Al Balqa Applied University
Faculty of Engineering

Pc remote control

Project submitted partial fulfillment of the requirements for the degree of B.SC. in computer and communication engineering

By

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PCRC

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Special thanks to our parents, sisters, and brothers for their unstoppable support.

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Abstract

Overview

PC Become One Of The most important requirement in any place, also control operation is one of the most important field in any machine, which can be either internal like the Administrated CPU, Programmable Integrated Circuit …Etc, and/or it can be external by using an implemented remote control like the remote of TV, Video, …Etc or an integrated component like what we want to talk about “The Remote Control” for a car, PC that can be considered as an additional accessory.

In order to come up with the rapid technology improvement, we decided to design a system to help making life easier and more comforting for the user.

We start to think of controlling the PC, everyone is using the PC for his own business but there is a common task that we all use the computer for which is playing multimedia whether a movies or songs , from this point we decided to make a remote control to control playing the multimedia on the pc .

Personal computer remote control (PCRC) is a device which can be used to take the control of many actions within any program application.

So this project based on designing the hardware circuit with the required software to build the device which can be used to control many actions within a software application, when the P.C is switched on, you can now take the function of the mouse or some functions of the keyboard by using the (PCRC).

The (PCRC) is working using the infrared spectrum just like TV remote control, the user especially in the presentation will be free to move , he doesn’t need to set in front of the keyboard and the mouse , now he can do many actions using (PCRC).

1.2 Block diagram

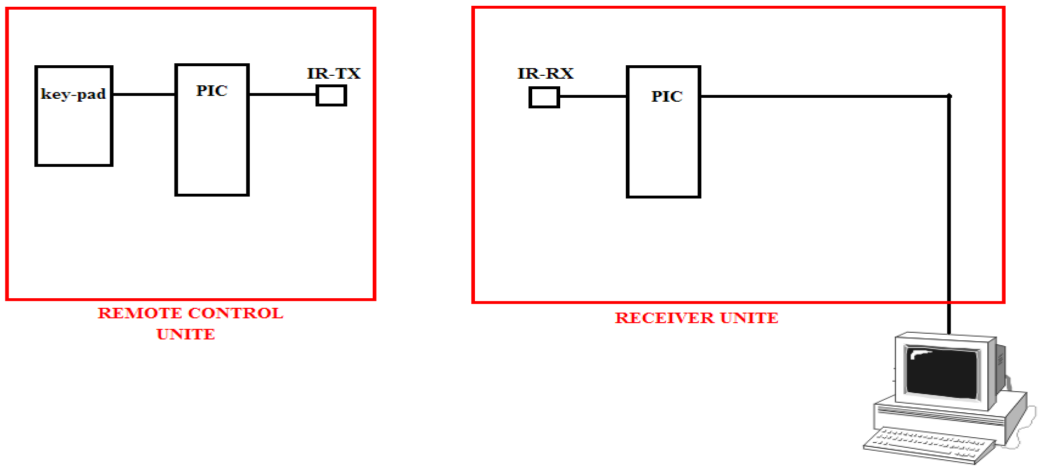


Figure (1.1) block diagram

Figure 1.1 shows a general block diagram of our system
The system will be divided into two main parts

1.2.1 Remote control (transmitter)

The transmitter will include a key-pad with 15 keys , so the user can use fifteen different functions, the key-pad is attached to a PIC microcontroller to make the all process of decoding the pressed key and sending the appropriate signal to the receiver as will be mentioned in hardware chapter

1.2.2 Receiver

The receiver will take the signal from the IR-receiver and fed this signal to a PIC microcontroller; the microcontroller will decode the signal, and then issue a certain code on the output pins which is connected to the PC through the parallel port.

Chapter One

Project plan

Description:

Our Project Consist Of Three Main Parts :

1) The Sender Which Is The Remote Itself.

2) The Receiver Which Must Be Designed To Understand The Signals Received From The Sender Which Are An Infrared Signals.

3) A Program To Receive The Translated Commands From The Parrallel Port To Apply The Function Needed, And We Use The VB.net Programming Language Here.

Through Those Main Components There're Many Fields To Use Like :

1) Electronics Design Skills
2) Logic Design
3) PIC Programming(Low Level Language)
4) VB.net Programming (High Level Language)
5) Dealing With Parallel Port Of The PC
6) Pulse Width Modulation
7) Infrared Technology

The 1st Main Part (The Sender),There Can Be Use A TV Remote Control But We Have To Know The Frequencies Used For Every Button In Order To Let The receiver Know The Required Frequency , So Anyway In Our Project We'll Design A 4*4 Keypad In Order To Provide 16 Functions.
We've To Use : 4*4 Keypad, Infrared Sender, using PWM…

(IR) Is Quite Antiquated. It's Cool For TV's And Video Where You Have Line Of Sight, But Not Much Use For Things Like Controlling Music From Another Room. Infrared (IR) Radiation Is Electromagnetic Radiation Of A Wavelength Longer Than That Of Visible Light, But Shorter Than That Of Radio Waves. The Name Means "Below Red" (From The Latin *infra*, "Below"), Red Being The Color Of Visible Light Of Longest Wavelength.

Infrared Radiation Spans Three Orders Of Magnitude And Has Wavelengths Between Approximately 750 nm And 1 mm. The Infrared Band Is Often Subdivided Into Smaller Sections But The Divisions Are Not Precise, And Are Used Differently By Different Authors. One Such Scheme Is:

Near Infrared (NIR, IR-A *DIN*) 0.75–1.4 µm In Wavelength, Defined By The Water Absorption, And Commonly Used In Fiber Optic Telecommunication Because Of Low Attenuation Losses In The SiO_2 Glass (Silica) Medium.

Short Wavelength IR (SWIR, IR-B *DIN*)
1.4–3 µm, Water Absorption Increases Significantly At 1450 nm. The 1530 to 1560 nm Range Is The Dominant Spectral Region For Long-Distance Telecommunications.
Mid Wavelength IR (MWIR, IR-C *DIN*) Also Intermediate-IR (IIR) 3–8 µm

Long Wavelength IR (LWIR, IR-C *DIN*)
8–15 µm
Far Infrared (FIR)
15–1,000 µm

Here Are Some Applications Of The Infrared :

1) Night Vision
2) Infrared Astronomy
3) Backside Emission Microscopy
4) Infrared Camera
5) Infrared Filter
6) Infrared Photography
7) Infrared Spectroscopy

We Also Use The Pulse Width Modulation (PWM) Which Is A technique To Provide A Logic "1" And Logic "0" For A controlled Period Of Time In Order To Differentiate Between The Functions Buttons By Giving An Every Button (Function) A Different Width.

Table 1. Data Values for Different Duty Cycles

Data Value	Duty Cycle (%)
11100110	90
11000000	75
10000000	50
01000000	25
00011001	10

Table (1.1)

(PWM) Is Programmed For The Buttons By The PIC Which Is An IC Programmed By The Computer (Low Level Language) Just Like The Assembly Language And Used As A part Of The Electronic Circuit According To Its Functions.

The Same Operation Is Set For The Receiver That Understand The Incoming Signals With An Infrared Receiver ,Using Another PIC To Differentiates Between The Frequencies By Setting A Timer To Count The Time Spent To Achieve The Required Signal.

When The PIC Got The Period, It Compares This Value With A table To Know What To Send Then To The Parallel Port Which Is An Intermediary Between The Hardware & The Software…

For The 3rd Main Part Which Is A Program That Check The Parallel Port Status By A Timer In Every Sec..
Then If The Parallel Port Status Changed, It Reads The PINs And Compare With A Table Inside The Code To Determine The Function To Apply.

And In Our Project We'll Use The Program To Control A Built-in Windows Media Player ,Also Control The Next & Previous Pages In Our Presentation.

Project Plan :

1_ Evaluating & Partitioning The Project Into Sessions.

2_ Determining The Primary Design Of The Hardware That Make The Same Goal Of The Project With A Less Cost, And Choose The Software That Can Serve The Requirements Of The Project & Can Use It In A Sufficient Manner.

3_ Looking & Searching For The Required HW Components & SW Libraries Needed To Make The System Operate In The right way.

4 _ Design Both HW & SW.

5_ Determining a way To Make A Connection Between The HW & The SW.

6_ Implementation Of The Whole System (HW&SW).

7_ Testing The System Functions & Trying To Improve The Nonfunctional Properties Like The Performance.

Goals & Objectives:

1-Make the Control of PC Much Easier In Some Cases.

2-saves the time required for control like in presentations.

3-making some applications like presentations more royal.

4-making it more comfortable for the user to control his PC when it's out of the way.

5-it can be designed to meet some personal functions and meets with inexpensive hardware.

6- Also it can be designed to be an instead device like the multimedia keyboard functions or the wireless mouse that are sold in the open market .

Output of the project:

1-Ease In Administrating The Conferences & Presentations That Needs A Second Hand To Control.

2-Provides A good way To Provide The Customers With A Useful Function For Those Who Uses The PC For A Limited Purposes.

3- Can Be Improved To Make The Control By A Radio Waves (Long Range),Instead Of Using The Infrared Waves(Short Range) For A Special Purposes.

4-also can increase the functions by increase the number of buttons (N*N) keypad to be more useful.

5 _ More Comfort Is Resulted.

Chapter two

2.1 History of Computers

The development of the modern day computer was the result of advances in technologies and man's need to quantify. The abacus was one of the first counting machines. Papyrus helped early man to record language and numbers. Some of the earlier counting machines lacked the technology to make the design work. For instance, some had parts made of wood prior to metal manipulation and manufacturing. Imagine the wear on wooden gears.

2.1.1 Pre-IBM PC Computers.

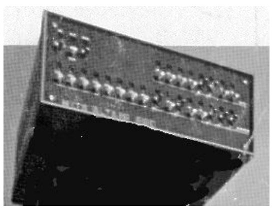


Figure (2.1)

2.1.2 MITS ALTAIR 8800-The start of it all

The MITS Altair was the first 8080 based kit microcomputer. It was first introduced in the January, 1975 issue of Popular Electronics magazine as a construction project. The reaction to the Altair was un-expected by either the magazine or by MITS who designed it. Although not the first available microcomputer, it was the start of the industry.

Figure (2.2)

2.1.3 IMSAI -8080 The microcomputer was more than a toy

The Imsai 8080 developed by IMS Associates, was designed to use the same bus structure as the Altair 8800 with interchangeable circuit boards. The Imsai 8080 however was much better built, had a more powerful power supply, and front panel. It supplanted the Altair A model as the standard S-

100 Bus computer. The Imsai was the first for a complete line of micros built by this company.

Figure (2.3)

2.1.4 Southwest Tech 6800- The kit builders favorite

The M6800 Computer kit from South West Technical Products Company used the Motorola 6800 processor and the SS-50 bus structure. Much less expensive than the S-100 bus computers and much simpler to build, the M6800 became very popular. In addition SWTPC provided a complete family of peripherals kits at very low cost. The software for the M6800 was excellent and very inexpensive.


Figure (2.4)

2.1.5 The SOL-First 8080 Desktop microcomputer

Processor Technology company designed and sold a full line of boards for the S-100 computers. In 1977 they designed the SOL Computer which used most of their circuit boards. The SOL had a video terminal built-in, only requiring a video monitor. In a very attractive case with walnut wood sides, the SOL became a very popular computer that influenced the design of future computers. Pro. Tech did not provide a low cost floppy disk system so users turned to North Star for their disk storage.


Figure (2.5)

2.1.6 Apple II The micro that made it into business and homes .

The Apple II was the first true "personal computer" it was factory built, inexpensive and easy to learn and use. Provided with the most extensive set of software and low cost floppy disks, the Apple II was also the first personal computer capable of color graphics and easy modem operation. Development of the VisiCalc spreadsheet program created a business tool that made adoption of Apple II a regular part of business.

Figure (2.6)

2.1.7 TRS-80 (Trash 80), The most popular home computer

Radio Shack's TRS-80 selling for about $500 complete with video monitor and BASIC took the personal computer market by storm. Using a fast Z-80 processor it use a cassette recorder for program and data storage. Later models incorporated disk drives and more memory. The Model III, housed in one case became the most popular personal computer in schools and homes rivaling the Apple II. Radio Shack also built other types of personal computers including the first practical laptop, the Model 100.

Figure (2.7)

2.1.8 Atari 800- The machine that won the color graphics race

The Atari Models 400 and 800 were considered the best personal computers for games and color graphics. They had a very large family of game software, but not much business software. Lack of good disk and peripheral support cased these machines to have a short life.

Figure (2.8)

2.1.9 Commodore 64- Breaking the price barrier

The Commodore 64 was the best-selling personal computer of all time. It had a large memory capacity, low cost floppy disks and peripherals and color graphics. It could use a TV for a monitor and there was all the software anyone could want. Commodore in a price war with Texas Instruments reduced the prices of the C-64 as low as $260 and more of them were sold than any computer in history.

Figure (2.9)

2.1.10 Texas Instruments TI 99-4

The Texas Instruments 99-4A used a TI 16-bit processor and was an excellent graphics computer. It lacked easy expansion capabilities and required proprietary software.

After engaging in a price war with Commodore, TI stopped production and sold out below $100 per computer

Figure (2.10)

2.1.11 Heath- Desktop with built-in floppy and monitor

The Heath Desktop was one of the first computers designed as complete desktop machines including monitor, floppy disks and keyboard. Heath made a full line of computers and was later bought by Zenith.

Figure (2.11)

2.1.12 Morrow- Powerful S-100 Z80 Computer using CP/M

The Morrow computer was one of last powerful Z-80 powered S-100 computers. Representative of the designs supplanted by the IBM PC, this machine was sold as a complete system including a video terminal and printer. It ran the CP/M operating system and the MP/M multi-user operating system. The Morrow Company was a leading supplier of disk systems for CP/M computers.

2.2 Introduction to PC Hardware

The PC may be the single most important tool for researchers and executives, but because it is purchased in a camera store or discount food warehouse it is often treated as a commodity item.
It is not possible to buy a PC with poor quality core components. AMD and Intel don't make bad CPUs. Main boards, disks, and video cards are uniformly decent quality. You can buy a cheap case (with sharp edges that cut your hands), but if you never open the covers you will never know. So in an era where game consoles cost $600, and you can spend real money on a flat panel TV set, you can still buy the least expensive Dell or HP system for $350 and get a pretty good computer. If that is all the advice you are looking for, read no farther.

2.2.1 The beginning:

IBM invented the modern PC design, but they recently sold that business to a Chinese company. This should not be a big surprise. Often the only American thing in a computer is the name on the cardboard box it came in. Apple assembles systems in Shanghai and ships them overnight to the US.
In a PC, however, the CPU, memory, disk, CD, power supply, and case are all manufactured to industry standards. You can take a hard disk or memory out of a Dell computer and put it into a system made by HP. The brand names you know are the names of companies that assemble, distribute, and support the computers, not the companies that make the parts.
The advanced technology is in the manufacture of the chips, not the final assembly of the finished product. A CPU chip is constructed in a plant that costs billions of dollars. The building is on shock absorbers because the vibration generated by passing trucks would disturb the process. People wear spacesuits not to protect them from the environment, but to protect the chips from flakes of loose skin or the particles we exhale in every breath.
Then the chip is packaged in plastic and shipped out. There is a socket on the main board. One corner of the chip has an arrow, and one corner of the socket has an arrow. Drop the chip into the socket while matching the two arrows, and then drop a lever to hold it in place. It is harder to tie a shoelace than to install a CPU chip on a main board.

2.3 There are 8 basic parts of computer:

Case
Power Supply
Main board
CPU (and cooling tower)
Memory
Video Card
Hard Disk
DVD Drive

2.3.1 Case

The case is the metal or plastic box that holds the computer. You can get small cases that look like stereo equipment or large cases with room for a lot of disks and add on cards. Enthusiasts may buy a case that is transparent or one that looks sporty.

Things to look for in a case: A smaller case is more convenient. The large case is mostly empty, which may seem like a waste of space. However, a computer needs airflow to cool the CPU and video card. Bigger cases have more air and are easier to cool. Also, noise from a computer mostly comes from fans. A small case has a small fan that has to rotate very fast and is loud. A big case can have a 120 mm fan that can rotate more slowly and still move a lot of air. If you have the space on the floor, the bigger case has advantages.

2.3.2 Main board

The main board must have a socket for at least one CPU chip, and sockets for typically 2 or 4 memory "sticks". The back panel will expose plugs for keyboard, mouse, USB, Ethernet, and maybe External SATA disks. Some main boards have integrated video. It will then have slots and connectors for the things you add it: SATA connectors for disk and PCI and PCI-e slots for adapter cards.

Things to look for in a main board: The CPU socket has to match the CPU chip. Main boards come in large (ATX) and small (MATX) sizes with a few other (jumbo, tiny) sizes used only for specialty purposes. The small MATX board will only have two memory slots and room for four adapter cards, but it will fit in media center cases designed to look like stereo equipment. If you get a big case you can fit a full sized ATX board. Gigabit Ethernet is useful, particularly when you move large files from machine to machine in a home network. External SATA (e-SATA) allows you to connect external disks to the computer at full speed. Integrated video is OK for running Office, but look for a DVI connector for modern flat panel screens. Otherwise, compare the adapter cards you want to install with the slots you have. Main boards can have four PCI slots, but boards designed for running video games often have room for a second oversized video card and cut the PCI slots down to two.

2.3.3 Video

The video card will plug into the large PCI Express slot on the main board. Enthusiasts will spend more on the video card (or cards) than they do on the rest of the computer. Video cards can use more power than the rest of the system. This makes sense, however, because for the specialized type of computing they do, a video card can be 10 times faster than the CPU on the main board. Gamers want the most powerful card they can afford. Home "media center" users probably want a card that supports HDCP and can play High Definition TV recordings. Business users don't need any of this, and will be satisfied with the integrated video that comes on some inexpensive main boards.

Things to look for in a Video card: Serious gamers already knew all this stuff and stopped reading long ago. You are therefore probably looking for integrated video or a single medium performance PCI Express video card. There are two main GPU chip makers: NVIDIA and ATI. Since you are not looking to spend a few thousand dollars for the biggest and baldest machine on the planet, the two vendors are approximately interchangeable. Minimally, you want video that supports DirectX 9 (Windows XP) and has some hardware support for decoding standard definition MPEG (DVD). If you read carefully, for the same money you can find integrated video or inexpensive adapters that will decode High Definition TV (broadcast and cable). In cards this means some type of ATI 1xxx (1600, 1900, and 1950) GPU or an Nvidia 7xxx (7600, 7900) GPU. If you get 256 megabytes of memory, this card will be ideal for Vista. However, if you plan to add a Blu-Ray or HD-DVD drive to your system and view recorded high definition movies on a big screen display, then you need a display and adapter card that support "HDCP" and, to be safe, a GPU that can decode a format called "H.264" (generally the same ATI 1xxx or Nvidia 7xxx, but read the specs). To do everything except high performance gaming, expect the video card to cost $150 to $200. Vista supports DirectX 10, but at the start of 2007 the only cards that support this (Nvidia 88xx) start at $400. If you have only flat panel displays, the DVI connectors are much better than old analog connectors. A few cards support the smaller digital HDMI connector normally associated with flat panel TV sets.

2.3.4 Power Supply

The Power Supply is rated by the maximum amount of power it must provide to the rest of the computer. Most business systems will get along with 350 watts, but a system with four cores or high end video cards can require 500 watts or more. The Power Supply is the component most likely to fail sometime during the life of the computer. It may overheat or the cooling fan may fail. As it starts to fail the voltage levels go bad (the 12 volt wires may carry only 11 volts) and that can make the computer unstable and it will start to crash.

Things to look for in a Power Supply: you should read reviews and buy one from the company that has the best reputation for reliability, but even the best company produces the occasional bad unit. So look for a unit with two 12 volt "rails" instead of one, and one with a 120 mm fan will make less noise than one with 80 mm fans. If you have a small case or one with a compartment for the Power Supply, watch out for units that are slightly larger than normal, especially if they have "modular cables" that plug into one end of the supply, because when you assemble everything the Power Supply may not fit. If you don't stock a spare Power Supply in your house, then know where to find a CompUSA or computer repair store where you can get one when you need it, or your computer may be down for a few days waiting for an internet vendor to ship one.

2.3.5 Disk

SATA is simpler and faster than the old parallel ATA. There is one high speed disk from WD called the "Raptor" that is at twice as fast as all other disks. Otherwise, you buy disks based on price, capacity, and reliability.

Things to look for in Disk: First consider your case. A small case may have only room for one or at most two disks, so you may want to buy the biggest disk you can get. A large case can have room for 6 disks, and you can add buy rails that adapt the unused front 5.25" CD-sized slots to hold even more disks. Now if you look carefully at prices, you will see that two 250 gigabyte hard drives are often less expensive than one 500 gigabyte disk. A disk has movable "arms" that position somewhere on the surface to read or write data. Each disk has its own position. So if you are copying data from one disk to another the arms on each disk can remain positioned in one place, but if you process data from one file to another on the same disk, the arms move back and forth and the same processing can take 20 times longer than a two disk operation.

2.4 The Main board (Motherboard)

The main board contains slots for the CPU, memory, and I/O devices. In current designs, one chip called the Northbridge sits between and connects the three high speed devices: CPU, memory, and AGP video port. It is then connected to a second chip called the Southbridge that provides logic for all the slow speed devices: the keyboard, mouse, modem port, printer port, IDE controller, PCI, USB, and any other devices.

2.4.1 motherboard

The main circuit board of a microcomputer. The motherboard contains the connectors for attaching additional boards. Typically, the motherboard contains the CPU, BIOS, memory, mass storage interfaces, serial and parallel ports, expansion slots, and all the controllers required to control standard peripheral devices, such as the display screen, keyboard, and disk drive. Collectively, all these chips that reside on the motherboard are known as the motherboard's chipset.

On most PCs, it is possible to add memory chips directly to the motherboard. You may also be able to upgrade to a faster PC by replacing the CPU chip. To add additional core features, you may need to replace the motherboard entirely.

2.4.2 Hyper threading and Multi-Core

The processing steps of a computer program can be decomposed into a set of independent "threads". To display a Web page, the Browser has to read in the page itself plus each individual file representing the pictures and ads displayed within the page. Then the text has to be arranged on the page and each picture has to be decompressed. Finally, the page has to be arranged and displayed on the screen. Each of these operations can be assigned to a thread. If a computer has (or appears to have) two CPUs, Windows will assign a separate thread to each processor and the computer will process two different streams of data at the same time.

No matter how fast Intel makes its chip, a modern CPU spends 50% or more of its time waiting for data to arrive from main memory. This is only getting worse, because CPU speed increases much more quickly than memory speed. A larger cache provides some help. Another idea, however, is for the CPU to have some way to switch from the instruction and thread that is blocked waiting for data to another thread that is ready to execute. This is the idea behind "Hyper threading". Each CPU pretends to be two processors. The OS assigns a thread to each pretend processor. When one thread is blocked waiting for data, the CPU can switch over to the other thread and get more work done.

2.4.3 Memory and "Burst" Speed

Technology has been applied to increase memory speed only when it can be done without reducing size or increasing cost. Current mass market designs favor Double Data Rate SDRAM. When a CPU instruction requires data from memory, it presents the address and then has to wait several cycles. Once the first block of data has been located by the memory hardware, the 32 bytes immediately surrounding the address can also be transferred in a "burst" of activity. DDR memory transfers the data at twice the ordinary speed of the memory bus by transferring bytes on both the tick and the tock of the clock.

2.5 Port :

2.5.1 Port scanning

The act of systematically scanning a computer's ports. Since a port is a place where information goes into and out of a computer, port scanning identifies open doors to a computer. Port scanning has legitimate uses in managing networks, but port scanning also can be malicious in nature if someone is looking for a weakened access point to break into your computer.

<u>Types of port scans:</u>

vanilla: the scanner attempts to connect to all 65,535 ports

strobe: a more focused scan looking only for known services to exploit

fragmented packets: the scanner sends packet fragments that get through simple packet filters in a firewall

UDP: the scanner looks for open UDP ports

sweep: the scanner connects to the same port on more than one machine

FTP bounce: the scanner goes through an FTP server in order to disguise the source of the scan

Stealth scan: the scanner blocks the scanned computer from recording the port scan activities.

Port scanning in and of itself is not a crime. There is no way to stop someone from port scanning your computer while you are on the Internet because accessing an Internet server opens a port, which opens a door to your computer. There are, however, software products that can stop a port scanner from doing any damage to your system.

2.5.2 Computer port (software)

A Software Port (usually just called a 'port') is a virtual data connection that can be used by programs to exchange data directly, instead of going through a file or other temporary storage location. The most common of these are TCP and UDP ports which are used to exchange data between computers on the Internet.

In Flow-based programming, a 'port' is a (named) point of contact between a process and a connection.

I/O or machine port- port-mapped. 2.5.3

For Input or Output (I/O) operations nearly all processor families use similar assembly instructions for both memory access and hardware I/O (see memory-mapped I/O for details). However, Intel microprocessors have assembly instructions (IN and OUT) that are used specifically for hardware I/O. These instructions figure out which hardware device to communicate with using the concept of an I/O port or machine port. These ports are numbered based on which hardware device they refer to.

Intel microprocessors generally allow one octet (8-bit byte or word) to be sent or received during each instruction. The hardware device decides how to interpret data sent to it and what data to send to the processor.

2.5.4 Computer port (hardware)

Figure (2.12)

In computer hardware, a port serves as an interface between the computer and other computers or devices. Physically, a port is a specialized outlet on a piece of equipment to which a plug or cable connects. Electronically, the several conductors making up the outlet provide a signal transfer between devices. Hardware ports may be physically male (unusual, since protruding pins easily break, a fate best left to inexpensive matching cable ends) or female (usual on equipment). Computer ports in common use cover a wide variety of shapes such as round (PS/2, etc.), rectangular (FireWire, etc.), square (telephone modem), trapezoidal (D-Sub—the old printer port was a DB-25), etc. There is some standardization to physical properties and function. For instance, most computers have a keyboard port (currently a round DIN-like outlet referred to as PS/2), into which the keyboard is connected.

Electronically, hardware ports can almost always be divided into two groups based on the signal transfer:

Serial ports send and receive one bit at a time via a single wire pair (Ground and +/-).

Parallel ports send multiple bits at the same time over several sets of wires.

After ports are connected, they typically require "handshaking," which is a similar concept to the negotiation that occurs when two fax machines make a connection, where transfer type, transfer rate, and other necessary information is shared even before data are sent.

Hot-pluggable ports can be connected while equipment is running. About the only port on personal computers that isn't hot-pluggable is the keyboard PS/2 connector; hot-plugging a keyboard on many computer models can cause permanent damage to the motherboard.

Plug-and-play ports are designed so that the connected devices automatically start handshaking as soon as the hot-plugging is done. USB ports and FireWire ports are plug-and-play.

Auto-detector auto-detection ports are usually plug-and-play, but they offer another type of convenience. An auto-detect port may automatically determine what kind of device has been attached, but it also determines what purpose the port itself should have. For example, some sound cards allow plugging in ("jacking in") several different types of audio speakers, then a dialogue box pops up on the computer screen asking whether the speaker is left, right, front, or rear for surround sound installations. The user's response determines the purpose of the port, which is physically a 1/4" tip-sleeve-ring (TSR) mini-jack. Some auto-detect ports can even switch between input and output based on context.

2.5.5 Port Applications

Costly, inaccurate and time-consuming paper-based administrative procedures associated with port operations can be replaced with automated, paperless RF-based material and container handling:
Loading and unloading schedules can be planned and confirmed before a vessel docks.
Container disposition is available in real-time, so extraneous workers, containers, or equipment is eliminated.
Operators use RF devices to schedule combined cargo drop-offs and pickups.
Wireless network messages can be routed automatically to vehicle operators about changed priorities, schedules, load transfers, or destinations.
Handling time is reduced with real-time systems.
Container and equipment service records can be automatically updated.
Managers can remotely issue repair schedules to devices as necessary.

2.6 Hard disk

A magnetic disk on which you can store computer data. The term hard is used to distinguish it from a soft, or floppy, disk. Hard disks hold more data and are faster than floppy disks. A hard disk, for example, can store anywhere from 10 to more than 100 gigabytes, whereas most floppies have a maximum storage capacity of 1.4 megabytes.
A single hard disk usually consists of several platters. Each platter requires two read/write heads, one for each side. All the read/write heads are attached to a single access arm so that they cannot move independently. Each platter has the same number of tracks, and a track location that cuts across all platters is called a cylinder. For example, a typical 84 megabyte hard disk for a PC might have two platters (four sides) and 1,053 cylinders.
In general, hard disks are less portable than floppies, although it is possible to buy removable hard disks.

2.6.1 Inside a Hard Drive:

All hard drives share a basic structure and are composed of the same physical features. However, not all hard drives perform the same way as the quality of the parts of the hard drive will affect its performance. Following is a description of the common features of the hard drive and how each part works in relation to the others. Hard drives are extremely sensitive equipment and the internal workings of a hard drive should not be handled by anyone other than an experienced professional.

2.6.2 The Platters

The platters are the actual disks inside the drive that store the magnetized data. Traditionally platters are made of a light aluminum alloy and coated with a magnetically material such as a ferrite compound that is applied in liquid form and spun evenly across the platter or thin metal film plating that is applied to the platter through electroplating, the same way that chrome is produced. Newer technology uses glass and/or ceramic platters because they can be made thinner and also because they are more efficient at resisting heat. The magnetic layer on the platters has tiny domains of magnetization that are oriented to store information that is transferred through the read/write heads. Most drives have at least two platters, and the larger the storage capacity of the drive, the more platters there are. Each platter is magnetized on each side, so a drive with 2 platters has 4 sides to store data.

2.6.3 The Spindle and Spindle Motor

The platters in a drive are separated by disk spacers and are clamped to a rotating spindle that turns all the platters in unison. The spindle motor is built right into the spindle or mounted directly below it and spins the platters at a constant set rate ranging from 3,600 to 7,200 RPM. The motor is attached to a feedback loop to ensure that it spins at precisely the speed it is supposed to.

2.6.4 The Read/Write Heads

The read/write heads read and write data to the platters. There is typically one head per platter side, and each head is attached to a single actuator shaft so that all the heads move in unison. When one head is over a track, all the other heads are at the same location over their respective surfaces. Typically, only one of the heads is active at a time, i.e., reading or writing data. When not in use, the heads rest on the stationary platters, but when in motion the spinning of the platters create air pressure that lifts the heads off the platters. The space between the platter and the head is so minute that even one dust particle or a fingerprint could disable the spin. This necessitates that hard drive assembly be done in a clean room. When the platters cease spinning the heads come to rest, or park, at a predetermined position on the heads, called the landing zone.

2.6.5 The Head Actuator

All the heads are attached to a single head actuator, or actuator arm, that moves the heads around the platters. Older hard drives used a stepper motor actuator, which moved the heads based on a motor reacting to stepper pulses. Each pulse moved the actuator over the platters in predefined steps. Stepper motor actuators are not used in modern drives because they are prone to alignment problems and are highly sensitive to heat. Modern hard drives use a voice coil actuator, which controls the movement of a coil toward or away from a permanent magnet based on the amount of current flowing through it. This guidance system is called a servo.

The platters, spindle, spindle motor, head actuator and the read/write heads are all contained in a chamber called the head disk assembly (HDA). Outside of the HDA is the logic board that controls the movements of the internal parts and controls the movement of data into and out of the drive.

2.7 **History of hard disks**

Figure (2.13)

2.7.1 IBM 62PC "Piccolo" HDD, circa 1979 - an early 8" disk

Figure (2.14)

2.7.2 A 2.5 " hard disk for laptops, circa 2000

For many years, hard disks were large, cumbersome devices, more suited to use in the protected environment of a data center or large office than in a harsh industrial environment (due to their delicacy), or small office or home (due to their size and power consumption). Before the early 1980s, most hard disks had 8-inch (20 cm) or 14-inch (35 cm) platters, required an equipment rack or a large amount of floor space (especially the large removable-media disks, which were often referred to as "washing machines"), and in many cases needed high-current or even three-phase power hookups due to the large motors they used. Because of this, hard disks were not commonly used with microcomputers until after 1980, when Seagate Technology introduced the ST-506, the first 5.25-inch hard disk, with a capacity of 5 megabytes. In fact, in its factory configuration, the original IBM PC (IBM 5150) was not equipped with a hard disk.

Most microcomputer hard disks in the early 1980s were not sold under their manufacturer's names, but by OEMs as part of larger peripherals (such as the Corus Disk System and the Apple Profile). The IBM PC/XT had an internal hard disk, however, and this started a trend toward buying "bare" disks (often by mail order) and installing them directly into a system. Hard disk makers started marketing to end users as well as OEMs, and by the mid-1990s, hard disks had become available on retail store shelves.

While internal disks became the system of choice on PCs, external hard disks remained popular for much longer on the Apple Macintosh and other platforms. The first Apple Macintosh built between 1984 and 1986 had a closed architecture that did not support an external or internal hard drive. In 1986, Apple added a SCSI port on the back, making external expansion easy. External SCSI drives were also popular with older microcomputers such as the Apple II series, and were also used extensively in servers, a usage which is still popular today. The appearance in the late 1990s of high-speed external interfaces such as USB and FireWire has made external disk systems popular among PC users once again, especially for users who move large amounts of data between two or more areas, and most hard disk makers now make their disks available in external cases.

2.7.3 Hard Disk Drive

Figure (2.15)

Figure (2.16)

The inside of a hard disk drive displaying the actuator arm traveling over the top platter

A hard disk (commonly known as a HDD (hard disk drive) or hard drive (HD) and formerly known as a fixed disk) is a non-volatile storage device which stores digitally encoded data on rapidly rotating platters with magnetic surfaces. Strictly speaking, "drive" refers to a device that drives (removable) media, such as a tape drive or (floppy) disk drive, while a hard disk contains fixed (non-removable) media. However, in recent times, the hard disk has become more commonly known as the "hard drive".

Hard disks were originally developed for use with computers. In the 21st century, applications for hard disks have expanded beyond computers to include digital video recorders, digital audio players, personal digital assistants, digital cameras, and video game consoles. In 2005 the first mobile phones to include hard disks were introduced by Samsung Group and Nokia. The need for large-scale, reliable storage, independent of a particular device, led to the introduction of configurations such as RAID, hardware such as network attached storage (NAS) devices, and systems such as storage area networks (SANs) for efficient access to large volumes of data.

2.7.4 Technology

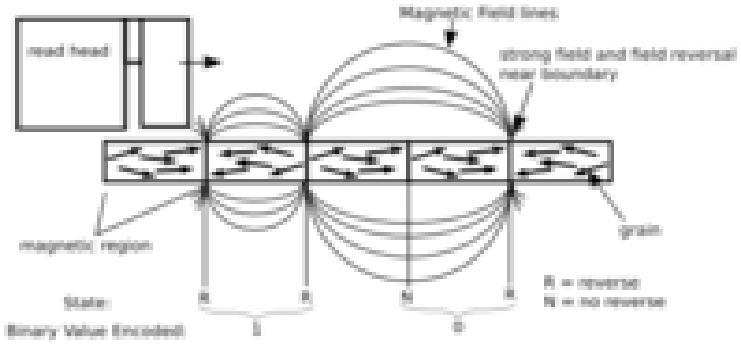


Figure (2.17)

A cross section of the magnetic surface in action. In this case the binary data encoded using frequency modulation.

Hard disks record data by magnetizing a magnetic material in a pattern that represents the data. They read the data back by detecting the magnetization of the material. A typical hard disk design consists of a spindle which holds one or more flat circular disks called platters, onto which the data is recorded. The platters are made from a non-magnetic material, usually glass or aluminum, and are coated with a thin layer of magnetic material. Older disks used iron(III) oxide as the magnetic material, but current disks use a cobalt-based alloy.

The platters are spun at very high speeds. Information is written to a platter as it rotates past mechanisms called read-and-write heads that fly very close over the magnetic surface. The read-and-white head is used to detect and modify the magnetization of the material immediately under it. There is one head for each magnetic platter surface on the spindle, mounted on a common arm. An actuator arm (or access arm) moves the heads on an arc (roughly radically) across the platters as they spin, allowing each head to access almost the entire surface of the platter as it spins.


Figure (2.18)

The inside of a hard disk drive with the disk(s) and spindle motor hub removed. To the left of center is the actuator arm. A read-write head is at the end of the arm. In the middle the internal structure of the drive's spindle motor can be seen.

The magnetic surface of each platter is divided into many small sub-micrometer-sized magnetic regions, each of which is used to encode a single binary unit of information. In today's hard disks each of these magnetic regions is composed of a few hundred magnetic grains. Each magnetic region forms a magnetic dipole which generates a highly localized magnetic field nearby. The write head magnetizes a magnetic region by generating a strong local magnetic field nearby. Early hard disks used the same inductor that was used to read the data as an electromagnet to create this field. Later versions of inductive heads included, metal in Gap (MIG) heads and thin film heads. In today's heads the read and write elements are separate but are in close proximity on the head portion of an actuator arm. The read element is typically magneto-resistive while the write element is typically thin-film inductive.

Hard disks have a mostly sealed enclosure that protects the disk internals from dust, condensation, and other sources of contamination. The hard disk's read-write heads fly on an air bearing which is a cushion of air only nanometers above the disk surface. The disk surface and the disk's internal environment must therefore be kept immaculate to prevent damage from fingerprints, hair, dust, smoke particles and such, given the sub-microscopic gap between the heads and disk.

Using rigid platters and sealing the unit allows much tighter tolerances than in a floppy disk drive. Consequently, hard disk drives can store much more data than floppy disk drives and access and transmit it faster. In 2007, a typical enterprise, i.e. workstation hard disk might store between 160 GB and 750 GB of data (as of local US market by December 2006), rotate at 7,200 to 10,000 revolutions per minute (RPM), and have a sequential media transfer rate of over 80 MB/s. The fastest enterprise hard disks spin at 15,000 RPM, and can achieve sequential media transfer hard disk are Laptop Mobile, i.e., speeds up to and beyond 110 MB/s. physically smaller than their desktop and enterprise counterparts, tend to be slower. In 2007 a typical and have les capacity. In the 1990's, most spun at 4200 RPM mobile hard disk spins at a 5400 RPM and 7200 RPM models are readily for a slight price premium.

Hard disk characteristics.5.7.5

Figure (2.19)

5.25" MFM 110 MB hard disk (2.5" ATA 6495 MB hard disk, US & UK pennies for comparison)
Capacity, usually quoted in gigabytes. (older hard disks used to quote their smaller capacities in megabytes), Physical size, usually quoted in inches:

Almost all hard disks today are of either the 3.5" or 2.5" varieties, used in desktops and laptops, respectively. 2.5" disks are usually slower and have less capacity, but use less power and are more tolerant of movement. However, as of early 2007, manufacturers have started selling SATA and SAS 2.5" drives for use in servers and desktops.
An increasingly common size is the 1.8" ATA-7 LIF form factor used inside digital audio players and subnotebooks, which provide up to 100GB storage capacity at low power consumption and are highly shock-resistant. A previous 1.8" hard disk standard exists, for 2-5GB sized disks that fit directly into PCMCIA or Card bus expansion slots. From these, the smaller 1" form factor was evolved, which is designed to fit the dimensions of CF Type II, which is also usually used as storage for portable devices including digital cameras. 1" was a de facto form factor led by IBM's Micro drive, but is now generically called 1" due to other manufacturers producing similar products. There is also a 0.85" form factor produced by Toshiba for use in mobile phones and similar applications, including SD/MMC slot compatible hard disks optimized for video storage on 4G handsets.

The size designations are more nomenclature than descriptive: for example, a 3.5" drive is named for the size of the floppy disk whose drive bay size it was originally designed to occupy; the drive itself is actually wider.
Number of I/O operations per second:
Modern disks can perform around 50 random access or 100 Sequential access operations per second.
Power consumption (especially important in battery-powered laptops).
Audible noise in DBA (although many still report it in bells, not decibels).
G-shock rating (surprisingly high in modern disks).
Transfer Rate:
Inner Zone: from 44.2 MB/s to 74.5 MB/s.
Outer Zone: from 74.0 MB/s to 111.4 MB/s.
Random access time: from 5 ms to 15 ms.

2.7.6 Integrity

Figure (2.20)

An IBM hard disk head suspended above the disk platter.
The hard disk's spindle system relies on air pressure inside the enclosure to support the heads at their proper *flying height* while the disk is in motion. A hard disk requires a certain range of air pressures in order to operate properly. The connection to the external environment and pressure occurs through a small hole in the enclosure (about 1/2 mm in diameter), usually with a carbon filter on the inside (the *breather filter*, see below). If the air pressure is too low, there will not be enough lift for the flying head, the head will not be at the proper height, and there is a risk of head crashes and data loss. Specially manufactured sealed and pressurized disks are needed for reliable high-altitude operation, above about 10,000 feet (3,000 m). This does not apply to pressurized enclosures, like an airplane pressurized cabin.

Modern disks include temperature sensors and adjust their operation to the operating environment.

Very high humidity for extended periods can cause accelerated wear of the heads and platters by corrosion. If the disk uses "Contact Start/Stop" (CSS) technology to park its heads on the platters when not operating, increased humidity can also lead to increased striation (the tendency for the heads to stick to the platter surface). This can cause physical damage to the platter and spindle motor and can also lead to head crash. Breather holes can be seen on all disks — they usually have a warning sticker next to them, informing the user not to cover the holes. The air inside the operating disk is constantly moving too, being swept in motion by friction with the spinning platters. This air passes through an internal recirculation (or "recurs") filter to remove any leftover contaminants from manufacture, any particles or chemicals that may have somehow entered the enclosure, and any particles or out gassing generated internally in normal operation.

Figure (2.21)

Landing zones 2.7.7

Figure (2.22)

Microphotograph of a hard disk head. The size of the front face (which is the "trailing face" of the slider) is about 0.3 mm × 1.0 mm. The (not visible) bottom face of the slider is about 1.0 mm × 1.25 mm (so called "nano" size) and faces the platter. One functional part of the head is the round, orange structure in the middle - the lithographically defined copper coil of the write transducer. Also note the electric connections by wires bonded to gold-plated pads.

Spring tension from the head mounting constantly pushes the heads towards the platter. While the disk is spinning, the heads are supported by an air bearing and experience no physical contact or wear. In CSS drives the sliders carrying the head sensors (often also just called *heads*) are designed to reliably survive a number of landings and takeoffs from the media surface, though wear and tear on these microscopic components eventually takes its toll. The heads typically land in a "landing zone" that does not contain user data. Most manufacturers design the sliders to survive 50,000 contact cycles before the chance of damage on startup rises above 50%. However, the decay rate is not linear—when a disk is younger and has fewer start-stop cycles, it has a better chance of surviving the next startup than an older, higher-mileage disk (as the head literally drags along the disk's surface until the air bearing is established). For example, the Seagate Barracuda 7200.10 series of desktop hard disks are rated to 50,000 start-stop cycles. This means that no failures attributed to the head-platter interface were seen before at least 50,000 start-stop cycles during testing.

2.7.8 Disk families used in PC

Notable disk families include:

Bit Serial Interfaces - These families connected to a hard disk controller with three cables, one for data, one for control and one for power. The hard disk controller provided significant functions such as serial to parallel conversion, data separation and track formatting, and required matching to the drive in order to assure reliability.

ST506 used MFM (Modified Frequency Modulation) for the data encoding method.

ST412 was available in either MFM or RLL (Run Length Limited) variants.

ESDI (Enhanced Small Disk Interface) was an interface developed by Maxtor to allow faster communication between the PC and the disk than MFM or RLL.

Word Serial Interfaces These families connect to a host bus adapter (today typically integrated into the "North Bridge") with two cables, one for data/control and one for power. The earliest versions of these interfaces typically had a 16 bit parallel data transfer to/from the drive and there are 8 and 32 bit variants. Modern versions have serial data transfer. The word nature of data transfer makes the design of a host bus adapter significantly simpler than that of the precursor hard disk controller.

Integrated Drive Electronics (IDE) was later renamed to ATA, and then later, PATA ("parallel ATA", to distinguish it from the new serial ATA interface, SATA). The name comes from the way early families had the hard disk controller external to the disk. Moving the hard disk controller from the interface card to the disk helped to standardize interfaces, including reducing the cost and complexity. The 40 pin IDE/ATA connection of PATA transfers 16 bits of data at a time on the data cable. The data cable was originally 40 conductor, but later higher speed requirements for data transfer to and from the hard drive led to an "ultra DMA" mode, known as UDMA, which required an 80 conductor variant of the same cable; the other conductors provided the grounding necessary for enhanced high-speed signal quality. The interface for 80 pin only has 39 pins, the missing pin acting as a key to prevent incorrect insertion of the connector to an incompatible socket, a common cause of disk and controller damage.

EIDE was an unofficial update (by Western Digital) to the original IDE standard, with the key improvement being the use of DMA to transfer data between the disk and the computer, an improvement later adopted by the official ATA standards. DMA is used to transfer data without the CPU or program being responsible to transfer every word. That leaves the CPU/program/operating system to do other tasks while the data transfer occurs.

SCSI (Small Computer System Interface) was an early competitor with ESDI, originally named SASI for Stuart Associates. SCSI disks were standard on servers, workstations, and Apple Macintosh computers through the mid-90s, by which time most models had been transitioned to IDE (and later, SATA) family disks. Only in 2005 did the capacity of SCSI disks fall behind IDE disk technology, though the highest-performance disks are still available in SCSI and Fiber Channel only. The length limitations of the data cable allows for external SCSI devices. Originally SCSI data cables used single ended data transmission, but server class SCSI could use differential transmission, and then Fiber Channel (FC) interface, and then more specifically the Fiber Channel Arbitrated Loop (FC-AL), connected SCSI hard disks using fiber optics. FC-AL is the cornerstone of storage area networks, although other protocols like SCSI and ATA over Ethernet have been developed as well.

SATA (Serial ATA). The SATA data cable has one data pair for differential transmission of data to the device, and one pair for differential receiving from the device, just like EIA-422. That requires that data be transmitted serially. The same differential signaling system is used in RS485, Local Talk, USB, Fire wire, and differential SCSI.

SAS (Serial Attached SCSI). The SAS is a new generation serial communication protocol for devices designed to allow for much higher speed data transfers and is compatible with SATA. SAS uses serial communication instead of the parallel method found in traditional SCSI devices but still uses SCSI commands for interacting with SAS

Acronym	Meaning	Description
SASI	Shugart Associates System Interface	Predecessor to SCSI
SCSI	Small Computer System Interface	Bus oriented that handles concurrent operations.
ST-506		Seagate interface
ST-412		Seagate interface (minor improvement over ST-506)
ESDI	Enhanced Small Disk Interface	Faster and more integrated than ST-412/506, but still backwards compatible
ATA	Advanced Technology Attachment	Successor to ST-412/506/ESDI by integrating the disk controller completely onto the device. Incapable of concurrent operations.

Table (2.1)

2.8 Video and Monitors

The video adapter requires higher data transfer speeds than any other device. While the disks and network plug into the PCI bus or Southbridge main board chip, the video adapter is connected at high speed to the CPU and memory. For a decade, the video connector has been an AGP slot rated by speed (2x, 4x, or 8x). In the last few months, Intel has begun to offer a new slot design called PCI-Express that on paper can operate four times as fast as the fastest AGP slot. However, at the currently available technology, no video adapter card requires that much extra speed.

2.9 PCI and PCI Express

For a decade starting in 1985, PC adapter cards all plugged into the "ISA" bus. Then Intel came up with a better, faster PCI bus, which has dominated the last decade. The good news from such a long period of stability is that there are lots of fast, cheap, compatible adapter cards to upgrade your computer with an extra disk controller or a better audio system. The bad news is that ten years are up and it is time for a new I/O bus. The only part of PCI-Express that is similar to the old PCI bus is its name. It provides a much higher speed in a much smaller socket. However, although there are a few PCI-Express video cards available, there are no PCI-Express adapter cards. Systems will continue to need PCI slots for at least the next few years.

2.10 Ethernet

An Ethernet adapter card connects an office PC to the corporate network. At home it connects several computers to each other for file sharing, and it allows all the computers to share a single high speed Ethernet connection over a DSL or Cable modem.

2.11 USB and FireWire

To connect external devices (printers, scanners, disks, and CD or DVD writers) to a computer there are two popular connection standards. USB 2.0 and FireWire provide full speed support for large numbers and a broad variety of external plug and play devices.

2.12 System Memory and CPU speeds:

2.12.1 Introduction

Some of the most important terms and concepts regarding system performance are also the hardest to understand. Terms like: System Clock, Quad Pumping, Double Pumping, DDR, FSB, SDRAM, Dual Channel, and QDR make many new builders cringe. In this article I will walk you through some of these important concepts so that you can make a more informed decision when upgrading your current system or building a new one.

2.12.2 Bus:

To get anything done with a computer you have to get the information you input to the CPU and then to any attached devices such as cards, displays, and other output devices. Inside the computer itself, this information travels in the form of signals over what is known as a bus. You can think of a bus as a road and the signals as cars. A wide road (bus) can support more cars

(signals), and a smaller road (bus) supports less. The cars (signals) on the road (bus) have a speed limit (the bus speed). Although a speed limit can be broken (an over clocked bus) doing so can have adverse effects on the cars (signals).
Going along with this analogy: A computer is like a small city. You do not have just one road, but instead you have several different roads with different names and speeds.

There are three main buses in most computers:

1. *PCI Bus*- The PCI bus connects your expansion cards and drives to your processor and other sub systems. On most systems the bus speed of the PCI bus is 33MHz. If you go higher than that, then cards, drives, and other devices can have problems. The exception to this is found in servers. In some servers you have a special 64-bit (extra wide) 66MHz PCI slots that can accept special high-speed cards. Think of this as a double sized passing lane on a major road that allows higher cars to go through. For information about PCI Express please see the PCI Express Guide.
2. *AGP Bus*- The AGP bus connects your video card directly to your memory and processor. It is very high speed compared to standard PCI and has a standard speed of 66MHz. Only one device can be hooked to the AGP bus as it only supports one video card so the speed is better compared to the PCI bus, which has many devices on it at once.
3) *Front Side Bus (FSB)* - The Front Side Bus is the most important bus to consider when you are talking about the performance of a computer. The FSB connects the processor (CPU) in your computer to the system memory. The faster the FSB is, the faster you can get data to your processor. The faster you get data to the processor, the faster your processor can do work on it. The speed of the front side bus depends on the processor and motherboard chipset you are using as well as the system clock. Read on for more information about the Front Side Bus later in this article.

2.12.3 The System Clock:

The system clock is the actual speed of your FSB without any enhancements (such as double pumping, or quad pumping) on it. The system clock is also sometimes just called the bus speed. From the system clock your PCI bus speed is determined via the use of a divider and then your AGP bus speed is determined by multiplying the PCI bus speed by 2. The dividers allow you to have a faster speed on your PCI and AGP bus while still allowing for the faster operation of the main FSB. In most systems PCI dividers are set

automatically and you can not alter them, however, in newer motherboards geared towards computer enthusiasts -- PCI dividers can sometimes be manually set in order to allow you to raise the System clock higher than its normal rate. The three most common dividers built in to motherboards are: 1/5 (used on a 166MHz system clock), 1/4 (used on a 133MHz system clock), and 1/3 used on a 100MHz system clock. A 1/6 divider is sometimes available for over clocking and future support.
Example: If you have a 166MHz system clock and you set a 1/5 divider in your motherboard's bios then your PCI bus speed would be 166/5 = ~33MHz and your AGP bus speed would be ~33*2 = 66MHz.

2.12.4 Double Pumping, Quad Pumping, and DDR:

Earlier in this article I compared a bus to a road, and the bus speed to a speed limit. This isn't entirely correct because unlike a standard speed limit in real life you are not talking about miles per hour or kilometers per hour, you are talking about MHz or millions of clock cycles a second. A cycle is easily represented by a sine wave.

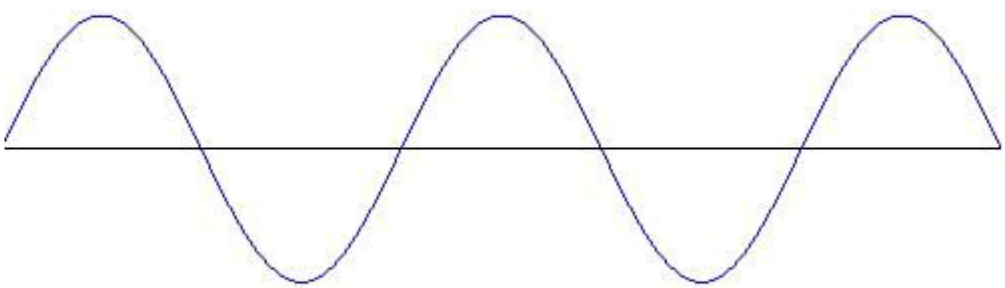


Figure (2.23)

A clock cycle is how long it takes to go from 1 to 0 (from the peek of the wave to the bottom of it). So how does that affect your system? Your processor and memory all can be affected by various enhancements to speed. To understand this you first must look back at the old way of doing things:

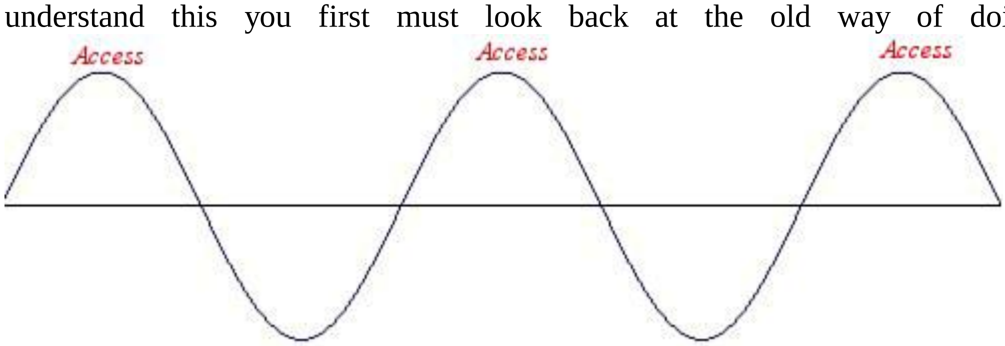


Figure (2.24)

Traditional parts without any enhancements can only send/receive a signal once a cycle. A good example of this as far as memory is concerned is standard SDRAM such as PC133. The traditional approach has been around for a long time and it matched well to the un-enhanced buses like you find on processors such as the Intel Pentium / II / III or AMD K6 series. For these types of systems standard SDRAM made a lot of sense because the memory and the processor both were able to transmit at the same time and the bus speed could be synchronized.

2.12.5 The Double Pumped bus w/DDR:

As time progressed processor and memory manufacturers found ways of improving the number of access times per cycle. With the release of the AMD Athlon Processor the world saw the concept of a "Double Pumped FSB". With a double pumped bus the processor could send and receive a signal from the memory sub system twice a cycle. This was a great idea; however this meant that standard SDRAM memory no longer lined up. Standard SDRAM memory could only send/receive once a cycle. What was created is what is known as a bottleneck -- or an obstacle to maximum performance. Removing the bottleneck required a new and faster type of memory and the memory that filled this gap was DDR memory or Double Data Rate memory.

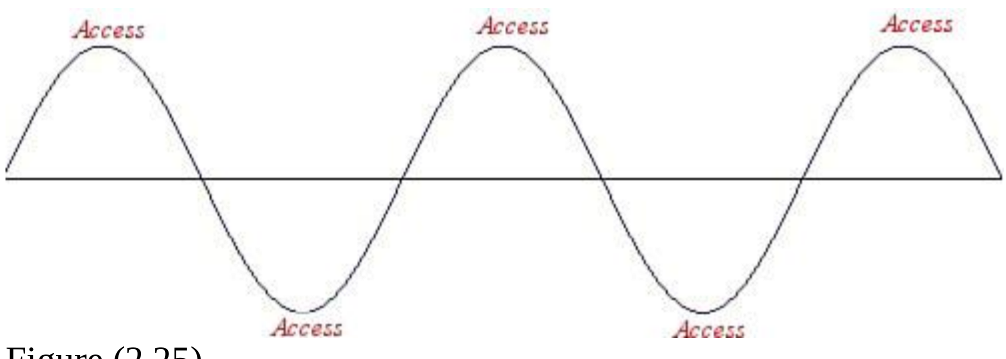


Figure (2.25)

DDR memory can transmit twice a cycle just like the double pumped bus on an Athlon processor, which means that using it with an Athlon processor creates an optimized situation just like you had before with the traditional system.

2.12.6 Quad Pumping, the P4, and Ram Bus Memory:

When the Pentium 4 came out they introduced a new catch phrase to the market: "Quad Pumped" (also known as QDR). The Pentium 4 FSB can handle 4 signals a cycle. When the P4 was first released motherboards only supported traditional SDRAM accessing once a cycle. As you can imagine, such a combination of single access a cycle memory and a four access a cycle processor gives you a massive bottleneck and greatly reduces the potential performance of the processor. Intel was very quick to adopt the fastest memory technology available: Ram bus RIMM memory. Although Ram bus memory only accesses twice a cycle like DDR, Ram bus memory comes in much higher speeds than DDR. The base speed of the popular Ram bus memory at the time was a double pumped 400MHz (800MHz). Although the memory does not handle 4 signals a cycle it does work very well since 400MHz is also the enhanced speed of the standard P4 FSB (4 accesses a cycle x 100MHz). The fact that the memory does two cycles for every cycle that the bus helps makes up for the two signals a cycle difference. It is not as good as true QDR would be but the technology is widely available unlike QDR memory.

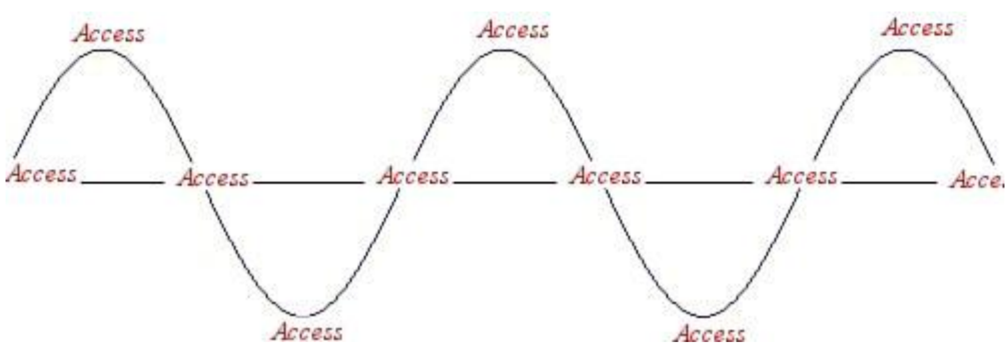


Figure (2.26)

2.12.7 Dual channel Technology

Lets say you have a car that can hold 4 people but you've got 8 people to transport across town. What do you do? Well you could take one load of people across town, and then go back and get another load of people (a standard memory system) or if money was no object you could simply buy another car and have the other half of the people follow you across town in the other car (a Dual channel memory bus). With dual channel technology you use two memory modules at once to further enhance performance. This essentially doubles the number of signals a second you can handle and doubles your bandwidth (volume of information that can be transferred at once). Point Blank: Dual channel technology increases memory performance but it costs more money because you have to buy memory modules in pairs. Dual channel technology also costs more because the motherboard has to support it in the chipset and a chipset that supports dual channel technology costs more due to the higher complexity of the memory bus. Higher motherboard cost + higher memory cost = higher overall system cost.

Dual channel Ram bus has been around for a long time but Dual Channel DDR technology is just now hitting the scene in mass. Since DDR memory is cheaper than Ram bus memory and more widely available, Dual Channel DDR should be a good option for the P4 processor but the problem is that as of this writing no consumer level chipset supporting Dual Channel DDR exists for the Pentium 4. (Dual channel DDR is widely available for the AMD Athlon XP series of processors via the nforce2 chipset by NVIDIA,) When Dual Channel DDR solutions emerge for the Pentium 4 they will quickly become the best price vs. performance ratio on the P4 side.

2.12.8 The System Clock, the Front Side Bus, and over clocking:

Now that you understand the performance enhancements in the FSB of a processor it is important that you understand how to figure out the processor multiplier and the proper system clock. When you go to purchase a processor you are told in the ad / description for the processor what FSB it has. To determine the proper system clock for the processor simply divide the FSB by the performance enhancer (2 for the double pumped bus on AMD Athlon XP/Thunderbird/Duron processors or 4 for the quad pumped bus on the Intel Pentium 4).

If your processor has a ... FSB then the system clock speed should be:

66MHz (Various Celeron and older): 66MHz clock
100MHz (Pentium II / Pentium III / K6): 100MHz clock
133MHz (Pentium II / Pentium III / K6): 133MHz clock
200MHz (Athlon, Duron, Thunderbird): 100MHz clock
266MHz (Thunderbird, XP): 133MHz clock
333MHz (XP): 166MHz clock
400MHz (Pentium 4): 100MHz clock
400MHz (AMD XP): 200MHz clock
533MHz (Pentium 4): 133MHz clock

800MHz (Pentium 4): 200MHz clock
800MHz (AMD64): 200MHz clock
1066MHz (Pentium 4/LGA775): 266MHz clock

Processor speed = processor multiplier x system clock

If you do not know the multiplier for your processor simply take the proper system clock speed for it and divide that into the rated processor speed and then round the dividend to the nearest .5. Examples: The Pentium4 3.06GHz processor has a FSB of 533MHz. Its system clock is 533 / 4 = ~133. The multiplier is 3,060 / 133 = ~23.

The AMD Athlon XP2700+ has a main clock speed of 2.17GHz and a FSB of 333MHz. Its system clock is 333 / 2 = ~166MHz. The multiplier is 2,170 / 166 = ~13

2.12.9 Under clocking and Over clocking:

Under clocking or the act of running a processor or device at under its rated speed is accomplished by simply running the device at a lower bus speed (or if possible a lower multiplier). Most under clocking is done by accident by new system builders. Most motherboards come defaulted to the lowest system clock speed that the motherboard supports. Since the system clock speed is usually not automatically set by the processor you put into the board, this means that if you put a processor with a higher bus speed than the lowest one the board supports, you are under clocking the processor. Over clocking or the act of running a processor or device higher then its rated speed is accomplished by increasing the system clock (or if possible the multiplier). The biggest issue with overcooking is keeping your PCI bus close to its speed limit (33MHz). Since a divider of your system clock determines your PCI bus, you not only affect your processor when you increase it, but also other parts of the system. Devices attached to the PCI bus are much less over clocking friendly then either memory or a CPU. When you over clock a processor using the system clock your processor speed is determined in the same way as one would for finding normal clock speed: processor multiplier x system clock = processor speed.

Example: An Athlon XP1800+ (1.53GHz) processor with a FSB of 266 and its system clock over clocked to 145MHz would give you a speed of ~1.67GHz and cause the board to detect the processor as a XP2000+.

2.12.10 Summary and Conclusion:

When you are choosing and installing components in a system you should now know how to properly set the system clock in order to achieve the full potential of the system. You should also now understand more about matching memory with a processor. Go with a motherboard/system that complements your CPU and provides it with memory support that well matches the FSB potential. Slower memory technologies such as PC133 SDRAM do not work well with current processors such as the Pentium 4 and Athlon XP. Although synchronizing the memory speed and the FSB speed is best it is OK to use memory that is faster then the FSB of your processor provided that the motherboard supports it.

2.11 CPU Speed:

CPU Freq is a Linux kernel subsystem which allows the clock speed of mobile CPUs (most often found in laptop computers) to be explicitly set. CPU Speed dynamically controls CPU Freq , slowing down the CPU to conserve power and reduce heat when the system is idle, on battery power or overheating, and speeding up the CPU when the system is busy and more processing power is needed. Using CPU Speed can significantly increase a laptop computer's battery life and significantly reduce the heat it generates while still allowing your system to perform at top speed when you need it.

Features in the current version

Dynamically adjusts CPU speed and voltage based on demand for CPU (idle/work ratio threshold is user-configurable)
Automatically detects available processor speeds
For normal operation, no configuration or options are necessary. Just run it!
Full multiprocessor support (each CPU separately run-time configurable)
One binary works on both Linux 2.4 with the 'proc' interface and Linux 2.6 with the 'sysfs' interface. No need to recompile if you switch kernels! (proc interface deprecated)
Configurable minimum and maximum allowed speeds
Can reduce CPU speed and voltage if AC power is disconnected from the computer (requires ACPI)
Can maximize CPU speed if AC power is connected to the computer (requires ACPI)
Can reduce CPU speed and voltage if CPU temperature gets too high (Requires ACPI, temperature is user-configurable)
Can be told to lock CPU at minimum or maximum frequency via signals

"nice()'d" processes and those waiting for I/O will not increase CPU speed
Polling interval for CPUs, temperature and AC adapter configurable separately
Crash-proof frequency switching even if you have an outdated version of CPU Freq and a very temperamental CPU (some AMD mobile Athlons in particular)
Handles strange processors with lots of little speed steps

1- Measured CPU Speed: The speed of your CPU, as determined by the actual performance measurement of your CPU. The speed text color is black, unless your CPU has a speed rating (see 2 below). Red means your CPU is over clocked -- running faster than the manufacturer rating. Yellow means your CPU is running slightly faster that it is rated. Green means OK.

2- Rated CPU Speed: If present (normally present on any Pentium 4 or later CPU), the actual manufacturer rated speed of your CPU. Your CPU should be running at (or below) this speed.

3- Caches: A detailed description of your Level 1, Level 2 and Level 3 caches as provided by your CPU. In general, the larger the cache sizes (as compared to another computer system), the faster your computer system will run.

4- Memory: The speed that you're CPU can access the memory in your computer, in megabytes per second -- as determined by timing a large memory to memory transfer. The larger this number, the faster your computer system will run.

2.14 Capacity

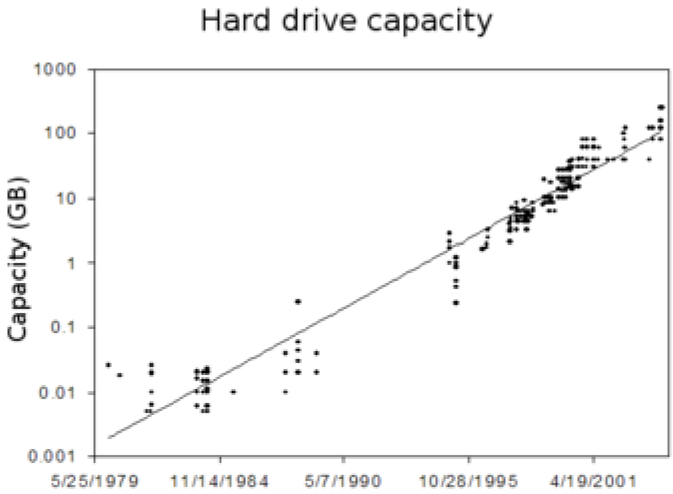


Figure (2.27)

PC hard disk capacity (in GB). The plot is logarithmic, so the fit line corresponds to exponential growth.
The exponential increases in disk space and data access speeds for hard disks has enabled the commercial viability of consumer products that require large storage capacities, such as the Apple IPod digital music player, the TIVO personal video recorder, and web-based email programs, like Google's G-mail. G-mail goes so far as to display a simulation of a real-time counter showing the amount of storage space available to an account as it increases each second.
This is also gradually but significantly altering how programmers think; in many programming tasks there is a time-space tradeoff, so as space becomes cheaper and cheaper relative to CPU cycles the appropriate choice about time versus space changes. For instance in database work it is now common practice to store precompiled views, transitive closures, and the like on disk in order to speed up queries; 20 years ago such profligate use of disk space would have been impractical.
A vice president of Seagate Technology projects a future growth in disk density of 40% per year. Access times have not kept up with throughput increases, which themselves have not kept up with growth in storage capacity.

The main way to decrease access time is to increase rotational speed, while the main way to increase throughput and storage capacity is to increase real density. However, real density is determined by two factors: recording density and track density. Track density measures how many tracks that can be packed into one area of space, while recording density measures the amount of data stored in a given physical length unit. Although higher track density can improve seek time, as disk head does not have to move as far to reach scattered data, improvement on transfer rate is not as important as increasing recording density. As of 2006, disk drives include perpendicular recording technology, in the attempt to enhance recording density and throughput.

2.14.1 Capacity measurements

Hard disk manufacturers specify disk capacity using the SI definition of the prefixes "mega", "Giga", and "Tera". This is largely for historical reasons. Disks with multi-million byte capacity have been used since 1956, long before there were standard binary prefixes. The International Electrotechnical Commission (IEC) only standardized binary prefixes in 1999. Many practitioners early on in the computer and semiconductor industries used the prefix kilo to describe 2^{10} (1024) bits, bytes or words because 1024 is close to 1000. Similar usage has been applied to the prefixes *mega*, *Giga*, *Tera*, and even *Peta*. Often this non-SI conforming usage is noted by a qualifier such as "1 kB = 1,024 bytes" but the qualifier is sometimes omitted, particularly in marketing literature.

Operating systems, such as Microsoft Windows, frequently report capacity using the binary interpretation of the prefixes, which results in a discrepancy between the disk manufacturer's stated capacity and what the system reports. The difference becomes much more noticeable in the multi-gigabyte range. For example, Microsoft's Windows 2000 reports disk capacity both in decimal to 12 or more significant digits and with binary prefixes to 3 significant digits. Thus a disk specified by a disk manufacturer as a 30 GB disk might have its capacity reported by Windows 2000 both as "30,065,098,568 bytes" and "28.0 GB." The disk manufacturer used the SI definition of "giga," 10^9. However utilities provided by Windows define a gigabyte as 2^{30}, or 1,073,741,824, bytes, so the reported capacity of the disk will be closer to 28.0 GB. For this reason, many utilities that report capacity have begun to use the aforementioned IEC standard binary prefixes (e.g. KiB, MiB, GiB) since their definitions are unambiguous.

Some people mistakenly attribute the discrepancy in reported and specified capacities to reserved space used for file system and partition accounting information. However, for large (several GiB) file systems, this data rarely occupies more than a few MiB, and therefore cannot possibly account for the apparent "loss" of tens of GBs.

The capacity of a hard disk can be calculated by multiplying the number of cylinders by the number of heads by the number of sectors by the number of bytes/sector (most commonly 512). However, the cylinder, head, sector values are not accurate for drives using zone bit recording, or address translation. On ATA drives bigger than 8 gigabytes, the values are set to 16383 cylinder, 16 heads, and 63 sectors for compatibility with older operating systems.

Chapter three

3.1 Wireless Technology:

When viewed as a method of data transport, wireless technology appears very similar to wired technology. You have a piece of hardware, a method of transmission, and connections on both ends that transform data from human-intelligible to transportable and back. For both wired and wireless technology, the range of transmission is an issue. You can't move your laptop 15 feet from the wall jack when depending on a 10-foot cable. Similarly, you can't go out for a jog and expect your in-home cordless phone to keep a connection five miles away from its receiver. But if you get either a 20-foot cable or a wireless connector of sufficient power, you can move your laptop 15 feet away from the wall jack; and if you get a cellular phone, you can go jogging five miles away from your house and still take calls (as long as your service provider has a reasonable antenna set up).
The methods of connection and ranges of service available vary in wireless technology just as they do in wired technology. Home telephones with a wireless handset have a more limited range than cellular phones; infrared transmissions have a more limited range than radio-wave (including microwave) transmissions. Different types of wireless solutions can communicate ten feet, ten miles, or with a satellite in orbit.

3.1.1 Advantages of Wireless Technology

1- Stay connected:

Among the most significant results revealed by recent end user surveys is that using wireless LANs allows users to stay connected to their network for approximately one and three-quarter more hours each day. A user with a laptop and a wireless connection can roam their office building without losing their connection, or having to log in again on a new machine in a different location. This translates to a very real increase in productivity, as much as 22% for the average user.

2- Access to accurate information:

A further advantage of wireless Local Area Networks (revealed by a recent NOP study) was greater accuracy in everyday tasks. For respondents from healthcare organizations, 51 percent felt the improvement in accuracy was "significant." The "anytime, anywhere" aspect of wireless communications allows increased access to accurate information when it is needed most - with health care, this could mean the difference between a life or death decision.

3- Spaghetti free:

Perhaps the most obvious advantage comes from removing the need for extensive cabling and patching. Are you moving your enterprise to a new building? Do you need to set up a new office and add it to your existing network? Are you adding a new department in the same building or simply adding a few machines to your network? A wireless LAN makes all these tasks substantially easier. Of course this translates directly into return on your wireless networking investment.

4- ROI:

ROI - perhaps the overriding consideration in IT spend. According to the NOP study, wireless networking has a measurable impact on return on investment (ROI), with organizations saving an average of $164,000 annually on cabling costs and labor, more than 3.5 times the amount IT staff had anticipated. These savings did not include the financial benefits of increased productivity, which can increase an organization's return on their wireless LAN investment by even more substantial amounts.

5- Increased productivity:

Referencing the NOP study, Charles Giancarlo, Senior Vice President of Cisco Systems, had this to say: "Current economic conditions have made productivity and profitability the new benchmarks for business success. Wireless networking has been viewed as one of the technologies promising the greatest impact on productivity but, until now, no formal studies existed to substantiate the many benefits of wireless LANs. The results of this research show that wireless LANs can have a direct impact on productivity - and that the benefits are even more significant than they were assumed to be.

Note:

Wireless technology also has advantages which are not so easy to measure, but still have real benefit for businesses. Happy employees means, a happier working environment which means a more productive working environment. 87 percent of respondents to the NOP study agreed that there is a discernible positive impact in their quality of life from wireless LAN use tied to increased flexibility, productivity and time savings. More can be accomplished in less time, leading to a better balance between work and life and a higher level of employee satisfaction. This translates to greater employee loyalty and productivity.

3.2 RF Technology:

Companies look for any edge to remain competitive in today's high-speed business climate. Streamlining supply chain management systems can deliver that advantage -- shaving even a few minutes off of order processing times can translate into better customer service through faster delivery of product to the customer, reduced costs, and ultimately increased profitability. Using RF technology to deploy fast real-time data capture and communications in the supply chain can turn saved minutes into true competitive advantage. With the time and cost savings of wireless communications substantiated, more and more companies are evaluating RF technology and the business benefits it can deliver throughout the enterprise. RF technology delivers a seamless flow of information between workers and critical business systems, leaving employees free to move about the company as needed to work, without losing touch with critical data and business systems.

3.2.1 The RF Advantage:

The advantages of an RF system are many:
WS2000 and WS5100 Symbol's Wireless Switches devices provide integrated wired and wireless networking solutions, offering enterprise class security (802.11i, site-to-site IPSec VPN), public/private network segmentation and 802.11a/b/g support.
Up-to-the minute data integrity and real-time communications increase the speed of all operations within a company.

Time spent manually updating data is eliminated, resulting in increased productivity.

3.2.2 Key Points:

Using RF technology in the supply management system turns saved minutes into competitive advantages
Real-time data integrity and communications speed all operations within a company
Less wasted time means fewer people can accomplish more in less time
Reduces time-consuming paperwork and related costs
Wireless infrastructure may be more cost effective than running cable
The productivity increase translates into fewer people accomplishing more tasks in less time.
Paper work -- and the associated costs -- are reduced or eliminated.
Up-to-date always available data allows for prompt response times and improved service levels.

3.2.3 At the physical level:

The need to lay cable is eliminated. Cable is expensive, less flexible than RF coverage and can be prone to damage.
For new facilities, implementing a wireless infrastructure may be more cost effective than running cable.
Supply Chain Applications
Many points in the supply chain can realize important advantages from accurate, real-time data that RF provides.
Shipping, Receiving and Internal Transport
When goods arrive, the bar code is scanned and data is sent to the host. At the same time, the received quantity is compared with the ordered quantity to immediately determine if there is a disparity.
If goods received are different from the order or are damaged, immediate action can be taken, depending on the disposition. The goods are then processed and sent to their destination. With RF, goods do not sit idle when instructions for de-positioning the received goods are sent wirelessly. Forklift operators receive instructions on a mobile device, eliminating dead-end trips, making more productive use of personnel and materials, and ultimately saving time.

Outgoing goods can be directed efficiently to trucks and confirmed via the RF system. Invoices, shipping notices and other forms and reports can be initiated the moment truck leaves the dock.

Inventory Control

RF in inventory control can offer huge savings in time and money. Because all events are recorded in real time, the host is continually aware of the current inventory. This high level of monitoring eliminates manual counting cycles. With RF, many companies reduce formal annual inventory cycles, and in some cases eliminate them altogether.
Further, an RF system allows stock "picking" and replenishment to be combined, dramatically reducing the number of movements involved in the internal transport of goods.

Order Picking and Stock Replenishment

RF offers many possibilities for speedy verification of previous transactions. For example: After a certain number of transactions, the remaining stock at the pick-up location can be counted for extra verification. If the physical stock is not the same as the administrative stock, those mistakes can be rectified before the goods are moved or shipped.
Users typically report significant gains in the number of pickups or put ways processed per hour after implementing RF operations.
When palliated goods are put into stock, forklift operators can use their mobile device to notify the host of the goods' disposition and that they are ready for another job.

Similarly, a forklift operator can receive instructions about an order similarly, a forklift operator can receive instructions about an order notify the management system. Delivery instructions are provided back to the operator on the mobile device, via RF.
Providing real-time updates of picking activity and order status enables the management system to continually calculate the most efficient pick and put away routes and order assignments.

Each time stock is "picked", the transaction is recorded by the mobile device and sent to the host. When stock reaches preset minimum levels, the system can alert a supervisor or automatically generate a stock replenishment request.

When bulk stock reaches order level, a purchase order is automatically created and an order placed. Reordering is instantaneous and inventory stocks can be kept low.

3.2.4 Manufacturing Applications

In manufacturing, RF can help automate the production, maintenance and repair processes. Typical medium and large manufacturers must stock, control and ensure the availability of thousands of items, from raw materials through finished products. Production of those items must be carefully coordinated so the company can meet order commitments and productivity goals.

Adding RF technology to a manufacturing tracking system ensures up-to-date information is available to operators, keeping production interruptions to a minimum. RF speeds ordering and guarantees replenishment quickly, resulting in faster moving product as well.
And real-time verification in the production process can reduce labor and expenses by preventing errors and costly rework.

Quality Control

The prompt RF communications increase the efficiency of quality control processes. When a problem arises that needs quick resolution, such as a bad batch of materials reaching the assembly line, instant messages can be sent to as all workers on the line. In turn, worker questions can be answered and reports taken immediately.
Labor/Human Resources Management
Managers always know where their staff is and what they are doing with an RF system. This allows them to make quick adjustments when necessary. For example, if one worker stops to handle a problem, another can be reassigned to continue filling an order that needs to ship. Job costing and payroll are streamlined and more efficient because all data entered into the mobile device is time-stamped and tracked within the host system.

3.2.5 Port Applications

Costly, inaccurate and time-consuming paper-based administrative procedures associated with port operations can be replaced with automated, paperless RF-based material and container handling:
Loading and unloading schedules can be planned and confirmed before a vessel docks.

Container disposition is available in real-time, so extraneous workers, containers, or equipment is eliminated. Operators use RF devices to schedule combined cargo drop-offs and pickups.

Wireless network messages can be routed automatically to vehicle operators about changed priorities, schedules, load transfers, or destinations. Handling time is reduced with real-time systems. Container and equipment service records can be automatically updated.

Managers can remotely issue repair schedules to devices as necessary. Symbol Solutions: Wi-Fi Infrastructure Management Symbol's Enterprise Mobility Services provide comprehensive support and technical expertise for designing, deploying and maintaining successful mobility solutions. With a full suite of products -- from wireless switches, access points and wireless handheld devices to the Mobility Services Platform (Symbol's network management system) -- Symbol's diverse service offerings enhance enterprise business operations, providing you with value and uptime throughout the entire lifecycle of your mobility solution.
Our Mobility Services give enterprise customers access to Symbol's expertise in designing and deploying global mobility solutions. The following products are included in Symbol's Enterprise Mobility Services product suite:

WS5100 and WS2000-Symbol Wireless Switches provide integrated wired and wireless networking solutions, offering enterprise class security (802.11i, site-to-site IPSec VPN), public/private network segmentation and 802.11a/b/g support.
AP300-Symbol's Access Ports represents the evolution of the access point from a difficult to scale network node to a simple RF media access device for the wireless switch with true "plug-and-play" (zero configuration) that is

operational right out-of-the-box. The AP300 Access Port delivers robust and feature rich IEEE 802.11a/b/g connectivity.
MSP-Symbol's Mobility Services Platform (MSP) is a scalable hardware and software enterprise management solution, providing a single point of visibility into -- and control over -- the mobile enterprise. With MSP, customers can rapidly deploy new mobile devices, upgrade existing devices, monitor health and performance, and quickly isolate and troubleshoot faults.
MC50/MC3000/MC9000-Symbol's small lightweight wireless PDA-style appliances support numerous data and voice enterprise-level communication applications.

MK1000/MK2000-Symbol's retail micro kiosk merchandising tools provide automated customer self-service for bar code pricing lookups while improving customer satisfaction via quick and easy usability.
Lower Total Cost of Ownership--Outstanding Investment Protection
Symbol's wireless portfolio removes the overhead and complexity of first-generation access point-based wireless LANs, delivering a wireless network that is less expensive to implement and manage. The extensive functionality, expandability, and centralized management eliminate the time and management costs associated with access point-based solutions, providing a lower total cost of ownership. And the flexibility to support the standards of today and tomorrow as well as the legacy wireless networks of yesterday provides outstanding investment protection.

Services and Support

Symbol Enterprise Mobility Services provide access to the deepest, richest technical expertise for mobility solutions. Symbol is equipped to deliver the level of repair service that is required for your mission critical solutions. Through a flexible and relevant service portfolio.
Customer Services ensure that your infrastructure is running efficiently and that their systems and solutions are running optimally. Symbol Enterprise Mobility Services delivers the knowledge and expertise to help you create new advantage through end-to-end mobility solutions.
About Symbol Technologies
Symbol Technologies, Inc., The Enterprise Mobility Company™, is a recognized worldwide leader in enterprise mobility, delivering products and solutions that capture, move and manage information in real time to and from the point of business activity. Symbol enterprise mobility solutions integrate advanced data capture products, radio frequency identification

technology, mobile computing platforms, wireless infrastructure, mobility software and world-class services programs. Symbol enterprise mobility products and solutions are proven to increase workforce productivity, reduce operating costs, drive operational efficiencies and realize competitive advantages for the world's leading companies.

3.3 Radio Frequencies

A radio wave is an electromagnetic wave propagated by an antenna. Radio waves have different frequencies, and by tuning a radio receiver to a specific frequency you can pick up a specific signal.

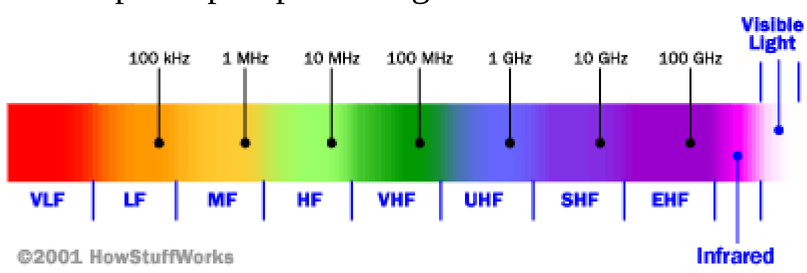


Figure (3.1)

In the United States, the FCC (Federal Communications Commission) decides who is able to use which frequencies for which purposes, and it issues licenses to stations for specific frequencies. See How Radio Works for more details on radio waves.
When you listen to a radio station and the announcer says, "You are listening to 91.5 FM WRKX The Rock!," what the announcer means is that you are listening to a radio station broadcasting an FM radio signal at a frequency of 91.5 megahertz, with FCC-assigned call letters of WRKX. Megahertz means "millions of cycles per second," so "91.5 megahertz" means that the transmitter at the radio station is oscillating at a frequency of 91,500,000 cycles per second. You're FM (frequency modulated) radio can tune in to that specific frequency and give you clear reception of that station. All FM radio stations transmit in a band of frequencies between 88 megahertz and 108 megahertz. This band of the radio spectrum is used for no other purpose but FM radio broadcasts.
In the same way, AM radio is confined to a band from 535 kilohertz to 1,700 kilohertz (kilo meaning "thousands," so 535,000 to 1,700,000 cycles per second). So an AM (amplitude modulated) radio station that says, "This is

AM 680 WPTF" means that the radio station is broadcasting an AM radio signal at 680 kilohertz and its FCC-assigned call letters are WPTF.

Common frequency bands include the following:

AM radio - 535 kilohertz to 1.7 megahertz

Short wave radio - bands from 5.9 megahertz to 26.1 megahertz

Citizens band (CB) radio - 26.96 megahertz to 27.41 megahertz

Television stations - 54 to 88 megahertz for channels 2 through 6

FM radio - 88 megahertz to 108 megahertz

Television stations - 174 to 220 megahertz for channels 7 through 13

What is funny is that every wireless technology you can imagine has its own little band. There are hundreds of them! For example:

Garage door openers, alarm systems, etc. - Around 40 megahertz

Standard cordless phones: Bands from 40 to 50 megahertz

Baby monitors: 49 megahertz

Radio controlled airplanes: Around 72 megahertz, which is different from...

Radio controlled cars: Around 75 megahertz

Wildlife tracking collars: 215 to 220 megahertz

MIR space station: 145 megahertz and 437 megahertz

Cell phones: 824 to 849 megahertz

New 900-MHz cordless phones: Obviously around 900 megahertz!

Air traffic control radar: 960 to 1,215 megahertz

Global Positioning System: 1,227 and 1,575 megahertz

Deep space radio communications: 2290 megahertz to 2300 megahertz

Why is AM radio in a band at 550 kilohertz to 1,700 kilohertz, while FM radio is in a band at 88 to 108 megahertz? It is all completely arbitrary, and a lot of it has to do with history.

AM radio has been around a lot longer than FM radio. The first radio broadcasts occurred in 1906 or so, and frequency allocation for AM radio occurred during the 1920s (The predecessor to the FCC was established by Congress in 1927.). In the 1920s, radio and electronic capabilities were fairly limited, hence the relatively low frequencies for AM radio.

Television stations were pretty much non-existent until 1946 or so, which is when the FCC allocated commercial broadcast bands for TV. By 1949, a million people owned TV sets, and by 1951 there were 10 million TVs in America.

FM radio was invented by a man named Edwin Armstrong in order to make high-fidelity (and static-free) music broadcasting possible. He built the first station in 1939, but FM did not become really popular until the 1960s. Hence the higher frequencies for FM radio.

3.4 Bluetooth Technology

The foundation of *Bluetooth* wireless technology is composed of the adopted specifications that are utilized and developed by the Bluetooth SIG’s global membership as guidelines for producing interoperable products. The *Bluetooth* specifications are categorized as the core specification, profiles, protocols, and transports.

The *Bluetooth* core specification describes the protocol stack up through the L2CAP layer and the characteristics of each of the relevant protocols, as well as the relationship between them.

Above the *Bluetooth* core specification are a set of protocols that have been defined for use by one or more profiles.

Profile specifications define a set of features required to support a particular usage model or set of usage models. A profile specification document describes how to use the protocol stack to implement a given profile.

Transport specifications define physical interfaces that can be used to implement the Host Controller Interface (HCI). The HCI transports are used in products that choose to separate the implementation of the Host and Controller functions.

Note:

The answers to all your questions are here in varying levels of detail to meet everyone’s needs. The information ranges from high-level overviews of the short-range wireless technology to detailed specification documents.

Read about *Bluetooth* technology benefits to the consumer as well as the enterprise. Better understand how *Bluetooth* technology works. Compare *Bluetooth* wireless technology to other similar short-range wireless technologies. Dig deeper into the specifications to fully comprehend the various levels of *Bluetooth* technology from the base band to profile and application levels

Educate yourself on how to keep your *Bluetooth* devices secure. Use the glossary as a reference as you run across new *Bluetooth* terminology. Consider this your *Bluetooth* classroom and explore.

Figure (3.2)

3.4.1 How *Bluetooth* Technology Works

Bluetooth wireless technology is a short-range communications system intended to replace the cables connecting portable and/or fixed electronic devices. The key features of *Bluetooth* wireless technology are robustness, low power, and low cost. Many features of the core specification are optional, allowing product differentiation.
The *Bluetooth* core system consists of an RF transceiver, base band, and protocol stack. The system offers services that enable the connection of devices and the exchange of a variety of data classes between these devices.

3.4.2 Overview of Operation

the *Bluetooth* RF (physical layer) operates in the unlicensed ISM band at 2.4GHz. The system employs a frequency hop transceiver to combat interference and fading, and provides many FHSS carriers. RF operation uses a shaped, binary frequency modulation to minimize transceiver complexity.
The symbol rate is 1 Mega symbol per second (Msps) supporting the bit rate of 1 Megabit per second (Mbps) or, with Enhanced Data Rate, a gross air bit rate of 2 or 3Mb/s. These modes are known as Basic Rate and Enhanced Data Rate respectively.

During typical operation, a physical radio channel is shared by a group of devices that are synchronized to a common clock and frequency hopping pattern. One device provides the synchronization reference and is known as the master. All other devices are known as slaves. A group of devices synchronized in this fashion form a piconet. This is the fundamental form of communication for *Bluetooth* wireless technology.

Devices in a piconet use a specific frequency hopping pattern which is algorithmically determined by certain fields in the *Bluetooth* specification address and clock of the master. The basic hopping pattern is a pseudo-random ordering of the 79 frequencies in the ISM band. The hopping pattern may be adapted to exclude a portion of the frequencies that are used by interfering devices. The adaptive hopping technique improves *Bluetooth* technology co-existence with static (non-hopping) ISM systems when these are co-located.

The physical channel is sub-divided into time units known as slots. Data is transmitted between *Bluetooth* enabled devices in packets that are positioned in these slots. When circumstances permit, a number of consecutive slots may be allocated to a single packet. Frequency hopping takes place between the transmission or reception of packets. *Bluetooth* technology provides the effect of full duplex transmission through the use of a time-division duplex (TDD) scheme.

Above the physical channel there is a layering of links and channels and associated control protocols. The hierarchy of channels and links from the physical channel upwards is physical channel, physical link, logical transport, logical link and L2CAP channel. Within a physical channel, a physical link is formed between any two devices that transmit packets in either direction between them. In a piconet physical channel there are restrictions on which devices may form a physical link. There is a physical link between each slave and the master. Physical links are not formed directly between the slaves in a piconet.

The physical link is used as a transport for one or more logical links that support uni-cast synchronous, asynchronous and isochronous traffic, and broadcast traffic. Traffic on logical links is multiplexed onto the physical link by occupying slots assigned by a scheduling function in the resource manager.

A control protocol for the baseband and physical layers is carried over logical links in addition to user data. This is the link manager protocol (LMP). Devices that are active in a piconet have a default asynchronous connection-oriented logical transport that is used to transport the LMP protocol signaling. For historical reasons this is known as the ACL logical transport. The default ACL logical transport is the one that is created whenever a device joins a piconet. Additional logical transports may be created to transport synchronous data streams when this is required.

The link manager function uses LMP to control the operation of devices in the piconet and provide services to manage the lower architectural layers (radio layer and baseband layer). The LMP protocol is only carried on the default ACL logical transport and the default broadcast logical transport.

Above the base band layer the L2CAP layer provides a channel-based abstraction to applications and services. It carries out segmentation and reassembly of application data and multiplexing and de-multiplexing of multiple channels over a shared logical link. L2CAP has a protocol control channel that is carried over the default ACL logical transport. Application data submitted to the L2CAP protocol may be carried on any logical link that supports the L2CAP protocol

The first in an anticipated wave of products based on Bluetooth wireless technology should be available in stores shortly. As a result, you can expect to hear a lot of hype and hopes about how the Bluetooth standard will finally and truly liberate those who rely on any combination of portable devices while away from the office.

Bluetooth, in brief, is a wireless radio technology that can transmit voice and data without the need for wired connections. It works over distances of as much as 30 feet, or 100 meters with a special amplifier. And it can be incorporated into notebook computers, cell phones, personal digital assistants, and peripheral devices, such as computers, with a special PC card.

The expected wave of Bluetooth products will eventually allow you to print directly from a cell phone, synchronize data between a laptop and handheld without running wires, and access the Internet over a wireless hub at a convention or in an airport. The PC cards will certainly spike awareness of the potential advantages of using Bluetooth technology, but they'll merely allow users to share data with similarly equipped PCs, one-to-one.

Analysts and industry observers expect it'll be early next year before the technology really begins to hit its stride. That's when it will appear in a broader range of mobile products.

Consider some of the most recent announcements concerning Bluetooth and you get a sense of its potential implications for you, who rely on mobile devices when you're on the road.

- Toshiba_is expected to be the first computer maker to ship a Bluetooth product—this week if it hasn't already—with the release of a PC card incorporating the technology. It should sell for under $200.

- IBM has already announced plans for a comparable product for its ThinkPad series of notebooks.

- Cellular telecommunications maker Ericsson has signed an agreement with software developer Wind River to incorporate Bluetooth technology into operating systems for future handheld wireless devices, including cell phones.

- The CNET news services reports Hewlett Packard could start selling its own Bluetooth PC card in November, which would equip its "Jornada" handheld PCs and inkjet printers for the technology .

Such activity will certainly generate interest, which translates into momentum for Bluetooth in the coming months. Still, if you think a wireless personal network could enhance your productivity, consider waiting until all the pieces are in place before you get caught up in the hype. As with any send-receive technology, Bluetooth must be installed at both ends of a transmission before it can offer any advantage.

3.5 History of Infrared Technology

Sir William Herschel, an astronomer, discovered infrared in 1800. He built his own telescopes and was therefore very familiar with lenses and mirrors. Knowing that sunlight was made up of all the colors of the spectrum, and that it was also a source of heat, Herschel wanted to find out which color(s) were responsible for heating objects. He devised an experiment using a prism, paperboard, and thermometers with blackened bulbs where he measured the temperatures of the different colors. Herschel observed an increase in temperature as he moved the thermometer from violet to red in the rainbow created by sunlight passing through the prism. He found that the hottest temperature was actually beyond red light. The radiation causing this heating was not visible; Herschel termed this invisible radiation "calorific rays." Today, we know it as infrared.

Figure (3.3)

3.5.1 Example:

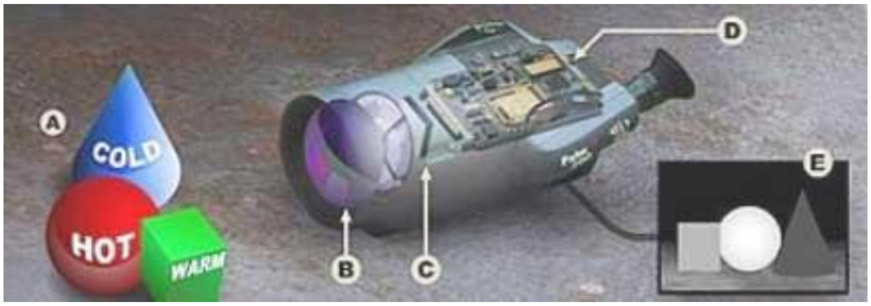


Figure (3.4)

How Do Infrared Cameras Work

Infrared cameras sense infrared energy to see in the dark. Infrared energy is emitted proportionately to the temperature of an object. As shown in the diagram above, infrared energy from objects in the scene (A) is focused by the optics (B) onto an infrared detector (C). The information from the infrared detector is passed to sensor electronics (D) for image processing. The signal processing circuitry translates the infrared detector data onto an image that can be viewed on a standard video monitor (E).

Chapter four

Hardware implementation

4.1 overview

In this chapter we will explain the hardware elements in our project in detail, and how they work together.
We will also mention the advantages and disadvantages of each element. And will mention also some of the alternative elements that we could have used in this project, and also will be mentioned why did not used.

We can divide our project into two main parts

4.2 Remote Controller Circuit (transmitter)

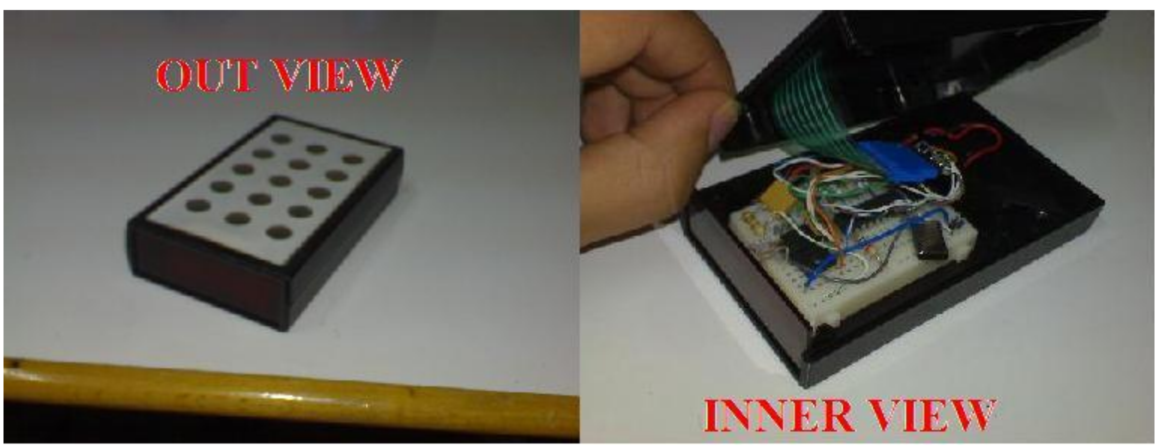


Figure (4.1)

Transmitter consists of the following elements:

key-pad
PIC microcontroller
Regulator

4.2.1 Key-pad

To make our device more friendly to the user and simple to use we decided to use a keypad, the keypad is a matrix of rows and columns as shown in figure xx below

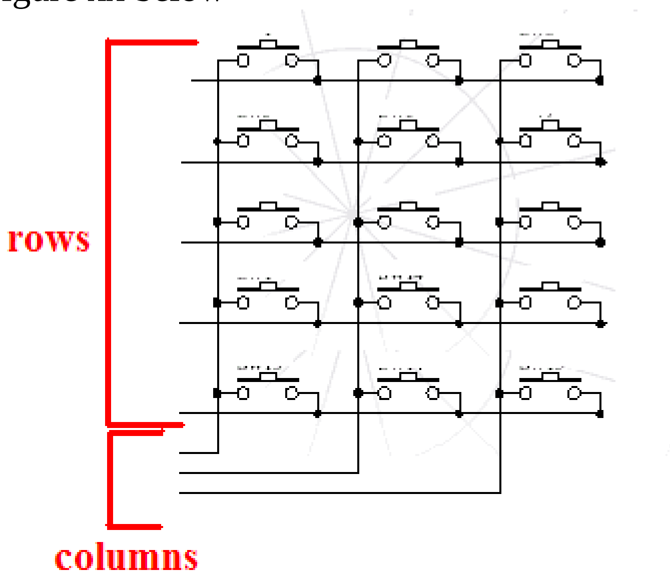


Figure (4.2)

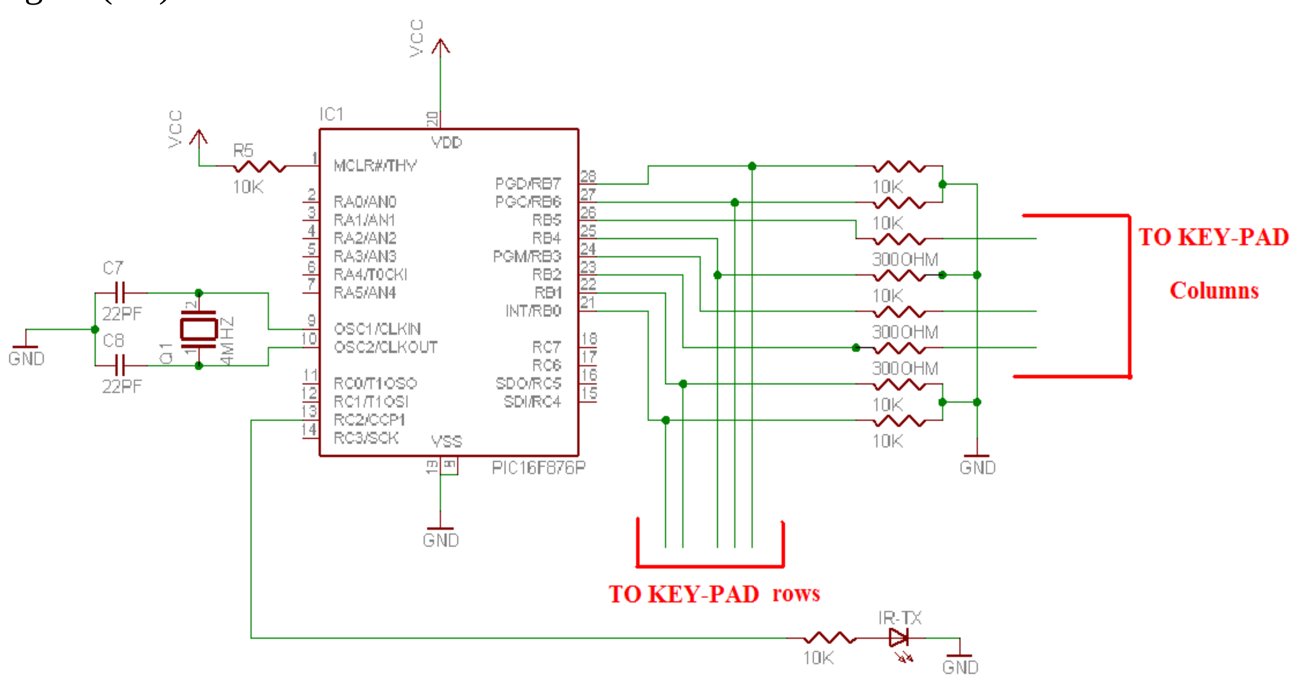


Figure (4.3)

Developed work

Our key-pad is consists of three columns and five rows , with a pin for each column and row, this will give a 15 different keys.
In order to the PIC microcontroller to specify which key is pressed we need to make just one column pin as output and all the other as input, this output will configured as logic high (5V) then the PIC will check if there is any logic 1 on any pin of the rows.
If there is any then the intersection button between the column and the row is pressed

4.2.2 PIC microcontroller

Today, the field of controller uses the technology of microcontrollers. This development has made it possible to store hundreds of thousands of transistors into one chip. That was a prerequisite for production of microprocessors, and the first computers were made by adding external peripherals such as memory, input-output lines, timers and others. Further increasing the volume of the package resulted in creation of integrated circuits. These integrated circuits contained both processor and peripherals. That is how the first chip containing a microcomputer, or what would later be known as a microcontroller came about.

A Microcontroller is by definition a computer on a chip. A person just need to apply the power and possibly clock signal to that device and it starts executing the program programmed to it. A Microcontroller generally has the main CPU core, ROM/ EPROM/ EEPROM/ FLASH, RAM and some accessory functions (like timers and I/O controllers) all integrated into one chip.

Microcontrollers are typically used where processing power is not so important. More important are generally compact construction, small size, low power consumption and that those chips are cheap. With the continuing process of high scale integration continuing at a dizzying pace, many standard architecture processors are turning up as microcontrollers [1].

4.3 Microcontrollers versus Microprocessors:

Microcontroller differs from a microprocessor in many ways. First and the most important is its functionality. In order for a microprocessor to be used, other components such as memory, or components for receiving and sending data must be added to it. In short that means that microprocessor is the very heart of the computer. On the other hand, microcontroller is designed to be all of that in one. No other external components are needed for its application because all necessary peripherals are already built into it. Thus, we save the time and space needed to construct devices [4].

4.3.1 Overview:

The microcontroller contains a Central Processing Unit CPU, Random Access Memory RAM, Read Only Memory ROM, Input/Output I/O lines, Serial and Parallel ports, timers and other built-in peripherals such as Analog to Digital A/D, Digital to Analog D/A and Pulse Width Modulation PWM. The Microcontrollers have RISC architectural features like Harvard architecture, Long word instructions, Single word instructions, Single cycle instructions, Instruction pipelining, Reduced instruction set, Register file architecture and Orthogonal (Symmetric) instructions.

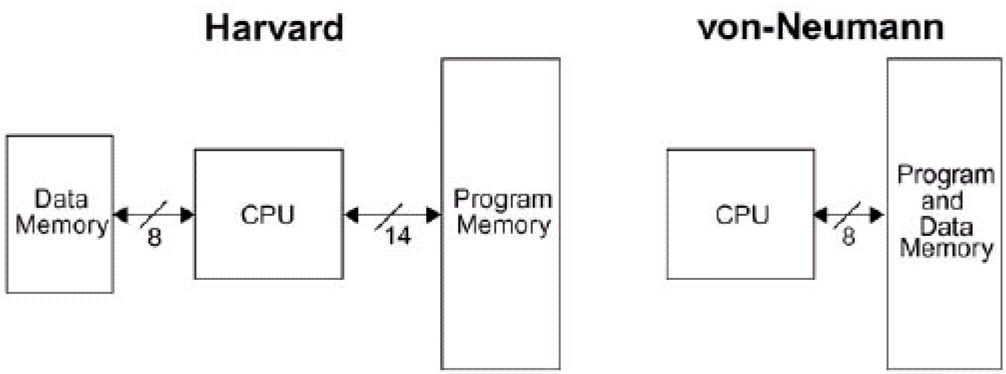


Figure (4.4): Harvard vs. von-Neumann Architectures

Microchip PIC micro-controller MCU 8-bit (8 Data Bits) Microcontrollers used what is called Harvard Architecture, while Microprocessors used von Neumann Architecture. That means the memory on the microcontroller is divided into program memory and data memory, also the CPU use separate buses to communicate with each program or data, this will improve bandwidth. Von Neumann architecture accesses program and data over the same bus [1] ,[4].

4.3.2 Microcontroller Core Features:

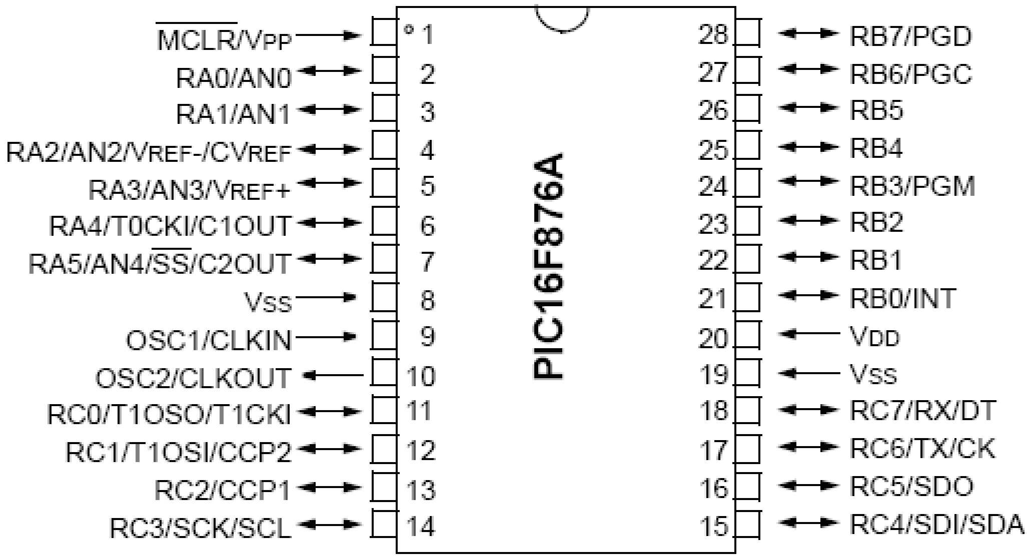


Figure (4.5) PIC16F876A Model

High performance RISC CPU.
35 single word instructions.
All single cycle instructions except for program branches which are two cycles.
Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle.
8K x 14 words of FLASH Program Memory, 368 x 8 bytes of Data Memory (RAM) and 256 x 8 bytes of EEPROM Data Memory.
Interrupt capability (14 sources).
Direct, indirect and relative addressing modes.
Power-on Reset (POR).
Power-up Timer (PWRT) and Oscillator Start-up Timer (OST).
Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation.
Programmable code protection.
Power saving SLEEP mode.
Selectable oscillator options.
Low power, high speed CMOS FLASH/EEPROM technology.
Fully static design.
Processor read/write access to program memory.
Wide operating voltage range: 2.0V to 5.5V.
High Sink/Source Current: 25 mA.

4.3.3 Memory organization:

There are three memory types in each PIC16F876A IC:
Flash EPROM (14-bit Program memory)
EEPROM (8-bit Data memory)
RAM (8-bit Data memory)

4.3.3.a Program memory:

FLASH: For storing a written program. Since memory made in FLASH technology can be programmed and cleared more than once, it makes this microcontroller suitable for device development. The PIC16F876A have a 13-bit program counter capable of addressing an 8K x 14 program memory space. It has either 2K (2048 Bytes) or 4K (4096 Bytes) or 8K (8192 Bytes) addresses of Program memory.
2K: need only on 11-bit, 2upper-bit ignore.
4K: need only on 12-bit, 1upper-bit ignore.
8K: need only on 13-bit, nothing ignore.

4.3.3.b Data memory organization:

RAM: Data memory used by a program during its execution. In RAM are stored all inter-results or temporary data during run-time. Data memory is partitioned into four banks that contain the General Purpose Registers - General Purpose RAM (GPR), and the Special Function Registers (SFR). We can select any bank through bits RP0 and RP1 from STATUS Register. Each bank extends up to 7Fh (128 bytes) with lower location's is for Special Function Registers, and the upper are for General Purpose Register's. The file register can be accessed either directly or indirectly through the File Select Register (FSR - Indirect Data Memory Address Pointer).

EEPROM: Data memory that needs to be saved when there is no supply. It is usually used for storing important data that must not be lost if power supply suddenly stops. For instance, one such data is an assigned temperature in temperature regulators. If during a loss of power supply this data was lost, we would have to make the adjustment once again upon return of supply. Thus our device looses on self-reliance.

Bank 0	File Address	Bank 1	File Address	Bank 2	File Address	Bank 3	File Address
Indirect addr.(*)	00h	Indirect addr.(*)	80h	Indirect addr.(*)	100h	Indirect addr.(*)	180h
TMR0	01h	OPTION_REG	81h	TMR0	101h	OPTION_REG	181h
PCL	02h	PCL	82h	PCL	102h	PCL	182h
STATUS	03h	STATUS	83h	STATUS	103h	STATUS	183h
FSR	04h	FSR	84h	FSR	104h	FSR	184h
PORTA	05h	TRISA	85h		105h		185h
PORTB	06h	TRISB	86h	PORTB	106h	TRISB	186h
PORTC	07h	TRISC	87h		107h		187h
PORTD(1)	08h	TRISD(1)	88h		108h		188h
PORTE(1)	09h	TRISE(1)	89h		109h		189h
PCLATH	0Ah	PCLATH	8Ah	PCLATH	10Ah	PCLATH	18Ah
INTCON	0Bh	INTCON	8Bh	INTCON	10Bh	INTCON	18Bh
PIR1	0Ch	PIE1	8Ch	EEDATA	10Ch	EECON1	18Ch
PIR2	0Dh	PIE2	8Dh	EEADR	10Dh	EECON2	18Dh
TMR1L	0Eh	PCON	8Eh	EEDATH	10Eh	Reserved(2)	18Eh
TMR1H	0Fh		8Fh	EEADRH	10Fh	Reserved(2)	18Fh
T1CON	10h		90h	General Purpose Register 16 Bytes	110h	General Purpose Register 16 Bytes	190h
TMR2	11h	SSPCON2	91h		111h		191h
T2CON	12h	PR2	92h		112h		192h
SSPBUF	13h	SSPADD	93h		113h		193h
SSPCON	14h	SSPSTAT	94h		114h		194h
CCPR1L	15h		95h		115h		195h
CCPR1H	16h		96h		116h		196h
CCP1CON	17h		97h		117h		197h
RCSTA	18h	TXSTA	98h		118h		198h
TXREG	19h	SPBRG	99h		119h		199h
RCREG	1Ah		9Ah		11Ah		19Ah
CCPR2L	1Bh		9Bh		11Bh		19Bh
CCPR2H	1Ch	CMCON	9Ch		11Ch		19Ch
CCP2CON	1Dh	CVRCON	9Dh		11Dh		19Dh
ADRESH	1Eh	ADRESL	9Eh		11Eh		19Eh
ADCON0	1Fh	ADCON1	9Fh		11Fh		19Fh
General Purpose Register 96 Bytes	20h	General Purpose Register 80 Bytes	A0h	General Purpose Register 80 Bytes	120h	General Purpose Register 80 Bytes	1A0h
			EFh		16Fh		1EFh
		accesses 70h-7Fh	F0h	accesses 70h-7Fh	170h	accesses 70h - 7Fh	1F0h
	7Fh		FFh		17Fh		1FFh

■ Unimplemented data memory locations, read as '0'.
* Not a physical register.

Note 1: These registers are not implemented on the PIC16F876A.
2: These registers are reserved; maintain these registers clear.

Figure (4.6)

4.4 Power, Oscillators and Resets:

Generally speaking, the correct voltage supply is of utmost importance for the proper functioning of the microcontroller system. For a proper function of any microcontroller, it is necessary to provide a stable source of supply; a sure reset when you turn it on and an oscillator. According to technical specifications by the manufacturer of PIC microcontroller, supply voltage should move between 2.0V to 6.0V in all versions. The simplest solution to the source of supply is using the voltage stabilizer LM7805 which gives stable +5V on its output. In order to function properly, or in order to have stable 5V at the output (pin 3), input voltage on pin 1 of LM7805 should be between 7V through 24V. Depending on current consumption of device we will use the appropriate type of voltage stabilizer LM7805. There are several versions of LM7805. For current consumption of up to 1A we should use the version in TO-220 case with the capability of additional cooling.

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 device clock periods generate one internal instruction clock (TCY) cycle. There are two modes 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 a general purpose function. The oscillator mode is selected by the device configuration bits. The device configuration bits are nonvolatile memory locations and the operating mode is determined by the value written during device programming. The PIC-micro has eight different external oscillator modes as follows:

EC	External Clock
ECIO	External Clock with I/O pin enabled
LP	Low Frequency (power) Crystal
XT	Crystal (Resonator)
XS	High Speed Crystal (Resonator)
RC	external Resistor / Capacitor
RCIO	external Resistor / Capacitor with I/O pin enabled
HS4	High Speed Crystal (Resonator) with 4xPLL frequency enabled

Table 4.1: Oscillator / Resonator Types

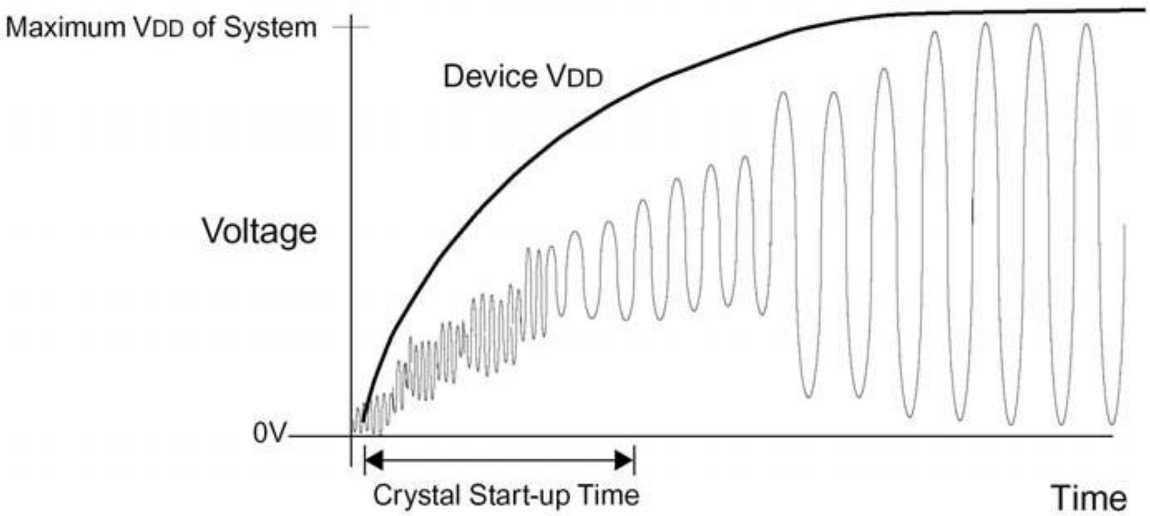


Figure (4.7) Oscillator / Resonator Start-up Characteristics

In XT, LP or HS modes a crystal or ceramic resonator is connected to the OSC1 and OSC2 pins to establish oscillation. The PICmicro oscillator design requires the use of a parallel cut crystal. Using a series cut crystal may give a frequency out of the crystal manufacturer's specifications.

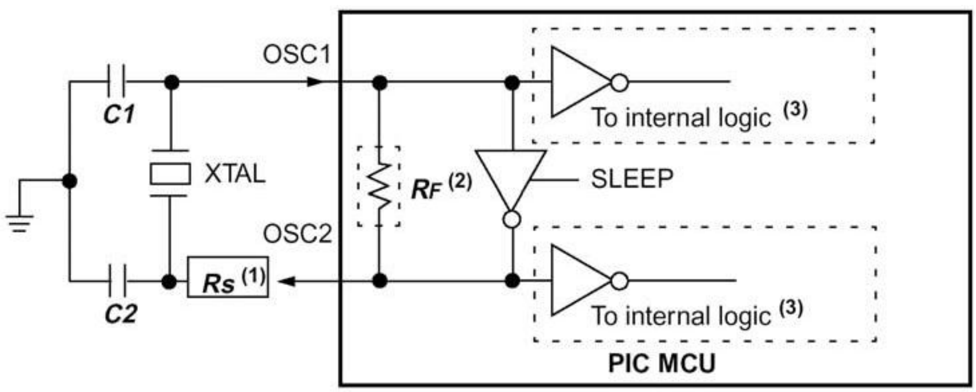


Figure (4.8) Crystal or Ceramic Resonator Operation (HS, XT or LP Oscillator Mode)

4.5 PIC Assembly Language:

The ability to communicate is of great importance in any field. However, it is only possible if both communication partners know the same language, i.e. follow the same rules during communication. Using these principles as a starting point, we can also define communication that occurs between microcontrollers and man. Language that microcontroller and man use to communicate is called "assembly language". The title itself has no deeper meaning, and is analogue to names of other languages, ex. English or French. More precisely, "assembly language" is just a passing solution. Programs written in assembly language must be translated into a "language of zeros and ones" in order for a microcontroller to understand it. "Assembly language" and "assembler" are two different notions. The first represents a set of rules used in writing a program for a microcontroller, and the other is a program on the personal computer which translates assembly language into a language of zeros and ones. A program that is translated into "zeros" and "ones" is also called "machine language".

The basic elements of PIC assembly language are Labels, Operands, Comments, Instructions and Directives.

Labels

A Label is a textual designation (generally an easy-to-read word) for a line in a program, or section of a program where the micro can jump to - or even the beginning of set of lines of a program. It can also be used to execute program branching (such as Goto ...) and the program can even have a condition that must be met for the Goto instruction to be executed. It is important for a label to start with a letter of the alphabet or with an underscore "_". The length of the label can be up to 32 characters. It is also important that a label starts in the first column.

Operands

Operands are the instruction elements for the instruction is being executed. They are usually registers or variables or constants.

Comments

Comment is a series of words that a programmer writes to make the program more clear and legible. It is placed after an instruction, and must start with a semicolon ";".

Instructions

Instructions are already defined by the use of a specific microcontroller, so it only remains for us to follow the instructions for their use in assembly language. The way we write an instruction is also called instruction "syntax".

Field	Description
f	Register file address (0x00 to 0x7F in Bank 0)
W	Working register (accumulator)
b	Bit address within an 8-bit file register
k	Literal field, constant data or label
x	Don't care location (=0 or 1), the assembler will generate code with x=0, it is the recommended form of use for compatibility with all Microchip software tools.
d	Destination select; d=0: store result in W register, d=1: store result in file register f, the default is d=1
label	Label name
TOS	Top of Stack
PC	Program Counter
PCLATH	Program Counter High Latch
GIE	Global Interrupt Enable bit
WDT	Watchdog Timer/Counter
TO	Time-out bit
PD	Power-down bit
dest	Destination either the W register or the specified register file location
[ ]	Options
( )	Contents
→	Assigned to
< >	Register bit field
∈	In the set of
italics	User defined term

Table (4.2)

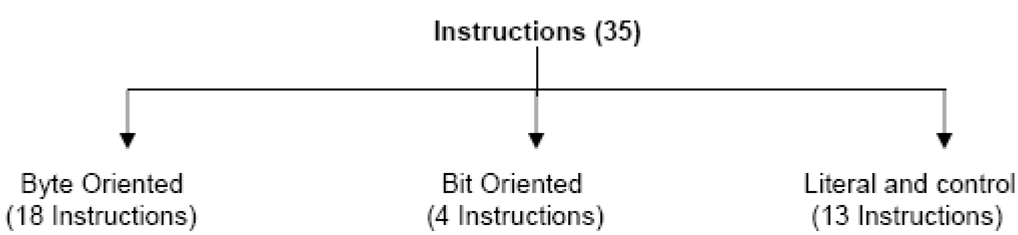


Figure (4.9)

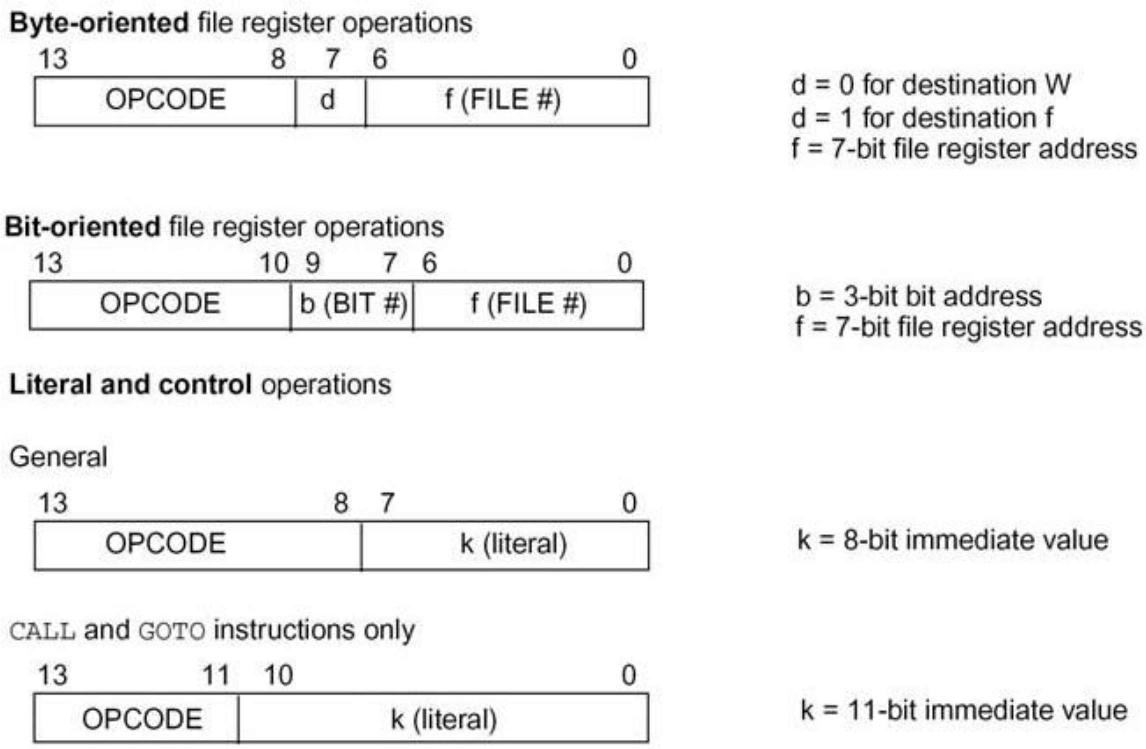

Byte-oriented file register operations
13 8 7 6 0
OPCODE
d
f (FILE #)
d = 0 for destination W
d = 1 for destination f
f = 7-bit file register address
Bit-oriented file register operations
13 10 9 7 6 0
OPCODE
b (BIT #)
f (FILE #)
b = 3-bit bit address
f = 7-bit file register address
Literal and control operations
General
13 8 7 0
OPCODE
k (literal)
k = 8-bit immediate value
CALL and GOTO instructions only
13 11 10 0
OPCODE
k (literal)
k = 11-bit immediate value

Figure (4.10)

1) Data Transfer Instructions (6):

• MOVLW	K	; Move the value of K to W
• MOVWF	f	; Move the content of W to f
• MOVF	f, d	; Move f to d (affect Z flag)
• CLRW		; Clear W reg. (W = 0) (affect Z flag)
• CLRF	f	; Clear f reg. (f = 0) (affect Z flag)
• SWAPF	f, d	; Swap nibbles in f

2) Arithmetic and logic Instructions (15):

• ADDLW	K	; Move (k + w) to w (affect C, DC, Z flags)
• ADDWF	f, d	; Move (f + w) to d (affect C, DC, Z flags)
• SUBLW	K	; Move (k – w) to w (affect C, DC, Z flags)
• SUBWF	f, d	; Move (f – w) to d (affect C, DC, Z flags)
• ANDLW	K	; Move (w.k) to w (affect Z flag)
• ANDWF	f, d	; Move (w.f) to d (affect Z flag)
• IORLW	K	; Move (w+K) 'Inclusive OR' to w (affect Z flag)
• IORWF	f, d	; Move (w+f) 'Inclusive OR' to d (affect Z flag)
• XORLW	K	; Move (w xor k) 'Exclusive OR' to w (affect Z flag)
• XORWF	f, d	; Move (w xor f) 'Exclusive OR' to d (affect Z flag)
• INCF	f, d	; Increment f (move (f + 1) to d) affect Z flag
• DECF	f, d	; Decrement f (move (f - 1) to d) affect Z flag
• RLF	f, d	; Rotate left f through carry (affect C flag)
• RRF	f, d	; Rotate right f through carry (affect C flag)
• COMF	f, d	; Complement f (move f to d) affect Z flag

3) Bit Operations Instructions (2):

• BCF	f, b	; Bit clear f, move (0 to f(b))
• BSF	f, b	; Bit set f, move (1 to f(b))

4) Directing a program flow (9):

• BTFSC	f, b	; Bit Test f, Skip if b is clear, Jump if f(b) = 0
• BTFSS	f, b	; Test f, Skip if b is set, Jump to the instruction after next Inst.
• DECFSZ	f, d	; Decrement f, Skip if (Z flag is set to 1)
• INCFSZ	f, d	; Increment f, Skip if (Z flag is set to 1)
• GOTO	K	; Goto address K
• CALL	K	; Call subroutine at K
• RETURN		; Return from subroutine
• RETLW	K	; Return with literal K in W
• RETFIE		; Return from interrupt

5) Other Instructions (3):

• NOP		; No operation, to make a small delay
• CLRWDT		; Clear watchdog timer (TO, PD flag)
• SLEEP		; Go into stand by mode

Table (4.3)

4.6 STATUS Register:

The figure (4.11) explains the status register.

STATUS Register (Address 03h, 83h, 103h, 183h):

R/W-0	R/W-0	R/W-0	R-1	R-1	R/W-x	R/W-x	R/W-x
IRP	RP1	RP0	$\overline{TO}$	$\overline{PD}$	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)

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

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

bit 2 **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)
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

Figure (4.11)

4.6.1 Define Input or output ports:

General purpose I/O pins can be considered the simplest of peripherals. They allow the Microcontroller to monitor and control external devices. To add flexibility and functionality to a device, some pins are multiplexed with an alternate function(s). These functions depend on which peripheral features are on the device. In general, when a peripheral is functioning, that pin may not be used as a general purpose I/O pin. For most ports, the I/O pin's direction (input or output) is controlled by the data direction register, called the TRIS register. TRIS<x> controls the direction of PORT<x>. A '1' in the TRIS bit corresponds to that pin being an input, while a '0' corresponds to that pin being an output. An easy way to remember is that a

‘1’ looks like an I (input) and a ‘0’ looks like an O (output). The PORT register is the latch for the data to be output. When the PORT is read, the device reads the levels present on the I/O pins (not the latch). This means that care should be taken with read-modify-write commands on the ports and changing the direction of a pin from an input to an output.

• Reading from the Port → Port is Input
• Writing on the Port → Port is Output
• We can define each bit from the same Port as Input or Output.
• We can define the bits of any Port as Input or Output by using the TRIS register of that Port, for example; the first bit is defined as Input in Port B and the other bit's Output.

0	0	0	0	0	0	0	1
bit 7							bit 0

Figure (4.12)

The problem called floating pin is occurred when we define some bits as input bits in the I/O port and we don't connect it to anything, this problem solved by either connect the not used pins directly to ground, or by using a button switch. The switch labeled (a) in the following figure connects the input pin to a +5V power supply through a 10 KΩ resistor. With the switch open, the electrical status of the input pin is kept high. When the switch is pressed, the input pin connects to ground, and the status of the input pin is brought low. The switch labeled (b) has an electrical function opposite the switch labeled (a). In this case, when the switch is open, the input pin is connected to ground, keeping the input pin low. When the switch is closed, the input pin is brought high.

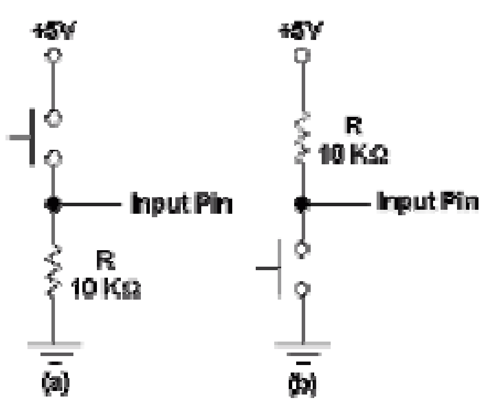


Figure (4.13) High/Low Input Configuration

4.7 LM7805 regulator:

Generally speaking, the correct voltage supply is of utmost importance for the proper functioning of the microcontroller system. For a proper function of any microcontroller, it is necessary to provide a stable source of supply; a sure reset when you turn it on ,According to technical specifications by the manufacturer of PIC microcontroller, supply voltage should move between 2.0V to 6.0V in all versions. The simplest solution to the source of supply is using the voltage stabilizer LM7805 (Figure 2.14) that gives stable +5V on its output. In order to function properly, or in order to have stable 5V at the output (pin 3), input voltage on pin 1 of LM7805 should be between 7V through 24V. Depending on current consumption of device we will use the appropriate type of voltage stabilizer LM7805. There are several versions of LM7805. For current consumption of up to 1A we should use the version in TO-220 case with the capability of additional cooling. Maybe some capacitors shunted to the input and output pins of regulator; pin 1 and pin 3 respectively to reduce any unwanted high frequency signals or what we called noise. These capacitors are working as a low pass filters to pass a DC component and reject any AC ripples.

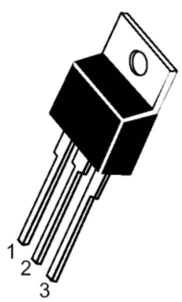


Figure (4.14) LM7805 Regulator

In our circuit we used a DC power supply so there is no need of the capacitor on the input of the regulator, but we attached a 470uF capacitor on the output to stabilize a +5V on the output regardless of the load being applied and the current being sourced by the regulator, the following figure 2.16 shows how exactly we connect the regulator in our circuit.

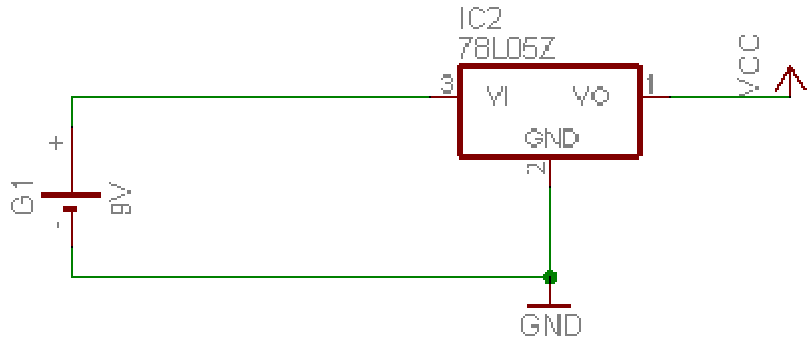


Figure (4.15) (Regulator Connection)

4.8 receiver circuit

Figure (4.16)

4.8.1 Developed work

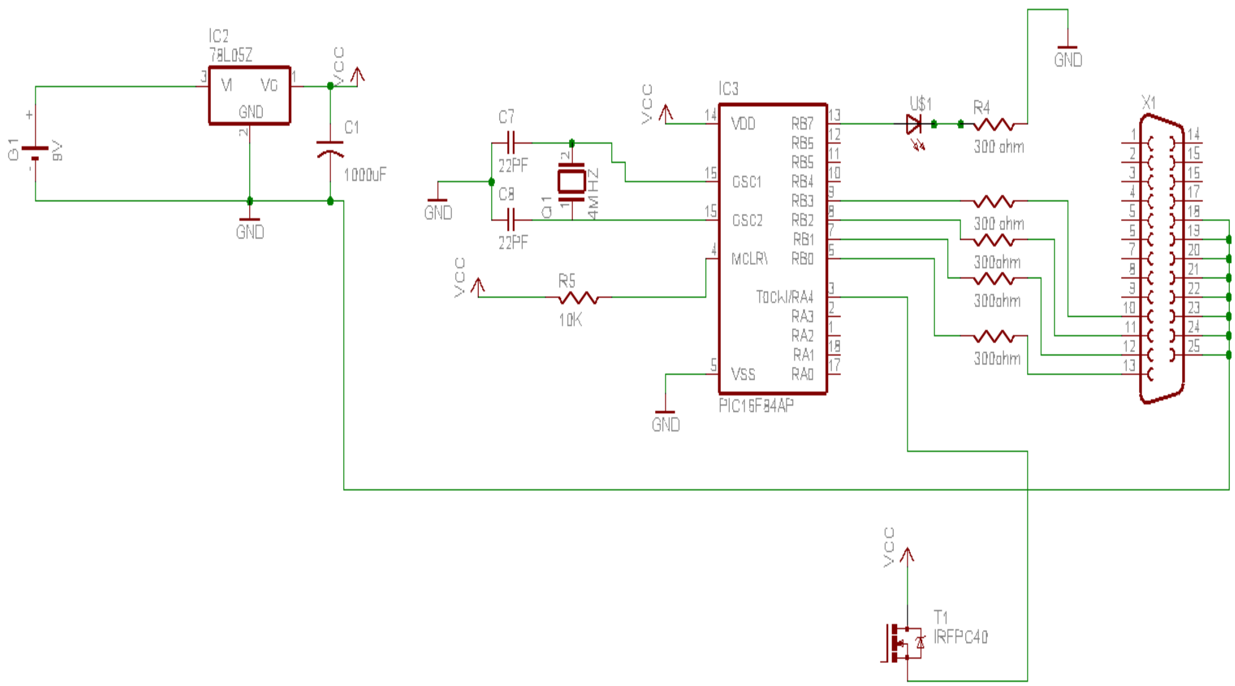


Figure (4.17)

As shown in figure xx above we connected the output of the IR-receiver to the PIC directly, the output of the IR-RX is 5V when there is a signal , and zero volts when signal is absent.

The connection between the PIC and the PC is a four wires connected to the status register parallel port as will explained in the next section of this chapter,

We use a 300 ohm resistor between the PIC and the PC to avoid any damage if a short circuit was occurred during the operation.

4.9 Dealing with parallel port

4.9.1 How to connect circuits to parallel port

PC parallel port is 25 pin D-shaped female connector in the back of the computer. It is normally used for connecting computer to printer, but many other types of hardware for that port is available today.

Not all 25 are needed always. Usually you can easily do with only 8 output pins (data lines) and signal ground. I have presented those pins in the table below. Those output pins are adequate for many purposes.

4.10 Hardware

The pin outs of DB25 connector is shown in the picture below
The lines in DB25 connector are divided in to three groups, they are
data register
Status register
Control register
As their names specifies, Data register is connected to Data lines, Control register is connected to control lines and Status register is connected to Status lines. (Here the word connection does not mean that there is some physical connection between data/control/status lines. The registers are virtually connected to the corresponding lines.). So whatever you write to these registers, will appear in corresponding lines as voltages, Of course, you can measure it with a millimeter. And Whatever you give to Parallel port as voltages can be read from these registers(with some restrictions). For example, if we write '1' to Data register, the line Data0 will be driven to +5v. Just like this ,we can programmatically turn on and off any of the data lines and Control lines.

4.10.1 Register’s location :

In an IBM PC, these registers are IO mapped and will have unique address. We have to find these addresses to work with parallel port. For a typical PC , the base address of LPT1 is 0x378 and of LPT2 is 0x278.

The data register resides at this base address , status register at base address + 1 and the control register is at base address + 2. So once we have the base address, we can calculate the address of each registers in this manner. The table below shows the register addresses of LPT1 and LPT2

Register	LPT1	LPT2
data register(base address + 0)	0x378	0x278
status register (base address + 1)	0x379	0x279
control register (base address + 2)	0x37a	0x27a

Table 4.4 Register’s Location

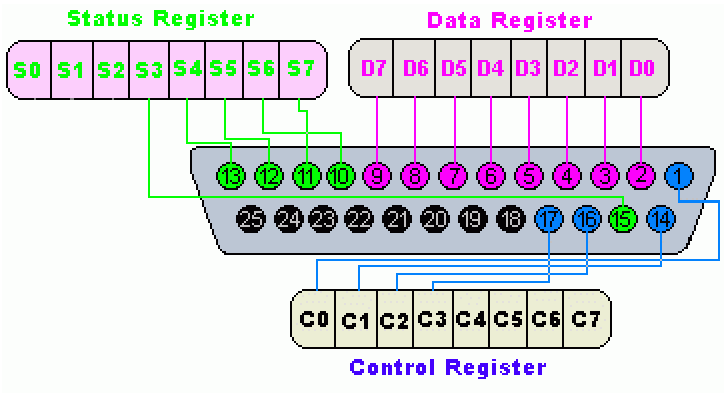
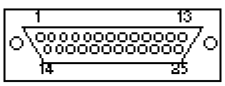


Figure (4.18) Printer's Cable pins



View is looking at
Connector side of
DB-25 Male Connector.

Pin	Description	
1	Strobe	PC Output
2	Data 0	PC Output
3	Data 1	PC Output
4	Data 2	PC Output
5	Data 3	PC Output
6	Data 4	PC Output
7	Data 5	PC Output
8	Data 6	PC Output
9	Data 7	PC Output
10	ACK	PC Input
11	Busy	PC Input
12	Paper Empty	PC Input
13	Select	PC Input
14	Auto Feed	PC Output
15	Error	PC Input
16	Initialize Printer	PC Output
17	Select Input	PC Output

Pin Assignments

Note: 8 Data Outputs
4 Misc Other Outputs

5 Data Inputs

Note: Pins 18-25 are
Ground

Figure (4.19) Pin Assignments

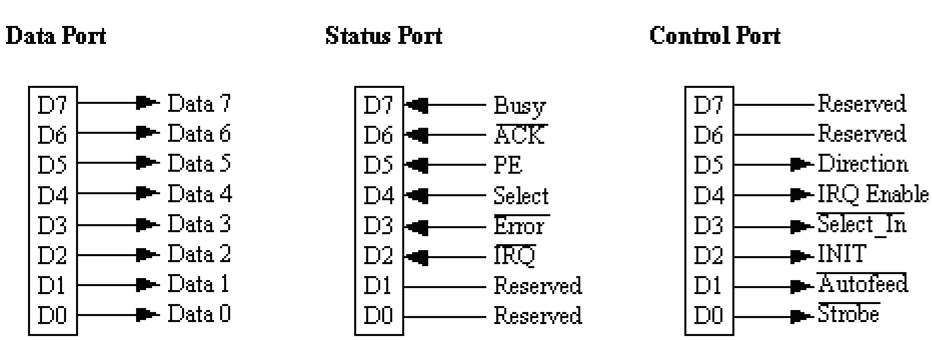


Figure (4.20) Port Assignments

Note that there are eight outputs on the Data Port (Data 7(msb) - Data 0) and four additional outputs on the low nibble of the Control Port. /SELECT_IN, INIT, /AUTO FEED and /STROBE.

Note that with /SELECT_IN, the "in" refers to the printer. For normal printer operation, the PC exerts a logic zero to indicate to the printer it is selected. The original function of INIT was to initialize the printer, AUTO FEED to advance the paper. In normal printing, STROBE is high. The character to be printed is output on the Data Port and STROBE is momentarily brought low.

All outputs on the Data Port are true logic. That is, writing a logic one to a bit causes the corresponding output to go high. However, the /SELECT_IN, /AUTOFEED and /STROBE outputs on the Control Port have inverted logic. That is, outputting a logic one to a bit causes a logic zero on the corresponding output. This adds some complexity in using the printer port, but the fix is to simply invert those bits using the exclusive OR function prior to outputting.

One might ask why the designers of the printer port designed the port in this manner. Assume you have a printer with no cable attached. An open usually is read as a logic one. Thus, if a logic one on the SELECT_IN, AUTOFEED and STROBE leads meant to take the appropriate action, an unconnected printer would assume it was selected, go into the auto feed mode and assume there was data on the outputs associated with the Data Port.

4.11 Different parallel port versions:

The first PC-compatible parallel printer ports were unidirectional, allowing 8-bit data transfer only from the host to the peripheral. These early Standard Printer Ports (SPP) implemented eight data lines and used nine handshaking lines, four output from the host and five input to the host. The SPP type implemented three registers for the control and monitoring of the data and handshaking lines; these are the data port, status port, and control port. The SPP type parallel ports are most commonly used for printers, plotters, keys, etc. Generally all modern parallel ports can operate in SPP mode. The maximum cable distance between computer and peripheral could only extend 6 feet.

Later came the PS/2 type bi-directional parallel port (BPP); this bi-directional port simply added the capability to read 8-bit data from the peripheral to the host. This parallel port type also implemented the same three registers as used by SPP for the control and monitoring of the data and handshaking lines; these are the data port, status port, and control port. In addition to normal operations there is one extra bit on control port that can set the data pins to output or input mode.

The IEEE 1284 standard, "Standard Signaling Method for a Bi-directional Parallel Peripheral Interface for Personal Computers", sought to correct the major drawbacks to the original parallel port structure. IEEE 1284 sets standards for the cable, connector, and electrical interface, which guarantee interoperability between all parallel peripherals. The specified configuration ensures that data integrity is maintained, even at the highest data rates, and at a distance of up to 30 feet. Two new types of parallel ports with extended features are now available: the Enhanced Parallel Port (EPP) and the Extended Capabilities Port (ECP). EPP and ECP are standards defined by IEEE 1284 and Microsoft ECP Specifications. Both EPP and ECP ports may be operated in the SPP and bi-directional modes; however, operation in their feature modes requires both compatible peripherals and appropriate software drivers.

The I/O interface on EPP and ECP ports is somewhat different from normal I/O port controls. They can be viewed as supersets of SPP. An EPP parallel port implements two registers in addition to the standard data, status, and control ports. The outputs are tri-state able outputs allow the EPP port to be used as a data bus for multiple EPP compatible devices. The entire data transfer occurs within one ISA I/O cycle. An ECP parallel port features two special modes, namely data and command cycles. In the Parallel Port Data FIFO Mode, data written or DMAed to a 16-byte FIFO is automatically transferred to a peripheral using standard parallel port protocol. The ECP Parallel Port Mode allows bi-directional data transfer using automatic interlocked handshaking via the ECP protocol. When the ECP protocol was proposed, a standard register implementation was also proposed through Microsoft ECP Specification. ECP protocol is meant to be driven by DMA rather than explicit I/O operations. ECP protocol is commonly seen on parallel port on motherboards and on high-end parallel port cards that plug to ISA bus, but often not on PCI bus parallel port cards (because PCI bus does not support ISA bus type DMA transfers).
Many modern parallel ports support SPPl, BPP, ECP and EPP modes, or at least most of them. On some systems and interface cards there has been even options to select in which operation mode it work (so avoid any potential problems).

4.11.1 Parallel port modes:

The IEEE 1284 Standard which has been published in 1994 defines five modes of data transfer for parallel port. They are,

Compatibility Mode *4) EPP*
Nibble Mode *5) ECP*
Byte Mode

CHAPTER FIVE

Software implementation

5.1 Overview

As it was mentioned before we used the PIC microcontroller is the brain of every aspect and every action in the system
First of all and after the PIC is powered on the initializations by software as follows:

5.2 Transmitter

Port a digital output (left open)
Port b three pins as output (columns) 5 is input (rows)
Port c has one output (out to IR led)
Assign a number for each button (1-15)

after the initialization the PIC will start the program as follows

the PIC microcontroller will check if there is any button pressed
if there is any pressed button , then the PIC will send a train of pulses , the number of pulses is equal to the number of that pressed key (i.e if the user pressed button three , then the PIC will send three pulses as shown in the figure below

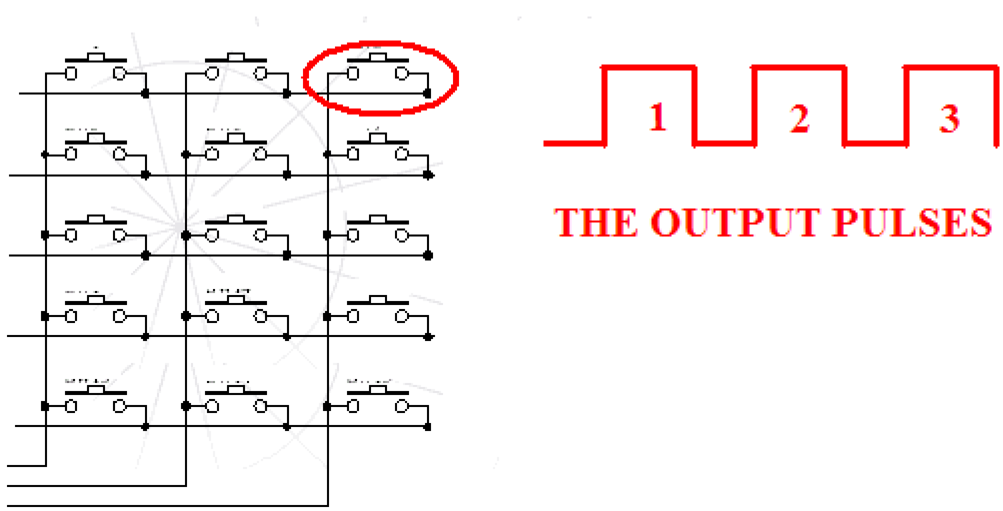


Figure (5.1)

5.3 Receiver

port a has one input (from IR receiver)
port b as output to parallel port

The microcontroller on the receiver side will check if there is any input on the IR-receiver
When receiving any input signal the PIC microcontroller will count the number of pulses and show the appropriate code on the four pins (interface with the parallel port)
As shown in table 5.1 .

BUTTON #	# OF TRANSMITTED PULSES	OUTPUT CODE
1	1	1111
2	2	1110
3	3	1101
4	4	1100
5	5	1011
6	6	1010
7	7	1001
8	8	1000
9	9	0111
10	10	0110
11	11	0101
12	12	0100
13	13	0011
14	14	0010
15	15	0001
16	16	0000

Table (5.1)

5.4 Programming a PIC:

5.4.1 MPLAB software

5.4.1.a Introduction

The PIC microcontroller used in this project is programmed in assembly language by using the Microchip MPLAB IDE Integrated Development Environment. This software is used for editing, compiling for syntax errors, simulation for logical errors and devices programming.

5.4.1.b MPLAB IDE Software Package

MPLAB Integrated Development Environment (IDE) is a comprehensive editor, project manager and design desktop for application development of embedded designs using Microchip PIC micro microcontrollers. MPLAB IDE is a Windows OS based Integrated Development Environment for the PIC micro MCU families and the DSPIC Digital Signal Controllers. The MPLAB IDE provides the ability to:
Create and edit source code using the built-in editor.
Assemble, compile and link source code.
Debug the executable logic by watching program flow with the built-in simulator or in real time with MPLAB ICE 2000 and 4000 emulators or MPLAB ICD 2 in-circuit debugger.
Make timing measurements with the simulator or emulator.
View variables in Watch windows.
Program firmware into devices with MPLAB ICD 2, PICSTART® plus or PRO MATE® II device programmers.
Find quick answers to questions from the extensive MPLAB IDE on-line help.

In order to create code that is executable by the target PIC micro MCU as shown in (Figure 5.2), source files need to be put into a project and then the code is built using selected language tools (assemblers, compilers, linkers, etc.). In MPLAB IDE, the project manager takes care of this process. The first step is writing a very short source code file. Next, a project is created, source code added, language tools are assigned to the project and finally, the code is built and tested

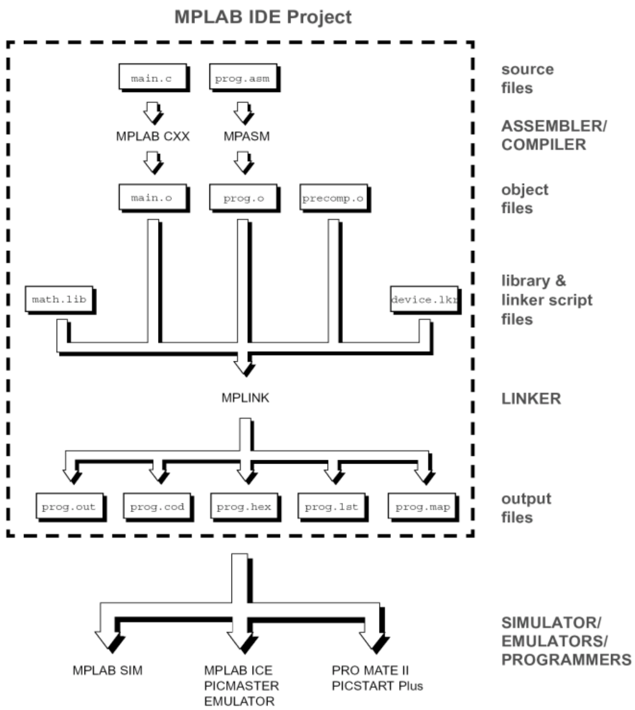


Figure (5.2) MPLAB IDE Project Relationships.

And after writing the code and compiling it we need to install this program on the PIC so we need a hardware.

5.5 Hardware:

The program can be easily downloaded on the PIC using a small circuit called programmer.

This programmer is connected to computer by parallel port. It is used for all PDIP PIC's ranges from 8pins to 40 pins.

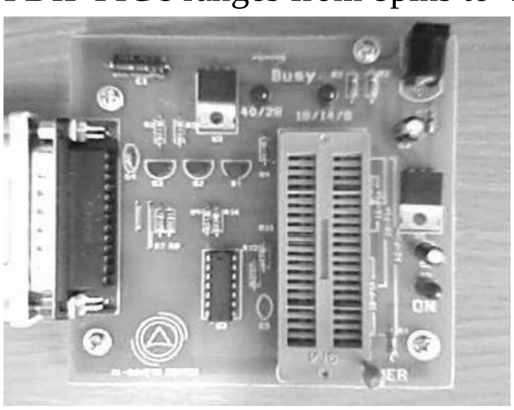


Figure (5.3)

Chapter six

Conclusions and Future Work

In this chapter ,conclusions will be presented and future work in this subject will be discussed

6.1 Conclusions

The main results and conclusions that can be drawn from this project are as follows:
- PIC microcontroller is a very helpful and strong IC, that can be really used in any application.
-Many software applications can be controlled by using the PCRC with satisfying results.
-The user now is free to move as we mentioned in the aspect of the project .
-the multimedia keyboard can be now replaced by the PCRC.
-the wireless mouse functions also now can be implemented via PCRC .

6.2 Future Work

- The radio frequency (RF) can be used in the future work to replace the IR, so the distance will be increased.
-Bluetooth also can be used within mid distance range.
-the function of the PCRC can be implemented and integrated within the intelligent remote control with many controlling functions and can be used in the smart house applications .
-carrying data using the PCRC as a second function .

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