
UNIT 4 THE I/O TECHNOLOGY

Structure	Page No.
4.0 Introduction	80
4.1 Objectives	81
4.2 Keyboard	81
4.2.1 Keyboard Layout	
4.2.2 Keyboard Touch	
4.2.3 Keyboard Technology	
4.3 Mouse	85
4.4 Video Cards	87
4.4.1 Resolution	
4.4.2 Colour Depth	
4.4.3 Video Memory	
4.4.4 Refresh Rates	
4.4.5 Graphic Accelerators and 3-D Accelerators	
4.4.6 Video Card Interfaces	
4.5 Monitors	92
4.5.1 Cathode Ray Tubes	
4.5.2 Shadow Mask	
4.5.3 Dot Pitch	
4.5.4 Monitor Resolutions	
4.5.5 DPI	
4.5.6 Interlacing	
4.5.7 Bandwidth	
4.6 Liquid Crystal Displays (LCD)	95
4.7 Digital Camera	96
4.8 Sound Cards	96
4.9 Printers	97
4.9.1 Classification of Printers	
4.9.2 Print Resolutions	
4.9.3 Print Speed	
4.9.4 Print Quality	
4.9.5 Colour Management	
4.10 Modems	99
4.11 Scanners	100
4.11.1 Resolution	
4.11.2 Dynamic Range/Colour Depth	
4.11.3 Size and Speed	
4.11.4 Scanning Tips	
4.12 Power Supply	102
SMPS (Switched Mode Power Supply)	
4.13 Summary	104
4.14 Solutions /Answers	104
References	

4.0 INTRODUCTION

In the previous units you have been exposed to Input/Output interfaces, control and techniques etc. This unit covers Input/Output devices and technologies related to them. The basic aspects covered include:

- The characteristics of the Device.
- How does it function?
- How does it relate with the Main computing unit?

4.1 OBJECTIVES

After going through this unit you will be able to:

- describe the characteristics, types, functioning and interfacing of Keyboards;
- describe the characteristics, technology and working of Mice;
- describe characteristics, technology and working of Video Cards including various parameters, Video Memory, interfaces and Graphic accelerators;
- describe the characteristics, technology and working of Monitors;
- describe the characteristics, technology and working of Liquid Crystal Displays (LCDs), and Video Cameras;
- describe the characteristics, technology and working of Sound Cards;
- describe the characteristics, technology and working of Printers;
- describe the characteristics, technology and working of Modems;
- describe the characteristics, technology and working of Scanners; and
- describe the the purpose of Power Supply and explain SMPS.

4.2 KEYBOARD

The keyboard is the main input device for your computer. It is a fast and accurate device. The multiple character keys allow you to send data to your computer as a stream of characters in a serial manner. The keyboard is one device which can be used in public spaces or offices where privacy is not ensured. The keyboard is efficient in jobs like data entry. The keyboard is one device which shall stay on for years to come, probably even after powerful voice-based input devices have been developed.

The precursor of the keyboard was the mechanical typewriter, hence it has inherited many of the properties of the typewriter.

The Keys

A full size keyboard has the distance between the centres of the keycaps (keys) as 19mm (0.75in). The keycaps have a top of about 0.5in (12.5in) which is shaped as a sort of dish to help you place your finger. Most designs have the keys curved in a concave cylindrical shape on the top.

4.2.1 Keyboard Layout

A keyboard layout is the arrangement of the array of keys across the keyboard. There is one keyboard layout that anybody who has worked on a standard keyboard or typewriter is familiar with; that layout is QWERTY. However, there are other less popular layouts also.

QWERTY

q,w,e,r,t,y are the first six letters of the top row of the alphabets of the QWERTY layout. The QWERTY arrangement was given by Sholes, the inventor of the typewriter. The first typewriter that Sholes created had an alphabetic layout of keys. However, very soon Sholes designed QWERTY as a superior arrangement though he gave no record of how he came upon this arrangement.

QWERTY-based keyboards

Besides the standard alphabet keys having the QWERTY arrangement, a computer keyboard also consists of the control (alt, Del, Ctrl etc. keys), the function keys (F1, F2 .. etc.), the numerical keypad etc.

PC 83-key and AT 84-key Keyboards

The PC 83-key was the earliest keyboard offered by IBM with its first Personal Computers (PC). This had 83 keys. Later IBM added one more key with its PC AT computer keyboards to make it a 84-key keyboard. The special feature of these keyboards was that they had function keys in two columns on the left side of the keyboard.

101-key Enhanced Keyboard

With its newer range of PCs IBM introduced the 101-key Enhanced/Advanced keyboard. This keyboard is the basic keyboard behind modern QWERTY keyboards. This has the function keys aligned in a separate row at the top of the PC, to

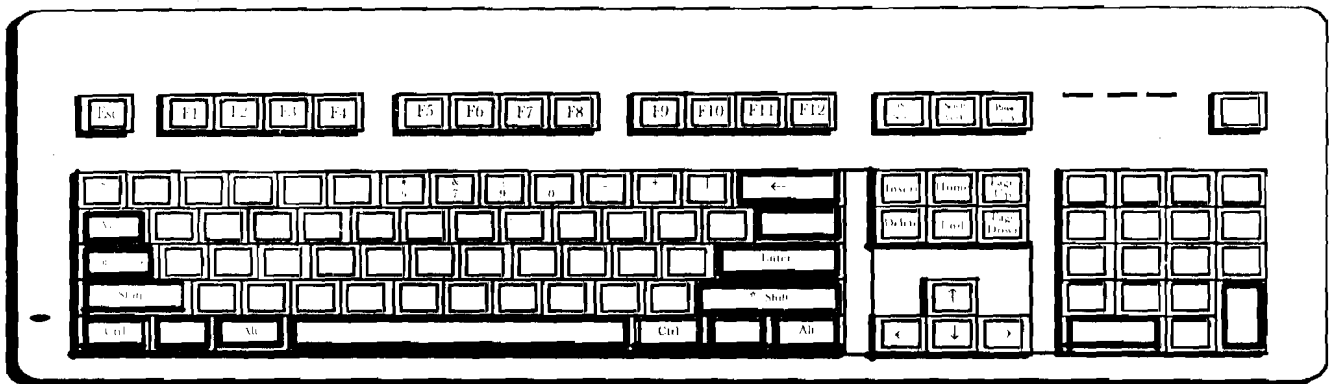


Figure 1: IBM 101-key Keyboard layout

correspond to the function keys shown by many software on the monitor. However, this has also been criticised at times for having a small enter key and function keys on the top! ! ! .

Windows 104-key keyboard

This is enhancements of the 101-key keyboard with special keys for Windows functions and popup. Individual vendors sometimes make changes to the basic keyboard design, for example by having a larger enter key.

Dvorak-Dealey keyboard

This was one keyboard layout designed to be a challenger to the QWERTY layout. This was designed by August Dvorak and William Dealey after much scientific research in 1936. This layout tries to make typing faster. The basic strategy it tries to incorporate is called *hand alteration*. *Hand alteration* implies that if you press one key with the left hand, the next key is likely to be pressed by the right hand, thus speeding up typing (assuming you type with both hands).

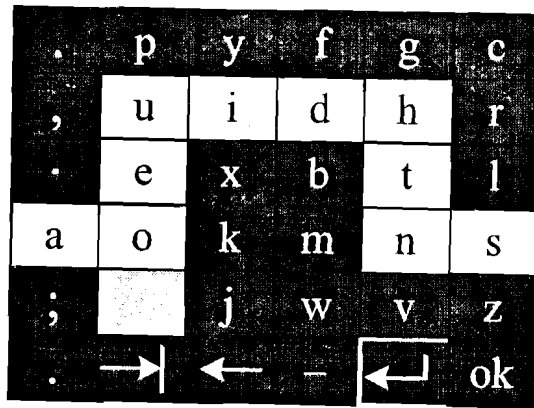


Figure 2: Dvorak keyboard layout

However, the Dvorak has not been able to compete with QWERTY and almost all systems now come with QWERTY 101-key or 104-key based keyboards. Still, there may be a possibility of designing new keyboards for specific areas, say, for Indian scripts.

4.2.2 Keyboard Touch

When using a keyboard, the most important factor is the feel of the keyboard, i.e., how typing feels on that particular keyboard. The keyboard must respond properly to your keypress. This not only means that keys must go down when pressed and then come up but also that there must be a certain feedback to your fingers when a key gets activated. This is necessary for you to develop faith in the keyboard and allow fast, reliable typing.

Linear travel or linear touch keyboards increase resistance linearly with the travel of the key. Therefore, you have to press harder as the key goes lower. There can be audible feedback as a click and visual feedback as the appearance of a character on screen letting you know when a key gets activated. Better keyboards provide tactile feedback (to your fingers) but suddenly reducing resistance when the key gets actuated. This is called an over-center feel. Such keyboards are best for quick touch typing. These were implemented by using springs earlier but now they are usually elastic rubber domes. Keyboards also differ in whether they 'click' or not (soundless), on the force required and the key travel distance to actuate a key. The choice is usually an issue of personal liking. Laptops usually have short travel keys to save space which is at a premium in laptops.

4.2.3 Keyboard Technology

Each key of a keyboard is like an electric switch changing the flow of electricity in some way. There are two main types — capacitor-based and contact-based keyboards.

Capacitor-Based Keyboards

These keyboards are based on the concept of Capacitance. A simple capacitor consists of a pair of conductive plates having opposite charges and separated by an insulator. This arrangement generates a field between the plates proportional to the closeness of the plates. Changing the distance between the plates causes current to flow. Capacitive keyboards have etched circuit boards, with tin and nickel-plated copper pads acting as capacitors under each key (a key is technically called a station). Each key press presses a small metal-plastic circle down causing electric flow. These keyboards work

well but have the drawback that they follow an indirect approach though they have a longer life than contact-based keyboards. These keyboards were introduced by IBM.

Contact-Based Keyboards

Contact-based keyboards use switches directly. Though they have a comparatively shorter life, they are the most preferred kind nowadays due to their lower cost. Three such kinds of keyboards have been used in PCs:

1. **Mechanical Switches:** These keyboards use traditional switches with the metal contacts directly touching each other. Springs and other parts are used to control positioning of the keycaps and give the right feel. Overall, this design is not suited to PC keyboards.
2. **Rubber Dome:** In rubber dome keyboards, both contact and positioning are controlled by a puckered sheet of *elastomer*, which is a stretchy, rubber-like synthetic material. This sheet is moulded to have a dimple or dome in each keycap. The dome houses a tab of carbon or other conductive material which serves as a contact. When a key is pressed, the dome presses down to touch another contact and complete the circuit. The elastomer then pushes the key back. This is the most popular PC keyboard design since the domes are inexpensive and proper design can give the keyboards an excellent feel.
3. **Membrane:** These are similar to rubber domes except that they use thin plastic sheets (membranes) with conductive traces on them. The contacts are in the form of dimples which are plucked together when a key is pressed. This design is often used in calculators and printer keyboards due to their low cost and trouble-free life. However, since its contacts require only a slight travel to actuate, it makes for a poor computer keyboard.

Scan Codes

A scan code is the code generated by a microprocessor in the keyboard when a key is pressed and is unique to the key struck. When this code is received by the computer it issues an interrupt and looks up the scan code table in the BIOS and finds out which keys have been pressed and in what combination. Special memory locations called *status bytes* tell the status of the locking and toggle keys, e.g., Caps lock etc. Each keypress generates two different scan codes — one on key-push down called Make code, another on its popping back called Break code. This two-key technique allows the computer to tell when a key is held pressed down, e.g., the ALT key while pressing another key, say, CTRL-ALT-DEL.

There are three standards for scan codes: Model (83-key keyboard PC, PC-XT), Mode2 (84-key AT keyboard), Mode3 (101-key keyboard onwards). In Model Make and Break codes are both single bytes but different for the same key. In Mode2 and Mode3, Make code is a single byte and Break code is two bytes (byte F0(Hex) + the make code).

Interfacing

The keyboard uses a special I/O port that is like a serial port but does not explicitly follow the RS-232 serial port standard. Instead of multiple data and handshaking signals as in RS-232, the keyboard uses only two signals, through which it manages a bi-directional interface with its own set of commands.

Using its elaborate handshaking mechanism, the keyboard and the PC send commands and data to each other. The USB keyboards work differently by using the USB coding and protocol.

OPERATOR

— means dash which is longer.
- means hyphen which is shorter.

Table 1: Some Scan Codes

Model1				Mode2	Mode 3
Key	KeyNo.	Make	Break	Make	Break
A	31	1E	9E	1C	F0 1C
0	11	0B	8B	45	F0 45
Enter	43	1C	9C	5A	F0 5A
Left Shift	44	2A	AA	12	F0 12
F1	112	3B	BB	07	F0 07

Connections

5-pin DIN connector: This is the connector of the conventional keyboard having 5 pins (2 IN, 2 OUT and one ground pin), used for synchronization and transfer.

PS/2 connector (PS/2 keyboards): These were introduced with IBM's PS/2 computers and hence are called PS/2 connectors. They have 6-pins but in fact their wiring is simply a rearrangement of the 5-pin DIN connector. This connector is smaller in size and quite popular nowadays. Due to the similar wiring, a 5-pin DIN can easily be connected to a PS/2 connector via a simple adapter.

Ergonomic Keyboards

Ergonomics is the study of the environment, conditions and efficiency of workers¹. Ergonomics suggests that the keyboard was not designed with human beings in mind. Indeed, continuous typing can be hazardous to health. This can lead to pain or some ailments like the Carpal Tunnel Syndrome.

For normal typing on a keyboard, you have to place your hands apart, bending them at the wrists and hold this position for a long time. You also have to bend your wrist vertically especially if you elevate your keyboard using the little feet behind the keyboards. This stresses the wrist ligaments and squeezes the nerves running into the hand through the Carpal tunnel, through the wrist bones.

To reduce the stress, keyboards called ergonomic keyboards have been designed. These split the keyboard into two and angle the two halves so as to keep the wrists straight. To reduce vertical stress, many keyboards also provide extended wrist rests. For those who indulge in heavy, regular typing, it is recommended that they use more ergonomics based keyboards and follow ergonomic advice in all aspects of their workplace.

4.3 MOUSE

The idea of the Mouse was developed by Douglas C. Engelbart of Stanford Research institute, and the first Mouse was developed by Xerox corporation. Mouse itself is a device which gives you a pointer on screen and a method of selection of commands through buttons on the top. A single button is usually sufficient (as in Mouse with Apple Macintosh machines) but Mice come with upto 3 buttons.

Types of Mice

Mice can be classified on the basis of the numbers of buttons, position sensing technology or the type of Interface:

¹Oxford Advanced Learner's Dictionary

Sensing Technology

The Mice can be Mechanical or Optical.

Mechanical Mice have a ball made from rough rubbery material, the rotation of which effects sensors that are perpendicular to each other. Thus, the motion of the ball along the two axes is detected and reflected as the motion of the pointer on the screen.

Optical Mice can detect movement without any moving parts like a ball. The typical optical Mouse used to have a pair of LEDs (Light Emitting Diodes) and photo-detectors in each axis and its own Mousepad on which it is slid. However, due to the maintenance needs of the Mousepad, this was not very successful. Recently, optical Mice have made a comeback since they can now operate without a Mousepad.

Interface

Mouse is usually a serial device connected to a serial port(RS232), but these connections can themselves take various forms:

Serial Mouse

Mice that use the standard serial port are called "serial". Since Serial ports 1 and 4 (COM1, COM4 under DOS, /dev/ttyS0 and /dev/ttyS3 under Unix/GNU-Linux systems) and ports 2 and 3 (COM2, COM3 or /dev/ttyS1/dev/ttyS2) share the same interrupts respectively, one should be careful not to attach the mouse so that it shares the interrupt with another device in operation like a modem.

Bus Mouse

These Mice have a dedicated Mouse card and port to connect to. Recently, USB mouse has become popular.

Proprietary

Mouse ports specific to some PCs e.g., IBM's PS/2 and some Compaq computers.

Mouse Protocols

The mouse protocol is the digital code to which the signal from the mouse gets converted. There are four major protocols: Microsoft, Mouse Systems Corporation(MSC), Logitech and IBM. Most mice available do support at least the Microsoft protocol or its emulation.

Resolution versus Accuracy

Resolution of mouse is given in CPI(Counts per Inch) i.e. the number of signals per inch of travel. This means the mouse will move faster on the screen but it also means that it will be more difficult to control the-accuracy.

Check Your Progress 1

1. Discuss the merits and demerits of Dvorak-Dealey keyboard vs. QWERTY keyboard.

.....

.....

.....

.....

.....

2. Why is keyboard touch important? What kind of touch would you prefer and which kind of keyboard will give that touch?

.....

.....

.....

.....

3. What precautions should be taken while attaching a Serial Mouse?

.....

.....

.....

.....

.....

4. You enter 'a' as left-shift + 'A' ? What will be the scan-code generated in Mode-3 by the keyboard?

- a) 2A1E9EAA b) 1CF01C
c) 121CF01CF012 d) 1CF01C5AF05A

4.4 VIDEO CARDS

Before discussing in detail video hardware, let us have a brief overview of graphic display technology. The purpose of your graphic display system is to display bit-mapped graphics on your monitor. The image displayed on your system thus consists of small dots called pixels (short for 'picture elements') and your video system contains a description of each of these dots in the memory. At any moment, the display memory contains the exact bit-map representation of your screen image and what is coming next. This is like a time-slice of what you see on your monitor. Therefore, display memory is also called a framebuffer. These frames are read dozens of times a second and sent in a serial manner through a cable to the monitor. The monitor receives the train of data and displays it on the screen. This happens by a scanning raster movement from up to down one row at a time. A CRT (Cathode Ray Tube) based monitor will light its small phosphor dots according to this raster movement. In this respect, it is like a television, which is also a CRT based device.

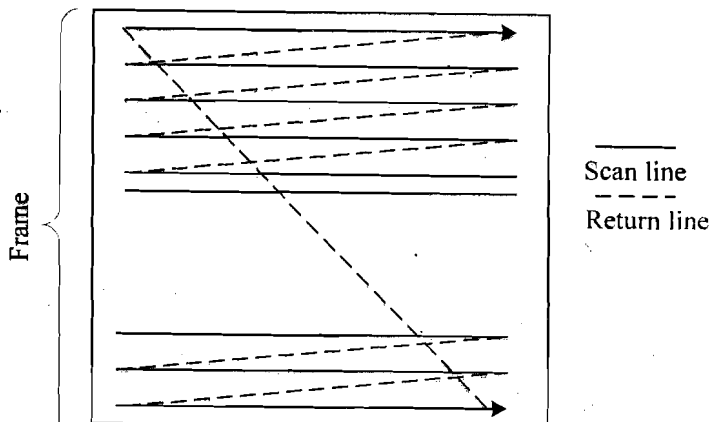


Figure 3: Raster Display

The more the number of dots, i.e., the higher the resolution of the image, the sharper the picture is. The richness of the image is also dependant on the number of colours (or gray levels for a monochrome display) displayed by the system. The higher the number of colours, the more is the information required for each dot. Hence, the amount of memory (framebuffer) required by a system is directly dependent on the resolution and colour depth required.

4.4.1 Resolution

Resolution is the parameter that defines the possible sharpness or clarity of a video image. Resolution is defined as the number of pixels that make up an image. These pixels are then spread across the width and height of the monitor. Resolution is independent of the physical characteristics of the monitor. The image is generated without considering the ultimate screen it is to be displayed upon. Hence, the unit of resolution is the number of pixels, not the number of pixels per inch. For example, a standard VGA native graphic display mode has a resolution of 640 pixels horizontally by 480 pixels vertically. Higher resolutions mean the image can be sharper because it contains more pixels.

The actual on-screen sharpness is given as dots-per-inch, and this depends on both the resolution and the size of the image. For the same resolution, an image will be sharper on a smaller screen, i.e., an image which may look sharp on a 15" monitor may be a little jagged on a 17" display.

4.4.2 Colour Depth

It is clear that an image consists of an array of pixels. If we tell which pixels are 'on' and which are 'off' to the monitor, it should be able to display the image as a pure black and white image. But what about Colour and Contrast? Clearly, if only a single bit is assigned to a pixel, we cannot give any additional quality to the image. It will look like a black and white line drawing. Such a system is typically called a two-colour system. Such black and white picture can be converted to gray levels by assigning more bits, e.g., with two bits we can get the following levels: White, Light Gray, Dark Gray and Black.

To add colour to an image, we have to store colour of the pixel with each pixel. This is usually stored as intensity measures of the primary light colours — Red, Green and Blue. That means we have to assign more than 1 bit to describe a pixel. Hence, 1 bit per pixel implies 2 colours or 2 gray-levels, 2 bits per pixel 4 colours or 4 gray-levels and so n bits per pixel means a display of colours or gray-levels is possible.

Colour Depth (or the number of *Colour Planes*) is the number of bits assigned to each pixel to code colour information in it. These are also called *Colour Planes* because each bit of a pixel represents a specific colour and the bit at the same position on every pixel represents the same colour. Hence, the bits at the same position can be thought of as forming a plane of a particular colour shade and these planes piled on top of each other give the final colour at each point. Thus, if each pixel is described by 3 bits, one each for red, green and blue colour, then, there are 3 *Colour Planes* (one each for red, green and blue) and 6 colour planes if there are 6 bits — see Figure 4.

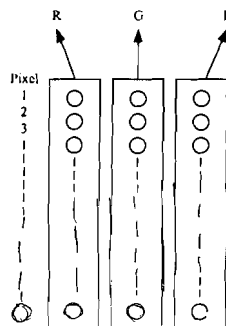


Figure 4: Colour Planes

What Colour depths are practically used?

Practically, the number of colours are an exponential power of 2, since for *Colour Depth n*, colours can be displayed. The most popular colour modes are given in Table 2.

	Colour Mode	Depth(bits/pixel)
1	Monochrome	1
2	16-Colours	4
3	256-Colours	8
4	High Color	16
5	True Color	24

Table 2: Major Colour Depths

The Bad News

The bad news is that most monitors can only display upto a maximum of 262,144 colours (= i.e. 18 bits/pixel *Colour Depth*). The other bad news is that the human eye can only perceive a few million colours at the most. So, even if you had lots of bits per pixel and very advanced display systems, it would be useless. Maybe, this is good news rather than bad news for the hardware developer!

This also implies that 24-bit colour bit-depth is the practical upper limit. Hence, this depth is also called true colour because with this depth the system stores more colours than can ever be seen by the human eye and, hence, it is a true colour representation of the image. *Though, 24-bit colour or true colour systems have more colour than possibly useful, they are convenient for designers because they assign 1 byte of storage for each of the three additive primary colours (red, green and blue).* Some new systems even have 32 bits per pixel. Why? Actually, the additional bits are not used to hold colours but something called an *Alpha Channel*. This 8-bit *Alpha Channel* stores special effect information for the image.

Why are all resolutions in the ratio of 4:3? The answer you'll find in a later section.

4.4.3 Video Memory

As stated before, video memory is also called framebuffer because it buffers video frames to be displayed. The quality of a video display depends a lot on how quickly can the framebuffer be accessed and be updated by the video system. In early video systems, video memory was just a fixed area of the system RAM. Later, there was video RAM which came with the video cards themselves and could be increased by putting additional video RAM under the UMA (Unified Memory Architecture). Video RAM is again part of the system RAM. UMA is what you get in the modern low-cost motherboards with on-board video and sound cards etc.

The amount of video memory required is dependant on the resolution and colour-depth required of the system. Let us see how to calculate the amount of video memory required. The video memory required is simply the resolution (i.e., the total number of pixels) multiplied by the Colour Depth. Let us do the calculations for a standard VGA graphics screen (640 × 480) using 16 colours.

Total number of Pixels = 640 × 480 =	307200	
Colour Depth (16-colours) =	4	bits
Total minimum Memory =	1,228,800	bits
Total minimum memory (in bytes) =	153,600	bytes
	153 KB	

Minimum Video RAM required and available = 256 KB.

Therefore, 16-colour VGA needs at least 153,600 bytes of memory but memory is only available in exponential powers of 2, hence, the next highest available memory is = 256 KB.

What is a good resolution? Actually, it depends on your hardware. So, it is the maximum your hardware can allow you. However, one odd-looking resolution which has become popular is 1152×864 pixels. Can you judge why this should be so? (Hint: Think of this resolution at 8-bit colour).

If you can't wait any longer, here is the answer: 1152×864 is nearly one million pixels. Since 8-bit colour depth means 8 million bits or 1 MB. This is the highest resolution you can get in 1 MB video memory at 8-bit colour depth, plus this still leaves you square pixels (in the ratio 4: 3) to allow easy programming.

The above calculations hold good for only two-dimensional display systems. This is because 3-D systems require much more memory because of techniques such as "Double Buffering" and "Z-Buffering".

4.4.4 Refresh Rates

A special circuit called the Video Controller scans the video memory one row at a time and reads data value at each address sending the data out in a serial data stream. This data is displayed by a process called *Scanning* where the electron beam is swept across the screen one-line-at-a-time and left-to-right. This is controlled by a vertical and a horizontal field generated by electromagnets — one moving the beam horizontally and another vertically.

The rate at which horizontal sweeps take place is called horizontal frequency or horizontal refresh rate and the rate at which vertical sweeps take place are called vertical frequency or vertical refresh rate or simply refresh rate or frame rate. The term frame rate is used because actually one vertical sweep means display of a single frame. Since each frame contains several hundred rows, horizontal frequency is hundreds of times higher than vertical frequency. Therefore, the unit of horizontal frequency is KHz and that of vertical frequency is Hz.

The most important thing is maintaining the same frequencies between the Video system and monitor. The monitor must support these refresh rates, hence the supported refresh rates are given with the manual of the monitor. More about this topic will be discussed in the section on Monitors.

4.4.5 Graphic Accelerators and 3-D Accelerators

A Graphic Accelerator is actually a chip, in fact the most important chip in your video card. The Graphic Accelerator is actually the modern development of a much older technology called the *Graphic Co-Processor*. The accelerator chip is actually a chip that has built-in video functions. These functions execute the algorithms for image construction and rendering. It does a lot of work which would otherwise have to be done by the microprocessor. Hence, the accelerator chip is actually optional but very important for good graphics performance.

The graphic accelerator determines whether your system can show 3-D graphics, how quickly your system displays a drop-down menu, how good is your video playback, etc. It determines the amount and kind of memory in the framebuffer and also the resolution your PC can display.

The first major graphic accelerators were made by the S3 corporation. Modern Graphic accelerators have internal registers at least 64-bit wide to work on at least 2 pixels at a time. They can use the standard Dynamic RAM (DRAM) or the more expensive but faster dual-ported Video RAM (VRAM). They support at least the standard resolutions up to 1024×768 pixels. They often use RAMDACs for colour support giving full 24-bit or 32-bit colour support. A RAMDAC (Random Access

Memory Digital-to-Analog Converter) is a microchip that converts digital image data into the analog data needed by a computer display. However, the higher the resolution required, the higher is the speed at which the chip has to function. So, for a resolution of 1280×1024 , the chip operates at 100 MHz. At the cutting edge of technology, chips now run even as fast as 180 or 200 Mhz.

What is a 3-D Accelerator?

3-D Accelerator is no magic technology. It is simply an accelerator chip that has built-in ability to carry out the mathematics and the algorithms required for 3-D image generation and rendering. A 3-D imaging is simply an illusion, a projection of 3-D reality on a 2-D screen. These are generated by projection and perspective effects, depth and lighting effects, transparency effects and techniques such as Ray-Tracing (Tracing the path of light rays emitting from a light source), Z-buffering (a buffer storing the Z-axis positions) and Double-Buffering (two buffers instead of one).

4.4.6 Video Card Interfaces

A video interface is the link of the video system to the rest of the PC. To enhance video performance, there is sought to be an intimate connection between the microprocessor and the video system, especially the framebuffer. In modern displays, only in the UMA system is the framebuffer actually a part of the main memory; in the rest the connection is through a bus, which may be PCI or AGP. Let us briefly discuss these interfaces:

PCI

PCI stands for Peripheral Connect Interface. It is the revolutionary high speed expansion bus introduced by Intel. With the growing importance of video, video cards were shifted to PCI from slower interfaces like ISA. The PCI standard has now developed into the even more powerful AGP.

AGP

AGP stands for Advanced (or Accelerated) Graphics Port. It is a connector standard describing a high speed bus connection between the PC video system, the microprocessor and the main memory. It is an advancement of the PCI interface.

AGP uses concepts such as pipelining to allow powerful 3-D graphic accelerators to function when used in conjunction with fast processors. AGP uses three powerful innovations to achieve its performance:

- Pipelined Memory: The use of Pipelining eliminates wait states allowing faster operation.
- Seperate Address and Data Lines.
- High speeds through a special 2X mode that allows running AGP at 133 MHz instead of the default 66 MHz.

Through AGP, the video board has a direct connection to the microprocessor as a dedicated high speed interface for video. The system uses DMA (Direct Memory Access) to move data between main memory and framebuffer. The accelerator chip uses the main memory for execution of high level functions like those used in 3-D rendering.

UMA

UMA stands for Unified Memory Architecture. It is an architecture which reduces the cost of PC construction. In this, a part of the main memory is actually used as framebuffer. Hence, it eliminates the use of a bus for video processing. Therefore, it is less costly. Though it is not supposed to perform as well as AGP etc., in some

cases it may give a better performance than the bus-based systems. It is the interface used nowadays in low-cost motherboards.

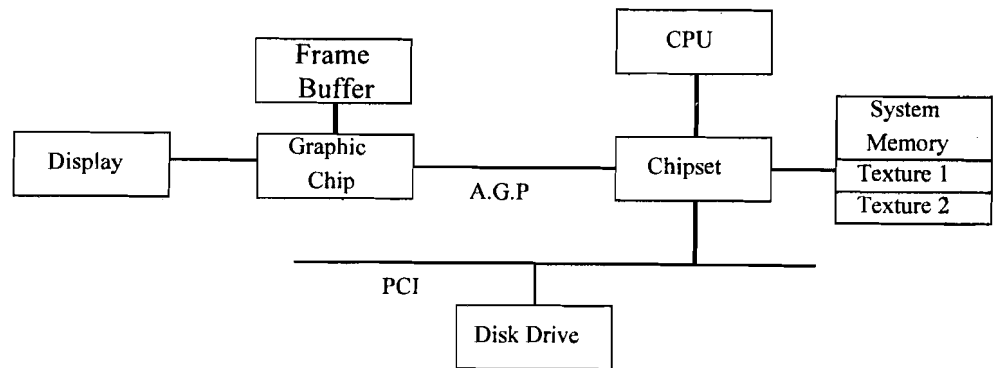


Figure 5: AGP Video Architecture and its working

4.5 MONITORS

A Monitor is the television like box connected to your computer and giving you a vision into the mind of your PC. It shows what your computer is thinking. It has a display which is technically defined as the image-producing device, i.e., the screen one sees and a circuitry that converts the signals from your computer (or similar devices) into the proper form for display.

Monitors are or were just like television sets except that television sets have a tuner or demodulator circuit to convert the signals. However, now monitors have branched beyond television. They have greater sharpness and colour purity and operate at higher frequencies.

Generally, when you go to purchase a monitor from the market, you see the following specifications: The maximum Resolution, the Horizontal and Vertical Frequencies supported, the tube size and the connectors to the monitor. There are many vendors on the market like Samsung, LG, Sony etc. Home users generally go in for monitors of size 17", 15" or 14". Monitors are also available as the traditional curved screens, flat screens or LCD. The technology behind Monitors and the above specifications are discussed ahead.

4.5.1 Cathode Ray Tubes

Cathode ray tube is the major technology on which monitors and televisions have been based. CRT is a partially evacuated glass tube filled with inert gas at low pressure. A specially designed Cathode (negatively charged electrode) shoots beams of electrons at high speed towards an anode (positively charged electrode) which impinges on the screen which is coated with small phosphor coated dots of the three primary colours. This cathode is also called an Electron Gun. In fact, there can be three separate guns for the three colours (Red, Green and Blue) or one gun for all three.

Four factors influence the quality of image of the monitor:

1. **The Phosphor coating** : This affects the colour and the persistence (The period the effect of a single hit on a dot lasts).
2. **The Cathode (Electron Gun)** : The sharpness of the image depends on the good functioning of this gun.

3. **Shadow Mask/ Aperture Grill :** This determines the resolution of the screen in colour monitors.
4. The Screen, glare and lighting of the monitor.

4.5.2 Shadow Mask

The Shadow Mask is a metal sheet which has fine perforations (holes) in it and is located a short distance before the phosphor coated screen. The Phosphor dots and the holes in the shadow mask are so arranged that the beams from a particular gun will strike the dots of that colour only. The dots of the other two colours are in the shadow. In an attempt to overcome some shortcomings of Shadow masks due to their round holes, Sony introduced Aperture grills (in their Trinitron technology) which are slots in an array of vertically arranged wires.

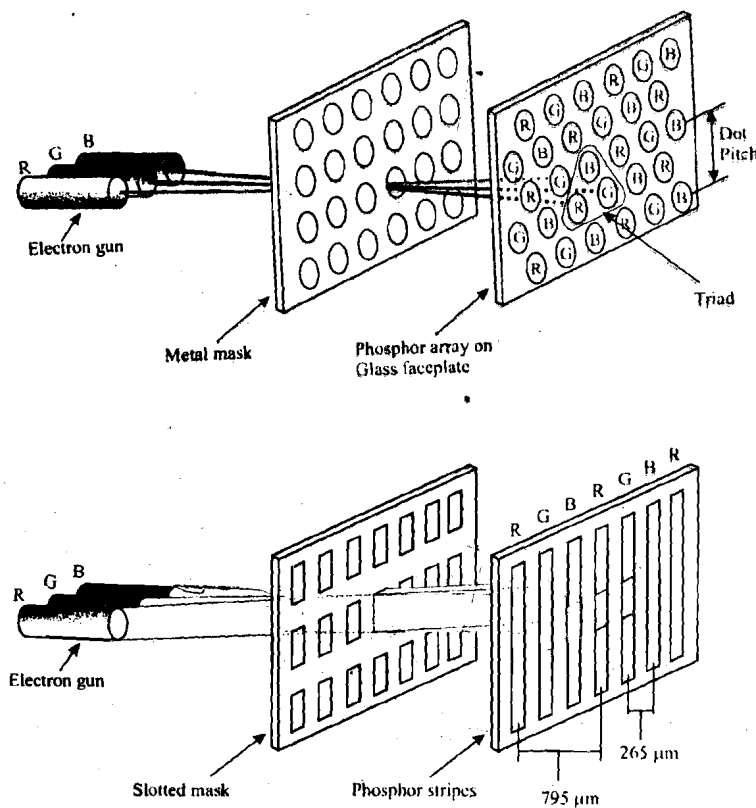


Figure 6: Shadow Mask and Aperture

4.5.3 Dot Pitch

Dot Pitch of a CRT is the distance between phosphor dots of the same colour. In Trinitron screens, the term Slot Pitch is used instead of Dot Pitch — this is the distance between two slots of the same colour. Dot Pitch is a very important parameter of monitor quality. For a particular resolution, you can get the minimum dot pitch required by dividing the physical screen size by the number of pixels. Therefore, for smaller screens, you require finer Dot Pitch.

4.5.4 Monitor Resolutions

We have discussed about resolutions and vertical and horizontal refresh rates in the section on Video Cards. Let us refer to them from the monitor point of view. So, we have the following definitions (from the manual of a monitor available in the market):

Horizontal Frequency: The time to scan one line connecting the right edge to the left edge of the screen horizontally is called the Horizontal cycle and the inverse number of the Horizontal cycle is called Horizontal Frequency. The unit is KHz (KiloHertz).

Vertical Frequency: Like a Fluorescent lamp, the screen has to repeat the same image many times per second to display an image to the user. The frequency of this repetition is called Vertical Frequency or Refresh Rate.

If the resolution generated by the video card and the monitor resolution is properly matched, you get a good quality display. However, the actual resolution achieved is a physical quality of the monitor. In colour systems, the resolution is limited by Convergence (Do the beam of the 3 colours converge exactly on the same dot?) and the Dot Pitch. In monochrome monitors, the resolution is only limited by the highest frequency signals the monitor can handle.

4.5.5 DPI

DPI (Dots Per Inch) is a measure for the actual sharpness of the onscreen image. This depends on both the resolution and the size of the image. Practical experience shows that a smaller screen has a sharper image at the same resolution than does a larger screen. This is because it will require more dots per inch to display the same number of pixels. A 15-inch monitor is 12-inches horizontally. A 10-inch monitor is 8 inches horizontally. To display a VGA image (640×480) the 15-inch monitor will require 53DPI and the 10-inch monitor 80 DPI.

4.5.6 Interlacing

Interlacing is a technique in which instead of scanning the image one-line-at-a-time it is scanned alternately, i.e., alternate lines are scanned at each pass. This achieves a doubling of the frame rate with the same amount of signal input. Interlacing is used to keep bandwidth (amount of signal) down. Presently, only the 8514/A display adapters use interlacing. Since Interlaced displays have been reported to be more flickery, with better technology available, most monitors are non-interlaced now.

4.5.7 Bandwidth

Bandwidth is the amount of signal the monitor can handle and it is rated in MegaHertz. This is the most commonly quoted specification of a monitor. The Bandwidth should be enough to address each pixel plus synchronizing signals.

Check Your Progress 2

1. Redraw Figure 4 showing Colour-Planes for a true-colour system.

.....

.....

.....

2. What is a FrameBuffer? Discuss the placement of the FrameBuffer w.r.t. to the different Video Card interfaces.

.....

.....

.....

.....

3. What is the difference between Shadow Mask and Dot Pitch for Trinitron and non-Trinitron monitors?
-
-
-
4. How much Video-RAM would you require for a high-colour (16-bits) Colour-Depth at 1024×768 resolution? What would be the size of the corresponding single memory chip you would get from the market?
- a) 900KB, 1MB b) 1.6 MB, 4MB
c) 12.6MB, 16MB d) 7.6MB, 8MB
5. There is an image of resolution 1024×768. It has to be displayed on a 15-inch monitor (12-inch horizontal, 9-inch Vertical display). What is the minimum Dot-pitch required for this image? (minimum here means the largest useful dot pitch).
- a) 1.4×10^{-4} inches b) 2.8×10^{-4} inches
c) 1.4×10^4 inches d) 1.2×10^{-2} inches

4.6 LIQUID CRYSTAL DISPLAYS (LCD)

LCDs are the screens of choice for portable computers and lightweight screens. They consume very little electricity and have advanced technologically to quite good resolutions and colour support. They were developed by the company RCA in the 1960s. LCDs function simply by blocking available light so as to render display patterns.

LCDs can be of the following types:

1. **Reflective LCDs:** Display is generated by selectively blocking reflected light.
2. **Backlit LCDs** : Display is due to a light source behind LCD panel.
3. **Edgelit LCDs** : Display is due to a light source adjacent to the LCD panel.

LCD Technology

The technology behind LCD is called Nematic Technology because the molecules of the liquid crystals used are nematic i.e. rod-shaped. This liquid is sandwiched between two thin plastic membranes. These crystals have the special property that they can change the polarity and the bend of the light and this can be controlled by grooves in the plastic and by applying electric current.

Passive Matrix

In a passive matrix arrangement, the LCD panel has a grid of horizontal and vertical conductors and each pixel is located at an intersection. When a current is received by the pixel, it becomes dark. This is the technology which is more commonly used.

Active Matrix

This is called TFT (Thin Film Transistor) technology. In this there is a transistor at every pixel acting as a relay, receiving a small amount and making it much higher to activate the pixel. Since the amount is smaller, it can travel faster and hence response times are much faster. However, TFTs are much more difficult to fabricate and are costlier.

4.7 DIGITAL CAMERA

A Digital camera is a camera that captures and stores still images and video (Digital Video Cameras) as digital data instead of on photographic film. The first digital cameras became available in the early 1990s. Since the images are in digital form they can be later fed to a computer or printed on a printer.

Like a conventional camera, a digital camera has a series of lenses that focus light to create an image of a scene. But instead of this light hitting a piece of film, the camera focuses it on to a semiconductor device that records light electronically. An in-built computer then breaks this electronic information down into digital data.

This semiconductor device is called an Image sensor and converts light into electrical charges. There are two main kinds of Image sensors: CCD and CMOS. CCD stands for Charge coupled devices and is the more popular and more powerful kind of sensor. CMOS stands for Complementary Metal oxide semiconductor and this kind of technology is now only used in some lower end cameras. While CMOS sensors may improve and become more popular in the future, they probably won't replace CCD sensors in higher-end digital cameras.

In brief, the CCD is a collection of tiny light-sensitive diodes called photosites, which convert photons (light) into electrons (electrical charge). Each photosite is proportionally sensitive to light – the brighter the light that hits a single photosite, the greater the electrical charge that will accumulate at that site.

A digital Camera is also characterised by its resolution (like monitors and printers) which is measured in pixels. The higher the resolution, the more detail is available in an image.

Mobile Cameras

Mobile cameras are typically low-resolution Digital cameras integrated into the mobile set. The photographs are typically only good enough to show on the low resolution mobile screen. They have become quite popular devices now and the photographs taken can be used for MMS messages or uploading to a Computer.

4.8 SOUND CARDS

Multimedia has become a very important part of today's PC. The home user wants to watch movies and hear songs. The Software developer hacking away at her computer wants to have the computer playing MP3 or OGG (The latest Free Sound format standard) in the background. Thus, the sound system is a very important part of the system.

As you must have read in your high school physics, sound is a longitudinal wave travelling in a medium, usually air in the case of music. Sound can be encoded into electrical form using electrical signals which encode sound strengths. This is called analog audio. This analog audio is converted to digital audio, which is conversion of those signals into bits and bytes through the process called Sampling. In Sampling, analog 'samples' are taken at regular intervals and the amplitude (Voltage) of these samples is encoded to bits. These sounds are manipulated by your PCs microprocessor etc. To play back these digital audio sounds, the data are sent to the Sound card which converts them to analog audio, which is played back through speakers.

The Sound card (The card is often directly built into motherboards nowadays) is a board that has digital to analog sound converter, amplifier, etc., circuitry to play sound and to connect the PC to various audio sources.

A sound card may support the following functions:

1. Convert digital sound to analog form using digital-to-analog converter to play back the sound.
2. May record sound to play back later with analog-to-digital converter.
3. May have built-in Synthesizers to create new sounds.
4. May use various input sources (Microphone, CD, etc.) and mixer circuits to play these sounds together.
5. Amplifiers to amplify the sound signals to nicely audible levels.

Sound cards are described by the Compatibility, Connections and Quality.

Compatibility: Sound cards must be compatible at both hardware and software levels with industry standards. Most software, especially games, require sound cards to be compatible with the two main industry standards: AdLib (A Basic standard) and Sound Blaster (an advanced standard developed by Creative Labs).

Connections: Sound cards should have connections to allow various functions. One of the most important is the MIDI port (MIDI stands for Musical Instrument Device Interface). MIDI port allows you to create music directly with your PC using the Sound Cards synthesizer circuit and even attach a Piano keyboard to your PC.

Quality: Sound Cards vary widely in terms of the quality they give. This ranges from the frequency range support, digital quality and noise control.

4.9 PRINTERS

Printers are devices that put ink on paper in a controlled manner. They manually produce readable text or photographic images. Printers have gone through a large transition in technology. They are still available in a wide range of technology and prices from the dot matrix printer to Inkjet printers to Laser Printers.

4.9.1 Classification of Printers

Printers can be classified on the following bases:

- a) **Impact:** Impact printers print by the impact of hammers on the ribbon (e.g., Dot-Matrix Printers) whereas non-impact printers use other means (e.g., Inkjet, Laser).
- b) **Character formation:** Character formed by Bit-maps or by dots.
- c) **Output :** The quantity of output processed at a time: Serial, Line or Page Printers.

Actually, there are many specifications one has to keep in mind while purchasing a printer. Some of these are Compatibility with other hardware, in-built Memory, maximum supported memory, actual technology, Printer resolution (Colour, BW), PostScript support, output type, Printer speed, Media capacity, Weight, Height and Width of the Printer.

Let us discuss some of these parameters that characterize printers :

4.9.2 Print Resolution

Print Resolution is the detail that a printer can give determined by how many dots a printer can put per inch of paper. Thus, the unit of resolution is *Dots per inch*. This is applicable to both impact and non-impact printer though the actual quality will depend on the technology of the printer.

The required resolution to a great extent determines the quality of the output and the time taken to print it. There is a tradeoff between quality and time. Lower resolution means faster printing and low quality. High resolution means slower printing of a higher quality. There are three readymade resolution modes: draft, near letter quality (NLQ) and letter quality. Draft gives the lower resolution print and letter quality higher resolution. In Inkjet and Laser Printers, the highest mode is often called 'best' quality print.

4.9.3 Print Speed

The speed at which a printer prints is often an important issue. However, the printer has to take a certain time to print. Printing time increases with higher resolution and coloured images. To aid printing, all operating systems have spooling software that accumulates print data and sends it at the speed that the printer can print it. The measure of speed depends on whether the printer is a **Line Printer** or **Page**

Printer. Let us understand these:

Line Printer: Line Printer processes and prints one line of text at a time.

Page Printer: A page printer processes and prints one full page at a time.

Actually, it rasterizes the full image of the page in its memory and then prints it as one line of dots at a time. For a line printer, the speed is measured in *characters per second* (cps) whereas for page printing, it is *pages per minute* (ppm). Hence, Dot Matrix usually have speeds given in *cps* whereas Lasers have speed in *ppm*. The actual speed may vary from the rating speed given by the manufacturer because, as expected, the printer chooses the more favourable values.

4.9.4 Print Quality

Print quality depends on various factors but ultimately the quality depends on the design of the printer and its mechanical construction.

DotMatrix/InkJet Printers

Three main issues determine the quality of characters produced by DotMatrix/InkJet Printers: - Number of dots in the matrix of each character, the size of the dots and the addressability of the Printer. Denser matrix and smaller dots make better characters.

Addressability is the accuracy with which a dot can be produced (e.g., 1/120 inch means printer can put a dot with 1/120 inch of the required dot). Minimum dot matrix used by general dot matrix printers is 9×9 dots, 18-pin and 24-pin printers use 12×24 to 24×24 matrices. Inkjets may even give up to 72×120 dots. Quality of output also depends on the paper used. If the ink of an Inkjet printer gets absorbed by the paper, it spreads and spoils the resolution.

Laser Printer

Laser Printers are page printers. For print quality, they also face the same addressability issues as DMP/InkJet Printers. However, some other techniques are possible to use for better quality here.

One of these is ReT (Resolution Enhancement Technology) introduced by Hewlett-Packard. It prints better at the same resolution by changing the size of the dots at character edges and diagonal lines reducing jagged edges.

A very important requirement for Laser Printers to print at high quality is Memory. Memory increases as a square of resolution, i.e., the Dot density, i.e., the dpi. Therefore, if 3.5 MB is required for a 600 dpi page, approximately 14 MB is required for 1200 dpi. You need even more memory for colour.

For efficient text printing, the Laser printer stores the page image as ASCII characters and fonts and prints them with low memory usage. At higher resolutions, the quality of print toner also becomes important since the resolution is limited by the size of toner particles.

4.9.5 Colour Management

There are three primary colours in pigments - *Red, Yellow and Blue*. There are two ways to produce more colours:

Physical Mixing: Physically mix colours to make a new colour. This is difficult for printers because their colours are quick drying and so colours to be mixed must be applied simultaneously.

Optical Mixing: Mixing to give the illusion of a new colour. This can be done in ways:

- Apply colours one upon another. This is done using inks which are somewhat transparent, as modern inks are.
- Applying dots of different colours so close to one another that the human eye cannot distinguish the difference. This is the theory behind **Dithering**.

3 or 4 colour Printing?

For good printing, printers do not use RBY, instead they use CMYK (Cyan instead of Blue, Magenta instead of Red, Yellow, and a separate Black). A separate Black is required since the 3 colours mixed to produce a black (which is called Composite Black) is often not satisfactory.

What is Dithering?

CMYK gives only 8 colours (C, M, Y, K, Violet = C + M, Orange = M + Y, Green = C + Y, and the colour of the paper itself!). What about other colours? For these, the technique of Dithering is used. Dithering is a method in which instead of being a single colour dot, it is a small matrix of a number of different colour dots. Such pixels are called **Super-pixels**. The dots of a given colour in a Super-pixel decide the intensity of that colour. The problem with dithering is that it reduces the resolution of the image since more dots are taken by a single pixel now.

Monitors versus Printer

Monitor screens and Printers use different colour technologies. The monitor uses RGB and the Printer CMYK. So, how does one know that the colour that is seen is going to be printed. This is where the Printer driver becomes very important, and where many computer models and graphic oriented machine score. For long, a claim to fame of the Apple Macintosh machines has been its very good correspondence between print and screen colours.

4.10 MODEMS

A Modem is one device that most computer users who have surfed the Internet are aware of. A modem is required because though most of the telecommunications have become digital, most telephone connections at the user end are still the analog POTS (Plain Old Telephone Systems/Sets/Service). However, the computer is a digital device and hence another device is needed which can convert the digital signals to analog signals and vice-versa. Such a device is the Modem.

Modem stands for Modulator/Demodulator. Modulation is the process which puts digital information on to the analog circuit by modifying a constant wave (signal) called the Carrier. This is what happens when you press a button to connect to the Internet or to a web site. Demodulation is the reverse process, which derived the digital signal from the modulated wave. This is what happens when you receive data from a website which then gets displayed by your browser.

Discussion of modulation techniques is out of scope here (you can refer to your course on Computer Networks).

Modems are available as the following types:

1. **Internal Modems:** Internal Modems plug into expansion slots in your PC. Internal Modems are cheap and efficient. Internal Modems are bus-specific and hence may not fit universally.
2. **External Modems:** Modems externally connected to PC through a serial or parallel port and into a telephone line at the other end. They can usually connect to any computer with the right port and have a range of indicators for troubleshooting.
3. **Pocket Modems:** Small external Modems used with notebook PCs.
4. **PC-Card Modems:** PC and Modems are read with PCMCIA slots found in notebooks. They are like external Modems which fit into an internal slot. Thus, they give the advantage of both external and internal modems but are more expensive.

Modems come according to CCITT/ITU standards, e.g., V.32, V.32bis, V.42 etc.

Modem Language

Modems understand a set of instructions called *Hayes Command Set* or the *AT Command Set*. These commands are used to communicate with the Modem.

Sometimes, when you are in trouble setting up your Modem, it is useful to know some basic commands, e.g., ATDT 17776 will dial the number 17776 across a Tone Phone and ATDP 17776 to the number 17776 if it is a Pulse phone.

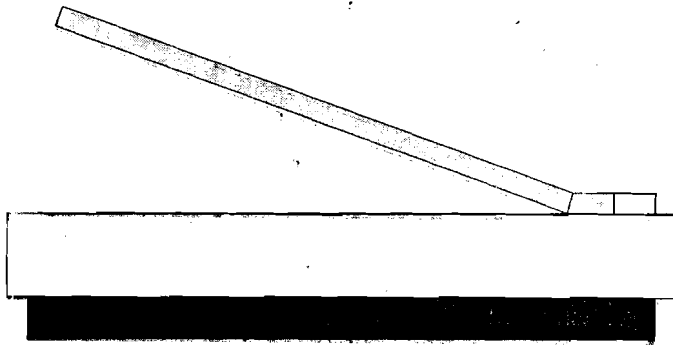
4.11 SCANNERS

A Scanner is a device that allows you to capture drawings or photographs or text from tangible sources (paper, slides etc.) into electronic form. Scanners work by detecting differences in brightness of reflections from an image or object using light sensors. These light sensors are arranged in an array across the whole width that is scannable. This packing determines the resolution and details that can be scanned.

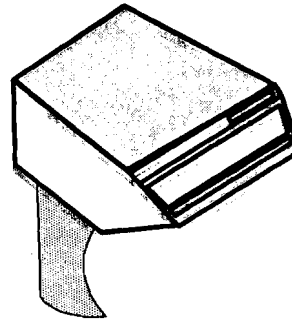
Scanners come in various types: *Drum Scanners*, *Flatbed Scanners*, *Hand Scanners* and *Video Scanners*. Drum Scanners use a rotating drum to scan loose paper sheets. Flatbed scanners have movable sensors to scan images placed on a flat glass tray.

These are the most expensive kind and hand held Scanners are the cheapest and most portable.

They are useful for many applications but are small in size and need good hand control for high quality scanning. Video Scanners use Video technology and Video cameras instead of Scanning technology. Potentially, they can give high resolutions, scanners in the economical range give poor resolutions.



Flatbed Scanner



Hand-held Scanner

Figure 7: Scanners

When you buy a scanner, there are many factors that can be looked at: Compatibility of the Scanner with your Computer, The Technology (Depth, Resolution), the media types supported for scanning, How media can be loaded, Media size supported, Interfaces supported, physical dimensions, style and ease of use of the scanner. One exciting application of Scanners is Optical Recognition of Characters (OCR). OCR software tries to recognise characters from their shapes and write out the scanned text as a text file. Though this technology is steadily improving, it is still not completely reliable especially w.r.t. Indian scripts. However, it can be very useful to digitize the ancient texts written in Indian scripts.

Scanning technology is also everpresent nowadays in Bar-Code readers and MICR (Magnetic Ink Character Recognition) cheques. This technology is very useful for automating data at source of origin, thereby avoiding problems like inaccuracies in data entry, etc.

4.11.1 Resolution

Optical Resolution

Optical resolution or hardware resolution is the mechanical limit on resolution of the Scanner. For scanning, the sensor has to advance after each line it scans. The smallness of this advancement step gives the resolution of the Scanner. Typically, Scanners may be available with mechanical resolutions of 300, 600, 1200 or 2400 dpi. Some special scanners even scan at 10,000 dpi.

Interpolated Resolution

Each Scanner is accompanied by a software. This software can increase the apparent resolution of the scan by a technique called Interpolation. By this technique, additional dots are interpolated (added) between existing dots. This gives a higher resolution and smoother picture but without adding any additional information. The added dots will however lead to larger file sizes.

4.11.2 Dynamic Range/Colour Depth

Dynamic Range is the number of colours a colour scan or the number of grays a monochrome scanner can differentiate. The dynamic range is usually given as bit-depth or colour depth. This is simply the number of bits to distinguish the colours. Most scanners can do 256(8-bit), 1024(10-bit) or 4096(12-bit) for each primary colour. This adds up to and is advertised as 24-bit, 30-bit and 36-bit colour scanners. Actually though, to utilise the Colour Depth, the image under scanning must be properly focused upon and properly illuminated by the scanner.

Since the minimum colour range useful for human vision is 24-bits, more bits may seem useful. However, extra bits of scanning give you firm control for filtering the image colour to your requirements.

4.11.3 Size and Speed

Before actual scanning, a quick, low resolution scan called pre-scan is made to preview the image and select scanning area. After this only does the actual scan take place. Early colour scanners used to take three passes for a scan - one pass for each colour. Now, Scanners use just one pass and use photodetectors to detect the colours. Then, they operate as fast as monochrome Scanners. However, other issues are also involved.

High resolution scans of large images result in large file sizes. These can slow down processing since they need Hard Disk I/O for virtual memory. Hence, for large scans, it is necessary to have higher RAM in your PC.

4.11.4 Scanning Tips

- Do not scan at more resolution than required. This saves both time and Disk Space.
- Usually, it is not useful to scan at more than the optical resolution since it adds no new information. Interpolation can be done later with Image processing softwares.
- If scanning photographs for Printers, it is enough to scan at one-third the resolution of printing, since Printers usually use Super-Pixels (Dithering) for printing. Only for other kind of Printers, like continuous tone Printers, do you need to scan at the Printer resolution for best quality.
- For images to be seen only at the Computer Monitor, you may need to only scan so that the image size in pixels is the same as display resolution. That is, $\text{Scan resolution} = \text{Height of image in pixels} \div \text{the screen size in inches}$. This may be surprisingly small.

4.12 POWER SUPPLY

Computer operate electronically — either through power supply obtained from your electric plug or batteries as in the case of portable computers. However, the current coming through your electric line is too strong for the delicate computer circuits. Also, electricity is supplied as AC but the computer uses DC. Thus, power supply is that equipment which takes AC from electrical supply and converts it to DC to supply to computer circuits. Early power supplies were linear power supplies and they worked by simply blocking one cycle of the AC current. They were superseded by the SMPS.

SMPS (Switched Mode Power Supply)

SMPS is the unit into which the electric supply from the mains is attached to your PC and this supplies DC to the internal circuits. It is more efficient, less expensive and more complex than linear supplies.

SMPS works in the following way: The electric supply received is sent to a component called **triac** which shifts it from 50 Hz to a much higher frequency (almost 20,000 Hz). At the same time, using a technique called **Pulse Width modulation**, the pulse is varied to the needs of the computer circuit. Shorter pulses give lower output voltage. A transformer then reduces back the voltage to the correct levels and rectifiers and filters generate the pure DC current.

SMPS has two main advantages: They generate less heat since they waste less power, and use less expensive transformers and circuits since they operate at higher frequencies.

The power requirement of a PC depends on the motherboard and the peripherals in your computer. Still, in modern PCs, your requirement may not be more than 150-200 Watts.

Check Your Progress 3

1. In what ways does a digital camera differ from a conventional camera?

.....

.....

.....

.....

2. Explain the term Resolution and how it applies to Monitors, Cameras, Printers, Scanners etc.

.....

.....

.....

.....

3. Explain the process of Colour management in Printers.

.....

.....

.....

.....

4. Compare Laptops using passive matrix and TFT technology. Which are cheaper in price?

.....

.....

.....

.....

5. To connect my modem to an ISP, I have to dial to the Pulse phone number 26176661, what Hayes Command set command would I give:
a) ATDT 1777626176661 b) ATDT 26176661
c) ATDP 1777626176661 d) ATDP 26176661
6. It is given that to print a 300dpi page on a particular Laser Printer, 2MB of memory is required. How much memory is required for a 600dpi page?
a) 2MB b) 4 MB
c) 8MB d) 16MB
7. Which of the following are Sound storage format standards?
a) MIDI b) WAVE
c) MP3 d) OGG

4.13 SUMMARY

In this unit, we discussed various Input/Output devices. We have covered the input devices Keyboard, Mouse and Scanner. Various types of Keyboards, Keyboard layouts (QWERTY, Dvorak) and technologies have been discussed. Various types of mice and their operation have been discussed. Different types of Scanners, the underlying technology and use in applications like OCR have been discussed.

The output devices discussed are Monitor, LCD and Printer. The technologies and specifications behind Monitors, LCD and Printers have been discussed. Colour management has also been discussed. Video cards, which control the display on monitors from the CPU and their system of display have been discussed with their characteristics like depth, resolution and memory. Modem is a communication device and thereby an I/O device. Its functioning has been discussed. The Power supply, and especially, the SMPS, which is actually in, ut of electric power for the computing unit, has also been discussed.

4.14 SOLUTIONS/ ANSWERS

Check Your Progress 1

1. The main Merit of Dvorak-Dealey keyboard is the scientific design using Hand alteration. However, since it came much later than QWERTY it did not become popular, as QWERTY was already well established.
2. Keyboard touch gives you a feedback mechanism. This tells you when you have pressed a key enough and involuntarily allows faster typing. The preferred touch is an individual choice but the best feedback is provided with an overcenter feel with a 'click' sound. The most suitable touch is given by Rubber Dome keyboards. (refer text for details).
3. Besides the standard precautions while attaching Hardware, one has to take precaution regarding interrupt conflict for serial devices., since Serial ports share their interrupts. (refer text for details).

1. A true-colour system has a depth of 24 bits per pixel. This means that 8 bits each are assigned to R, G and B i.e. there are 8 Colour Planes. Hence, in figure-4 replace 'n' by 8 to draw the new figure.
2. Framebuffer is another name for the Display Memory. This is like a time-slice of what you see on your monitor. Discuss how framebuffer is handled differently in early display systems, PCI, AGP and UMA. (refer text for details).
3. Shadow Mask: Trinitron uses Aperture Grills instead of Shadow Mask, for the same purpose.
Dot Pitch: Similarly, instead of Dot Pitch, there is Slot Pitch.
explain the terms Shadow Mask, Aperture Grill, Dot Pitch and Slot Pitch (refer text).
4. Ans. (b) $1024 \times 768 \times 2\text{Bytes} = 1.6\text{MB}$. RAM is/was available as 1MB, 4MB, 16MB etc.
5. Ans. (a) Total screen size = $12 \times 9 = 108$ inches. image size = $1024 \times 768 = 786432$ pixels. divide 108 inches by 786432.

Check Your Progress 3

1. In a digital camera, photos are stored in digital format. Instead of film, these cameras use Semiconductor devices, called image sensors. There are many other differences regarding quality, resolution etc.
2. Resolution is a generic term the parameter that defines the possible sharpness or clarity of something i.e. how clearly that thing can be resolved. This applies especially to images. See in what different ways it is used for Monitors, Cameras, Printers, Scanners and even Mice.
3. It tells about physical mixing, optical mixing and RGB and CMYK schemes. The technique of dithering is used for rich colour quality. Colours also differ on monitors and printers. To maintain similarity is also an important issue.
4. Compare Laptops made using passive matrix and TFT technology. Which are cheaper in price?
In a Passive matrix arrangement, the LCD has a grid of horizontal and vertical conductors. Each pixel is located at an intersection. When a current is received by the pixel, it becomes dark whereas in Active Matrix, also called TFT (Thin Film Transistor) technology, each pixel is active, working as a relay. Hence, it needs less power and gives better quality display. Passive matrix LCDs are cheaper but now, TFT LCDs are also economically available. (find out the latest from the market).
5. Ans. (d) ATDP 26176661.
6. Ans. (c) 8MB. The memory requirement increases as a square of the resolution(dpi), so an increase of two times in the dpi leads to an increase of four times in the memory requirement.
7. Ans. All of them.

References:

- 1) [http: //what's.techtarget.com/](http://what's.techtarget.com/).
- 2) [http: //www.epanorama.net/links/pc/index.htm](http://www.epanorama.net/links/pc/index.htm).
- 3) [http: //www.howstuffworks.com/](http://www.howstuffworks.com/).
- 4) Mark Minasi. *The Complete PC Upgrade and Maintenance Guide*. BPB Publications, New Delhi, 2002.
- 5) Winn L. Rosch. *Hardware Bible*. Techmedia, New Delhi, 1997.