RFID BASED PETROL BUNK AUTOMATION SYSTEM

A PROJECT REPORT

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In partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE

ANNA UNIVERSITY: CHENNAI 600 025

APRIL 2008

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BONAFIDE CERTIFICATE

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Final year ECE students of KCT college has successfully completed their project entitled "RFID BASED PETROL BUNK AUTOMATION SYSTEM" in embedded system using PIC microcontroller at our concern.

FOR AKIRA CONTROLS

12/4/08

ACKNOWLEDGEMENT

We are greatly indebted to our beloved Principal **Dr.Joseph.V.Thanikal, Ph.D.,** Who has been the backbone of all our deeds.

We profusely thank **Dr. Rajeswari Mariappan, Ph.D.,** Head of Department, Department of Electronics and Communication Engineering, for lending a help hand in this project.

We are highly grateful to our beloved Project Coordinator **Ms. R.Latha, M.E.,** and Project guide **Ms.S.Sasikala,MTech** ,Senior Lecturer, E.C.E Department for their valuable guidance, timely helps, constant encouragement and advice rendered throughout the project period for the successful completion of the project

We are also grateful to the faculty members of Electronic testing laboratory and Department of Electronics and Communication Engineering, Who have helped us in innumerable ways.

We also thank our parents without whom we could not have come so far and friends for their timely help that culminated as good in end.

TABLE OF CONTENTS

ABSTRACT

The main aim of the project entitled "RFID BASED PETROL BUNK AUTOMATION SYSTEM" is to implement a secured vending system for petrol bunks using RFID tags. Each employer will be given the RFID tag. Initially, the employer has to swipe his RFID tag near the reader. Then, he has to enter the quantity to be vended in the machine. The reader receives the data from the card and in turn transmits to the microcontroller. The microcontroller in turn switches on the vending pump. Depending on the quantity, the relay on time differs. Simultaneously the microcontroller transmits the total quantity, total amount and the employer ID to the PC. At the end of the day the amount to be paid by the employer and the quantity he has vended will be displayed in the PC and it can be cross verified to the actual. The unit works only for the authorized RFID tags. This project provides secured and centralized system for petrol bunk.

LIST OF FIGURES

LIST OF ABBREVIATIONS

RFID-RADIO FREQUENCY IDENTIFICATION

EIRP-EFFECTIVE ISOTROPIC RADIATED POWER

ISO-INTERNATIONAL ORGANIZATION FOR STANDARDS

IEC-INTERNATIONAL ELECTRO-TECHNICAL COMMISSION

USART –UNIVERSAL SYNCHRONOUS AND ASYNCHRONOUS TRANSMISSION AND RECEPTION

GTIN-GLOBAL TRADE ITEM NUMBER

EPC-ELECTRONIC PRODUCT CODE

PIC-PERIPHERAL INTERFACE CONTROLLER

PWM-PULSE WIDTH MODULATOR

CHAPTER 1:INTRODUCTION

1.INTRODUCTION

Nowadays the technology is going on attaining its various stepping stone and almost it has attained its saturation level. So far, as this development is concerned the industrial life is fully converted into an automated one. Actually the term automation is reducing the manual power i.e., reducing the burden of manual work to perform a particular task. This not only reduces the man power but also it avoids the human error and provides the accuracy in the task that is going to be performed.

The automation provides the at most security for the work that is performed. Time consumption is reduced by this automation and the total cost of the project can be considerably reduced by subjecting the system to automation. Now, as far as the technical and modernized world is concerned, the automation plays a vital role and it occupies the core area in our project which makes fuel vending system as an automated one. So this type of complication less automation gives us a easy way to lead our life.

1.1. PROBLEM STATEMENT

In the present conditions, the fuel vending system is working under the manual control, so many problems sustain due to the currently prevailing system. There is no centralized system for monitoring transactions in petrol bunk and also there is no security in operating vending pump. The automation of fuel vending system if implemented will provide solution to these problems.

1.2 OBJECTIVE

The main objective of our project is to provide an automated fuel vending system in which the manual power used is reduced to its least, the accuracy and security provided to its maximum. The concept of secured system is implemented using RFID technology and providing centralized system for monitoring transactions in petrol bunk.

CHAPTER 2:BLOCK DESCRIPTION

2.BLOCK DESCRIPTION

2.1. BLOCK DIAGRAM

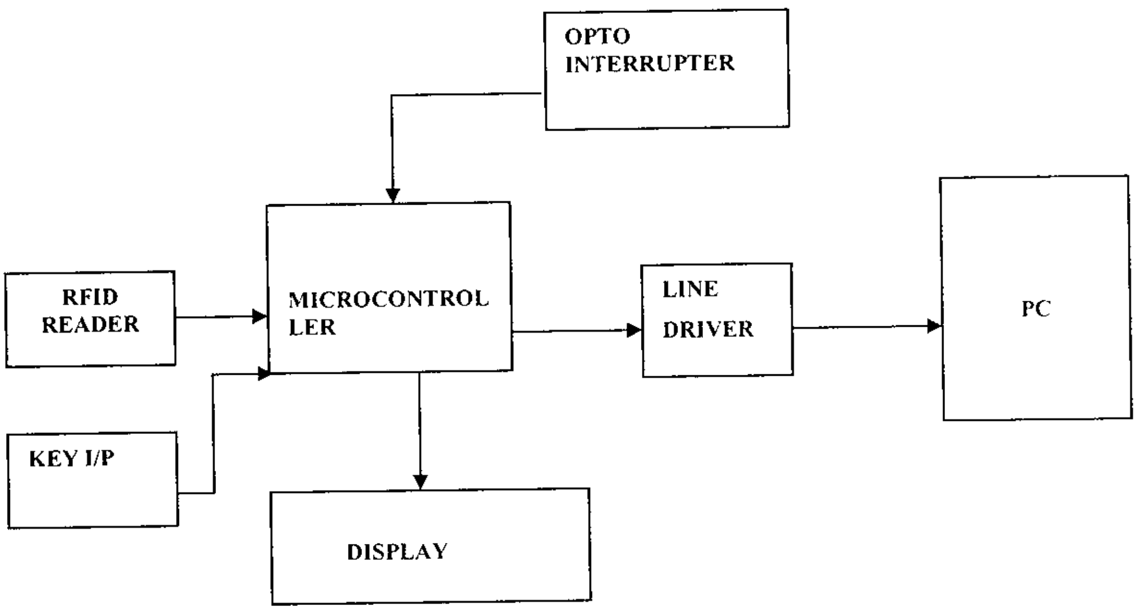


FIG.1.1.Block digram of RFID based petrol bunk automation system

2.2. DESCRIPTION

Overview of Peripheral Interface Controller(16F73)

PIC has Harvard architecture in which the data memory and program memory have separate blocks. The bus width of the program memory is 14-bit and that of data memory is 8-bit. It is a RISC controller with 35 instructions.

In this project PIC 16F73 microcontroller is used which has the peripherals like 4k ROM, 192 Bytes RAM, timers, PWM, A/D, USART etc. A/D is used to convert analog signal into digital. USART is serial communication protocol, which is for Micro controller to mobile communication. PWM is used for speed control and
Timer 0 is used to calculate the speed. These are the basic requirements of this project.

Overview of RFID

RFID uses wireless technology operating with the 50 KHz to 2.5 GHz frequency range. A RFID system consists of a RFID tag or transponder that contains data about the tagged item/object, and antenna, a RF transceiver to generate RF signals, and a RFID reader used for collecting RFID data, which it passes to a host system for processing.

RFID does not require line-of-sight to operate for communications between a tagged object (which could be almost anything including a car, merchandise, package, files etc.) and a reader.

Data encoded on the RFID tag can contain a variety of information about the object including item description through the use of an electronic product code (EPC). The EPC is an electronic representation of a product, which can include information about the product, manufacturer, and uniquely identify the product.

Overview of Transceiver (IC MAX232)

Transceiver is an IC MAX 232. It is a RS 232 transceiver IC. It is popularly known as voltage shifter. It converts CMOS level micro controller data into RS232 level data and vice-versa. It internally consists of voltage doublers and inverters.

Overview of Sensors

In this project Opto Interrupter are used to sense the amount of fuel delivered. Opto interrupter has two parts.

- Transmitter
- Receiver

LED acts as a transmitter and phototransistor works as a receiver.The output control is done using relays.

CHAPTER 3:HARDWARE DESCRIPTION

3. HARDWARE DESCRIPTION

3.1 PERIPHERAL INTERFACE CONTROLLER(16F73)

Introduction

A Single chip microcontroller is obtained by integrating all the components of a microcomputer in one IC package. Hence apart from CPU such a single chip microcomputer will therefore contain its own clock generator and some amount of ROM or EPROM, RAM and I/O ports on the same chip. It may also have other features like timer/counter, USART, PWM, A/D etc., on the chip.

3.1.1 Architecture of PIC Microcontroller (16F73)

Microcontroller is a tiny chip. It has inbuilt memory, timer, ports and other additional features. There are several companies manufacturing the micro controllers like Intel, Motorola and Microchip. PIC is the product of microchip. The following are the special characteristics of PIC. The architecture of PIC microcontroller (16F73) is shown in the figure 3.1. (a).[1]

Features of PIC

1. Long Word Instructions
2. Single Word Instructions
3. Instruction Pipeline
4. Single Cycle Instruction
5. Reduced Instruction Set
6. Register File Architecture
7. Orthogonal (Symmetric) Instructions
8. Instruction Flow/Pipelining

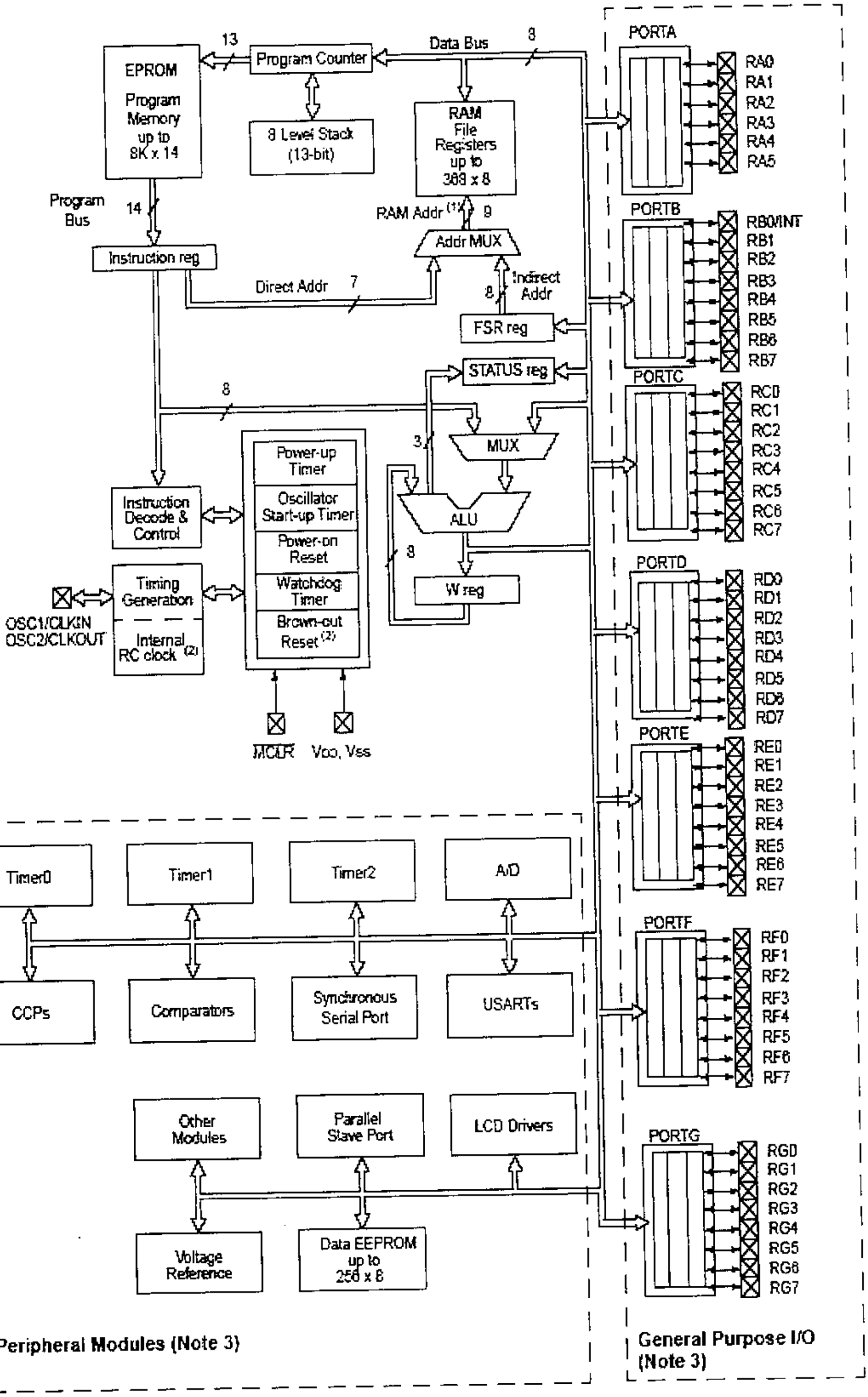


Fig 3.1. (a)Architecture of PIC (16F73)

Arithmetic Logical Unit (ALU)

PIC Micro controllers contain an 8-bit ALU and an 8-bit working register. The ALU is a general-purpose arithmetic and logical unit. It performs arithmetic and Boolean functions between the data in the working register and any register file.

The ALU is 8-bits wide and is capable of addition, subtraction, shift and logical operations. Unless otherwise mentioned, arithmetic operations are two's complement in nature. In two-operand instructions, typically one operand is the working register ('W' register). The other operand is a file register or an immediate constant. In single operand instructions, the operand is either the 'W' register or a file register. The 'W' register is an 8-bit working Register used for ALU operations. It is not an addressable register. Fig 3.2 shows the block diagram of ALU of PIC 16F73 [1].

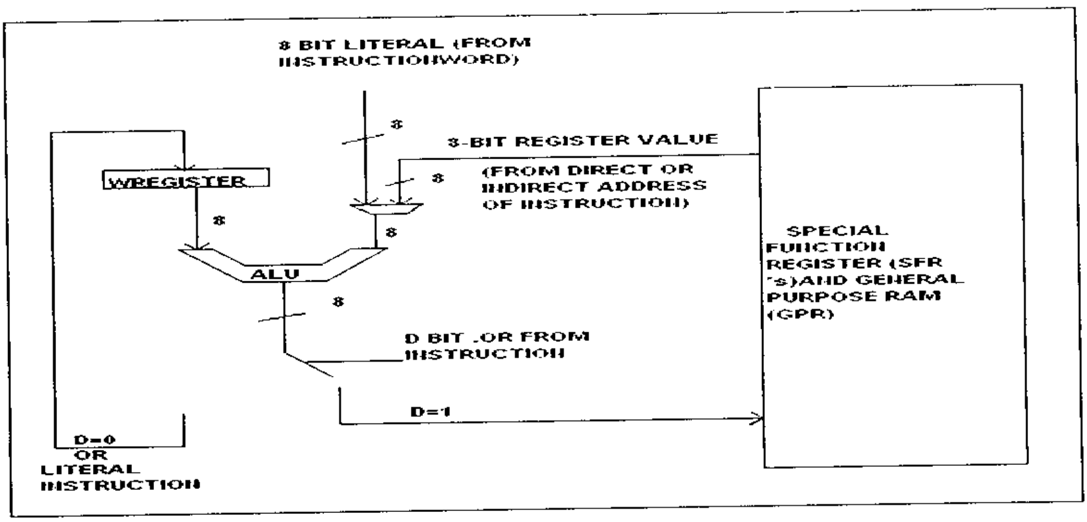


Fig. 3.1. (b) Block diagram of ALU of PIC 16F73

Status Register

The STATUS register contains the arithmetic status of the ALU, the RESET status and the bank select bits for data memory. Since this register controls the selection of the Data Memory banks, it is required to be present in every bank. Also, this register is in the same relative position (offset) in each bank.

The STATUS register can be the destination for any instruction, as with any other register. If the STATUS register is the destination for an instruction that affects the Z, DC or C bits, then the write to these three bits is disabled. These bits are set or cleared according to the device logic. Furthermore, the TO and PD bits are not writable. Therefore, the result of an instruction with the STATUS registers, as destination may be different than intended. For example, CLRF STATUS will clear the upper-three bits and set the Z bit. This leaves the STATUS register as 000u u1uu (where u=unchanged).

It is recommended therefore, that only BCF, BSF, SWAPF and MOVWF instructions be used to alter the STATUS register because these instructions do not affect the Z, C or DC bits from the STATUS register. [6]

IRP	RP1	RP0	T0	PD	Z	DC	C

Bit 7 Bit 0

Bit 7 **IRP:** Register Bank Select bit (used for indirect addressing)

1 = Bank 2, 3 (100h - 1FFh)

0 = Bank 0, 1 (00h - FFh)

For devices with only Bank0 and Bank1 the IRP bit is reserved, always maintain this bit clear.

Bit 6:5 **RP1:RP0**: Register Bank Select bits (used for direct addressing)

11 = Bank 3 (180h - 1FFh)

10 = Bank 2 (100h - 17Fh)

01 = Bank 1 (80h - FFh)

00 = Bank 0 (00h - 7Fh)

Each bank is 128 bytes. For devices with only Bank0 and Bank1 the IRP bit is reserved, always maintain this bit clear.

Bit 4 **TO**: Time-out bit

1 = After power-up, CLRWDT instruction, or SLEEP instruction

0 = A WDT time-out occurred

Bit 3 **PD**: Power-down bit

1 = After power-up or by the CLRWDT instruction

0 = By execution of the SLEEP instruction

Bit2 **Z**: Zero bit

1 = The result of an arithmetic or logic operation is zero

0 = The result of an arithmetic or logic operation is not zero

Bit 1 **DC**: Digit carry/borrow bit (ADDWF, ADDLW, SUBLW, SUBWF instructions) (for borrow the polarity is reversed)

1 = A carry-out from the 4th low order bit of the result occurred

0 = No carry-out from the 4th low order bit of the result

Bit 0 **C**: Carry/borrow bit (ADDWF, ADDLW, SUBLW, SUBWF instructions)

1 = A carry-out from the most significant bit of the result occurred

0 = No carry-out from the most significant bit of the result occurred

3.1.2 MEMORY ORGANIZATION

There are two-memory blocks

1. Program memory
2. Data memory

Each block has its own bus, so that access to each block can occur during the same oscillator cycle. The data memory can further be broken down into

General Purpose RAM,

Special Function Register (SFRs).

Program Memory Organization

Mid-Range MCU devices have a 13-bit program counter capable of addressing an 8K x 14 program memory space. The width of the program memory bus (instruction word) is 14-bits. Since all instructions are a single word, a device with an 8K x 14 program memory has space for 8K of instructions. This makes it much easier to determine if a device has sufficient program memory for a desired application .

Program Counter (PC)

The program counter (PC) specifies the address of the instruction to fetch for execution. The PC is 13-bits wide. The low byte is called the PCL register. This register is readable and writable. The high byte is called the PCH register. This register contains the PC 12:8 bits and is not directly readable or writable. All updates to the PCH register go through the PCLATH register.

Stack

The stack allows a combination of up to 8 program calls and interrupts to occur. The stack contains the return address from this branch in program execution. Mid-Range MCU devices have an 8-level deep x 13-bit wide hardware stack.The stack space is not part of either program or data space and the stack pointer is not readable or writable.The PC is PUSH onto the stack when a CALL instruction is executed or an interrupt causes a branch. The stack is POP in the event of a RETURN,RETLW or a RETFIE instruction execution.PCLATH is not modified when the stack is PUSH or POP[6].

Data Memory Organization

Data memory is made up of the Special Function Registers (SFR) area, and the General Purpose Registers (GPR) area. The SFRs control the operation of the device, while GPRs are the general area for data storage and scratch pad operations. The data memory is banked for both the GPR and SFR areas. The GPR area is banked to allow greater than 96 bytes of general purpose RAM to be addressed. SFRs are for the registers that control the peripheral and core functions.

Banking requires the use of control bits for bank selection. These control bits are located in the STATUS Register (STATUS 7:5). To move values from one register to another register, the value must pass through the W register. This means that for all register-to-register moves, two instruction cycles are required. The entire data memory can be accessed either directly or indirectly. Direct addressing may require the use of the RP1:RP0 bits. Indirect addressing requires the use of the File Select Register (FSR) Indirect addressing uses the Indirect Register Pointer (IRP) bit of the

STATUS register for accesses into the Bank0 / Bank1 or the Bank2 / Bank3 areas of data memory .

Special Function Registers (SFR)

The CPU and Peripheral Modules use the SFRs for controlling the desired operation of the device. These registers are implemented as static RAM. The SFRs can be classified into two sets, those associated with the "core" function and those related to the peripheral functions. Switching between these banks requires the RP0 and RP1 bits in the STATUS register to be configured for the desired bank. A Power-on Reset and other resets initialize some SFRs, while other SFRs are unaffected .

3.1.3 OSCILLATOR

The internal oscillator circuit is used to generate the device clock. The device clock is required for the device to execute instructions and for the peripherals to function. Four clock periods generate one internal instruction clock (TCY) cycle. There are up to eight different modes, which the oscillator may have. There are two mode which allow the selection of the internal RC oscillator clock out (CLKOUT) to be driven on an I/O pin, or allow that I/O pin to be used for general purpose function the device configuration bits select the oscillator mode .The device configuration bits are non volatile memory location and the operating mode is determined by the value written during device programming the RC oscillator option saves system cost while the LP crystal option saves power. Configuration bits are use to select the various option.[1]

3.1.4 PORT CONTROL REGISTERS

PortA and TrisA Register

The RA4 pin is a Schmitt Trigger input and an open drain output. All other port pins have TTL input levels and full CMOS output drivers. All pins have data direction bits (TRIS registers), which can configure these pins as output or input.

Setting a TRISA register bit puts the corresponding output driver in a hi-impedance mode. Clearing a bit in the TRISA register puts the contents of the output latch on the selected pin(s).

PortB and TrisB Register

PORTB is an 8-bit wide bi-directional port. The corresponding data direction register is TRISB. Setting a bit in the TRISB register puts the corresponding output driver in a high-impedance input mode. Clearing a bit in the TRISB register puts the contents of the output latch on the selected pin(s).

PortC and TrisC Register

PORTC is an 8-bit bi-directional port. Each pin is individually configurable as an input or output through the TRISC register. PORTC pins have Schmitt Trigger input buffers. When enabling peripheral functions, care should be taken in defining TRIS bits for each PORTC pin. Some peripherals override the TRIS bit to make a pin an output, while other peripherals override.[7]

3.2 SERIAL PORT STANDARDS

PC communication is established using RS232 protocol. RS232 is a serial protocol mainly used for PC communication. The maximum distance it can run is 15 meters.

3.2.1 RS 232 Connector Pin Assignment

RS 232 connector was originally developed to use 25 pins. In this, pin-out provisions were made for a secondary RS232 communication channel. Now a days, the smaller 9-pin version is most commonly used which is shown in the fig.3.2.1(a) and fig 3.2.1(b).

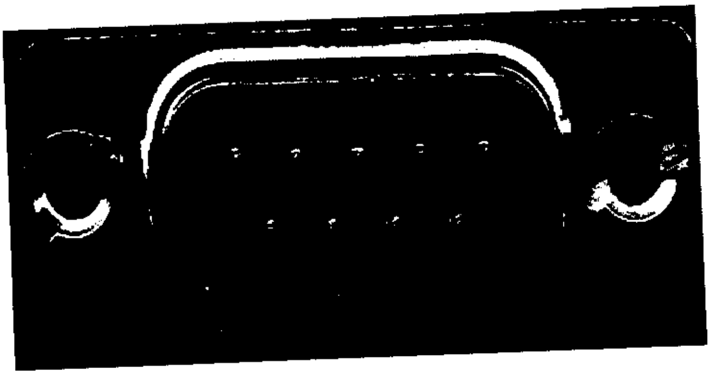
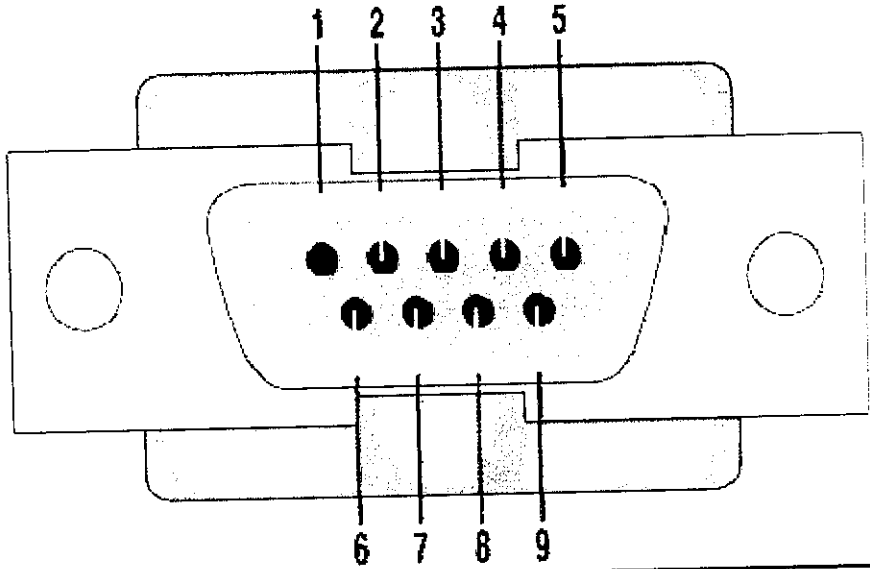


Fig 3.2.1.(a) PC Com Port - EIA-574 RS-232/V.24 pin out on a DB-9 pin Used for Asynchronous Data



Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator
5	Signal Ground		

Fig: 3.2.1(b) Pin out diagram of RS 232 port

Electronic data communications between elements will generally fall into two broad categories, single-ended and differential. RS232 (single-ended) was introduced in 1962, and despite rumors for its early demise, has remained widely used through the industry.

Independent channels are established for two-way (full-duplex) communications. The RS232 signals are represented by voltage levels with respect to a system common (power / logic ground). The "idle" state (MARK) has the signal level negative with respect to common, and the "active" state (SPACE) has the signal level positive with respect to common. RS232 has numerous handshaking lines (primarily used with modems), and also specifies a communications protocol.

The RS-232 interface presupposes a common ground between the DTE and DCE. This is a reasonable assumption when a short cable connects the DTE to the DCE, but with longer lines and connections between devices that may be on different electrical busses with different grounds, this may not be true.

RS232 data is bi-polar.... +3 TO +12 volts indicates an "ON or 0-state (SPACE) condition" while A -3 to -12 volts indicates an "OFF" 1-state (MARK) condition.... Modern computer equipment ignores the negative level and accepts a zero voltage level as the "OFF" state. In fact, the "ON" state may be achieved with lesser positive potential. This means circuits powered by 5 VDC are capable of driving RS232 circuits directly, however, the overall range that the RS232 signal may be transmitted/received may be dramatically reduced.

The output signal level usually swings between +12V and -12V. The "dead area" between +3v and -3v is designed to absorb line noise. In the various RS-232-like definitions this dead area may vary. For instance, the definition for V.10 has a dead area from +0.3v to -0.3v. Many receivers designed for RS-232 are sensitive to differentials of 1v or less.

This can cause problems when using pin-powered widgets - line drivers, converters, modems etc. These types of units need enough voltage & current to power them self's up. Typical USART (the RS-232 I/O chip) allows up to 50ma per output pin - so if the device needs 70ma to run we would need to use at least 2 pins for power. Some devices are very efficient and only require one pin (some times the Transmit or DTR pin) to be high - in the "SPACE" state while idle.

An RS-232 port can supply only limited power to another device. The number of output lines, the type of interface driver IC, and the state of the output lines are important considerations. Data is transmitted and received on pins 2 and 3 respectively[7].

3.2.2 IC MAX 232

This IC is popularly known as a voltage shifter. It's a 16- pin IC used for the PC to microcontroller communication. This IC is connected between router and PC. The voltage level of microcontroller is 0 TO 5 Volts. In order to make communication between PC and microcontroller voltage conversion is essential. MAX 232 achieves this voltage conversion. This internally consists of diodes, logic gates, and capacitors. MAX 232 modifies the voltage level with respect to PC and vice versa. Fig.3.2.2 shows the logic diagram of MAX 232 IC.

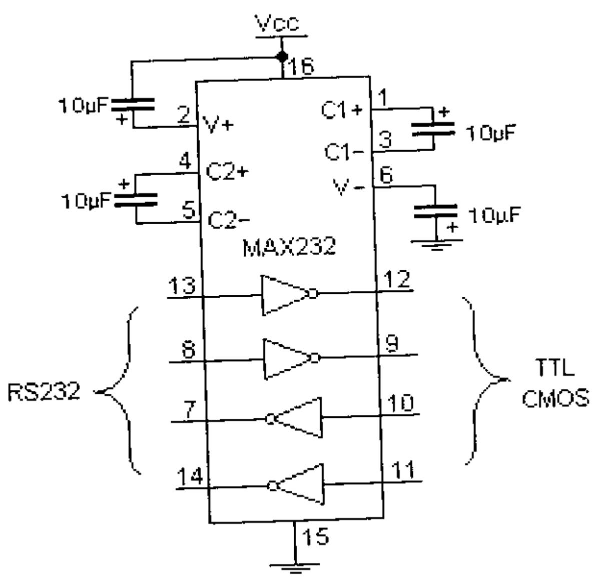


Fig.3.2.2. Logic diagram of MAX232

3.3. RFID SYSTEM

Although it may seem like a new technology, Radio Frequency Identification (RFID) has been around since the 1940's. In fact the United States Air Force first used RF id technology to track friendly aircraft in World War II.

Today, RF id has the potential to dramatically improve many applications in the industrial, transportation and service industries through automatic detection, identification, and control of products and assets. The hope for RFID is to provide supply chain efficiencies, reduced labor costs, and accurate real-time resource information.

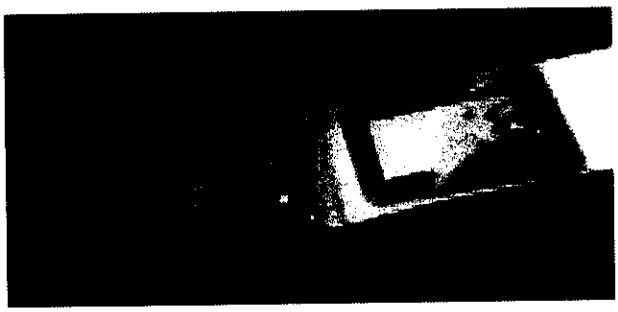


Fig.3.3 (a) Photo Copy of RFID Strip

Definition

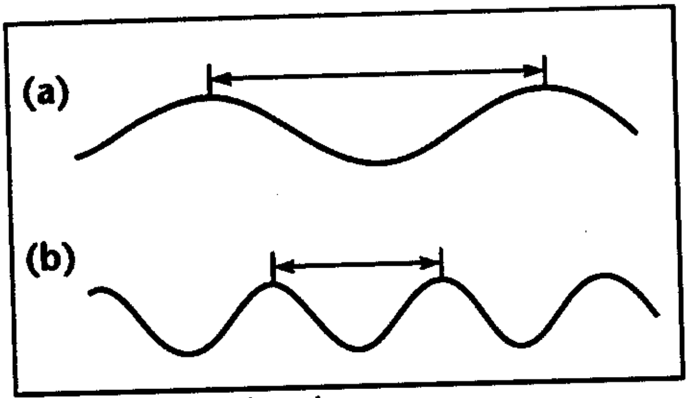
RFID is a term used for any device that can be sensed at a distance by radio frequencies or thereabouts, with few problems from obstruction or mis-orientation. The origins of the term lie in the invention of tags that reflect or re-transmit a radio frequency signal. In its current usage, those working below 300 Hz and those working above 300 MHz, such as microwave (GHz) tags, are included. For example, one type of chip less tag works at 100 Hz and one recent type of battery-driven chip tag works across the range 5.7 – 7.0 GHz, rather than at one frequency. Higher frequencies such as visible and infrared devices are excluded as these systems have very different properties and are frequently sensitive to obscuration, heat, light, and orientation. The term "tag" is used to describe any small device – shapes vary from pendants to beads, nails, labels or micro wires and fibers – that can be incorporated into paper and even special printed inks on, for example, paper[4].

3.3.1. RFID FREQUENCY

To understand RFID, it is necessary to understand Radio Frequency Technology.

Radio Frequency (RF) is all about physics. RF communication works by creating electromagnetic waves at a source and being able to pick up those electromagnetic waves at a particular destination. These electromagnetic waves travel through the air at near the speed of light. The wavelength of an electromagnetic signal is inversely proportional to the frequency; the higher the frequency, the shorter the wavelength.

Frequency is measured in Hertz (cycles per second) and radio frequencies are measured in kilohertz (KHz or thousands of cycles per second), megahertz (MHz or millions of cycles per second) and gigahertz (GHz or billions of cycles per second). Higher frequencies result in shorter wavelengths. The wavelength for a 900 MHz device is longer than that of a 2.4 GHz device.



(a) A Long Wavelength
(b) A Short Wavelength
Note how the length of the wave affects the *frequency* of waves (two versus four in the same space).

Fig.3.3 (b) RFID Frequency

In general, signals with longer wavelengths travel a greater distance and penetrate through, and around objects better than signals with shorter wavelengths.

Imagine an RF transmitter wiggling an electron in one location. This wiggling electron causes a ripple effect, somewhat akin to dropping a pebble in a pond. The effect is an electromagnetic (EM) wave that travels out from the initial location resulting in electrons wiggling in remote locations. An RF receiver can detect this remote electron wiggling.

The RF communication system then utilizes this phenomenon by wiggling electrons in a specific pattern to represent information. The receiver can make this same information available at a remote location; communicating with no wires.In most wireless systems, there are two primary concerns: it must operate over a certain distance (range) and transfer a certain amount of information within a time frame (data rate).

RFID uses wireless technology operating with the 50 KHz to 2.5GHz frequency range. A RFID system consists of a RFID tag or transponder that contains data about the tagged item/object, an antenna, a RF transceiver to generate RF signals, and a RFID reader used for collecting RFID data, which it passes to a host system for processing. RFID does not require line-of-sight to operate for communications between a tagged object (which could be almost anything including a car, merchandise, package, files etc.) and a reader (an electronic device used to capture the RFID signal, as in the picture above).

Data encoded on the RFID tag can contain a variety of information about the object including item description through the use of an electronic product code (EPC). The EPC is an electronic representation of a product, which can include information about the product, manufacturer, and uniquely identify the product[8].

3.3.2. WORKING OF RFID

An RFID tag consists of a microchip and a coiled antenna.RFID tags may be either active or passive. Active tags tend to be larger and more expensive than passive tags as they contain more electronics due to the fact that they actively transmit data to a reader.

In comparison, passive tags draw power from the magnetic field generated between itself and a reader to power its microchip's circuits, allowing it to reflect the RF signal transmitted to it from a reader, adding information by modulating the reflected signal.

Tags can also be either read-only, volatile read/write, or write one/read many. In order for communication to occur between a tag and a reader, they must be tuned to the same frequency. RFID systems can be configured to operate in a variety of frequencies from low to ultra-high frequency (UHF) or even microwave.

Being that RF propagation is different at different frequencies due to power and wave form properties, RFID system configuration must be considered in accordance with the applications that the system is designed to support. For example, low frequency tags are a good choice for applications in which the distance between tag and reader is small (typically less than a foot) as apposed to UHF, which supports applications at greater distances (up to about 20 feet).

Data gathered about the tagged RFID item/object may include its Electronic Product Code (EPC), Location, Physical parameters (temperature, pressure, humidity, etc.), Time Scanned, etc.

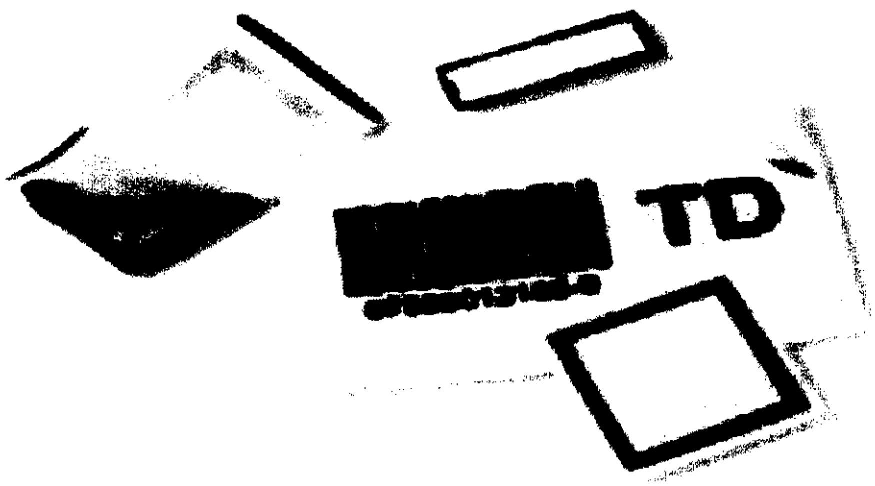


Fig.3.3. (c) Photo Copy of RFID Tags

3.3.3. RFID TAGS

Tags include the following options

- Active or passive tags
- Read-only, read-write or write once
- Short-range or long range

Each option has certain advantages and disadvantages. For example, active tags cost more and are larger, but are a better choice for use with high value goods and/or those that require continuous identification and location. Read-write tags, while expensive compared to read-only, are a good choice for monitoring for security, quality assurance, and/or theft deterrence.

Active tags may either provide active presence or active location information. This means that they can either provide general information about the presence of an object/item or more precise location information. Active location RFID systems support a higher effective read range with greater resolution capabilities, allowing for more precise tag location determination. Read-write tags have reduced range due to the increased signal overhead of the full duplex communications, causing these systems to not perform location determination as well as read-only systems.

Fig.3.3. (d) Photo Copy of RFID Tags Internal View

3.3.4. RFID READER

There is much debate on this particular topic. Keeping in mind that the tag response is a modification of the reflection of the signal it receives (backscatter), there is not much power available to communicate back to the reader. With respect to the signal emitted by the reader, the backscatter response is much closer to the noise floor than the peak reader emissions. Different methods of encoding data are used by a variety of manufacturers, but basically all can be discussed in two types – in-band, and out of band.

In-band responses offer a very discrete channel of operation, which seems on the surface a clean design. However, many issues surround this method making RFID systems difficult to design in general. One large issue is that the reader must emit a very pure tone for a relatively long time so that the tag response(s) can be decoded. The reader, when sending data, is occupying the same frequencies as the tag responses. Unlike typical methods where transmission stops when changing from Tx mode to Rx mode, passive RFID readers must continue to transmit carrier to power the passive tags. Most tag backscatter is relatively low in frequency, and this forces the reader carrier to be extremely clean so as not to interfere with the tag responses. Another issue for design on in-band tag responses is that there must be some wasted time in switching from reader transmit to tag transmit modes, and back again. This time directly and negatively impacts system performance.

Lastly, in attempting to keep the tag response in-band, the data bandwidth must be kept at approximately the same rate as the reader data rate – relatively slow, and it is typically implemented in a digital baseband type encoding (one cycle decode), which is less noise robust than other methods. Frequently, however, there will be products that implement a much higher data rate from the tag to the reader while staying in regulation. This is not as a result that the tag backscatter is 'in channel', but that the tag emissions are not substantial enough to produce prohibited power levels outside the reader channel. These systems are typically more robust as they frequently encode multiple signals to produce a bit – placing a better opportunity for decoding the signal.

Out of band tag responses have many benefits – such as the previous paragraph seems to suggest. Multiple duplicate signals encoded produce a better chance of a proper decodes – Manchester encoding is an excellent example. Even more robust, though, is a particular frequency repeated in the 10's, even 20's of time. This gives a solid 'tone' onto which the reader can lock. 'Tones' can be easily and very discretely decoded while ignoring frequencies both lower and higher –net effect is much more rejection of interfering signals known not to be the desired tag transmissions. The trade-off, though, is obviously time (10x-20x lengthened time frame). Increasing the frequency of the response shows many improvements in overall system design, while keeping in mind that these emissions by the tag are very low in power.

High frequencies allow the reader to receive at the same time it is transmitting -- since it's signature out of band is required to be very low by regulation, tag energy in higher frequencies become larger than reader emissions that can be substantially filtered. This full duplex signaling eliminates time spent changing from reader TX to tag TX and back. The signal also allows for a less expensive reader transmitter since inherent noise can exist in the channel as it does not impact the receiver channel from the tag backscatter. For the same reasons, a reader can be built to receive tag backscatter from a longer distance as compared to some real technology limits of in-band signaling and reader receiver technology.

As it turns out, in-band signaling for backscatter responses offers some large hurdles for reader designs that are not much of a problem for out of band designs. Out of band designs do have to take into account the effect of signals within the target backscatter receiver band, and also the interference of RFID systems into other systems operating in the chosen frequencies. It can easily be shown that RFID readers themselves emit a majority of the radiation that would interfere with their own receiver circuits. Thus placing signals to be received by an RFID reader outside the band in a majority of the cases is a much better condition.

The latter is of concern to regulators; however, the signal strengths need to be discussed as a primary factor over the actual frequency of operation. Signal strengths
of these out of band signals from backscatter devices are confined to the realism that a number of conditions limit the power of backscatter:

The tag cannot reflect 100% of the power received by the reader – backscatter is created by detuning the antenna and this in actuality can only achieve in the 10's of percentages of variance. The smaller the change the better, as tags require as much power absorbed as possible to maintain operational power.Tags are most likely to be located away from the reader antenna by several meters. Reflections from the tag in the first few feet are the only considerably powered out of band signals that could be generated.

Passive tags are quite small circuits, without the ability to regulate power via resistance / heat dissipation design. Instead, the tags will detune the antenna so as not to absorb the excess power. This substantially inhibits the tag's ability to generate large variances of detuning and backscatter power under substantial power conditions (close to the reader).

Backscatter is not a generated precise tone; in real designs it is a sub-modulation of a reflected signal, and more closely resembles a square wave control signal than a pure tone sine wave. Energy is evenly divided into the higher and lower frequencies by nature. The square wave effect further spreads energy out into even higher offset frequencies, but at extremely low levels as opposed to the than confining a majority of energy into a particular frequency.

In reasonable designs, backscatter energy is typically 40-60dB less (a minimum) than an RFID reader's output, and is most likely to be in the range of 'spurious emissions' than an offending signal. In fact, it is entirely likely that a rapidly rotating fan blade produces the same level of reflected signal out of a band as compared to a passive RFID tag. The US regulations (FCC) qualifies a passive radiator as an 'unintentional' radiator as they have investigated the emissions in general to be so trivial.

The US / FCC maintains the position of not requiring any tests of emissions with RFID tags as it is not relevant.

If the backscatter is to be considered in a systematic approach, issues such as distance from reader to tag, and both reader and tag from test equipment receiving antennae must be specified in a test. Additionally, power levels of the reader and of the tag must be specified. And, since tag backscatter produces energy across many frequencies (a result of a more square wave than sine wave modulation), ALL tag types, both in-band and out of band, must conform to these levels.

All things considered, evaluating passive tag backscatter seems much more trouble than it is worth, further supporting the US / FCC viewpoint on the subject and also our recommendation.

3.3.5. RFID vs. OTHER TECHNIQUES

While Universal Product Codes (UPC) used with bar coding systems have provided many benefits, EPC's used with RFID systems are poised to provide increased efficiency and productivity by way of automatic identification and tracking.

Unlike bar code systems, which use a reader and code labels that are attached to the object, RFID uses an electronic tag on the object to acquire an RF signal at an RFID reader. Information is transferred via an optical signal with bar codes as apposed to RF signals with RFID.

Bar codes and RFID tend to be used for different applications. The fact that RFID does not depend on line-of-sight, makes it particularly useful for applications, such as package management, in which the item must be handled many times. Being that standard bar codes typically only contain information about the manufacturer or originator of an item and basic information about the object itself, RFID is particularly useful for applications in which the item must be identified uniquely.

Since RFID uses radio waves rather than optics, RFID can penetrate non-metallic materials, allowing the RFID tag to be embedded or encased within an item or object. In contrast, the bar code must be physically exposed to the surface of the object, and in the case of bar code labels, can fall off the object.

Generally speaking, RFID is a better choice for situations in which there is a need for a lot of handling, such as in a manufacturing and/or moving inventory situations.

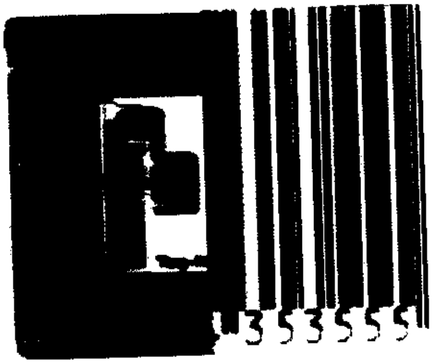


Fig.3.3. (e) RFID Tags VS Barcodes

3.3.6. RFID APPLICATIONS

Applications enabled be RFID systems are limited only by the imagination, but generally fall into the following categories:

- Metering applications such as electronic toll collection
- Telemetry, telemetries, and sensor applications
- Inventory control and tracking such as merchandise control
- Asset tracking and recovery such as computing equipment monitoring
- Tracking parts moving through a manufacturing process
- Payment systems
- Tracking goods in a supply chain

RFID systems can improve CRM systems through inventory control. For example, a customer service person can immediately and authoritatively tell a customer whether a particular merchandise item is in the store and exactly where it is within the store. In addition to the CRM benefit, this can provide a huge benefit in productivity, virtually eliminating the time and expense of employees locating merchandise.

Combining RFID systems with sensor applications enables solutions such as detecting when a uniquely identified object has come into contact with an environment that it should not, such as an area that is too hot, too dusty, to humid, etc. Sensor systems can also provide valuable CRM data via RFID communication such as detecting that car engine needs maintenance when a consumer brings a car in for an oil change.

RFID can be invaluable for applications in which uniquely identifying the item/object is critical due to concern over safety or quality assurance such as management of hazardous materials or manufacturing situations in which quality control depends on precise parts control.

As RFID evolves to allow for standardization and personal RFID readers, various presence-based wireless marketing features will be enabled such as the ability to automatically inform a consumer when they are within the vicinity of a product type that they desire.

RFID and Business Processes

RFID is expected to dramatically improve many different business processes including Supply Chain Management (SCM), Customer Relationship Management (CRM), Manufacturing Resource Planning (MRP), and Enterprise Resource Planning (ERP).

The benefits to SCM are expected to be enormous. By way of example, a study conducted at the University of Florida in 2001 found that $5.8 billion (US) was worth of inventory was lost due to administration errors. The use of RFID for tracking the movements of inventory can easily save hundreds of millions or even billions of dollars.

In general, RFID can be used to improve supply chain integrity, reduce labor costs, provide greater inventory/merchandise visibility, reduce material/product loss, promote vendor-managed inventory control, virtually eliminate the need for physical inventory management, and ensure product authenticity.

In a manufacturing environment, RFID can be used to improve:

- Management of inventory and materials
- Timing and control of critical resources
- Improve Warehouse Management Systems (WMS)

Manufacturing and warehousing processes improved include shipping and receiving, put away processes, picking processes, zone tracking, yard management, and lot tracking.

In a retail environment, RFID can be used to improve:

- Merchandise inventory and ordering processes
- Customer Relationship Management (CRM)
- Merchandise tracking and fraud prevention

While people typically think of only the front-end portion of a RFID system such as tags and readers, the back-end processing systems are critical to fully realize the benefits of RFID. Front-end RFID sub-systems can capture and report an enormous amount of data. Back-end subsystems must process the data and manage it in a way that it becomes useful information. Back-end RFID sub-systems must manage the interface to and communications with various consuming applications and processes such as inventory management and tracking, ordering, shipping and receiving.

3.3.7. RFID IMPLEMETATION ISSUES

RFID Privacy Issues

Some consumer and privacy advocacy groups fear that RFID will take away personal privacy through exploiting the use of RFID to monitor peoples' movements and behaviors without their knowledge or consent, for example, by tracking them via RFID tags in their clothes. While there may be some legitimate concern about RFID privacy, this type of issue is not well founded, as it would require satellite-based tracking, which while possible, is not practical for commercial consumer operations such as consumer market research. Still, some groups are making a lot of noise about this issue.

Implementation and Operational Issues.

Since radio waves bounce off metal and are absorbed by water, RFID tags may not be embedded within metal objects or items with high water content. This can be overcome by using lower frequency tags, which have better penetration capabilities. However, low frequency tags also require a clearer signal path between the tag and the reader, but not as close as bar codes.

Readers are often designed to support time division multiplexing to prevent the signal from one reader interfering with the signal from another reader known as tag collision. Designing RFID systems to capture signals from individual tags in a serial fashion prevents reader collision.

RFID Standardization

Whereas closed loop systems, such as military or toll reading systems do not necessarily require standards-based approaches, most commercial open loop systems will benefit from standards-based implementation. RFID standards affect the format and content of tag codes, protocols and frequencies for tags and readers, security procedures and applications.

As a means of promoting widespread adoption, the basic structure of the Electronic Product Code (EPC) is patterned after the Global Trade Item Number (GTIN) scheme. The EPC standard framework consists of 96 bits of information with a unique naming scheme. The Header, containing 8 bits, defines the number, type and length of all subsequent data. The EPC Manager consists of 28 bits, which identifies the originating entity (manufacturer) of the object/item. The Object Class, containing 24 bits, acts as the tracking mechanism for specific groups such as lot number. The final frame, the Object Identification Number, consists of 36 bits that uniquely identify the object/item.

The Physical Markup Language (PML), based on XML, is used in the RFID database registration and lookup process represents a new standard language for describing physical objects. Standards organizations for bar codes have historically been the EAN and the UCC. Going forward, EPC global will be leading the charge for RFID standardization.

Low Cost RFID

In the past few years, the term "low cost RFID" has begun to be used, and this may seem an artificial distinction at first sight. However, low cost RFID tags, typically taken as those costing less than one dollar each for up to 1 meter range and less than $5 above that, are different from conventional tags in several important respects. These differences mean that low cost RFID tags can be applied in very different, new applications and interest very different groups of suppliers and end users. This alternative to the barcode, magnetic stripe or printed label has advantages that include tolerance of mis-orientation and obscuration, lower cost over life and ability to "read". Most importantly, they are usually cheap enough to be disposable and thin enough to go in new locations, even inside sheets of paper in some cases, so all flat versions, including smart tickets and laminates, are usually called smart labels.

Almost all conventional RFID devices contain a transistor circuit employing a microchip. By contrast, the potential in low cost RFID is split between chip-based technologies and "chip less" tags. Chip less tags can still be interrogated through a brick wall and hold data but most are cheaper and more primitive in electronic performance than chip tags[2].

3.4. OPTO INTERRUPTER

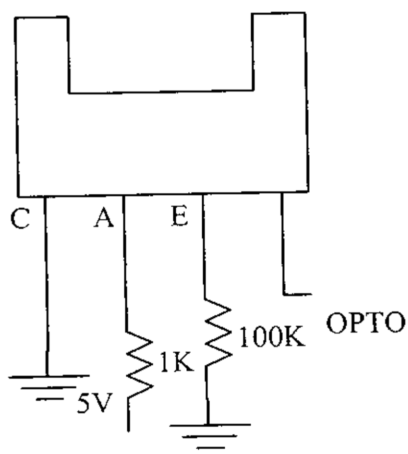
This is a subminiature photo reflector whose GaAs infrared emitting diode and silicon transistor are assembled in the same package allowing for easy installation and handling. This has an excellent S/N ratio (more than 40dB) and contains a built–in filter for cutting visible light

It's an optical sensor. Opto interrupter has two parts.

Transmitter.

Receiver.

LED acts as a transmitter and phototransistor works as a receiver. If the light ray emitted by a LED is interrupted, it will produce one pulse, which is given to PIC. This Opto interrupter circuit is utilized for counting the number of out coming products.



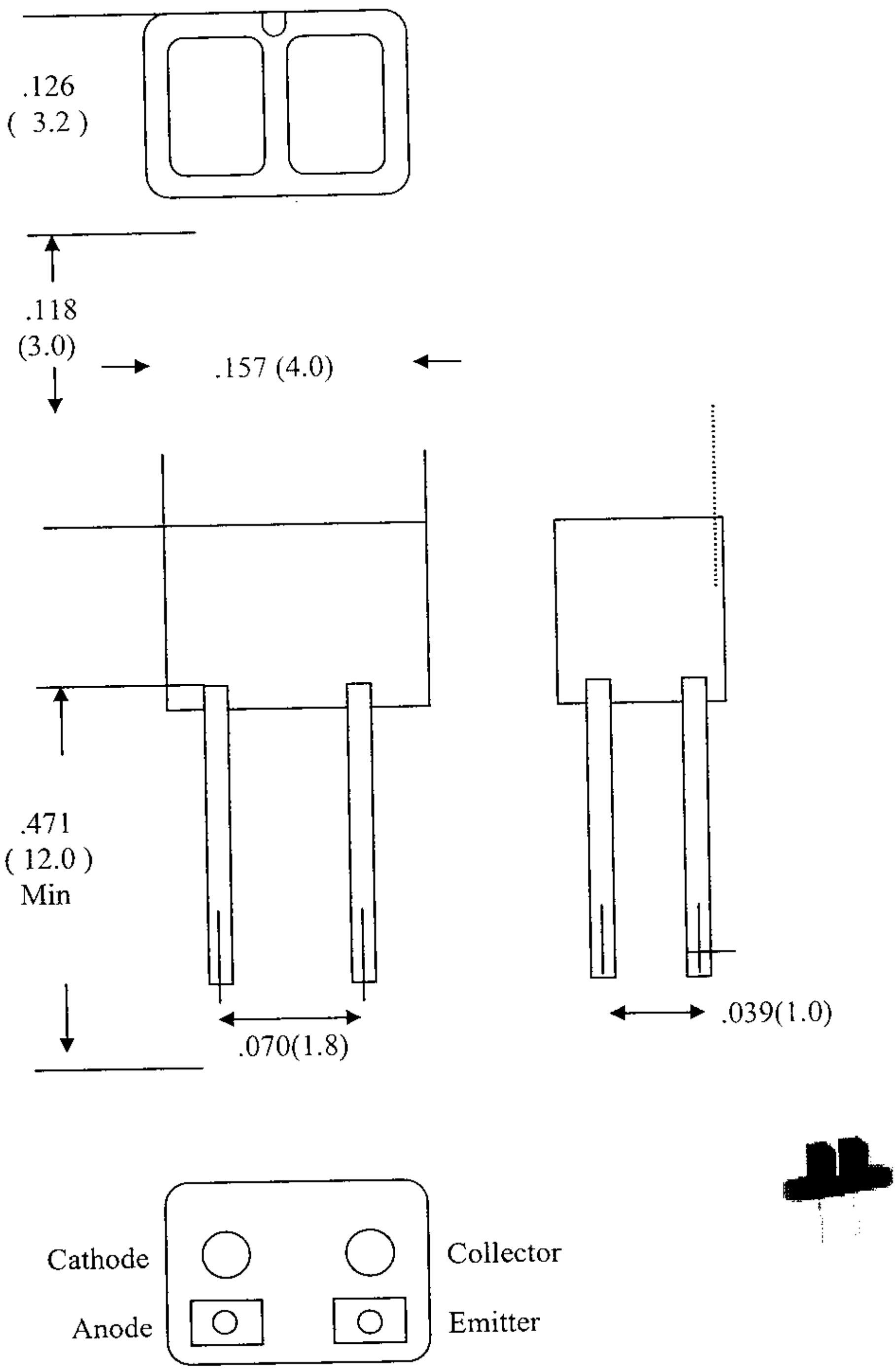


Fig.3.4 (b) Internal and external diagram of opto interrupter

3.5. SEGMENT DISPLAY

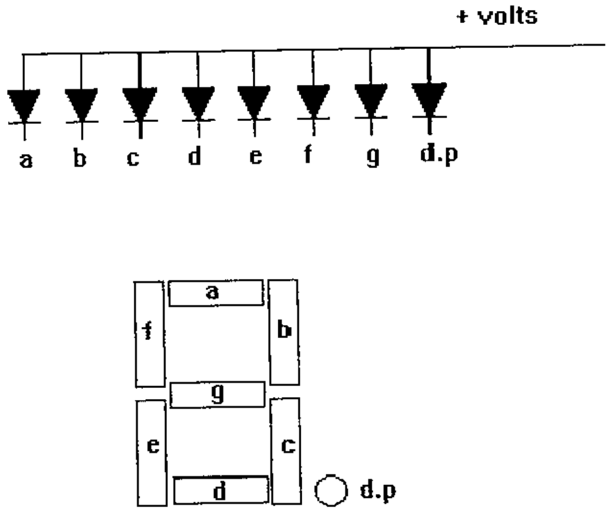


Fig.3.5 Seven segment display

The 7 segment display is used as a numerical indicator on many types of test equipment. It is an assembly of light emitting diodes which can be powered individually. They most commonly emit red light.

They are arranged and labeled as shown in the diagram. Powering all the segments will display the number 8. Powering a, b, c, d and g will display the number 3.Numbers 0to9 can be displayed. The d.p represents a decimal point.

The one shown is a common anode display since all anodes are joined together and go to the positive supply. The cathodes are connected individually to zero volts.

Resistors must be placed in series with each diode to limit the current through each diode to a safe value. Early wrist watches used this type of display but they used so much current that the display was normally switched off. To see the time you had to push a button.

Common cathode displays where all the cathodes are joined are also available. Liquid crystal displays do a similar job and consume much less power. Alphanumeric displays are available which can show letters as well as numbers[7].

3.6. POWER SUPPLY

Since all electronic circuits work only with low DC voltage, a power supply unit is needed to provide the appropriate voltage supply. This unit consists of transformer, rectifier, filter and regulator. AC voltage typically 230V is connected to a step down transformer. The output of transformer is given to the bridge rectifier and then a simple capacitor filter to produce a DC voltage initially filters it. This DC voltage is given to regulator, which gives a constant DC voltage. The Power supply unit and the Circuit diagram of GSM based process control system is shown in Figures 4.1 and 4.2 respectively.

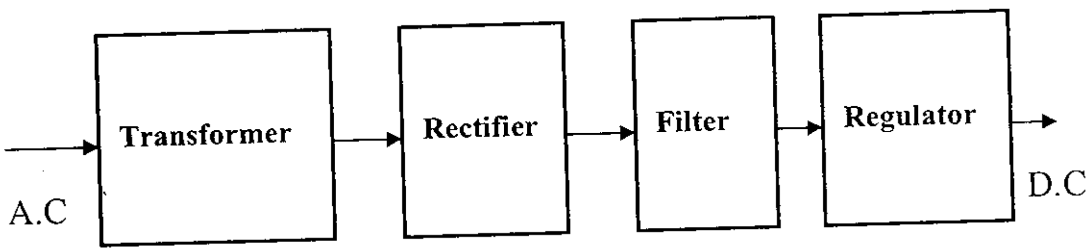


Fig. 3.6.Power supply unit

Transformer

A transformer is a static piece of which electric power in one circuit is transformed into electric power of same frequency in another circuit. It can raise or lower the voltage in a circuit but with corresponding decrease or increase in current. Step down transformer have been used for providing a necessary supply for the electronic circuits. In this project 230/12V transformer is used.

Rectifier

The DC level obtained from a sinusoidal input can be improved 100% using a process called full wave rectification. It uses four diodes in a bridge configuration. From the bridge configuration two diodes (D2 & D3) are conducting when the other two diodes (D1 & D4) are in off state. Accordingly for the negative of the input the conducting diodes are D1 & D4. Thus the polarity across the load is the same.

Filter

The filter circuit used here is capacitive filter circuit. This is connected at the rectifier output and the DC is obtained across it. The filtered waveform is essentially a DC voltage with negligible ripples.

Regulator

Regulator IC units contain the circuitry for reference source, comparator amplifier, control device and over load protection in a single IC. Although the internal construction of the IC is somewhat different from that described for discrete voltage regulator circuits, the external operation is the same. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, are an adjustably set voltage.

A power supply can be built using a transformer connected to the AC supply line to step the AC voltage to the desired amplitude. It is then rectified, filtered with the capacitor and finally regulating the dc voltage using an IC regulator. The regulators can be selected for operation with load currents from hundreds of milliamperes to tens of amperes, corresponding to power ratings from milliwatts to tens of watts.

The seven-segment display is connected to the microcontroller's PORTB pin numbers 21-28, key i/p are connected to PORTA pin numbers 2 – 5. By using the keys the amount of fuel to be vended is selected. The amount of fuel dispensed is sensed using a Opto Interrupter which is connected to pin number 6 of microcontroller. After selecting the amount of fuel to be vended the user has to swipe his RFID card for Identity (mean time the processor reads the ID no in the card and adds the qty to his cart.) then start key has to be pressed to start the vending. Once the qty reaches the set level then the machine stops. The processor sends the collected data from the card and sends it to the PC. At the end of the day the total qty vended, the qty vended by the individual the amount to be paid are all displayed in the PC.

The communication between microcontroller, PC and RFID reader is established using universal synchronous asynchronous receiver and transmitter (USART). It is a serial communication protocol. Pin 17 is used for transmission and pin 18 is used for reception. The transmission pin and the reception pin of microcontroller are connected to the corresponding transmit and receive pin of IC MAX 232 and then it is connected to the corresponding transmit and receive pin of PC'sserial port and RFID respectively.

CHAPTER 4:SOFTWARE DESCRIPTION

4. SOFTWARE DESCRIPTION

4.1 SOFTWARE TOOLS USED

1. MPLAB - IDE (Integrated Development Environment).
2. HITECH-C - Cross compiler.
3. PROPIC - PIC Programmer.
4. PROTEL - PCB Designing software
5. VB - Front end tool

4.2. VISUAL BASIC®

Visual Basic® 6.0 is a programming language used to create windows based application. VB makes it very easy to get user interface portion of this application. Forms are windows upon which the user interface is built and controls are the building blocks (interfacing tools) of this user interface. Controls used in this project are text box, command buttons, MScomm. Text box is used to display information to the user. Command buttons respond to user action.

MScomm communicates with control device through RS232. When the vehicle is to be moved to a specific location, the calculations performed are sent through MScomm and similarly position reached is then received and it is updated.

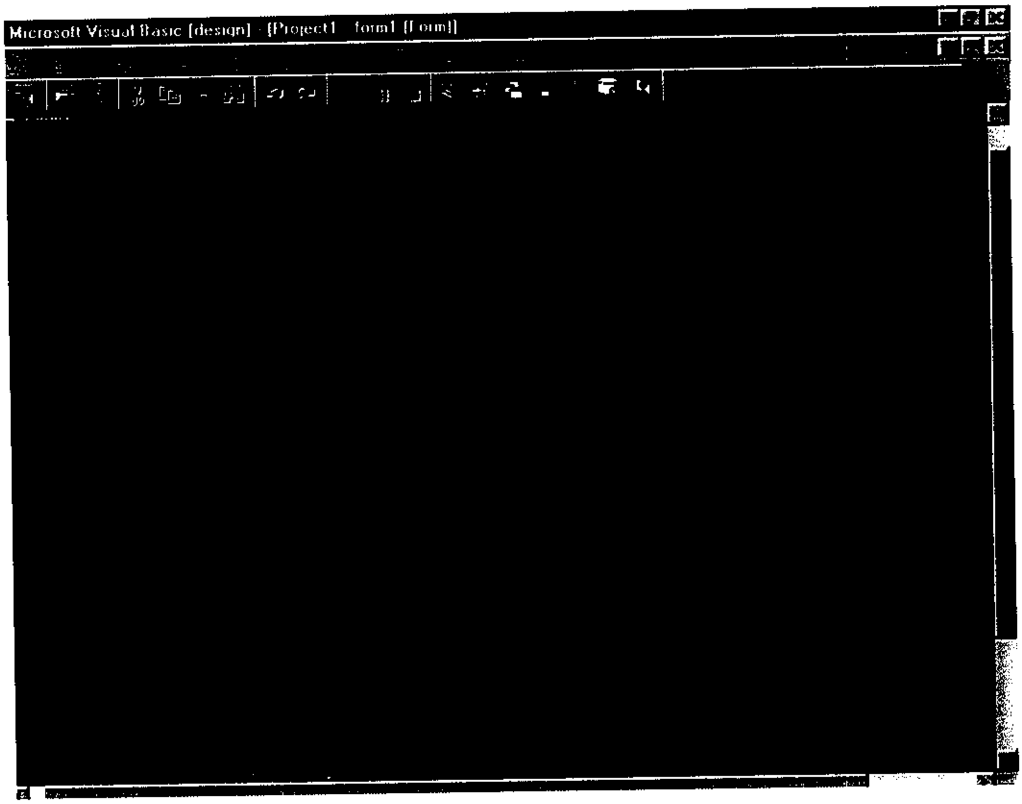


Fig 4.2 VB output form

4.3 PROPIC

PROPIC software helps to burn the PIC. The program is converted into HEX code and it is loaded in the software. The oscillator type is also mentioned in the software (i.e.) XT, AT, etc. The power up timer (PWRTE) is switched on. The PIC is placed in the programming kit and the PIC is burned with the program. It gives security for the code which we have burned by selecting the code protection option.

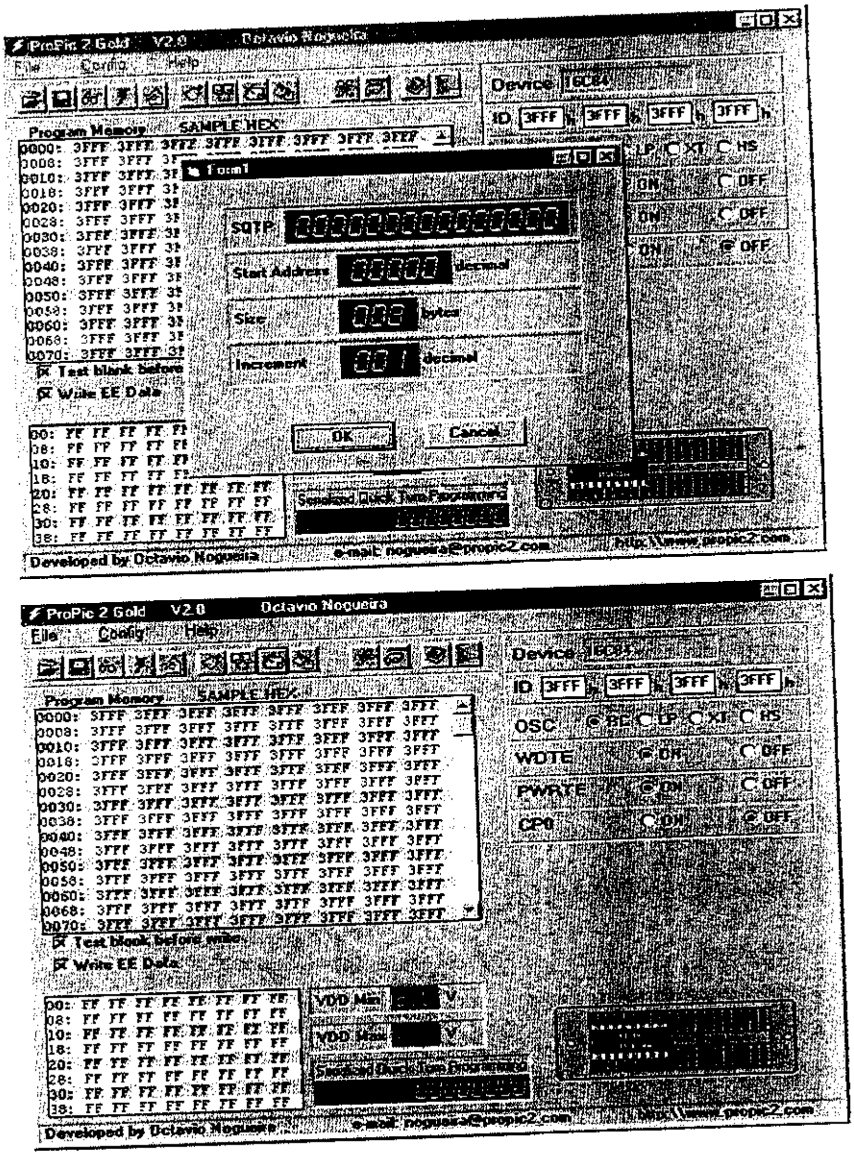


Fig 4.3 Screenshot of PROPIC Software

4.4 MPLAB

To make working with the PIC microcontroller even easier, Microchip provides an excellent group of software it is called MPLAB IDE. MPLAB IDE is a software program that runs on a PC to develop applications for Microchip microcontrollers. It is called an Integrated Development Environment, or IDE, because it provides a single integrated "environment" to develop code for embedded microcontrollers. MPLAB IDE contains a text editor, assembler (MPASM assembler) and simulator (MPSIM) and this stuff will run under DOS or WINDOWS. With MPLAB IDE in hand we can write the program using the included text editor, and then assemble it with the MPASM assembler program. The MPASM assembler will develop the code format (HEX) that the PIC Microcontroller wants that code can then be burned into a PIC with the programmer.

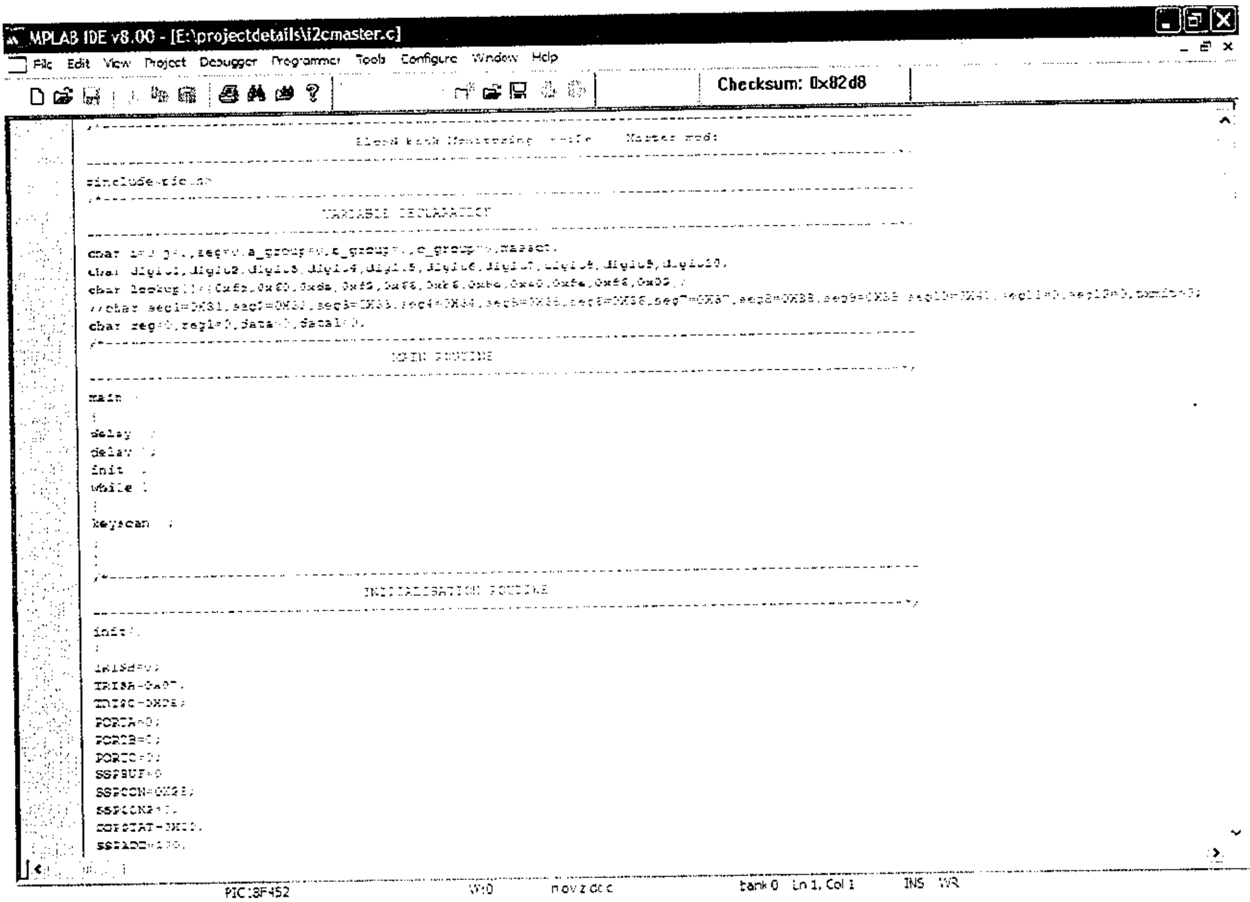


Fig 4.4 Screenshot of MPLAB Software

4.5. PIC PROGRAMMING

4.5.1. USART

USART is the abbreviation for Universal synchronous asynchronous receiver transmitter. It is a serial protocol, which makes the communication between PC–to-router and router-to-RTUs. Fundamentally, protocol is nothing but a rules and regulations derived for the communication[6],[7] .

CONTROL REGISTERS

TXSTA: Transmit Status and Control Register

CSRC	TX9	TXEN	SYNC	-------	BRGH	TRMT	TX9D

bit 7 Bit 0

bit 7 **CSRC:**Clock Source Select bit

Asynchronous mode

Don't care

Synchronous mode

1 = Master mode (Clock generated internally from BRG)

0 = Slave mode (Clock from external source)

bit 6 **TX9**: 9-bit Transmit Enable bit

1 = Selects 9-bit transmission

0 = Selects 8-bit transmission

bit 5 **TXEN**: Transmit Enable bit

1 = Transmit enabled

0 = Transmit disabled

bit 4 **SYNC**: USART Mode Select bit

1 = Synchronous mode

0 = Asynchronous mode

bit 3 **Unimplemented:** Read as '0'

bit 2 **BRGH**: High Baud Rate Select bit

Asynchronous mode

1 = High speed

0 = Low speed

Synchronous mode

Unused in this mode

bit 1 **TRMT**: Transmit Shift Register Status bit

1 = TSR empty

0 = TSR full

bit 0 **TX9D:**

9th bit of transmit data. Can be parity bit

RCSTA: Receive Status and Control Register

SPEN	RX9	SREN	CREN	-----	FERR	OERR	RX9D
bit 7							bit0

bit 7 **SPEN:**Serial Port Enable bit

1 = Serial port enabled (Configures RX/DT and TX/CK pins as serial port pins)

0 = Serial port disabled

bit 6 **RX9**: 9-bit Receive Enable bit

1 = Selects 9-bit reception

0 = Selects 8-bit reception

bit 5 **SREN**: Single Receive Enable bit

Asynchronous mode

Don't care

Synchronous mode - master

1 = Enables single receive

0 = Disables single receive

This bit is cleared after reception is complete.

Synchronous mode - slave

Unused in this mode

bit 4 **CREN** : Continuous Receive Enable bit

Asynchronous mode

1 = Enables continuous receive

0 = Disables continuous receive

Synchronous mode

1 = Enables continuous receive until enable bit CREN is cleared (CREN overrides SREN)

0 = Disables continuous receive

bit 3 **Unimplemented:**

Read as '0'

bit 2 **FERR**: Framing Error bit

1 = Framing error (Can be updated by reading RCREG register and receive next valid byte)

0 = No framing error

bit 1 **OERR**: Overrun Error bit

1 = Overrun error (Can be cleared by clearing bit CREN)

0 = No overrun error

bit 0 **RX9D**

9th bit of received data can be parity bit.

BAUD RATE REGISTER

Baud rate (Bits/second) register is used to set the speed of USART communication.

Block diagram of USART Transmitter

The Block diagram of USART transmitter is shown in Fig. 4.5.1(a).

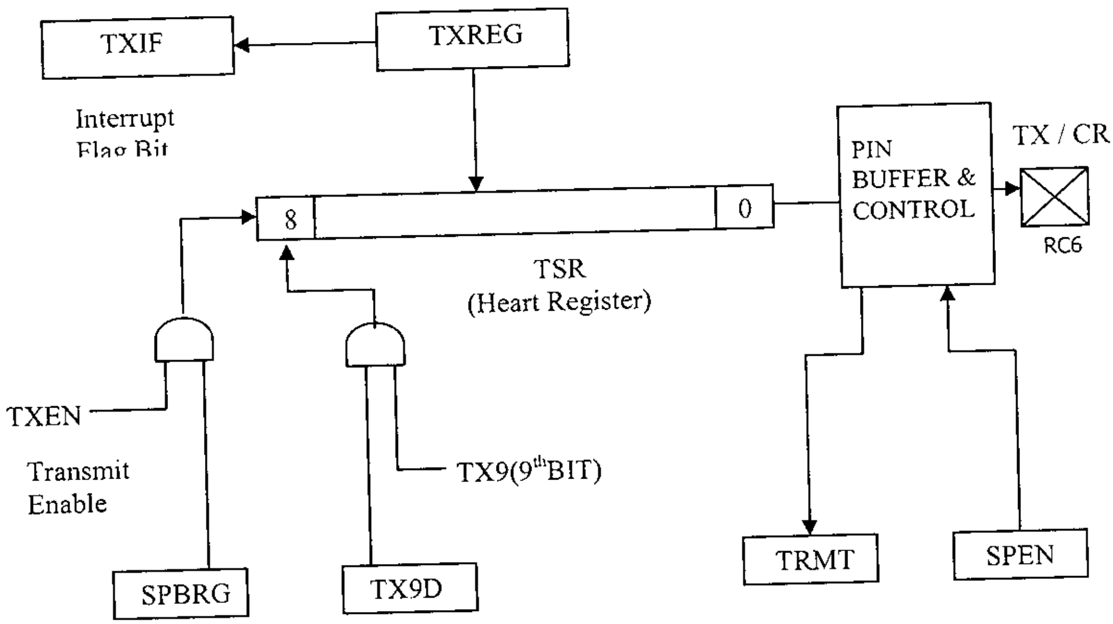


Fig 4.5.1(a). Block diagram of USART Transmitter

Procedure for USART transmission

1. The seventh pin (RC6) of the PortC is dedicated for USART transmission. So, it is assigned as input by setting seventh pin of Tris C
2. Baud rate for communication is set by SPBRG register. For that decimal value of twenty-five is move on to SPBRG.

3. Bit SPEN is set to one (This is available in RCSTA) to enable serial data communication.
4. Sending data 0x20 configures transmission control register TXSTA.
5. In this register only TXEN pin is set to one to initiate transmission.
6. Require data is moved to the TXREG.
7. Finally TRMT pin is checked to know the transmission is completed or not

Block diagram of USART Receiver

The block diagram of USART receiver is shown in fig 4.5.1(b)

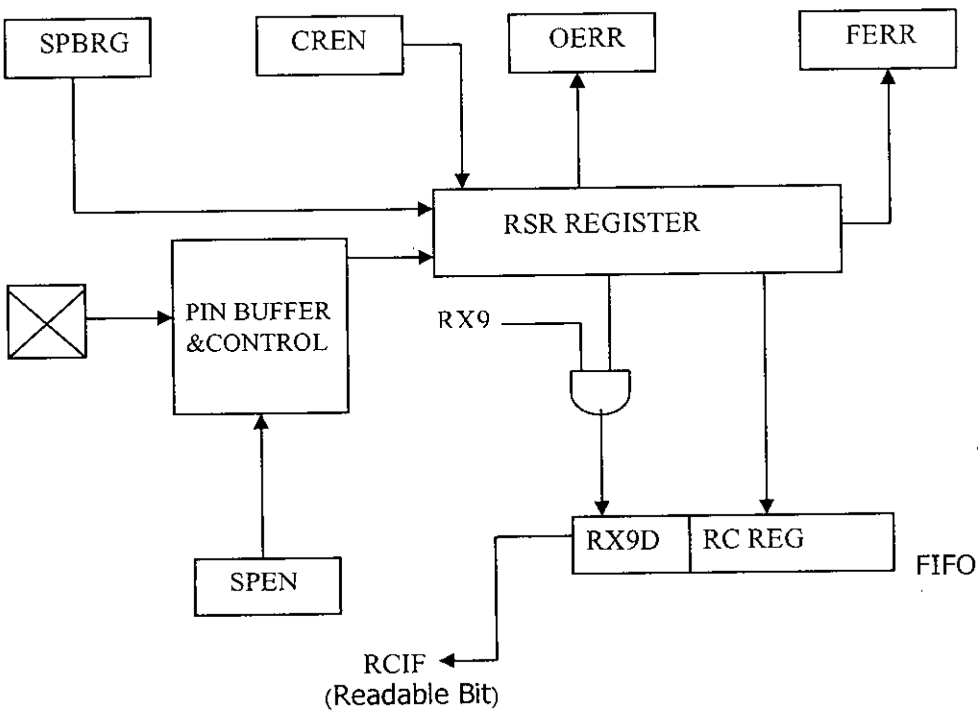


Fig 4.5.1(b) Block diagram of USART Receiver

Procedure for USART reception

1. The eighth pin (RC7) of the Port C is dedicated for USART reception. So, it is assigned as input by setting seventh pin of TrisC.
2. Baud rate for communication is set by SPBRG register. For that decimal value of twenty-five is move on to SPBRG.
3. Bit SPEN is set to one (This is available in RCSTA) to enable serial data communication.
4. The bit CREN (Continues receive enable bit) is set to one to enable continues data reception.
5. Poll the RCIF flag (flag in the PIR 1 register) to check either the reception is completed or not.

4.5.2 COUNTING PROCESS

Control Register

The OPTION_REG register is a readable and writable register, which contains various control bits to configure the TMR0/WDT prescaler, the External INT Interrupt, TMR0, and the weak pull-ups on PORTB.

OPTION_REG Register

To achieve a 1:1 prescaler assignment for the TMR0 register, assign the prescaler to the Watchdog Timer.

bit 7 **RBPU(1):**Weak Pull-up Enable bit

1 = Weak pull-ups are disabled

0 = Weak pull-ups are enabled by individual port latch values

bit 6 **INTEDG**: Interrupt Edge Select bit

1 = Interrupt on rising edge of INT pin

0 = Interrupt on falling edge of INT pin

bit 5 **T0CS**: TMR0 Clock Source Select bit

1 = Transition on T0CKI pin

0 = Internal instruction cycle clock (CLKOUT)

bit 4 **T0SE**: TMR0 Source Edge Select bit

1 = Increment on high-to-low transition on T0CKI pin

0 = Increment on low-to-high transition on T0CKI pin

bit 3 **PSA**: Prescaler Assignment bit

1 = Prescaler is assigned to the WDT

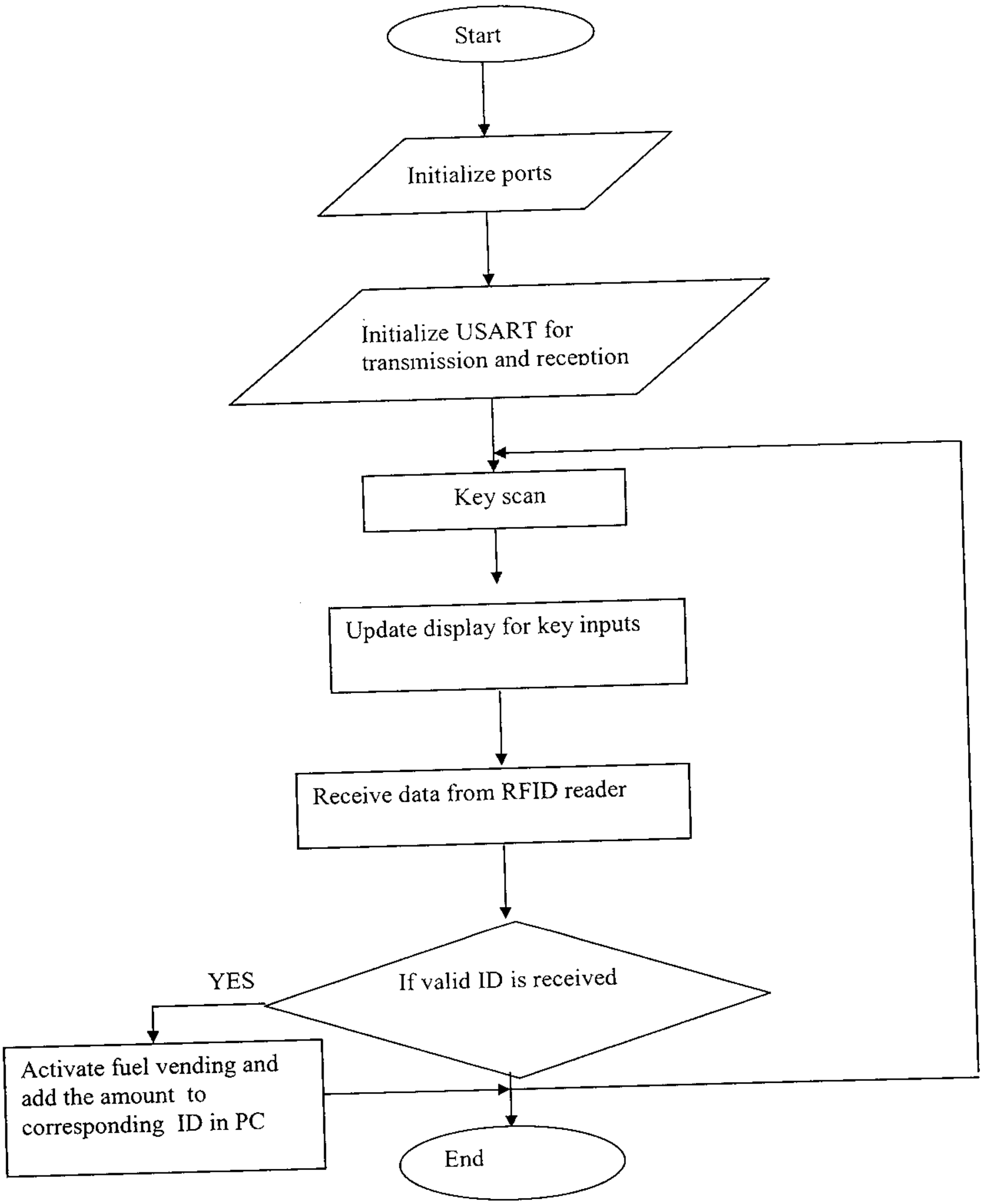
0 = Prescaler is assigned to the Timer0 module

bit 2:0 **PS2:PS0**: Prescaler Rate Select bits

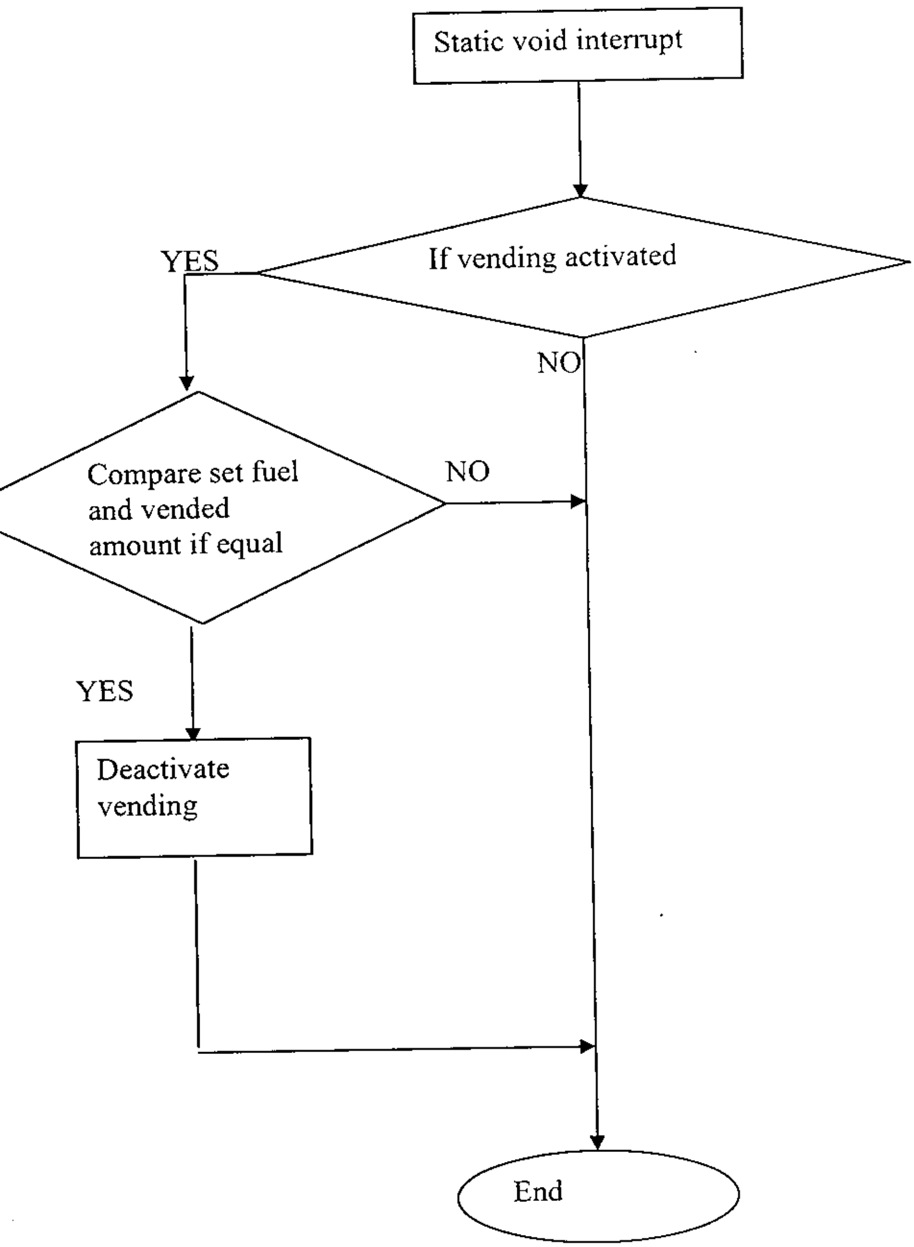
Bit Value	TMRO Rate	WDT Rate
0 0 0	1 : 2	1 : 1
0 0 1	1 : 4	1 : 2
0 1 0	1 : 8	1 : 2
0 1 1	1 : 16	1 : 8
1 0 0	1 : 32	1 : 16
1 0 1	1 : 64	1 : 32
1 1 0	1 : 128	1 : 64
1 1 1	1 : 258	1 : 128

CHAPTER 5:FLOWCHART OF OPERATION

5. FLOWCHART OF OPERATION OF RFID BASED FUEL VENDING SYSTEM



FLOW CHART OF OPERATION



CHAPTER 6: CONCLUSION

6.CONCLUSION

Thus if the concept of automated fuel vending system is implemented it is clear that the present difficulties in the vending system can be avoided and this industry can reach tremendous heights. This system brings out the functionality appropriately as well as to reduce the cost factor so that this application can be implemented at any level. Some of the important advantages that can be obtained by implementing this system are listed below.

- Man power is reduced due to automation.
- Cost centralization can be subjected effectively.
- Automatic billing can be provided.
- Risks of handling direct cash transactions can be avoided.
- Total capital investment of the project can be reduced.
- 24hrs service can be provided at any cause.

CHAPTER 7:FUTURE ENHANCEMENTS

7. FUTURE ENHANCEMENTS

This project can be further extended to completely automate fuel filling stations. By using high range radio frequency identification, the system can be designed, so that it automatically identify customers, who have set up credit or debit accounts with the issuer and charge them for their purchases. The RFID payment systems automatically deduct money for purchases from prepaid accounts or charge them to a personal account.

Further, by using robotic arms filling of fuel can be automated. With the help of a robotic arm, we can make the arm to extend the fuel nozzle into the tank opening of automobiles and to begin the actual filling process. Centralised monitoring within one gas station can be extended to cover many filling stations with the help of latest communication technology.

APPENDIX A

MICROCHIP

PIC16F7X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

Devices Included in this Data Sheet:

- PIC16F73
- PIC16F74
- PIC16F76
- PIC16F77

High Performance RISC CPU:

- 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)
- Pinout compatible to the PIC16C73B/74B/76/77
- Pinout compatible to the PIC16F873/874/876/877
- Interrupt capability (up to 12 sources)
- Eight level deep hardware stack
- Direct, Indirect and Relative Addressing modes
- Processor read access to program memory

Special Microcontroller Features:

- 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
- In-Circuit Serial Programming™ (ICSP™) via two pins

Peripheral Features:

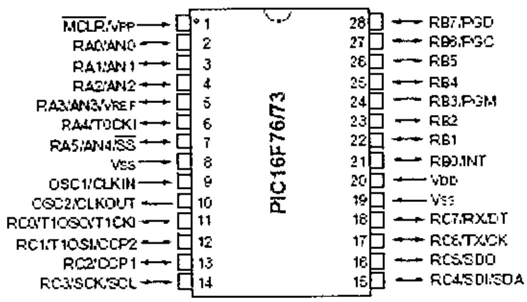
- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during SLEEP via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- 8-bit, up to 8-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I²C™ (Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI)
- 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)

CMOS Technology:

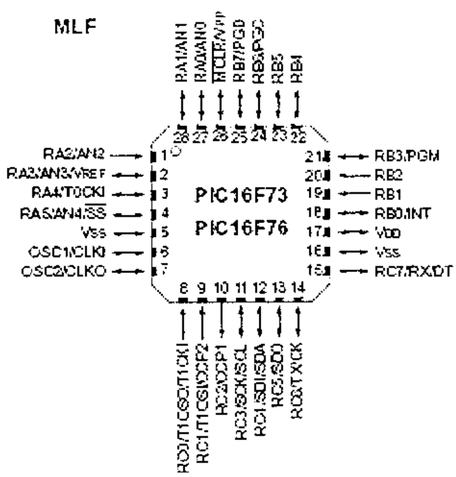
- Low power, high speed CMOS FLASH technology
- Fully static design
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Industrial temperature range
- Low power consumption:
  - < 2 mA typical @ 5V, 4 MHz
  - 20 μA typical @ 3V, 32 kHz
  - < 1 μA typical standby current

Pin Diagrams

DIP, SOIC, SSOP



MLF



PDIP

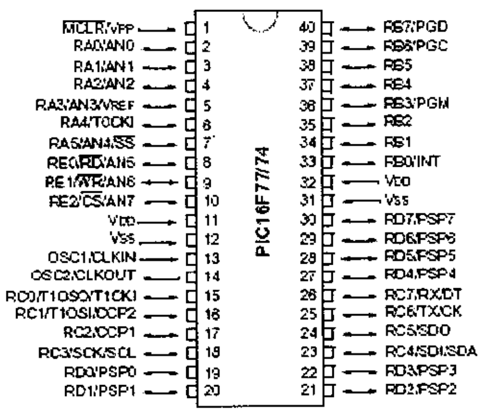


TABLE 1-1: PIC16F7X DEVICE FEATURES

Key Features	PIC16F73
Operating Frequency	DC - 20 MHz
RESETS (and Delays)	POR, BOR (PWRT, OST)
FLASH Program Memory (14-bit words)	4K
Data Memory (bytes)	192
Interrupts	11
I/O Ports	Ports A,B,C
Timers	3
Capture/Compare/PWM Modules	2
Serial Communications	SSP, USART
Parallel Communications	—
8-bit Analog-to-Digital Module	5 Input Channels
Instruction Set	35 Instructions
Packaging	28-pin DIP 28-pin SOIC 28-pin SSOP 28-pin MLF

1.0 DEVICE OVERVIEW

This document contains device specific information about the following devices:

- PIC16F73
- PIC16F74
- PIC16F76
- PIC16F77

PIC16F73/76 devices are available only in 28-pin packages, while PIC16F74/77 devices are available in 40-pin and 44-pin packages. All devices in the PIC16F7X family share common architecture, with the following differences:

- The PIC16F73 and PIC16F76 have one-half of the total on-chip memory of the PIC16F74 and PIC16F77
- The 28-pin devices have 3 I/O ports, while the 40/44-pin devices have 5
- The 28-pin devices have 11 interrupts, while the 40/44-pin devices have 12
- The 28-pin devices have 5 A/D input channels, while the 40/44-pin devices have 8
- The Parallel Slave Port is implemented only on the 40/44-pin devices

The available features are summarized in Table 1-1. Block diagrams of the PIC16F73/76 and PIC16F74/77 devices are provided in Figure 1-1 and Figure 1-2, respectively. The pinouts for these device families are listed in Table 1-2 and Table 1-3.

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.

TABLE 1-2: PIC16F73 AND PIC16F76 PINOUT DESCRIPTION

Pin Name	DIP SSOP SOIC Pin#	MLF Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKI	9	6		ST/CMOS(3)	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	10	7		—	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.
$\overline{MCLR}$/VPP	1	26		ST	Master Clear (input) or programming voltage (output).
$\overline{MCLR}$			I		Master Clear (Reset) input. This pin is an active low RESET to the device.
VPP			P		Programming voltage input.
					PORTA is a bi-directional I/O port.
RA0/AN0	2	27		TTL	
RA0			I/O		Digital I/O.
AN0			I		Analog input 0.
RA1/AN1	3	28		TTL	
RA1			I/O		Digital I/O.
AN1			I		Analog input 1.
RA2/AN2	4	1		TTL	
RA2			I/O		Digital I/O.
AN2			I		Analog input 2.
RA3/AN3/VREF	5	2		TTL	
RA3			I/O		Digital I/O.
AN3			I		Analog input 3.
VREF			I		A/D reference voltage input.
RA4/T0CKI	6	4		ST	
RA4			I/O		Digital I/O – Open drain when configured as output.
T0CKI			I		Timer0 external clock input.
RA5/$\overline{SS}$/AN4	7	5		TTL	
RA5			I/O		Digital I/O.
$\overline{SS}$			I		SPI slave select input.
AN4			I		Analog input 4.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

TABLE 1-2: PIC16F73 AND PIC16F76 PINOUT DESCRIPTION (CONTINUED)

Pin Name	DIP SSOP SOIC Pin#	MLF Pin#	I/O/P Type	Buffer Type	Description
					PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	21	18		TTL/ST(1)	
RB0			I/O		Digital I/O.
INT			I		External interrupt.
RB1	22	19	I/O	TTL	Digital I/O.
RB2	23	20	I/O	TTL	Digital I/O.
RB3/PGM	24	21		TTL	
RB3			I/O		Digital I/O.
PGM			I/O		Low voltage ICSP programming enable pin.
RB4	25	22	I/O	TTL	Digital I/O.
RB5	26	23	I/O	TTL	Digital I/O.
RB6/PGC	27	24		TTL/ST(2)	
RB6			I/O		Digital I/O.
PGC			I/O		In-Circuit Debugger and ICSP programming clock.
RB7/PGD	28	25		TTL/ST(2)	
RB7			I/O		Digital I/O.
PGD			I/O		In-Circuit Debugger and ICSP programming data.
					PORTC is a bi-directional I/O port.
RC0/T1OSO/T1CKI	11	8		ST	
RC0			I/O		Digital I/O.
T1OSO			O		Timer1 oscillator output.
T1CKI			I		Timer1 external clock input.
RC1/T1OSI/CCP2	12	9		ST	
RC1			I/O		Digital I/O.
T1OSI			I		Timer1 oscillator input.
CCP2			I/O		Capture2 input, Compare2 output, PWM2 output.
RC2/CCP1	13	10		ST	
RC2			I/O		Digital I/O.
CCP1			I/O		Capture1 input/Compare1 output/PWM1 output.
RC3/SCK/SCL	14	11		ST	
RC3			I/O		Digital I/O.
SCK			I/O		Synchronous serial clock input/output for SPI mode.
SCL			I/O		Synchronous serial clock input/output for I²C mode.
RC4/SDI/SDA	15	12		ST	
RC4			I/O		Digital I/O.
SDI			I		SPI data in.
SDA			I/O		I²C data I/O.
RC5/SDO	16	13		ST	
RC5			I/O		Digital I/O.
SDO			O		SPI data out.
RC6/TX/CK	17	14		ST	
RC6			I/O		Digital I/O.
TX			O		USART asynchronous transmit.
CK			I/O		USART 1 synchronous clock.
RC7/RX/DT	18	15		ST	
RC7			I/O		Digital I/O.
RX			I		USART asynchronous receive.
DT			I/O		USART synchronous data.
V_{SS}	8, 19	5, 16	P	—	Ground reference for logic and I/O pins.
V_{DD}	20	17	P	—	Positive supply for logic and I/O pins.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

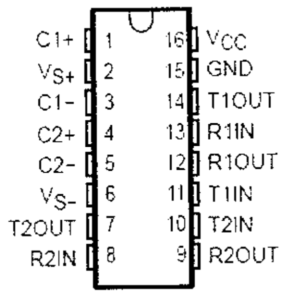
Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

APPENDIX B

MAX232

- Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
- Operates From a Single 5-V Power Supply With 1.0-μF Charge-Pump Capacitors
- Operates Up To 120 kbit/s
- Two Drivers and Two Receivers
- ±30-V Input Levels
- Low Supply Current . . . 8 mA Typical
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
- Upgrade With Improved ESD (15-kV HBM) and 0.1-μF Charge-Pump Capacitors is Available With the MAX202
- Applications
  - TIA/EIA-232-F, Battery-Powered Systems, Terminals, Modems, and Computers

MAX232 . . . D, DW, N, OR NS PACKAGE
MAX232I . . . D, DW, OR N PACKAGE
(TOP VIEW)



description/ordering information

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5-V supply. Each receiver converts TIA/EIA-232-F inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V, a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP (N)	Tube of 25	MAX232N	MAX232N
	SOIC (D)	Tube of 40	MAX232D	MAX232
		Reel of 2500	MAX232DR	
	SOIC (DW)	Tube of 40	MAX232DW	MAX232
		Reel of 2000	MAX232DWR	
	SOP (NS)	Reel of 2000	MAX232NSR	MAX232
−40°C to 85°C	PDIP (N)	Tube of 25	MAX232IN	MAX232IN
	SOIC (D)	Tube of 40	MAX232ID	MAX232I
		Reel of 2500	MAX232IDR	
	SOIC (DW)	Tube of 40	MAX232IDW	MAX232I
		Reel of 2000	MAX232IDWR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Input supply voltage range, V_{CC} (see Note 1) .... –0.3 V to 6 V
Positive output supply voltage range, V_{S+} .... V_{CC} – 0.3 V to 15 V
Negative output supply voltage range, V_{S-} .... –0.3 V to –15 V
Input voltage range, V_I: Driver .... –0.3 V to V_{CC} + 0.3 V
Receiver .... ±30 V
Output voltage range, V_O: T1OUT, T2OUT .... V_{S-} – 0.3 V to V_{S+} + 0.3 V
R1OUT, R2OUT .... –0.3 V to V_{CC} + 0.3 V
Short-circuit duration: T1OUT, T2OUT .... Unlimited
Package thermal impedance, θ_{JA} (see Notes 2 and 3): D package .... 73°C/W
DW package .... 57°C/W
N package .... 67°C/W
NS package .... 64°C/W
Operating virtual junction temperature, T_J .... 150°C
Storage temperature range, T_{stg} .... –65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltages are with respect to network GND.
2. Maximum power dissipation is a function of $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
3. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IH}	High-level input voltage (T1IN,T2IN)		2			V
V_{IL}	Low-level input voltage (T1IN, T2IN)				0.8	V
R1IN, R2IN	Receiver input voltage				±30	V
T_A	Operating free-air temperature	MAX232	0		70	°C
		MAX232I	–40		85	

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Note 4 and Figure 4)

PARAMETER		TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
I_{CC}	Supply current	V_{CC} = 5.5 V, All outputs open, T_A = 25°C		8	10	mA

‡ All typical values are at V_{CC} = 5 V and T_A = 25°C.
NOTE 4: Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.

DRIVER SECTION

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (see Note 4)

PARAMETER			TEST CONDITIONS	MIN	TYP†	MAX	UNIT
V_{OH}	High-level output voltage	T1OUT, T2OUT	R_L = 3 kΩ to GND	5	7		V
V_{OL}	Low-level output voltage‡	T1OUT, T2OUT	R_L = 3 kΩ to GND		–7	–5	V
r_o	Output resistance	T1OUT, T2OUT	$V_{S+} = V_{S-} = 0$, $V_O = \pm 2$ V	300			Ω
I_{OS}§	Short-circuit output current	T1OUT, T2OUT	V_{CC} = 5.5 V, V_O = 0		±10		mA
I_{IS}	Short-circuit input current	T1IN, T2IN	V_I = 0			200	µA

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
§ Not more than one output should be shorted at a time.
NOTE 4: Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see Note 4)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SR	Driver slew rate	R_L = 3 kΩ to 7 kΩ, See Figure 2			30	V/µs
SR(t)	Driver transition region slew rate	See Figure 3		3		V/µs
	Data rate	One TOUT switching		120		kbit/s

NOTE 4: Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.

RECEIVER SECTION

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature range (see Note 4)

PARAMETER			TEST CONDITIONS	MIN	TYP†	MAX	UNIT
V_{OH}	High-level output voltage	R1OUT, R2OUT	I_{OH} = –1 mA	3.5			V
V_{OL}	Low-level output voltage‡	R1OUT, R2OUT	I_{OL} = 3.2 mA			0.4	V
V_{IT+}	Receiver positive-going input threshold voltage	R1IN, R2IN	V_{CC} = 5 V, T_A = 25°C		1.7	2.4	V
V_{IT-}	Receiver negative-going input threshold voltage	R1IN, R2IN	V_{CC} = 5 V, T_A = 25°C	0.8	1.2		V
V_{hys}	Input hysteresis voltage	R1IN, R2IN	V_{CC} = 5 V	0.2	0.5	1	V
r_i	Receiver input resistance	R1IN, R2IN	V_{CC} = 5, T_A = 25°C	3	5	7	kΩ

† All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡ The algebraic convention, in which the least-positive (most negative) value is designated minimum, is used in this data sheet for logic voltage levels only.
NOTE 4: Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C (see Note 4 and Figure 1)

PARAMETER		TYP	UNIT
$t_{PLH(R)}$	Receiver propagation delay time, low- to high-level output	500	ns
$t_{PHL(R)}$	Receiver propagation delay time, high- to low-level output	500	ns

NOTE 4: Test conditions are C1–C4 = 1 µF at V_{CC} = 5 V ± 0.5 V.

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