Unit 5

Introduction of Microprocessor & Microcontroller

5.1 Buses

Local buses are intenal to a device and the communicate with outside world. Within the CPU, local buses can generally be divided in three types : address bus, data bus, or control bus local buses with special extensions for use outside the CPU; mostly found in microcomputer systems. The key is that the CPU's clock and timing regulates these buses; while in true system buses, the timing is independent of that of CPU's

5.2 Interfacing Buses

In computing an interface is a shared boundary across which two seperate components of a computer system exchange information. The exchange can be between software, computer hardware, peripheral devices, humans and combinations of these. Some of computer hardware devices such as a touchscreen can send and receive datathrough the interface while others such as a mouse, microphone or jaystick are one way only. Two typoes of interface- Hardware and Softwares. Buses are come in Hardware interface.

Bus formats

Three types of Bus Formats are available-

(a) Address Bus

(b) Data bus

(c) Control bus.

5.2.1 Address bus

Most microprocessors can store inforamtion and instructions in a wide range of memory locations. Usually the memory locations are in a memory chip rather than in the microprocessor. The microprocessor needs a way to tell the memory chip which memory location it wants to put data into or take data from. It does this through the address bus.

The address bus is a communication link between the microprocessor and the memory chips. Physically it is simply a group of electrical paths which are connected to RAM, ROM and the I/O chips. Through this bus the microprocessor can specify the address of any memory location in any chip or device. Notice in Fig. 1 that information travels on the address bus in only one direction from the microporcessor to memory and I/O. There are more details involved but this is the basic idea.

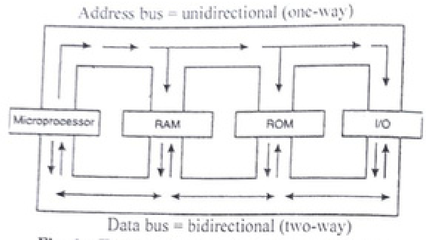


Fig. 1 : Two different buses data and address

An address is a binary number that identifies a specific memory storage location or I/O port involved in a data transfer. The address bus is used to transmit the address of the location to the memory of the port. An 8-bit microporcessor has 16 address pins, labelled A0 to A15 and the system address byt has 16 lines, one for each address pin on the processor. The address bus is unidirectional (one way); address is always issued by the microporcessor. Every piece of information (instruction and data) stored in the memory, has its location identified by a address.

Address buses are present and basically the same in all microprocessors. They are incorporated into the system to address the memory and the I/O equipment. Address buses in various microprocessor differ only in width. The most common number of address connections available today is 16, with some of the newer microporcessor containing either 20 or 24 connections. Most address buses are three state connections which will go to their high impedance state at some time during normal microprocessor operation.

The address bus consists of 16, 20, 24 or more parallel signal lines. On these lines the CPU sends out the address of the memory location that is to be written to or read from. The number of memory locations that the CPU can address is determined by the number of address lines. If the CPU has N address lines then it can directly address 2 to the N power memory locations. For example a CPU has N address lines then it can directly address 2 to the N power memory locations 2^{16} or 65,536 memory locations. a CPU with 20 address lines can address 2^{20} or 1,048,576 locations, and a CPU with 24 address lines can address 2^{24} or 16,777,216 locations. When the CPU reads data from or writes data to a port, the port address is also sent out on the address bus.

5.2.2 DATA BUS

Once the microprocessor has specified which memory location or device it wents to put data into or take data from, it then needs a set of electrical paths for this information to travel on. This set of paths is called the data bus.

It is this set of electrical paths that allows data to flow from one chip to the next. Notice in Fig. 3.6 that information on the data bus travels both to and from the microprocessor, memory, and I/O devices. Eight-bit microporcessors have a data bus that is 8 bits wide; 16 bit microprocessors have a data bus that is 16 bits wide. That is the bus consists of 8 or 16 parallel connecting paths.

The data bus carries the data which is being transferred throughout the system Example of data transfers are :

- Program instruction being read from RAM into the processor
- Data being read from RAM into the processor
- Results being sent from the processor to RAM.
- Data being sent from the processor to the output port.
- Data being read in from the port to the processor.

There are 8 data pins on an 8-bit microprocessor labelled D0 to D7 and the data bus has eight lines, on for each pin. So that bus can carry simultaneously 8-bit data words. The data bus is bidirectional which means that can travel in both directions.

The size of a bus, know as its width, is important because it determines how much data can be transferred of one time.

The data bus is typically a bidirectional bus that may in some processors also be multiplexed with some other information. If an external buffer is required on this bus, it takes the form of bidirectional bus buffer or bus transceiver.

The data bus consists of 8, 16, 32 or more parallel signal lines. As indicated by the double ended arrows on the data bus line in Fig. 3.1 the data bus lines are bidirectional. This means that the CPU can read data in on these lines from memory or from a port as well as send data out on these lines to a memory location or to a port. many devices in a system will have their outputs connected to the data bus, but the outputs of only one device at a time will be enabled. Any decvice output connected on the data bus must be three-state so that they can be floated when the device is not in use.

5.2.3 CONTROL BUS

The control bus is one of the most important buses in the sytem, since it actually controls the memory and I/O equipment. Each microprocessor in production today has a slightly different control bus configuration. The most important control bus signals are the read and write signals since these are the basic function of the memory and the input/output circuitry.

The control bus consists of 4–10 parallel signal lines. the CPU sends out signals on the control bus to enable the output of addressed memory devices or port devices. Typical control bus signals are memroy read, memory write I/O read, and I/O write. To read a bute of data from a memory location for example the CPU sends out the address of the desired byte on the address bus and then sends out a memory read signal on the control bus. The memory read signal enables the addressed memory device the output the byte of data onto the data bus where it is read by the CPU.

The control bus is another group of pins on the MPU, READ is an example of a control bus signal. This signal is generated by the timing control circuits of the microprocessor whenever it needs to read information from the memory or an input/output port via the data bus. From the data bus the data is taken into the microprocessor. Each line of the control bus goes only one way. some lines such as READ and WRITE, are output lines, while others which we will discuss later, act as inputs to the MPU (interrupts).

Bus timing is extremely important to the hardware engineer, who mainly concentrates on the timing required to achieve a particular result. Some of these times are memory access time, read or write pulse widths, memory cycle time, clock pulse width, and clock period.

5.3 Interfacing Keyboard

A keyboard is an input device, partially modeled after the typewriter keyboard, which uses an arrangement of buttons or keys, which act as electronic switches. A keyboard typically has characters engraved or printed on the keys and each press of a key typically corresponds to a single written symbol. However, to produce some symbols requires pressing and holding several keys simultaneously or in sequence. While most keyboard keys produce letters, numbers or signs (characters), other keys or simultaneous key presses can produce actions or computer commands. In normal usage, the keyboard is used to type text and numbers into a word processor, text editor or other program. In a modern computer, the interpretation of key presses is generally left to the software. A computer keyboard distinguish each physical key from every other and reports all key presses to the controlling software. Keyboards are also used for computer gaming, either with regular keyboards or by using keyboards with special gaming features, which can expedite frequently used keystroke combinations.

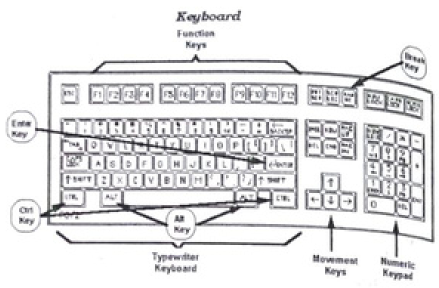


Fig. 2 : Simple layout of the keyboard

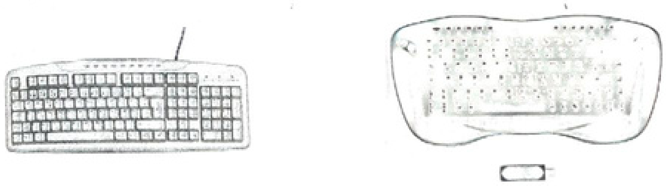
A typical diagram of a keyboard is shown below:

There are various types of the keyboard. Some of these are as follows:

- **Standard:** Standard keyboards, such as the 101-key US traditional keyboard 104-key Windows keyboards, include alphabetic characters, punctuation symbols, numbers and a variety of function keys.
- **Laptop-size:** Keyboards on laptops and notebook computers usually have a shorter travel distance for the keystroke and a reduced set of keys. As well, they may not have a numerical keypad, and the function keys may be placed in locations that differ from their placement on a standard, full-sized keyboard.
- **Gaming and multimedia:** Keyboards with extra keys, such as multimedia keyboards, have special keys for accessing music, web and other frequently used programs and featuresx, such as a mute button, volume buttons or knob and standby (sleep) button.
- **Thumb-sized:** Smaller keyboards have been introduced for laptops, PDAs, cellphones or users who have a limited workspace. The size of a standard keyboard is dictated by the practical consideration that the keys must be large enough to be easily pressed by fingers.

- **Numeric:** Numeric keyboards contain only numbers, mathematical symbols for addition, subtraction, multiplication, and division, a decimal point, and several function keys.
- **Chorded:** A keyset or chorded keyboard is a computer input device that allows the user to enter characters or commands formed by pressing several keys together, like playing a "chord" on a piano.
- **Virtual :** Virtual keyboards project an image of a full-size keyboard onto a surface. The iPhone uses a multi-touch screen to display a virtual keyboard.
- **Touchscreens:** Touchscreens, such as with the iPhone and the OLPC laptop, can be used as a keyboard. It can be used as a convertible Tablet PC where the keyboard is one half-screen.
- **Foldable:** Foldable (also called flexible) keyboards are made of soft plastic which can be rolled or folded on itself for travel. It can be connected to portable devices and smartphones.

So these are the types of the keyboard. Some fig. of keyboard are as follows:



(a) (b)

Fig. 3 : (a) Standard keyboard (b) wireless multimedia keobyard

There are various keys on the keyboard. Keys can be classified in some ways like as:

- **Alphabetical keys:** There are 26 alphabetical keys on the keyboad and they are marked A to Z.
- **Numeric keys:** There are 10 numeric key on the keyboard and they are marked 0 to 9.
- **Functional keys:** Function keys are placed at top most on the keyboard. These keys are marked F1 to F12. each kay contains some specific program to implementations. On the pressing these keys, it executes the related function for the program. For example F1 is used for the list of the document.
- **Special character keys:** There are some special keys on the keyboard like as #, @, $,

%. ^. &. ! etc. this type of keys can be used by using the shift key.

- **Modifier keys:** Modifier keys are special keys that modify the normal action of another key, when the two are pressed in combination. For example, <Alt> + <F4> in Microsoft Windows will close the program in an active window. In contrast, pressing just <F4> will probably do nothing, unless assigned a specific function in a particular program. By themselves, modifier keys usually do nothing. The most widely-used modifier keys include the Control key, Shift key and the Alt key. The AltGr key is used to access additional symbols for keys, that have three symbols printed on them.
- **Navigation keys:** Navigation keys include a variety of keys which move the cursor to different positions on the screen. Arrow keys are programmed to move the cursor in a specified direction: page scroll keys, such as the 'Page Up keys and Page Down keys', scroll the page up and down. The Home key is used to return the cursor to the beginning of the page where the cursor is located; the End key puts the cursor at the end of the line. The Tab key advances the cursor to the next tab stop. The Insert key is mainly used to switch between overtype mode. The Delete key discards the character ahead of the cursor's position. The Backspace key deletes the preceding character. The Escape key (Esc) is used to initiate an escape sequenceThe Menu key or Application key is a key found on Windows-oriented computer keyboards. It is used launch a context menu with the keyboard rather than with the usual right mouse button.

There are several ways of connecting a keyboard using cables, including the standard AT connector commonly found on motherboards, which was eventually replaced by the USB connection. Wireless keyboards have become popular for their increased user freedom. A wireless keyboard often includes a required combination transmitter and receiver unit that attaches to the computer's keyboard port.

5.4 Display

Almost all computers have a monitor. Monitors are also known as Visual Display Units (VDUs). Most computers use this display as the main output device. A monitor is a piece of electrical equipment which displays images generated by devices such as computers, without producing a permanent record. The monitor comprises the actual display device, circuitry, and an enclosure. The display device in modern monitors is typically a thin film transistor liquid crystal display (TFT-LCD), while older monitors use a cathode ray tube (CRT). As with television, many different hardware

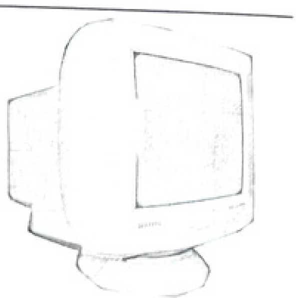


Fig. 4 : Standard Monitor

technologies exist for displaying computer-generated output:

- Liquid crystal display (LCD).
- Cathode ray tube (CRT)
- Plasma display
- Surface-conduction electron-emitter display (SED)
- Organic light-emitting diode (OLED) display
- Penetron military aircraft displays.

The three most important features of a screen are its size, the colors it can display and its resolution. There is more information about these features below. They apply to both desktop monitors and LCDs.

- **Size:** How big is the screen? Typical sizes are 10" or 12" for LCDs and 14", 15" or 21" for desktop monitors. The size is measured along the diagonal from the bottom left hand corner to the top right hand corner of the screen.
- **Color:** Is the monitor color or black & white? Most new desktop computers have color screens as they are no longer that much more expensive than black & white ones and modern computer applications work better with a color monitor.
- **Resolution:** An image displayed on the screen is made up of lots of dots called pixels. If you look closely at the screen you may be able to see these pixels. The resolution of the screen is how many pixels there are up and down and from left to right across the screen. A variety of different resolutions are available. For PCs these resolutions have names. For e.g. VGA is 640 x 480. This means that there are 640 pixels in each row across the screen and 480 pixels in each column up and down the screen.

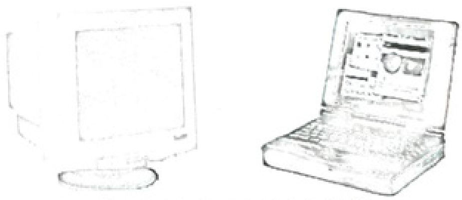


Fig. 5 : Desktop monitor and LCD

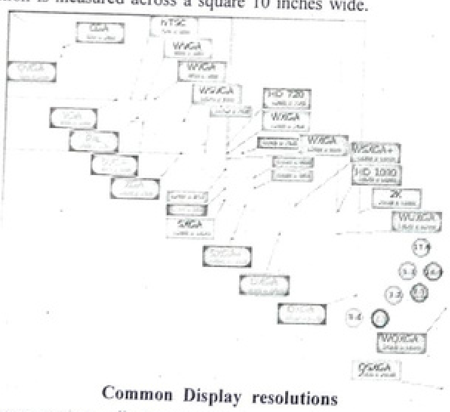
There are two terms related with the monitors.

- Refresh rate
- Resolution

Refresh Rate : The refresh rate (most commonly the "vertical refresh rate", "vertical scan rate" for CRTs) is the number of times in a second that display hardware draws the data it is being given. This is distinct from the measure of frame rate in that the refresh rate includes the repeated drawing of identical frames, while frame rate measures how a video source can feed an entire frame of new data to a display.For example, most movie projectors advance from one frame to the next one 24 times each second. But each frame is illuminated two or three times before the next frame is projected using a shutter in front of its lamp. As a result, the movie projector runs at 24 frames per second, but has a 48 or 72 Hz refresh rate.On CRT displays, increasing the refresh rate decreases flickering, thereby reducing eye strain. However, if a refresh rate is specified that is beyond what is recommended for the display, damage to the display can occur. The refresh rate can be calculated from the horizontal scan rate by dividing by the number of horizontal lines multiplied by 1.05 (since about 5% of the time it takes to scan the screen is spent moving the electron beam back to the top). For instance, a monitor with a horizontal scanning frequency of 96 kHz at a resolution of 1280 × 1024 results in a refresh rate of 96,000 / (1024 × 1.05) ? 89 Hz (rounded down).

Resolution : The display resolution of a digital television or display typically refers to the number of distinct pixels in each dimension that can be displayed. It can be an ambiguous term especially as the displayed resolution is controlled by all different factors in cathode ray tube (CRT) and flat panel or projection displays using fixed picture-element (pixel) arrays.

One use of the term "display resolution" applies to fixed-pixel-array displays such as plasma display panels (PDPs), liquid crystal displays (LCDs), or similar technologies, and is simply the physical number of columns and rows of pixels creating the display (e.g., 1280×1024). Note that the use of the word resolution here is misleading. The term "display resolution" is usually used to mean pixel dimensions (e.g., 1280×1024), which does not tell anything about the resolution of the display on which the image is actually formed. In digital measurement the display resolution would be given in pixels per inch. In analog measurement, if the screen is 10 inches high then the horizontal resolution is measured across a square 10 inches wide.



Common Display resolutions

The most common computer display resolutions are as follows:

Resolution	% of Internet Users
Higher than 1024×768	57%
1024×768	36%
800×600	2%
Lower than 800×600	< 1%
Unknown	5%

Colour Graphics Adapter (CGA):

The Color Graphics Adapter (CGA), introduced in 1981, was IBM's first color graphics card, and the first color computer display standard for the IBM PC.CGA card support several graphics and text modes. The highest resolution of any mode was 640×200, and the highest color depth supported was 4-bit (16 colors).

CGA offers four BIOS text modes:

- **40×25 characters** in up to 16 colors. Each character is a pattern of 8×8 dots. The effective screen resolution in this mode is 320×200 pixels. BIOS Modes 0 & 1 select 40 column text modes. The difference between these two modes can only be seen on a composite monitor; mode 0 disables the color burst, making colors appear in grayscale. Mode 1 enables the color burst, allowing for color.
- **80×25 characters** in up to 16 colors. Each character is again an 8×8 dot pattern (the same character set is used as for 40×25), in a pixel aspect ratio of 1:2.4. BIOS Modes 2 and 3 select 80 column text modes. As with the 40-column text modes, Mode 2 disables the color burst in the composite signal and Mode 3 enables it.

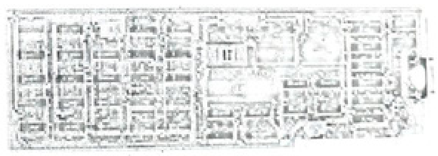


Fig. 6 : CGA card with Synertek SY6845

Video Grphic Array (VGA):

The term Video Graphics Array (VGA) refers specifically to the display hardware first introduced with the IBM PS/2 line of computers in 1987, but through its widespread adoption has also come to mean either an analog computer display standard, the 15-pin D-subminiature VGA connector or the 640×480 resolution itself. While this resolution has been superseded in the personal computer market, it is becoming a popular resolution on mobile devices.

Video Graphics Array (VGA) was the last graphical standard introduced by IBM that the majority of PC clone manufacturers conformed to, making it today (as of 2009) the lowest common denominator that all PC graphics hardware supports, before a device-specific driver is loaded into the computer. VGA was officially superseded by IBM's XGA standard, but in reality it was superseded by numerous slightly different extensions to VGA made by clone manufacturers that came to be known collectively as "Super VGA".

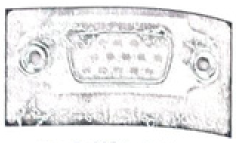


Fig. 7: VGA Port

VGA is referred to as an "array" instead of an "adapter" because it was implemented from the start as a single chip (an ASIC).

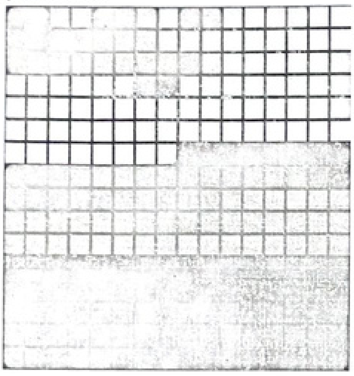


Fig. 8 : VGA 256 color palette scheme

The VGA color system is backwards compatible with the EGA and CGA adapters, and adds another level of configuration on top of that. CGA was able to display up to 16 colors, and EGA extended this by allowing each of the 16 colors to be chosen from a 64-color palette (these 64 colors are made up of two bits each for red, green and blue: two bits × three channels = six bits = 64 different values). VGA further extends this scheme by increasing the EGA palette from 64 entries to 256 entries. Two more blocks of 64 colors with progressively darker shades were added, along with 8 "blank" entries that were set to black.

SUPER VIDEO GRAPHICS ARRAY (SVGA)

Originally, it was an extension to the VGA (video graphics array) standard first released by IBM in 1987. Unlike VGA-a purely IBM-defined standard-Super VGA was defined by the Video Electronics Standards Association (VESA), an open consortium set up to promote interoperability and define standards. When used as a resolution specification, in contrast to VGA or XGA for example, the term SVGA normally refers to a resolution of 800 × 600 pixels.Though Super VGA

cards appeared in the same year as VGA, it wasn't until 1989 that Super VGA was defined by VESA. In that first version, it called for a resolution of 800 × 600 4-bit pixels. Each pixel could therefore be any of 16 different colours. It was quickly extended to 1024 × 768 8-bit pixels, and well beyond that in the following years the interface between the video card and the VGA or Super VGA monitor uses simple analog voltages to indicate the desired colour depth. In consequence, so far as the monitor is concerned, there is no theoretical limit to the number of different colours that can be displayed. Note that this applies to any VGA or Super VGA monitor.While the output of a VGA or Super VGA video card is analog, the internal calculations the card performs in order to arrive at these output voltages are entirely digital. To increase the number of colours a Super VGA display system can reproduce, no change at all is needed for the monitor, but the video card needs to handle much larger numbers and may well need to be redesigned from scratch. Even so, the leading graphics chip vendors were producing parts for high-colour video cards within just a few months of Super VGA's introduction.

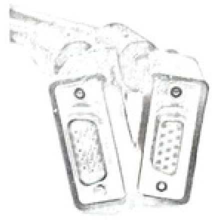


Fig. 9 : SVGA port

Extended Graphics Array (XGA):

XGA, the Extended Graphics Array, is an IBM display standard introduced in 1990. Today, it is the most common appellation of the 1024×768 pixels display resolution. It was not a new and improved replacement for Super VGA, but rather became one particular subset of the broad range of capabilities covered under the "Super VGA" umbrella.The initial version of XGA expanded upon IBM's VGA, adding support for two resolutions:

- 800×600 pixels with high color (16 bits per pixel; i.e.. 65,536 colors).
- 1024×768 pixels with a palette of 256 colors (8 bits per pixel)

Like its predecessor (the IBM 8514), XGA offered fixed function hardware acceleration to offload processing of 2D drawing tasks. XGA and 8514 could offload line-draw, bitmap-copy (bitblt), and color-fill operations from the host CPU. XGA's acceleration was faster than 8514's, and more comprehensive in that it supported more drawing primitives and XGA's 16 bits per pixel (65,536 color) display-mode.

Super Extended Graphics Araay (SXGA):

SXGA is stands for **Super eXtended Graphics Array** referring to a standard monitor resolution of 1280x1024 pixels. This display resolution is the "next step" above the XGA resolution that IBM developed in 1990.A standard 4:3 monitor using this resolution will have rectangular rather than square pixels, meaning that unless the software compensates for this the picture will be distorted, causing circles to appear

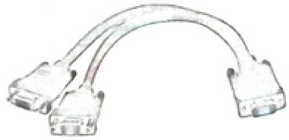
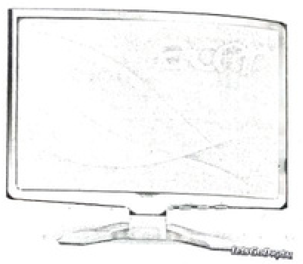


Fig. 10 : SXGA PORT

elliptical. There is a less common 1280×960 resolution sometimes unofficially called "SXGA-" (to avoid confusion with the "standard" SXGA) that preserves the common 4:3 aspect ratio.SXGA is the most common native resolution of 17" and 19" LCD monitors. An LCD monitor with SXGA native resolution will typically have a physical 5:4 aspect ratio, preserving a 1:1 pixel aspect ratio.SXGA is also a popular resolution for cell phone cameras, such as the Motorola Razr and most Samsung and LG phones. Although being taken over by newer UXGA (2.0 megapixel) cameras, the 1.3 megapixel is the most common for the time being.

Liquid Crystal Display (LCD)

A liquid crystal display (LCD) is an electronically-modulated optical device shaped into a thin, flat panel made up of any number of color or monochrome pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector. It is often used in battery-powered electronic devices because it requires very small amounts of electric power.Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each other. With no actual liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.



There are many features of the LCDs. Some of these are as follows:

- **Resolution:** The horizontal and vertical size expressed in pixels (e.g., 1024 × 768). Unlike CRT monitors, LCD monitors have a native-supported resolution for best display effect.
- **Response time:** The minimum time necessary to change a pixel's color or brightness.
- **Refresh rate:** The number of times per second in which the monitor draws the data it is being given.
- **Matrix type:** Active TFT or Passive.
- **Color support:** How many types of colors are supported.
- **Brightness:** The amount of light emitted from the display.
- **Contrast ratio:** The ratio of the intensity of the brightest bright to the darkest dark.
- **Input ports:** (e.g., DVI, VGA, LVDS, DisplayPort, or even S-Video and HDMI).

A simple fig. of LCD screen is shown below:

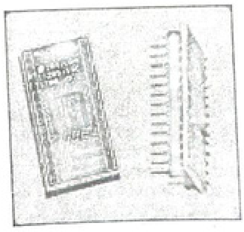
Video controller

A Video Display Controller or VDC is an integrated circuit which is the main component in a video signal generator. Some VDCs also generate a sound signal, but in that case it's not their main function.VDCs were most often used in the old home-computers of the 80s, but also in some early video game systems.The VDC is always the main component of the video signal generator logic, but sometimes there are also other supporting chips used, such as RAM to hold the pixel data, ROM to hold character fonts, or perhaps some discrete logic such as shift registers were

necessary to build a complete system. In any case, it's the VDC's responsibility to generate the timing of the necessary video signals, such as the horizontal and vertical synchronisation signals, and the blanking interval signal.Most often the VDC chip is completely integrated in the logic of the main computer system, (its video RAM appears in the memory map of the main CPU), but sometimes it functions as a coprocessor that can manipulate the video RAM contents independently. There are various types of the video controllor. Some of these are as follows:

- Video shifters, or "Video shift register based systems" are the most simple type of video controllers; they are responsible for the video timing signals, but they normally do not access the Video RAM directly. They get the video data from the main CPU, a byte at a time, and convert it to a serial bitstream (hence the technical name "Video shifter"). This serial data stream is then used, together with the synchronisation signals, to output a video signal. Example of video shifter is Television Interface Adapter (TIA).
- A CRTC, or CRT Controller, generates the video timings and reads video data from a RAM attached to the CRTC, to output it via an external character generator ROM to the video output shift register. Because the actual capabilities of the video generator depend to a large degree on the external logic, video generator based on a CRTC chip can have a wide range of capabilities. From very simple systems to very high resolution systems supporting a wide range of colours. Sprites however are normally not supported by these systems. Example of CRTC controllor is Intel 8275 controllor. The Intel 8275 CRT controller was not used in any mainstream system, but was used in some S100 bus systems.
- Video interface controllers are much more complex than CRT controllers, and the external circuitry that is needed with a CRTC is embedded in the video controller chip. Sprites are often supported, as are (RAM based) character generators and video RAM dedicated to colour attributes and pallette registers for the high-resolution and/or text-modes. The Signetics 2636 and 2637 are video controllers best known for their use in the Interton VC 4000 and Emerson Arcadia 2001 respectively.
- Video coprocessors have their own internal CPU dedicated to reading (and writing) their own video RAM, and converting the contents of this video RAM to a video signal. The main CPU (central processing unit) can give commands to the coprocessor, for example to change the video modes or to manipulate the video ram contents. The video coprocessor also controls the (most often RAM based) character generator, the colour attribute RAM, Palette registers and the Spite logic. Example of video coprocessors is ANTIC (Alpha-Numeric Television Interface Circuit).

VRAM:



VRAM is a dual-ported variant of DRAM which was once commonly used to store the frame-buffer in some graphics adaptors.It was invented by F. Dill and R. Matick at IBM Research in 1980, with a patent issued in 1985 (US Patent 4,541,075). The first commercial use of VRAM was in the high resolution graphics adapter introduced in 1986 by IBM with the PC/RT system.VRAM has two sets of data output pins, and thus two ports that can be used simultaneously.

The first port, the DRAM port, is accessed by the host computer in a manner very similar to traditional DRAM. The second port, the video port, is typically read-only and is dedicated to providing a high bandwidth data channel for the graphics chipset. VRAM operates by not discarding the excess bits which must be accessed, but making full use of them in a simple way. If each horizontal scan line of a display is mapped to a full word, then upon reading one word and latching all 1024 bits into a separate row buffer, these bits can subsequently be serially streamed to the display circuitry. This will leave access to the DRAM array free to be accessed (read or write) for many cycles, until the row buffer is almost depleted. A complete DRAM read cycle is only required to fill the row buffer, leaving most DRAM cycles available for normal accesses.

VRAM can be represented as:

Comparision of varoius monitor standard:

Video standard	Full name	Description	Display resolution (pixels)	Aspect ratio	Color depth
MDA	Monochrome Display Adapter	The original standards on IBM PCs and IBM PC XTs with 4 KB video RAM. Introduced in 1981 by IBM. Supports text mode only.	720×350 (text)	72:35	1 bpp
CGA	Color Graphics Adapter	Introduced in 1981 by IBM, as the first color display standard for the IBM PC. The standard CGA graphics cards were equipped with 16 KB video RAM.	640×200 (128k) 320×200 (64k) 160×200 (32k)	16:5 16:10 4:5	1 bpp 2 bpp 4 bpp
EGA	Enhanced Graphics Adapter	Introduced in 1984 by IBM. A resolution of 640 × 350 pixels of 16 different colors (4 bits per pixel, or *bpp*), selectable from a 64-color palette (2 bits per each of red-green-blue).	640×350 (224k)	64:35	4 bpp
VGA	Video Graphics Array	Introduced in 1987 by IBM. VGA is actually a set of different resolutions, but is most commonly used today to refer to 640 × 480 pixel displays with 16 colors and a 4:3 aspect ratio. VGA displays and adapters are generally capable of Mode X graphics, an undocumented mode to allow increased non-standard resolutions.	640×480 (307k) 640×350 (224k) 320×200 (64k) 720×400 (text)	4:3 64:35 16:10 9:5	4 bpp 4 bpp 4/8 bpp 4 bpp
SVGA	Super VGA	A video display standard created by VESA for IBM PC compatible personal computers. Introduced in 1989.	800×600 (480k)	4:3	4 bpp
XGA	Extended Graphics Array	An IBM display standard introduced in 1990. XGA-2 added 1024 × 768 support for high color and higher refresh rates, improved performance, and support for 1360 × 1024 in 16 colors.	1024×768 (786k) 640×480 (307k)	4:3 4:3	8 bpp 16 bpp
XGA+	Extended Graphics Array Plus	Although not an official name, this term is now used to refer to 1152 x 864, which is the largest 4:3 array yielding under one million pixels. Variants of this were used by Apple Computer (at 1152x870) and Sun Microsystems (at 1152x900) for 21-inch CRT displays.	1152×864 (995k) 640×480 (307k)	4:3 4:3	8 bpp 16 bpp
SXGA	Super XGA	A widely used 32 bit True color standard, with an unusual aspect ratio of 5:4 (1.25:1) instead of the more common 4:3 (1.33:1), which means that 4:3 pictures and video will appear letterboxed on the narrower 5:4 screens. This is generally the physical aspect ratio & native resolution of standard 17" and 19" LCD monitors.	1280×1024 (1310k)	5:4	32 bpp
SXGA+	Super XGA+	Used on 14 inch and 15 inch notebook LCD screens and a few smaller screens.	1400×1050 (1470k)	4:3	32 bpp

5.5 Auxiliary Storage Devices

Computer data storage, often called **storage** or **memory**, refers to computer components, devices, and recording media that retain digital data used for computing for some interval of time. Computer data storage provides one of the core functions of the modern computer, that of information retention. It is one of the fundamental components of all modern computers, and coupled with a central processing unit (CPU, a processor). In contemporary usage, memory usually refers to a form of semiconductor storage known as random access memory (RAM) and sometimes other forms of fast but temporary storage. Similarly, storage today more commonly refers to mass storage - optical discs, forms of magnetic storage like hard disks, and other types slower than RAM, but of a more permanent nature.

Many different forms of storage, based on various natural phenomena, have been invented. So far, no practical universal storage medium exists, and all forms of storage have some drawbacks. Therefore a computer system usually contains several kinds of storage, each with an individual purpose. In practice, almost all computers use a variety of memory types, organized in a storage hierarchy around the CPU, as a tradeoff between performance and cost. Generally, the lower a storage is in the hierarchy, the lesser its bandwidth and the greater its access latency is from the CPU. This traditional division of storage to primary, secondary, tertiary and off-line storage is also guided by cost per bit.

1. Types of Storage

There are various types of the storage like as :

- Primary storage
- Secondary storage
- Tertiry storage
- Off line storage

Hierarchy of storage is shown in the given diagram:

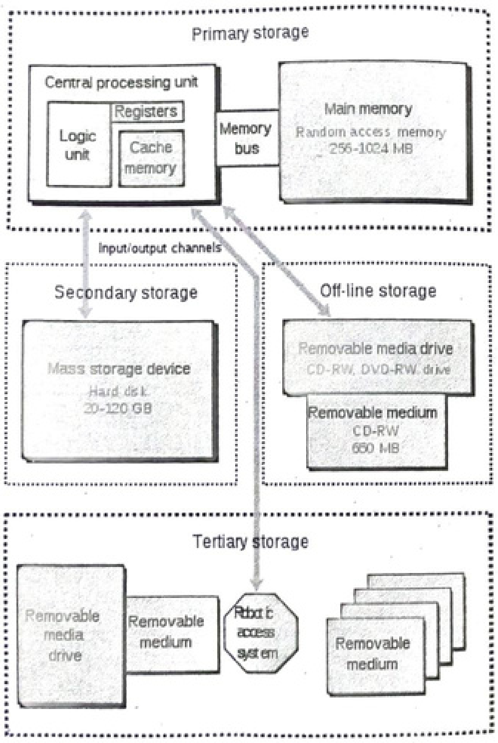


Fig. 11 : Hierarchy of storage types

Primary storage, presently known as **memory**, is the only one directly accessible to the CPU. The CPU continuously reads instructions stored there and executes them as required. This led to a modern random access memory (RAM). It is small-sized, light, but quite expensive at the same time. The particular types of RAM used for primary storage are also volatile, i.e. they lose the information when powered not on. In the primary storage the main memory is connected with the CPU through the address and data bus. **Secondary storage** in popular usage, differs from primary storage in that it is not directly accessible by the CPU. The computer usually uses its input/output channels to access secondary storage and transfers the desired data using intermediate area in primary storage. Secondary storage does not lose the data when the device is powered down-it is non-volatile. it is typically also an order of magnitude less expensive than primary storage. In modern computers, hard disks are usually used as secondary storage. Some other examples of secondary storage technologies are: flash memory (e.g. USB sticks or keys), floppy disks, magnetic tape, paper tape, punch cards, standalone RAM disks, and Zip drives. **Tertiary storage** or **tertiary memory**, provides a third level of storage. Typically it involves a robotic mechanism which will mount (insert) and dismount removable mass storage media into a storage device according to the system's demands; this data is often copied to secondary storage before use. It is primarily used for archival of rarely accessed information since it is much slower than secondary storage. Off-line storage, also known as disconnected storage, is a computer data storage on a medium or a device that is not under the control of a processing unit. The medium is recorded, usually in a secondary or tertiary storage device, and then physically removed or disconnected. It must be inserted or connected by a human operator before a computer can access it again.

In modern personal computers, most secondary and tertiary storage media are also used for off-line storage. Optical discs and flash memory devices are most popular, and to much lesser extent removable hard disk drives. In enterprise uses, magnetic tape is predominant.

2. Characteristics of Storage

- Volatility
- Mutability
- Addressability
- Performance
- Differentiation
- Accessibility
- Capacity
- Environmental Impact

So these are the various characteristics of the storage. So after that we can start the study of the storage device.

3. Storage Device

A **data storage device** is a device for recording (storing) information (data). Recording can be done using virtually any form of energy, spanning from manual power in handwriting, to acoustic vibrations in phonographic recording, to electromagnetic energy modulating magnetic tape and optical discs. A storage device may hold information, process information, or both. A device that only holds information is a recording medium. Devices that process information may either access a separate portable recording medium or a permanent component to store and retrieve information. Many data storage devices are also media players. Any device that can store and playback multimedia may also be considered a media player such as in the case with the HDD media player. Designated hard drives are used to play saved or streaming media on home theatare systems.

There are various types of storage device. Some of these are as follows:

- Magnetic
- Magneto- optical
- Optical
- Solid state

(a) Magnetic Storage Device

Magnetic storage are terms from engineering referring to the storage of data on a magnetized medium. Magnetic storage uses different patterns of magnetization in a magnetizable material to store data and is a form of non-volatile memory. The information is accessed using one or more read/ write heads. As of 2009, magnetic storage media, primarily hard disks, are widely used to store computer data as well as audio and video signals. In the field of computing, the term magnetic storage is preferred and in the field of audio and video production, the term magnetic recording is

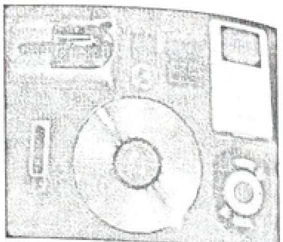


Fig. 12 : Magnetic storage device

more commonly used. The distinction is less technical and more a matter of preference. Magnetic storage media can be classified as either sequential access memory or random access memory although in some cases the distinction is not perfectly clear. In the case of magnetic wire, the read/ write head only covers a very small part of the recording surface at any given time. common uses of magnetic storage media are for computer data mass storage on hard disks and the recording of analog audio and video works on analog tape. Since much of audio and video production is moving to digital systems, the usage of hard disks is expected to increase at the expense of analog tape.

(b)Optical Storage Device

Optical storage is a term from engineering referring to the storage of data on an optically readable medium. Data is recorded by making marks in a pattern that can be read back with the aid of light. A common modern technique used by computers involves a tiny beam of laser light precisely focused on a spinning disc. An older example, that does not require the use of computers, is microform. There are other means of optically storing data and new methods are in development..The term optical drive usually refers

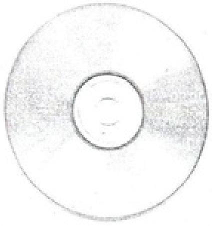


Fig. 13 : Optical Storage (Blank CD)

to a device in a computer that can read CD-ROMs or other optical discs. Optical storage devices provide direct-access secondary storage that is faster than tape and less expensive than disk. Optical storage offers you additional flexibility in determining how much data to store for how long. The data stored on optical devices is accessed just like data on magnetic disks. Although the access time is

longer, the cost is significantly less. Optical devices are a good choice for infrequently accessed data that you neither want to relegate to tape archives nor want to store on magnetic disks (because they are more expensive).

(c) Magneto-Optical Storage Device

A magneto-optical drive is a kind of optical disc drive capable of writing and rewriting data upon a magneto-optical disc. Both 130 mm (5.25 in) and 90 mm (3.5 in) form factors exist. The technology was introduced at the end of the 1980s. Although optical, they appear as hard disk drives to the operating system and do not require a special filesystem (they can be formatted as FAT, NTFS, etc.). This type of disc consists of a ferromagnetic material sealed beneath a plastic coating. There is never any physical contact during reading or recording. During recording, the laser power is increased so it can heat the material up to the Curie point in a single spot.

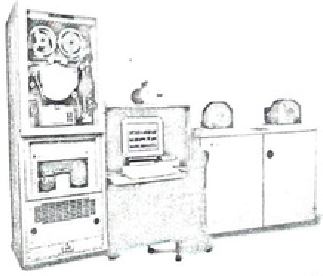


Fig. 14 : Magneto-optical storage device

(d) Solid State

A **solid-state drive (SSD)** is a data storage device that uses solid-state memory to store persistent data. An SSD emulates a hard disk drive interface, thus easily replacing it in most applications. An SSD using SRAM (static random access memory)or DRAM (dynamic random access memory) is often called a RAM-drive, not to be confused with a RAM disk.The original usage of the term solid-state (from solid-state physics) refers to the use of semiconductor devices rather than electron tubes, but in this context, has been adopted to distinguish solid-state electronics from electromechanical devices as well. Most SSD manufacturers use non-volatile flash memory to create more rugged and compact devices for the consumer market. These flash memory-based SSDs, also known as flash drives, do not require batteries. They are often packaged in standard disk drive form factors. In addition, non-volatility allows flash SSDs to retain memory even during sudden power outages, ensuring data persistence. SSDs are slower than DRAM and some designs are slower than even traditional HDDs on large files. Fig. of solid state drive is shown in fig. 5.

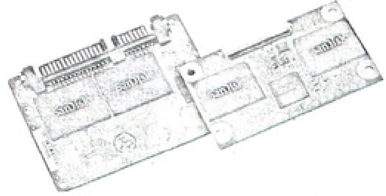


Fig. 15 : Solid state storage (sandisk)

4. RANDOM AND SEQUENTIAL ACCESS

Random access (direct access) is the ability to access an arbitrary element of a sequence in equal time. The opposite is sequential access, where a remote element takes longer time to access.

An example of the random access is a cassette tape (sequential-you have to fast-forward through earlier songs to get to later ones) and a compact disc (random access-you can jump right to the track you want). The term random access memory (RAM), however, is used for semiconductor chip memory circuits used in computers. In data structures, random access implies the ability to access the Nth entry in a list of numbers in constant time. Very few data structures can guarantee this, other than arrays (and related structures like dynamic arrays). Random access is critical to many algorithms such as quicksort and binary search. Other data structures, such as linked lists, sacrifice random access to make for efficient inserts, deletes, or reordering of data.

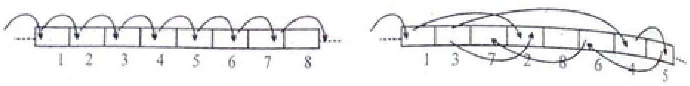


Fig.71 : Comparision between Random access and sequential access.

Formatting

Before a magnetic disk can be used, it must be formatted. A process that maps the disk's surface and determines how data will be stored. During formatting, the drive creates circular tracks around the disk's surface, and then divides each track into sectors. The OS organizes sectors into groups, called clusters, and then tracks each file's location according to the clusters it occupies. Or in another word.

Disk formatting is the process of preparing a hard disk or other storage medium for use, including setting up an empty file system. Large disks can be partitioned, that is, divided into distinct sections that are formatted with their own file systems. This is normally only done on hard disks because of the small sizes of other disk types, as well as compatibility issues. A corrupted operating system can be reverted to a clean state by formatting the disk and reinstalling the OS, as a drastic way of combating a software problem. There are two type of the formatting known as low-level and high-level formatting.

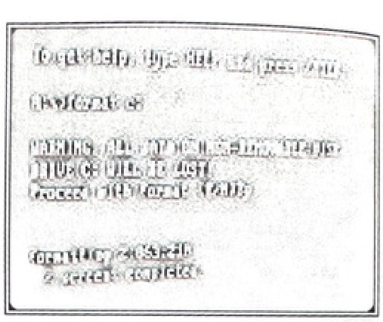


Fig. 16 : Formatting a hard drive using MS-DOS

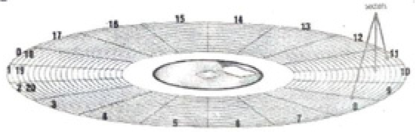


Fig. 17 : Formatted disk

The low-level format of floppy disks (and early hard disks) is performed by the disk drive hardware. The process is most easily described with a standard 1.44 MB floppy disk in mind. Low-level formatting of the floppy normally writes 18 sectors of 512 bytes each on each of 160 tracks (80 on each side) of the floppy disk, providing 1,474,560 bytes of storage on the disk.

High-level formatting is the process of setting up an empty file system on the disk, and installing a boot sector. This alone takes little time, and is sometimes referred to as a "quick format". In the case of floppy disks, both high- and low-level formatting are customarily done in one pass by the software.

When a disk is formatted, the OS creates four Areas on its surface:

- **Boot sector** - stores the master boot record, a small Program that runs when you first start (boot) the Computer.
- **File allocation table (FAT)** - a log that records each file's location and each sector's status.
- **Root folder** - enables the user to store data on the disk in a logical way.
- **Data area** - the portion of the disk that actually holds Data.

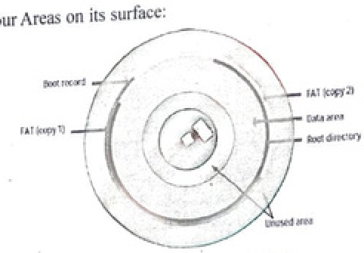


Fig. 18 : Formatted disk

Storage Capacity

The storage capicity of the large computer systems is nornally more than the small system or machines.capicity is in terms of bytes and words. There are mainly two types of the capicity.

- **Raw capacity :** The total amount of stored information that a storage device or medium can hold. It is expressed as a quantity of bits or bytes.
- **Density :** The compactness of stored information. It is the storage capacity of a medium divided with a unit of length, area or volume (e.g. 1.2 megabytes per square inch).

5. Tracks and Sectors

A sector is a subdivision of a track. on a magnetic disk or optical disc. Each sector stores a fixed amount of data. The typical formatting of these media provides space for 512 bytes (for magnetic disks) or 2048 bytes (for optical discs) of user-accessible data per sector.Mathematically, the word sector means a portion of a disk between a center, two radii and a corresponding arc shaped like a slice of a pie. Thus, the common disk sector actually refers to the intersection of a track and mathematical sector.

Platters are organized into specific structures to enable the organized storage and retrieval of data. Each platter is broken into tracks--tens of thousands of them--which are tightly-packed concentric circles. These are similar in structure to the annual rings of a tree. A track holds too much information to be suitable as the smallest unit of storage on a disk, so each one is further broken down into sectors. A sector is normally the smallest individually-addressable unit of information stored on a hard disk, and normally holds 512 bytes of information. The first PC hard disks typically held 17 sectors per track. Today's hard disks can have thousands of sectors in a single track.

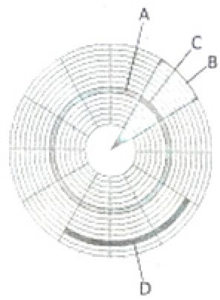


Fig. 19. Disk structures : A-Track, B- Geometrical sector, C-Track sector

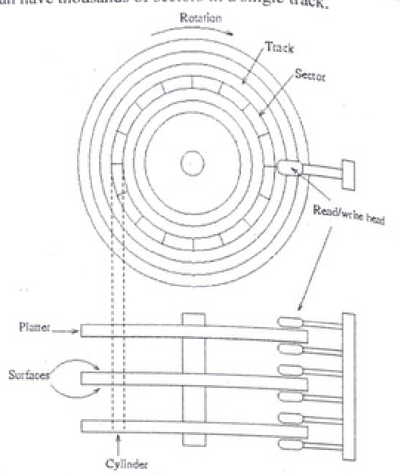


Fig. 20. Representation of track and sectors

6. Floppy Disk Drive

A **floppy disk** is a data storage medium that is composed of a disk of thin, flexible ("floppy") magnetic storage medium encased in a square or rectangular plastic shell. Floppy disks are read and written by a floppy disk drive or FDD.floppy disks in 8-inch (200 mm), 5¼-inch (133.35 mm), and 3½-inch (90 mm) formats enjoyed many years as a popular and ubiquitous form of data storage and exchange, from the mid-1970s to the late 1990s. While floppy disk drives still have some limited uses, especially with legacy industrial computer equipment. Before hard disks became affordable, floppy disks were often also used to store a computer's operating system (OS), in addition to application software and data. Most home computers had a primary OS stored permanently in on-board ROM. with the option of loading a more advanced disk operating system from a floppy, whether it be a proprietary system, CP/M, or later, DOS. The 5¼-inch disk had a large circular hole in the center for the spindle of the drive and a small oval aperture in both sides of the plastic to allow the heads of the drive to read and write the data. The magnetic medium could be spun by rotating it from the middle hole. A small notch on the right hand side of the disk would identify whether the disk was read-only or writable, detected by a mechanical switch or photo transistor above it. The 8-inch, 5¼-inch and 3-inch formats can be considered almost completely obsolete, although 3½-inch drives and disks are still widely available. Floppies are still used for emergency boots in aging systems which may lack support for other bootable media such as CD-ROMs and USB devices. They are also still often

required for setting up a new PC from the ground up, since even comparatively recent operating systems like Windows XP and Windows Server 2000 rely on third party drivers shipped on floppies. A simple FDD is shown below:

Fig. 21 : FLOPPY DISC

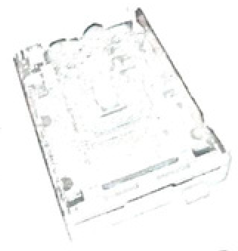


Fig. 22 : Floppy disk Drive

Floppy Disk Drive

Date invented	1969 (8-inch), 1976 (5¼-inch), 1982 (3½-inch)
Invented by	IBM team led by David L. Noble
Connects to	Cable

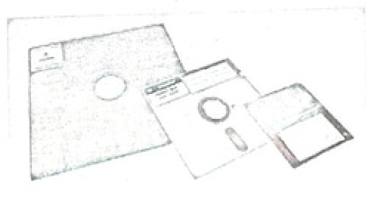


Fig. 23 : 8-inch, 5¼-inch, and 3½-inch floppy disks

There are various types of the floppy disc drive. Some of these are as follows:

- Sony HiFD
- 5¼-inch floppy disk
- 3½-inch floppy disk
- Zip drive
- 2HD
- super disc floppy

So these are the types of the floppy disc. Now we will cover one by one as in following manner:

Hi Floppy Disk :

The HiFD (High capacity Floppy Disk) was an attempt by Sony to replace their own aging 3.5 inch floppy disk.The first HiFD was launched in late 1998, boasting a capacity of 150MB and backwards compatibility with 3.5 inch floppy disks. It was available in Parallel port and ATA versions with a SCSI version planned, but never launched. A few months after launch it emerged that the HiFD suffered from frequent crashes during read/write operations, and had a tendency of having its read rate drop into the low kilobyte per second range, effectively rendering it unusable. Initially it was thought that a new driver could solve these problems - instead, Sony issued a full recall at the start of the following year.The HiFD was re-released in November 1999, now sporting a 200MB capacity and using a USB connection for the external drive.Sony

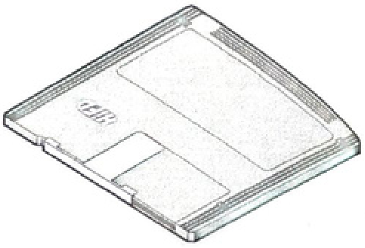


Fig. 24 : The HiFD

3½-Inch Floppy Disk:

The three densities of 3½-inch floppy disks are partially compatible. Higher density drives are built to read, write and even format lower density media without problems, provided the correct media are used for the density selected. Still, a fresh diskette that has been manufactured for high density use can theoretically be formatted as double density, but only if no information has ever been written on the disk using high density mode. The magnetic strength of a high density record is stronger and will "overrule" the weaker lower density, remaining on the diskette and causing problems. The holes on the right side of a 3½-inch disk can be altered as to 'fool' some disk drives or operating systems (others such as the Acorn Archimedes simply do not care about the holes) into treating the disk as a higher or lower density one, for backward compatibility or economical reasons. Fig. of floppy is shown below:

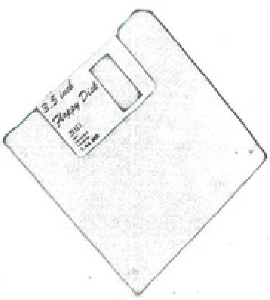


Fig. 25 :3.5 inch floppy disc

5¼-inch floppy disk:

In 1976 Shugart Associates introduced the first 5¼-inch FDD and associated media. By 1978 there were more than 10 manufacturers producing 5¼-inch FDDs, in competing physical disk formats: hard-sectored and soft-sectored. The 5¼-inch formats quickly displaced the 8-inch for most applications, and the 5¼-inch hard-sectored disk format eventually disappeared.Originally designed to be smaller and more practical than the 8-inch format, the 5¼-inch system was itself too large, and as the quality of the recording media grew, the same amount of data could be placed on a smaller surface. The 5.25-inch diskettes did not have a hard shell and were flimsy. The 5.25-inch diskettes were available in a capacity of 360kb low-density and 1.2MB high-density size; by 1994 the 5.25-inch disk was extinct and was replaced by the popularity of the 3.5-inch disks.

5 1/4" 256 Bytes disk

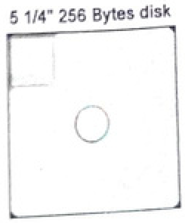


Fig. 26 : 5.25 inch floppy disc

SUPER DISC FLOPPY:

The SuperDisk, sometimes marketed by as LS-120 and a later variant LS-240, is a high-speed, high-capacity alternative to the 90 mm (3.5 in), 1.44 MB floppy disk. The Superdisk hardware was introduced by 3M's storage products groupcirca. SuperDisk should not be confused with SuperDrive, which is a trademark used by Apple Computer for various disk drive products. The SuperDisk's format was designed to supersede the floppy disk with its higher-capacity media that imitated the then ubiquitous format with its own 120MB disk storage while the SuperDisk drive itself was backwards compatible with 1.44 MB and 720 KB floppy formats. Superdisk drives seemed to read and write faster to these sorts of disks than conventional 1.44 MB or 720 KB floppy drives.

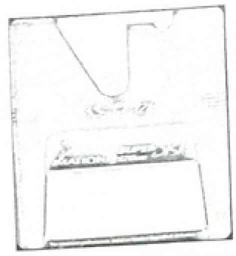


Fig. 27 : Super Disc Floppy

ZIP DRIVE:

Iomega company introduced the Zip drive. Although it's not true to the 3½-inch form factor, it still became the most popular of the "super floppies". It boasted 100 MB, later 250 MB, and then 750 MB of storage. Though Zip drives gained in popularity for several years they never reached the same market penetration as standard floppy drives, since only some new computers were sold with the drives. A major reason for the failure of the Zip Drives is also attributed to the higher pricing they carried. Zip drive media were primarily popular for the excellent storage density and drive speed they carried, but were always overshadowed by the price.

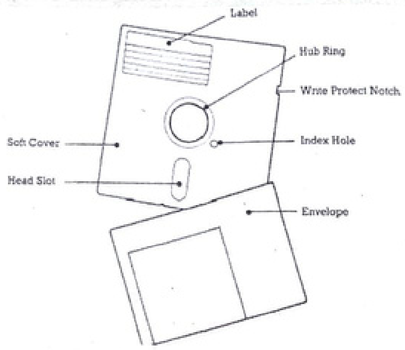


Fig. 27 : Block diagram of the FDD

HARD DISK:

A **hard disk drive** ("hard disk",or "HDD"), 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 distinct from its medium, such as a tape drive and its tape, or a floppy disk drive and its floppy disk. Early HDDs had removable media; however, an HDD today is typically a sealed unit (except for a filtered vent hole to equalize air pressure) with fixed media. A typical hard drive has two electric motors, one to spin the disks and one to position the read/write head assembly. The disk motor has an external rotor attached to the platters; the stator windings are fixed in place. The actuator has a read-write head under the tip of its very end. a thin printed-circuit cable connects the read-write head to the hub of the actuator. A flexible, somewhat 'U'-shaped, ribbon cable, seen edge-on below and to the left of the actuator arm in the first image and more clearly in the second, continues the connection from the head to the controller board on the opposite side.

There are many characteristics of the hard disk. It have very high data transfer rate i.e. 70 megabytes per seconddata transfer rate depends on the track location, so it will be highest for data on the outer tracks (where there are more data sectors) and lower toward the inner tracks (where there are fewer data sectors); and is generally somewhat higher for 10,000rpm drives. Secondly it take very less time to complete a task. currently ranges from just under 2 ms for high-end server drives, to 15 ms for miniature drives, with the most common desktop type typically being around 9 ms. Third one is power consuption. There is very less power ponsuption. Smaller form factor drives often use less power than larger drives. A simple view of hard disk is shown in fig. 20.

In this fig. we can see that Each surface is divided into tracks (and sectors) in the same way. This means that when the head for one surface is on a track, the heads for the other surfaces are also on the corresponding tracks. All the corresponding tracks taken together are called a cylinder. It takes time to move the heads from one track (cylinder) to another, so by placing the data that is often accessed together (say, a file) so that it is within one cylinder, it is not necessary to move the heads to read all of it. This improves performance. The number of surfaces (or heads, which is the same thing), cylinders, and sectors vary a lot; the specification of the number of each is called the geometry of a hard disk. History of hard disk is shown below.

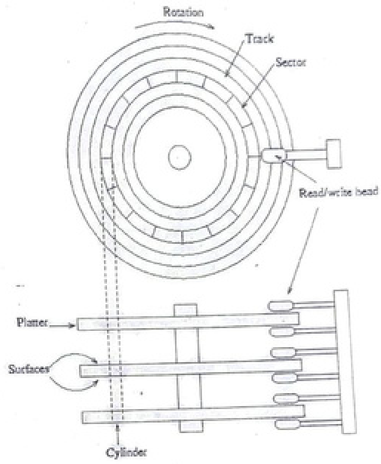
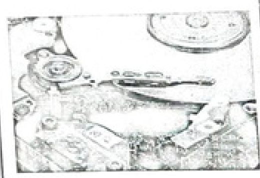


Fig. 85 : A Simple view of hard disk

Date invented	December 14, 1954
Invented by	Rey Johnson
Connects to interface	Host adapter of system, in PCs typically integrated into motherboard. via one of: • PATA (IDE) interface • SATA interface • SAS interface • SCSI interface • FC interface
Market Segments	Desktop computers Mobile computing



A HARD DISK DRIVE

Each hard disk is represented by a separate device file. There can (usually) be only two or four IDE hard disks. Hard disks use multiple platters, stacked on a spindle. Each platter has two read/ write heads, one for each side. Hard disks use higher-quality media and a faster rotational speed than diskettes. Removable hard disks combine high capacity with The convenience of floppy disks.

Cylinder

Cylinder-head-sector, also known as CHS, was an early method for giving addresses to each physical block of data on a hard disk drive (HDD). In the case of floppy drives, for which the same exact floppy medium can be truly low-level formatted to different capacities, this is still true.Though CHS values no longer have a direct physical relationship to the data stored on disks, pseudo CHS values are still being used by many utility programs. In other words A cylinder comprises the same track number but spans all such tracks across each platter surface that is able to store data. Thus, it is a three-dimensional object. Any track that comprises the same cylinder can be written to and read from while the actuator assembly remains stationary. One way drive makers have been able to increase drive speed is by increasing the number of platters that can be read at a given time.

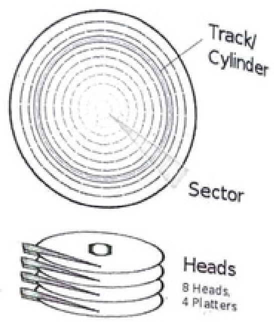
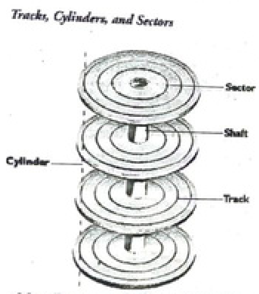


Fig. 28 : Representation of cylinders

Comparision among hard disk sectors, tracks and cylinder:

A hard disk is usually made up of multiple platters, each of which use two heads to record and read data, one for the top of the platter and one for the bottom, All information stored on a hard disk is recorded in tracks, which are concentric circles placed on the surface of each platter, much like the annual rings of a tree. A cylinder is basically the set of all tracks that all the heads are currently located at. So if a disk had four platters, it would (normally) have eight heads, and cylinder number 720 (for example) would be made up of the set of eight tracks, one per platter surface, at track number 720. The fig. 22 also explains the difference all of these:



29 : Representation of tracks, cylinder, and sectors

Hard Disk Interfaces

There are many types of the hard disk interfaces. Some of these are as follows:

- Integrated drive electronics (IDE)
- Enhanced Integrated drive electronics (EIDE)

- Small computer system interface (SCSI)

So these are all the hard disk interfaces. Now we will study one by one in the following manner:

Integrated Disk Interfaces

Integrate disk interface (IDE) is also known as Parallel ATA (PATA). It is an interface standard for the connection of storage devices such as hard disks, solid-state drives, and CD-ROM drives in computers. It uses the underlying AT Attachment and AT Attachment Packet Interface (ATA/ATAPI) standards.The current Parallel ATA standard is the result of a long history of incremental technical development. As a result, many near-synonyms for ATA/ATAPI and its previous incarnations exist, including abbreviations such as IDE which are still in common informal use. Parallel ATA only allows cable lengths up to 18 in (460 mm). Because of this length limit the technology normally appears as an internal computer storage interface. For many years ATA provided the most common and the least expensive interface for this application. By the beginning of 2007, it had largely been replaced by Serial ATA (SATA) in new systems. History of IDE is as follows:

Type	Internal storage device connector	
	Production history	
Designer	Western Digital, subsequently amended by many others	
Designed	1986-87	
Superseded by	Serial ATA	
	Specifications	
Hot pluggable	No	
External	No	
	Width	16 bits
	Bandwidth	16 MB/s originally
	Max. devices	2 (master/slave)
	Protocol	Parallel
Cable	40 or 80 wires ribbon cable	
Pins	40	

Parallel ATA

A simple diagram of the IDE or ATA is shown below:

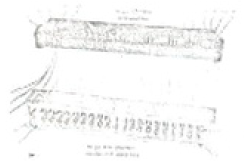


Fig. 30 : IDE connector

There are mainly two versions of the IDE or ATA connecter. The first version of what is now called the ATA/ATAPI interface and second one is ATA-2.

Enhanced Integrated Disk Interfaces (EIDE)

Modern computers come with EIDE (enhanced IDE) built into the main board. This is perfectly adequate for personal workstations. A high performance SCSI controller can be added to a new

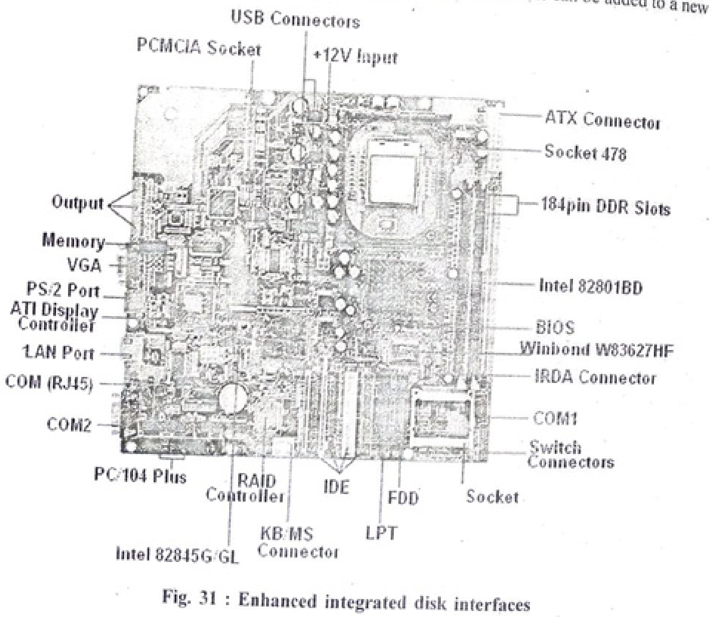


Fig. 31 : Enhanced integrated disk interfaces

system for an extra $220. IDE and SCSI disks operate at the same speed, but SCSI has advantages for a multitasking server because it allows many devices to be performing operations at the same time. When they designed the EIDE standard, they needed compatibility with all the existing IDE devices. So they didn't change the rules on the cable. An EIDE interface chip can support four devices, but it has two interface cables each connecting two devices. The EIDE chip looks and acts like two IDE chips. An old IDE disk can be connected to a new EIDE connector. A EIDE connecter is shown below:

Comparison between EIDE and IDE:

- IDE supports only disks. EIDE supports a mixture of disks, tapes, and CDROM drives.
- IDE supports only two devices. EIDE supports up to four devices on the same controller chip although it uses two cables.
- EIDE allows disks up to 1 gigabyte. Larger disks may also work, but that is up to the vendor. IBM, for example, doesn't officially support EIDE disks larger than one gigbyte
- IDE disks are cheaper and EIDE disks are expensive.

Small Computer System Interface

Most popular hard disk interface used in PCs today is the Small Computer Systems Interface, abbreviated SCSI and pronounced "skuzzy". SCSI is a much more advanced interface than its chief competitor, IDE/ATA, and has several advantages over IDE that make it preferable for many situations, usually in higher-end machines. It is far less commonly used than IDE due to its higher cost and the fact that its advantages are not useful for the typical home or business desktop user. SCSI is a much higher-level protocol than IDE is. In fact, while IDE is an interface, SCSI is really a system-level bus, with intelligent controllers on each SCSI device working together to manage the flow of information on the channel. SCSI supports many different types of devices. The SCSI standards define commands, protocols, and electrical and optical interfaces. SCSI is most commonly used for hard disks and tape drives, but it can connect a wide range of other devices, including scanners and CD drives. The SCSI standard defines command sets for specific peripheral device types. A SCSI cable is shown below in fig.25..

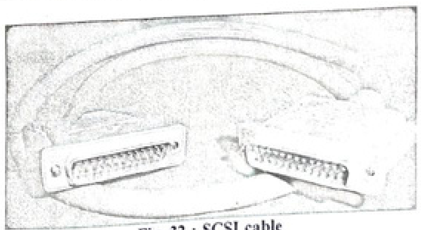


Fig. 32 : SCSI cable

There are many types of SCSI cable. Some of these are as follows:

- Fast SCSI
- Fast / Wide SCSI
- Ultra SCSI

These SCSI interfaces can compare in concern of the data width, transfer rate, internal device, external device etc. in the following table:

TYPE	Data width	Transfer rate	Internal disk drive connector	External device connector	No. of devices	'Max. cable length
SCSI-1	8 bits	5 MB/s	50-pin or 68-pin + MOLEX Power Connector	50-pin Centronics	7	6 meters (SE) or 12 meters (LVD)
Fast SCSI	8 bits	10 MB/s	50-pin or 68-pin + MOLEX Power Connector	50-pin high-density	7	3 meters (SE) or 12 meters (LVD)
Fast Wide SCSI	16 bits	20 MB/s	68-pin + MOLEX or 80-Pin SCA (Single-Connector-Attachment)	68-pin high-density	15	3 meters (SE) or 12 meters (LVD)
Ultra SCSI	8 bits	20 MB/s	50-pin or 68-pin + MOLEX Power Connector	50-pin high-density	7	1.5 meters (SE) or 12 meters (LVD)

An example of ultra SCSI is shown below:

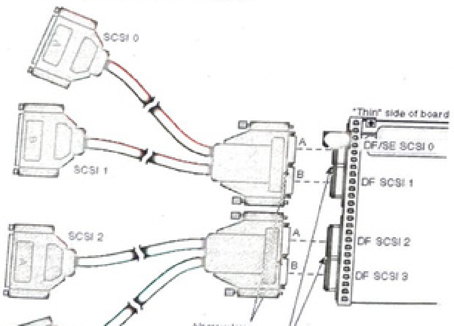


Fig. 33 : Ultra SCSI

Hard Disk Cartridges :

Disk cartridge is a single hard disk platter encased in a protective plastic shell. When the removable cartridge was inserted into the **cartridge drive** peripheral device, the read/write heads of the drive could access the magnetic data storage surface of the platter through holes in the shell. The disk cartridge is a direct evolution from the disk pack drive, or the early hard drive. As the storage density improved, even a single platter would provide a useful amount of data storage space, with the benefit being easier to handle than a removable disk pack. An example of a cartridge drive is the IBM 2310. Some more recent removable disk storage media are referred to as **disk cartridges.** This is most common with Zip disks. It is very rare, but not unheard of, to refer to the 3½-inch floppy as a disk cartridge

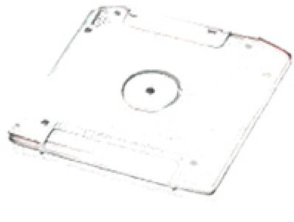


Fig. 34: Disk Cartridge

Redundant Array of Indpependent Disk (RAID)

RAID is stands for redundant array of inexpensive disks, a technology that allowed computer users to achieve high levels of storage reliability from low-cost and less reliable PC-class disk-drive components, via the technique of arranging the devices into arrays for redundancy.More recently, marketers representing industry RAID manufacturers reinvented the term to describe a redundant array of independent disks as a means of disassociating a "low cost" expectation from RAID technology. RAID is now used as an umbrella term for computer data storage schemes that can divide and replicate data among multiple hard disk drives. The different architectures are named by the word RAID followed by a number, as in RAID 0, RAID 1, RAID 2, RAID 3 etc. RAID's various designs all involve two key design goals: increased data reliability or increased input/output performance. RAID systems with redundancy continue working without interruption when one disks of the array fail, although they are then vulnerable to further failures. When the bad disk is replaced by a new one the array is rebuilt while the system continues to operate normally. RAID is not a good alternative to backing up data. Data may become damaged or destroyed without harm to the drive on which they are stored. RAID combines two or more physical hard disks into a single logical unit by using either special hardware or software. There are three key concepts in RAID: mirroring, the copying of data to more than one disk; striping, the splitting of data across more than one disk; and error correction, where redundant data is stored to allow problems to be detected and possibly fixed (also known as fault tolerance).

There are various problem with the RAID. Some of these are as follows:

- Correlated failures
- Atomicity
- Write cache reliability
- Equipment compatibility
- Data recovery in the event of a failed array
- Drive error recovery algorithms

- Other Problems and Viruses

So these are the problems with the RAID. There is no need to detail study of each problem. There are various types of the RAID. Some of these are as follows:

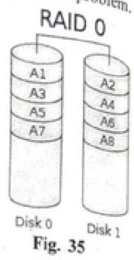


Fig. 35

RAID-0: It is the Stripped Disk Array with no fault tolerance and it requires at least 2 drives to be implemented. Due to no redundancy feature, RAID 0 is considered to be the lowest ranked RAID level. RAID 0 is useful for setups such as large read-only NFS servers where mounting many disks is time-consuming or impossible and redundancy is irrelevant.

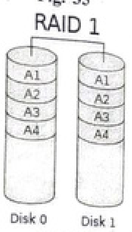


Fig. 36

RAID-1: A RAID 1 creates an exact copy of a set of data on two or more disks. This is useful when read performance or reliability are more important than data storage capacity.RAID 1 controller is able to perform 2 separate parallel reads or writes per mirrored pair. It also requires at least 2 drives to implement a non-redundant disk array. High level of availability, access and reliability can be achieved by entry-level

RAID 1 array. RAID 1 has many administrative advantages. For instance it is possible to "split the mirror": declare one disk as inactive, do a backup of that disk, and then "rebuild" the mirror.

RAID-2: It is the combination of Inherently Parallel Mapping and Protection RAID array. It's also known as ECC RAID because each data word bit is written to data disk which is verified for correct data or correct disk error when the RAID disk is read. It uses a Hamming code for error correction.Due to special disk features required, RAID 2 is not very popular among the corporate data storage masses.

RAID-3: RAID 3 works on the Parallel Transfer with Parity technique. The least number of disks required to implement the RAID array is 3 disks. In the RAID 3, data blocks

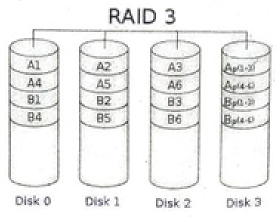


Fig. 37

are striped and written on data drives and then the stripe parity is generated, saved and afterwards used to verify the disk reads. Read and write data transfer rate is very high in RAID 3. it is very rare in practice. One of the side effects of RAID 3 is that it generally cannot service multiple requests simultaneously. Example of RAID-3 is shown in fig. 30.

RAID-4: RAID 4 requires a minimum of 3 drives to be implemented. It is composed of independent disks with shared parity to protect the data. Data transaction rate for Read is exceptionally high and highly aggregated.

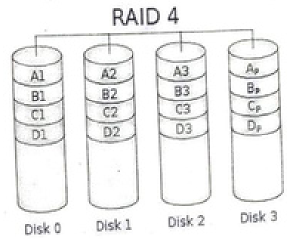


Fig. 38

RAID-5: A RAID 5 uses block-level striping with parity data distributed across all member disks.it is Independent Distributed parity block of data disks with a minimum re

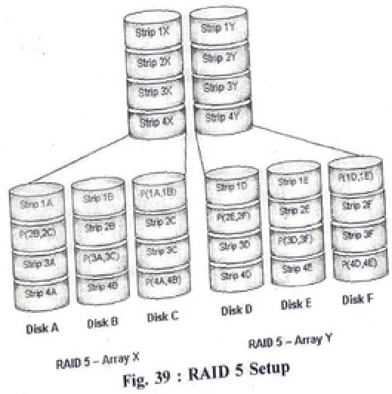


Fig. 39 : RAID 5 Setup

quirement of at least 3 drives to be implemented and N-1 array capacity. It helps in reducing the write inherence found in RAID 4. RAID 5 array offers highest data transaction Read rate, medium data transaction Write rate and good cumulative transfer rate. Example of RAID-5 is shown in fig. 32.

RAID 5 implementations suffer from poor performance when faced with a workload which includes many writes which are smaller than the capacity of a single stripe.

RAID- 6: It is Independent Data Disk array with Independent Distributed parity. It is known to be an extension of RAID level 5 with extra fault tolerance and distributed parity scheme added. RAID 6 is the best available RAID array for mission critical applications and data storage needs, though the controller design is very complex and overheads are extremely high.

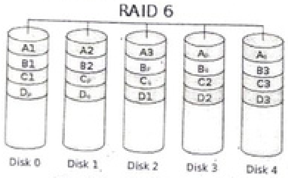


Fig. 40 : RAID 6 Setup

RAID-7: RAID 7 is the Optimized Asynchrony array for high I/O and data transfer rates and is considered to be the most manageable RAID controller available. RAID 7 is registered as a standard trademark of Storage Computer Corporation.

RAID-10: RAID 10 is classified as the futuristic RAID controller with extremely high Reliability and performance embedded in a single RAID controller. The minimum requirement to form a RAID level 10 controller is 4 data disks. The implementation of RAID 10 is based on a striped array of RAID 1 array segments. RAID 10 controllers and arrays are suitable for uncompromising availability and extremely high throughput required systems and environment.

With all the significant RAID levels discussed here briefly, another important point to add is that whichever level of RAID is used regular and consistent data backup maintenance using tape storage is must as the regular tape storage is best media to recover from lost data scene. RAID can involve significant computation when reading and writing information. With traditional "real" RAID hardware, a separate controller does this computation. In other cases the operating system or simpler and less expensive controllers require the host computer's processor to do the computing, which reduces the computer's performance on processor-intensive tasks.

Optical Disk

An optical disc is a flat, generally circular disc which can contain data encoded in microscopic pits. The encoding material sits atop a thicker substrate which makes up the bulk of the disc. The encoding pattern follows a continuous, spiral path covering the entire disc surface and extending from the innermost track to the outermost track. The data is stored on the disc with a laser or

stamping machine, and can be accessed when the data path is illuminated with a laser diode in an optical disc drive which spins the disc at speeds of about 200 RPM up to 4000 RPM. The reverse side of an optical disc usually has a printed label, generally made of paper but sometimes printed or stamped onto the disc itself. This (non-encoded) side of the disc is typically coated with a transparent material, usually lacquer. Unlike the 3½-inch floppy disk, most optical discs do not have an integrated protective casing and are therefore susceptible to data transfer problems due to scratches, fingerprints, and other environmental problems.

Optical discs are usually between 7.6 and 30 cm (3 to 12 inches) in diameter, with 12 cm (4.75 inches) being the most common size. A typical disc is about 1.2 mm (0.05 inches) thick, while the track pitch is typically 1.6 µm (microns). An optical disc is designed to support one of three recording types:

- read-only (CD and CD-ROM)
- recordable (write-once, CD-R)
- re-recordable (rewritable, CD-RW).

Optical discs are most commonly used for storing music (e.g. for use in a CD player), video (e.g. for use in a DVD player), or data and programs for personal computers. The Optical Storage Technology Association (OSTA) promotes standardized optical storage formats.

A simple view of the optical disk is shown below:

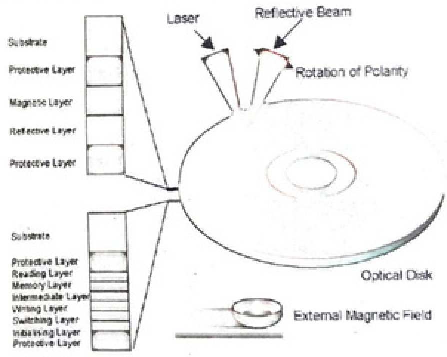


Fig. 41 : Optical disk

Compact Disk

A Compact Disc (CD) is an optical disc used to store digital data. It was developed to store music at the start, but later it also allowed to store other kinds of data. Standard CDs have a diameter of 120 mm and can hold up to 80 minutes of audio (700 MB of data). The Mini CD has various diameters ranging from 60 to 80 mm; they are sometimes used for CD singles or device drivers, storing up to 24 minutes of audio.

The technology was later adapted and expanded to include data storage CD-ROM, write-once audio and data storage CD-R, rewritable media CD-RW, Video Compact Discs (VCD), Super Video Compact Discs (SVCD).

(A) (B)

Fig. 42 : (A) Front portion of CD (B) Back side of the CD

There are three category of the compact disk (CD):

- CD- ROM
- CD- R
- CD- RW

Now we will study one by one in th following manner:

Compact disc- read only memory(CD-ROM)

CD-ROM is a pre-pressed compact disc that contains data accessible to, but not writable by, a computer. While the compact disc format was originally designed for music storage and playback. Five years later CD-ROM drives were being introduced on to computers. In 1994, they called a computer with a CD-ROM a Multimedia computer since it could play music and specially coded videos. CD-ROMs are popularly used to distribute computer software, including games and multimedia applications, though any data can be stored (up to the capacity limit of a disc). Although many people use lowercase letters in this acronym, proper presentation is in all capital letters with a hyphen between CD and ROM. It was also suggested by some, especially soon after the technology was first released, that CD-ROM was an acronym for "Compact Disc read-only-media". This was not the intention of the original team who developed the CD-ROM, and common acceptance of the "memory" definition is now almost universal. Simple view of CD-ROM is as follows:

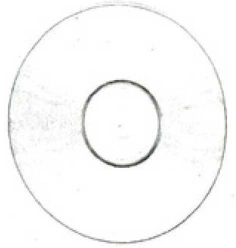


Fig. 43 :

Compact Disc-Recordable (CD- R):

A **CD-R** (Compact Disc-Recordable) is a variation of the Compact Disc invented by Philips and Sony. CD-R is a Write Once Read Many (WORM) optical medium, though the whole disk does not have to be entirely written in the same session. The word "recordable" is used because CD-R are often used to record audio, which can be played back by most CD players. However, many other kinds of data can also be written to a CD-R, so the discs are also referred to as "writable CDs."CD-R retains a high level of compatibility with standard CD readers. A standard CD-R is a 1.2 mm thick disc made of polycarbonate with a 120 mm or 80 mm diameter. The 120 mm disc has a storage capacity of 70 minutes of audio or 650 MB of data. The data burned onto a CD-R disc is permanent, meaning it can not be altered or erased like the data on a hard drive. Typically, once a CD has been burned, it will not be able to record any more data. Some CD burning programs can record data as "sessions," allowing a disc to be written to multiple times until it is full. Each session creates a new partition on the disc, meaning a computer will read a disc with multiple sessions as multiple discs. Speed of the CD-R is shown below in the table:

Drive speed	Data rate	Write time for 80 minute/700 MB CD-R
1X	150 KiB/s	80 minutes
4X	600 KiB/s	20 minutes
8X	1200 KiB/s	10 minutes
12X	1800 KiB/s	6.7 minutes
32X	4800 KiB/s	2.5 minutes
52X	7800 KiB/s	1.5 minutes

Compact Disc Re-Writable (CD-RW):

CD-WR Stands for "Compact Disc Re-Writable." A CD-RW is a blank CD that can be written to by a CD burner. Unlike a CD-R (CD-Recordable), a CD-RW can be written to multiple times. The data burned on a CD-RW cannot be changed, but it can be erased. Therefore, you have to completely erase a CD-RW every time you want to change the files or add new data.CD-RW discs are usually produced in the most common CD-R disc capacities such as 650 and 700 MB, while smaller and larger capacities are rarer. CD-RW recorders typically handle the most common capacities best. In theory a CD-RW disc can be written and erased roughly 1000 times, although in practice this number is much lower. CD-RW recorders can also read CD-R discs.

CD-RW discs never gained the widespread popularity of CD-R, partly due to their higher per-unit price, lower recording and reading speeds, and compatibility issues with CD reading units, as well as between CD-RW formats of different speeds specifications. Also, compared to other forms of rewritable media such as Zip drives, Magneto-optical and flash memory based media, the CD-RW format uses the standard CD-ROM and CD-R file systems and storage strategies.

Digital Versatile Disc (DVD):

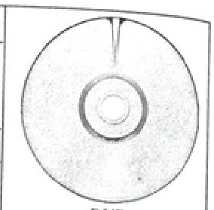
DVD, also known as "Digital Versatile Disc", is an optical disc storage media format. Its main uses are video and data storage. DVDs are of the same dimensions as compact discs (CDs), but store more than six times as much data. There are many variation of the DVD. Such as:

- DVD-ROM
- DVD-R
- DVD-RW

The term DVD often describe the way data is stored on the discs: DVD-ROM (Read Only Memory) has data that can only be read and not written; DVD-R and DVD+R can record data only once. DVD-RW can both record and erase data multiple times. The wavelength used by standard DVD lasers is 650 nm.DVD Video and DVD Audio discs refer to properly formatted and structured video and audio content, respectively. History of DVD is shown in table below:

History of DVD

Media type	Optical disc
Capacity	4.7 GB (single-sided, single-layer) 8.54 GB (single-sided, double-layer) 17.08 GB (double-sided, double-layer-rare)
Read mechanism	650 nm laser, 10.5 Mbit/s
Write mechanism	10.5 Mbit/s
Usage	Data storage, video, audio.



DVD

DVD-R:

DVD-R is a DVD recordable format. A DVD-R typically has a storage capacity of 4.71 GB, although the capacity of the original standard developed by Pioneer was 3.95 GB. Both values are significantly larger than the storage capacity of its optical predecessor. the 700 MB CD-R - a DVD-R has 6.4 times the capacity of a CD-R. Data on a DVD-R cannot be changed. Recording speed is generally denoted in values of X (similar to CD-ROM usage), where 1X in DVD usage is equal to 1.321 MB/s. A simple view of the DVD-R is shown in figure 39.

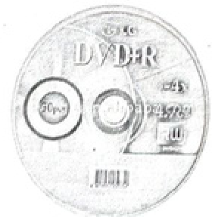


Fig. 44 : Simple view of DVD-R

DVD recorders have several technical advantages. Some of these are as follows:

- Superior video and audio quality
- Easy-to-handle smaller form-factor disc media, and more durable than magnetic tape.
- Reduced playback wear and tear
- High-quality digital copying.

- Improved editing, at least on rewritable media
- Playlisting
- No risk of accidentally recording over existing content or unexpectedly running out of space during recording
- Easy to find recordings due to chapter menu.

DVD-RW:

A **DVD-RW** disc is a rewritable optical disc with equal storage capacity to a DVD-R, typically 4.7 GB. The format was developed by Pioneer in November 1999.Unlike DVD-RAM, it is playable in about 75% of conventional DVD players.The primary advantage of DVD-RW over DVD-R is the ability to erase and rewrite to a DVD-RW disc. According to Pioneer, DVD-RW discs may be written to about 1,000 times before needing replacement, making them comparable with the CD-RW standard. DVD-RW discs are commonly used for volatile data, such as backups or collections of files. They are also increasingly used for home DVD video recorders. One benefit to using a rewritable disc is if there are writing errors when recording data, the disc is not ruined and can still store data by erasing the faulty data.The current fastest speed a DVD-RW disc can be written to is 6x speed, with many at this speed having DVD-RW2 capabilities. A simple fig. of DVD-RW is shown in fig. 40.

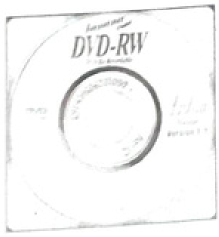
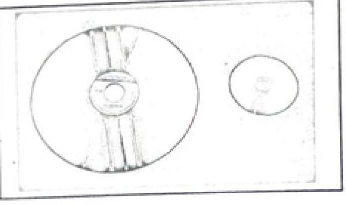


Fig. 45 : Simple view of DVD-RW

Laser CD:

The Laserdisc (LD) is an obsolete home video disc format, and was the first commercial optical disc storage mediumThe technology and concepts provided with the Laserdisc would become the forerunner to Compact Discs and DVDs.The standard home video laserdisc is 30 cm in diameter and made up of two single-sided aluminum discs layered in plastic. Although read and featuring properties similar to a compact disc or DVD. History of laser CD is shown below:

Media type	Optical disc
Encoding	NTSC
Capacity	60 minutes per side CLV
Developed by	Philips & MCA
Usage	Home video Data Storage



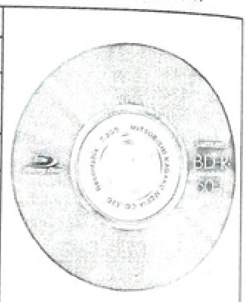
A simple view of the laser disc is shown below:

Fig. 46 : LASER DISC

BLUE-RAY DISC:

Blue-ray Disc is an optical disc storage medium to supersede the standard DVD format. Its main uses are for storing games, high-definition video and data storage with up to 50GB per disc. The disc has the same physical dimensions as standard DVDs and CDs.The name Blu-ray Disc derives from the blue-violet laser used to read the disc. While a standard DVD uses a 650 nanometre red laser. Blu-ray uses a shorter wavelength, a 405 nm blue-violet laser, and allows for almost six times more data storage than on a DVD.Blu-ray Disc uses a "blue" (technically violet) laser operating at a wavelength of 405 nm to read and write data. Conventional DVDs and CDs use red and near infrared lasers at 650 nm and 780 nm respectively. History of blue ray disc is shown below:

Media type	High-density optical disc
Encoding	MPEG-2, MPEG-4 AVC, and VC-1
Capacity	25 GB (single layer) 50 GB (dual layer)
Block size	64kb ECC
Read mechanism	405 nm laser: 1× at 36 Mbit/s 2× at 72 Mbit/s 4× at 144 Mbit/s 6× at 216 Mbit/s 8× at 288 Mbit/s
Usage	Data storage, High-definition video, games



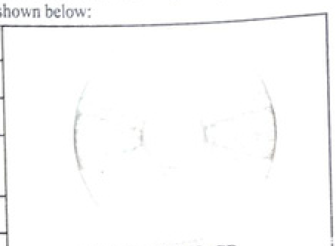
Blue Ray disk

Super Video CD (SVCD):

Super Video CD (Super Video Compact Disc or SVCD) is a digital format for storing video on standard compact discs. SVCD was intended as a successor to Video CD and an alternative to

DVD-Video, and falls somewhere between both in terms of technical capability and picture quality and good performance. History of super video cd is shown below:

Media type	Optical disc
Encoding	MPEG-2 video + audio
Capacity	Up to 800 MB
Read mechanism	780 nm wavelength semiconductor laser
Standard	IEC 62107
Usage	audio and video storage



SUPER VIDEO CD

Magnetic Tape

Magnetic tape is a medium for magnetic recording generally consisting of a thin magnetizable coating on a long and narrow strip of plastic. Nearly all recording tape is of this type, whether used for recording audio or video or for computer data storage. Devices that record and playback audio and video using magnetic tape are generally called tape recorders and video tape recorders respectively. A device that stores computer data on magnetic tape can be called a tape drive, a tape unit, or a streamer. The use of magnetic tape for computer data storage has been one of the constants of the computer industry. In all formats, a tape drive uses precisely-controlled motors to wind the tape from one reel to another, passing a tape head as it does.A simple magnetic tape is shown in fig. 42.

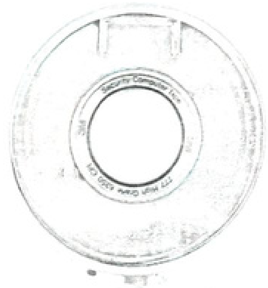


Fig. 47 : Magnetic tape

There are various types of the magnetic tape. Some of these are as follows:

- Reels
- Streamers
- Digital audio tape(DAT)
- Digital linear tape(DLT)
- Magnetic stripe
- Smart card

So these are all the types of the magnetic tape. Now we will study one bu one in the following manner:

REELS:

A reel is an object around which lengths of another material are wound for storage. Generally a reel has a cylindrical core and walls on the sides to retain the material wound around the core. In some cases the core is hollow, although other items may be mounted on it, and grips may exist for mechanically turning the reel. The size of the core is dependent on several factors. A smaller core will obviously allow more material to be stored in a given space. However, there is a limit to how tightly the stored material can be wound without damaging it and this limits how small the core can be.

Other issues affecting the core size include:

- Mechanical strength of the core (large reels).
- Acceptable turning speed (for a given rate of material moving on or off the reel a smaller core will mean that an almost empty reel has to turn faster)
- Any functional requirements of the core.

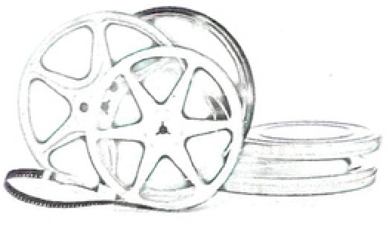


Fig. 48 : Reel

STREAMERS:

A streamer is a data storage device that reads and writes data stored on a magnetic tape. It is typically used for archival storage of data stored on hard drives. Tape media generally has a favorable unit cost and long archival stability. Instead of allowing random-access to data as hard disk drives do, streamers only allow for sequential-access of data. A hard disk drive can move its read/write heads to any random part of the disk platters in a very short amount of time, but a streamer must spend a considerable amount of time winding tape between reels to read any one particular piece of data. As a result, streamer has very slow average seek times. Despite the slow seek time, tape drives can stream data to tape very quickly.

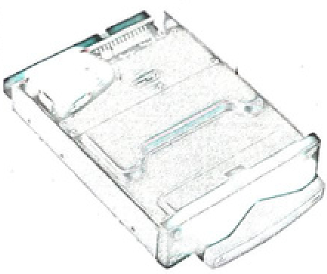


Fig. 49 : Reel

Digital Audio Tape (DAT) :

Digital Audio Tape (DAT) is a signal recording and playback medium. In appearance it is similar

to a compact audio cassette, using 4 mm magnetic tape enclosed in a protective shell, but is roughly half the size at 73 mm × 54 mm × 10.5 mm. As the name suggests, the recording is digital rather than analog. DAT has the ability to record at higher, equal or lower sampling rates than a CD. If a digital source is copied then the DAT will produce an exact clone, unlike other digital media such as Digital Compact Cassette or non-Hi-MD MiniDisc, both of which use lossy data compression. Like most formats of videocassette, a DAT cassette may only be recorded on one side, unlike an analog compact audio cassette. History of DAT is shown below:

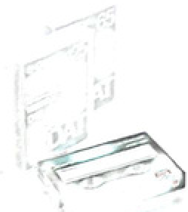
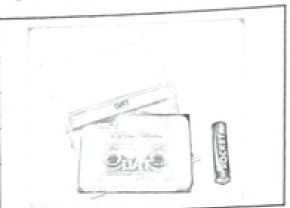


Fig. 50. Digital Audio Tape(DAT)

Media type	Magnetic tape
Capacity	120 minutes
Read mechanism	Rotating head
Write mechanism	Rotating head, helical scan
Usage	Audio storage



Digital Linea Tape (DLT)

Digital Linear Tape (DLT) is a magnetic tape data storage (drive) technology developed by Digital Equipment Corporation (DEC) from 1984 onwards. In 1994 the technology was purchased by Quantum Corporation, who currently manufactures drives and licenses the technology and trademark. A variant with higher capacity is called **Super DLT (SDLT).** DLT uses linear serpentine recording with multiple tracks on half-inch (12.7 mm) wide tape. The cartridges contain a single reel and the tape is pulled out of the cartridge by means of a leader tape attached to the takeup reel inside the drive. The drive leader tape is buckled to the cartridge leader during the load process. The tape is guided by 4 to 6 rollers that touch only the back side of the tape.

All DLT drives support hardware data compression. Note that drive compression applied to pre-compressed data can actually make the written data larger than having compression turned off in the tape drive. Media are guaranteed for 30 years of data retention under specified environmental conditions. Current manufacturers of cartridges for the DLT/SDLT market are Fujifilm, Hitachi/Maxell. All other companies/brands (even Quantum) are contractors and/or resellers of these companies. DLT includes Write Once Read Many (WORM) capability. fig. of DLT is shown below:

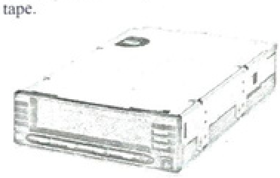


Fig. 51 : Data Linear Tape(DLT)

Magnetic Strip

A magnetic stripe card is a type of card capable of storing data by modifying the magnetism of tiny iron-based magnetic particles.The magnetic stripe, sometimes called a magstripe, is read by physical contact and swiping past a reading head. Magnetic stripe cards are commonly used in credit cards, identity cards, ATM cards and transportation tickets. They may also contain an RFID tag, a transponder device and a microchip mostly used for business premises or e:ectronic payement. An International Organization for Standardization standards, define the physical properties of the card, including size, flexibility, location of the magstripe, magnetic characteristics, and data formats. They also provide the standards for financial cards, including the allocation of card number ranges to different card issuing institutions.

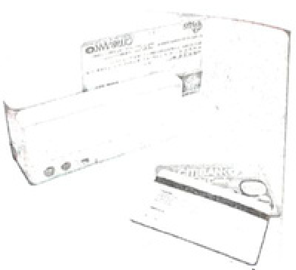


Fig. 52 : Magetic stripe card

In most magnetic stripe cards, the magnetic stripe is contained in a plastic-like film. The magnetic stripe is located 0.223 inches from the edge of the card, and is 0.375 inches wide. The magnetic stripe contains three tracks, each 0.110 inches wide. Tracks one and three are typically recorded at 210 bits per inch, while track two typically has a recording density of 75 bits per inch . Each track can either contain 7-bit alphanumeric characters, or 5-bit numeric characters. A fig. of magnetic stripe is shown in figure 47.

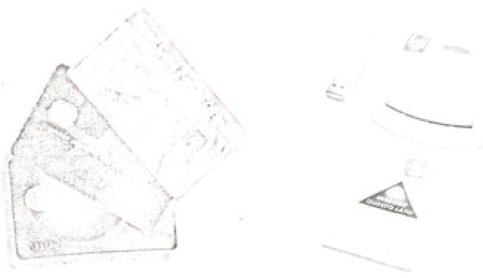
Magstripes come in two main varieties: high-coercivity (HiCo) and low-coercivity (LoCo). High-coercivity magstripes are harder to erase, and therefore are appropriate for cards that are frequently used or that need to have a long life. Low-coercivity magstripes require a lower amount of magnetic energy to record, and hence the card writers are much cheaper than machines which are capable of recording high-coercivity magstripes.

Smart Card

A smart card is any pocket-sized card with embedded integrated circuits which can process data. Smart card also known as chip card or integrated circuit card (ICC).This implies that it can receive input which is processed - by way of the ICC applications - and delivered as an output. There are two broad categories of ICCs. Memory cards contain only non-volatile memory storage components, and perhaps some specific security logic. Microprocessor cards contain volatile memory and microprocessor components. The card is made of plastic, generally PVC.The card may embed a hologram to avoid any duplicacy .Using smartcards also is a form of strong security authentication for single sign-on within large companies and organizations.

Smart card Dimensions are normally credit card size. It Contains a security system with tamper-resistant properties and is capable of providing security services (confidentiality of information in the memory). Card data is transferred to the central administration system through card reading devices,

such as ticket readers, ATMs etc. Smart cards can be used for identification, authentication, and data storage. Smart cards provide a means of effecting business transactions in a flexible, secure, standard way with minimal human intervention. The international payment brands MasterCard, Visa, and Europay agreed to work together to develop the specifications for the use of smart cards in payment cards used as either a debit or a credit card. A smart card and smart card reader is shown below:



(A) (B)

Fig. 53 : (A) Smart cards (B) Smart card reader

5.6 PRINTERS

A printer is a peripheral which produces a hard copy of documents stored in electronic form, usually on physical print media such as paper or transparencies. Many printers are primarily used as local peripherals, and are attached by a printer cable or, in most newer printers, a USB cable to a computer which serves as a document source. Some printers, commonly known as network printers, have built-in network interfaces (typically wireless or Ethernet), and can serve as a hardcopy device for any user on the network. Individual printers are often designed to support both local and network connected users at the same time.In addition, a few modern printers can directly interface to electronic media such as memory sticks or memory

Fig. 54 : Simple view of printer

cards, or to image capture devices such as digital cameras, scanners; some printers are combined with a scanners and/or fax machines in a single unit, and can function as photocopiers. Printers that include non-printing features are sometimes called Multifunction Printers (MFP), Multi-Function Devices (MFD), or All-In-One (AIO) printers. Most MFPs include printing, scanning, and copying among their features. Printers are designed for low-volume, short-turnaround print jobs; requiring virtually no setup time to achieve a hard copy of a given document. However, printers are generally slow devices and the cost per page is actually relatively high. The printing press remains the machine of choice for high-volume, professional publishing. However, as printers have improved in quality and performance, many jobs which used to be done by professional print shops are now done by users on local printers; see desktop publishing.

There are various types of printers. Some of these are as follows:

- Dot matrix printer
- Inkjet printer
- Label printer
- Thermal wax transfer printer
- IRIS printer
- Daisy wheel printer
- Line printer
- Page printer
- Dye- submilation printer
- Laser printer

So these are the types of the printers. Now we will study one by one in following way:

1. DOT Matrix printer (DMP)

A dot matrix printer or impact matrix printer is a type of computer printer with a print head that runs back and forth, or in an up and down motion, on the page and prints by impact, striking an ink-soaked cloth ribbon against the paper, much like a typewriter. Each dot is produced by a tiny metal rod, also called a "wire" or "pin", which is driven forward by the power of a tiny electromagnet or solenoid, either directly or through small levers (pawls). the term dot matrix printer is specifically used for impact printers that use a matrix of small pins to create precise dots. The advantage of dot-matrix over other impact printers is that they can produce graphical images in addition to text; however the text is generally of poorer quality than impact printers that use letterforms.The moving portion of the printer is called the print head, and when running the printer as a generic text device generally prints one line of text at a time. Most dot matrix printers have a single vertical line of dot-making equipment on their print heads; others have a few interleaved rows in order to improve dot density.These machines can be highly durable. When they do wear out, it is generally due to ink invading the guide plate of the print head, causing grit to adhere to it; this grit slowly causes the channels in the guide plate to wear from circles into ovals or slots, providing less and less accurate guidance to the printing wires.

Dot-matrix printers can be broadly divided into two major classes:

- Ballistic wire printers
- Stored energy printers

Dot matrix printers can either be character-based or line-based (that is, a single horizontal series of pixels across the page), referring to the configuration of the print head.At one time, dot matrix printers were one of the more common types of printers used for general use - such as for home and small office use. Such printers would have either 9 or 24 pins on the print head.

24-pin print heads were able to print at a higher quality. Once the price of inkjet printers dropped to the point where they were competitive with dot matrix printers, dot matrix printers began to fall out of favor for general use.

Some dot matrix printers, such as the NEC P6300, can be upgraded to print in color. This is achieved through the use of a four-color ribbon mounted on a mechanism that raises and lowers the ribbons as needed. Color graphics are generally printed in four passes at standard resolution, thus slowing down printing considerably. As a result, color graphics can take up to four times longer to print than standard monochrome graphics, or up to 8-16 times as long at high resolution mode.Dot matrix printers are still commonly used in low-cost, low-quality applications like cash registers, or in demanding, very high volume applications like invoice printing.

The main use of Dot-Matrix Printers are in areas of intensive transaction-processing systems that churn out quite a lot of printing. Many companies who might have started off with dot-matrix printers are not so easily convinced to go for printers based on other technologies because of the speed advantage that they have with dot-matrix printers. A simple view of Dot matrix printer is shown in fig. below.

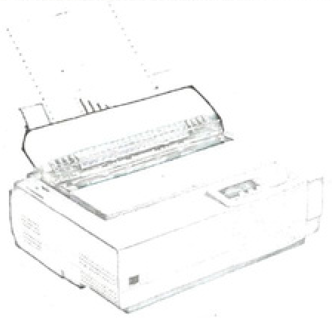


Fig. 55 : Dot Matrix printer

There are many types of dot matrix printer. Some of these are as follows:

- **LA180** -- 180 c/s line printer
- **LS120** -- 120 c/s terminal
- **LA120** -- 180 c/s advanced terminal
- **LA34** -- Cost-reduced terminal printer
- **LA38** -- An LA34 with more features
- **LA12** -- A portable terminal printer

There are various advantage and disadvantage of the printer. First we will discuss advantage then we will discuss the disadvantage.

Advantage:

Dot matrix printers, like any impact printer, can print on multi-part stationery or make carbon-copies. Impact printers have one of the lowest printing costs per page. As the ink is running out, the printout gradually fades rather than suddenly stopping partway through a job. it could print to wider (132 column) paper. Standard-carriage printers printed on letter-width (8.5") paper. They are able to use continuous paper rather than requiring individual sheets, making them useful for data logging. This type of printer allowed user control of a font's printed-size. Unlike the traditional bitmap representation of typeface data, scalable typefaces used a vector-based definition.They are good, reliable workhorses ideal for use in situations where printed content is more important than quality. The ink ribbon also does not easily dry out, including both the ribbon stored in the casing as well as the portion that is stretched in front of the print head; this unique property allows the dot-matrix printer to be used in environments where printer duty can be rare, for instance, as with a Fire Alarm Control Panel's output.

Disadvantage:

Dot matrix or Impact printers are usually noisy, to the extent that sound dampening enclosures are available for use in quiet environments. They can only print low resolution graphics, with limited color performance, limited quality and comparatively low speed. While they support fanfold paper with tractor holes, single-sheet paper usually has to be wound in and aligned by hand, which is relatively inconvenient and time-consuming. While far better suited to printing on labels than a laser printer or an inkjet printer, they are prone to bent pins (and therefore a destroyed printhead) caused by printing a character half-on and half-off the label.

2. Daisy Wheel Printer

Daisy wheel printing is an impact printing technology invented in 1969 by David S. Lee.It uses interchangeable pre-formed type elements, each with 96 glyphs, to generate high-quality output comparable to premium typewriters such as the IBM "Golfball" Selectric, but three times faster. Daisy-wheel printing was used in electronic typewriters, word processors and computer systemsfrom 1972.In early days daisy-wheel printers had become the dominant technology for high-quality

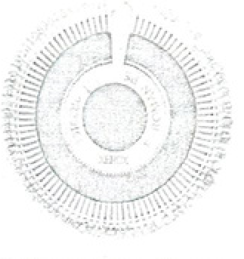


Fig. 56: Metal Daisy Wheel for Xerox

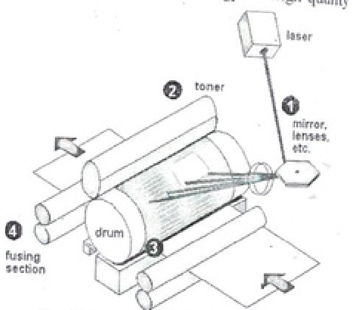


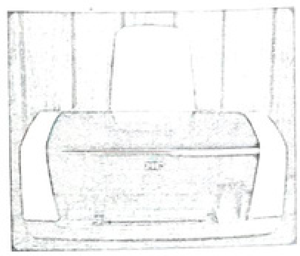
Fig. 57: Working of Daisy wheel printer

print. Dot-matrix impact or thermal printers were used where higher speed was required and poor print quality was acceptable. Both technologies were rapidly superseded for most purposes when dot-based printers-in particular laser printers-that could print any characters or graphics rather than being restricted to a limited character set became able to produce output of comparable quality. Daisy-wheel technology is now found only in some electronic typewriters. Like all other

impact printers, daisy wheel printers are noisy. Although the daisy wheel principle is basically inappropriate for printing bitmap graphics, there were attempts to enable them to do so. Most daisy wheel printers supported a relatively coarse and extremely slow graphics mode by printing the image entirely out of full stops.

3. Inkjet Printer

Inkjet printers operate by propelling variably-sized droplets of liquid or molten material onto almost any sized page. They are the most common type of computer printer for the general consumer due to their low cost, high quality of output, capability of printing in different colors, and ease of use.Like most modern technologies, the present-day inkjet has built on the progress made by many earlier versions. Among many contributors, Epson, Hewlett-Packard and Canon can claim a substantial share of the credit for the development of the modern inkjetThe emerging ink jet material deposition market also uses ink jet technologies.There are three main technologies in use in contemporary inkjet printers: thermal, piezoelectric, and continuous.The ink used is known as aqueous (i.e. water-based inks using pigments or dyes) and the print head is generally cheaper to produce than other inkjet technologies.



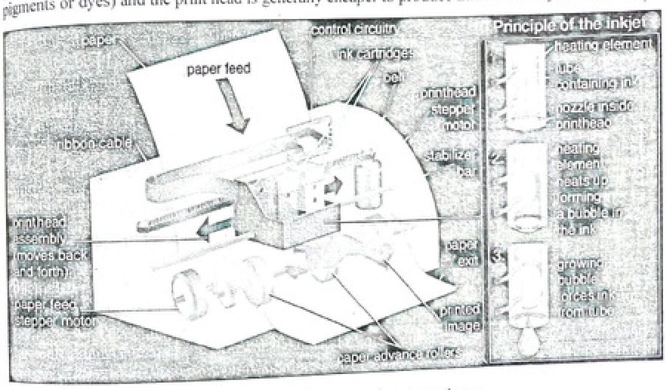


Fig. 58: Block Diagram Inkjet printer

Advantages

Compared to earlier consumer-oriented color printers, inkjets have a number of advantages. They can print finer. They are quieter in operation than impact dot matrix or daisywheel printers.

smoother details through higher printhead resolution, and many consumer inkjets with photographic-quality printing are widely available.In comparison to more expensive technologies like dye sublimations, and laser printers, inkjets have the advantage of practically no warm up time and lower cost per page. For some inkjet printers, monochrome ink sets are available either from the printer manufacturer or third-party suppliers. These allow the inkjet printer to compete with the silver-based photographic papers traditionally used in black-and-white photography.

Disadvantages

There are various advantages of the inkjet printer. The ink is often very expensive. (For a typical OEM cartridge priced at $15, containing 5 mL of ink, the ink effectively costs $3000 per liter--or $8000 per gallon.) According to the BBC (2003.Many "intelligent" ink cartridges contain a microchip that communicates the estimated ink level to the printer; this may cause the printer to display an error message, or incorrectly inform the user that the ink cartridge is empty. In some cases, these messages can be ignored, but some inkjet printers will refuse to print with a cartridge that declares itself empty, in order to prevent consumers from refilling cartridges. The lifetime of inkjet prints produced by inkjets using aqueous inks is limited; they will eventually fade and the color balance may change. On the other hand, prints produced from solvent-based inkjets may last several years before fading, even in direct sunlight, and so-called "archival inks" have been produced for use in aqueous-based machines which offer extended life. Because the ink used in most consumer inkjets is water-soluble, care must be taken with inkjet-printed documents to avoid even the smallest drop of water, which can cause severe "blurring" or "running." Similarly, water-based highlighter markers can blur inkjet-printed documents. The ink consumed cleaning them - either during cleaning invoked by the user, or in many cases, performed automatically by the printer on a routine schedule - can account for a significant proportion of the total ink installed in the machine.

Even with many available options for cost-reduction, inkjet printing using desktop printers is costly over time due to expensive replacement ink cartridges with much lower capacity than laser-printer cartridges. Major applications where these printers are used are for outdoor settings for billboards, truck sides and truck curtains, building graphics and banners, while indoor displays include point-of-sales displays, backlit displays, exhibition graphics and museum graphics.

4. Line Printer

The line printer is a form of high speed impact printer in which one line of type is printed at a time. They are mostly associated with the early days of computing, but the technology is still in use. Print speeds of 600 to 1200 lines-per-minute were common.

There are Four principal of designs existed:

- Drum printers
- Chain (train) printers
- Bar printers
- Comb printers

In a typical **drum printer** design, a fixed font character set is engraved onto the periphery of a number of print wheels, the number matching the number of columns (letters in a line) the printer could print. Chain printers (also known as **train printers**) placed the type on moving bars. As with the drum printer, as the correct character passed by each column, a hammer was fired from behind the paper. Compared to drum printers, chain printers had the advantage that the type chain could usually be changed by the operator. **Band printers** are a variation of chain printers, where a thin steel band is used instead of a chain, with the characters embossed on the band.

Bar printers were similar to chain printers but were slower and less expensive. Rather than a chain moving continuously in one direction, the characters were on fingers mounted on a bar that moved left-to-right and then right-to-left in front of the paper. An example was the IBM 1443. **Comb printers**, also called line matrix printers, represent the fourth major design. These printers were a hybrid of dot matrix printing and line printing. In these printers, a comb of hammers printed a portion of a row of pixels at one time. By shifting the comb back and forth slightly, the entire pixel row could be printed (continuing the example, in eight cycles). The paper then advanced and the next pixel row was printed.

All line printers used paper provided in boxes of continuous fan-fold forms rather than cut-sheets. The paper was usually perforated to tear into cut sheets if desired and was commonly printed with alternating white and light-green areas, allowing the reader to easily follow a line of text across the page. This technology is still in use in a number of applications. It is usually both faster and has lower total cost of ownership, including purchase price, consumables, paper, and maintenance, than laser printers. Line printers continue to be used for printing box labels, medium volume accounting and other large business applications,. Multi-part paper forms printed in one operation are sometimes useful. The the limited character set, fixed character spacing, and relatively poor print quality make impact line printers unsuitable for correspondence, books, and other applications requiring high print quality.

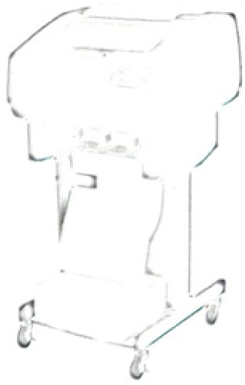


Fig. 59: Line Printer

5. Label Printer

A **label printer** is a computer printer that prints on self-adhesive label material and/or card-stock (tags). Label printers with built-in keyboards and displays, for stand-alone use (without a computer), are often called label makers. Label printers are different from ordinary printers because they need to have special feed mechanisms to handle rolled stock, or tear sheet (fanfold) stock. Common connectivity for label printers include RS-232 serial, Universal Serial Bus, parallel, Ethernet.Label printers have a wide variety of applications, including supply chain management, retail price marking, packaging labels, blood and laboratory specimen marking, and fixed assets management.

Types of Label Printers

- **Desktop label printers** are generally designed for light- to medium-duty usage with a roll of stock up to 4" wide. They are quiet and inexpensive.
- **Commercial label printers** can typically hold a larger roll of stock (up to 8" wide) and are geared for medium-volume printing.
- **Industrial label printers** are designed for heavy-duty, continuous operation in warehouses, distribution centers, factories and large organization.
- **Industrial portable label** printers are designed for heavy-duty operation on location. Examples of applications are labeling for electrical installations, construction sites, where

there are no computers.

- **RFID readers** are specialized label printers that print and encode at the same time on RFID transponders (tags) enclosed in paper or printable synthetic materials. RFID tags need to have printed information for backwards compatibility with barcode systems, so humans can identify the tag.
- **Personal label printers or label makers** are handheld or small desktop devices. They are intended for home office, small office, or small businesses use. The cost of the printers is generally very low, making them popular with low volume users.

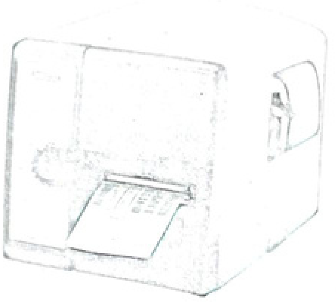


Fig. 60: Label Printer

6. Laser Printer

The laser printer was invented at Xerox in 1969 by researcher Gary Starkweather.**A laser printer** is a common type of computer printer that rapidly produces high quality text and graphics on plain paper. As with digital photocopiers and multifunction printers (MFPs), laser printers

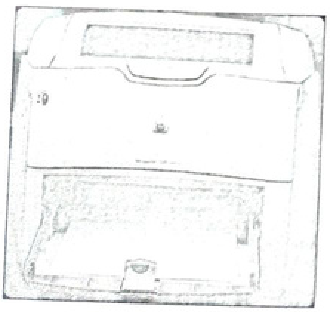


Fig. 61: LASER Printer

LASER PRINTER COMPONENT

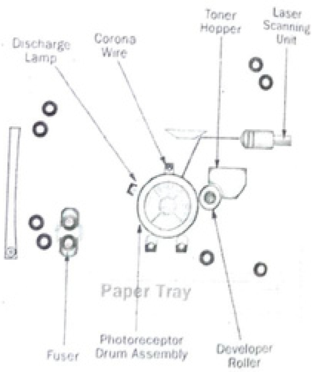


Fig. 62 : Component of LASER Printer

employ a xerographic printing process but differ from analog photocopiers in that the image is produced by the direct scanning of a laser beam across the printer's photoreceptor. Laser printers have many significant advantages over other types of printers. Unlike impact printers, laser printer speed can vary widely, and depends on many factors, including the graphic intensity of the job being processed. In comparison with the laser printer, most inkjet printers and dot-matrix printers simply take an incoming stream of data and directly imprint it in a slow lurching process that may include pauses as the printer waits for more data. A laser printer is unable to work this way because such a large amount of data needs to output to the printing device in a rapid, continuous process.

Most consumer and small business laser printers use a toner cartridge that combines the photoreceptor (sometimes called "imaging drum") with the toner supply bin, the waste toner hopper, and various wiper blades. When the toner supply is consumed, replacing the toner cartridge automatically replaces the imaging drum, waste toner hopper, and wiper blades.Some laser printers maintain a page count of the number of pages printed since last maintenance. On these models, a reminder message will appear informing the user it is nearing time to replace standard maintenance parts.

7. Thermal Wax Transfer Printer

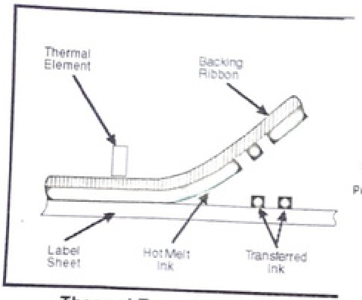
A thermal transfer printer is a printer which prints on paper by melting a coating of ribbon so that it stays glued to the material on which the print is applied. It contrasts with Direct Thermal printing where no ribbon is present in the process. It was invented by SATO corporation around the late 1940s.Usage of TT printers in industry includes:

- barcode labels (as labels printed with thermal printer tend not to last long), or for marking clothing labels (shirt size etc)
- Printing plastic labels for chemical containers (because the cheaper types of plastic would melt in a laser printer)

Barcode printers typically come in fixed sizes of 4 inches, 6 inches or 8 inches wide etc. Although a number of manufacturers have made differing sizes in the past, most have now standardised on these sizes. The main application for these printers is to produce barcode labels for product and shipping identification.The printers use a fixed width thermal print head, pressing onto a paper or plastic label, over a driven rubber roller called a platen.

Between the print head and the label is sandwiched a very thin thermal transfer ribbon (or sometimes called "foil"), which is a polyester film which has been coated on the label side with a wax, wax-resin or pure resin "ink". Thermal printing technology can be used to produce color images by adhering a wax-based ink onto paper. As the paper and ribbon travel in unison beneath the thermal print head, the wax-based ink from the transfer ribbon melts onto the paper. When cooled, the wax is permanently adhered to the paper. This type of thermal printer uses a like-sized panel of ribbon for each page to be printed, regardless of the contents of the page.

A working diagram of thermal wax printer is as follows:



Thermal Transfer Printing

Fig. 63

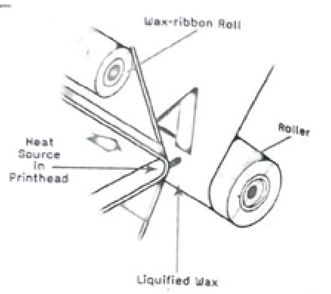


Fig. 64: Working diagram of thermal wax printer

8. IRIS Printer

An Iris printer is a large format color inkjet printer manufactured by the Graphic Communications Group of Eastman Kodak, which is used for digital prepress proofing. Iris printers use a continuous flow ink system to produce continuous-tone output on various media, including paper, canvas, silk,

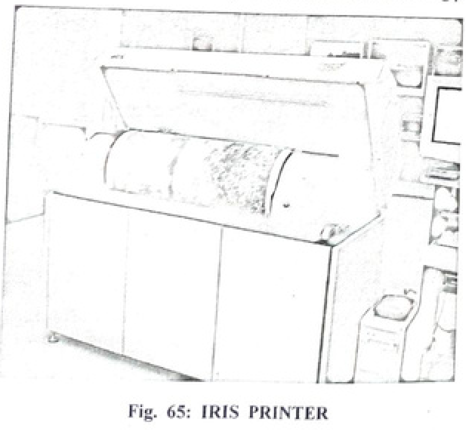


Fig. 65: IRIS PRINTER

linen and other textiles. the Iris printers' four 1 micrometre glass jets operate continuously under high pressure, vibrated by a piezoelectric crystal to produce drops at a 1 mHz rate. The prints are noted for their accurate color reproduction. Iris printers are also noted for the low cost of their consumables compared to other printing technologies. Prints produced by an Iris printer are commonly called "Iris prints", "Iris proofs", or simply "Irises".The Iris printer was originally developed by Iris Graphics. Iris printers are used in prepress proofing for color on printing jobs where color match is critical, such as commercial product packaging and magazine layout. Their output is used to check (proof) what the colors will look like before mass production begins. The Iris printer's connection with industrial printing meant the name "Iris print" was synonymous with a disposable prepress proof. Nash and Holbert came up with the name "digigraph" to try to distinguish their work from the industrial process.

9. DYE-SUBLIMATION PRINTER:

A **dye-sublimation printer** (or dye-sub printer) is a computer printer which employs a printing process that uses heat to transfer dye to a medium such as a plastic card, paper, or fabric. The process is usually to lay one color at a time using a ribbon that has color panels. Most dye-sublimation printers use CMYO colors which differs from the more recognized CMYK colors in that the black dye is eliminated in favour of a clear overcoating. Many consumer and professional dye-sublimation printers are designed and used for producing photographic prints.

Sublimation is when a substance transitions between the solid and gas states without going through a liquid stage; the action of dry ice exposed to room temperature is a common example. In a dye-sublimation printer the printing dye is heated up until it turns into a gas, at which point it diffuses onto the printing media and solidifies. Prior to printing, the dye is stored on a cellophane ribbon. The ribbon is made up of three colored panels (cyan, magenta, and yellow) and one clear panel which holds the lamination material for the overcoating. During the printing, the printer rollers will move the media and one of the colored panels together under a thermal printing head, which is usually the same width as the shorter dimension of the print media. Tiny heating elements on the head change temperature rapidly, laying different amounts of dye depending on the amount of heat applied. After the printer finishes covering the media in one color, it winds the ribbon on to the next color panel and partially ejects the media from the printer to prepare for the next cycle. The entire process is repeated four times in total: the first three lay the colors onto the media to form a complete image, while the last one lays the laminate over top.

The advantage of dye-sublimation printing has been the fact that it is a continuous-tone technology, where each dot can be any color. In contrast, inkjet printers can vary the location and size of ink droplets, a process called dithering, but each drop of ink is limited to the colors of the inks installed.Dye sublimation offers advantages over inkjet printing. For one, the prints are dry and ready to handle as soon as they exit the printer. Since the thermal head doesn't have to sweep back and forth over the print media, there are fewer moving parts that can break down. As the dye never enters a liquid phase, the whole printing cycle is extremely clean; there are no liquid inks to clean up and no print heads to get clogged. These factors make dye-sublimation generally a more reliable technology over inkjet printing. Dye-sublimation printers have some drawbacks compared to inkjet printers. Each of the colored panels of the ribbons, and the thermal head itself, must match the size of the media that is being printed on. Furthermore, only specially-coated paper can accept the sublimated ink. This means that dye-sublimation printers cannot match the flexibility of inkjet printers in printing on a wide range of media.

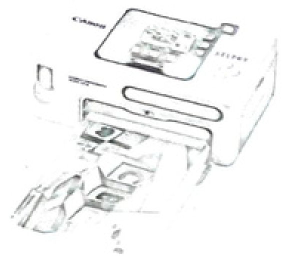


Fig. 66 : Dye-Sublimation printer

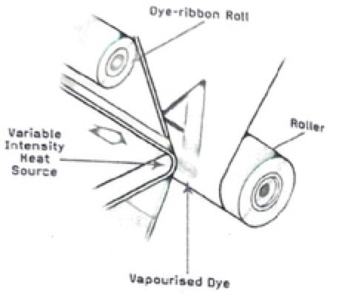


Fig. 67: Working diagram of Dye -Sublimation Printer

10. Fiery Printer

"Fiery" is usually software that is used for graphics processing to a production printer or plotter. Printers using fiery software are usually in the $1,500.00 and up bracket all the way to production presses at 100's of thousands each.

Fiery isn't really the printer but actually a software to drive a printer. Better systems are actually provided on a server that is dedicated and hooked to whichever machine the software is going to control.

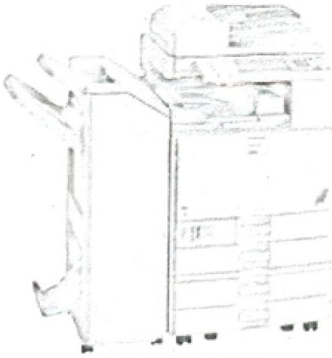


Fig. 68 : Fiery Printer

I/O Cards in Personal computers

A PC card network adapter	
Year	1990
Superseded by	Expressed Card (2003)
Width in bits	32
Number of devices	1 per slot
Speed	133 MB/s
Style	Parallel
Hot plugging interface	Yes
External interface	Yes

In computing, PC card is a form factor peripheral interface designed for laptop computers. Originally introduced as PCMCIA card, the PC card standard as well as its successors like cardbus were defined and developed by the personal computer memory card International Association (PCMCIA).

It was originally designed as a standard for money-expansion cards for computer storage.

5.7. Introduction Microprocessor

The microprocessor (also known as the processor, central processing unit, or CPU) can be thought of as the Brain of a computer. The business of computers in numbers, and the microprocessor is where numbers are crunched. Physically, they are little black or gray boxes a little larger than saltiness. The CPU determines the identityof you computer more so than anything else. Computewr systems are typically listed and named with the name and speed of the CPU they contain.

A microporcessor is an integrated circuit built on a tiny piece of silicon. It contains thousands, or even millions, of transistors, which are interconnected via superline traces of aluminum, The transistors work together to store and manipulate data so that the microprocessor can perform a wide variety of usuful functions. The particular function a microprocessor performs are dictated by software. Intel's first micrporocessor was the 4004. It was introduced in 1971, and contained 2,300 transistors. Today's Pentium (r) II processor, by contrast, contains 7.5 million transistros. One of the most common tasks microprocessors perform is to serve as the "brains" inside personal computers, but they deliver "intelligence" to countless other devices as well. For example, they may give you telephone speeddial and redial options, automatically turn down your house's thermostat at night, and make your car safer and more energy efficient.

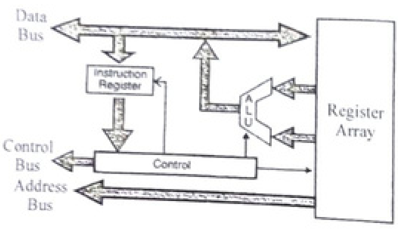


Fig. 69 : The internal representation of a microporcessor.

A microprocessor is a complete CPU on a single IC chip...i.e., a chip that contains the control unit, ALU, and memory. I/O units, additional memories, and possibly other equipment are connected externally to the CPU. The microprocessors of the intel Corp, such as 80386, 80486 and Pentium, and those of the motorola Corp., such as 68030 and 68040, are popular high performance microprocessor. Such chips have been used in personal computers, workstations, minicomputers, and massively parallel computers but usually are not incorporated into supercomputers or mainframes.

Microprocessor chips with simpler system structures and lower perfomance are called microcontrollers they are used in numberous products such as home applicances (e.g., refrigerators and air conditioners), calculators such as ADD, which is the instruction to add a number stored in a specified memory address to a number residing in the ALU or STORE which is the instruction to store and number in the ALU into a specified memory address.

Each computer architecture has a unique instruction set that determines how the operations are actually executed by the computer hardware. The traditional complex instruction set Computer (CISC) has many instructions that do long, complex operations. In the 1980s, Reduced Instruction Set Computer became popular in microprocessors. RISC has fewer instructions, which do short, simple operations. Each RISC instruction is executed much faster than a CISC instruction; and computational tasks can be processed faster than with CISC, except for tasks that extensively use I/O units, RISC is preferable for scientific and engineering problems, while CISC is better for general computational problems such as business applications. There are also many sets of instructions that combine the attributes of CISC and RISC.

Fig. represents the generral architecture of many of the microporcessor that are available today. The internal architecture is composed of an instruction register, an arithmetic and logic unit (ALU), a register array and a control circuit that coordinates the operation of the microprocessor.

The control logic causes the microprocessor to perform its two main functions, the fetch, or acquisition and execution phases of operation. The fetch phase causes the microprocessor to send the address of the next instruction to be executed out of the device through the address bus. The control logic then causes the memory to read information from the addressed location by sending a MEMORY READ single out through the control bus. Data is fetched into an internal register called

an 1, or insturction register which holds the instruction while the control logic decodes it, begins executing it. One other very important event occurs during the fetch sequence: the program counter is incremented so that the next fetch phase will fetch the next sequential instruction from the memory. This is the basic sequence of events required to fetch an instruction from the memory and to begin executing it.

The program counter is a register located within the register array that is used by the microprocessor of track the program. Each memory location in a computer system is numbered so that the program counter can address the next step in a program. In this fashion the program counter counts up through the program to locate each subsequent step or instruction.

5.8 Microcontroller

A microcontroller (sometimes abbreviated μC, 4C or MCU) in a small computer on a single integrated circuit containing a processor core, memory and programmable intput/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip as well as a typically small amount of RMA.

Microcontroller are designed for embedded applications, in contrast to the microprocessor used in personal computers or other general purpose applications.

Microcontrollers are used in autematically controlled products and devices such as automobile engine control system, inplantable medical devices, remote controls office machines, appliances, power tools, toys and other embedded system. By reducing the size and cost compared to a design uses a seperate microprocesor memory and input/output devices, microcontroller make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common integrating anolog components needed to control non digital electronic systems.

Some microcontroller may used four bit words and operate at clook rate frequencies as low as 4 KHz, for low power consumption. They will generally have the ability to retain functionality while waiting for a event such as butten dpress or other interrupt power consumption while sleeping (CPU clock and most peripherals off) may just nanowatts, making may of them well ruited for long lasting battery application other microcentroller may some performance caritical roles where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

5.9. Microprocessor of 8080/8085/Z80 Family

This section deals with the 8080 and 8085 microprocessors from intel and the Z80 microprocessor manufactured by the zilog Corp.

The 8080 and 8085 are nearly identical the 8085 being a slightly improved version of the 8080. Except for two instructions the instruction sets for the two chips are identical.

The Z80 is a considerably enhanced version of the 8080. It understands all the instruction of the 8080 and many more. It has all the registers of the 8080 plus a number of additional registers. We will cover only those aspects of the Z80 that are found in the 8080 and 8085 at this time.

Accumulator

The 8080/8085/Z80 chips have one 8-bit accumulator. It operates as described in the New Concepts section of this chapter. Its operation is shown in Fig. 3.18. The Z80 also has a second alternate accumulator.

Fig. 70 : 8080/8085/Z80 accumulator model

General Purpose Registers

The 8080/8085/Z80 chips have an abundance of general purpose registers. These registers are arranged in pairs. Notice the arrangement of one of these pairs in Fig. 3.22.

In this Fig. 8 bits of data can go into and out of either registewr B or C. or. 16 bits can go into and out of the pair. at which point they act as one 16 bit register.

There are three sets of these general purpose register pairs. They are the BC pair, the DE pair, and the pair. The letters B. C. D and E are assigned to stand for each register. The letters H and L stand for high and low. The HL register pair is usually used for a different purpose than the other two pairs. We will discuss that purpose more in a later chapter.

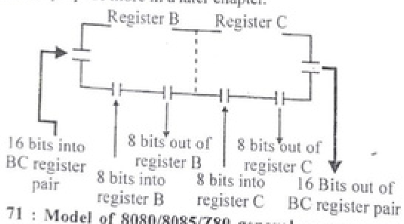


Fig. 71 : Model of 8080/8085/Z80 general purpose registers

Each of these registers has a mate, or "alternate" register in the Z80.

Program Counter

The 8080/8085/Z80 chips each have a 16 bits program countewr which sperates as described in the new concepts section of this chaper. This program counter, as is the case with the 6502 family and the 8800 family, is divided into two halves for some operations. The upper byte or 8 bits are called the PCn (for program counter high), and the lower byte is called the PCL (program counter low).

Most of the time the program counter operates as one 16 bit counter but there are times, particularly when subroutines are involved when division into 2 bytes is necessary. The display for the program counter will appear as four hexadecimal digits.

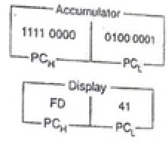


Fig. 72 : Sixteen bit 8080/8085/Z80 program counter and display

Index Register (s)

The 8080 and 8085 have no index registers. The Z80 has two an X index register and a Y index registor. The index registers in the Z80 are each 16 bits wide.

Status Register

The status register in the 8080 and 8085 contains five flags in an 8-bit register. See fig. 3.24. The Parity flag involves a topic which has not been discussed yet. Parity refers to the number of 1s in a binary number. Even parity axists when there is a even number of 1s. For example the binary number 0110 000 has even parity because it has two 1s and 2 is an even number. Odd parity exists when there is an odd number of 1s. For example, the binary number 0111 0000 has odd parity because there are three 1s and 3 is an odd number. It is sometimes useful to keep track of parity for errorchecking routines and in data communications. If the parity is even, the parity flage becomes set (1); if parity is odd, it clears (0).

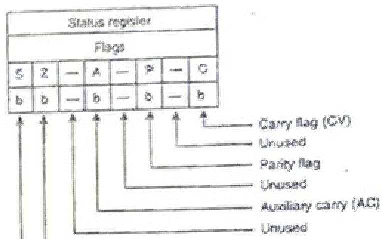


Fig. 73 : 8080/8085 status register, (b's represent bits)

inside the 8085 there are 10 seperate register. They are called A, B, C, D, E, H, L, PSW, PC and SP. All but the PSW, PC and SP registers are used for temporary storage of whatever is needed by the program. The accumulator called A is also different from the other registers. It is used to accumulate the results of various instruction like add or sub (subtract). The program Counter (PC) we have already mentioned while the stack pointer (SP) actually holds addresses and is 16 bits wide. All rthe others are 8 bits wide.

Complete Model

Let's look at a complete model of the 8080/8085/Z80 family of microprocessor. Refer to Fig. at this time.

A Couple of points conceming differencesa between the 8080/8085 and the Z80 should be noted. Fig. is a model of the 8080/8085. The Z80 has a additional set 0 ; alternate registers and two index registers which are not shown in the model. The status register in the Z80 has an additional flag called the negative flag. And the auxillary carry flag in the 8080/8085 is usually called the half-carry flag in the Z80.

In our model we will not show the binary numbers that are actually in each register or location but rather than hexadecimal numbers which appear in the display of microporcesor trainers. The exception is the status registering which both binary and hexadecimal are shown. The small h's and b's represent the data that would be in each register or memory location. Each "h" stands for one hexadecimal digit or nibble, which is to say 4 bits. Each "b" stands for 1 bit. When we use this model in later chapters, we will place actual values in place of the h's and b's.

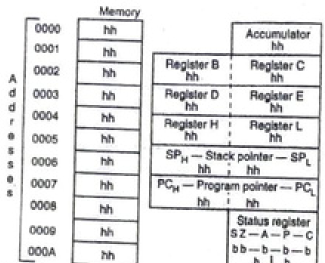


Fig. 74 : Complete 8080/8085 and Z80 (8080 subset) programming model.

There is one point of singificant difference between the 8080/8085/Z80 family and the 6502 or 6800 family. In the case of the 6502 and 6800 microprocessors, the register and accumulators are completely independent of one another. In the 8080/8085/Z80 family, the six registers namely B and C, D and E and H and L, can operate as six independent 8-bit registers or as three 16-bit register pairs. This allows single operations to be performed on 16-bit data words.

8086/8088 Family

In this section we will examine the 8086 and 8088 microprocessors from intel. The 8088 is the microprocessor used in the popular IBM PCs, XTs, and compatibles. The 80286 used in ATs and the 50386 can also be used with this text.

5.10 Addressing

A memory's address is something like we use in our real life. Everybody's house has got an address to identify its location. Every house is given a unique address which is not repeated. Inside someone's house there are tables, chairs, TV and other belongings. Notiee here that your home's address and your home's contents are not the same.

Each memory location ahs an address and contents. The address is necessary to specify which memory location to read information from or write information into. The contents is the information itsetself.

Typically memory addresses are numbered from 0000 (inhexadecimal) to the highest location say in some particular case FFFF. This sequential number is called address.

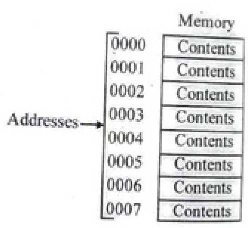


Fig. 75 : Memory Addressing

A computer's memory stores all of the data currently being processed as well as the program that controls the processing. These data are stored in cells. In computers used for commercial applications each memory cell stores one byte of data. The size of a computer's memory is measured in terms of kilobytes or megabytes. Because "kilo" stands for 1,000 and "mega" stands for 1,00,000 computer memory is measured by the thousands or millions of bytes that can be stored in memory at

ne time. In computer usage, the prefix "kilo" actually stands for 1,024 bytes. Because computers e binary devices most of the numbers found in the internal operations of computers are powers of 2. A kilobytes, then, is $2^{10} = 1,024$ bytes. It is usually indicated with the initial K or sometimes, KB. Thus a computer with a memory size of 512 K is said to have a 512,000 byte main storage. Really it's 512×1024, or 524, 248 bytes. A memory with a capacity of one megabyte (abbreviated 1m or 1 MB) has $2^{20} = 1,024,576$ memory locations.

5.11. Difference between Microporcessor and Microcontroller

Microprocessor	Microcontroller
Read only memory (ROM); Read Write memory; Micro processor; System Bus; Serial Interface; Timer; I/O Port	Microcontroller; Read only memory; Read write memory; Timer; I/O port; Serial Interface
1. Microprocessor is heart of computer system	Microcontroller is heart of embedded system.
2. It is just a processor. Memory and I/O components have to be connected externally.	Micro controller has external processor along with internal memory and I/O components.
3. Since memory and I/O has to be connected externally the circuit become large.	Since memory and I/O are present internally the circuit is small.
4. Cannot be used in compact system and hence in efficient	Can be used in compact system and hence it is an efficient technique.
5. Cost of entire system increases	Cost of entire system is low.
6. Due to external components the entire power consumption is high. Hence it is not suitable to be used with devices running on stored power like batteries.	Since external components are low, total power consumption is less and can be used with device running on stored power like batteries.
7. Most of the microprocessor do not have power saving features.	Most of the microcontroller have power saving modes like idle mode and power saving mode helps to reduce power consumption even further.
8. Since memory and I/O components are all external each instruction will need external operation hence it is relatively slower	Since components are internal most of the operations are internal instruction hence speed fest.
9. Microprocessor have less number of register hence more operations are memory based.	Micro controller have more number of registers hence the programs are easier to write.
10. Microprocessors are based on von neuman model/architecture where program and data stored in some memory module.	Microcontroller are barked on haward architecture where program memory and data memory are seperate.
11. Mainly used in personal computers.	Used mainly in washing machine, MP3 Players.

5.12 RISC Vs CISC

Architectural Characteristic	RISC	CISC
Instruction-set size and instruction formats	Small set of instructions with fixed (32-bit) format and most register-based instructions (<100)	Large set of Instructions with variable formats (16-64 bits per instructions) (120-350)
Addressing modes	Limit to 3-5	12-24
General Purpose registers and cache design	Large numbers (32-192) of GPRS with mostly split data cache and instruction cache	8-24 GPRS, mostly with a unified cache for instructions and data, recent designs also use split caches.
Rate and CPI	50-150 MHz in 1993 with one cycle for almost all instructions and an average CPI < 1.5	33-50 MHz in 1992 with a CPI between 2 and 15.
CPU Control	Most hardwired without control memory	Most microcoded using control memory (ROM), but modern CISC also uses hardwired control.

EXERCISES

Very Short Answer Type Questions (2 Marks each)

1. What is auxiliary device ?
2. Cache memory is used in computer system to .... **(Raj. B.C.A. 2012)**
3. An external processessor which communicate direct with all I/O devices without any intervention of CPU is called .... **(Raj. B.C.A. 2009)**
4. Which part of the computer perform arithmetic calculations ?
5. A process is ....

Short Answer Type Questions (4 Marks each)

1. Define buses ? Explain different type of buses ?
2. What is interfacing keyboard ? Define it ? **(Raj. B.C.A. 2010)**

3. What is microprocessor ? Explain in brief ?
4. Differentiate between RISC and CISC? **(Raj. B.C.A. 2012)**
5. Differentiate between Microprocssor and Micro controller ?

Long Answer Type Questions (12 Marks each)

1. What do you mean by motherboard ? Explain its characteristics with 810 chipset. **(Raj. B.C.A. 2012)**
2. Explain different types of system buses ? **(Raj. B.C.A. 2011)**
3. What do you mean by printer ? Explain different types of printers.
4. What is Microprocessor and Microcontroller ? Explain the difference between this ?
5. Differentiate between RISC and CISC. **(Raj. B.C.A. 2012, 2011, 2010)**
6. Explain in detail 8085 microiprocessor.
7. What do you mean by memory management and describe methods of memory management ? **(Raj. B.C.A. 2012)**
8. Write short note :
   (a) Random Access Memory (RAM)
   (b) Auxiliary storage device
   (c) Microprocessor.
9. Differentiate between microcontroller and microprocessor.
10. Explain printers. Define different types of printers.

■■■