SMART SYSTEM OF ULTRASONIC CAR PARKING

MAHMAD TAJUDIN BIN MAHMAD TABIB

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

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

NOVEMBER 2008

"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 : CIK ROHANA BINTI ABDUL KARIM

Date : 30 OCTOBER 2008

“All the trademark and copyrights use herein are property of their respective owner. References of information from other sources are quoted accordingly; otherwise the information presented in this report is solely work of the author.”

Signature : ____________________________

Author : MAHMAD TAJUDIN BIN MAHMAD TABIB

Date : 30 OCTOBER 2008

DEDICATION

Specially dedicated to

My beloved parents, brother,

and all of my best friends.

ACKNOWLEDGEMENT

I am greatly indebted to my supervisor, Miss Rohana Binti Abdul Karim for her advice and guidance throughout my project. Thank you.

I would like to thank my family member for giving me their loves and supports throughout my four years study in Universiti Malaysia Pahang.

Special thanks to FKEE staffs for helping me to complete my project. Suggestions and criticisms from my friends have always been helpful in finding solutions to my problems. Thank you all.

Finally, I would like to express my thanks to those who involves directly or indirectly in completion of my project.

ABSTRACT

With the development of automobile industry, the number of private cars is greatly increasing. Correspondingly, the number of rookie drivers is increasing as well. For the rookie drivers, how to backing is always a troublesome operation. Many of them complained that their valuable cars are easily got damaged by obstacles that are hardly seen through their rearview mirror. So in this project, a new type system has been designed: smart system of ultrasonic car parking with different display mode, audio mode and smart mode:

i. Liquid crystal display (LCD) display modes: Used to display the zone of your car based on condition that have been set.
ii. LED display modes: Ordinary display modes. 6 LEDs are used to display the distance of obstacles. The more LEDs are lightening, the closer obstacles are.
iii. A buzzer or a beeper which is a signaling device is used to show the distance of the car with the obstacles behind it. The faster tone of the beep of buzzer means the distance of obstacles and car are closer.
iv. Smart mode: The engine will automatically stop if the car is in stop zone which mean it is dangerous condition to parking the car.

The ultrasonic sensor used in security technology such as car collision avoidance and distance measurement, is the best device can be used in detecting obstruction behind the car when backing up. In this paper, we analyze the interference of ultrasonic signal when transmitting and receiving, and then resolve it by software. There is a blind area and distance limitation in ultrasonic distance measurement. The result of project shows that the system's efficiency is not 100% successfully because of error of the ultrasonic sensor sensitivity itself. The system cannot display the exact distance between car and the obstacle although the entire output modes are successfully functioning.

ABSTRAK

Melalui pembangunan industri automobil, jumlah hakmilik kereta persendirian meningkat dengan mendadak. Berikutan itu, kadar pemandu baru yang bertauliah turut meningkat sejajar dengan peningkatan tersebut. Bagi jenis pemandu tersebut, cara pengunfuran kereta adalah dianggap sebagai sukar. Kebanyakkan daripada mereka mengadu bahawa kereta mereka tercalar akibat daripada halangan yang suakr dilihat melalui cermin pandang sisi. Oleh itu, suatu bentuk sistem yang baru diperkenalkan dalam projek ini iaitu Sistem Pintar Letak Kereta Ultrasonik yang mempunyai pelbagai mod paparan yang berbeza serta mod audio dan mod pintar iaitu:

i. Mod paparan Paparan Kristal Cecair (LCD): Digunakan untuk memaparkan zon kedudukan kereta berdasarkan keadaan yang telah ditetapkan.

ii. Mod Paparan LED: Mod paparan yang biasa dugunakan ketika ini. 6 LED digunakan untuk memaparkan jarak halangan. Lebih babyak LED yang menyala bermaksud halangan semakin dekat.

iii. Satu buzzer yang mana berfungsi sebagai alat pemberi amaran digunakan sebagai alat memberitahu jarak halangan dengan kereta. Semakin cepat bunti ton yang dihasilkan buzzer tersebut bermakna jarak halangan adalah semakin hamper dengan kereta.

iv. System pintar: Enjin kereta akan berhenti secara automatic sekiranya kereta berada dalam zon berhenti yang bermaksud keadaan merbahaya untuk meletakkan kereta.

Sensor ultrasonic digunakan dalam teknologi sekuriti seperti pencegahan pelanggaran kereta dan pengukuran jarak adalah alat terbaik yang boleh digunakan dalam mengesan halangan dibelakang kereta ketika mengundur. Didalam laporan ini, kita akan menganalisis campurtangan signal ultrasonic ketika dipancar dan diterima. Kawasan buta dan jarak yang terhad turut wujud dalam pengukuran jarak ultrasonic. Hasil keputusan projek menunjukkan keberkesanan sistem adalah bukan 100% berhasil kerana ketidakcekapan kesensitifan sensor ultrasonik itu sendiri. Sisyem tidak dapat memaparkan nilai jarak halangan dengan kereta yang tepat walaupun semua mod keluaran adalah berfungsi sepenuhnya.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **SMART SYSTEM OF ULTRASONIC CAR PARKING**

SESI PENGAJIAN: **2008/2009**

Saya **MAHMAD TAJUDIN BIN MAHMAD TABIB (860118-02-5271)**
(HURUF BESAR)

mengaku membenarkan tesis (Sarjana Muda/~~Sarjana~~ /~~Doktor Falsafah~~)* ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hakmilik Universiti Malaysia Pahang (UMP).
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

[ ]	**SULIT**	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
[ ]	**TERHAD**	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
√	**TIDAK TERHAD**	

Disahkan oleh:

__________________________ (TANDATANGAN PENULIS)

__________________________ (TANDATANGAN PENYELIA)

Alamat Tetap:

NO 19,TAMAN KOTA NELAYAN,
06600 KUALA KEDAH,
PAHANG

ROHANA BINTI ABDUL KARIM
(Nama Penyelia)

Tarikh: **30 OKTOBER 2008**

Tarikh: : **30 OKTOBER 2008**

CATATAN:
* Potong yang tidak berkenaan.
** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh tesis ini perlu dikelaskan sebagai atau TERHAD.
♦ Tesis dimaksudkan sebagai tesis bagi Ijazah doktor Falsafah dan Sarjana secara Penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).

CHAPTER 1

INTRODUCTION

1.1 Introduction

Presently, the detection technique of laser, radar, infrared ray and ultrasonic have been widely applied at the aspects of safety technique of car collision avoidance and distance measurement. At the aspect of collision avoidance laser, radar and infrared ray are commonly applied to measure the control range between two cars and the range which should be measured behind the car. At the aspect of distance measurement the technique of ultrasonic is applied to measure the detection range when a car change the driveway and to detect the obstruction behind the car when backing up or parking. Because of the expensive price, the distance measurement system of backing up with the technique of laser and radar is only set on the minority of slap-up cars, so the research of the distance measurement system of backing up with high ratio of capability and price for the medium cars and the low-end cars is an important task of auto-electron industry.

The Smart System of Ultrasonic Car Parking introduced in this thesis can automatically measure the distance between the trail of the car and detect the obstruction behind the car, further more it can show the distance and give a sound-light alarm in real time, so it can ensure the car to run safely and reduce the accident ratio. With this system, the driver can know either he is in safe zone, warning zone or stop zone to parking your car. If his car is in some distance in stop zone, your car engine will stop automatically to avoid unpredicted thing from happen. It also suitable to be applies to van and small lorry. The driver does not need to intermeddle in or manipulate this system.

This system will have a prosperous application prospect. It will cut a way through the market of the medium cars and the low-end cars and provide a new research method for the car collision avoidance. When the electric signal is imported into the transmitter, the transmitter transmits ultrasonic, the receiver receives the reflected wave, and the sound wave transmitting time and the distance are in direct ratio, so obtain the function of distance measurement.

1.2 Problem Statement

There are many cases of accidents occurred because reverse parking problem .These are examples of cases of the problem:

1. *Anak maut dilanggar secara tidak sengaja oleh bapa* (From Utusan Malaysia, 17th January 2002)

   KLUANG 16 Jan. - Seorang kanak-kanak, Nur Faridah Mohd. Affandi, 2 tahun, mati setelah dilanggar secara tidak sengaja oleh bapanya yang memandu kenderaan pacuan empat roda di pekarangan rumahnya di Ladang Bukit Cantik, Kahang.Menurut polis, kejadian tersebut berlaku kira-kira pukul 6 petang ketika bapa kanak-kanak itu, Affandi Isnin, 29, seorang jurutera ladang mengalihkan kenderaan tersebut selepas mencucinya di kawasan lapang berdekatan rumah.Kejadian itu disedari oleh bapa berkenaan sebaik sahaja mengundurkan kenderaannya.``Kanak-kanak itu ditemui terbaring dengan berlumuran darah pada hidung dan telinga berhampiran tayar kanan hadapan," kata polis.Anak tunggal Affandi itu kemudian dikejarkan ke Pusat Kesihatan Kahang dan disahkan telah meninggal dunia sebaik tiba di situ.

   Timbalan Ketua Polis Daerah Kluang, Deputi Supritendan Mohd. Zam Mohd. Zain mengesahkan polis menerima laporan mengenai kejadian itu daripada bapanya pada pukul 8 malam hari yang sama.Menurut beliau, kes itu disiasat mengikut Seksyen 304 A, Kanun Keseksaan kerana kecuaian menyebabkan kematian.

2. *Budak maut dilanggar lori dipandu bapa saudara* (From Utusan Malaysia, 4th March 2005)

KUALA KANGSAR 3 Mac - Seorang kanak-kanak, Khairul Ikmal Abu Bakar, 2, maut setelah dilanggar oleh lori yang dipandu bapa saudaranya di Kampung Keruh Hilir, Padang Rengas, dekat sini pagi ini.Ketua Polis Daerah Kuala Kangsar, Supritendan Zakaria Pagan berkata, kejadian berlaku ketika bapa saudara mangsa, Mohd. Nor Shadan, 46, sedang mengundurkan lorinya di halaman rumah kira-kira pukul 10 pagi.Katanya, Mohd. Nor terasa lori itu seolah-olah lori itu tersangkut pada sesuatu dan tidak dapat bergerak.Katanya, sebaik sahaja turun dari lorinya, dia mendapati Khairul Ikmal terperosok di bawah tayar belakang lori. Menurutnya, kanak-kanak tersebut yang tinggal bersamanya, cedera parah di kepala dan dikejarkan ke klinik Padang Rengas tetapi disahkan meninggal dunia.Zakaria memberitahu, mayat Khairul Ikmal dihantar ke Hospital Kuala Kangsar untuk bedah siasat sebelum dituntut oleh keluarganya.

Statistic that show amount of accidents in Malaysia in year 2006 until 2007 (Jan - Sep):

Perangkaan Kematian Jalan Raya Bagi Tahun 2006 Hingga 2007 (Jan - Sep)						
Kategori Pengguna	2006	%	2006 (Jan-Sep)	2007 (Jan-Sep)	Perbezaan	%
Pemandu / Penumpang Motokar	1,215	19.3	920	1113	-193	21.0
Penunggang / Pembonceng Motosikal	3,693	58.7	2,736	2476	-260	-9.5
Pejalan Kaki	595	9.5	438	482	44	10.0
Penunggang / Pembonceng Basikal	242	3.8	183	141	-42	-23.0
Pemandu / Penumpang Bas	39	0.6	26	64	38	146.2
Pemandu / Kelindan Lori	229	3.6	174	145	-29	-16.7
Pemandu / Kelindan Van	103	1.6	73	101	28	38.4
Pemandu / Kelindan Pacuan 4 Roda	110	1.7	73	65	-8	-11.0
Lain-Lain Kenderaan	61	1.0	48	59	11	22.9
Jumlah	**6,287**	**100**	**4,671**	**4,646**	**-25**	**-0.5**

Table 1.1: Accident Statistic (Source by PDRM)

From the research, there are a few factors why the accidents occurred because reverse parking problem happened:

1. Drivers fail to detect if there any obstacle behind the car.
2. The common alarm system is not efficient.
3. Driver unable to determine the distance between the car and an obstacle behind it.

In conclusion, Smart System of Ultrasonic Car Parking is a complete system which is needed by each driver to make sure their driving is safe and to prevent accident that caused by parking problem from happened.

1.3 Objectives

The objective of this project are:

1. To determine the distance between car with an obstacle behind it.
2. To inform the driver the state of car condition either they are in safe, warning or stop zone through the colors of LED and display of LCD.
3. The car engine will stop automatically if the car is in stop zone.

1.4 Scope of project

There are several scopes that need to be proposed for the project. Those are:

i. Car
ii. Van
iii. Small lorry

1.5 Outline Thesis

This thesis consists of six chapters. In Chapter 1, the explanation for the project will be given in a general term. The objectives of the project will be elaborated. It is followed by the exploration in microcontroller field with a basic coverage of the general knowledge on microcontroller.

Chapter 2 contains literature reviews that have relation with this project. Explanation will be based on comparison, effect and contribution of some device that have been used in this project. Some practical approach in this project will also be discussed.

In Chapter 3, hardware design is explained in detail. The explanation will be given separately according to the function of the board. Explanation will be given in a more technical way and specific terms.

In Chapter 4, hardware and software design and implementation are discussed. Source code will be published in the thesis.

In Chapter 5, the result, discussion and analysis are discussed. The strengths and weakness of the Smart System of Ultrasonic Car Parking will be discussed. Improvement or future enhancement will be explained to ensure this will benefit to the people.

Chapter 6 will conclude the final of the project. The contents include the experience and the knowledge gained during accomplishing this project. Furthermore, a few recommendations will also be suggested.

CHAPTER 2

LITERATURE REVIEW

2.1 Microcontroller

A microcontroller is an integrated chip that is often part of an embedded system. The microcontroller includes a CPU, RAM, ROM, I/O ports, and timers like a standard computer, but because they are designed to execute only a single specific task to control a single system, they are much smaller and simplified so that they can include all the functions required on a single chip.

A microcontroller differs from a microprocessor, which is a general-purpose chip that is used to create a multi-function computer or device and requires multiple chips to handle various tasks. A microcontroller is meant to be more self-contained and independent, and functions as a tiny, dedicated computer.

The great advantage of microcontrollers, as opposed to using larger microprocessors, is that the parts-count and design costs of the item being controlled can be kept to a minimum. They are typically designed using CMOS (complementary metal oxide semiconductor) technology, an efficient fabrication technique that uses less power and is more immune to power spikes than other techniques.

There are also multiple architectures used, but the predominant architecture is CISC (Complex Instruction Set Computer), which allows the microcontroller to contain multiple control instructions that can be executed with a single macro instruction. Some use a RISC (Reduced Instruction Set Computer) architecture, which implements fewer instructions, but delivers greater simplicity and lower power consumption.

Early controllers were typically built from logic components and were usually quite large. Later, microprocessors were used, and controllers were able to fit onto a circuit board. Microcontrollers now place all of the needed components onto a single chip. Because they control a single function, some complex devices contain multiple microprocessors.

Microcontrollers have become common in many areas, and can be found in home appliances, computer equipment, and instrumentation. They are often used in automobiles, and have many industrial uses as well, and have become a central part of industrial robotics. Because they are usually used to control a single process and execute simple instructions, microcontrollers do not require significant processing power.

2.2 Application of Microcontroller

Microcontrollers are typically used where processing power isn't so important. Although some of you out there might find a microwave oven controlled by a UNIX system an attractive idea, controlling a microwave oven is easily accomplished with the smallest of microcontrollers. On the other hand, if he or she putting together a cruise missile to solve the problem of his or her neighbor's dog barking at 3 in the morning, he or she will probably need to use processors with a bit more computing power.

Embedded processors and microcontrollers are used extensively in robotics. In this application, many specific tasks might be distributed among a large number of controllers in one system. Communications between each controller and a central, possibly more powerful controller (or micro/mini/mainframe) would enable information to be processed by the central computer, or to be passed around to other controllers in the system (Barr, 1997).

A special application that microcontrollers are well suited for is data logging. Stick one of these chips out in the middle of a corn field or up in a balloon, and monitor and record environmental parameters (temperature, humidity, rain, etc). Small size, low power consumption, and flexibility make these devices ideal for unattended data monitoring and recording.

2.3 Drivers Behavior

Shinar (1999) reports a strong association between environmental conditions and driver behavior. He has reported a fairly strong relationship between the length of the red phase and length of the green phase at an intersection, on the one hand, and the tendency for drivers either run a red light or honk their horns when they are delayed by a vehicle that fails to proceed when the light turns green. In parking perspective, drivers are tending to parking in such dangerous way without thinking first (Yagil, 1998).This action may cause harm to another people or traffic violation.

There are more than 2, 500 cases of accidents happened cause by car parking error (Beirness, 1996) every year in U.S.A. Year by year, the statistic of the accidents suddenly increasing. Many actions had be taken to reduce this problem but there no one that so efficient recently. Until now, there are many agencies try to take step to overcome the problem by design new systems that hopefully can help the driver while parking their car and make awareness campaigns in government department, private agencies and colleges.

2.4 Understanding Ultrasonic

Ultrasonic signals are like audible sound waves, except the frequencies are much higher. The ultrasonic transducers have piezoelectric crystals which resonate to a preferred frequency and convert electric energy into acoustic energy and vice versa (Watson, 2006).

The illustration in Figure 2.1 shows how sound waves, transmitted in the shape of a cone, are reflected from a target back to the transducer. An output signal is produced to perform some kind of indicating or control function. A minimum distance from the sensor is required to provide a time delay so that the "echoes" can be interpreted. Variables which can affect the operation of ultrasonic sensing include: target surface angle, reflective surface roughness or changes in temperature or humidity. The targets can have any kind of reflective form - even round objects.

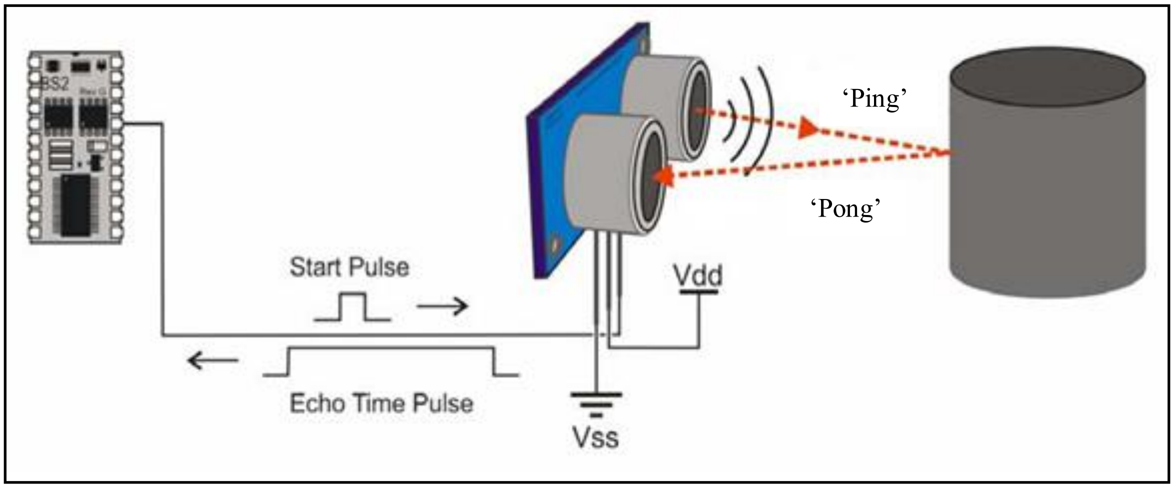


Figure 2.1: Basic concepts of 'ping' and 'pong'

When used for sensing functions, the ultrasonic method has unique advantages over conventional sensors such as infrared or reverse sensor (Larson, 1960):

a. Discrete distances to moving objects can be detected and measured.
b. Less affected by target materials and surfaces, and not affected by color. Solid-state units have virtually unlimited, maintenance free life. Have ability to detect small objects over long operating distances.
c. Have resistance to external disturbances such as vibration, infrared radiation, ambient noise, and EMI radiation.

2.5 Smart Car

Smart car is an automobile with some artificial intelligence (or "AI") functionality (IHS Automotive News, February 23, 2006). As automation technology has progressed, especially in the decades after the invention of the integrated circuit, more and more functions have been added to automobiles, relieving the driver of much of the mundane moment-to-moment decision making that may be regarded as having made driving tedious.

The fictional car KITT (Knight Industries Two Thousand)in the television series Knight Rider is the archetypal smart car. A number of real-life vehicles have been designed, built and sold commercially that incorporate AI technology such as the Mercedes-Benz Robot Cars which have led to the development of the S-Class, a series of vehicles that are generally seen as an industry leader in new technology. A similar production example is the Lexus LS, with its object recognition pre-collision systems, self-steering Lane Keep Assist, and automated parking systems.

Advanced Parking Guidance System (APGS) is an automatic parking system first developed by Toyota Motor Corporation in 2004 for its latest Lexus models and also the Japanese market hybrid Prius models. In Europe, the APGS is marketed as the Intelligent Park Assist system. On vehicles equipped with the APGS, via an in-dash screen and button controls, the car can steer itself into a parking space with little input from the user. The latest version of APGS helps determine that the car has enough clearance for a particular space, and calculates the steering maneuvers needed for parallel or reverse parking

On the Lexus LS, the Advanced Parking Guidance System uses computer processors which are tied to the Lexus Intuitive Park Assist (sonar warning system) feature, backup camera, and two additional forward sensors on the front side fenders. The Intuitive Park Assist feature includes multiple sensors on the forward and rear bumpers which detect obstacles, allowing the system to sound warnings and calculate optimum steering angles during regular parking. These sensors plus the two additional APGS sensors are tied to a central computer processor, which in turn is integrated with the backup camera system to provide the driver parking information.

When the Intuitive Park Assist feature is used, the processor(s) calculate steering angle data which are displayed on the navigation/camera touch screen along with obstacle information. The Advanced Parking Guidance System expands on this capability and is accessible when the vehicle is shifted to reverse (which automatically activates the backup camera). When in reverse, the backup camera screen features APGS buttons which can be used to activate automated parking procedures. When the Advanced Parking Guidance System is activated, the central processor calculates the optimum parallel or reverses park steering angles and then interfaces with the Electric Power Steering systems of the vehicle to guide the car into the parking spot.

2.6 The History of LCD

The modern history of liquid crystals has been dominated by the development of electronic displays. These developments began in 1964, when Heilmeier of RCA Laboratories discovered the guest-host mode and the dynamic-scattering mode. He thought a wall-sized flat-panel color TV was just around the corner. From that point on, twisted-nematic (TN) mode, super TN mode, amorphous-Si field-effect transistor, and room-temperature liquid crystals were developed (G. H. Heilmeier, 1976).

In the beginning, liquid-crystal displays (LCDs) were limited to niche applications such as small-size displays for digital watches, pocket calculators, and small handheld devices. That all changed with the development of the notebook computer industry. In 1988, Washizuka et al. of Sharp Corporation demonstrated an active-matrix full-color full-motion 14-in display using a thin-film-transistor array. The electronics industries now recognized that Heilmeier's 25-year dream of a wall-hanging television had become reality. LCDs could be used to replace existing cathode ray tubes. Through the cooperation and competition of many electronics giants, the LCD industry was firmly established.

2.7 Car LCD Screens

Modern car LCD screens can be built small enough to fit almost anywhere in the vehicle. LCD screens are the industry standard when it comes to in-vehicle entertainment. They are used in car DVD players, navigation devices and vehicle display systems. Recent developments in LCD technology have allowed for screens to be incredibly small and still provide a sharp, clear picture.

LCD stands for Liquid Crystal Display. Liquid crystals were first discovered more than 100 years ago (Hiroshi Kawamoto, 2002). They were incredibly fascinating, but at the time they did not serve any practical purpose. It wasn't until around 1970 when something called the twisted nematic field effect was discovered that liquid crystals became viable (George W. Gray, Stephen M. Kelly, 1999). Shortly after the discovery, the first digital quartz wrist watch was developed in Japan and an industry was born.

Liquid Crystal Displays may be reflective or possess their own light source. Reflective car LCD screens are comprised of six layers. On the outside is a film which filters and polarizes light as it enters. Next comes a thin piece of glass equipped with electrodes. The shape of the electrodes dictate the dark shapes that will appear on the display. Smooth, slight vertical ridges are etched into the surface of the glass. Within the next layer are the guts of the system: twisted nematic liquid crystals. Behind the crystals another layer of glass features electrode film and a series of horizontal lines. The lines of this glass substrate match up with lines on the next layer: a horizontal filter film. The final layer is a highly reflective surface to send light back through the first five layers. The reflective layer would be a light source in a backlit LCD system.

When shopping for car LCD screens there are several factors of which to become aware. Attributes include:

• Resolution- The best indicator of picture quality, resolution is expressed in terms of pixilation. For example, a screen with a resolution of 1024 x 768 will include 1024 horizontal pixels and 768 vertical pixels.

• Viewable Size (or Active Display Area)- This is exactly what it sounds like, measured diagonally just like standard TVs. Car LCD screens as small as 2.5 inches are not unusual.

• Dot Pitch- Typically the same vertically and horizontally, this is the distance between the centers of two consecutive pixels. A shorter distance will result in a sharper picture.

• Contrast Ratio- Represents the range between the brightest bright and the darkest dark.

Many features of car LCD screens are the same as those of regular television screens. Features like brightness (also known as luminance) are measured the same way regardless of screen size or type. The aspect ratio is a measure of the relationship between width and height. An aspect ratio of 4:3 would indicate that the screen was four units across and three from top to bottom. The ratio will usually be expressed in larger numbers with larger sets because higher values allow for more detail.

2.8 Assembly Languages: Low-Level Language

An assembly language is a low-level language for programming computers. It implements a symbolic representation of the numeric machine codes and other constants needed to program a particular CPU architecture (David Salomon, 1993). This representation is usually defined by the hardware manufacturer, and is based on abbreviations (called mnemonics) that help the programmer remember individual instructions, registers, etc.

Assembly languages were first developed in the 1950s, when they were referred to as second generation programming languages. They eliminated much of the error-prone and time-consuming first-generation programming needed with the earliest computers, freeing the programmer from tedium such as remembering numeric codes and calculating addresses. They were once widely used for all sorts of programming. Today, assembly language is used primarily for direct hardware manipulation, access to specialized processor instructions, or to address critical performance issues. Typical uses are device drivers, low-level embedded systems, and real-time systems.

A utility program called an assembler is used to translate assembly language statements into the target computer's machine code. The assembler performs a more or less isomorphic translation (a one-to-one mapping) from mnemonic statements into machine instructions and data. (This is in contrast with high-level languages, in which a single statement generally results in many machine instructions. A compiler, analogous to an assembler, is used to translate high-level language statements into machine code; or an interpreter executes statements directly.)

Many sophisticated assemblers offer additional mechanisms to facilitate program development, control the assembly process, and aid debugging. In particular, most modern assemblers (although many have been available for more than 40 years already!) include a macro facility (described below), and are called macro assemblers.

2.9 Comparison of Assembly and High Level Languages

Assembly languages are close to a one to one correspondence between symbolic instructions and executable machine codes. Assembly languages also include directives to the assembler, directives to the linker, directives for organizing data space, and macros (Murdocca, Miles J.; Vincent P. Heuring, 2000). Macros can be used to combine several assembly language instructions into a high level language-like construct (as well as other purposes). There are cases where a symbolic instruction is translated into more than one machine instruction. But in general, symbolic assembly language instructions correspond to individual executable machine instructions.

High level languages are abstract. Typically a single high level instruction is translated into several (sometimes dozens or in rare cases even hundreds) executable machine language instructions. Some early high level languages had a close correspondence between high level instructions and machine language instructions. For example, most of the early COBOL instructions translated into a very obvious and small set of machine instructions. The trend over time has been for high level languages to increase in abstraction. Modern object oriented programming languages are highly abstract (although, interestingly, some key object oriented programming constructs do translate into a very compact set of machine instructions).

Assembly language is much harder to program than high level languages. The programmer must pay attention to far more detail and must have an intimate knowledge of the processor in use. But high quality hand crafted assembly language programs can run much faster and use much less memory and other resources than a similar program written in a high level language. Speed increases of two to 20 times faster are fairly common, and increases of hundreds of times faster are occasionally possible.

High level programming languages are much easier for less skilled programmers to work in and for semi-technical managers to supervise. And high level languages allow faster development times than work in assembly language, even with highly skilled programmers. Development time increases of 10 to 100 times faster are fairly common. Programs written in high level languages (especially object oriented programming languages) are much easier and less expensive to maintain than similar programs written in assembly language (and for a successful software project, the vast majority of the work and expense is in maintenance, not initial development).

2.10 Motor vs. DC Motor

Electric motors can be divided into two types: alternating current (AC) electric motors and direct current (DC) electric motors (Donald G. Fink, 1978). A DC electric motor will not run when supplied with AC current, nor will an AC motor run with DC current.

Figure 2.2: Structure of AC Motor

AC electric motors are further subdivided into single phase and three phase motors. Single phase AC electrical supply is what is typically supplied in a home. Three phase electrical power is commonly only available in a factory setting.

DC electric motors are also split into many types. These include brush motors, brushless motors, and stepper motors.

Of these types, brush electric motors are by far the most common. They are easy to build and very cost effective. Their major drawback is that they use carbon brushes to transfer electrical current to the rotating part, and these brushes wear over time and eventually result in the failure of the electric motor.

The DC brushless motor eliminates the brushes, but is more costly and requires much more complicated drive electronics to operate.

A stepper motor is a special type of brushless motor that is used primarily in automation systems. A stepper motor uses a special type of construction that allows a computerized control system to “step” the rotation of the motor.

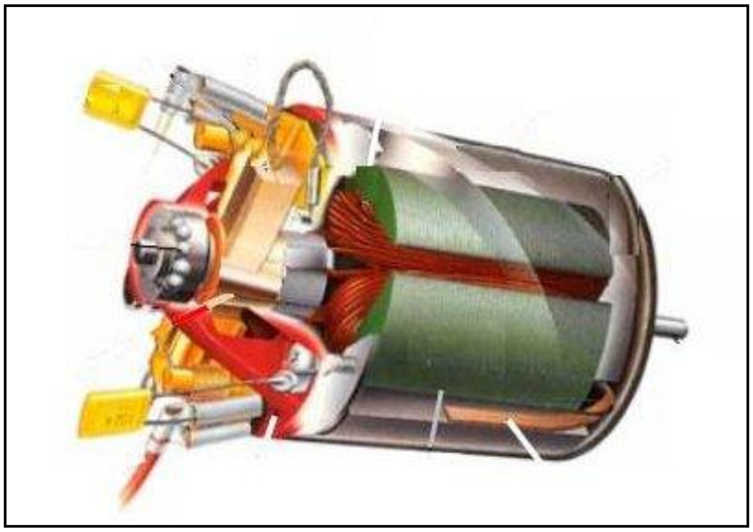


Figure 2.3: Structure of DC Motor

CHAPTER 3

METHODOLOGY OF SMART SYSTEM OF ULTRASONIC CAR PARKING

3.1 Hardware Overview of The Project

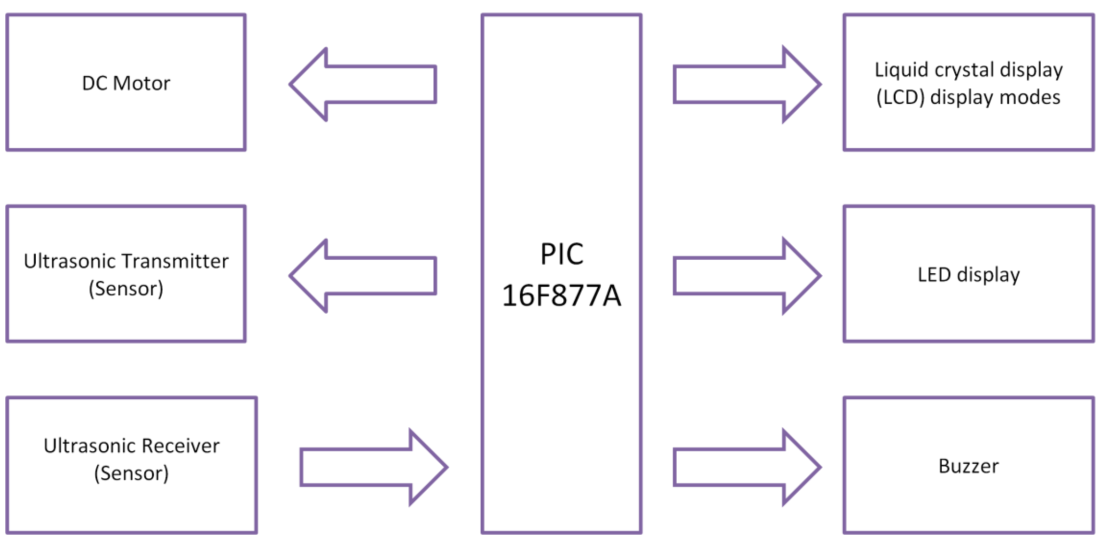


Figure 3.1: Hardware Structure Diagram

3.2 List of Hardware Components

No.	Component	Quantity
1	PIC16F877A	1
2	Capacitor 100µF	1
3	Capacitor 0.1µF	3
4	Capacitor 22µF	1
5	Capacitor 10pF	2
6	Crystal 4MHz	1
7	Heat Sink	1
8	Regulator 7805 (1.5A)	1
9	Reset Button	1
10	Resistor 220Ω	6
11	Resistor 10kΩ	1
12	Ribbon Cable	1m
13	Potentiometer (5kΩ)	1
14	LED (green, yellow & red)	6
15	Ultrasonic Transmitter	1
16	Ultrasonic Receiver	1
17	Buzzer	1
18	LCD Display (16 x 2)	1
19	DC Motor	1
20	Strip Board	1
21	Battery Connector	1
22	DC Jack	1
23	Battery 9v	1
24	Power Adapter	1

Table 3.1: List of Hardware Components

3.3 Hardware Concept Of The Project

3.3.1 Basic Theory

The basic theory behind the hardware circuit is the Sound Navigation and Ranging (SONAR) technique that is used for finding the distance and direction of a remote object underwater by transmitting sound waves and detecting reflections from it.

First, a series of short ultrasonic pulses are transmitted using a transducer that changes voltage into sound waves. The transmitted pulse is reflected off an object, and the reflected wave is then received by another transducer that converts sound waves into voltage. The transmitted signal is also known as the 'ping' and the received signal is known as the 'pong'. By counting the elapsed time between the ping and the pong, the distance between the device and an object can be easily calculated by multiplying the elapsed time with the speed of sound. Note that the time measured represents the time it takes a pulse to travel to an object plus the time it takes to travel back to the receiver. In short form, we can describe the flow of the process as in the diagram below:

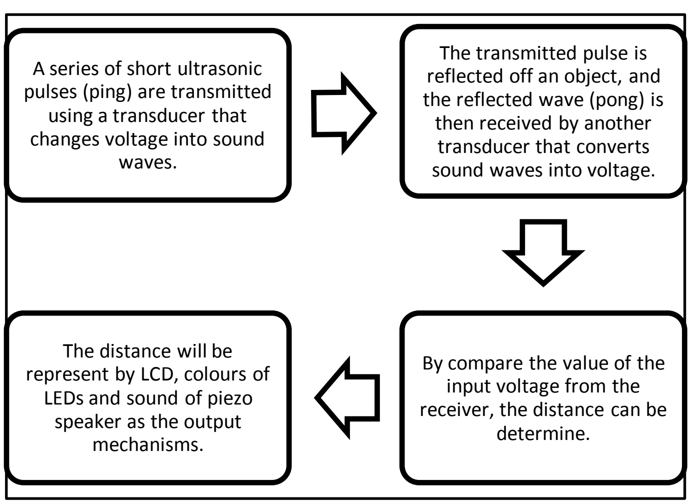


Figure 3.2: Flow process of the system

3.3.2 Design /Component/ selection

In this system, ultrasonic sensor is selected as a distance sensor because it is more efficient and sensitive compare to the common sensor such as infra-red sensor and reverse sensor. Based on the size of required memory that needed in the program, 16F877A as the microcontroller for the project.

3.4 Software Design

In this project, assembly language will be used to programming the system. This is the flowchart of the program:

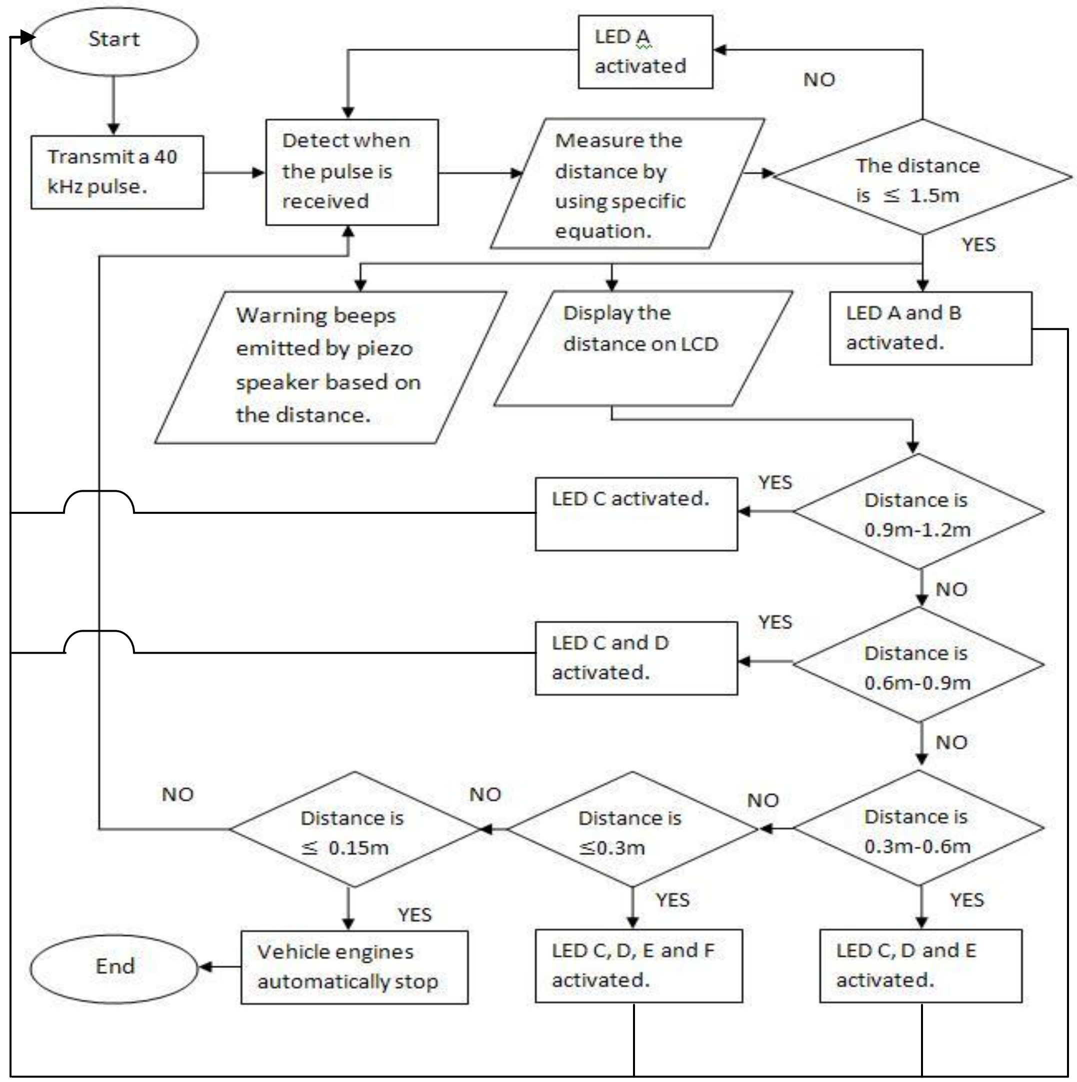


Figure 3.3: Flowchart of the system

CHAPTER 4

HARDWARE AND SOFTWARE DESIGN AND IMPLEMENTATION

4.1 Hardware Overview

4.1.1 PIC Microcontroller - PIC16F877A

4.1.1.1 Device Overview

PIC16F877A devices are available in 40-pin and 44-pin packages. PIC16F877A architectures are:

i. The PIC16F877A have two of the total on-chip memory of the PIC16F873A and PIC16F874A.
ii. The PIC16F877A have five I/O ports.
iii. The PIC16F877A have fifteen interrupts.
iv. The PIC16F877A have eight A/D input channels.
v. The Parallel Slave Port is implemented only on the 40/44-pin devices which mean the PIC16F877A also have it.

The available features are summarized in Table 4.1. Block diagram of the PIC16877A device is provided in Figure 4.1, respectively. The pinouts for this device are listed in Table 4.2.

Key Features	PIC16F873A	PIC16F874A	PIC16F876A	PIC16F877A
Operating Frequency	DC – 20 MHz	DC – 20 MHz	DC – 20 MHz	DC – 20 MHz
Resets (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
Flash Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory (bytes)	128	128	256	256
Interrupts	14	15	14	15
I/O Ports	Ports A, B, C	Ports A, B, C, D, E	Ports A, B, C	Ports A, B, C, D, E
Timers	3	3	3	3
Capture/Compare/PWM modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 input channels	8 input channels	5 input channels	8 input channels
Analog Comparators	2	2	2	2
Instruction Set	35 Instructions	35 Instructions	35 Instructions	35 Instructions
Packages	28-pin PDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN	28-pin PDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN

Table 4.1: PIC16F87XA Device Features

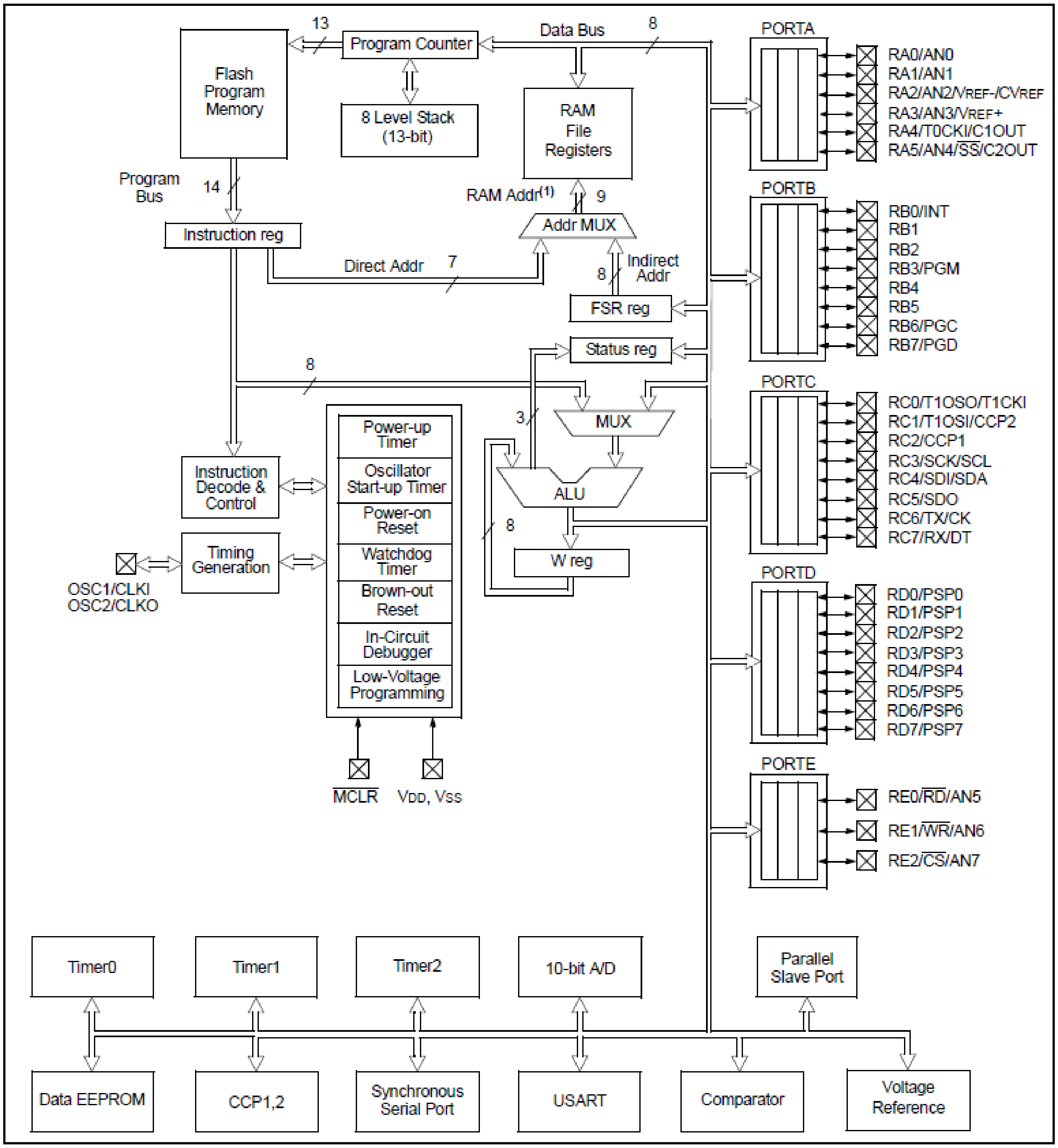


Figure 4.1: PIC16F877A Block Diagram

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKI	13	14	30	32		ST/CMOS[4]	Oscillator crystal or external clock input.
OSC1					I		Oscillator crystal input or external clock source input. ST buffer when configured in RC mode; otherwise CMOS.
CLKI					I		External clock source input. Always associated with pin function OSC1 (see OSC1/CLKI, OSC2/CLKO pins).
OSC2/CLKO	14	15	31	33		—	Oscillator crystal or clock output.
OSC2					O		Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode.
CLKO					O		In RC mode, OSC2 pin outputs CLKO, which has 1/4 the frequency of OSC1 and denotes the instruction cycle rate.
$\overline{\text{MCLR}}$/VPP	1	2	18	18		ST	Master Clear (input) or programming voltage (output).
$\overline{\text{MCLR}}$					I		Master Clear (Reset) input. This pin is an active low Reset to the device.
VPP					P		Programming voltage input.
							PORTA is a bidirectional I/O port.
RA0/AN0	2	3	19	19		TTL	
RA0					I/O		Digital I/O.
AN0					I		Analog input 0.
RA1/AN1	3	4	20	20		TTL	
RA1					I/O		Digital I/O.
AN1					I		Analog input 1.
RA2/AN2/VREF-/CVREF	4	5	21	21		TTL	
RA2					I/O		Digital I/O.
AN2					I		Analog input 2.
VREF-					I		A/D reference voltage (Low) input.
CVREF					O		Comparator VREF output.
RA3/AN3/VREF+	5	6	22	22		TTL	
RA3					I/O		Digital I/O.
AN3					I		Analog input 3.
VREF+					I		A/D reference voltage (High) input.
RA4/T0CKI/C1OUT	6	7	23	23		ST	
RA4					I/O		Digital I/O – Open-drain when configured as output.
T0CKI					I		Timer0 external clock input.
C1OUT					O		Comparator 1 output.
RA5/AN4/$\overline{\text{SS}}$/C2OUT	7	8	24	24		TTL	
RA5					I/O		Digital I/O.
AN4					I		Analog input 4.
$\overline{\text{SS}}$					I		SPI slave select input.
C2OUT					O		Comparator 2 output.

Table 4.2.1: PIC16F874A/877A Pinout Description

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
							PORTB is a bidirectional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	9		TTL/ST(1)	
RB0					I/O		Digital I/O.
INT					I		External interrupt.
RB1	34	37	9	10	I/O	TTL	Digital I/O.
RB2	35	38	10	11	I/O	TTL	Digital I/O.
RB3/PGM	36	39	11	12		TTL	
RB3					I/O		Digital I/O.
PGM					I		Low-voltage ICSP programming enable pin.
RB4	37	41	14	14	I/O	TTL	Digital I/O.
RB5	38	42	15	15	I/O	TTL	Digital I/O.
RB6/PGC	39	43	16	16		TTL/ST(2)	
RB6					I/O		Digital I/O.
PGC					I		In-circuit debugger and ICSP programming clock.
RB7/PGD	40	44	17	17		TTL/ST(2)	
RB7					I/O		Digital I/O.
PGD					I/O		In-circuit debugger and ICSP programming data.

Table 4.2.2: PIC16F874A/877A Pinout Description

4.1.1.2 Memory Organization

There are three memory blocks in the PIC16F877A device. For program memory organization, The PIC16F877A device have 8K words x 14 bits of Flash program memory. Accessing a location above the physically implemented address will cause a wraparound. The Reset vector is at 0000h and the interrupt vector is at 0004h.

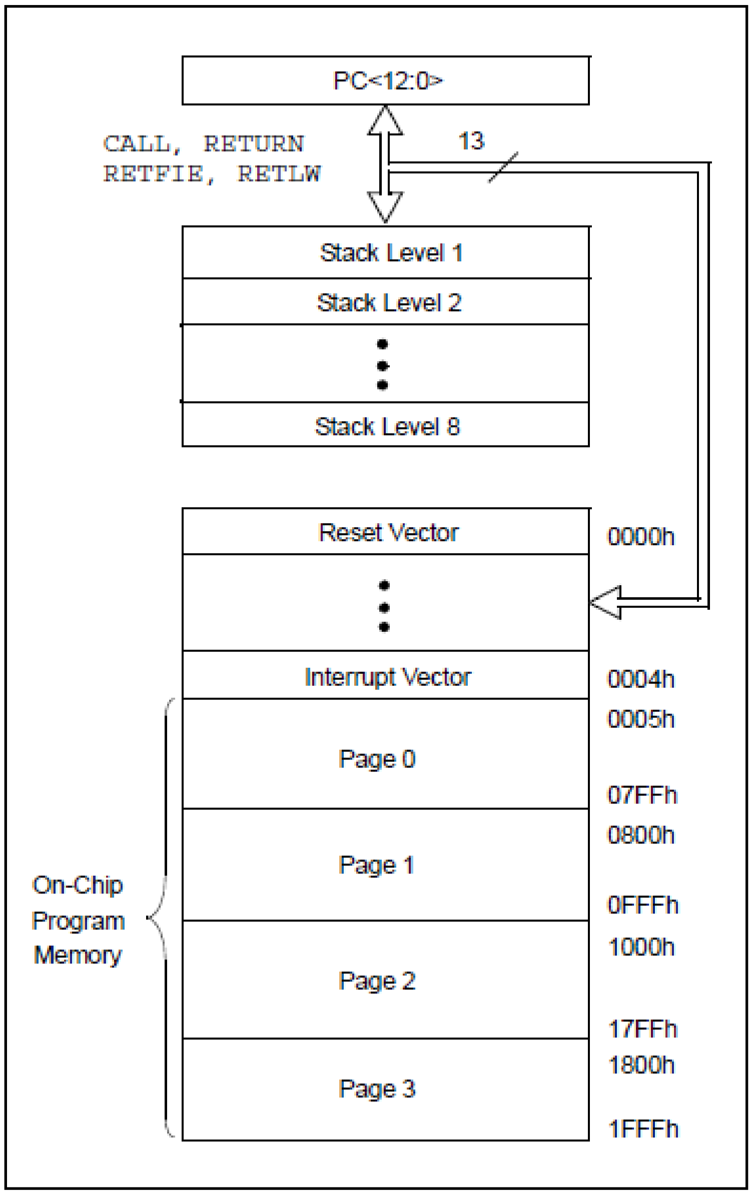


Figure 4.2: PIC16F8877A Program Memory Map and Stack

4.1.1.3 Data Eeprom and Flash Program Memory

The data EEPROM and Flash program memory is readable and writable during normal operation (over the full VDD range). This memory is not directly mapped in the register file space. Instead, it is indirectly addressed through the Special Function Registers. There are six SFRs used to read and write this memory:

- EECON1
- EECON2
- EEDATA
- EEDATH
- EEADR
- EEADRH

When interfacing to the data memory block, EEDATA holds the 8-bit data for read/write and EEADR holds the address of the EEPROM location being accessed. These devices have 128 or 256 bytes of data EEPROM (depending on the device), with an address range from 00h to FFh. On devices with 128 bytes, addresses from 80h to FFh are unimplemented and will wraparound to the beginning of data EEPROM memory. When writing to unimplemented locations, the on-chip charge pump will be turned off. When interfacing the program memory block, the EEDATA and EEDATH registers form a two-byte word that holds the 14-bit data for read/write and the EEADR and EEADRH registers form a two-byte word that holds the 13-bit address of the program memory location being accessed. These devices have 4 or 8K words of program Flash, with an address range from 0000h to 0FFFh for the PIC16F873A/874A and 0000h to 1FFFh for the PIC16F876A/877A. Addresses above the range of the respective device will wraparound to the beginning of program memory.

The EEPROM data memory allows single-byte read and write. The Flash program memory allows single-word reads and four-word block writes. Program memory write operations automatically perform an erase-before-write on blocks of four words. A byte write in data EEPROM memory automatically erases the location and writes the new data (erase-before-write). The write time is controlled by an on-chip timer. The write/erase voltages are generated by an on-chip charge pump, rated to operate over the voltage range of the device for byte or word operations. When the device is code-protected, the CPU may continue to read and write the data EEPROM memory. Depending on the settings of the write-protect bits, the device may or may not be able to write certain blocks of the program memory; however, reads of the program memory are allowed. When code-protected, the device programmer can no longer access data or program memory; this does NOT inhibit internal reads or writes.

4.1.1.4 I/O Ports

Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

Name	Bit#	Buffer	Function
RA0/AN0	bit 0	TTL	Input/output or analog input.
RA1/AN1	bit 1	TTL	Input/output or analog input.
RA2/AN2/VREF-/CVREF	bit 2	TTL	Input/output or analog input or VREF- or CVREF.
RA3/AN3/VREF+	bit 3	TTL	Input/output or analog input or VREF+.
RA4/T0CKI/C1OUT	bit 4	ST	Input/output or external clock input for Timer0 or comparator output. Output is open-drain type.
RA5/AN4/$\overline{SS}$/C2OUT	bit 5	TTL	Input/output or analog input or slave select input for synchronous serial port or comparator output.

Table 4.3: Port A Functions

Name	Bit#	Buffer	Function
RB0/INT	bit 0	TTL/ST(1)	Input/output pin or external interrupt input. Internal software programmable weak pull-up.
RB1	bit 1	TTL	Input/output pin. Internal software programmable weak pull-up.
RB2	bit 2	TTL	Input/output pin. Internal software programmable weak pull-up.
RB3/PGM(3)	bit 3	TTL	Input/output pin or programming pin in LVP mode. Internal software programmable weak pull-up.
RB4	bit 4	TTL	Input/output pin (with interrupt-on-change). Internal software programmable weak pull-up.
RB5	bit 5	TTL	Input/output pin (with interrupt-on-change). Internal software programmable weak pull-up.
RB6/PGC	bit 6	TTL/ST(2)	Input/output pin (with interrupt-on-change) or in-circuit debugger pin. Internal software programmable weak pull-up. Serial programming clock.
RB7/PGD	bit 7	TTL/ST(2)	Input/output pin (with interrupt-on-change) or in-circuit debugger pin. Internal software programmable weak pull-up. Serial programming data.

Table 4.4: Port B Functions

Name	Bit#	Buffer Type	Function
RC0/T1OSO/T1CKI	bit 0	ST	Input/output port pin or Timer1 oscillator output/Timer1 clock input.
RC1/T1OSI/CCP2	bit 1	ST	Input/output port pin or Timer1 oscillator input or Capture2 input/ Compare2 output/PWM2 output.
RC2/CCP1	bit 2	ST	Input/output port pin or Capture1 input/Compare1 output/ PWM1 output.
RC3/SCK/SCL	bit 3	ST	RC3 can also be the synchronous serial clock for both SPI and I^2C modes.
RC4/SDI/SDA	bit 4	ST	RC4 can also be the SPI data in (SPI mode) or data I/O (I^2C mode).
RC5/SDO	bit 5	ST	Input/output port pin or Synchronous Serial Port data output.
RC6/TX/CK	bit 6	ST	Input/output port pin or USART asynchronous transmit or synchronous clock.
RC7/RX/DT	bit 7	ST	Input/output port pin or USART asynchronous receive or synchronous data.

Table 4.5: Port C Functions

Name	Bit#	Buffer Type	Function
RD0/PSP0	bit 0	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 0.
RD1/PSP1	bit 1	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 1.
RD2/PSP2	bit2	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 2.
RD3/PSP3	bit 3	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 3.
RD4/PSP4	bit 4	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 4.
RD5/PSP5	bit 5	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 5.
RD6/PSP6	bit 6	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 6.
RD7/PSP7	bit 7	ST/TTL(1)	Input/output port pin or Parallel Slave Port bit 7.

Table 4.6: Port D Functions

Name	Bit#	Buffer Type	Function
RE0/$\overline{\text{RD}}$/AN5	bit 0	ST/TTL(1)	I/O port pin or read control input in Parallel Slave Port mode or analog input: $\overline{\text{RD}}$ 1 = Idle 0 = Read operation. Contents of PORTD register are output to PORTD I/O pins (if chip selected).
RE1/$\overline{\text{WR}}$/AN6	bit 1	ST/TTL(1)	I/O port pin or write control input in Parallel Slave Port mode or analog input: $\overline{\text{WR}}$ 1 = Idle 0 = Write operation. Value of PORTD I/O pins is latched into PORTD register (if chip selected).
RE2/$\overline{\text{CS}}$/AN7	bit 2	ST/TTL(1)	I/O port pin or chip select control input in Parallel Slave Port mode or analog input: $\overline{\text{CS}}$ 1 = Device is not selected 0 = Device is selected

Table 4.7: Port E Functions

4.1.1.5 PWM Modules

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.

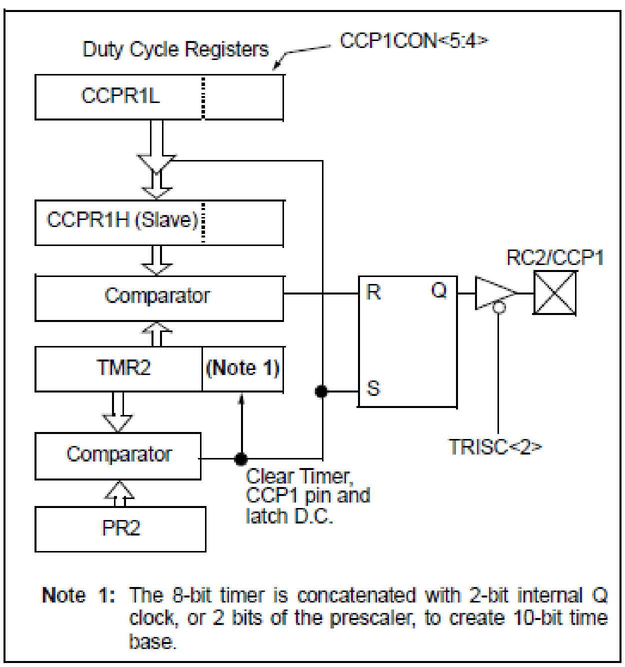


Figure 4.3: Simplified PWM Block Diagram

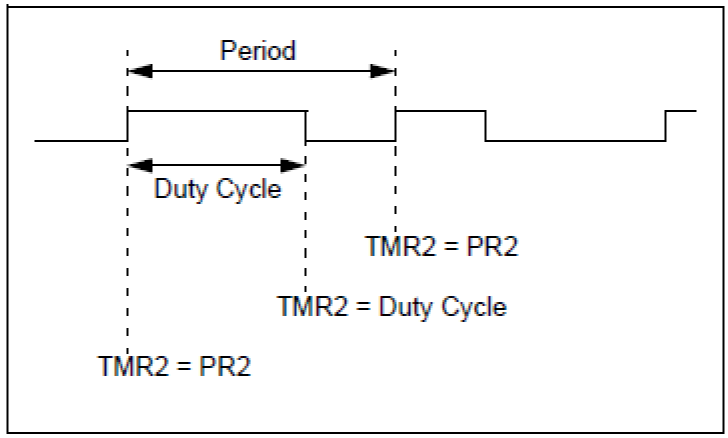


Figure 4.4: PWM Output

A PWM output (Figure 4-4) 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). The PWM period is specified by writing to the PR2 register. The PWM period can be calculated using the following formula:

$$\text{PWM Period} = [(\text{PR2}) + 1] \bullet 4 \bullet \text{TOSC} \bullet (\text{TMR2 Prescale Value})$$

PWM frequency is defined as 1/[PWM period]. When TMR2 is equal to PR2, the following three events occur on the next increment cycle:

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

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:

PWM Duty Cycle = (CCPR1L:CCP1CON<5:4>) • TOSC • (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 following formula.

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

4.1.1.6 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 40/44-pin devices. The conversion of an 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 Register 0 (ADCON0)
- A/D Control Register 1 (ADCON1)

The ADCON0 register controls the operation of the A/D module. The ADCON1 register 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.

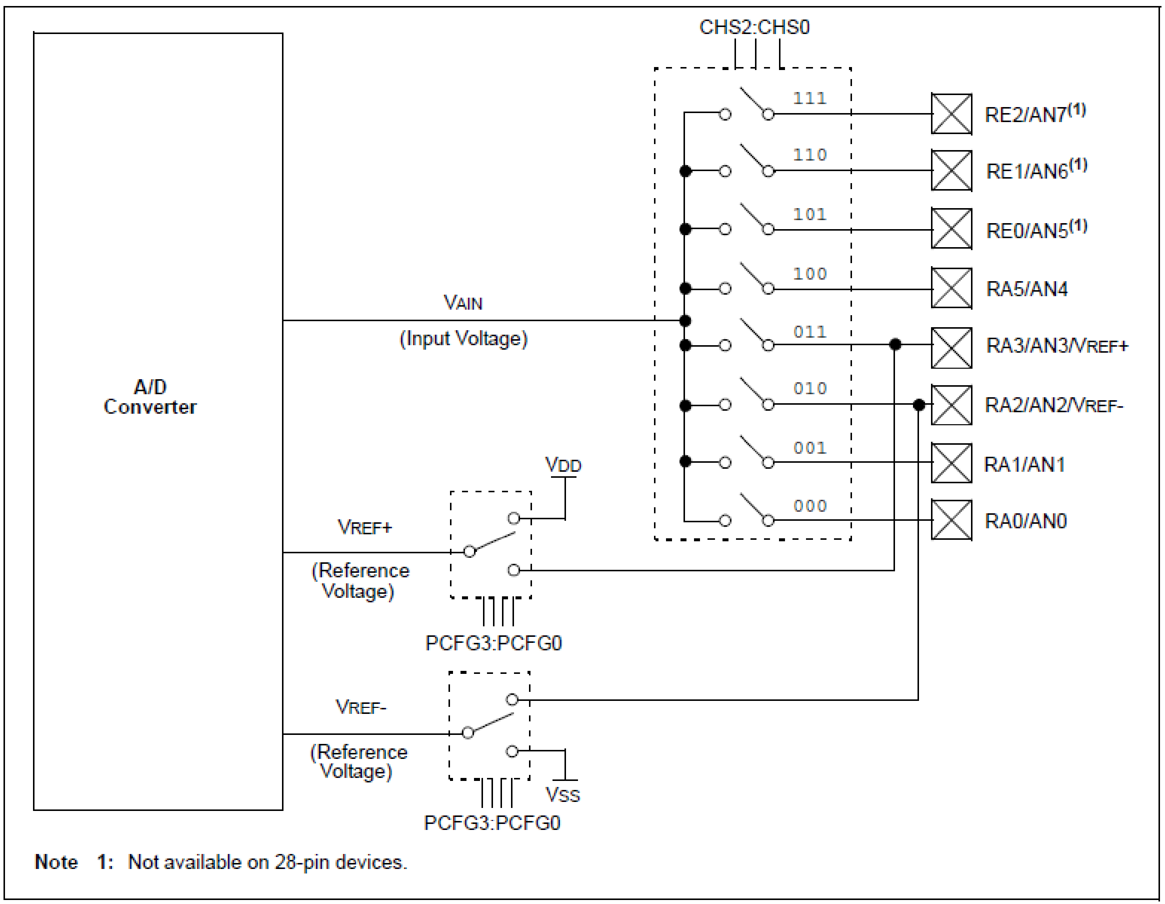


Figure 4.5: A/D Block Diagram

4.1.1.7 Development Support

The PIC16F877A microcontroller is supported with a full range of hardware and software development tools:

- Integrated Development Environment
  -MPLAB® IDE Software
- Assemblers/Compilers/Linkers
  -MPASMTM Assembler, MPLAB C17 and MPLAB C18 C Compilers, MPLINKTM Object Linker/MPLIBTM Object Librarian, MPLAB C30 C Compiler, MPLAB ASM30 Assembler/Linker/Library

4.1.1.8 Conclusion on PIC16F877A

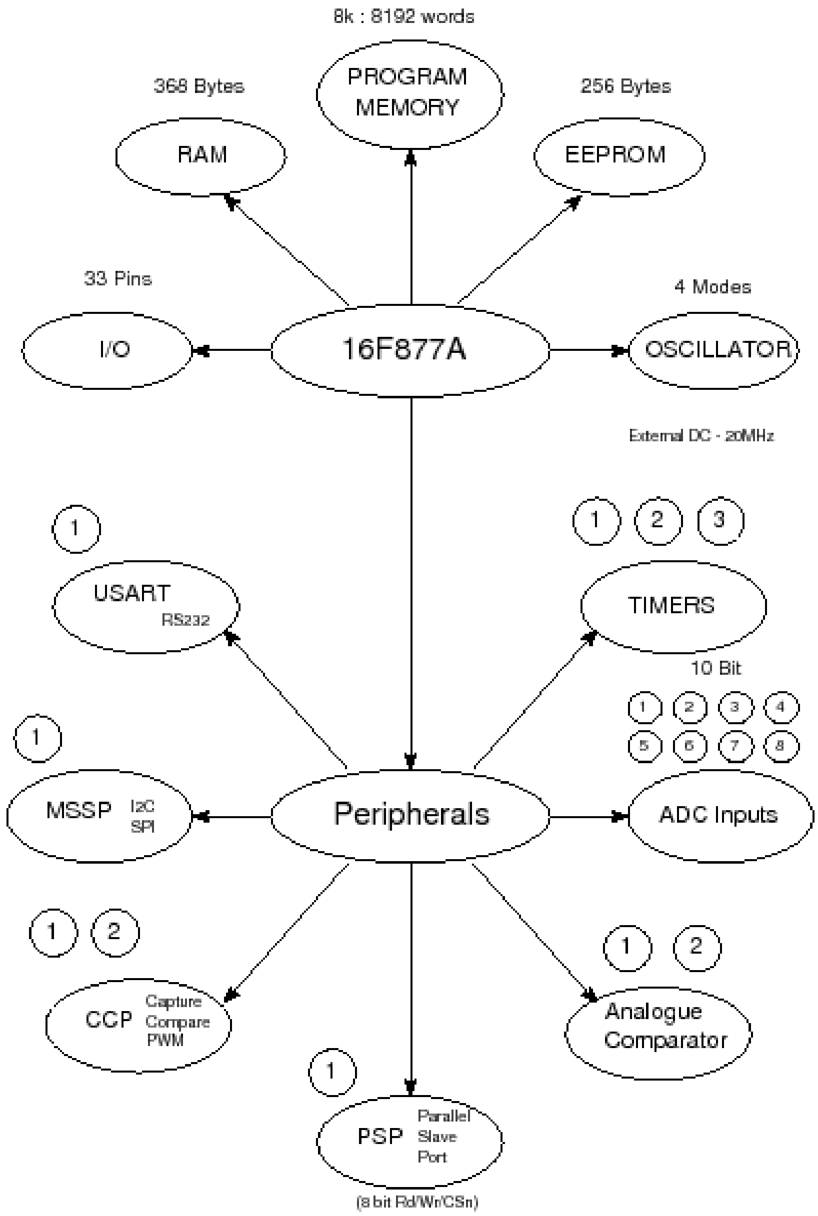


Figure 4.6: PIC16F877A Overview

4.1.2 LM7805

The 78xx (also sometimes known as LM78xx) series of devices is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is a very popular choice for many electronic circuits which require a regulated power supply, due to their ease of use and relative cheapness. When specifying individual ICs within this family, the xx is replaced with a two-digit number, which indicates the output voltage the particular device is designed to provide (for example, the 7805 has a 5 volt output, while the 7812 produces 12 volts). The 78xx line is positive voltage regulators, meaning that they are designed to produce a voltage that is positive relative to a common ground. There is a related line of 79xx devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide both positive and negative supply voltages in the same circuit, if necessary.

78xx ICs have three terminals and are most commonly found in the TO220 form factor, although smaller surface-mount and larger TO3 packages are also available from some manufacturers. These devices typically support an input voltage which can be anywhere from a couple of volts over the intended output voltage, up to a maximum of 35 or 40 volts, and can typically provide up to around 1 or 1.5 amps of current (though smaller or larger packages may have a lower or higher current rating).

4.1.3 Light-emitting diode (LED)

Light-emitting diode, usually called an LED is a semiconductor diode that emits incoherent narrow-spectrum light when electrically biased in the forward direction of the p-n junction, as in the common LED circuit. This effect is a form of electroluminescence.

A LED is usually a small area light source, often with extra optics added to the chip that shapes its radiation pattern. The color of the emitted light depends on the composition and condition of the semiconducting material used, and can be infrared, visible, or ultraviolet.

4.2 Software Overview

The PICBAsic compiler is used to allow ease of using basic language coupled with the speed of assembly language. Basic is a user-friendly language, it is easier to learn and master than either assembly or C language. When the basic code is compiled to its assembly language equivalents, it is 20 to 100 times faster than standard Basic code, effectively countering the speed advantages C or assembly languages typically offer. The complied Basic the code (assembly language equivalent) is programmed into PIC microcontroller. As stated, this methodology increases the code execution 20 to 100 times faster than the equivalent interpreted basic code that is used in other microcontroller systems like Basic Stamp.

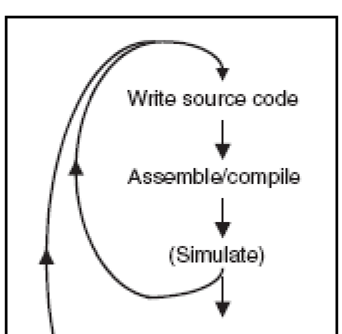


Figure 4.7: The program development process using PicBasic Pro Compiler.

CHAPTER 5

DISCUSSION AND RESULT

5.1 Introduction

Various tests are conducted in this project. The results of the testing reveal the system have achieved of substantial goal. Finally, the modules are integrated and tested for its functionality.

5.2 System Board Testing

The core of the project is output mode of the system. Thus, various tests are conducted in the system to ensure its functionality. The initial test involves a free running test where a hardware circuit that shown before is used. When the program is executed, a free running pattern is provided. It concludes that the microcontroller system is fully functioning. The program coding to run the system board testing is in Appendix B.

Figure 5.1: Plan View of Smart System of Ultrasonic Car Parking

5.3 Explanation for PWM

'Setting up hardware PWM for 38KHz operation.

```
PR2 = 25              ' Set PWM Period for approximately 38KHz
CCPRIL = 13           ' Set PWM Duty-Cycle to 50%
CCP1CON = %00001100   ' Select PWM Mode
T2CON = %00000100     ' Timer2 = ON + 1:1 prescale
```

PortC.2 on the PIC16F877 also functions as the hardware PWM output pin (CCP1) when not being used for normal I/O operations. Several registers need to be configured to use the PWM feature.

Timer2 (TMR2), and PR2 (timer2 module's period register) are used to establish the period. Figure 5.2 shows a graphical representation of how this works.

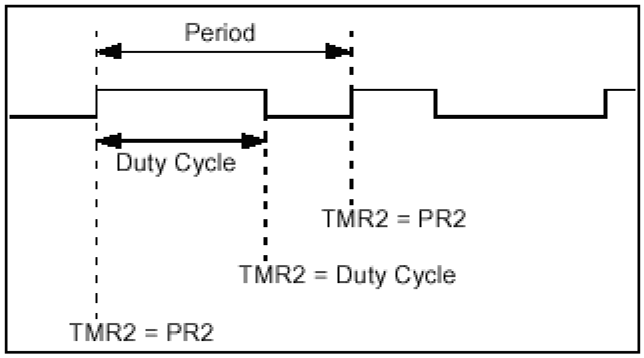


Figure 5.2: PWM Output

As shown in the previous code segment, we first have to load the timer2 period register (PR2) to setup the period for our required frequency (38 KHz) output. A PWM output (Figure 5.2) 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 - which is (1/period). Figure 5.2 shows the period from TMR2 = PR2 to TMR2 = PR2. This represents one complete cycle. To determine the period required to generate a frequency of 38 KHz, simply take 1/38 KHz, or 1/38,000. The result is 1/38,000 = 0.000026316 (26.3uS). We know that in order to generate our 38 KHz frequency, we'll need each period to be approximately 26 microseconds. A duty cycle of 50% would need 13uS high, and 13uS low on the I/O-pin to generate our required frequency of 38 KHz at a duty cycle of 50%. Frequency (f) and period (P) are inversely proportional.

$$f = 1/P, \ \& \ P = 1/f.$$

To calculate the value to be loaded into PR2:

PR2 = (4MHz / (4 * TMR2 prescale value * 38 KHz)) - 1

We'll use a prescale value of 1 for timer2.Hence,

PR2 = (4MHz / (4 * 1 * 38,000)) - 1

= (4MHz / (152,000)) – 1

= 26.315 - 1

= 25.315

We'll load 25 into PR2, and accept the minimal error. Use the equation below to find resolution:

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

The equation above shows how to find the maximum PWM resolution (in bits) for a given PWM frequency, with our selected oscillator frequency. This application uses the PIC16F877 with a 4MHz oscillator, so we need to calculate: Log (4 MHz/38KHz) / Log (2) to find our maximum resolution in bits.

Maximum Resolution = Log (4,000,000/38,000) / Log (2)

= 2.022/.301

= 6.7-bits

I chose a duty cycle of 50% for this application. To setup the duty cycle, there are two registers that need to be configured. CCPRL1 contains the eight (most significant bits), and CCP1CON <4:5> (CCP1CON bits 4 and 5) contain the two (least significant bits). Since we will only have a maximum of 6-bits resolution, we only need to load the CCPR1 register. CCP1CON bits 4 & 5 will be loaded with 0's.

To figure the value to load into CCPRL1 for 38 KHz @ 4MHz with a 50% duty cycle:

Value for CCPRL1 = (PR2 + 1) * TMR2 prescale * 50% Duty Cycle
= (25 + 1) * 1 * 0.50 = 26 * 0.50
= 13

Insert the value for CCPRL1 in the coding:

```
TRISC.2 = 0        ' CCP1 (PortC.2 = Output)
PR2 = 25           ' Set PWM Period for approximately 38KHz
CCPR1L = 13        ' Set PWM Duty-Cycle to 50%
CCP1CON = %00001100  ' Mode select = PWM
T2CON = %00000100    ' Timer2 ON + 1:1 prescale
```

Above is the code that used in for PWM programming. Notice register CCP1CON is loaded with a binary value that sets bits 2 and 3. These are CCP1M3 and CCP1M2, and set the PWM mode. Timer2 T2CON bit 2 is set to start the timer. Bits 1 and 0 are left clear for a prescaler of 1. TRISC.2 sets up portC.2 as an output which is necessary to have portC.2 output the 38 KHz carrier (PWM) frequency.

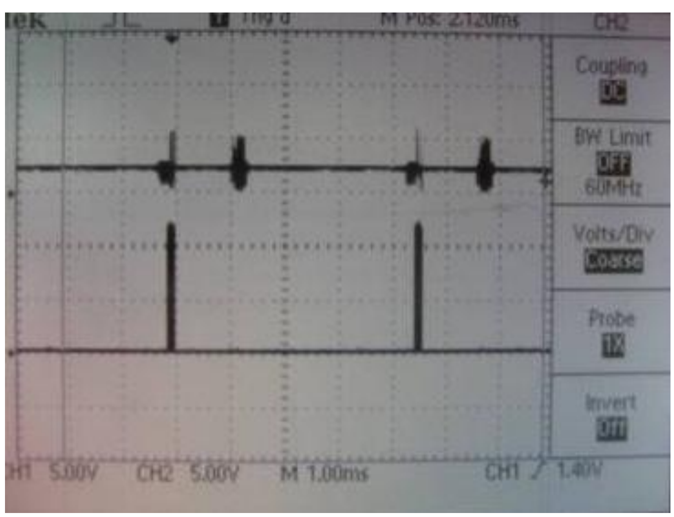


Figure 5.3: Transmitted signal (bottom) and received signal on 1ms scale.

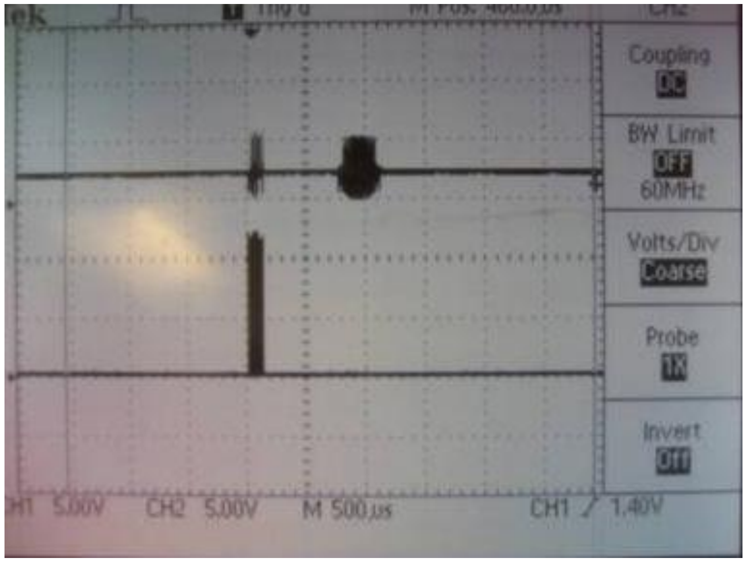


Figure 5.4: Transmitted signal (bottom) and received signal on 500us scale.

5.4 Overall Result

The ultrasonic distance measurement is an untouchable detection mode. Compared with else detection modes, it does not influenced by ray, temperature and color, and it has the great capability to adapt to the circumstance. The ultrasonic sensor adopts transmission mode or reflection mode on the physical configuration, the reflection mode has the single explore-head and the double explore- head, his system adopts double explore-head reflection mode, it is that the sending signal and the receiving signal are on the same side. The double explore-head mode has a unique advantage, which is that there is much less blind area than single explore-head mode. Because the sending explore-head is separated from the receiving explore-head, the sending explore-head does not have sending voltage directly, theoretically, it does not have blind area. But the receiving circuit is influenced by the sending circuit more or less, and the ultrasonic from the sending explore-head possibly move around to the receiving explore-head directly. So there should be existed some blind area, but in fact more less than the blind area of single explore-head. It is the ultrasonic pulse echo technique (sonar technique) that is most widely used in the continuous distance measurement technique.

The ultrasonic detection distance relates with size, figure, material and position of the object. The bigger the reflector is, the better the reflectance is, and the stronger the reflection signal is. Generally speaking, the detection distance is farther if the facade of the reflector is smooth and flat than that if the facade of the reflector is coarse, the detection distance of the reflector with solidity facade is farther than that with loose facade, the detection distance is farther if the reflector facade is vertical to the sending signal than that if there is a obliquity between the reflector facade and the sending signal (the reflected ultrasonic does not return to the explore-head along the primary path, so the reflected signal received by the receiving explored-head will be greatly weakened).

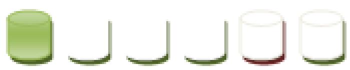
In this project, the system cannot determine the accurate value of the distance although all the outputs are functioning well because the ultrasonic sensor is unstable. First reason why the system fails to determine the accurate is because the sensors have a blind zone in which they cannot accurately detect the target. This is the distance between the sensing face and the minimum sensing range. When the target is too close, the tone burst's leading edge can travel to the target and strike it before the trailing edge has left the transducer. Echo information returning to the sensor is ignored, because the transducer is still transmitting and not yet receiving. The echo generated could also reflect off the face of the sensor and again travel out to the target. These multiple echoes can cause errors when the target is in the blind zone. Therefore, the system cannot determine the precise distant value. Next reason is the system programming has some error in order to process the received signal from the receiver. The microcontroller cannot be able to make the comparison between the values of received voltage in order to determine the accurate distance and also to fulfill requirement of the system. The program of the system is attached in the appendix.

The system outputs are:

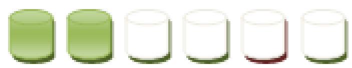
1. Safe Zone

- Display zone at LCD.

- The tone of beep is based on the distance and LEDs lighting based on zone.



For distance >1.5m

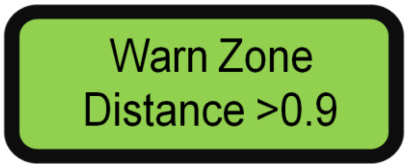


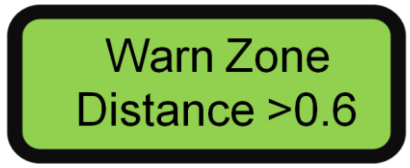
For distance >1.2m

- The dc motor is running to show that the engine car is still running.

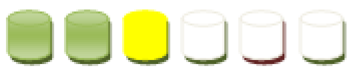
2. Warn Zone

- Display zone at LCD.

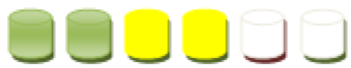




- The tone of beep is based on the distance and LEDs lighting based on zone.



For distance >0.9m



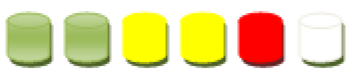
For distance >0.6m

- The dc motor is running to show that the engine car is still running.

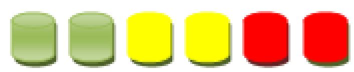
3. Stop Zone

- Display zone at LCD.

- The tone of beep is based on the distance and LEDs lighting based on zone.



For distance >0.3m



For distance <0.3m

- The dc motor for distance above 0.3m is running to show that the engine car is still running. For the distance below than 0.3m, the dc motor is stop running to show that engine car is automatically stop when the car is in stop zone.

5.5 Problems

5.5.1 Hardware part

5.5.1.1 Short circuit

Short circuit is an electrical circuit in which a path of very low resistance has been opened, usually accidentally. When the resistance drops, the electric current in the circuit becomes very high, and can cause damage to the components of the circuit and start fires.

5.5.1.2 Sensitivity of sensor

Ultrasonic distance measurement has blind area and distance limitation. The reason of existing blind area is the signal cannot reach that area in term of relative distance between sensors and targets and the velocities and altitudes of the targets.

5.5.2 Software part

5.5.2.1 Determination and comparison of the distance

In order to calculate the distance, the value of the input voltage from the receiver sensor needs to be determined. Then comparison of the value should be done to fulfill the requirement of the system.

5.6 Solution

5.6.1 Hardware part

5.6.1.1 Short circuit

Troubleshooting: recheck the connection and join to find and remove the cause of the short circuit.

5.6.1.2 Sensitivity of sensor

Choose the best of ultrasonic sensor in term of sensitivity and efficiency. A good sensor obeys the following rules:

i. the sensor should be sensitive to the measured property
ii. the sensor should be insensitive to any other property
iii. the sensor should not influence the measured property

5.6.2 Software part

5.6.2.1 Determination and comparison of the distance

If … then … condition programming is used to determine the comparison for the value that has been read from the received signal.

CHAPTER 6

CONCLUSION

6.1 Conclusion

As a conclusion, this project is considered almost success as the project has achieved most of the requirements. The software and the hardware developed of Smart System of Ultrasonic Car Parking are ready to be explored for educational purposes with minor modification.

The system board which consists of PIC16F877A is designed to allow user to explore a large amount of I/O devices and extra analog-to-digital converter (a/d) port.

6.2 Recommendations

Although most of the goals are achieved, there are still some enhancement should be introduced to improve its quality. Some suggestions for improvement are:

- The system should be constructed using PCB (printed circuit board) to produce reliable system. By using PCB, the probability of short circuit can be reduced and the cost of manufacturing can be decrease.
- Program of the system should be improved to provide more user friendly environment. For example, LCD Graphic Display can be used to replace LCD Character Display to display the zone of the car in more interesting way to attract the attention from the driver. The zone condition range and tone of the buzzer also can be setting by the driver for his comfortable.
- Choose more suitable kind of ultrasonic sensor in term of sensitivity and efficiency. For example, you can use Ultrasonic Range Finder - SN-LV-EZ1. The sensor provides very accurate readings of 0 to 255 inches (0 to 6.45m) in 1 inch increments with little or no blind zone but it is more expensive than the ultrasonic that have been used in this project.

6.3 Costing and Commercialization

The overall cost of the whole project is based on the hardware development. As discussed in previous chapter, the hardware development only consist one board. Therefore the whole project cost is depending on the cost of electronic devices.

The total cost for the Smart System of Ultrasonic Car Parking is RM 170.30. This cost is far cheaper to the car parking system that exists in the market such as Directed Electronics Ultrasonic Parking Sensor which cost RM 199.84 and Ultrasonic Parking Sensor Kit K3502 that are we can buy with price RM 180.40. In addition, the system offers various forms of I/O devices and provides user friendly-functions which normally are not provided by the current market. Furthermore, the system can be redesigned to suit and meet the requirement of the user. Needless to say, the product has highly potential to be commercialized.

No.	Component	Quantity	Price/quantity	Cost
1	PIC16F877A	1	RM 33.79	RM 33.79
2	Capacitor 100µF	1	RM 0.20	RM 0.20
3	Capacitor 0.1µF	3	RM 0.25	RM 0.75
4	Capacitor 22µF	1	RM 0.25	RM 0.25
5	Capacitor 10pF	2	RM 0.25	RM 0.50
6	Crystal 4MHz	1	RM 2.27	RM 2.27
7	Heat Sink	1	RM 2.50	RM 2.50
8	Regulator 7805 (1.5A)	1	RM 0.89	RM 0.89
9	Reset Button	1	RM 2.00	RM 2.00
10	Resistor 220Ω	6	RM 0.20	RM 1.20
11	Resistor 10kΩ	1	RM 0.20	RM 0.20
12	Ribbon Cable (32 way)	1m	RM 16.00	RM 16.00
13	Potentiometer (5kΩ)	1	RM 3.85	RM 3.85
14	LED (green, yellow & red)	6	RM 0.15	RM 0.90
15	Ultrasonic Transducer	1	RM 30.00	RM 30.00
16	Buzzer	1		
17	LCD Display (16 x 2)	1	RM 35.00	RM 35.00
18	DC Motor	1	RM 5.00	RM 5.00
19	Strip Board	1	RM 5.00	RM 5.00
20	Battery Connector	1	RM 1.00	RM 1.00
21	DC Jack	1	RM 1.00	RM 1.00
22	Battery 9v	1	RM 10.00	RM 10.00
23	Power Adapter	1	RM 18.00	RM 18.00
Total Cost				**RM 170.30**

Table 6.1: List cost of the project

REFERENCES

1. Wutong Wang, Ultrasonic Crack Detection Chang Energy Machine and the Demand of Its Performance, Nondestructive Testing, Period 3, Volume 10
2. Acoustics Lab of Tongji University, Ultrasonic industry measurement technique, ShangHai People Publishing Company, 1977
3. Zhaofu Zhang, Overseas Auto Electron Information, Auto Magazine, 1996.6
4. http://en.wikipedia.org/wiki/PIC_microcontroller
5. Beirness, D., (1996) *The relationship between lifestyle factors and collisions involving young drivers*, in (H. Simpson, Editor) New To The Road: Reducing The Risks For Young Drivers, Regents of the University of California, pp. 71-77
6. Shinar, David, (1998) *Aggressive driving: the contribution of the drivers and the situation*, Transportation Research Part F 1, pp. 137-160
7. Yagil, Dana, (1998) *Gender and age-related differences in attitudes toward traffic laws and trafficviolations*, Transportation Research Part F 1, pp.123-135
8. Barr, Michael (1997). *Embedded Systems*. Netrino Technical Library

APPENDIX A

Data Sheets

FAIRCHILD SEMICONDUCTOR®

www.fairchildsemi.com

KA78XX/KA78XXA

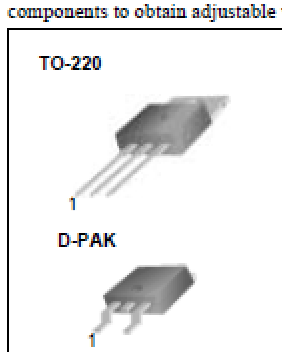
3-Terminal 1A Positive Voltage Regulator

Features

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

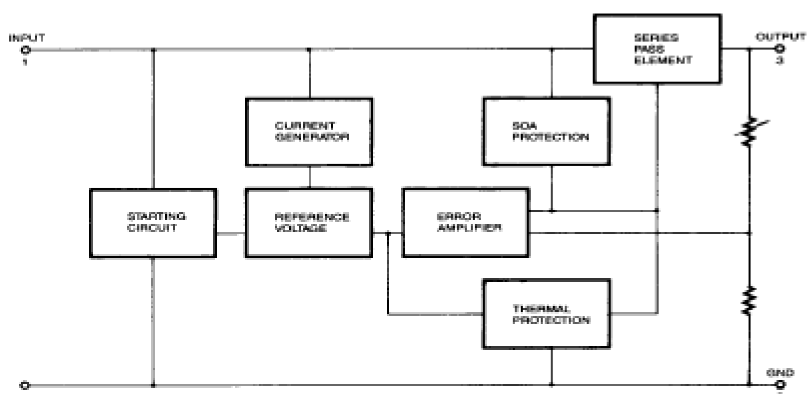
Description

The KA78XX/KA78XXA series of three-terminal positive regulator are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.



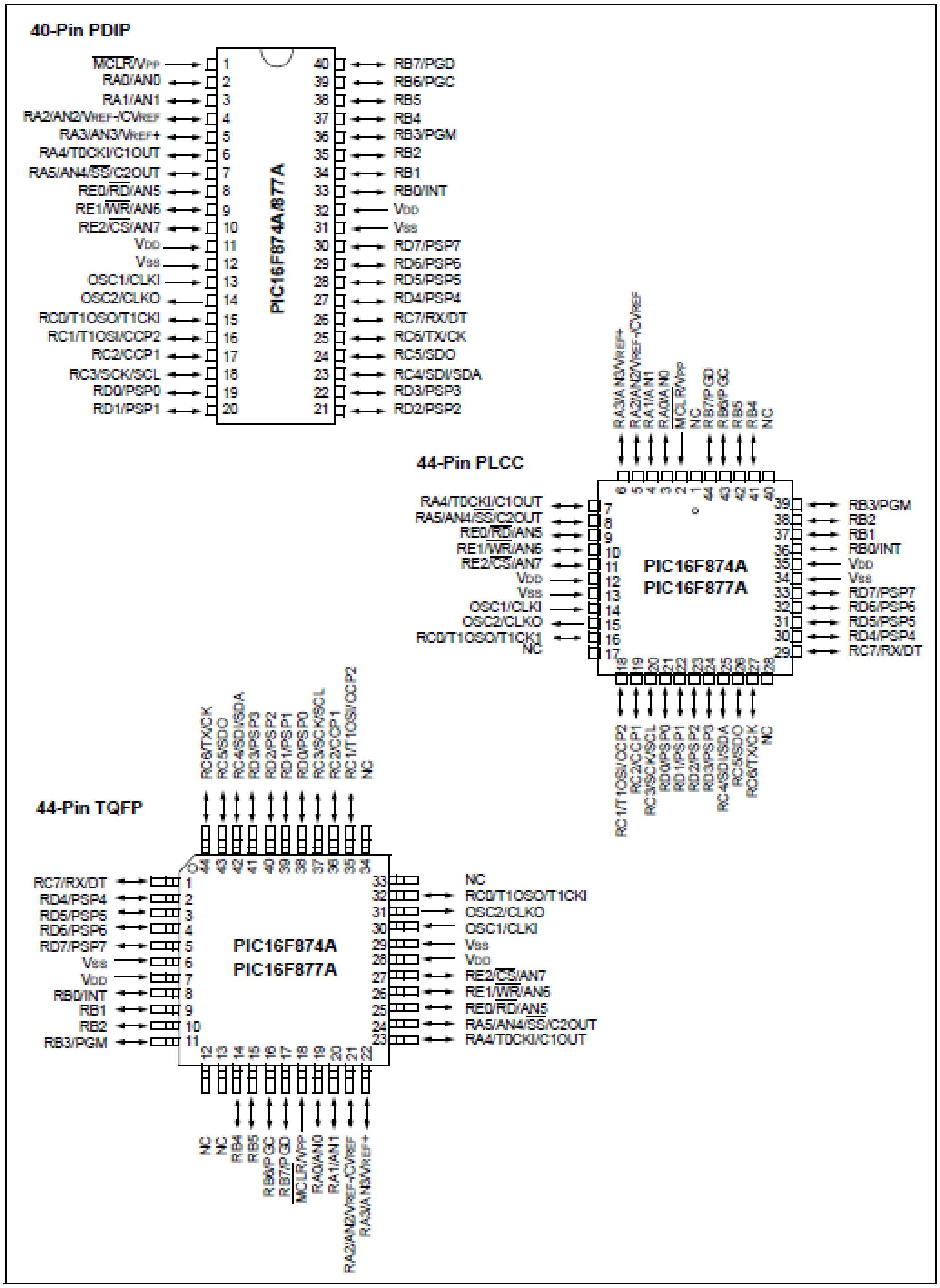
1. Input 2. GND 3. Output

Internal Block Digram



Rev. 1.0.0

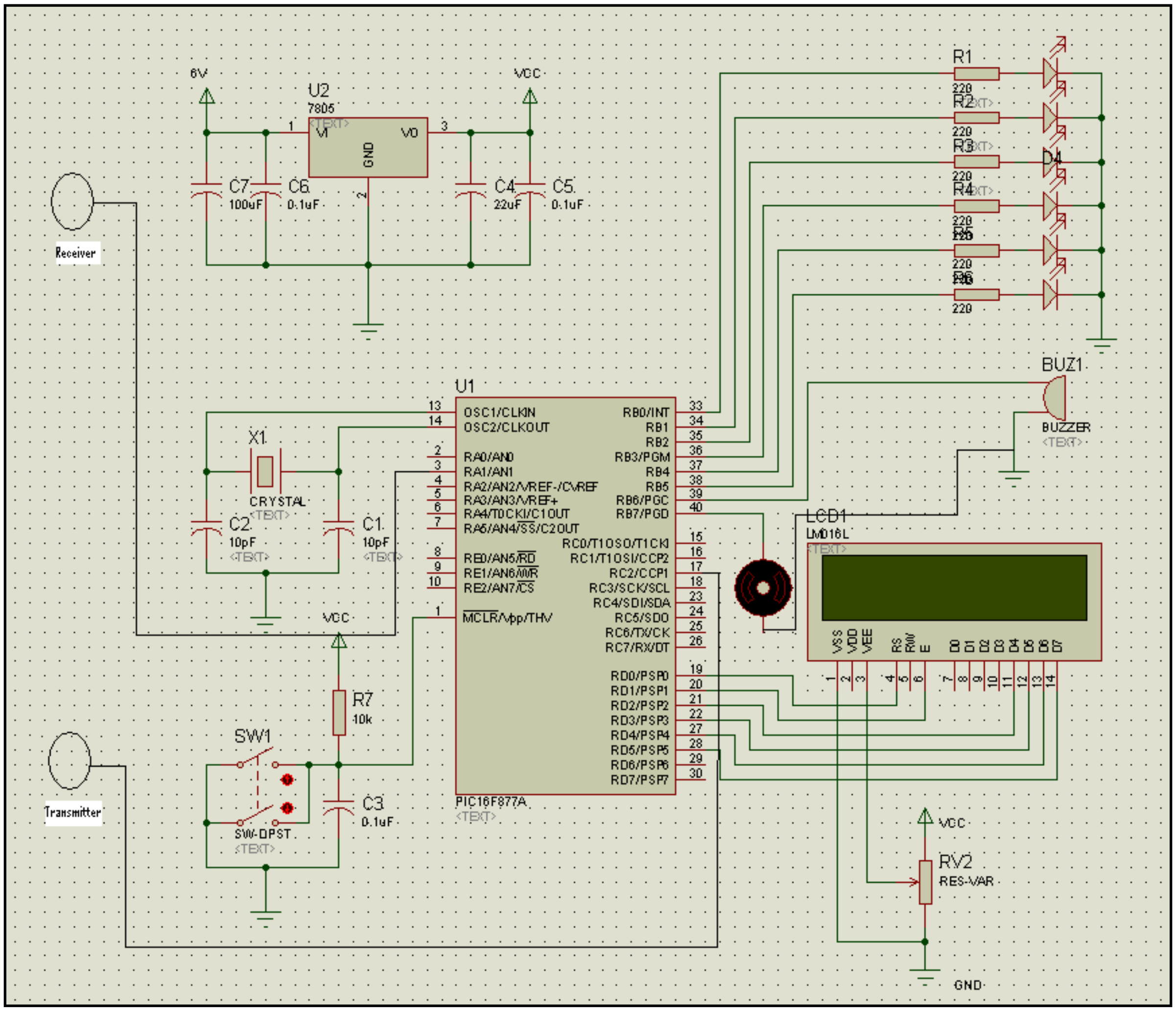
Pin Diagrams (Continued)



APPENDIX B

Schematic Circuit Diagram

1. Schematic Circuit Diagram



APPENDIX C

Testing & Project Program

1. Testing Program

```
'****************************************************************
'*  Name    : PAKDIN.BAS                                        *
'*  Author  : [select VIEW...EDITOR OPTIONS]                    *
'*  Notice  : Copyright (c) 2008 [select VIEW...EDITOR OPTIONS] *
'*          : All Rights Reserved                               *
'*  Date    : 8/22/2008                                         *
'*  Version : 1.0                                               *
'*  Notes   :                                                   *
'*          :                                                   *
'****************************************************************

DEFINE LCD_DREG PORTD       'set LCD data port
DEFINE LCD_DBIT 4           'set starting data bit (0 or 4)if 4-bit bus
DEFINE LCD_RSREG PORTD      'set LCD register port
DEFINE LCD_RSBIT 0          'set LCD register select bit
DEFINE LCD_EREG PORTD       'set LCD enable port
DEFINE LCD_EBIT 1           'set LCD enable bit
DEFINE LCD_BITS 7           'set LCD BUS size
DEFINE LCD_LINES 2          'set no. of lines on LCD
DEFINE LCD_COMMANDUS 2000   'set command delay time in us
DEFINE LCD_DATAUS 50        'set data delay time in us
DEFINE osc 8
DEFINE ADC_BITS 8
DEFINE ADC_CLOCK 3
DEFINE ADC_SAMPLEUS 50

PAUSE 500



trisb=%00000000
trisc=%00000000
trisd=%00000000

main:

PR2 = 25              ' Set PWM Period for approximately 38KHz
CCPRIL = 13           ' Set PWM Duty-Cycle to 50%
CCP1CON = %00001100   ' Select PWM Mode
T2CON = %00000100     ' Timer2 = ON + 1:1 prescale

PAUSE 100           'nie utk lcd'
LCDOUT $fe,1
LCDOUT $fe,$80+3, "Safe Zone"
LCDOUT $fe,$c0+2, "Distance >1.5"

portb=%00000001    'nie utk led hijau'
HIGH portc.0       'utk motor'
PAUSE 4000
LOW portc.0

HIGH portb.6       'nie utk buzer'
PAUSE 1000
```

```
LOW portb.6
PAUSE 1000
HIGH portb.6       'nie utk buzer'
PAUSE 1000
LOW portb.6
PAUSE 1000
HIGH portb.6       'nie utk buzer'
PAUSE 1000
LOW portb.6

PAUSE 300           'nie utk lcd'
LCDOUT $fe,1
LCDOUT $fe,$80+3, "Safe Zone"
LCDOUT $fe,$c0+2, "Distance >1.2"

portb=%00000011    'nie utk led hijau'
HIGH portc.0       'utk motor'
PAUSE 4000
LOW portc.0

HIGH portb.6       'nie utk buzer'
PAUSE 1000
LOW portb.6
PAUSE 1000
HIGH portb.6       'nie utk buzer'
PAUSE 1000
LOW portb.6
PAUSE 1000
HIGH portb.6       'nie utk buzer'
PAUSE 1000
LOW portb.6

PAUSE 3000
LCDOUT $fe,1
LCDOUT $fe,$80+2, "Warn Zone"
LCDOUT $fe,$c0+2, "Distance >0.9 "

portb=%00000111    'nie utk kuning'
HIGH portc.0       'utk motor'
PAUSE 2000
LOW portc.0

HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
PAUSE 500
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
PAUSE 500
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
PAUSE 500
```

```
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
PAUSE 500
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6

PAUSE 3000
LCDOUT $fe,1
LCDOUT $fe,$80+2, "Warn Zone"
LCDOUT $fe,$c0+2, "Distance >0.6 "

portb=%00001111    'nie utk kuning'
HIGH portc.0       'utk motor'
PAUSE 2000
LOW portc.0

HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
PAUSE 500
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
PAUSE 500
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
PAUSE 500
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6
PAUSE 500
HIGH portb.6       'nie utk buzer'
PAUSE 500
LOW portb.6

PAUSE 3000
LCDOUT $fe,1
LCDOUT $fe,$80+2, "Stop Zone"
LCDOUT $fe,$c0+2, "Distance >0.3 "

portb=%00011111    'nie utk led merah'

HIGH portb.6       'nie utk buzer'
PAUSE 250
LOW portb.6
PAUSE 250
HIGH portb.6
PAUSE 250
LOW portb.6
PAUSE 250
HIGH portb.6
```

```
PAUSE 250
LOW portb.6
HIGH portb.6       'nie utk buzer'
PAUSE 250
LOW portb.6
PAUSE 250
HIGH portb.6
PAUSE 250
LOW portb.6
PAUSE 250
HIGH portb.6
PAUSE 250
LOW portb.6

PAUSE 3000
LCDOUT $fe,1
LCDOUT $fe,$80+2, "Stop Zone"
LCDOUT $fe,$c0+2, "Distance <0.3 "

portb=%00111111   'nie utk led merah'

HIGH portb.6       'nie utk buzer'
PAUSE 250
LOW portb.6
PAUSE 250
HIGH portb.6
PAUSE 250
LOW portb.6
PAUSE 250
HIGH portb.6
PAUSE 250
LOW portb.6
HIGH portb.6       'nie utk buzer'
PAUSE 250
LOW portb.6
PAUSE 250
HIGH portb.6
PAUSE 250
LOW portb.6
PAUSE 250
HIGH portb.6
PAUSE 250
LOW portb.6

RETURN
```

2. Project program

```
'****************************************************************
'*  Name    : Mahmadtajudin.BAS                                     *
'*  Author  : [select VIEW...EDITOR OPTIONS]                    *
'*  Notice  : Copyright (c) 2008 [select VIEW...EDITOR OPTIONS] *
'*          : All Rights Reserved                               *
'*  Date    : 9/13/2008                                         *
'*  Version : 1.0                                               *
'*  Notes   :                                                   *
'*          :                                                   *
'****************************************************************

DEFINE LCD_DREG PORTD          'set LCD data port
DEFINE LCD_DBIT 4              'set starting data bit (0 or 4)if 4-bit bus
DEFINE LCD_RSREG PORTD         'set LCD register port
DEFINE LCD_RSBIT 0             'set LCD register select bit
DEFINE LCD_EREG PORTD          'set LCD enable port
DEFINE LCD_EBIT 1              'set LCD enable bit
DEFINE LCD_BITS 7              'set LCD BUS size
DEFINE LCD_LINES 2             'set no. of lines on LCD
DEFINE LCD_COMMANDUS 2000      'set command delay time in us
DEFINE LCD_DATAUS 50           'set data delay time in us
DEFINE osc 8
DEFINE ADC_BITS 8
DEFINE ADC_CLOCK 3
DEFINE ADC_SAMPLEUS 50


PAUSE 500


trisa.1=1
trisb=%00000000
trisc=%00000000
trisd=%00000000
adcon1=0
adcon0=%11001101

volt VAR WORD

PR2 = 25      ' Set PWM Period for approximately 38KHz
CCPR1L = 13   ' Set PWM Duty-Cycle to 50%
CCP1CON = %00001100   ' Select PWM Mode
T2CON = %00000100     ' Timer2 = ON + 1:1 prescale

ADCIN 1,volt
PAUSE 500
```

```
Main:

    IF volt>0 THEN              ' 0<volt<42
        IF volt<42 THEN
            GOSUB safezoneone
        ENDIF
    ENDIF
    IF volt>41 THEN              ' 0<volt<42
        IF volt<85 THEN
            GOSUB safezonetwo
        ENDIF
    ENDIF
    IF volt>84 THEN              ' 0<volt<42
        IF volt<128 THEN
            GOSUB warnzoneone
        ENDIF
    ENDIF
    IF volt>127 THEN              ' 0<volt<42
        IF volt<170 THEN
            GOSUB warnzonetwo
        ENDIF
    ENDIF
    IF volt>169 THEN              ' 0<volt<42
        IF volt<213 THEN
            GOSUB stopzoneone
        ENDIF
    ENDIF
    IF volt>212 THEN              ' 0<volt<42
        IF volt<255 THEN
            GOSUB stopzonetwo
        ENDIF
    ENDIF

GOTO Main

safezoneone:
    PAUSE 100          'Wait for LCD to start'
    LCDOUT $fe,1
    LCDOUT $fe,$80+3, "Safe Zone"
    LCDOUT $fe,$c0+2, "Distance >1.5"

    portb=%00000001    'nie utk led hijau'
    HIGH portc.0       'utk motor'
    PAUSE 2000
    HIGH portb.6       'nie utk buzer'
    PAUSE 1000
    LOW portb.6
    PAUSE 1000
    HIGH portb.6
    PAUSE 1000
    LOW portb.6
    PAUSE 1000
RETURN
```

```
safezonetwo:
    PAUSE 100           'Wait for LCD to start'
    LCDOUT $fe,1
    LCDOUT $fe,$80+3, "Safe Zone"
    LCDOUT $fe,$c0+2, "Distance >1.2"

    portb=%00000011    'nie utk led hijau'
    HIGH portc.0       'utk motor'
    PAUSE 2000
    HIGH portb.6       'nie utk buzer'
    PAUSE 1000
    LOW portb.6
    PAUSE 1000
    HIGH portb.6
    PAUSE 1000
    LOW portb.6
    PAUSE 1000

RETURN

warnzoneone:
    PAUSE 100           'Wait for LCD to start'
    LCDOUT $fe,1
    LCDOUT $fe,$80+3, "Warn Zone"
    LCDOUT $fe,$c0+2, "Distance >0.9 "

    portb=%00000111    'nie utk kuning'
    HIGH portc.0       'utk motor'
    PAUSE 2000
    HIGH portb.6       'nie utk buzer'
    PAUSE 500
    LOW portb.6
    PAUSE 500
    HIGH portb.6       '
    PAUSE 500
    LOW portb.6
    PAUSE 500

RETURN

warnzonetwo:
    PAUSE 100           'Wait for LCD to start'
    LCDOUT $fe,1
    LCDOUT $fe,$80+3, "Warn Zone"
    LCDOUT $fe,$c0+2, "Distance >0.6 "

    portb=%00001111    'nie utk kuning'
    HIGH portc.0       'utk motor'
    PAUSE 2000
    HIGH portb.6       'nie utk buzer'
    PAUSE 500
    LOW portb.6
    PAUSE 500
    HIGH portb.6
    PAUSE 500
    LOW portb.6
    PAUSE 500
```

```
RETURN

stopzoneone:
    PAUSE 100           'Wait for LCD to start'
    LCDOUT $fe,1
    LCDOUT $fe,$80+2, "Stop Zone"
    LCDOUT $fe,$c0+2, "Distance >0.3 "

    portb=%00011111    'nie utk led merah'
    HIGH portc.0       'utk motor'
    PAUSE 2000
    HIGH portb.6       'nie utk buzer'
    PAUSE 250
    LOW portb.6
    PAUSE 250
    HIGH portb.6
    PAUSE 250
    LOW portb.6
    PAUSE 250

RETURN

stopzonetwo:
    PAUSE 100           'Wait for LCD to start'
    LCDOUT $fe,1
    LCDOUT $fe,$80+2, "Stop Zone"
    LCDOUT $fe,$c0+2, "Distance <0.3 "

    portb=%00111111    'nie utk led merah'

    HIGH portb.6       'nie utk buzer'
    PAUSE 250
    LOW portb.6
    PAUSE 250
    HIGH portb.6
    PAUSE 250
    LOW portb.6
    PAUSE 250

RETURN
```