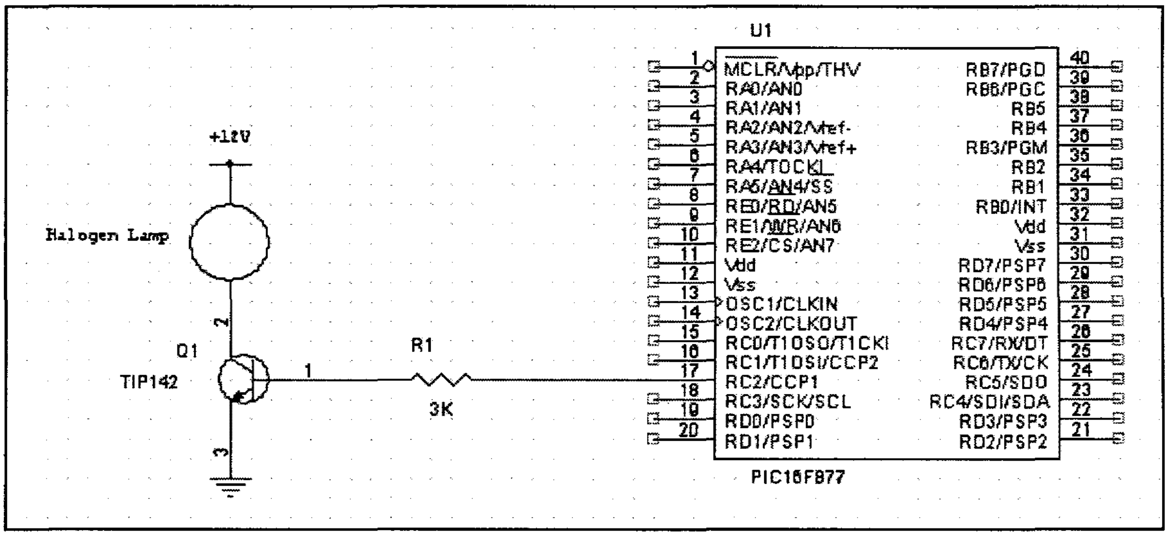
LDR sensor



PIR sensor

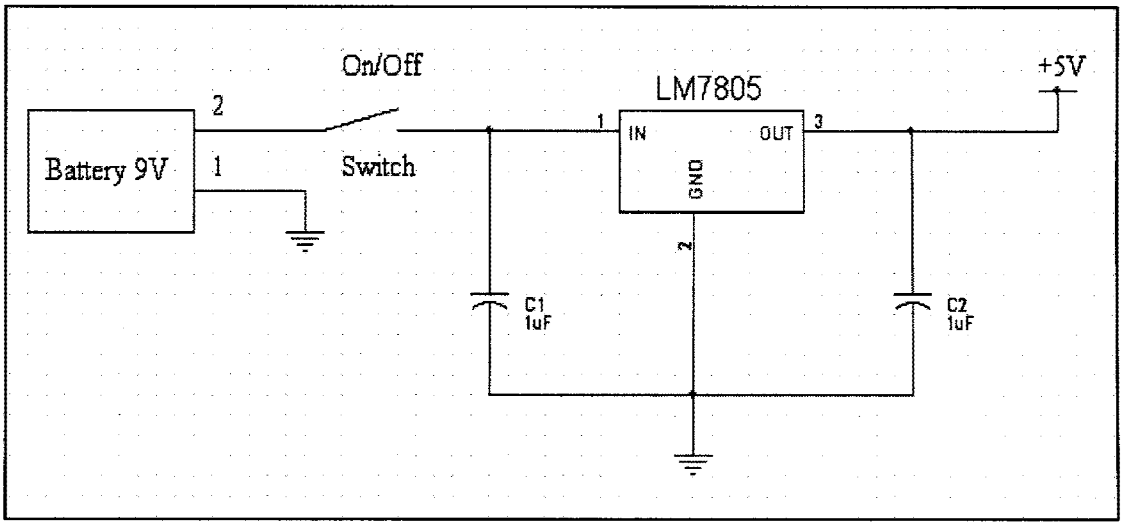
CIRCUIT IV

Driver & Halogen Lamp



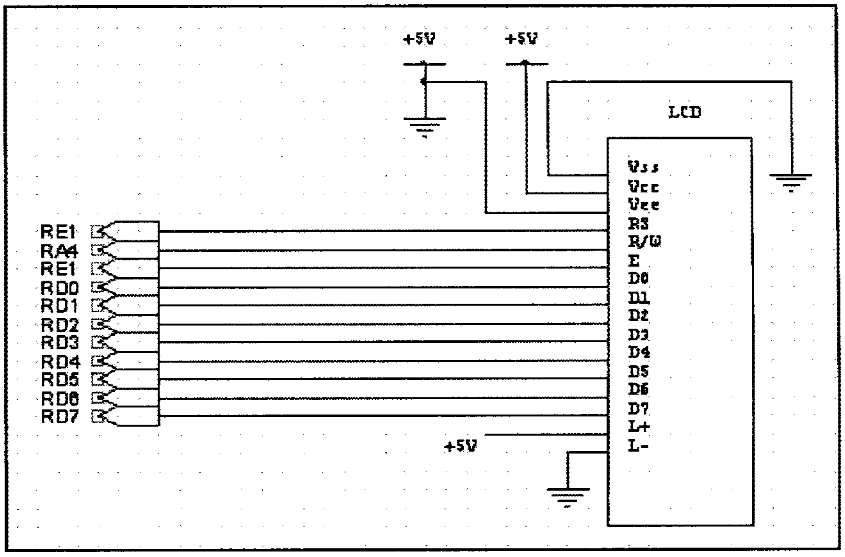
CIRCUIT V

Power Supply Circuit



CIRCUIT VI

LCD Circuit



APPENDIX C

DATASHEET

DATASHEET I

PIC16F877

MICROCHIP

PIC16F87X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

Devices Included in this Data Sheet:

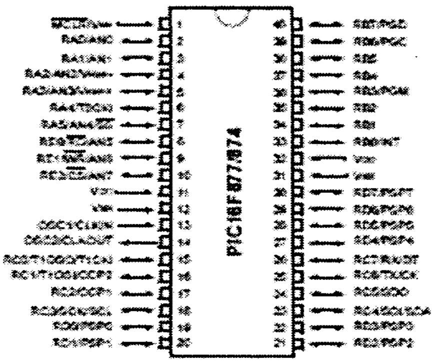
- PIC16F873
- PIC16F876
- PIC16F874
- PIC16F877

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, Industrial and Extended temperature ranges
- Low-power consumption:
  - < 0.6 mA typical @ 3V, 4 MHz
  - 20 µA typical @ 3V, 32 kHz
  - < 1 µA typical standby current

Pin Diagram

PDIP

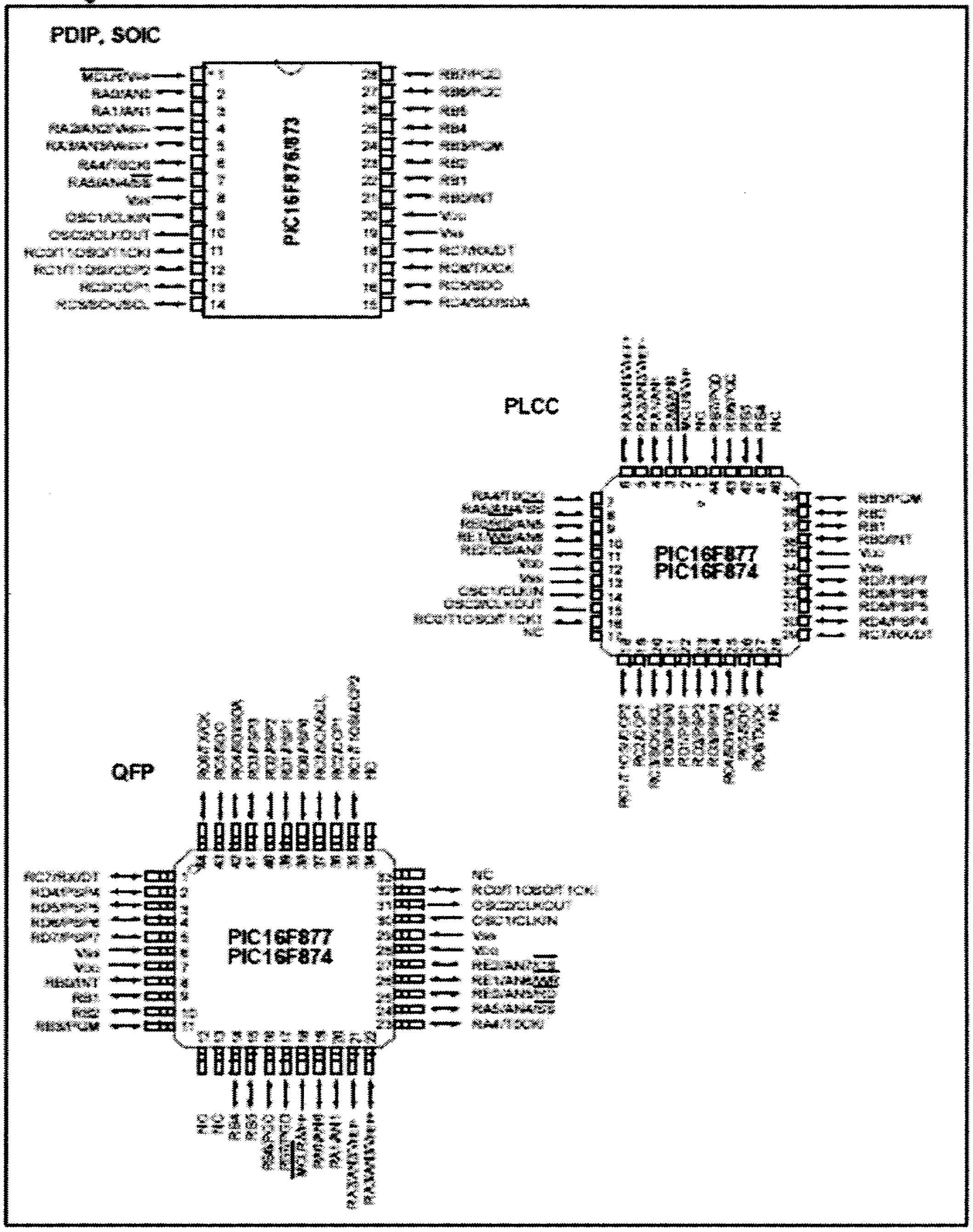


Peripheral Features:

- 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)

PIC16F87X

Pin Diagrams



1.0 DEVICE OVERVIEW

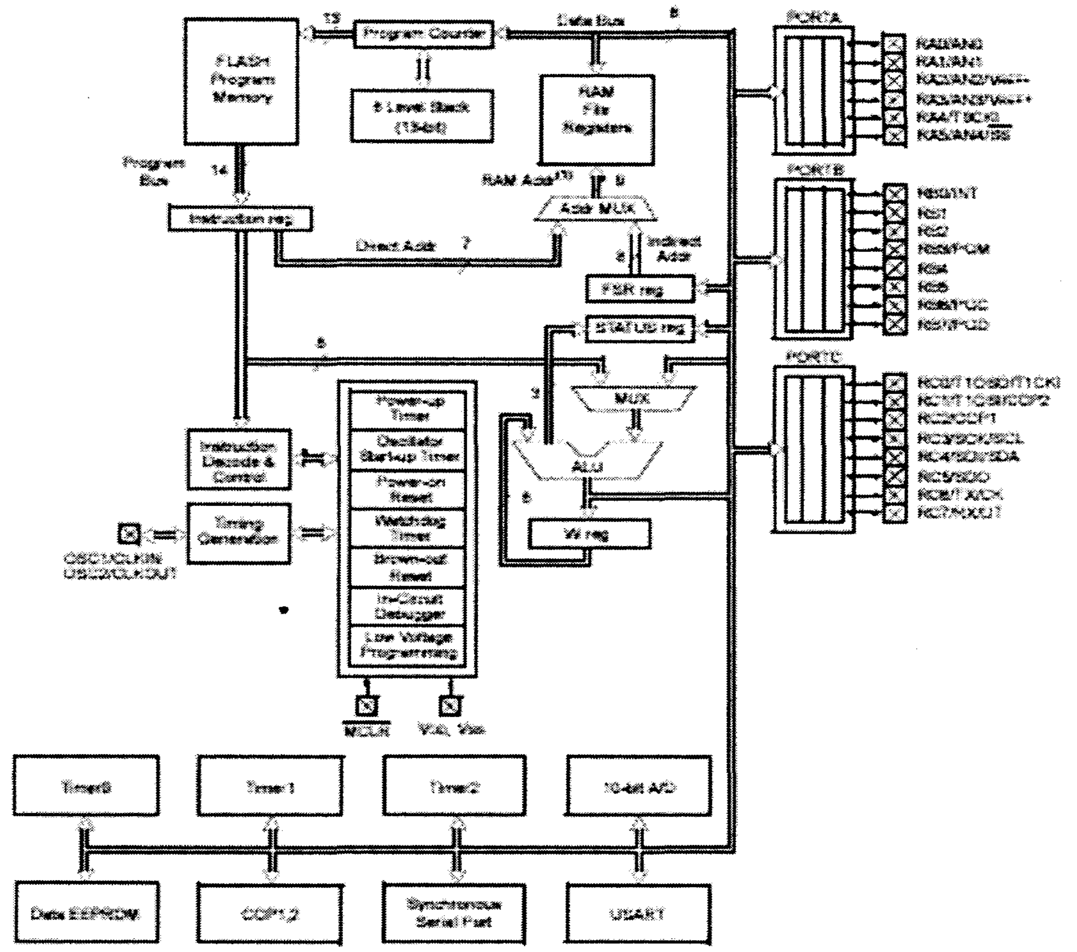
This document contains device specific information. Additional information may be found in the PICmicro™ Mid-Range Reference Manual (DS33023), which may be obtained from your local Microchip Sales Representative or downloaded from the Microchip website. The Reference Manual should be considered a complementary document to this data sheet, and is highly recommended reading for a better understanding of the device architecture and operation of the peripheral modules.

There are four devices (PIC16F873, PIC16F874, PIC16F876 and PIC16F877) covered by this data sheet. The PIC16F876/873 devices come in 28-pin packages and the PIC16F877/874 devices come in 40-pin packages. The Parallel Slave Port is not implemented on the 28-pin devices.

The following device block diagrams are sorted by pin number; 28-pin for Figure 1-1 and 40-pin for Figure 1-2. The 28-pin and 40-pin pinouts are listed in Table 1-1 and Table 1-2, respectively.

FIGURE 1-1: PIC16F873 AND PIC16F876 BLOCK DIAGRAM

Device	Program FLASH	Data Memory	Data EEPROM
PIC16F873	4K	192 Bytes	128 Bytes
PIC16F876	8K	368 Bytes	256 Bytes



Note 1: Higher order bits are from the STATUS register.

11.0 ANALOG-TO-DIGITAL CONVERTER (A/D) MODULE

The Analog-to-Digital (A/D) Converter module has five inputs for the 28-pin devices and eight for the other devices.

The analog input charges a sample and hold capacitor. The output of the sample and hold capacitor is the input into the converter. The converter then generates a digital result of this analog level via successive approximation. The A/D conversion of the analog input signal results in a corresponding 10-bit digital number. The A/D module has high and low voltage reference input that is software selectable to some combination of VDD, VSS, RA2, or RA3.

The A/D converter has a unique feature of being able to operate while the device is in SLEEP mode. To operate in SLEEP, the A/D clock must be derived from the A/D's internal RC oscillator.

The A/D module has four registers. These registers are:

- A/D Result High Register (ADRESH)
- A/D Result Low Register (ADRESL)
- A/D Control Register0 (ADCON0)
- A/D Control Register1 (ADCON1)

The ADCON0 register, shown in Register 11-1, controls the operation of the A/D module. The ADCON1 register, shown in Register 11-2, configures the functions of the port pins. The port pins can be configured as analog inputs (RA3 can also be the voltage reference), or as digital I/O.

Additional information on using the A/D module can be found in the PICmicro™ Mid-Range MCU Family Reference Manual (DS33023).

REGISTER 11-1: ADCON0 REGISTER (ADDRESS: 1Fh)

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0
ADCS1	ADCS0	CHS2	CHS1	CHS0	GO/$\overline{DONE}$	—	ADON
bit 7							bit 0

bit 7-6 **ADCS1:ADCS0**: A/D Conversion Clock Select bits
00 = FOSC/2
01 = FOSC/8
10 = FOSC/32
11 = FRC (clock derived from the internal A/D module RC oscillator)

bit 5-3 **CHS2:CHS0**: Analog Channel Select bits
000 = channel 0, (RA0/AN0)
001 = channel 1, (RA1/AN1)
010 = channel 2, (RA2/AN2)
011 = channel 3, (RA3/AN3)
100 = channel 4, (RA5/AN4)
101 = channel 5, (RE0/AN5)(1)
110 = channel 6, (RE1/AN6)(1)
111 = channel 7, (RE2/AN7)(1)

bit 2 **GO/$\overline{DONE}$**: A/D Conversion Status bit
If ADON = 1:
1 = A/D conversion in progress (setting this bit starts the A/D conversion)
0 = A/D conversion not in progress (this bit is automatically cleared by hardware when the A/D conversion is complete)

bit 1 **Unimplemented**: Read as '0'

bit 0 **ADON**: A/D On bit
1 = A/D converter module is operating
0 = A/D converter module is shut-off and consumes no operating current

Note 1: These channels are not available on PIC16F873/876 devices.

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

PIC16F87X

REGISTER 11-2: ADCON1 REGISTER (ADDRESS 9Fh)

U-0	U-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
ADFM	—	—	—	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							bit 0

bit 7 **ADFM:** A/D Result Format Select bit
1 = Right justified. 6 Most Significant bits of ADRESH are read as '0'.
0 = Left justified. 6 Least Significant bits of ADRESL are read as '0'.

bit 6-4 **Unimplemented:** Read as '0'

bit 3-0 **PCFG3:PCFG0:** A/D Port Configuration Control bits:

PCFG3: PCFG0	AN7[1] RE2	AN6[1] RE1	AN5[1] RE0	AN4 RA5	AN3 RA3	AN2 RA2	AN1 RA1	AN0 RA0	VREF+	VREF-	CHAN/ Refs[2]
0000	A	A	A	A	A	A	A	A	VDD	VSS	8/0
0001	A	A	A	A	VREF+	A	A	A	RA3	VSS	7/1
0010	D	D	D	A	A	A	A	A	VDD	VSS	5/0
0011	D	D	D	A	VREF+	A	A	A	RA3	VSS	4/1
0100	D	D	D	D	A	D	A	A	VDD	VSS	3/0
0101	D	D	D	D	VREF+	D	A	A	RA3	VSS	2/1
011x	D	D	D	D	D	D	D	D	VDD	VSS	0/0
1000	A	A	A	A	VREF+	VREF-	A	A	RA3	RA2	6/2
1001	D	D	A	A	A	A	A	A	VDD	VSS	6/0
1010	D	D	A	A	VREF+	A	A	A	RA3	VSS	5/1
1011	D	D	A	A	VREF+	VREF-	A	A	RA3	RA2	4/2
1100	D	D	D	A	VREF+	VREF-	A	A	RA3	RA2	3/2
1101	D	D	D	D	VREF+	VREF-	A	A	RA3	RA2	2/2
1110	D	D	D	D	D	D	D	A	VDD	VSS	1/0
1111	D	D	D	D	VREF+	VREF-	D	A	RA3	RA2	1/2

A = Analog input D = Digital I/O

Note 1: These channels are not available on PIC16F873/876 devices.
2: This column indicates the number of analog channels available as A/D inputs and the number of analog channels used as voltage reference inputs.

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

The ADRESH:ADRESL registers contain the 10-bit result of the A/D conversion. When the A/D conversion is complete, the result is loaded into this A/D result register pair, the GO/$\overline{DONE}$ bit (ADCON0<2>) is cleared and the A/D interrupt flag bit ADIF is set. The block diagram of the A/D module is shown in Figure 11-1.

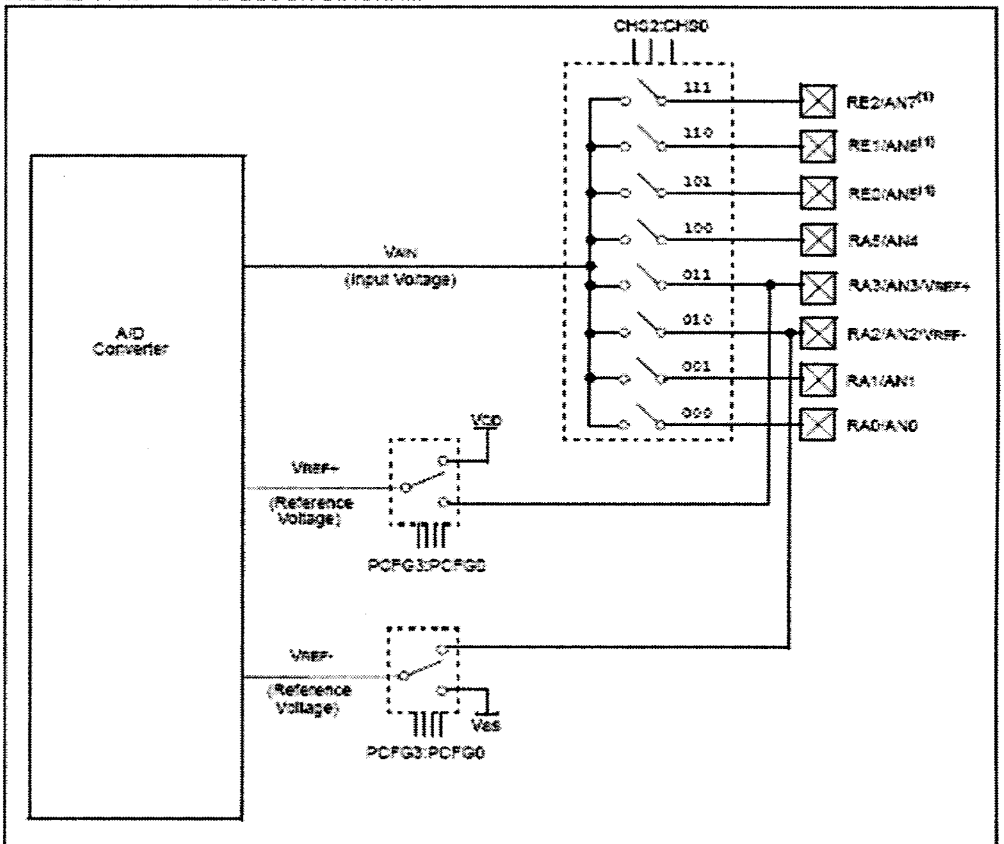
After the A/D module has been configured as desired, the selected channel must be acquired before the conversion is started. The analog input channels must have their corresponding TRIS bits selected as inputs.

To determine sample time, see Section 11.1. After this acquisition time has elapsed, the A/D conversion can be started.

These steps should be followed for doing an A/D Conversion:

1. Configure the A/D module:
   - Configure analog pins/voltage reference and digital I/O (ADCON1)
   - Select A/D input channel (ADCON0)
   - Select A/D conversion clock (ADCON0)
   - Turn on A/D module (ADCON0)
2. Configure A/D interrupt (if desired):
   - Clear ADIF bit
   - Set ADIE bit
   - Set PEIE bit
   - Set GIE bit
3. Wait the required acquisition time.
4. Start conversion:
   - Set $GO/\overline{DONE}$ bit (ADCON0)
5. Wait for A/D conversion to complete, by either:
   - Polling for the $GO/\overline{DONE}$ bit to be cleared (with interrupts enabled); OR
   - Waiting for the A/D interrupt
6. Read A/D result register pair (ADRESH:ADRESL), clear bit ADIF if required.
7. For the next conversion, go to step 1 or step 2, as required. The A/D conversion time per bit is defined as T_{AD}. A minimum wait of $2T_{AD}$ is required before the next acquisition starts.

FIGURE 11-1: A/D BLOCK DIAGRAM



Note 1: Not available on PIC16F873/876 devices.

8.0 CAPTURE/COMPARE/PWM MODULES

Each Capture/Compare/PWM (CCP) module contains a 16-bit register which can operate as a:

- 16-bit Capture register
- 16-bit Compare register
- PWM Master/Slave Duty Cycle register

Both the CCP1 and CCP2 modules are identical in operation, with the exception being the operation of the special event trigger. Table 8-1 and Table 8-2 show the resources and interactions of the CCP module(s). In the following sections, the operation of a CCP module is described with respect to CCP1. CCP2 operates the same as CCP1, except where noted.

CCP1 Module:

Capture/Compare/PWM Register1 (CCPR1) is comprised of two 8-bit registers: CCPR1L (low byte) and CCPR1H (high byte). The CCP1CON register controls the operation of CCP1. The special event trigger is generated by a compare match and will reset Timer1.

CCP2 Module:

Capture/Compare/PWM Register2 (CCPR2) is comprised of two 8-bit registers: CCPR2L (low byte) and CCPR2H (high byte). The CCP2CON register controls the operation of CCP2. The special event trigger is generated by a compare match and will reset Timer1 and start an A/D conversion (if the A/D module is enabled).

Additional information on CCP modules is available in the PICmicro™ Mid-Range MCU Family Reference Manual (DS33023) and in application note AN594, "Using the CCP Modules" (DS00594).

TABLE 8-1: CCP MODE - TIMER RESOURCES REQUIRED

CCP Mode	Timer Resource
Capture	Timer1
Compare	Timer1
PWM	Timer2

TABLE 8-2: INTERACTION OF TWO CCP MODULES

CCPx Mode	CCPy Mode	Interaction
Capture	Capture	Same TMR1 time-base
Capture	Compare	The compare should be configured for the special event trigger, which clears TMR1
Compare	Compare	The compare(s) should be configured for the special event trigger, which clears TMR1
PWM	PWM	The PWMs will have the same frequency and update rate (TMR2 interrupt)
PWM	Capture	None
PWM	Compare	None

PIC16F87X

REGISTER 8-1: CCP1CON REGISTER/CCP2CON REGISTER (ADDRESS: 17h/1Dh)

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	CCPxX	CCPxY	CCPxM3	CCPxM2	CCPxM1	CCPxM0
bit 7							bit 0

bit 7-6 **Unimplemented:** Read as '0'

bit 5-4 **CCPxX:CCPxY:** PWM Least Significant bits

<u>Capture mode:</u>
Unused

<u>Compare mode:</u>
Unused

<u>PWM mode:</u>
These bits are the two LSbs of the PWM duty cycle. The eight MSbs are found in CCPRxL.

bit 3-0 **CCPxM3:CCPxM0:** CCPx Mode Select bits

`0000` = Capture/Compare/PWM disabled (resets CCPx module)
`0100` = Capture mode, every falling edge
`0101` = Capture mode, every rising edge
`0110` = Capture mode, every 4th rising edge
`0111` = Capture mode, every 16th rising edge
`1000` = Compare mode, set output on match (CCPxIF bit is set)
`1001` = Compare mode, clear output on match (CCPxIF bit is set)
`1010` = Compare mode, generate software interrupt on match (CCPxIF bit is set, CCPx pin is unaffected)
`1011` = Compare mode, trigger special event (CCPxIF bit is set, CCPx pin is unaffected); CCP1 resets TMR1; CCP2 resets TMR1 and starts an A/D conversion (if A/D module is enabled)
`11xx` = PWM mode

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

8.3 PWM Mode (PWM)

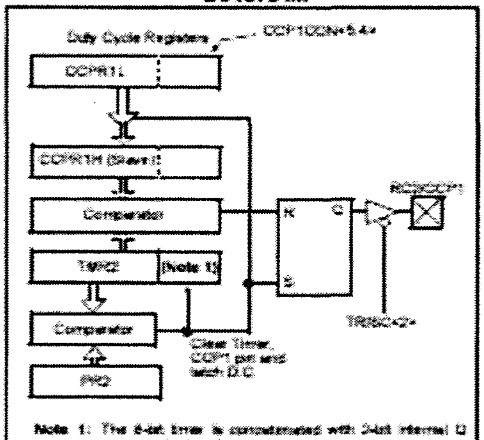
In Pulse Width Modulation mode, the CCPx pin produces up to a 10-bit resolution PWM output. Since the CCP1 pin is multiplexed with the PORTC data latch, the TRISC<2> bit must be cleared to make the CCP1 pin an output.

Note:	Clearing the CCP1CON register will force the CCP1 PWM output latch to the default low level. This is not the PORTC I/O data latch.

Figure 8-3 shows a simplified block diagram of the CCP module in PWM mode.

For a step-by-step procedure on how to set up the CCP module for PWM operation, see Section 8.3.3.

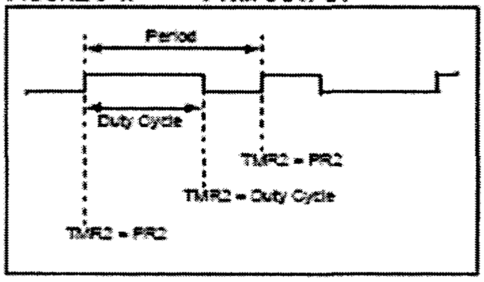
FIGURE 8-3: SIMPLIFIED PWM BLOCK DIAGRAM



Note 1: The 8-bit timer is concatenated with 2-bit internal Q clock, or 2 bits of the prescaler, to create 10-bit time-base.

A PWM output (Figure 8-4) has a time-base (period) and a time that the output stays high (duty cycle). The frequency of the PWM is the inverse of the period (1/period).

FIGURE 8-4: PWM OUTPUT



8.3.1 PWM PERIOD

The PWM period is specified by writing to the PR2 register. The PWM period can be calculated using the following formula:

$$\text{PWM period} = [(PR2) + 1] \cdot 4 \cdot T_{OSC} \cdot (\text{TMR2 prescale value})$$

PWM frequency is defined as 1 / [PWM period].

When TMR2 is equal to PR2, the following three events occur on the next increment cycle:

- TMR2 is cleared
- The CCP1 pin is set (exception: if PWM duty cycle = 0%, the CCP1 pin will not be set)
- The PWM duty cycle is latched from CCPR1L into CCPR1H

Note:	The Timer2 postscaler (see Section 7.1) is not used in the determination of the PWM frequency. The postscaler could be used to have a servo update rate at a different frequency than the PWM output.

8.3.2 PWM DUTY CYCLE

The PWM duty cycle is specified by writing to the CCPR1L register and to the CCP1CON<5:4> bits. Up to 10-bit resolution is available. The CCPR1L contains the eight MSbs and the CCP1CON<5:4> contains the two LSbs. This 10-bit value is represented by CCPR1L:CCP1CON<5:4>. The following equation is used to calculate the PWM duty cycle in time:

$$\text{PWM duty cycle} = (CCPR1L:CCP1CON<5:4>) \cdot T_{OSC} \cdot (\text{TMR2 prescale value})$$

CCPR1L and CCP1CON<5:4> can be written to at any time, but the duty cycle value is not latched into CCPR1H until after a match between PR2 and TMR2 occurs (i.e., the period is complete). In PWM mode, CCPR1H is a read-only register.

The CCPR1H register and a 2-bit internal latch are used to double buffer the PWM duty cycle. This double buffering is essential for glitch-free PWM operation.

When the CCPR1H and 2-bit latch match TMR2, concatenated with an internal 2-bit Q clock, or 2 bits of the TMR2 prescaler, the CCP1 pin is cleared.

The maximum PWM resolution (bits) for a given PWM frequency is given by the formula:

$$\text{Resolution} = \frac{\log\left(\frac{F_{OSC}}{F_{PWM}}\right)}{\log(2)} \text{ bits}$$

Note:	If the PWM duty cycle value is longer than the PWM period, the CCP1 pin will not be cleared.

8.3.3 SETUP FOR PWM OPERATION

The following steps should be taken when configuring the CCP module for PWM operation:

1. Set the PWM period by writing to the PR2 register.
2. Set the PWM duty cycle by writing to the CCPR1L register and CCP1CON<5:4> bits.
3. Make the CCP1 pin an output by clearing the TRISC<2> bit.
4. Set the TMR2 prescale value and enable Timer2 by writing to T2CON.
5. Configure the CCP1 module for PWM operation.

TABLE 8-3: EXAMPLE PWM FREQUENCIES AND RESOLUTIONS AT 20 MHz

PWM Frequency	1.22 kHz	4.88 kHz	19.53 kHz	78.12kHz	156.3 kHz	208.3 kHz
Timer Prescaler (1, 4, 16)	16	4	1	1	1	1
PR2 Value	0xFFh	0xFFh	0xFFh	0x3Fh	0x1Fh	0x17h
Maximum Resolution (bits)	10	10	10	8	7	5.5

TABLE 8-4: REGISTERS ASSOCIATED WITH CAPTURE, COMPARE, AND TIMER1

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other RESETS
0Bh, 8Bh, 10Bh, 18Bh	INTCON	GIE	PEIE	T0IE	INTE	RBIE	T0IF	INTF	RBIF	0000 000x	0000 000u
0Ch	PIR1	PSPIF(1)	ADIF	RCIF	TXIF	SSPIF	CCP1IF	TMR2IF	TMR1IF	0000 0000	0000 0000
0Dh	PIR2	—	—	—	—	—	—	—	CCP2IF	---- ---0	---- ---0
8Ch	PIE1	PSPIE(1)	ADIE	RCIE	TXIE	SSPIE	CCP1IE	TMR2IE	TMR1IE	0000 0000	0000 0000
8Dh	PIE2	—	—	—	—	—	—	—	CCP2IE	---- ---0	---- ---0
87h	TRISC	PORTC Data Direction Register								1111 1111	1111 1111
0Eh	TMR1L	Holding Register for the Least Significant Byte of the 16-bit TMR1 Register								xxxx xxxx	uuuu uuuu
0Fh	TMR1H	Holding Register for the Most Significant Byte of the 16-bit TMR1 Register								xxxx xxxx	uuuu uuuu
10h	T1CON	—	—	T1CKPS1	T1CKPS0	T1OSCEN	T1SYNC	TMR1CS	TMR1ON	--00 0000	--uu uuuu
15h	CCPR1L	Capture/Compare/PWM Register1 (LSB)								xxxx xxxx	uuuu uuuu
16h	CCPR1H	Capture/Compare/PWM Register1 (MSB)								xxxx xxxx	uuuu uuuu
17h	CCP1CON	—	—	CCP1X	CCP1Y	CCP1M3	CCP1M2	CCP1M1	CCP1M0	--00 0000	--00 0000
1Bh	CCPR2L	Capture/Compare/PWM Register2 (LSB)								xxxx xxxx	uuuu uuuu
1Ch	CCPR2H	Capture/Compare/PWM Register2 (MSB)								xxxx xxxx	uuuu uuuu
1Dh	CCP2CON	—	—	CCP2X	CCP2Y	CCP2M3	CCP2M2	CCP2M1	CCP2M0	--00 0000	--00 0000

Legend: x = unknown, u = unchanged, - = unimplemented, read as '0'. Shaded cells are not used by Capture and Timer1.

Note 1: The PSP is not implemented on the PIC16F873/876; always maintain these bits clear.

TABLE 8-5: REGISTERS ASSOCIATED WITH PWM AND TIMER2

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other RESETS
0Bh,8Bh, 10Bh, 18Bh	INTCON	GIE	PEIE	T0IE	INTE	RBIE	T0IF	INTF	RBIF	0000 000x	0000 000u
0Ch	PIR1	PSPIF[1]	ADIF	RCIF	TXIF	SSPIF	CCP1IF	TMR2IF	TMR1IF	0000 0000	0000 0000
0Dh	PIR2	—	—	—	—	—	—	—	CCP2IF	---- ---0	---- ---0
8Ch	PIE1	PSPIE[1]	ADIE	RCIE	TXIE	SSPIE	CCP1IE	TMR2IE	TMR1IE	0000 0000	0000 0000
8Dh	PIE2	—	—	—	—	—	—	—	CCP2IE	---- ---0	---- ---0
87h	TRISC	PORTC Data Direction Register								1111 1111	1111 1111
11h	TMR2	Timer2 Module's Register								0000 0000	0000 0000
92h	PR2	Timer2 Module's Period Register								1111 1111	1111 1111
12h	T2CON	—	TOUTPS3	TOUTPS2	TOUTPS1	TOUTPS0	TMR2ON	T2CKPS1	T2CKPS0	-000 0000	-000 0000
15h	CCPR1L	Capture/Compare/PWM Register1 (LSB)								xxxx xxxx	uuuu uuuu
16h	CCPR1H	Capture/Compare/PWM Register1 (MSB)								xxxx xxxx	uuuu uuuu
17h	CCP1CON	—	—	CCP1X	CCP1Y	CCP1M3	CCP1M2	CCP1M1	CCP1M0	--00 0000	--00 0000
1Bh	CCPR2L	Capture/Compare/PWM Register2 (LSB)								xxxx xxxx	uuuu uuuu
1Ch	CCPR2H	Capture/Compare/PWM Register2 (MSB)								xxxx xxxx	uuuu uuuu
1Dh	CCP2CON	—	—	CCP2X	CCP2Y	CCP2M3	CCP2M2	CCP2M1	CCP2M0	--00 0000	--00 0000

Legend: x = unknown, u = unchanged, - = unimplemented, read as '0'. Shaded cells are not used by PWM and Timer2.

Note 1: Bits PSPIE and PSPIF are reserved on the PIC16F873/876; always maintain these bits clear.

DATASHEET II

LCD JHD162A

JHD162A SERIES

DISPLAY CONTENT• 16 CHAR x 2ROW

CHAR. DOTS• 5 x 8

DRIVING MODE• 1/16D

AVAILABLE TYPES• •

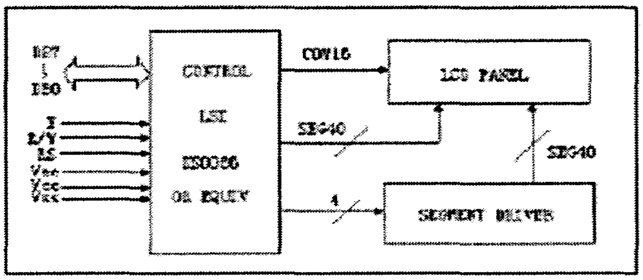
TN• STN(YELLOW GREEN• GREY• B/W)

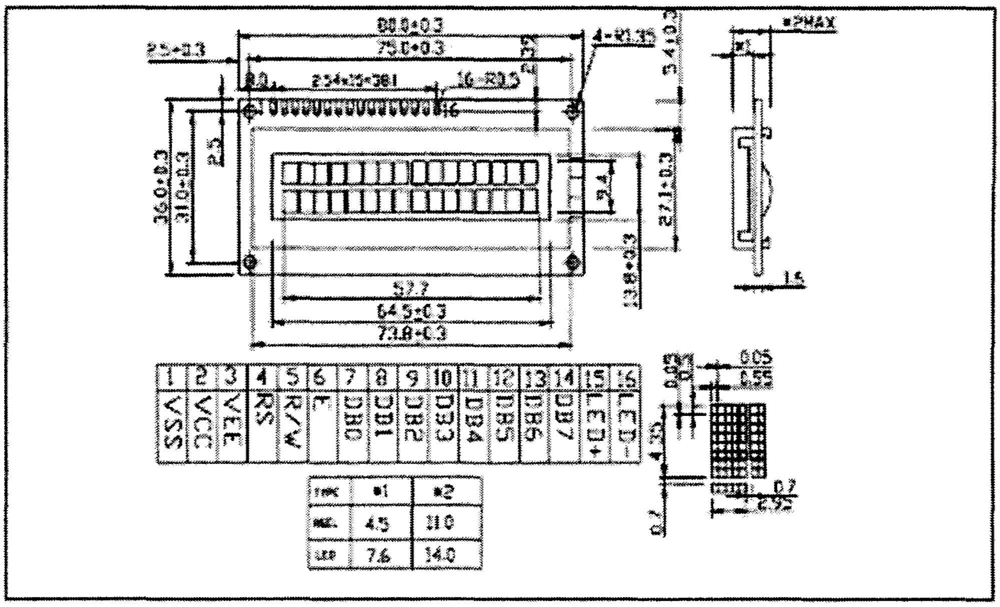
REFLECTIVE• WITH EL OR LED BACKLIGHT

EL/100VAC• 400HZ

LED/4.2VDC

Parameter	Symbol	Testing Criteria	Standard Values			Unit
			Min	Typ.	Max	
Supply voltage	Vdd-Vss	-	4.5	5.0	5.5	V
Input high voltage	Vih	-	2.2	-	Vdd	V
Input low voltage	Vil	-	-0.3	-	0.6	V
Output high voltage	Voh	-Ioh=0.2mA	2.4	-	-	V
Output low voltage	Vol	Iol=1.2mA	-	-	0.4	V
Operating voltage	Idd	Vdd=5.0V	-	1.5	3.0	mA





1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
VSS	VCC	VEE	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	LED+	LED+

■ **AC Characteristics Read Mode Timing Diagram**

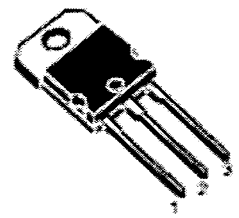
DATASHEET III

TIP142

TIP140/141/142
TIP145/146/147

COMPLEMENTARY SILICON POWER DARLINGTON TRANSISTORS

- TIP141, TIP142, TIP145 AND TIP147 ARE STMicroelectronics PREFERRED SALESTYPES
- COMPLEMENTARY PNP - NPN DEVICES
- MONOLITHIC DARLINGTON CONFIGURATION
- INTEGRATED ANTIPARALLEL COLLECTOR-EMITTER DIODE



TO-218

APPLICATIONS

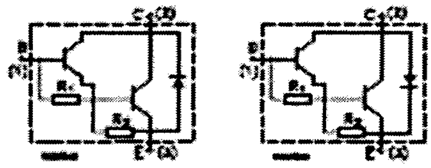
- LINEAR AND SWITCHING INDUSTRIAL EQUIPMENT

DESCRIPTION

The TIP140, TIP141 and TIP142 are silicon Epitaxial-Base NPN power transistors in monolithic Darlington configuration, mounted in TO-218 plastic package. They are intented for use in power linear and switching applications.

The complementary PNP types are TIP145, TIP146 and TIP147 respectively.

INTERNAL SCHEMATIC DIAGRAM



R_1 Typ. = 5 KΩ R_2 Typ. = 150 Ω

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Value			Unit
		NPN	TIP140	TIP141	TIP142	
		PNP	TIP145	TIP146	TIP147	
V_{CBO}	Collector-Base Voltage (I_E = 0)		60	80	100	V
V_{CEO}	Collector-Emitter Voltage (I_B = 0)		60	80	100	V
V_{EBO}	Emitter-Base Voltage (I_C = 0)		5			V
I_C	Collector Current		10			A
I_{CM}	Collector Peak Current		20			A
I_B	Base Current		0.5			A
P_{tot}	Total Dissipation at T_{case} ≤ 25 °C		125			W
T_{stg}	Storage Temperature		-65 to 150			°C
T_j	Max. Operating Junction Temperature		150			°C

For PNP types voltage and current values are negative.

TIP140 / TIP141 / TIP142 / TIP145 / TIP146 / TIP147

THERMAL DATA

$R_{thj-case}$	Thermal Resistance Junction-case	Max	1	°C/W

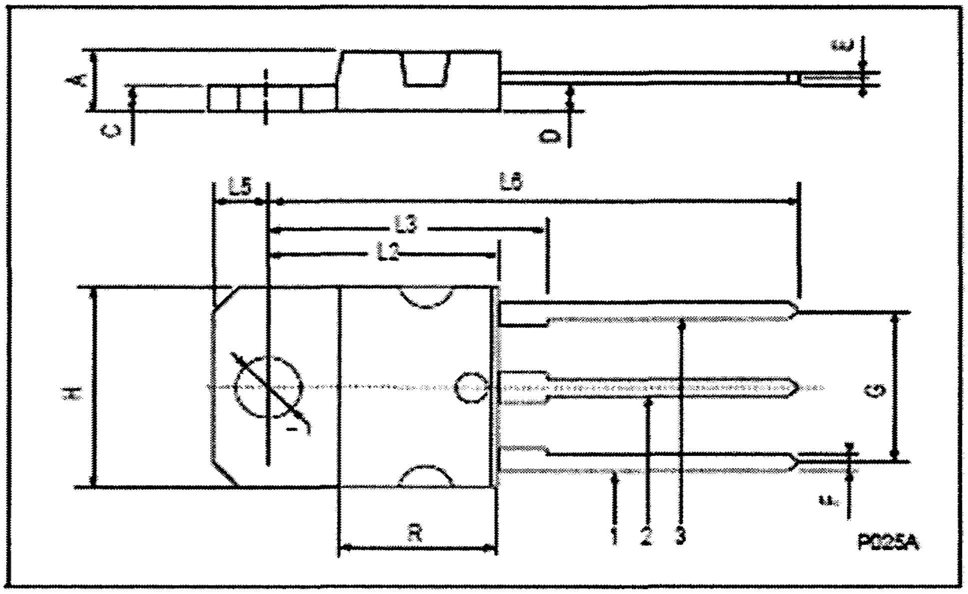
ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector Cut-off Current (I_E = 0)	for **TIP140/145** V_{CB} = 60 V for **TIP141/146** V_{CB} = 80 V for **TIP142/147** V_{CB} = 100 V			1 1 1	mA mA mA
I_{CEO}	Collector Cut-off Current (I_B = 0)	for **TIP140/145** V_{CE} = 30 V for **TIP141/146** V_{CE} = 40 V for **TIP142/147** V_{CE} = 50 V			2 2 2	mA mA mA
I_{EBO}	Emitter Cut-off Current (I_C = 0)	V_{EB} = 5 V			2	mA
$V_{CEO(sus)}$*	Collector-Emitter Sustaining Voltage (I_B = 0)	I_C = 30 mA for **TIP140/145** for **TIP141/146** for **TIP142/147**	 60 80 100			 V V V
$V_{CE(sat)}$*	Collector-Emitter Saturation Voltage	I_C = 5 A I_B = 10 mA I_C = 10 A I_B = 40 mA			2 3	V V
$V_{BE(on)}$*	Base-Emitter Voltage	I_C = 10 A V_{CE} = 4 V			3	V
h_{FE}*	DC Current Gain	I_C = 5 A V_{CE} = 4 V I_C = 10 A V_{CE} = 4 V	1000 500			
 t_{on} t_{off}	RESISTIVE LOAD Turn-on Time Turn-off Time	I_C = 10 A I_{B1} = 40 mA I_{B2} = -40 mA R_L = 3 Ω		 0.9 4		 μs μs

For PNP types voltage and current values are negative.
* Pulsed: Pulse duration = 300 μs, duty cycle 1.5 %

TO-218 (SOT-93) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.7		4.9	0.185		0.193
C	1.17		1.37	0.046		0.054
D		2.5			0.098	
E	0.5		0.78	0.019		0.030
F	1.1		1.3	0.043		0.051
G	10.8		11.1	0.425		0.437
H	14.7		15.2	0.578		0.598
L2	–		16.2	–		0.637
L3		18			0.708	
L5	3.95		4.15	0.155		0.163
L6		31			1.220	
R	–		12.2	–		0.480
Ø	4		4.1	0.157		0.161



DATASHEET IV

Voltage Regulator 7805

KEC SEMICONDUCTOR TECHNICAL DATA | **KIA7805AP/API ~ KIA7824AP/API**

KOREA ELECTRONICS CO.,LTD.

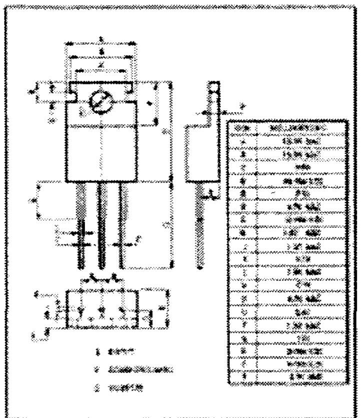
BIPOLAR LINEAR INTEGRATED CIRCUIT

THREE TERMINAL POSITIVE VOLTAGE REGULATORS
5V, 6V, 8V, 9V, 10V, 12V, 15V, 18V, 20V, 24V.

FEATURES
- Suitable for C-MOS, TTL, the Other Digital IC's Power Supply.
- Internal Thermal Overload Protection.
- Internal Short Circuit Current Limiting.
- Output Current in Excess of 1A.
- Satisfies IEC-65 Specification. (International Electronical Commission).

MAXIMUM RATINGS (Ta=25℃)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Input Voltage	KIA7805AP/API ~ KIA7815AP/API	V_{IN}	35	V
	KIA7818AP/API ~ KIA7824AP/API		40	
Power Dissipation (Tc=25℃)		P_D	20.8	W
Power Dissipation (Without Heatsink)	KIA7805API ~ KIA7824API	P_D	2.0	W
Operating Junction Temperature		T_j	-30~150	℃
Storage Temperature		T_{stg}	-55~150	℃



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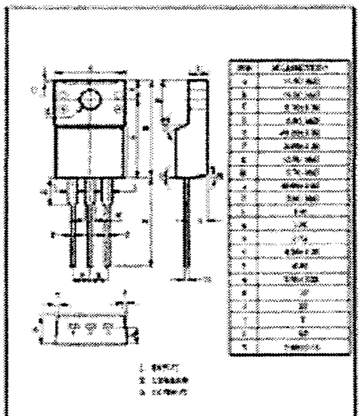

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APPENDIX D

COSTING

Bil	Component	Specification	Price/Unit (RM)	Quantity	Price (RM)
1	LDR		0.58	1	0.58
2	Resistor	3kΩ	0.05	3	0.15
3	Resistor	1kΩ	0.05	2	0.10
4	Potentiometer	10kΩ	0.50	1	0.50
5	IC Regulator	7805	1.00	1	1.00
6	LCD	JHD162A	30.00	1	30.00
7	Capacitor	0.1μF	0.30	3	0.90
8	LED		0.20	2	0.40
9	Battery connector		3.00	1	3.00
10	PIC	16F877A	25.00	1	25.00
11	Header		0.80	7	5.60
12	Wrapping Wire		15.00	1	15.00
13	Head Sink		0.90	1	0.90
14	Strip Board		5.00	1	5.00
15	Crystal	8MHz	0.90	1	0.90
16	Switch	Push button	0.60	2	1.20
17	BJT NPN	TIP142	5.00	1	5.00
18	Halogen Lamp	12V 20W	5.60	2	11.20
19	Socket Lamp		3.00	1	3.00
20	PIR sensor		45.00	1	45.00
TOTAL PRICE					**154.43**