Draft Study material

Assistant Technician Computing And Peripherals

Qualification Pack - ELE/Q4609
Sector- Electronics

Class 10th

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION
(A constituent unit of National Council of Educational Research and Training, under Ministry of Education, Government of India)
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(Assistant Technician Computing and Peripherals)

(Job Role)

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Preface

Vocational Education is a dynamic and evolving field, and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation, and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives.

The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants, and all other people who contributed their expertise and insights to the creation of the draft study material.

Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material.

Deepak Paliwal
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Date: 17 Oct. 2024

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Module 1 Basic Electronics, Tools and Equipment

Module Overview

Electricity plays a pivotal role in modern society, powering the majority of electronic devices essential to our daily lives. The computer, a key electronic device, operates primarily on electricity, as do its peripheral devices. Ensuring a consistent and proper power supply is crucial for the optimal functioning of electronic equipment. To address this, protective measures such as surge protectors and uninterruptible power supplies (UPS) are employed, emphasizing the indispensability of electricity in the world of computing.

This unit delves into the foundational concepts of electricity, encompassing electrical quantities and the diverse array of electronic components. A critical aspect of this understanding involves the power supply, an electrical device dedicated to delivering the necessary operating voltage to computers. Power supplies for PCs necessitate a minimum load, with specific requirements like 7A at 5V and 6.5A at 12V. The power demands of modern PCs fall within the range of 60W to 250W, highlighting the importance of a reliable power source. Notably, the electronic components within computers demand very low DC voltage, underscoring the precision required in managing electrical power within the intricate computing environment. As technology advances, the synergy between electricity and computing remains integral to the seamless operation of electronic systems.

Learning Outcomes

After completing this module, you will be able to:

- Understand the fundamental principles of electronics, including voltage, current, and resistance.
- Identify and describe the functions of basic electronic circuit components, such as resistors, capacitors, and diodes.
- We learn to properly use tools, equipment, and measuring instruments to work with and analyze electronic circuits.

Module Structure

Session 1: The Basic Concepts of Electronics

Session 2. Electronic Circuit Components

Session 3. Use Tools, Equipment and Measuring Instruments

Session 1. The Basic Concepts of Electronics

Electricity has an important place in modern society. In the current age, most of the electronic devices work on electricity. Computer is electronic device which mainly works on electricity. The peripheral devices attached to the computer also work on electricity. It is necessary to provide the proper and continuous power to the electronics equipment to work properly. For this purpose, the surge protector and uninterrupted power supply (UPS) are used, which also works on electricity. Hence electricity has an important place in the world of computing and computer. In this Session you will understand the basic concept of electricity, electrical quantities and various electronic components.

1.1 ELECTRICITY

Electricity is the set of physical phenomena associated with the presence and flow of electric charge. Electricity gives a wide variety of well-known effects, such as lightning, static electricity, electromagnetic induction and electrical current.

1.1.1 Energy Foundation

Everything in the universe solid, liquid, gases are made up of atoms. Atoms are the building blocks of the universe. Atoms are so small that millions of them would fit on the head of a pin.

The centre of an atom is called the nucleus. Atoms consist of sub atomic particles – protons, electrons and neutrons. Electrons spin around the nucleus in shells a great distance from the nucleus. Protons carries positive (+) charge, electrons carry negative (-) charge, neutrons are neutral. The positively charge protons attract negatively charge electrons and hence holding the atomic structure as shown in Figure 1.1.

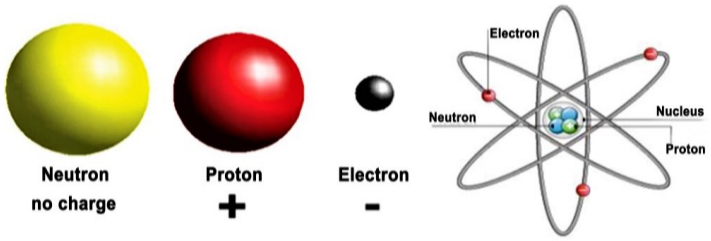


Fig.1.1: Atomic structure

1.2 Conductors and Insulators

When electrons move among the atoms of matter, an electric current is created. As in case of piece of wire, the electrons are passed from atom to atom, creating an electrical current from one end to another.

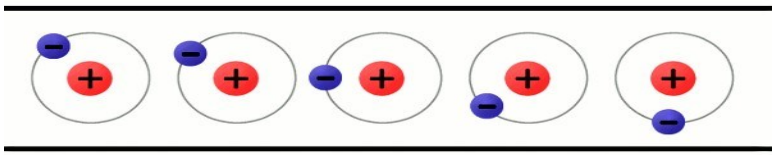


Fig.1.2 Atom in the wire which shows electrons travel from one atom to another atom

1.2.1 Conductors: The material, in which the electrons are loosely held, can move very easily. These are called conductors. The metals like copper, aluminium or steel are good conductors of electricity.

Fig.1.3 Different metal which can be used as conductors

1.2.2 Insulators: The materials which hold their electrons very tightly, do not allow to move the electrons through them very well. These are called insulators. Rubber, plastic, cloth, glass and dry air are good insulators and have very high resistance.

Fig.1.4 Different materials which can be used as an insulator

1.3 ELECTRICAL QUANTITIES

Current, voltage, and resistance are the three basic building blocks of electrical and electronics. These are called as electrical quantities.

1.3.1 Voltage

Voltage is the potential difference between two points. Voltage is also the amount of work required to move one coulomb charge from one point to another point. Mathematically it can be written as,

$V=W/Q$

where,

'V' is the voltage,

'W' is the work in joule,

'Q' is the charge in coulomb.

Value of voltage is measured in volt or joules per coulomb. Symbolic representation of voltage is **'V'** or **'v'**.

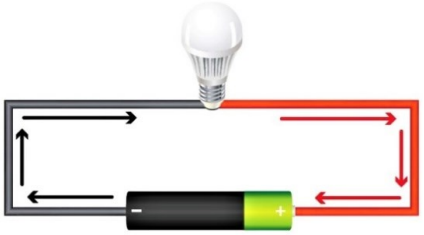


Fig.1.5 Voltage in the form of battery is applied across the LED bulb

1.3.2 Current

Electric charge often called as current. It is the flow of electrons. These electrons carry the charge. The electrons flow from one place to another. The amount of charge with electrons flowing from one place to another is called electric current in figure 1.7. Unit of current is ampere (A). Symbolic representation of current is 'I'or 'i'.

I= Q/t

Where,

'I' is the current,

'Q' is the amount of charge in coulombs

't' is the time in seconds

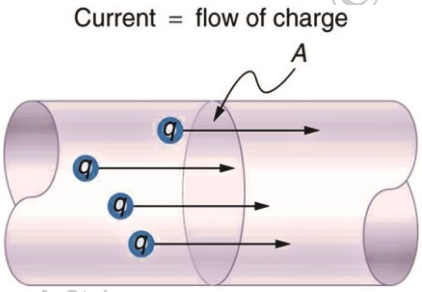


Fig. 1.6: Flow of charge through a cross section 'A'

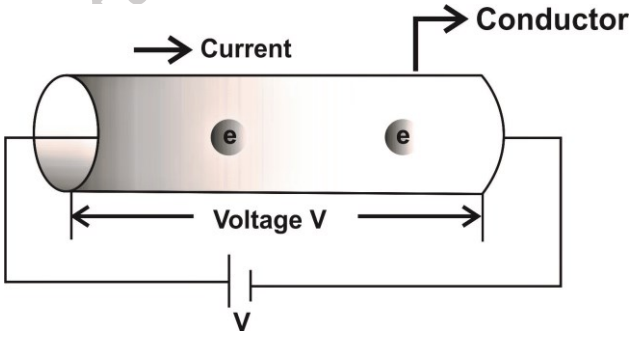


Fig.1.7 Flow of electrons in the conductor

1.3.3 Resistance

As its name suggests, it resists the flow of electron and hence electric current in the circuit. Conceptually the resistance controls the flow of electric current. The resistance is represented by the symbol "R". The SI unit of electrical resistance is the ohm (Ω).

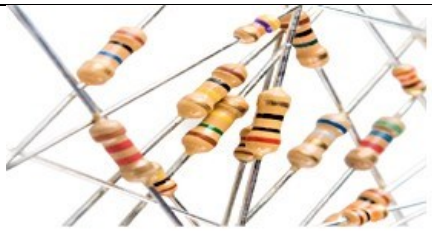


Fig.1.8 Resistor and its symbol

1.4 ELECTRONIC COMPONENTS – ACTIVE AND PASSIVE COMPONENTS

An electronic circuit is composed of various electronic components. Electronic components usually have two or more leads which can be fitted into the PCB to form a working electronic circuit. Electronic components are mainly classified into two classes – **Active and Passive components**.

Fig.1.9 Different types of components used in electrical and electronics

1.4.1 Active components: Active components produce energy in the form of Voltage or Current. These components are required external source for their operation. An active component has an analog electronic filter with the ability to amplify a signal or produce a power gain. Examples of active components are: Diode, Transistors.

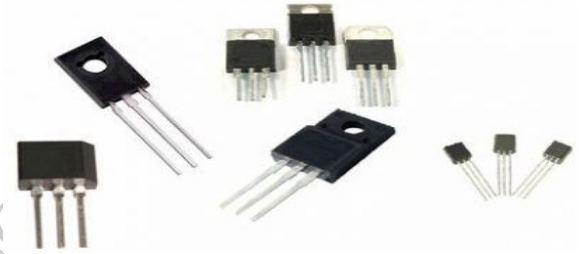
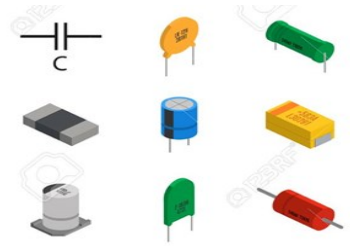
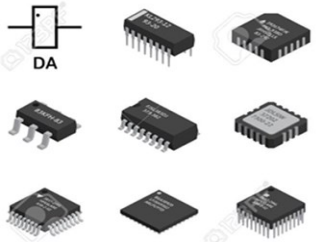
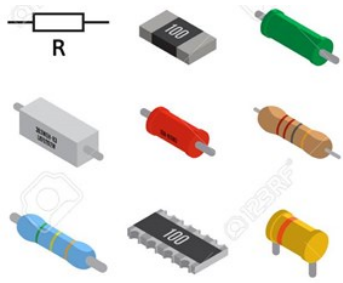


Fig.1.10 Active components

Fig.1.11 Passive components

1.4.2 Passive components: Passive components which do not produce energy in the form of Voltage or Current. They do not require external energy to operate. They cannot generate energy of their own and depend on the power provided from the AC circuit. Examples of passive components are Resistors, Capacitors, Inductors, Sensors, and Transducers as shown in figure 1.11.

Assignment: Identify the components used in electrical and electronics.	
Pictorial representation of the component	Write down the name and identify which category it belongs i.e. Active or Passive
	Name of component..... Active ☐ Passive ☐
	Name of component..... Active ☐ Passive ☐
	Name of component..... Active ☐ Passive ☐
	Name of component..... Active ☐ Passive ☐

1.5 PASSIVE COMPONENTS

1.5.1 Resistor

Resistors are the basic component in an electronic circuit which is used to generate Voltage and Current in the circuit. Resistor opposes movement of electrons. This opposition is called as resistance. Resistance is measured in ohms (Ω). The standard resistor values are 10 Ω, 12 Ω, 15 Ω, 18 Ω, 22 Ω, 27 Ω, 33 Ω, 47 Ω, 82 Ω.

Color bands on the resistors are used to represent the resistance values on each of the resistor. There are 4 band, 5 band and 6 band resistors.

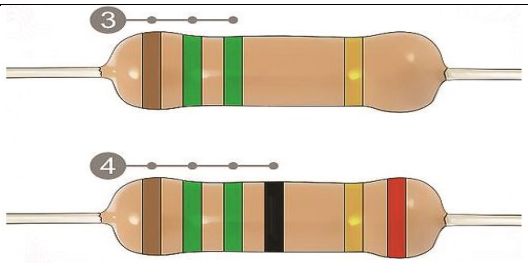


Fig. 1.12: 4 band and 5 band color coded resistor

In 4 band resistors as shown Figure 1.13, first and the second band represent the numerical value of the resistor, the third band is a multiplier to the power of ten and the fourth band is the tolerance level. In 5 bands resistor first three bands represent significant digit, forth band represents multiplier and fifth band represent tolerance.

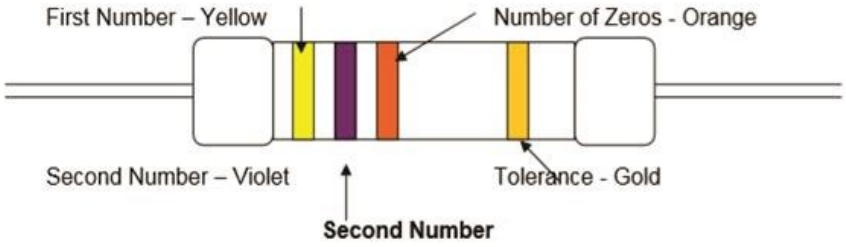


Fig. 1.13: Four band Resistor Specification

Each color on the color coded resister has the specific value as per the color scheme shown in figure 1.14.

Code	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

Fig. 1.14 Colour Code

The tolerance gives an upper and lower value the resistor must be in, take the following example for a 100Ω resistor:

Tolerance	Colour	Stated Resistor Value	Allowed Upper Value	Allowed Lower Value
+/- 1%	Brown	100Ω	101 Ω	99 Ω
+/- 2%	Red	100 Ω	102 Ω	98 Ω
+/- 5%	Gold	100 Ω	105 Ω	95 Ω
+/- 10%	Silver	100 Ω	110 Ω	90 Ω

Fig. 1.15 Tolerance value

Resistance calculation using Color Codes:

The resistance of the resister in figure 1.15 is calculated as:

First Band Yellow Second Band Violet Multiplier Number of zeros Third Band Orange, Tolerance Yellow = 4, Violet = 7, Orange = 3 number of zeros, Gold = 5% tolerance.

Hence Resistance = 47000 Ω (or 47 kΩ), 5% tolerance.

According to Ohm's Law, Power is calculated as the product of Voltage and Resistance.

Alphanumerically Coded (Surface Mounted) Resistors

Surface mounted resistors are rectangular in shape as shown in figure 1.16(a). Surface mount resistor have leads which are coming out from the resistor, these leads are used for mounting of resistor on the PCB. Some surface mount resistor uses plates on the bottom side of resistor.

Fig. 1.16 (a) **Fig. 1.16(b)**

The first 2 or 3 numbers printed on the surface mount resistor represents significant digits and the last digit represents the number of zero that should follow. For example, as shown in figure 1.16(b), a resistor reading 1252 indicates a value 125200 ohm, for tolerance value use the letter at the end of the code.

Compare the letter at the end of the code with the tolerance it represents as shown in figure 1.16(b).

There are two types of resistor, they are Fixed Resistor and Variable Resistor

Fixed resistor:

The resistors made up of ceramic body and are cylindrical in shape with definite or fixed resistance values are fixed resistors. The resistive element could be either carbon film, thick film or a wound wire element. The properties of fixed resistors depend upon the type of fixed resistor used.

- Based on the type of material used in constructing a resistor it is classified into: Carbon composition, carbon pile, carbon film, metal film and metal oxide film.

- Carbon Composition is made up of carbon clay composition with plastic coating around it.
- Carbon Pile is made up of a stack of carbon disks compressed between two metal contact.
- Carbon film is deposited on an insulating substrate and cut into thin resistive path.
- Metal Film is cylindrically shaped and coated with Nickel Chromium.
- Metal Oxide Film is made up of tin oxide.
- A carbon film resistor has 5% tolerance, power rating of 0.125W–2W, Temperature coefficient of 250-450 ppm/k.
- A metal film resistor has 1% tolerance, power rating of 0.1–5W and Temperature coefficient of 10-250ppm/K.

Fig.1.17 (a) Fixed resistor **Fig.1.17 (b) Variable resistor**

Variable resistor

Variable Resistors are the resistors in which the resistance can be continually altered and is not fixed. A variable resistor has 3 terminals out of which 2 are connected to the ends of the track and a third terminal is connected to the wiper. The motion of the wiper allows in increasing and decreasing resistance. Potentiometer, Rheostat and Trim Pot are the variable resistor as shown in figure 1.17.

Assignment: Calculate the value of resistors by using color code.

Brown-black-yellow-yellow

Yellow-violet-red-yellow

Red-red-brown-yellow

1.5.2 Capacitor

A capacitor is a passive electronic component used to store electric charge. The unit for measuring capacitance is Farads. In a capacitor energy is stored in the form of electric field. Capacitor have two parallel sections, between this section energy is stored. The standard capacitor values are 1, 10,100, 510, 910pF. Capacitors are also marked with color bands to denote value. The first 2 bands are the first and second digit whereas the third band denotes the multiplier. The capacitor and its symbol are shown in figure below.

Fig. 1.18 (a) Capacitor (b) Capacitor Symbol

The capacitance of capacitor can vary from – 20% to +80% of actual capacitance. The parameters of capacitor are maximum voltage, capacitance, tolerance. Maximum voltage defines the maximum voltage value of capacitor. The figure 1.19 shows the various parameters of a capacitor.

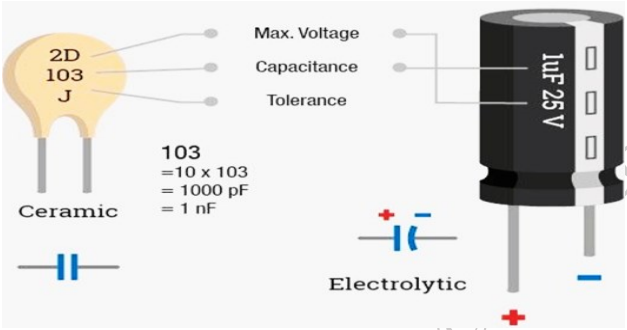


Fig. 1.19 Parameters of capacitor

The capacitor is marked with the value of capacitance and voltage. You can calculate the amount of charge in the capacitor with the equation Q= C x V

Where, Q= Charge in coulomb

C= Capacitance in farad

V= Voltage in volt

Types of Capacitors

There are various types of capacitors based on the type of materials used in the capacitor plates. They are Ceramic Capacitors, Film Power Capacitors, Super Capacitors and Variable Capacitors.

- **Ceramic Capacitors:** Ceramic capacitors are made up of ceramic and metal where metal acts as the electrode and ceramic is the dielectric. This type of capacitor is used in applications of high frequency and high current pulse loads.
- **Film Power Capacitors:** In film power capacitors, the dielectric films are drawn to a thin layer surrounded by metallic electrodes on a cylindrical wiring. Polypropylene is used as the dielectric.
- **Super Capacitors:** Super capacitors are electrochemical capacitors with no specific dielectric in it. The storage of charge is obtained by either separation of charge or redox reactions.
- **Variable Capacitors:** All the above-mentioned capacitors are fixed capacitors which cannot vary their capacitance. A variable capacitor can vary its capacitance by mechanical motion.

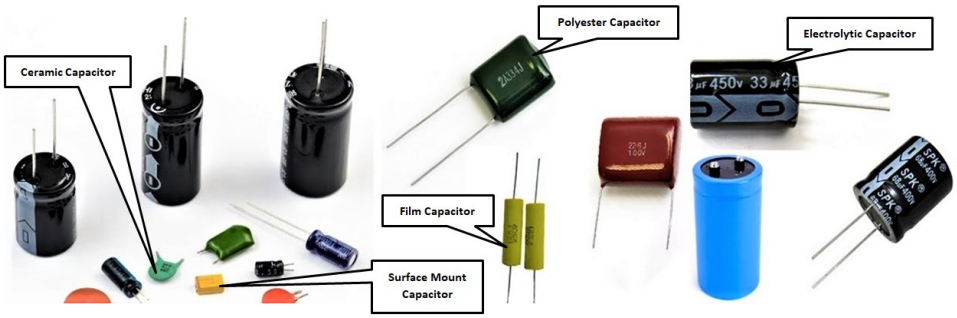


Fig.1.20 Different types of capacitors

1.5.3 Inductor

An inductor is a two terminal electric component which resists changes in electric current. The value of inductance is measured in Henry. Inductive tolerance is usually in the range of -5% to +20%.

Inductor is a conductor wire wound into coil. Inductors are made up of insulating wire like copper wire wound on a plastic or ferromagnetic material. The inductor and its symbol is shown in figure 1.21.

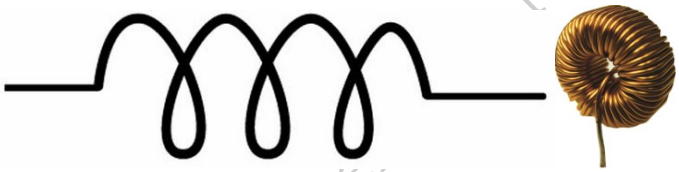


Fig. 1.21 (a) Inductor (b) Symbol of inductor

When current flows through the coil, a magnetic field is set. This field restricts the flow of current. Once the field is created then current passed normally through it thus resisting any change in the flow of current.

Types of inductor

The types of inductors are: Air core inductor, Ferromagnetic core inductor, variable inductor.

Air core inductor: It has its coil wound on non-magnetic material like plastic or ceramic and there is only air present in between the windings.

Ferromagnetic inductor: It has its coil wound on a magnetic core made up of ferromagnetic or ferromagnetic material.

Variable inductor: It is made up of ferrite magnetic core which can be slid or screwed to change inductance.

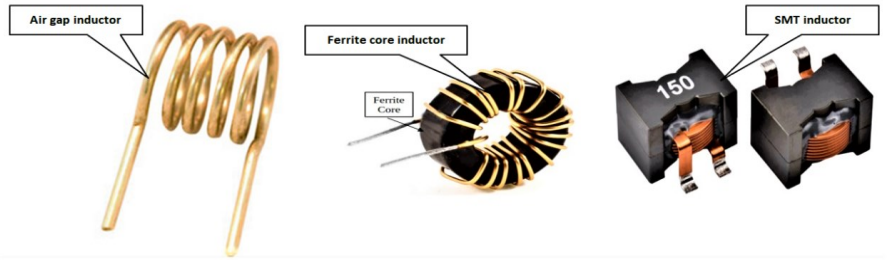


Fig.1.22 Different types of inductor

TRANSFORMER

Transformer is an electric unit that transfers energy between two circuits using Electromagnetic Induction. It is a static unit that simply transforms the voltage level of an AC signal. It either step-up or step down the AC voltage. Transformer does not change the frequency of applied AC signal.

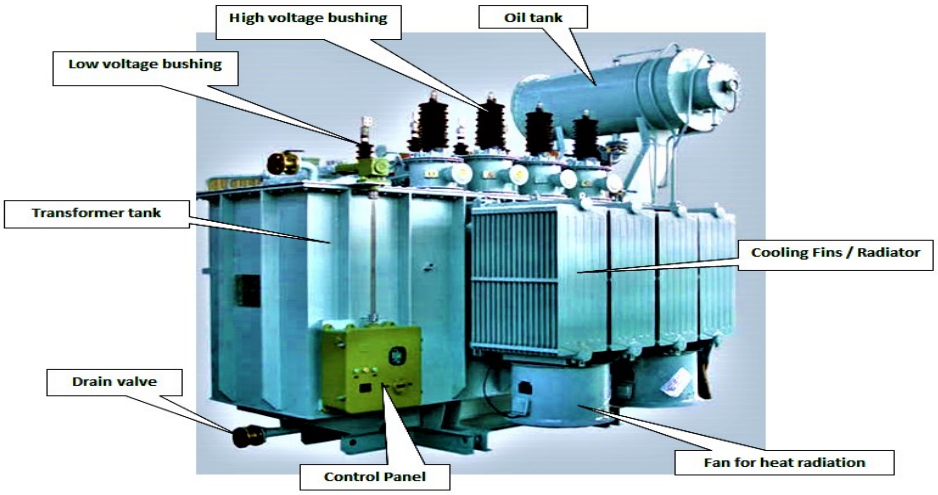
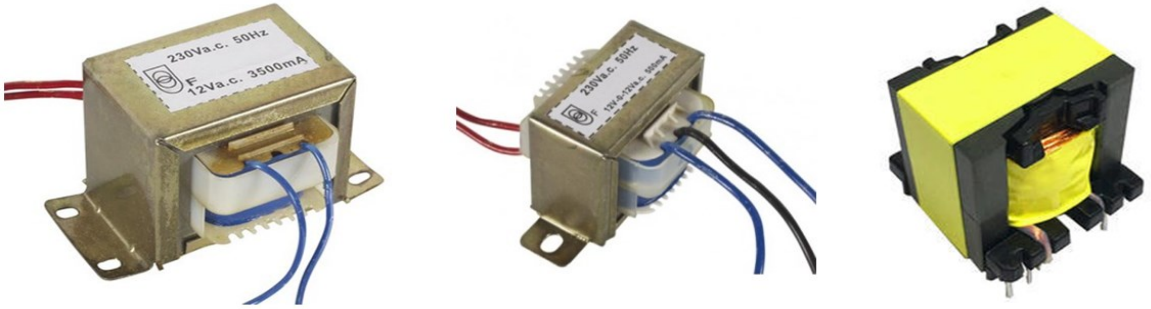


Fig. 1.23 Transformer Parts

Transformer consists of a core made up of ferromagnetic or ceramic material and a coil made up of some insulating magnetic material or copper wires. Transformer oil is used for cooling transformer.

Based on the purpose, there are different types of transformer such as Power transformers, Instrument transformers, RF transformers, Audio Transformers. However, in computers the step-down transformer, center-taped and high frequency transformer are used.



Step-down transformer Center tape transformer High frequency transformer

Fig. 1.24 Different types of transformer

Fuse: A fuse is a protective device employed to safeguard electrical systems from excessive current. It acts as a safety mechanism by interrupting the circuit in the presence of an overcurrent, preventing potential damage to electronic components or the system itself. Fuses consist of a conducting material that melts when current surpasses a predetermined threshold, breaking the circuit and halting the flow of electricity. This fundamental role in preventing electrical overloads makes fuses essential components in various applications, ensuring the

reliability and longevity of electrical systems, as shown figure 1.25.

Fig. 1.25: fuse

1.6 ACTIVE COMPONENTS

The basic material used to manufacture the active components is semiconductor. Let us first understand the basics of semiconductors.

1.6.1 Semiconductor

Semiconductors are materials whose conductivity has between conductors and insulators. Electronics device are made up of semiconductor material. In semiconductor industry silicon and germanium are used. Semiconductors materials are of two types which are as follows:

Intrinsic (pure), it is a pure form of a semiconductor. The pure word here specifics that this semiconductor does not contain any other impurity atom.

Extrinsic (impure), when impurity atoms are added in the pure (intrinsic) form of semiconductor, then that semiconductor is called as extrinsic semiconductor. The extrinsic semiconductors are also known as impure semiconductor.

- When pentavalent impurity atom is added an extrinsic semiconductor is formed which is known as **P-type semiconductor.**
- When trivalent impurity atom is added an extrinsic semiconductor is formed which is known as **N-type semiconductor.**

1.6.2 Diode

A diode is an electronic device which allows current to flow easily in the circuit. The most common form of diode is P-N junction diode.

When two semiconductors i.e. P-type semiconductor and N-type semiconductor are combined to form new component, which is known as **diode**. The diode and its symbol are shown in figure 1.26.

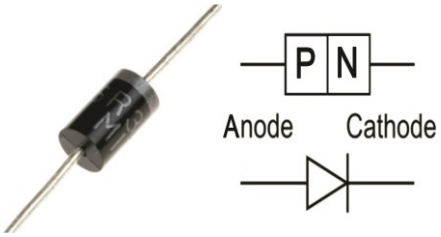


Fig. 1.26 (a) Diode (b) Diode symbol

The silver ring in figure 1.27 represents the cathode of a diode.

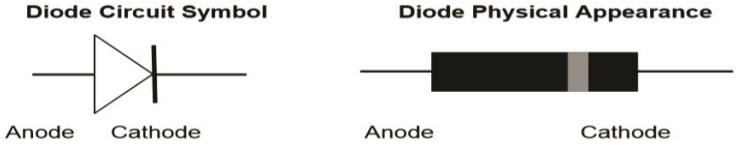


Fig. 1.27 Terminals of diode

Diode passes current only in one direction. The P-side is called anode and the N-side is called cathode. When the anode and cathode of a PN-junction diode are connected to external voltage source such that the positive end of a battery is connected to the anode and negative end of the battery is connected to the cathode, diode is said to be **forward biased** or we can say that diode will acts as a close switch (it will be turned "ON"). In a forward-biased condition, diode will pass the current through it.

When the P-side of diode are connected to the negative terminal of the battery and N-side of the diode is connected to positive terminal of the battery, diode is said to be **reverse biased** or we can say that diode will acts as an open switch (it will be turned "OFF"). In reverse-biased condition, diode will not pass the current through it.

Diode can be connected in forward bias and reverse bias as shown in figure. 1.28.

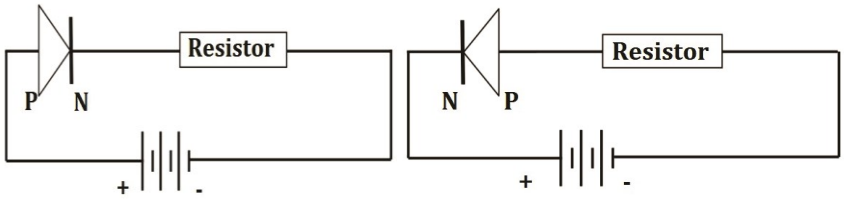


Fig. 1.28 (a): Diode connected in Forward bias (b) Diode connected in Reverse bias

There are various types of diodes such as Avalanche Diode, Crystal Diode, Light Emitting Diode (LED), Photodiode, Varactor Diode, Zener Diode.

1.6.2 Transistor

Transistor is an active semiconductor device formed by two P-N junctions which amplify electric current and voltage. It is a three-layer semiconducting device. These three layers have three terminals emitter, base, and collector respectively. It has two junctions, where the two layers touch each other is called as **junction**. The junction where emitter layer and base layer touch each other is named as **emitter base junction**. The junction where collector layer and base layer touch each other is named as **collector base junction.**

To understand the functioning of a transistor, we can relate it with the water supply system in our home. Storage tank which is kept at the roof of the building is similar to emitter in transistor which acts as source of charge carrier (i.e. electrons and holes in semiconductor). The tap at the ground is similar to the base of transistor; this tap controls the flow of water likewise base control the flow of charge carrier. Bucket at the ground collect the water coming from the storage tank likewise collector of transistor collects the charge carriers coming from emitter.

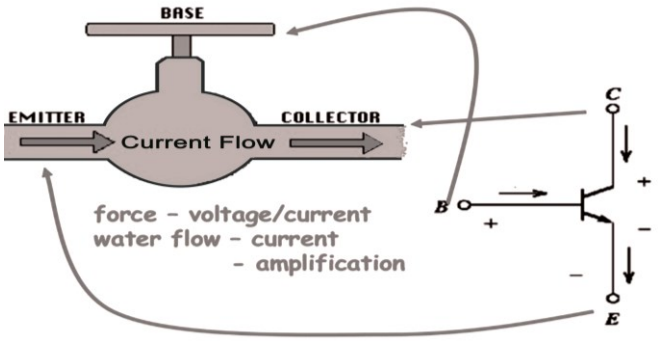


Fig.1.29 Analogy of transistor

Identifying BJT Terminals:

Keep the transistor such that the flat surface facing towards you as shown in the below figure 1.30(a) and figure 1.30(b):

We know that the bipolar junction transistor has three terminals namely

1. Emitter (E)
2. Base (B)
3. Collector(C)

The bipolar junction transistor (BJT) and its symbol is shown in figure 1.27.

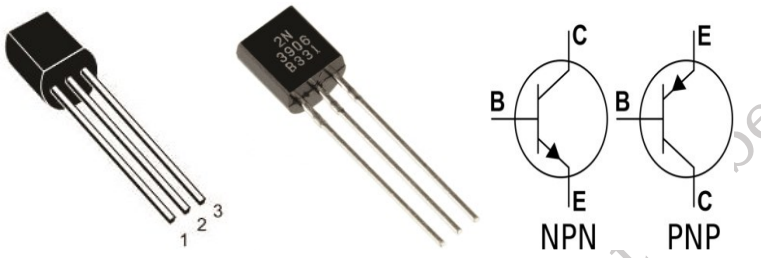


Fig. 1.30 (a) Bipolar Junction Transistor (b) Symbol of BJT

The figure 1.31 shows the details junctions of BJT.

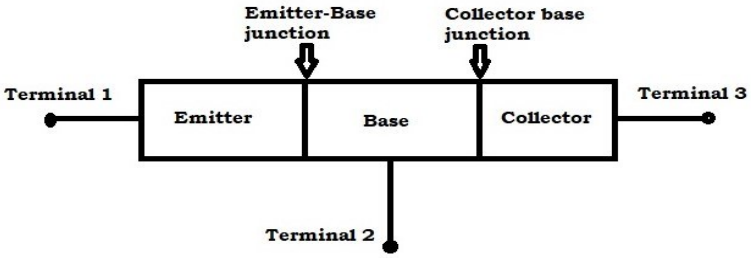


Fig. 1.31 EB and CB junction of bipolar junction transistor

INTEGRATED CIRCUIT (IC)

Digital ICs are used in computers, computer networks. An integrated circuit is a combination of electronic components on single piece (or "chip") of semiconductor material as shown in figure 1.32. Integrated circuit has large numbers of tiny transistors into a small chip and results in circuits that are smaller, cheaper, and faster. Integrated circuit has number of pins. The internal structure of IC is shown in figure 1.33.

Fig. 1.32 Integrated Circuit

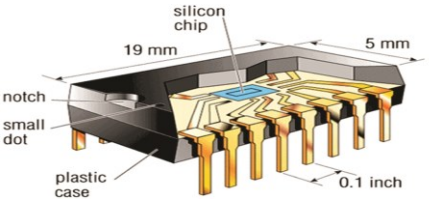


Fig. 1.33 Internal structure of IC

SEMICONDUCTOR MEMORY

Semiconductor memory is an electronic data storage device which is implemented on integrated circuits (IC). As we have discussed semiconductors have conductivity in between conductors and insulators. Electronic devices are made up of semiconductor material. In semiconductor

industry silicon and germanium are widely used. In computer memory is a physical electronic device. It is used to store applications and data. This storage can be temporary or permanent, as required by a computer and/or its user. There are two types of memory – primary and secondary. Primary memories include RAM, ROM and secondary memories are: Hard Disk Drive, CD/DVD, Magnetic Tape, Pen Drive etc. The primary memory can be classified into the two types: Read Only Memory (ROM) and Random-Access Memory (RAM).

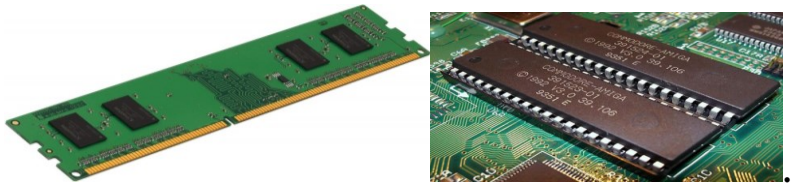


Fig. 1.34: Primary Memory (a) RAM (b) ROM

LED: The Light Emitting Diode (LED) functions as a p-n junction diode that emits light upon activation. This two-lead semiconductor serves as a source of light, releasing energy in the form of photons when an appropriate voltage is applied to its leads. The unique property of electroluminescence within the p-n junction facilitates the conversion of electrical energy into visible light. LEDs have become integral in various applications, from indicator lights to display screens, owing to their energy efficiency, durability, and the ability to produce light across a spectrum of colors. As shown figure 1.35.

Fig. 1.35: LED

Power Source: A power source is a provider of energy to an electrical circuit, typically in the form of a generator or a battery. Generators convert mechanical energy into electricity through processes like electromagnetic induction, while batteries store and release chemical energy as needed. These sources are fundamental to various applications, offering a reliable supply of power for both small-scale electronics and larger industrial systems, as shown figure 1.36.

Fig. 1.36: Battery

Solenoid: A solenoid is a coil of insulated or enameled wire wound around a solid cylindrical core, typically composed of iron, steel, or powdered iron. In electronic circuits, solenoids serve dual purposes as electromagnets and inductors. The electromagnetic property arises when current flows through the coil, creating a magnetic field. Motherboards often incorporate solenoids to fulfill various functions, leveraging their ability to generate controlled magnetic fields. This makes solenoids invaluable in applications such as relays and actuators, where their electromechanical response plays a vital role in executing specific tasks within the intricate workings of electronic systems, as shown figure 1.37.

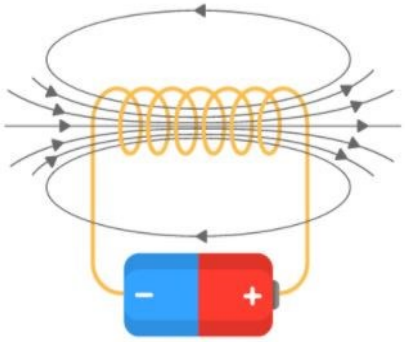


Fig. 1.37: Solenoid

Check Your Progress

A. Multiple choice questions (MCQs)

1. What is the main difference between a conductor and an insulator? (a) Conductors allow electricity to flow, while insulators block it. (b) Conductors block electricity, while insulators allow it. (c) Both conductors and insulators block electricity. (d) Both conductors and insulators allow electricity to flow.
2. Which of the following is an electrical quantity? (a) Transformer (b) Insulation (c) Memory (d) Voltage
3. Which component stores electrical energy in a circuit? (a) Resistor (b) Capacitor (c) Transistor (d) Diode
4. What is the main function of a transformer? (a) To store data (b) To conduct electricity (c) To change the voltage level (d) To stop electricity flow
5. What type of memory is commonly used in computers and smartphones? (a) Conductor memory (b) Semiconductor memory (c) Transformer memory (d) Passive memory

B. Fill in the blank questions

1. Materials that allow electricity to flow easily are called _____, while materials that do not allow electricity to flow are called _____.
2. The three main electrical quantities are voltage, current, and _____.
3. A resistor is a _____ component, while a transistor is an _____ component.
4. A _____ is a device that changes the voltage level in an electrical circuit.
5. _____ memory is a type of memory used in computers, commonly made from semiconductor materials.

C. True or False

1. Conductors block the flow of electricity, while insulators allow it to flow.
2. Voltage, current, and resistance are important electrical quantities.
3. Resistors and capacitors are active components in electronic circuits.
4. A transformer is used to increase or decrease voltage levels in an electrical circuit.
5. Integrated Circuits (ICs) are made up of multiple electronic components like transistors

and resistors.

D. Short Questions

1. What is the difference between conductors and insulators in terms of electricity flow?
2. What are the three main electrical quantities used in measuring and analyzing electrical circuits?
3. What are active and passive components in electronic circuits, and can you give examples of each?
4. How does a transformer work, and what is its primary function in an electrical system?
5. What is semiconductor memory, and why is it important in modern electronic devices?

Session 2. The Electronic Circuit Components

Electronics

Electronics, a scientific discipline, explores the dynamics of electron flow, control, and their impact on electricity. This field revolves around the study of electrical circuits, incorporating active components like vacuum tubes, transistors, diodes, and integrated circuits. Passive components such as resistors, capacitors, and inductors complement this, contributing to circuit functionality. The intricate interplay of these components is orchestrated on Printed Circuit Boards (PCBs), with interconnection technologies like wires and connectors facilitating seamless collaboration. In essence, electronics is the art and science of manipulating electrons, fostering technological advancements that shape our modern world.

Electric Circuit

An Electric Circuit is a closed path for transmitting an electric current through the medium of electrical and magnetic fields. The flow of electrons across the loop constitutes the electric current. Electrons enter the circuit through the 'Source' which can be a battery or a generator. The source provides energy to the electrons, by setting up an electrical field which provides the electromotive force. The electrons leave the circuit through the load, to the earth ground, thus completing a closed path. The load or output can be any simple home appliance like television, lamp, refrigerator, or can be a complex load such as that on a hydroelectric power generating station. A simple electric circuit consists of a source (such as a battery), wires as conducting medium and a load (such as a light bulb). The battery provides required energy for flow of electrons, to the light bulb.

Electronic circuits can be classified into two main types: analog and digital circuits. Analog circuits process continuous signals, such as varying voltages, to represent information. They are vital for tasks like audio amplification and radio frequency modulation. On the other hand, digital circuits handle discrete signals, represented by binary code (0s and 1s). They form the backbone of modern computing and communication systems. Within these categories, circuits can further be classified as linear or nonlinear, passive or active, and into specific functions like amplifiers, oscillators, and filters. This classification facilitates a systematic understanding of their roles in various electronic applications and technologies.

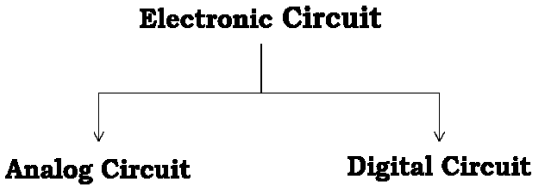


Fig. 2.1 Classification of electronic circuits

Analog Circuit: In analog circuits, there is a continuous variation of voltage or current with time. These circuits are a combination of basic components such as resistors, capacitors, diodes, inductors and transistors. The following figure represents an analog circuit:

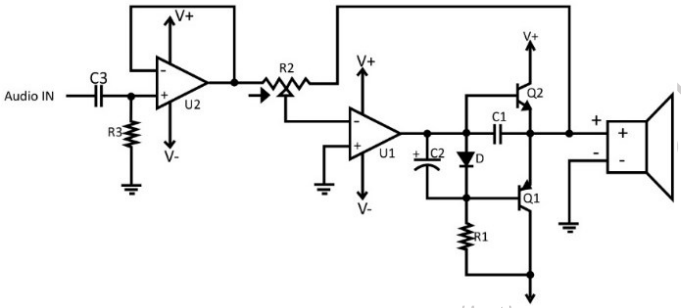


Fig 2.2 An analog circuit

The fundamental building blocks of analog circuits are:

- Series connection
- Parallel connection

Series Connection: In series connection, the magnitude of current is same through all the connected components. The following figure shows a series circuit and, in the figure, R = R1 + R2 + R3, where, R represents the resistance in the circuit:

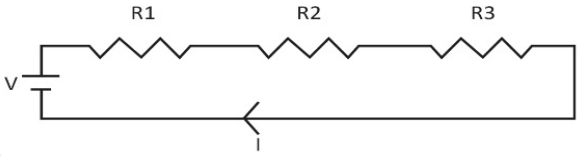


Fig. 2.3 A series circuit

Parallel Connection: In a parallel connection, the magnitude of voltage is same through all the connected components and the current is divided among the various components. The following figure represents a parallel circuit. 1/R = 1/R1 + 1/R2 + 1/R3, where, R shows the resistance in the circuit and I represent the current:

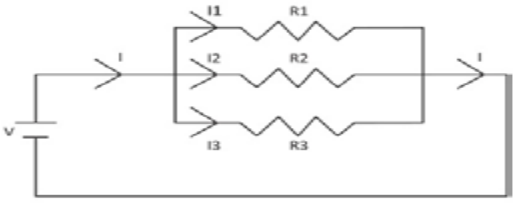


Fig. 2.4 A parallel circuit

Digital Circuit: Digital circuits use a binary scheme for digital signaling. Two different voltages (high or low) are represented by different logic levels. High voltage, generally 5V, represents one value and the other value represents low voltage that is generally 0V. The following figure shows a digital circuit:

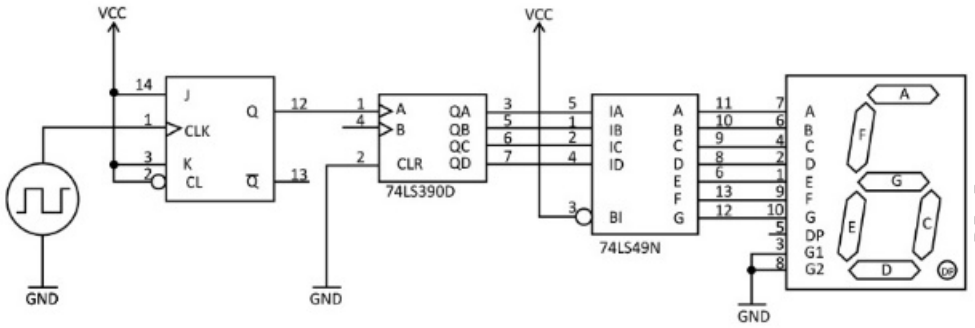


Fig. 2.5 A digital circuit

Types of Electronic Circuits

Electronic Circuits

An electrical circuit is a structured assembly of components designed for the storage, transmission, and conversion of energy. Energy is introduced into a circuit through one or more sources and exits through one or more sinks. Sources undergo a transformation, converting thermal, chemical, electromagnetic, or mechanical energy into electrical form, while sinks reverse this process. Within an electrical circuit, energy travels via electrical charge, facilitated by magnetic and electric fields. Two common configurations are parallel and series circuits, each influencing the flow of energy. Parallel circuits allow independent pathways for the current, while series circuits force the current through a single route. This organized interplay of energy transformation and transmission forms the foundation of diverse electronic systems.

Logic Gates

Logic gates are fundamental building blocks of digital circuits and are essential components in the field of digital electronics. These gates perform logical operations based on binary input signals (0s and 1s) and produce a binary output. There are several types of basic logic gates, each with its specific function:

AND Gate:

Symbol:

Operation: The output is high (1) only when both inputs are high (1).

Input A	Input B	Output
0	0	0
0	1	0
1	0	0

1	1	1

OR Gate:

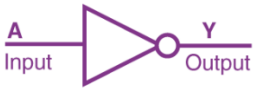
Symbol:

Operation: The output is high (1) when at least one input is high (1).

Input A	Input B	Output
0	0	0
0	1	1
1	0	1
1	1	1

NOT Gate/(Inverter):

Symbol:



Operation: The output is the opposite (complement) of the input.

Input	Output
0	1
1	0

NAND Gate:

Symbol:

Operation: The output is low (0) only when both inputs are high (1).

Input A	Input B	Output
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate:

Symbol:

Operation: The output is low (0) when at least one input is high (1).

Input A	Input B	Output
0	0	1
0	1	0
1	0	1
1	1	0

Application of Logic Gates

Logic gates, fundamental components in digital electronics, have diverse applications based on their modes of operation and truth tables. They are integral to a variety of circuits found in everyday electronic devices. Basic logic gates, including AND, OR, NOT, NAND, and NOR gates, are commonly employed in circuits such as safety thermostats, push-button locks, automatic watering systems, light-activated burglar alarms, and numerous other electronic devices.

One of the significant advantages of basic logic gates lies in their versatility—they can be combined in various ways to perform advanced operations. This flexibility allows engineers to design complex circuits tailored to specific functionalities. There is essentially no theoretical limit to the number of gates that can be integrated into a single device, although practical constraints such as physical space within the device may impose limitations.

In digital integrated circuits (ICs), an assortment of logic gates is typically arranged in an organized manner. This array forms the basis for the circuitry in countless electronic devices, providing the logic and decision-making capabilities necessary for their operation. The widespread use of logic gates in such devices underscores their importance in modern electronics and their role in advancing technology across various applications.

De Morgan's Theorem

De Morgan's Theorems are a pair of fundamental principles in Boolean algebra that describe the relationship between the logical operations of negation, conjunction (AND), and disjunction (OR). These theorems are named after the British mathematician and logician Augustus De Morgan. There are two

First De Morgan's Theorem:

The complement of the product of two variables is equal to the sum of their complements.

Mathematically, it can be expressed as:

$A \cdot B = A + B$

This theorem is essentially stating that the negation of the AND operation is equivalent to the OR operation of the negations of the individual variables.

Second De Morgan's Theorem:

The complement of the sum of two variables is equal to the product of their complements.

Mathematically, it can be expressed as:

$A+B = A \cdot B$

This theorem is stating that the negation of the OR operation is equivalent to the AND operation of the negations of the individual variables.

These theorems are particularly useful for simplifying Boolean expressions and manipulating logic gates in digital circuit design. They provide a way to express complex logic circuits in a more concise and simplified form. By applying De Morgan's Theorems, engineers can optimize the design of circuits and improve their efficiency.

Microprocessor/Chip: An IC containing all the functions of a computer's CPU.

Fig. 2.6 Microprocessor/chips

Microcontroller: A small computer on an IC which controls devices that contain the microprocessor such as remote controls, office machines and appliances.

Fig. 2.7 Microcontroller

Basic Integrated Circuits: When an electronic circuit array is created by the fabrication process of different electrical and electronic components on a silicon wafer, then that circuit is known as Integrated circuit or simply IC. These circuits have operations similar to the large discrete electronic circuits made of discrete electronic components. The following table describes some basic integrated circuits:

Digital Integrated Circuit: These types of integrated circuits do not operate at all the levels of the signal. They operate only at some defined levels. The basic building blocks of these circuits are logical gates, multiplexers, de-multiplexers, flip flops and other electronic components of circuits.

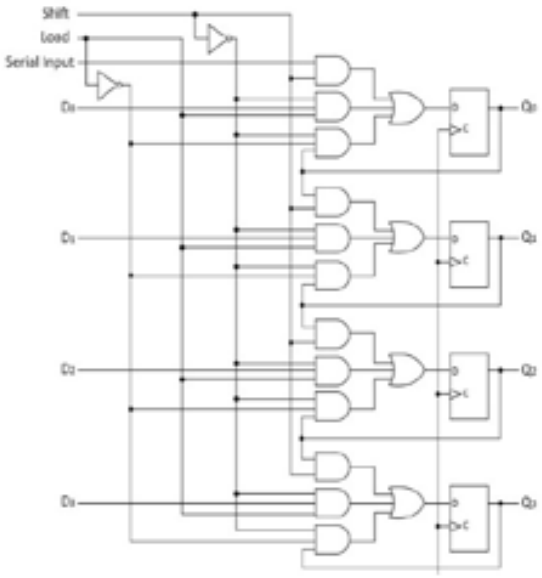


Fig. 2.8 Digital Integrated Circuit

Analog Integrated Circuit: These types of integrated circuits operate over a continuous range of signals. These circuits can be further classified as linear integrated circuits (Linear ICs) and radio frequency integrated circuits (RF ICs). A commonly used analog integrated circuit is an operational amplifier (op-amp). The basic building block of these type of circuits are integrated circuits (analog ASICs).

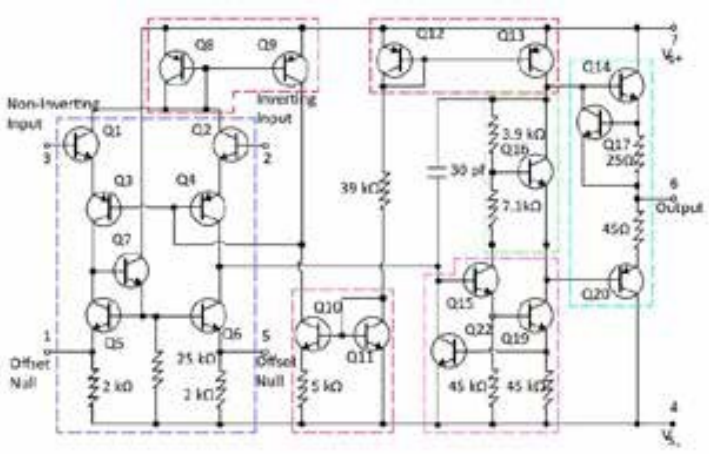


Fig. 2.9 Analog Integrated Circuit

Mixed Integrated Circuit: These types of circuits are formed by the combination of analog integrated circuits and digital integrated circuits on a single chip. These circuits are mainly used as digital to analog converts (DAC) and analog to digital converters (ADC).

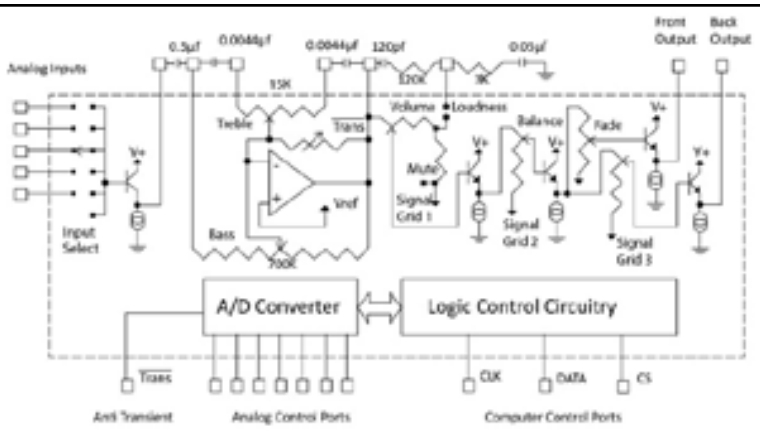


Fig. 2.10 Mix Integrated Circuit

General type of Integrated Circuit: These types of circuits include:

- Logic Circuits
- Comparators
- Switching IC
- Timer IC
- Audio Amplifiers

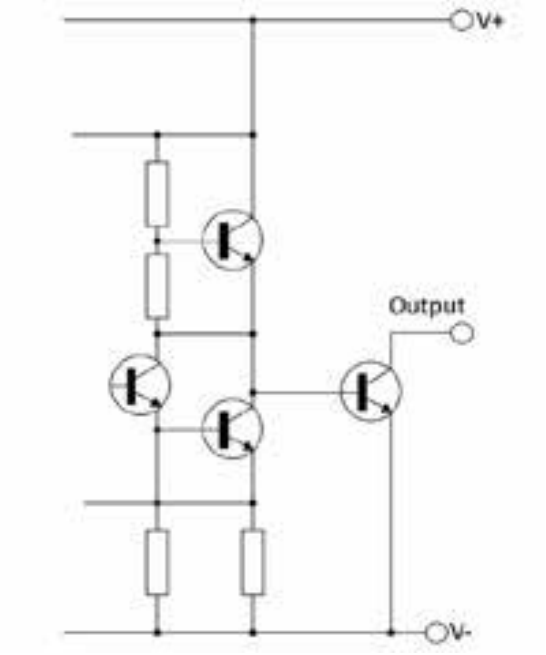


Fig. 2.11 Type of Integrated Circuit diagram

Voltage and Power

Voltage is the potential difference between a negatively charged component and a component with positive charge. It is a measure of the energy carried by the charge and is the "energy per unit charge". The proper name for voltage is potential difference or p.d. in short and it is measured in volts. Power is the amount of electrical energy per unit time given by an electric

circuit. It is measured in watts (W) or joules per second. Voltage and Power Requirement by Hardware Devices Computer is an electronic machine and hence it can only be operated with a source of energy. It requires a standard power and voltage range for its operation. Every electronic device or circuit is fed by the PSU.

Computer Power Supply Voltages

All the hardware components present in a computer, require some amount of DC voltage to run. This amount may differ from component to component. The following table lists a few components and their voltage requirement:

Table 2.1 component power supply voltage

Component	Voltage Requirement (in volts)
Mainboard or motherboard	12
CPU	3.3
Graphic cards	12
CPU Fan	5
USB ports	5

So, in a computer broadly three types of DC voltages are required, which are +12V, +5V and +3.3 V.

Know more….

Power ratings and voltages outside the permissible range can cause system failure.

PSU:

A PSU draws the AC voltage from the source (generally from the socket) and converts it to the desired level of DC voltage. It is usually found at the back side of a computer case. The following figure lists the parts found on the back of a PSU:

- **A connection for the power cord to the computer.**
- **A fan opening to draw air out of the PSU.**
- **A red switch to change the power supply voltage.**
- **A rocker switch to turn the power supply on and off.**

Fig. 2.12 Interior view of a PSU

There are different types of power supplies available in the market but switched-mode power supplies are globally used today in personal computers.

There is also a stack of different coloured cables inside a PSU.

The following figure lists the colour codes of the PSU cables:

Black Wires	These wires are used to provide grounding. Every other color should be paired with a black wire.
Yellow Wires	These wires denote +12V
Blue Wires	These wires denote -12V
Red Wires	These wires denote +5V
White Wires	These wires denote -5V
Orange Wires	These wires denote 3.3V
Green Wires	These are control wires to check the DC voltage
Purple Wires	These wires denote +5V on standby mode

Know more....

Power supply and computer can be protected from a surge and voltage drops by simply adding a UPS (backup) to the computer.

Internal Hardware Components

Inside a computer, there are various small electrical and electronic components. These form the internal hardware parts of a computer. The components such as the keyboard, mouse, speakers and printers are called peripherals and form the external hardware parts of a computer. The following image shows some internal hardware components of a computer:

Fig. 2.13 Internal hardware components

Motherboard

A motherboard is the main PCB of a computer. It contains the CPU, memory, expansion cards to regulate the audio and video, the attachments for the hard drive and optical drives and links to ports of the computer such as the USB port. There is a direct or an indirect connection between the motherboard and every other part of the computer.

CPU

A CPU, also called as the processor, is positioned on the motherboard, inside the computer case. It is called the brain of the computer. This unit takes data and instructions from the storage unit and processes it as per the instructions given and the type of data provided. It is then sent back to the storage unit. Whenever any keyboard key is pressed, or the mouse is clicked or any application is started, the instructions are sent to the CPU.

The CPU chip (processor chip) can be identified by the processor type and the name of the manufacturer. This information can be found on the chip itself. For example, Intel 386, Advanced Micro Devices (AMD) 386, Cyrix 486, Pentium MMX, Intel Core 2Duo and iCore7.

RAM

RAM is the short-term memory in a computer that is used to store documents while they are being processed. It is available as a chip and is an IC soldered on the motherboard. RAM slots are present on the motherboard and provide slots for inserting RAM chips. These can be easily removed and replaced.

BIOS

A motherboard also has a provision for initial set up of a computer after the power is turned on, which is called BIOS or boot firmware. The BIOS consists of a software code that gives a computer the basic instructions to start. Whenever the computer is turned on, it runs the program within BIOS to do some basic system checks, locates the operating system on the disk and starts the computer.

PSU

A PSU converts the input AC to low-voltage regulated DC power for the internal components of a computer. The most commonly used PSU in modern computers is Switched-mode Power Supply SMPS.

SMPS

An SMPS is also known as switching-mode power supply, switch-mode power supply, switched power supply or simply a switcher. It is an electronic power supply which efficiently converts electrical power, i.e. transfers power from a DC or AC source to DC loads, such as a personal computer. The conversion process of electrical power becomes more efficient with high input voltage and synchronous rectification.

The following images shows an SMPS:

Fig. 2.14 An SMPS

The following figure shows the block diagram of a mains operated AC/DC SMPS with output voltage regulation:

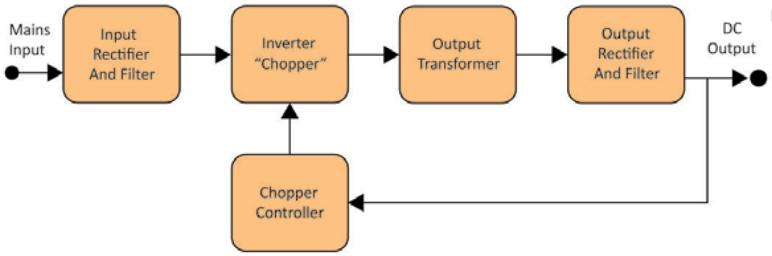


Fig. 2.15 Block diagram of a mains operated AC/DC SMPS

In the process of output voltage regulation by SMPS, there are certain stages involved which are:

Input rectifier stage: This is the first stage of voltage regulation known as rectification. In this stage an AC input is converted into DC. If the input is already in the form DC, then there is no requirement of this stage.

Inverter stage: The second stage of voltage regulation converts the input DC, which comes either directly from the source or from the rectification stage, into AC. DC is converted into AC by passing it through a power oscillator.

Voltage converter and output rectifier: The inverted AC should drive the primary winding of a transformer, if the output needs to be isolated from the input. This in turn makes the voltage high or low to reach the desired output level on the secondary winding of the transformer. The AC output is rectified from the transformer if the desired output is DC.

Regulation: The output voltage is monitored by a feedback circuit and is compared with a reference voltage. An additional power supply is used because the feedback circuit needs power to function before it can generate it.

Expansion Cards

The motherboard also contains slots and provision for expansion cards. The circuit boards which are inserted in the slots are called expansion cards. These cards allow a computer to connect and communicate with various input and output devices. The various types of expansion cards are video card, sound card, graphic card, network interface card and Bluetooth card.

Check Your Progress

A. Multiple choice questions (MCQs)

1. Which of the following is a type of electronic circuit? (a) Analog Circuit (b) Digital Circuit (c) Both a and b (d) None of the above
2. What is the main function of logic gates in electronics? (a) To store data (b) To perform logical operations (c) To supply power (d) To increase voltage
3. Which logic gate outputs true (1) only when both inputs are true (1)? (a) AND gate (b) OR gate (c) NOT gate (d) XOR gate
4. What is the function of SMPS (Switched-Mode Power Supply)? (a) To store electricity (b) To provide regulated power supply to electronic devices (c) To perform logical operations (d) To increase resistance
5. Voltage is measured in which unit? (a) Watts (b) Amperes (c) Ohms (d) Volts

B. Fill in the blank questions

1. Electronic circuits are classified into two types: _____ circuits and _____ circuits.
2. A _____ gate outputs true only when all inputs are true.
3. Logic gates are widely used in _____, where they perform decision-making operations.
4. The unit of voltage is _____, while the unit of power is _____.
5. SMPS stands for _____, which is used to provide regulated power to electronic devices.

C. True or False

1. Analog circuits deal with continuous signals, while digital circuits work with binary (0 and 1) signals.
2. A NOT gate outputs the same value as the input.
3. Logic gates are mainly used for performing arithmetic operations in circuits.
4. The unit of power is volts.
5. SMPS provides a regulated and efficient power supply to electronic devices.

D. Short Questions

1. What are the two main types of electronic circuits, and how do they differ?
2. What is the function of a logic gate in an electronic circuit?
3. Can you describe an application of logic gates in modern technology?
4. What is the relationship between voltage and power in an electrical system?
5. What does SMPS (Switched-Mode Power Supply) do, and why is it important in electronic devices?

Session 3. Use Tools, Equipment and Measuring Instruments

Tools, equipment, and measuring instruments are essential for tasks of installation of repairing in electronics and electrical appliances. Common tools include screwdrivers and wrenches for fastening, while equipment like drills and saws aid in cutting and shaping materials. Measuring instruments like rulers and calliper ensure accurate measurements, while specialized tools such as multi meters and oscilloscopes are used for electrical testing and signal analysis. These tools enhance efficiency and accuracy in various tasks.

3.1 Common hands tools

Hand tools are absolutely necessary for daily tasks. Since ancient times, people have utilized them to carry out a variety of beneficial tasks. There are many varieties of hand tools that are suitable for any type of task. Certain tools are designed for a particular purpose, while others are multipurpose.

Understanding their design and appropriate use is crucial if you want the best results from your work. Many errors and injuries can result from carelessness or ignorance.

When using hand tools, accuracy and proper use are more crucial than productivity. A craftsman must select the appropriate tools for the job based on the nature of the work that needs to be done. He needs to know which tool is best for the job. If not, work output and quality will deteriorate.

Some Common hands tools that are used frequently are described as follows:

Cutter

Cutters are hand tools made for cutting a variety of materials, including thin metal sheets and wires. They are available in various varieties, such as cable cutters, wire strippers, and diagonal cutters. The image of most used type of cutter is shown below in Figure 3.1.

Fig. 3.1: Cutter

Use: Wire strippers are useful for removing insulation, and diagonal cutters work well for cutting wires. Thick wires and cables are the intended use for cable cutters.

Scissors

Scissors are cutting tools with two opposing blades that pivot around a fulcrum. They are commonly used for cutting paper, fabric, or other thin materials. The image of most used type of

cutter is shown below in Figure 3.2.

Fig.3.2: Scissors

Use: Scissors are versatile and can be used for a variety of tasks, from crafting and office work to cutting packaging materials.

Screwdriver

A screwdriver is a hand tool used for turning screws. It typically consists of a handle and a shaft with a tip that fits into the screw's head. Screwdrivers are very important and are used to tighten the screws, bolts, and nuts. They come in various shapes and also can be altered as per the size of the bolt. The image of screwdriver is depicted below in Figure 3.3.

Fig. 3.3: Screwdriver

Use: Screwdrivers come in various types, such as flathead and Phillips, and are essential for assembling and disassembling items held together by screws.

Combination Pliers

Combination pliers are versatile hand tools that combine features of both cutting pliers and gripping pliers. They often have a cutting edge and serrated jaws for gripping. It is shown below in Figure 3.3.

Fig. 3.4: Combination pliers

Use: Combination pliers are useful for gripping, twisting, bending, and cutting various materials, making them an essential tool for electricians, mechanics, and DIY enthusiasts.

3.2 Measuring Instruments

A device or mechanism used to determine the present value of the quantity under measurement

is classified as a Measuring Instrument. It acts as a user 's interface between the physical world and the information world.

Phase Tester

A phase tester, also known as a voltage tester, is used to determine the presence or absence of an electrical voltage in a circuit. It looks like as shown in following Figure 3.5.

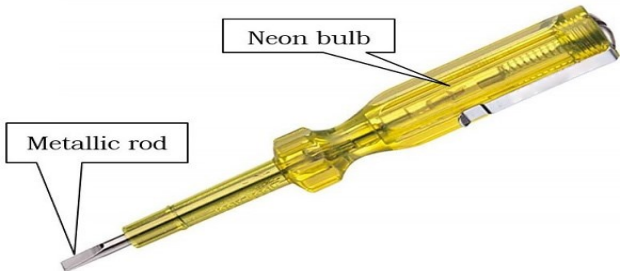


Fig. 3.5: Phase Tester

Use: It helps ensure that electrical circuits are de-energized before maintenance or repair work, preventing accidents.

Earth Tester

An earth tester measures the resistance between the grounding system and the Earth. It ensures that electrical systems have a proper ground connection. The image of earth tester is shown in Figure 3.6.

Fig. 3.6: Earth Tester

Use: Used to maintain electrical safety by verifying that the grounding system is functioning correctly.

Watt Meter

A watt meter measures electrical power consumption in watts, helping users monitor and control energy usage as shown in Figure 3.7

Fig. 3.7: Watt meter

Use: Useful for assessing the power consumption of electrical appliances and optimizing energy efficiency.

Energy Meter

An energy meter measures the total electrical energy consumed over time, typically in kilowatt-hours (kWh). It is shown in the following Figure 3.8.

Fig. 3.8: Energy meter

Use: Essential for utility billing and monitoring energy consumption in residential, commercial, and industrial settings.

Multi-meter

A multi-meter is a versatile instrument that combines multiple measurement functions, including voltage, current, and resistance. The real view of multi meter is shown below in Figure 3.9.

Fig. 3.9: Multi meter

Use: Widely used for troubleshooting electrical circuits, checking continuity, and measuring various electrical parameters.

Clamp Meter

A clamp meter is an electrical test instrument that combines a current sensor and a simple digital multi meter. Current is measured by clamps. Voltage is measured by probes. Electrical meters with hinged jaws enable technicians to measure current in a circuit without disconnecting or deenergizing it by clamping the jaws around a wire, cable, or other conductor at any point in the electrical system.

A clamp meter measures current by clamping around a conductor without the need for direct contact. Its different parts and design are shown in following Figure 3.10.

Fig.3.10: Clamp meter

Use: Ideal for measuring AC current in live electrical circuits safely, especially in situations where accessing the conductor is challenging.

3.3 Measurements Using Multi-meter

Different measurements can be performed using a multi-meter like voltage, current, resistance etc. The position of knob on the multi meter for these measurements are shown in the following Figure 3.11.

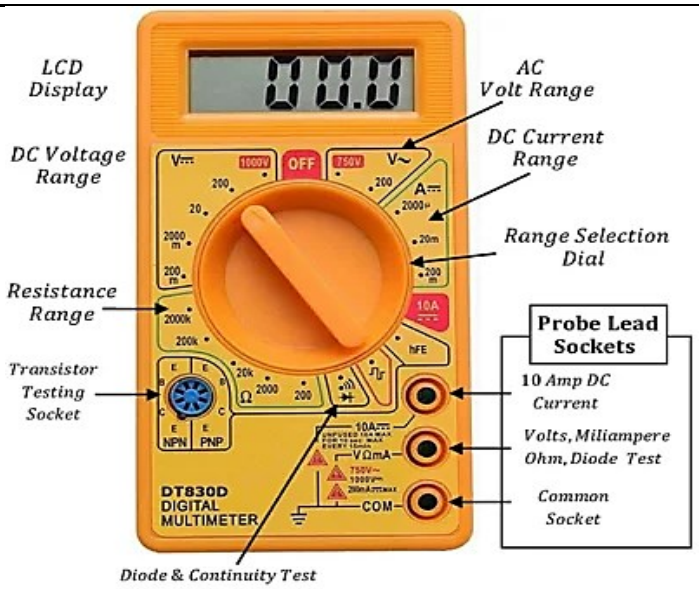


Fig. 3.11: Measurements Using Multi-meter

3.3.1 Measurement of AC and DC voltage

Measuring AC (Alternating Current) and DC (Direct Current) voltage using a multi meter involves setting the multi meter to the appropriate mode and connecting the probes to the circuit being measured. Here's a step-by-step guide:

Measurement of AC Voltage

Set the Selector Switch – Turn the selector switch to the AC voltage (V~) setting. This is usually denoted by a "~" symbol.

Select the Range – Choose the appropriate voltage range on the multi meter. Start with a higher range and then adjust as needed.

Connect the Probes – Connect the red probe to the positive (+) terminal and the black probe to the negative (-) terminal. If measuring across a component, connect the probes to the two points in the circuit.

Take the Reading – Place the probes at the points in the circuit where you want to measure AC voltage. The multi meter will display the AC voltage in volts on the screen. This procedure is shown in Figure 3.12.

Fig. 3.12: Measurements of AC Voltage

Measurement of DC Voltage

Set the Selector Switch – Turn the selector switch to the DC voltage (V-) setting. This is usually denoted by a "V-" or "VDC" symbol.

Select the Range – Choose the appropriate voltage range on the multi meter. Start with a higher range and then adjust as needed.

Connect the Probes – Connect the red probe to the positive (+) terminal and the black probe to the negative (-) terminal. If measuring across a component, connect the probes to the two points in the circuit.

Take the Reading – Place the probes at the points in the circuit where you want to measure DC voltage. The multi meter will display the DC voltage in volts on the screen. Connection for this measurement is shown in Figure 3.13.

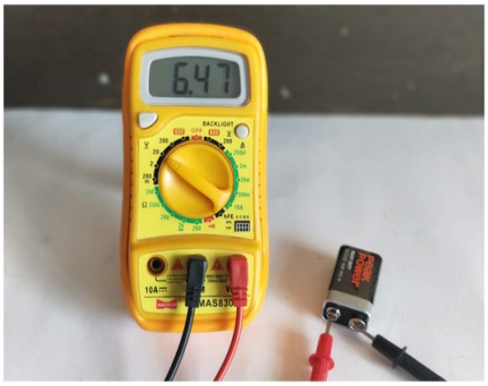


Fig. 3.13: Measurements of DC Voltage

Measurement of Current

Setting the Selector Switch – Turn the selector switch to the current (A) setting.

Connecting the Probes – For measuring current, the multi meter must be inserted into the circuit. Break the circuit and connect the multi meter in series with the load.

Reading the Display – The multi meter will display the current value in amperes. The connection can be done as shown below in Figure 3.13.

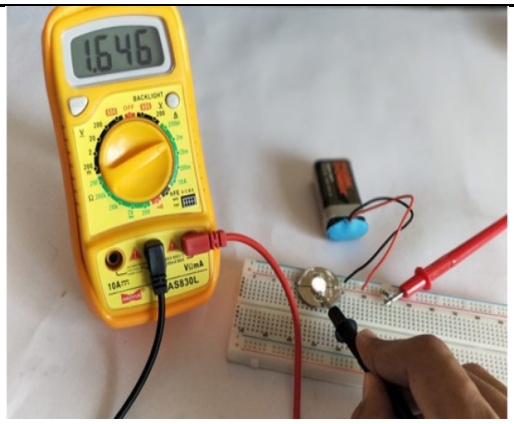


Fig. 3.14: Measurements of Current

Measurement of Resistance

Setting the Selector Switch – Turn the selector switch to the resistance (Ω) setting.

Connecting the Probes – Connect the probes to the two ends of the resistor or component being measured.

Reading the Display – The multi meter will display the resistance value in ohms. It can be performed as shown in following Figure 3.15.

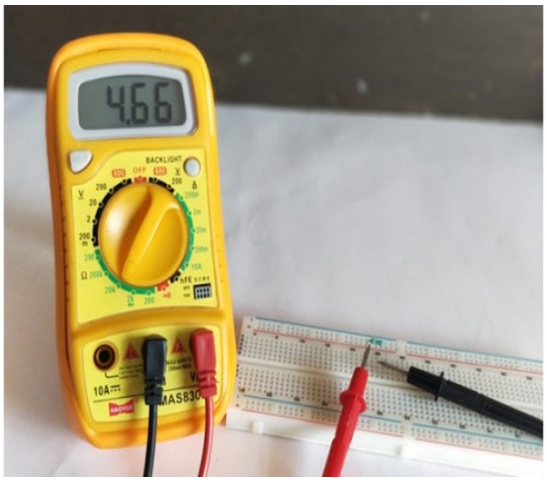


Fig. 3.15: Measurements of resistance

Continuity Test using Multi meter

Setting the Selector Switch – Turn the selector switch to the continuity setting (often represented by a symbol that looks like sound waves).

Connecting the Probes – Touch the probes to the two points in the circuit being tested.

Reading the Display – The multi meter will produce a beep if there is continuity, indicating a low resistance path. The position of knob and wires for continuity testing is as shown in Figure 3.16.

Fig. 3.16: Continuity Test using Multi meter

Cleaning Tools

Soft lint-free cloth

It used to clean different computer components without scratching or leaving debris.

Compressed air

It used to blow away dust and debris from different computer parts without touching the components.

Cable ties

They are used to bundle cables neatly inside and outside of a computer.

Parts organizer

It used to hold screws, jumpers, fastners, and other small parts and prevent them from getting mixed up together.

Diagnostic Tools

Digital multimeter

It is used to test the integrity of circuits and the quality of electricity in computer components. A digital multimeter displays the information on an LCD or LED.

Loopback adapter

It is also known as a loopback plug and is used to test the basic functionality of computer ports. The adapter is specific to the port that you want to test.

Toner probe

It is a two-part tool. The toner part is connected to a cable at one end using specific adapters such as an RJ-45, coaxial, or metal clips. The toner generates a tone that travels the length of the cable. The probe part traces the cable. When the probe is in near proximity to the cable to which the toner is attached, the tone can be heard through a speaker in the probe.

Safety

While installing computer and peripherals, you should follow the basic safety guidelines to prevent cuts, burns, electrical shock, and damage to eyesight. As a best practice, make sure that

a fire extinguisher and first aid kits are available in case of fire or injury. Place the cables in conduit or cable trays to prevent hazards. Some basic safety precautions to be followed when working on a computer are as below:

Basic safety guidelines

- Remove your watch and jewellery.
- Turn off the power and unplug equipment before installation.
- Never open a power supply or a CRT monitor.
- Do not touch the computer and the printer's part that use high voltage.
- Know about the location of fire extinguisher and its use.
- Take necessary precautions when lifting heavy objects to avoid injury.
- Keep food and drinks out of your workspace.

Electrical safety

Follow electrical safety guidelines to prevent electrical fires and injuries. Power supplies and CRT monitors

contain high voltage.

Precautions

Do not wear the anti-static wrist strap when repairing power supplies or CRT monitors. Some components

retain a high voltage even after the printer is turned off. Check the printer manual for the location of high voltage components.

Fire safety

Follow fire safety guidelines to protect yourself and equipment. To avoid an electrical shock and to prevent damage to the computer, turn off and unplug the computer before beginning installation.

Fire can spread rapidly. Proper use of a fire extinguisher can prevent a small fire from getting out of

control. When working with computer components, be aware of the possibility of an accidental fire and know how to react. Be alert for odours emitting from computers and electronic devices. When electronic components overheat or short out, they emit a burning odour. In case of fire, follow the following safety procedures—

- Never fight a fire that is out of control.
- Keep a planned fire escape route before beginning any work.
- Get out of the building quickly.
- Contact emergency services for help.
- Read the instructions on the fire extinguishers in workplace before you have to use them.

Be familiar with the types of fire extinguishers. Each type of fire extinguisher has specific chemicals to fight different types of fires (causes)—paper, wood, plastics, cardboard, gasoline, kerosene, organic solvents, electrical equipment, or combustible metals.

It is important to know how to use a fire extinguisher. Use the memory aid P-A-S-S to remember

the basic

rules of fire extinguisher operation:

P — pull the pin.

A — aim at the base of the fire, not at the flames.

S — squeeze the lever.

S — sweep the nozzle from side to side.

Protecting Equipment

Electrostatic discharge (ESD)

Electrostatic discharge (ESD) and poor-quality sources of electricity can cause damage to computer equipment. Follow proper handling guidelines, be aware of environmental issues, and use equipment that stabilizes power to prevent equipment damage and data loss. Static electricity is an electric charge resting on a surface. ESD occurs when this build-up charge jumps to a component and causes damage. ESD can be destructive to the electronics in a computer system.

At least 3,000 volts of static electricity must build up before a person can feel ESD. For example, static electricity can build up on you as you walk across a carpeted floor. When you touch another person, you both receive a shock. If the discharge causes pain or makes a noise, the charge was probably above 10,000 volts. By comparison, less than 30 volts of static electricity can damage a computer component.

ESD can cause permanent damage to electrical components. Follow these recommendations to help

prevent ESD damage:

• Keep all components in anti-static bags until you install them.

• Use grounded mats on workbenches.

• Use grounded floor mats in work areas.

• Use anti-static wrist straps when working on computers.

Electromagnetic interference

It is the intrusion of outside electromagnetic signals in a transmission media, such as copper cabling. In a network environment, EMI distorts the signals so that the receiving devices have difficulty interpreting them.

EMI does not always come from expected sources, such as cellular phones. Other types of electric equipment can emit a silent, invisible electromagnetic field. There are many sources of EMI:

• Any source designed to generate electromagnetic energy.

• Man-made sources like power lines or motors.

• Natural events such as electrical storms, or solar and interstellar radiations.

Wireless networks are affected by radio frequency interference (RFI). RFI is caused by radio transmitters

and other devices transmitting in the same frequency. For example, a cordless telephone can cause problems with a wireless network when both devices use the same frequency. Microwaves

can also cause interference when positioned in close proximity to wireless networking devices.

Climate

This affects the computer equipment in variety of ways:

• If the environment temperature is too high, equipment can overheat.

• If the humidity level is too low, the chance of ESD increases.

• If the humidity level is too high, equipment can suffer from moisture damage.

Power fluctuations

Voltage is a measure of work required to move a charge from one location to another. The movement of electrons is called current. Computer circuits need voltage and current to operate electronic components. When the voltage in a computer is not accurate or steady, computer components might not operate correctly. Unsteady voltages are called power fluctuations.

The following types of AC power fluctuations can cause data loss or hardware failure:

• Blackout — complete loss of AC power. A fuse, damaged transformer, or downed power line can cause a blackout.

• Noise — interference from generators and lightning. Noise results in poor quality power, which can cause errors in a computer system.

• Spike — sudden increase in voltage that lasts for a short period and exceeds 100 per cent of the normal voltage on a line. Spikes can be caused by lightning strikes, but can also occur when the electrical system comes back on after a blackout.

• Power surge — dramatic increase in voltage above the normal flow of electrical current. A power surge lasts for a few nanoseconds, or onebillionth of a second.

Power protection devices

To help shield against power fluctuation problems, use devices to protect the data and computer equipment:

• surge suppressor — It diverts extra electrical voltage that is on the line to the ground. It helps to protect against damage from surges and spikes.

Uninterruptible power supply (UPS) — It provides a consistent quality of power when power supply goes off. It helps to protect against potential electrical power problems by supplying a consistent level of electrical power to a computer or other device. The battery is constantly recharging while the UPS is in use. Never plug in a laser printer into a UPS because the printer could overload the UPS.

Proper Disposal to Protect Environment

To protect the environment, it is essential to properly dispose or recycle the hazardous computer components.

Batteries: They contain rare earth metals that can be harmful to the environment. Batteries from portable computer

systems contain lead, cadmium, lithium, alkaline manganese, and mercury. These metals do not decay and they remain in the environment for many years. Mercury is commonly used in the manufacturing of

batteries and is extremely toxic and harmful for human beings. Hence, recycling of batteries

should be adopted as a standard practice.

Monitors: They contain glass, metal, plastics, lead, barium, and rare earth metals. They must be disposed of in compliance with environmental regulations. CRT monitors must be handled with care. Extremely high voltage can be stored in these monitors, even after being disconnected from a power source.

Toner kits, cartridges, and developers

Used printer toner kits and printer cartridges must be disposed of properly or recycled. Some toner cartridge suppliers and manufacturers take empty cartridges for refilling. Some companies specialize in refilling empty cartridges. Kits to refill inkjet printer cartridges are available but are not recommended, because the ink might leak into the printer causing irreparable damage.

Chemical solvents and aerosol cans

Contact the local sanitation company to learn how and where to dispose of the chemicals and solvents used to clean computers. Never dump chemicals or solvents down a sink or dispose them in a drain that connects to public sewers.

The cans or bottles that contain solvents and other cleaning supplies must be handled carefully. Make sure, that they are identified and treated as special hazardous waste. For example, some aerosol cans explode when exposed to heat if the contents are not completely used.

3.4 Safety practices to use Tools, Equipment and Measuring instrument

Safety practices are paramount for technicians working with tools, equipment, and measuring instruments. Adhering to proper safety procedures helps prevent accidents, ensures the well-being of the technician, and promotes a secure working environment. Here's a detailed guide on safety practices for technicians:

3.3.1 General Safety Practices

Personal Protective Equipment (PPE)

Always wear the appropriate PPE for the task at hand. This may include safety glasses, gloves, hearing protection, and, if necessary, a helmet or other specialized equipment. The images of PPE kit are given in Figure 3.17.

Fig. 3.17: Personal Protective Equipment (PPE)

Tool Inspection

Before using any tool or equipment, inspect it for damage, wear, or defects. Do not use tools that

are damaged, as they can pose a safety risk.

Proper Tool Use

Use each tool for its intended purpose, following manufacturer guidelines and safety recommendations. Improper tool use can lead to accidents and damage to the equipment.

Secure Work Area

Keep the work area clean and organized. Remove clutter to prevent tripping hazards and ensure easy access to tools and equipment.

Training and Certification

Ensure that technicians are adequately trained and certified to use specific tools and equipment. Ongoing training is essential to stay updated on safety protocols and industry best practices.

3.3.3 Mechanical and Hand Tool Safety

Wear Safety Gloves

Use appropriate safety gloves when handling sharp or rough materials. Gloves provide protection against cuts, abrasions, and other hand injuries.

Eye Protection

Wear safety glasses or goggles to protect the eyes from flying debris, dust, or chemical splashes. Use a face shield when needed.

Proper Lifting Techniques

When lifting heavy objects, use proper lifting techniques to prevent back injuries. Lift with the legs, not the back, and seek assistance for heavy loads.

Fire Safety

Fire Extinguishers: Know the location of fire extinguishers in the work area. Understand how to use them and participate in fire safety drills.

Flammable Materials

Store flammable materials properly, away from heat sources. Follow safety protocols for handling and disposing of flammable substances.

3.3.4 Emergency Preparedness

First Aid

Have a well-equipped first aid kit accessible in the work area. Ensure that all technicians are trained in basic first aid procedures.

Emergency Procedures

Establish and communicate emergency procedures, including evacuation plans, in case of accidents, fires, or other emergencies.

By prioritizing these safety practices, technicians can create a work environment that minimizes risks, protects individuals, and promotes efficient and secure operations. Regular safety training and a commitment to best practices contribute to a culture of safety in the workplace.

Summary

The "Tools, Equipment and Measuring Instruments" Session explores crucial hand tools like cutters, scissors, and screwdrivers, emphasizing precision and safety. It introduces measuring

instruments for electrical systems, including phase testers and watt meters. The guide covers multi-meter usage for AC/DC voltage, current, resistance, and continuity tests. Key safety practices include PPE use, proper tool inspection, and emergency preparedness.

Check Your Progress

A. Multiple choice questions (MCQs)

1. Which of the following is a common hand tool used in electronics? (a) Hammer (b) Screwdriver (c) Saw (d) Shovel
2. What is the main purpose of measuring instruments in electronics? (a) To cut wires (b) To measure electrical quantities like voltage and current (c) To fix circuits (d) To protect the environment
3. A multimeter is commonly used to measure _____. (a) Resistance, voltage, and current (b) Temperature (c) Pressure (d) Speed
4. What is important to do when handling electronic equipment to ensure safety? (a) Wear loose clothing (b) Use insulated tools (c) Touch live wires (d) Ignore warning labels
5. Why is proper disposal of electronic waste important? (a) To save money (b) To protect the environment from harmful materials (c) To create more waste (d) To increase pollution

B. Fill in the blank questions

1. Common hand tools used in electronics include pliers, screwdrivers, and _____.
2. A _____ is an instrument used to measure electrical quantities such as voltage, current, and resistance.
3. When measuring resistance with a multimeter, the circuit must be _____ to get an accurate reading.
4. It is important to wear _____ equipment, such as gloves and goggles, to ensure safety when working with electrical devices.
5. Proper disposal of electronic waste helps to protect the _____ from harmful materials and pollution.

C. Short Questions

1. What are some examples of common hand tools used in electronics, and what are their primary functions?
2. How do measuring instruments, like multimeters, contribute to effective troubleshooting in electrical circuits?
3. What steps should be taken when measuring resistance with a multimeter to ensure accurate results?
4. What types of protective equipment should be worn when working with electrical components to ensure safety?
5. Why is it important to properly dispose of electronic waste, and what are some methods for doing so responsibly?

Module 2 Installation and Configuration

Module Overview

Computer hardware refers to the physical components of a computer. Computer consists of various internal components, such as, motherboard, CPU, memory, disk drives, and SMPS. For proper functioning of a computer system, each and every component must be installed and configured properly. For installation, one should have the relevant knowledge of that component as well as the installation process. The motherboard is the main circuit board inside a computer. The important system components like CPU, RAM modules are connected directly to the motherboard via slots or sockets. All the ports to interface with both inside and outside of the computer are fixed on the motherboard. Internal integrated ports are directly wired to the motherboard. External ports are grouped together and connected to the motherboard directly (integrated) or by circuit boards that are inserted into slots on the motherboard. CPU is the main component of a computer system. It is necessary to understand the working principle and architecture of the CPU. In this Unit, we will understand the basic working principle and installation of internal components of computer system. The installation process of these components is demonstrated.

Learning Outcomes

After completing this module, you will be able to:

- We learn how to properly install the motherboard in a computer case, including securing it with appropriate tools and connecting essential cables.
- Understand how to correctly install the CPU on the motherboard, including applying thermal paste and attaching the cooling solution.
- We able to correctly install RAM modules in the appropriate slots on the motherboard, ensuring proper alignment and functionality.

Module Structure

Session 1: Install the Motherboard

Session 2: Install the CPU and Processor on the Motherboard

Session 3: Install the RAM Modules on the Motherboard

Session 1. Install the Motherboard

The motherboard is the main circuit board inside a computer. The important system components

like the central processing unit (CPU) and random-access memory (RAM) modules are connected directly to the motherboard via slots or sockets designed specifically for those components. The motherboard will also provide a number of expansion slots designed to accommodate add-on cards such as video graphics adapter (VGA) cards and network interface cards (NICs). In this Session, we will understand the main features of the motherboard, types of motherboard, motherboard form factors, and various components of motherboard.

Note: We have to introduce all internal components first here then start from Motherboard.

1.1 Introduction to Motherboard

The motherboard is also known as main board or system board. The motherboard connects the components of a computer and provides power to the systems that need low power. The motherboard contains a socket in which one or more processors are attached. In addition, it has slots that allow connecting peripheral cards such as video cards, sound cards, and networking cards. The internal structure of a motherboard is shown in the Figure 1.1.

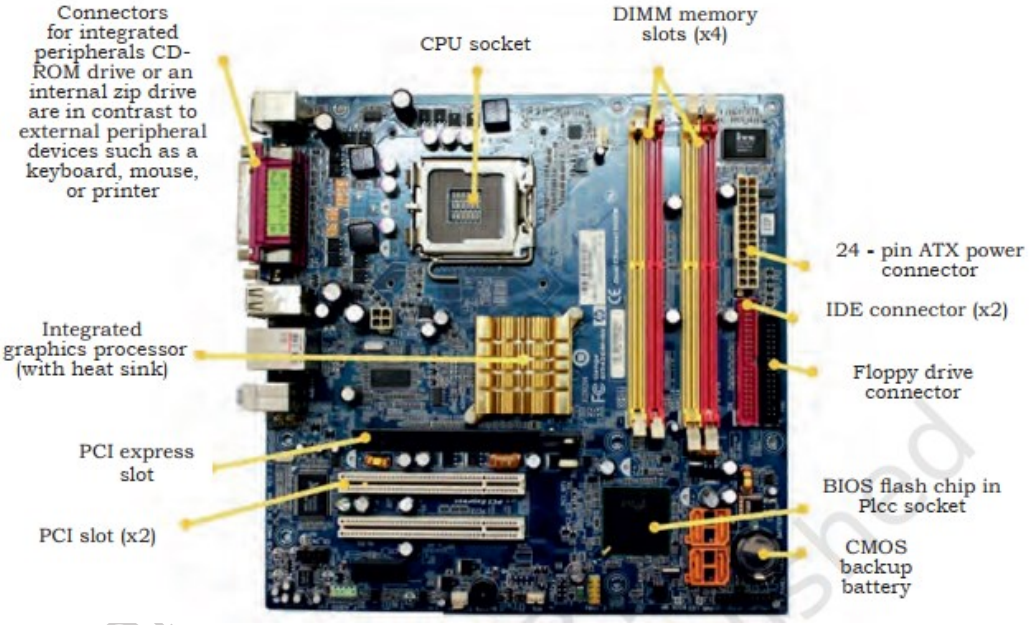


Fig. 1.1: Motherboard

1.1.1 Types of Motherboard

Motherboards are classified as either integrated or nonintegrated.

Integrated motherboard

This has several components integrated into the board itself. These may include the video card, sound card, and various controller cards. The maintenance is of a specific nature as the repairing of the whole board is a complex task. The integrated structure of a motherboard is shown in the Figure 1.1.

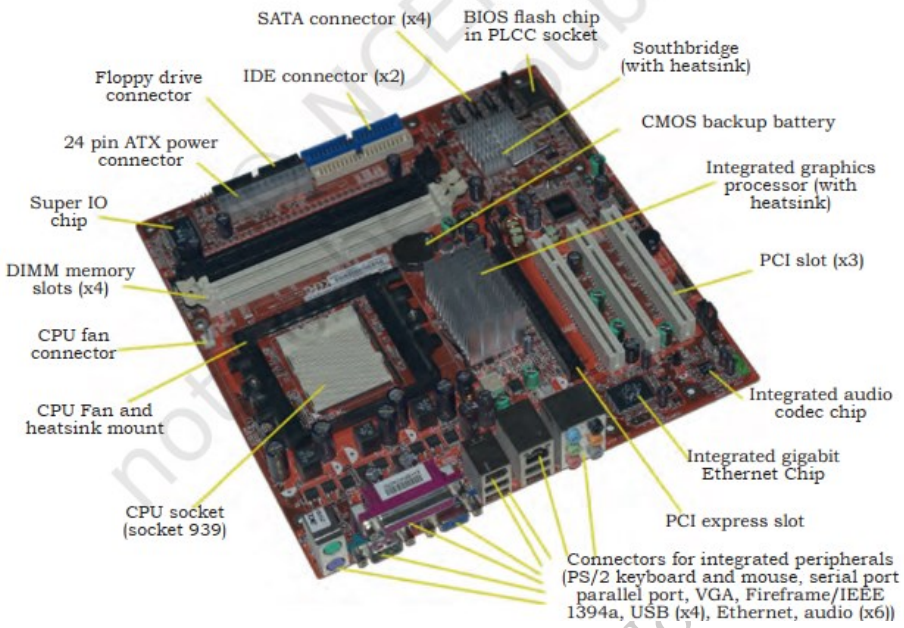


Fig. 1.2: Integrated Motherboard

Non-integrated motherboard

This motherboard uses installable components and expansion cards. In non-integrated motherboard, if any component fails, it is possible to replace that component instead of changing the entire motherboard. For example, you can remove the old video card and install a new one. Non-integrated motherboards typically have several PCI Expansion slots as well.

A non-integrated motherboard, also known as a traditional or discrete motherboard, is a type of motherboard that relies on separate, individual components for various functions rather than having them built directly onto the board. This design allows for greater flexibility, upgradability, and often better performance, as users can choose and replace components as needed.

1.1.2 Basic Components of Motherboard

The modern motherboard has the following components—

1. **Mouse & keyboard:** Keyboard connectors come in two primary types. All PCs feature a keyboard port that connects directly to the motherboard. The older, yet still commonly used type, is a special DIN connector. This AT-style keyboard connector was standard in most PCs until recently. However, it is now being rapidly replaced by the smaller mini DIN PS/2-style keyboard connector.
2. **USB:** USB is a general-purpose connection for PCs. You can find USB versions of many different devices, including mice, keyboards, scanners, cameras, and even printers. The distinctive rectangular shape of a USB connector makes it easily recognizable.
3. **Parallel port:** Most printers use a special connector called a parallel port, which carries data on multiple wires, unlike a serial port that uses only one wire. Parallel ports use a 25-pin female DB connector and are directly supported by the motherboard, either through a direct connection or via a dongle.
4. **CPU Chip:** The central processing unit, commonly known as the microprocessor, handles all the calculations within a PC. CPUs are available in various shapes and sizes. Modern CPUs

produce significant heat and therefore need a cooling fan or heat sink. While the cooling device, like a cooling fan, is often detachable, some CPU manufacturers offer the CPU with a fan permanently attached.

5. **RAM slots: Random**-Access Memory (RAM) stores programs and data that are currently being utilized by the CPU. RAM is measured in bytes. Over time, RAM has been packaged in various formats, with the most recent being the 168-pin DIMM (Dual Inline Memory Module).
6. **Floppy controller**: The floppy drive connects to the computer via a 34-pin ribbon cable, which then attaches to the motherboard. A floppy controller manages the operations of the floppy drive.
7. **IDE controller: Two** common types of hard drives are defined by industry standards: EIDE and SCSI. The majority of PCs utilize EIDE drives, while SCSI drives are found in high-end PCs such as network servers or graphical workstations. The EIDE drive connects to the hard drive via a 2-inch-wide, 40-pin ribbon cable, which then links to the motherboard. The IDE controller is responsible for overseeing the hard drive.
8. **PCI slot:** Intel introduced the Peripheral Component Interconnect (PCI) bus protocol, used to connect I/O devices like NICs or RAID controllers to the computer's main logic. The PCI bus has replaced the ISA bus.
9. ISA slot: Industry Standard Architecture (ISA) is the standard architecture of the Expansion bus. Some motherboards may include slots for connecting ISA-compatible cards.
10. **CMOS Battery:** To provide power to the CMOS when the computer is turned off, all motherboards are equipped with a battery. These batteries are mounted on the motherboard in one of three ways: the obsolete external battery, the most common onboard battery, and the built-in battery.
11. **AGP slot:** Modern motherboards often feature a single connector resembling a PCI slot, albeit slightly shorter and usually brown. This is an Advanced Graphics Port (AGP) slot, commonly used for graphics cards.
12. **CPU slot:** Installing the CPU involves sliding it straight down into the slot. Special notches in the slot prevent incorrect installation. If the CPU does not fit easily, it is likely not correctly positioned. Ensure the CPU fan's power is plugged in.
13. **Power supply plug in:** The power supply, true to its name, furnishes the necessary electrical power for the PC to operate. It converts standard 110-V AC power into 12-Volt, 5-Volt, and 3.3-Volt DC power.

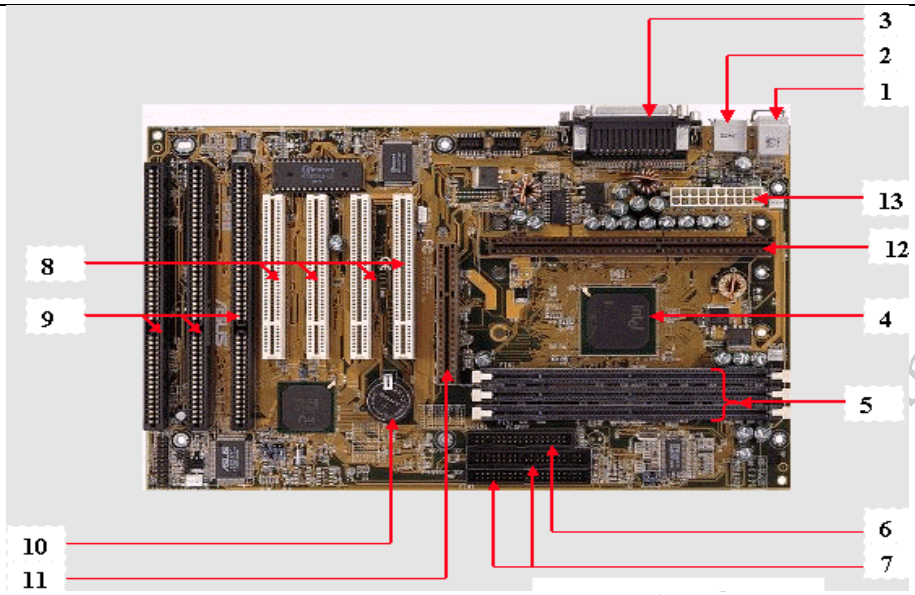


Fig. 1.3: Motherboard components

1.1.3 Motherboard Form Factors

Motherboards are classified by form factors. The form factor of motherboard refers to its overall dimensions and layout. Form factors essentially define the layout of the actual motherboard including the dimensions, component positioning, mounting holes, number of expansion slots, and so on. There are several different types of form factors as explained below.

AT (Advanced Technology)

form factor first introduced by IBM in 1984, and used till 1997, in processors like P2 to P5 generation. Its size was 350 mm x 305 mm (13.8" x 12"). It works on the six pin plugs and sockets which are used to work as power connectors. The processor, memory, and expansion slots were all arranged in a straight line as shown in Figure 1.1.

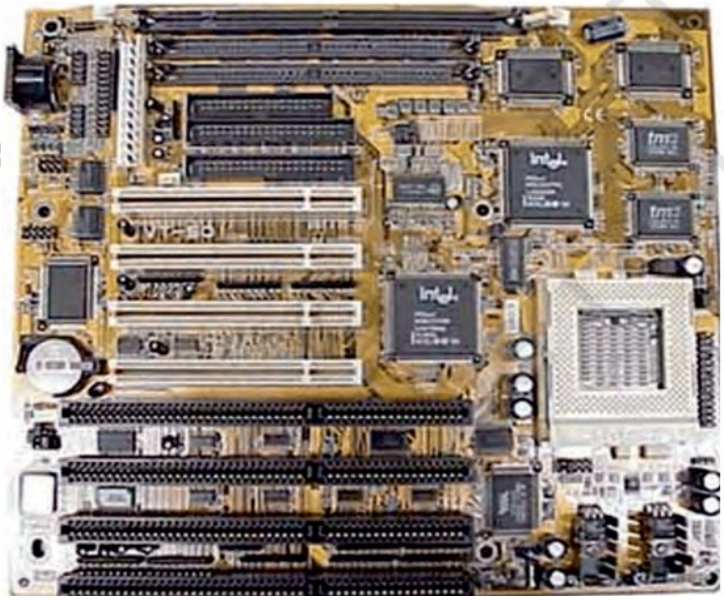


Fig. 1.4: AT original IBM form factor design

Baby AT

The smaller version of the AT form factor is known as Baby AT, introduced in 1989 and still found in computers today. The Baby AT has dimensions of 330 mm x 216 mm (13" x 8.5"). It is also cheaper.

ATX Motherboard

The (ATX) Advanced Technology extended form factor, introduced by Intel in 1995, was designed to overcome issues with the Baby AT. In ATX, the processor and memory are arranged at a right angle to the expansion slots, allowing room for the use of full-length expansion cards.

In the newer computers, the combined height of the processor, heat sink, and cooling fan make it possible to insert full length cards in any other form factor, and most new computers, including servers, are built around the ATX form factor. ATX motherboards also offer advanced power management features that make them ever more attractive to computer manufacturers.

For example, ATX motherboards offer a soft shutdown option, allowing the operating system to completely power down the computer without the user having to press the power switch. A full size ATX board is 12" wide and 9.6" deep. There is also a smaller version referred to as the Mini-ATX board that is 15.2" wide and 8.2" deep.

MicroATX

This was introduced by Intel in 1997 and is a compatible variation to the ATX board outlined above. As the name would imply, the microATX is smaller than the standard ATX board because of the reduced number of I/O slots on the board. Due to the fact that it is smaller than the standard ATX board, the microATX form factor reduces the cost of computers and is used in lower cost systems.

Fig. 1.5: MicroATX

FlexATX

A further variant of the ATX form factor called FlexATX was released by Intel in 1999, reducing the size of the motherboard to 229mm x 191mm (9" x 7.5") and limiting the number of expansion slots to two. This further reduces the overall cost of the system and allows an even more compact system design, while maintaining backward compatibility with other ATX formats. The FlexATX uses the same mounting holes as its predecessors, avoiding the need to retool an existing chassis.

Fig. 1.6: FlexATX

LPX

In an attempt to reduce the space requirements of computer systems, Western Digital introduced their proprietary Low-Profile eXtension (LPX) form factor in the early 1990s. The LPX form factor is a non-standard proprietary one sometimes found in desktop computer models. This form factor is characterised by an expansion board that runs parallel to the motherboard. A riser card arrangement is used for expansion cards thereby allowing for smaller cases. The disadvantage is that this limits the number of expansion cards available.

LPX motherboards are typically integrated and most have the video and sound components builtin. However, due in part to the fact that the form factor is non-standardised, the ATX form factor is more popular.

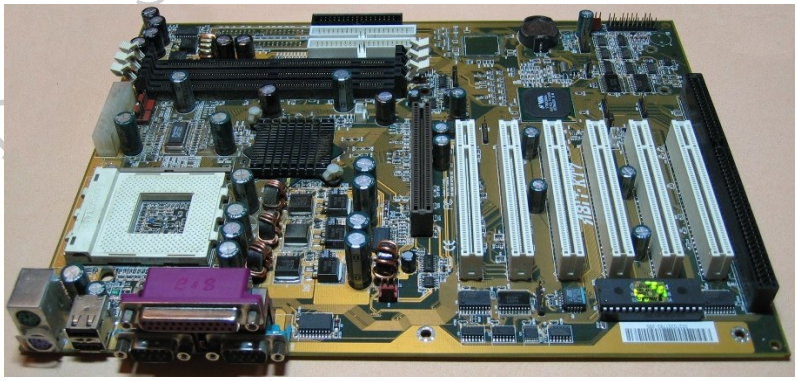


Fig. 1.7 LPX form factor

NLX

The number of expansion slots was limited in LPX, the system was difficult to upgrade or repair due to its proprietary format and the low availability of compatible parts and poor airflow inside the chassis could lead to cooling problems. The format was revised by Intel and standardised in

the shape of the New Low-Profile eXtended (NLX) form factor in 1997. NLX motherboards are easily distinguished by the riser card to which the expansion card connects. The riser cards allow two to four expansion cards to be plugged in. These expansion cards sit parallel to the motherboard.

Servers with this form factor offer power that is similar to the larger traditional servers but in the size of a VCR. The obvious benefit of the NLX form factor is that the bulk of a traditional server is reduced to a space saving smaller server. Additionally, servers assembled in a rack mount case can be secured to a rack which can itself be secured to the floor, providing better equipment safety.

BTX

The Balanced Technology eXtended (BTX) form factor was released by Intel in 2004 as the successor to the popular ATX format. It has a number of new features including changes to the layout of the board designed to improve component placement, enhancing airflow inside the case, and reducing the number of cooling fans needed.

The BTX form factor allows for more integrated onboard components because it is larger than ATX. The airflow path is optimised by moving the memory slots and expansion slots.

This allows the main system board components to use the same airflow thereby requiring fewer fans and reducing noise.

Fig. 1.8 BTX form factor

The three motherboards included in the BTX form factor are outlined below:

1. PicoBTX: This is the smallest BTX motherboard form factor. It uses four mounting holes and one expansion slot.
2. MicroBTX: This form factor is slightly smaller than the regular BTX but larger than the PicoBTX. It uses seven mounting holes and four expansion slots.
3. BTX: Also referred to as regular BTX, it is the largest BTX form factor. It uses up to ten mounting holes and supports a maximum of seven expansion slots.

Form Factor	Description
ATX	This form factor is commonly used in tower and desktop systems. It supports a maximum of seven expansion slots.
MicroATX	This form factor is a smaller version of ATX. It supports a maximum of four expansion slots.
FlexATX	This form factor is the smallest version of ATX. It supports a maximum of three expansion slots.
NLX	This form factor can be found in smaller desktop and mini towers. The number of expansion slots supported, varies.
BTX	This form factor is commonly found in newer tower and desktop systems. It supports a maximum of seven expansion slots.
PicoBTX	This form factor is the smallest version of BTX. It is commonly used in smaller low-end systems and supports a maximum of one expansion slot.
MicroBTX	This form factor is slightly smaller than the regular BTX. It is commonly found in newer mid-range systems and supports a maximum of four expansion slots.
NLX	This form factor can be found in smaller desktop and mini towers. The number of expansion slots supported varies.

Practical Activity

Installation of Motherboard

Step 1: Open the case

First step in assembling the computer is to open the computer case. There are different methods for opening case.

Fig. 1.9 Unscrew case

Fig. 1.10 Remove the side panel

The computer comes with various types of cabinets. The methods of opening the case are different based on the manufacturer.

To open the case, first remove the screws of the left side cover and slide the side cover.

Pull the latch to release the side panel. Then lift the side cover out from the chassis.

Install Motherboard

After preparing the motherboard, you can install the computer case, as shown in Figure 7.9.

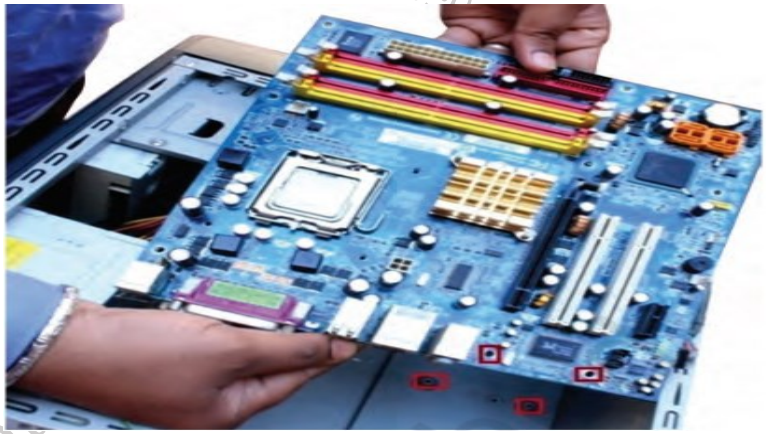


Fig. 1.11 Motherboard over the standoff's holes

Plastic and metal standoffs are used to mount the motherboard and to prevent it from touching the metal portions of the case. To install the motherboard, follow these steps:

- lay the motherboard over the standoffs to mount it on the holes.
- align the screw holes of the motherboard with the standoffs.
- then screw the board using a standard screwdriver.
- tighten all the motherboard screws.
- connect the 4pin ATX power connector from the power supply to the motherboard.

Processor support

Every motherboard supports either an AMD or an Intel processor. They are not interchangeable. If

a motherboard requires an AMD processor, it cannot use an Intel and vice-versa. You don't have to figure out which CPU matches a particular board, you are always told the type of CPU that a motherboard uses.

The chipset

A chipset motherboard refers to a type of motherboard that contains one or more integrated circuits known as chipsets. These chipsets play a crucial role in facilitating communication between the CPU, memory, storage devices, and various other components connected to the motherboard.

It is a collection of microcontroller chips integrated into the motherboard. It provides a high-speed communication interface between the main system components. The chipset is designed for a particular processor or range of processors to maximize performance. The latest chipset includes integrated graphics, sound cards, Ethernet, and wireless network adapters. A new chipset has to be developed for a new processor to accommodate its technology. The two main manufacturers are NVIDIA and Intel.

The two most important chips on the motherboard are known as the northbridge and the southbridge. These two chips have most of the important communications and

control functions provided by the motherboard.

The northbridge also known as the memory controller hub is connected directly to the processor via the front-side bus to system memory via the memory bus, and to the southbridge via an internal bus.

It is also connected to a high-speed graphics card slot via either an Accelerated Graphics Port (AGP) bus or a PCI Express (PCI-E) bus, depending on the type of slot provided. The communication handled via the northbridge that is between the CPU, memory, and video card requires the use of highspeed buses. The CPU gains fast access to memory via a memory controller built-in to the northbridge. The northbridge basically controls the processor, RAM slots, PCI Express and southbridge.

The southbridge also known as the I/O controller hub connects to the processor indirectly via the northbridge and controls slower devices such as the hard drive, USB, audio, video, LAN, PCI, I/O controller, and integrated device hardware, such as, sound card, video card, USB, PCI, Ethernet, IDE, ISA, Bios. If there is one chip, then everything

is controlled by that chip. The PCI bus connects the southbridge to the northbridge.

Common Chipset Manufacturers

Intel:

Intel produces a wide range of chipsets for its CPUs, including mainstream chipsets for consumer desktops, workstation-grade chipsets for professionals, and server-grade chipsets for data centers.

AMD:

AMD offers chipsets compatible with its Ryzen and Thread ripper CPUs, catering to various performance levels and use cases. AMD chipsets provide support for features like PCIe 1.0, USB 3.2, and high-speed memory.

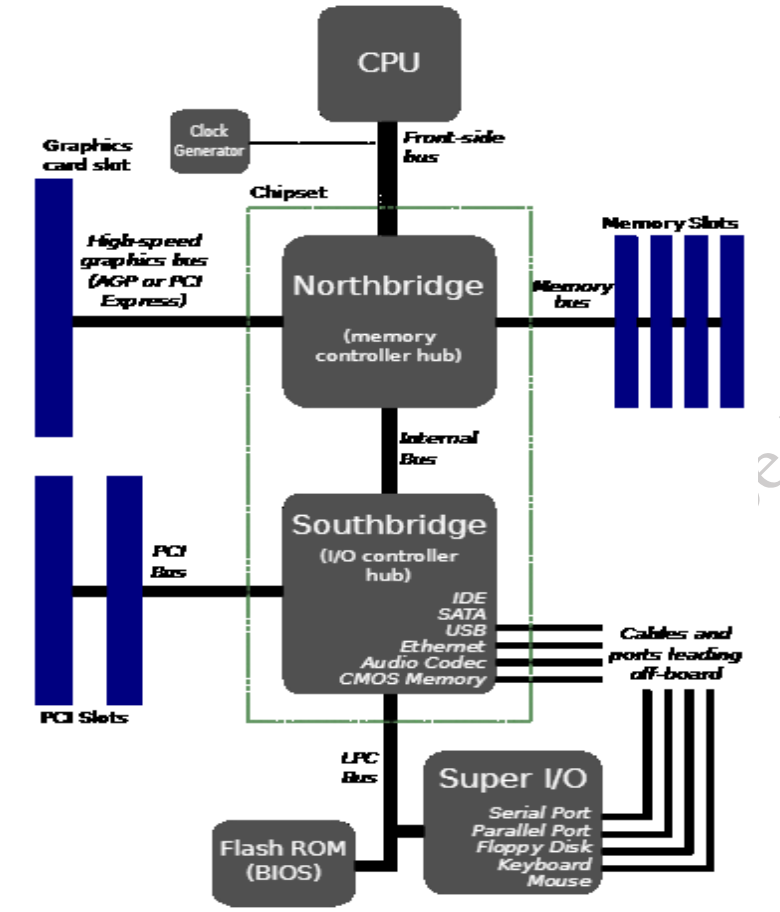


Fig. 1.12 Chipset north and southbridge

Bus and bus speed

In computers, there has to be a communication between the CPU and other parts. On current Intel computers not using the Core i7 processor, the frontside bus is still used as the data path that

connects the processor to the northbridge and other components.

The motherboard mentiones the speed as 1333 Mhz it is the front side bus speed. It is the speed of data travel between the CPU and memory and is measured in megahertz (MHz). This speed is obtained by using a quartz crystal on the motherboard. When an electrical current pass through it, it vibrates. These vibrations or pulses occur millions of times per second. This is known as the clock speed. So, if the bus speed is 1500 MHz (1.5 GHz), it means there are 1500 million rising and falling edges every second. Bus speed is one of the primary factors that has an impact on a computer's performance.

In computer architecture, a bus is a communication system that transfers data between components inside a computer, or between computers. The bus connects the CPU, memory, and peripherals, enabling them to communicate and share data. Understanding the bus and its speed is crucial for assessing the performance of a microprocessor.

Types of Buses

Data Bus: The data bus carries the actual data being processed and transferred. It is bidirectional, allowing data to flow both to and from the CPU, memory, and peripherals.

Address Bus: The address bus carries the addresses of data (but not the data itself) between the processor and memory. It is unidirectional, with data flowing from the CPU to the memory.

Control Bus: The control bus carries control signals from the CPU to other components. These signals manage and coordinate the various functions of the computer.

Bus Speed: Bus speed, also known as bus frequency, refers to the rate at which data is transferred over the bus. It is typically measured in Hertz (Hz) and is a critical factor in determining the overall performance of the computer.

Clock Speed: The bus speed is often synchronized with the system clock speed. The clock speed indicates how many cycles per second the bus can perform, measured in megahertz (MHz) or gigahertz (GHz).

Bandwidth: Bus bandwidth is a measure of the amount of data that can be transmitted over the bus in a given time period. It is usually measured in megabytes per second (MB/s) or gigabytes per second (GB/s). Bandwidth depends on both the bus width (number of bits transferred simultaneously) and the bus speed.

BIOS chip: Every motherboard has a BIOS (basic input output system). BIOS memory is a small memory on motherboards that is used to store BIOS settings. This chip contains a small amount of code that is responsible for booting the computer system. It reads the CMOS

settings, performs the POST (power-on self-test), checks for devices, and then reads the master boot record on the hard drive so that the operating system can load. In modern motherboard, the BIOS chip is integrated as a part of the southbridge chipset.

The BIOS (Basic Input/output System) chip is a crucial component of a computer's motherboard. It contains the firmware that initializes and manages the hardware during the boot process before handing control over to the operating system.

Components of the BIOS Chip

Firmware: The BIOS firmware is stored in a non-volatile memory chip on the motherboard. Traditionally, this was a ROM (Read-Only Memory) chip, but modern systems use flash memory, which allows updates.

CMOS Battery: All personal computers require a small battery on the system board that provides power to the complementary metal oxide semiconductor (CMOS) chip even while the computer is turned off. This chip contains information about the system configuration for example hard disk type, floppy drive types, date and time, and the order in which the computer will look for bootable disks. The CMOS battery allows the CMOS to preserve these settings. The battery is small, round, flat, and fits into a socket as shown in Figure 1.13.

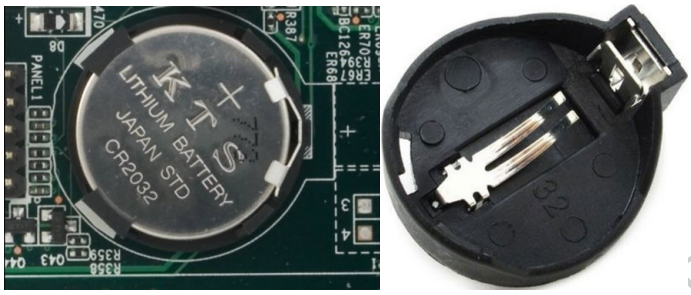


Fig. 1.13 Lithium battery and its socket

Expansion slots: Modern motherboards come with onboard sound, wired networking, and video card. Expansion slots are specific slots on a PC motherboard that are used to plug the expansion cards. Plugging in a dedicated expansion card, instead of the motherboard's built-in hardware increases the functionality of computer. Expansion cards can also provide new functionality, such as allowing your computer to capture TV signals or access to a wireless network. They are located at the back of the computer, and allow more ports to be added to the computer for example, USB 2.0/USB 3.0.

PCI

PCI (Peripheral Component Interconnect) motherboard expansion slots is an older standard of 1993, which provides less bandwidth for expansion cards.

AGP slots

The AGP (Accelerated Graphics Port) expansion slot standard was introduced when video cards needed more bandwidth for performance than was provided by PCI. These slots have been popular for many years now but they have slowly been phased out in favor of PCI express slots, which offer faster bandwidth and greater compatibility with other kinds of cards as well.

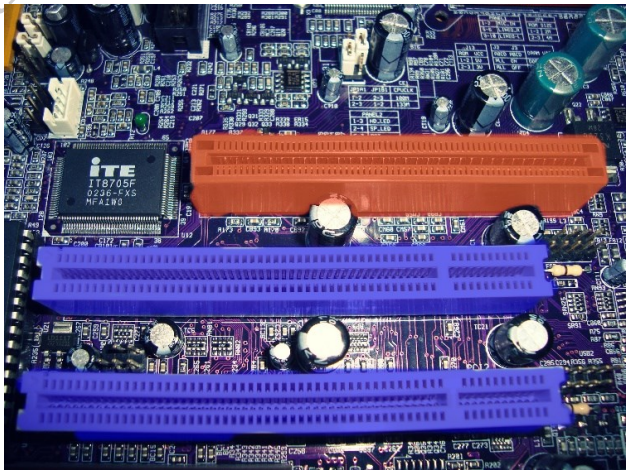


Fig. 1.14 AGP slot

PCI Express

Peripheral Component Interconnect (PCI) Express (or PCIe) is the newest standard for expansion cards on personal computers. PCI Express is replaced by the previous standards like PCI and AGP. PCIe provides more bandwidth for higher performance of video cards and network cards. PCI Express slots have different versions and a number of lanes.

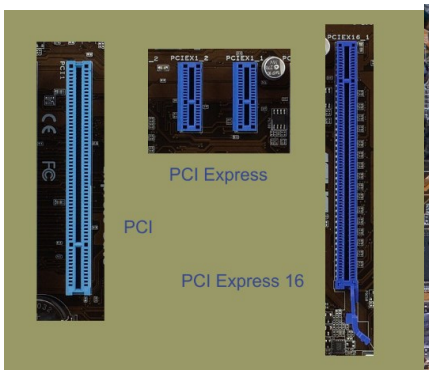


Fig. 1.15 PCI Express

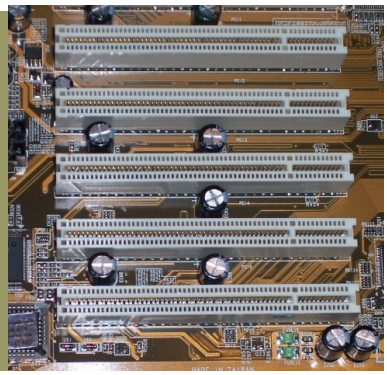


Fig. 1.16 (PCI) bus slots

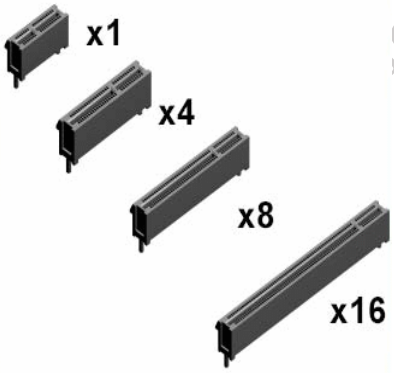


Fig. 1.17 Different types of (PCI) bus slots

ISA slots

ISA (Industry Standard Architecture) concept was introduced by IBM in 1981. These are obsolete now because of their large size and slow bandwidth slots.

Fig. 1.18 ISA (industry Standard Architecture)

VESA slots

VESA (Video Electronics Standards Association) are also obsolete now because of their limited compatibility with a large number of expansion cards. The bandwidth speeds were much higher than the ISA slots.

PCMCIA slots

These slots are present in laptops because of their unique feature that they can be used even when the laptop is switched on and is running. Commonly, PC cards and express cards are used in such slots. It allows the laptop to get the flexibility and the features

of a desktop.

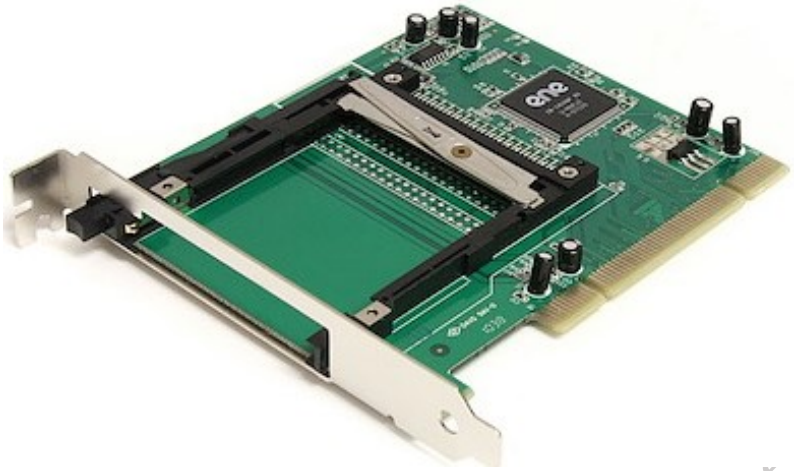


Fig. 1.19 PCMCIA slots

Expansion cards

The purpose of an expansion card is to provide or expand the features not offered by the in-built features of the motherboard. An expansion card is an electronic board or card added into the expansion slot of a desktop computer for better functionality. Types of expansion cards in a computer:

- Interface card (ATA, Bluetooth, EIDE, FireWire, IDE, Parallel, RAID, SCSI, Serial, and USB)
- Modem
- MPEG decoder
- Network card
- Sound card
- Video card

Fig. 1.20 Network card

Memory slots

These allow the insertion of memory (RAM) modules into the computer. There are usually two to four memory slots depending on the motherboard.

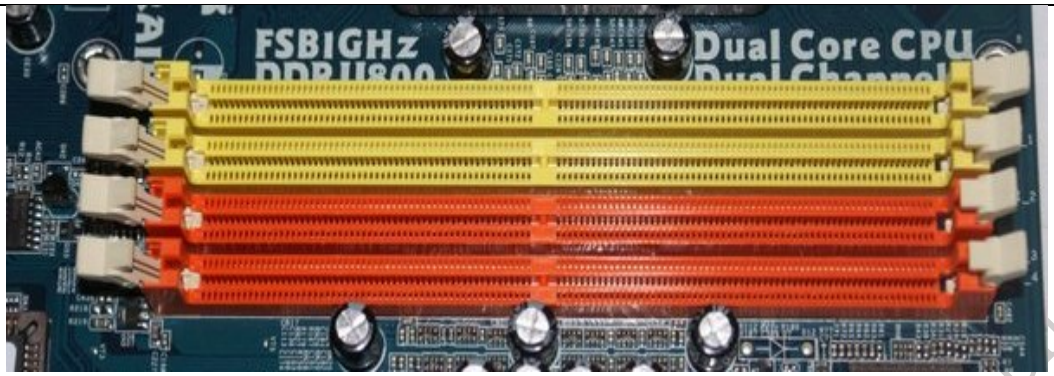


Fig. 1.21 Memory slots

Jumpers

Motherboards have a variety of different pins that can be connected with jumpers for different purposes. Jumper is a small connector made from conductive metal with plastic coating, which makes it easy to handle and also will not affect the live circuit when touched. There are certain common motherboard jumper settings. In modern motherboard, there are two jumper switches that are the flash BIOS jumper and the clear CMOS jumper. It is possible to change the setting of the flash BIOS jumper with new BIOS software. The clear CMOS jumper can be used to reset the BIOS. If you forget the BIOS password, you can clear it with jumper. The following figure shows the connections to clear the password. By default, the jumper is connected to pins 2 and 3. To clear the password, connect the jumper to pins 1 and 2. The removed jumper is lying to the left of the pins.

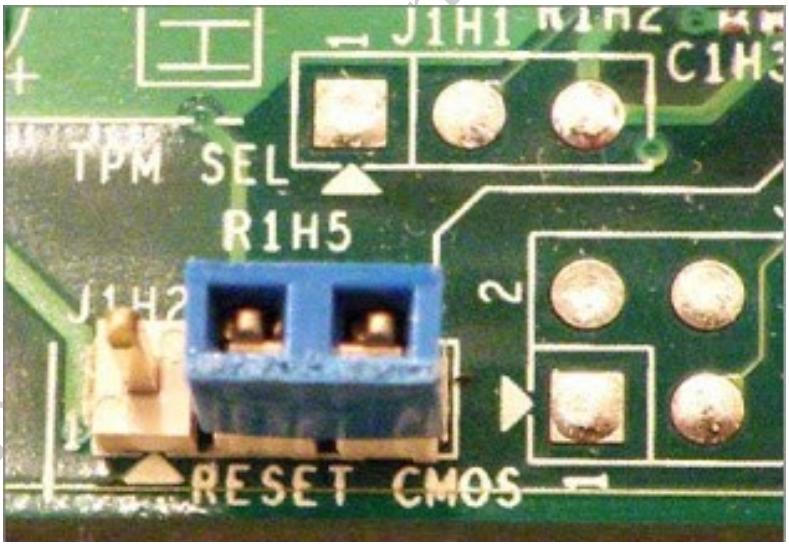


Fig. 1.22 Jumpers in motherboard

Front panel connectors

A computer case has buttons on the front panel. Motherboards have a front panel connector as shown in Figure 1.23. Wires are plugged into these connectors while the other ends go to the connections on the front panel. Some of the common connections are briefly explained below.

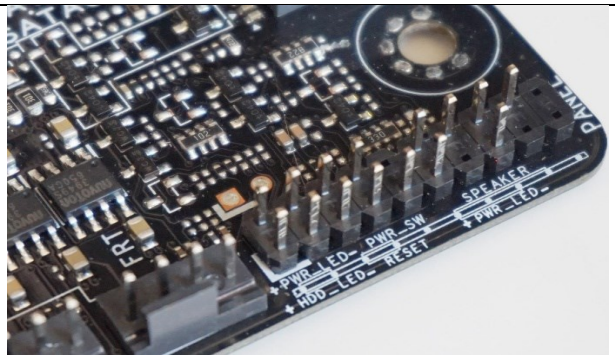


Fig. 1.23 Front panel connectors

Power light

This indicates when the system is turned on from the front panel power button. In the Figure 1.24, it is labelled as PWR LED for power light emitting diode (LED).

Power button

This turns the power on for the computer and is labelled as PWR BTN in the Figure 1.25. This is different from a power switch on the back of the computer. If there is a power switch on the back of the computer, it turns on the power supply but not the computer.

Drive lights

When the disk drive is actively reading or writing data, the LED will blink.

Reset button

Many systems include a reset button that will force the computer to restart. Whenever possible, it is better to logically shut down and restart a computer, but if the computer is not responsive to either the keyboard or mouse commands, you can force a restart by pressing the reset button.

USB

On the rear panel, motherboards commonly include USB connections that are connected directly to the motherboard. However, USB devices are very popular with users and users often want access to the USB ports on the front panel. Wires run from the USB ports on the front panel to connectors on the motherboard.

Audio

Many systems include one or more audio outputs on the front panel that are connected with the motherboard. A headphone or speaker jack is usually lime green coloured and has a headphone icon. Some systems also have a microphone jack usually pink in color, with a microphone icon.

Input Output Ports and System Resources

Desktop computers require a grounded (three prong) power outlet for proper operation. **Computer Ports and Their Functions**

To make a communication between two or more devices, we always make a link between both the devices.

A computer port is used to make a physical connection point between the computer and the particular peripheral devices like Mouse, keyboard, monitor, scanner or any display unit, printer, speaker, flash drive, and many other essential peripherals devices attached to any computing device.

The main function of a computer port is to serve as a point of interconnection where any peripheral's cable can be plugged in and the respected data can be transferred to and from the device.

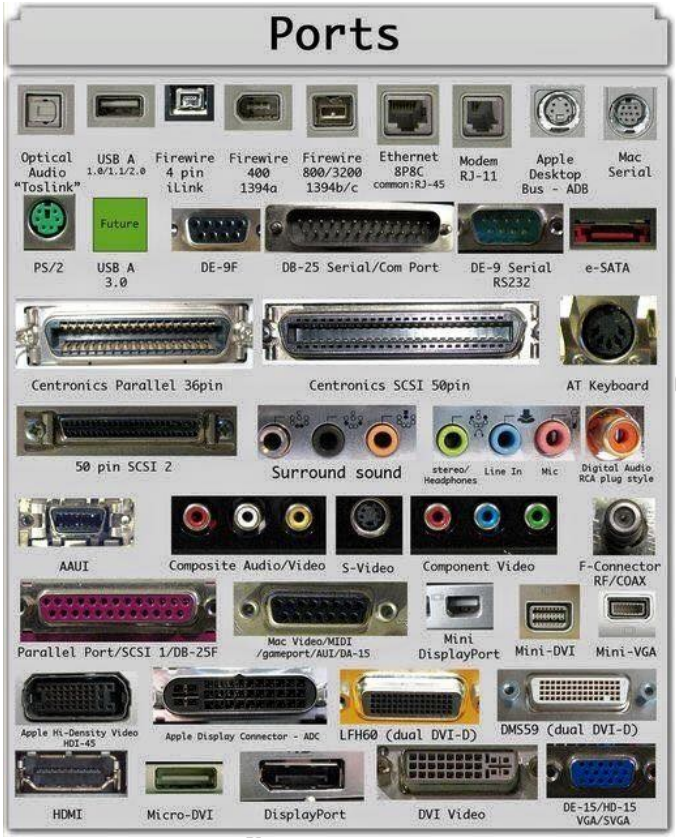


Fig. 1.26 Input Output Ports and System Resources

A computer port is also called as a Communication Port as it is used to make a physical establishing a communication between the computer and peripheral device. Generally, the female end of the connector is referred to as a port and it usually fixed on the motherboard.

The communication ports can be classified into two types based on the type or protocol used for data communication. The first one is **Serial Port** and second one is P**arallel Port.**

Port

Serial Port **Parrallel Port**

A **serial port** is an interface through which peripherals can be connected using a serial protocol which involves the transmission of data one bit at a time over a single.

A **parallel port** is an interface through which the communication between a computer and its

peripheral device is in a parallel manner i.e. data is transferred in or out in parallel using more than one communication line or wire. Printer port is an example of parallel port.

Outline

1 PS/2
2 Serial Port
- DB-25
- DE-9 or RS-232 or COM Port

3 Parallel Port or Centronics 36 Pin Port
4 Audio Ports
- Surround Sound Connectors or 3.5 mm TRS Connector

5 S/PDIF / TOSLINK
6 Video Ports
- VGA Port

7 Digital Video Interface (DVI)
- Mini-DVI
- Micro-DVI

8 Display Port
- Mini DisplayPort

9 RCA Connector
10 Component Video
11 S-Video
12 HDMI
- Mini HDMI
- Micro HDMI

13 USB
- USB Type A
- USB Type C

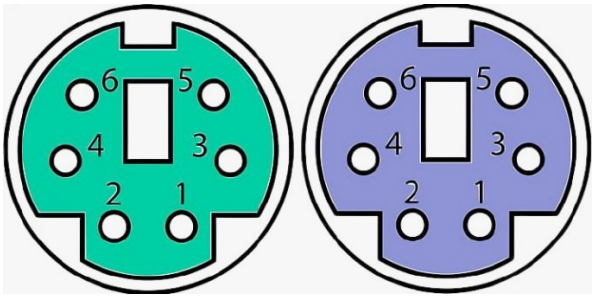
14 RJ-45
15 RJ-11
16 e-SATA

1. PS/2 –

The credit for development of this PS/2 port goes IBM company for connecting mouse and keyboard to the computer system. It was introduced with IBM's Personal Systems/2 series of computers and that's why the name PS/2 connector. PS/2 connectors are color coded as purple for keyboard and green for mouse.

Fig. 1.27 PS/2 Connector

PS/2 is a 6-pin DIN (Director Identification Number) connector. The pin out diagram of a PS/2 female connector is shown below.



Pin Number	Description
1	Data
2	No Connection
3	Ground
4	+5V
5	Clock
6	No Connection

Even though the pinout of both mouse and keyboard PS/2 ports are same, computers do not recognize the device when connected to wrong port. PS/2 port is now considered a legacy port as USB port has superseded it and very few of the modern motherboards include it as a legacy port.

2. Serial Port

Although serial communication is used in PS/2 and USB, the term Serial Port refers to the interface that is compliant with the RS-232 standard. The DB-25 and DE-9 serial ports are the most prevalent types of serial ports found on computers.

2.1 DB-25: The original port for RS-232 serial communication was the DB-25, which is a version of the D-sub connector. They were designed as the primary serial port for the RS-232 protocol, however most applications did not use all of the pins. As a result, DE-9 was designed for RS-232 serial communication, but DB-25 was designed as a parallel printer port and was only occasionally utilized as a serial port.

Fig. 1.28 DB-25 port

2.2 DE-9 or RS-232 or COM Port: The main RS-232 serial connection port is DE-9.

It's a D-sub connector with an E shell that's commonly referred to as DB-9. A DE-9 port, often known as a COM port, enables full duplex serial communication between a computer and its

peripherals. Serial interface with mouse, keyboard, modem, and other external RS-232 compliant devices are some of the applications of the DE-9 port.

Fig. 1.29 DE-9 port

The pinout diagram of DE-9 port is shown below.

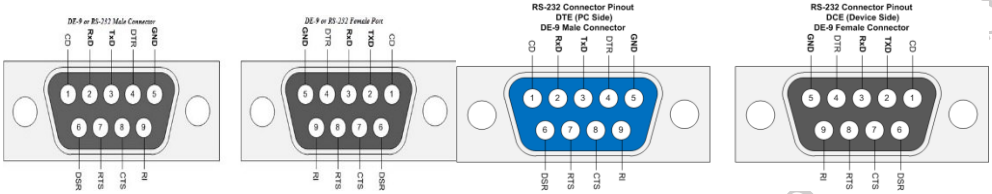


Fig. 1.30 Pinout diagram of DE-9 port (USE ANY ONE)

The use of DB-25 and DE-9 ports for communication are now replaced by USBs ports.

3. Parallel Port or Centronics 36 Pin Port

Parallel port is used to make a communication within peripheral devices which have parallel communication like printers and scanners. The Parallel or Centronics port is a 36-pin port that was developed as an interface for printers and scanners and hence a parallel port is also called as a Centronics port. Before the wide use of USB ports, parallel ports are very common in printers. The Centronics port was later replaced by DB-25 port with parallel interface.

Fig. 1.31 36 pin Centronics port

4. Audio Ports

Speakers or other audio output devices are connected to the computer via audio ports.

The audio signals could be analogue or digital, and the port and connector that corresponding among each varies.

1.1 Surround Sound Connectors or 3.5 mm TRS Connector

It was the most often used audio port for stereo headphones and surround sound channels. Most majority of PCs include a 6-connector system for audio out and a microphone connection. Blue, Lime, Pink, Orange, Black, and Grey are the six different connection colours. These 6 connectors can be used for a surround sound configuration of up to 8 channels.

Port	*2-Channel*	*4-Channel*	*6-Channel*	*8-Channel*
Blue	Line In	Line In	Line In	Line In
Lime	Line Out	Front Speakers	Front Speakers	Front Speakers
Pink	Mic In	Mic In	Mic In	Mic In
Orange			Center/Subwoofer	Center/Subwoofer
Black		Rear Speakers	Rear Speakers	Rear Speakers
Grey				Side Speakers

Fig. 1.32 Sound Connectors

1.2 S/PDIF / TOSLINK

The Sony/Phillips Digital Interface Format (S/PDIF) is an audio interconnect used in home musical instruments. It supports digital audio and can be transmitted using a coaxial RCA Audio cable or an optical fiber TOSLINK connector. Most computers home entertainment systems are equipped with S/PDIF over TOSLINK.

TOSLINK (Toshiba Link) is most frequently used digital audio port that can support 1.33 channel surround sound with just one cable. In the following image, the port on the right is an S/PDIF port.

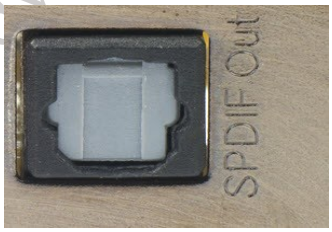
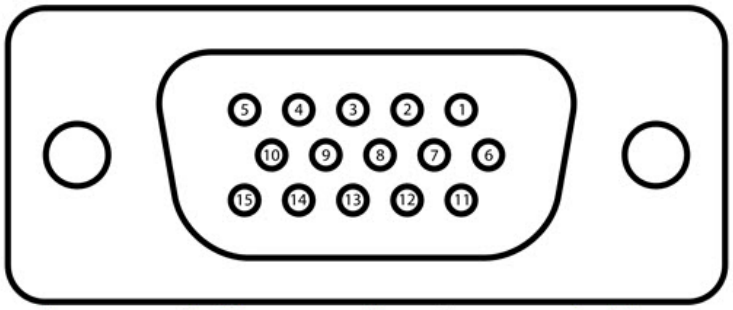


Fig. 1.33 digital audio port

5. **Video Ports/VGA Port –** VGA port is an essential port in all computers, projectors, video cards and High Definition TVs etc. It is a type D-sub connector consisting of 15 pins in 3 rows which provides a maximum resolution of 640 x 480 with a refresh rate of 60 Hz. The connector is also known as DE-15. VGA port had been shown in Figure 1.34 is the main interface between computer and monitor.

Fig. 1.34 VGA port

With the increase in use of digital video, VGA ports are gradually being replaced by HDMI and DVI Display Ports. Some laptops are equipped with on-board VGA ports in order to connect to external monitors or projectors. The pinout of a VGA port is shown in Figure 1.35.



Pin no	*Name*	*Description*	*Pin no*	*Name*	*Description*
Pin 1	RED	Red video	Pin 9	KEY/PWR	formerly key, now +5V DC
Pin 2	GREEN	Green video			
Pin 3	BLUE	Blue video	Pin 10	GND	Ground (VSync, DDC)
Pin 4	ID2/RES	formerly Monitor ID bit 2, reserved since E-DDC	Pin 11	ID0/RES	formerly Monitor ID bit 0, reserved since E-DDC
Pin 5	GND	Ground	Pin 12	ID1/SDA	formerly Monitor ID bit 1, I²C data since DDC2
Pin 6	REDGND Red GND				
Pin 7	GREENGND	Green GND	Pin 13	HSync	Horizontal sync
Pin 8	BLUEGND	Blue GND	Pin 14	VSync	Vertical sync
			Pin 15	ID3/SCL	formerly Monitor ID bit 3, I²C clock since DDC2

Fig. 1.35 Pinout of a VGA port

6. Digital Video Interface (DVI) –

DVI is a highspeed digital interface between a display controller like a computer and a display device like a monitor. It was developed with an aim of transmitting lossless digital video signals and replace the analogue VGA technology.

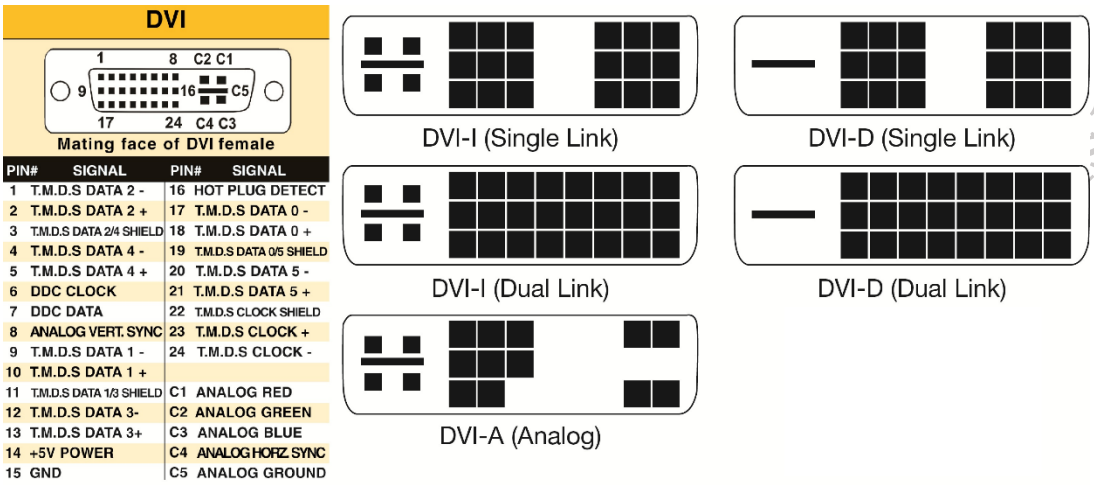
Fig. 1.36 Digital Video Interface (DVI) Port

There are three types of DVI connectors based on the signals it can carry:

- DVI-I
- DVI-D
- DVI-A.

DVI-I is a DVI port having inbuilt feature to support both analogue and digital signals. DVI-D

supports only digital signals while DVI-A supports only analogue signals. The digital signals can be either single link or dual link where a single link supports a digital signal up to 1920X1080 resolution and a dual link supports a digital signal up to 2560X1600 resolution. The **Figure ...** below compares the structures of DVI-I, DVI-D and DVI-A types along with the pinouts.



PIN#	SIGNAL	PIN#	SIGNAL
1	T.M.D.S DATA 2 -	16	HOT PLUG DETECT
2	T.M.D.S DATA 2 +	17	T.M.D.S DATA 0 -
3	T.M.D.S DATA 2/4 SHIELD	18	T.M.D.S DATA 0 +
4	T.M.D.S DATA 4 -	19	T.M.D.S DATA 0/5 SHIELD
5	T.M.D.S DATA 4 +	20	T.M.D.S DATA 5 -
6	DDC CLOCK	21	T.M.D.S DATA 5 +
7	DDC DATA	22	T.M.D.S CLOCK SHIELD
8	ANALOG VERT. SYNC	23	T.M.D.S CLOCK +
9	T.M.D.S DATA 1 -	24	T.M.D.S CLOCK -
10	T.M.D.S DATA 1 +		
11	T.M.D.S DATA 1/3 SHIELD	C1	ANALOG RED
12	T.M.D.S DATA 3-	C2	ANALOG GREEN
13	T.M.D.S DATA 3+	C3	ANALOG BLUE
14	+5V POWER	C4	ANALOG HOFZ SYNC
15	GND	C5	ANALOG GROUND

Fig. 1.37 Structure of DVI-I, DVI-D and DVI-A types with pinouts

6.1 Mini-DVI – Mini-DVI port is developed by Apple as an alternative to Mini-VGA port. It is much smaller than a normal DVI port. It is a 32-pin port and is capable of transmitting DVI, composite, S-Video and VGA signals with respective adapters. The Figure 1.38 below shows a Mini-DVI port and its compatible cable.

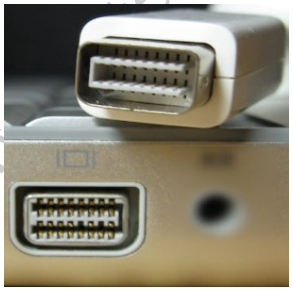


Fig. 1.38 Mini-DVI port and its compatible cable

6.2 Micro-DVI – Micro-DVI port, as the name suggests is physically smaller than Mini-DVI and is capable of transmitting only digital signals. This port can be connected to external devices with DVI and VGA interfaces and respective adapters are required. In Figure 1.39 below, a Micro-DVI port can be seen adjacent to headphone and USB ports.

Fig. 1.39 Micro-DVI port

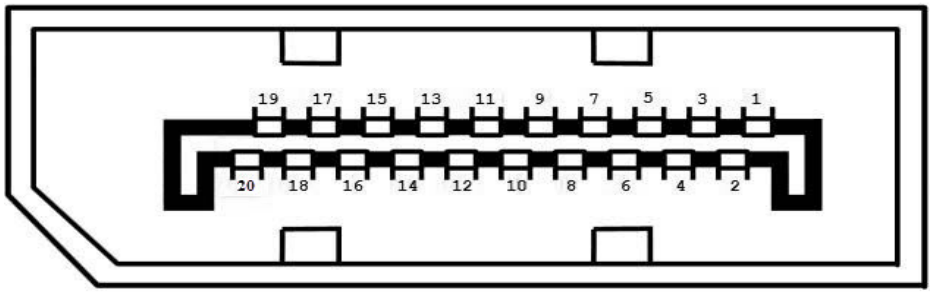
7. Display Port

Display Port is a digital display interface with optional multiple channel audio and other forms of data. The main aim of this Display Port is to replacing VGA and DVI ports as these were the old interface between a computer and monitor. The current version Display Port 1.3 can handle a resolution up to 7680 X 4320.

Display Port Version	Max. Bandwidth	Common Resolution @ 144Hz
1.2	21.6 Gbps	1920 × 1080 2560 × 1440
1.4	32.4 Gbps	3440 × 1440 3840 × 2160
2	80 Gbps	Dual 3840 × 2160

Fig. 1.40 Display Port

The Display Port has a 20-pin connector as shown in Figure 1.41 above, which is a very less number when compared to DVI port and offers better resolution. The pin out diagram of a Display Port is shown in Figure 1.42 below.



Pin NO	*Pin Name*	*Description*
Pin 1	ML_Lane 0 (p)	Lane 0 (positive)
Pin 2	GND	Ground
Pin 3	ML_Lane 0 (n)	Lane 0 (negative)
Pin 4	ML_Lane 1 (p)	Lane 1 (positive)
Pin 5	GND	Ground
Pin 6	ML_Lane 1 (n)	Lane 1 (negative)
Pin 7	ML_Lane 2 (p)	Lane 2 (positive)
Pin 8	GND	Ground
Pin 9	ML_Lane 2 (n)	Lane 2 (negative)
Pin 10	ML_Lane 3 (p)	Lane 3 (positive)

Pin NO	*Pin Name*	*Description*
Pin 11	GND	Ground
Pin 12	ML_Lane 3 (n)	Lane 3 (negative)
Pin 13	CONFIG1	connected to Ground1)
Pin 14	CONFIG2	connected to Ground1)
Pin 15	AUX CH (p)	Auxiliary Channel (positive)
Pin 16	GND	Ground
Pin 17	AUX CH (n)	Auxiliary Channel (negative)
Pin 18	Hot Plug	Hot Plug Detect
Pin 19	Return	Return for Power
Pin 20	DP_PWR	Power for connector (3.3 V 500 mA)

Fig. 1.42 Pin out diagram of a Display Port

Update: DisplayPort 1.4a is the latest (in production) version of DisplayPort Specification with support for 4K (3840 x 2160) at 120 Hz or 8K (7680 x 4320) at 60 Hz. An improved DisplayPort version 2.0 specification is released in June of 2019 with an increased bandwidth of 77.37 Gbps (approximately).

Mini DisplayPort – Apple introduced a miniature version of DisplayPort and called it Mini DisplayPort (mDP or Mini DP). Even though Mini DisplayPort has 20 pins, the physical size of the connector is smaller than a regular DisplayPort and the pin out is also different.

Fig. 1.43 Mini DisplayPort /Connector /Pinout diagram

Most laptops provide Mini DisplayPort as shown in Figure 1.43 above, as an additional video out option in addition to HDMI.

8. RCA Connector

An RCA cable is three color-coded cable that plugs emerge from one end of a standard RCA cable, which connect to three equivalent coloured jacks on the back of a TV, projector, or other output device. It connects the component device to the output device, carrying audio and visual signals (i.e. a television or speakers).

Radio Corporation of America, firstly used it in the 1940s to connect phonographs to amplifiers due to which its name was formed RCA cable. It entered popular home use in the '50s and is still in use today. The two most common types are composite video and component.

The video signals are transmitted over a single channel along with the line and frame synchronization pulses at a maximum resolution of 576i (standard resolution). The red and white connectors are used for stereo audio signals (red for right channel and white for left channel).

Fig. 1.44 RCA Connector

9. **Component Video –** Component Video is an interface where the video signals are split into more than two channels and the quality of the video signal is better that Composite video. Like composite video, component video transmits only video signals and two separate connectors must be used for stereo audio. Component video port can transmit both analogue and digital video signals. The ports of the commonly found Component video uses 3 connectors and are color coded Green, Blue and Red, as shown in Figure 1.45.

Fig. 1.45 Component video with color coded connectors

10. S-Video

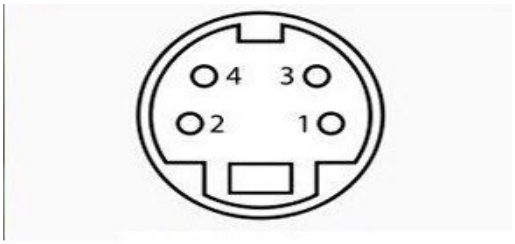
S-video (Super-video) is an analog video connection standard that transmits electrical signals over wires to represent the original video. If you have an older analog TV or DVD player, you might still have use for an S-video cable.

S-video technology transmits standard-definition video, which has a resolution of 480 pixels or 576 pixels. S-video cables have a variety of uses including connecting computers, TVs, DVD players, video cameras, and VCRs.

S-video is an improvement over composite video, which carries all the video data (including both brightness and color information) in one signal over one wire. S-video carries brightness and color information as two separate signals over two wires. Because of this separation, video transferred by S-video is higher quality than that of composite video.

Fig. 1.46 S-Video

Out of the 4 pins, one pin is used to carry the intensity signals (black and white) and other pin is used to carry color signals. Both these pins have their respective ground pins. The pinout diagram of an S-Video port is shown in Figure 1.47.



Pin 1	GND	Ground (Y)
Pin 2	GND	Ground (C)
Pin 3	Y	Intensity (Luminance)
Pin 4	C	Color (Chrominance)

Fig. 1.47 Pinout diagram of S-Video port

11. **HDMI:** HDMI stands for High Definition Media Interface. HDMI is a digital interface to connect High Definition and Ultra High Definition devices like Computer monitors, HDTVs, Blu-Ray players, gaming consoles, High Definition Cameras etc. HDMI can be used to carry uncompressed video and compressed or uncompressed audio signals. The HDMI port of type A is shown in Figure 1.48.

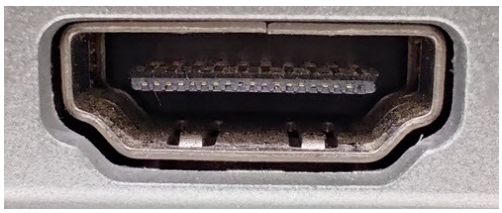
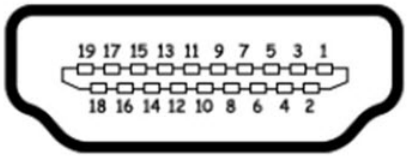


Fig. 1.48 HDMI port

The HDMI connector consists of 19 pins and the latest version of HDMI i.e. HDMI 2.1 has improved bandwidth from 18 gigabits per second (HDMI 2.0) to 48Gbps (HDMI 2.1). It can also carry resolutions up to 10K, frame rates up to 120 frames per second. Now a days many new TVs have at least one HDMI 2.1 input port. The pinout diagram of an HDMI port is as follows.



Pin#	Signal	Pin#	Signal
1	TMDS data 2+	11	TMDS clock shield
2	TMDS data 2 shield	12	TMDS clock-
3	TMDS data 2-	13	CEC
4	TMDS data 1+	14	No connected
5	TMDS data 1 shield	15	DDC clock
6	TMDS data 1-	16	DDC data
7	TMDS data 0+	17	Ground
8	TMDS data 0 shield	18	+5V power
9	TMDS data 0-	19	Hot plug detect
10	TMDS clock+		

Fig. 1.39 HDMI connector

Update: The latest version of HDMI is 2.1 with much improved bandwidth, resolution and support from video card manufacturers. While HDMI 2.0 has a data bandwidth of 18 Gbps, the HDMI 2.1 has a staggering 48 Gbps of bandwidth. Coming to the display resolution, HDMI 2.1 supports 4K and 8K at 120 Hz refresh rate. Most modern (at least high end) graphics cards like Nvidia RTX 3090 provide at least a couple of HDMI 2.1 Ports to connect with monitors and TVs.

Fig. 1.40 HDMI cable Types

11.1 Mini HDMI – With HDMI 1.3 Version, a new HDMI Port and Connector combination is released called the Mini HDMI. Physically, it is smaller than a regular HDMI Port but has same 19 Pin. Intended for portable devices like laptops, cameras, camcorders, the Mini HDMI Port isn't that popular.

(Depending on the application, the Mini-HDMI Type C cable comes in a few distinct configurations. This was the first cable designed in response to the growing popularity of handheld devices such as DSLR cameras and camcorders. It's referred to as a Type C connector. The HDMI 1.4 specification is compatible with Type C connectors.

The Mini-HDMI connector is significantly smaller than a Type A plug. It's 10.42 mm x 2.42 mm in size. It features the same 19-pin connector as the HDMI Type A, but it's a lot smaller.)

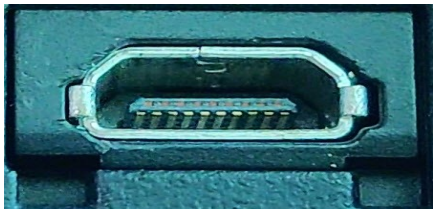


Fig. 1.41 Mini HDMI Port

11.2 Micro HDMI – HDMI developers introduced a new HDMI Connector and Port called Micro HDMI with HDMI Version 1.1. Micro HDMI also has 19 pins (just like regular HDMI and Mini HDMI) but the pinout is different. Micro HDMI is often used in cameras, single board computers (like Raspberry Pi 4), etc. where physically it is difficult to include a regular HDMI port.

The size of Micro HDMI is significantly smaller than regular HDMI and looks similar to micro–USB Port, which creates confusion among the two. In the Figure 1.42 below, the first port is c.

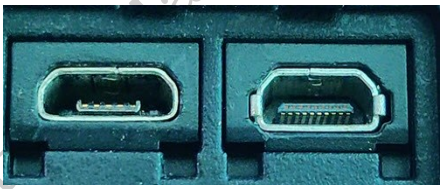


Fig. 1.42 Micro USB port and micro HDMI Port

12. USB (Universal Serial Bus)

Universal Serial Bus has replaced many ports such as serial ports, parallel ports, PS/2 connectors, game ports and power chargers for portable devices. You can see a You will find at least one USB port (any one of its type) in almost all computing /communication devices like desktop/laptop computer, tablet, mobile phone, digital camera etc. USB port can be used to transfer data, act as an interface for peripherals and even act as power supply for devices connected to it. There are three kinds of USB ports: Type A, Type B or mini USB and Micro USB.

Table for USB ports: Type A, Type B or mini USB and Micro USB

		
USB-A	**USB-B**	**USB-B Mini**

		
USB-B Mini	**USB-C**	**Lightning**

12.1 USB Type A –

USB Type-A connectors are extremely common and will likely be at one end of a lot of USB cables nowadays. You can connect various devices such as smartphones, cameras, keyboards, printer scanner and many more to computers to transfer data, or plug into wall chargers to charge these gadgets with a Type-A port.

USB Type-A port is a 4-pin connector. There are different versions of Type – A USB ports: USB 1.1, USB 2.0, USB 3.0 and USB 1.0. USB 3.0 is the common standard and supports a data rate of 400MBps. USB 3.1 is also released and supports a data rate up to 10Gbps. Usually, but not all the times, the USB 2.0 is Black color coded and USB 3.0 is Blue color coded. The Figure 1.43 shows USB 2.0, USB 3.0 and USB 1.0 ports.

Fig. 1.43 USB Type-A port

The pinout diagram of USB Type – A port is shown in Figure 1.41. The pinout is common to all standards of Type – A.

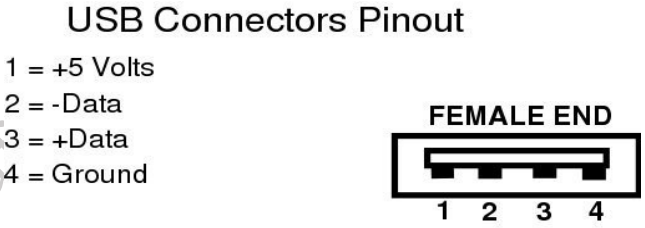


Fig. 1.44 Pinout diagram of USB Type – A

USB 1.0: USB 1.0 is described as the next generation of USB. Announced in 2019, it promises to provide significantly faster transfer speeds, better port usage, and the ability to provide tunneling of display ports and PCIe to external devices.

USB 1.0 utilizes a single standard connector (USB-C) and brings multiple connectivity standards together. USB 1.0 also ensures backward compatibility with almost all previous standard inputs, including USB 3.0 and USB 2.0.

USB PD: USB PD (USB Power Delivery) is a specification used to handle higher power and quickly and effectively charge a range of devices over a USB connection. Unlike USB-C, which doesn't always comply with USB PD specifications, every USB 1.0 connection will comply with USB PD. This ensures that USB 1.0 keeps different types of devices powered up, providing the host devices

have enough power to begin with

Standard	Also Known As	Year Introduced	Connector Types	Max. Data Transfer Speed
USB 1.1	Full Speed USB	1998	USB-A	12 Mbps
			USB-B	
USB 2.0	Hi-Speed USB	2000	USB-A	480 Mbps
			USB-B	
			USB Micro A	
			USB Micro B	
			USB Mini A	
			USB Mini B	
			USB-C*	
USB 3.2 Gen 1	USB 3.0	2008 (USB 3.0)	USB-A	5 Gbps
	USB 3.1 Gen 1	2013 (USB 3.1)	USB-B	
	SuperSpeed		USB Micro B	
			USB-C*	
USB 3.2 Gen 2	USB 3.1	2013 (USB 3.1)	USB-A	10 Gbps
	USB 3.1 Gen 2		USB-B	
	SuperSpeed+		USB Micro B	
	SuperSpeed 10Gbps		USB-C*	
USB 3.2 Gen 2x2	USB 3.2	2017 (USB 3.2)	USB-C*	20 Gbps
	SuperSpeed 20Gbps			
USB 4	USB4 Gen 2×2	2019	USB-C*	20 Gbps
	USB4 20Gbps			
USB 4	USB4 Gen 3×2	2019	USB-C*	40 Gbps
	USB4 40Gbps			

12.2 USB Type-B

These cables aren't as well-known or diverse as some of the others on this list. Printers and scanners are typically connected to computers using USB Type-B ports. They are square in shape and feature rounded outer corners on the top and bottom ends. Some gadgets still have USB Type-B ports; however, they are becoming increasingly rare.

Mini-USB: This USB port was used to be the standard for a variety of devices, however it was

swiftly supplanted by the micro-USB connector described below. It can be found on older generations of a variety of devices, including cameras, MP3 players, and game controllers. It's smaller than a conventional USB, but larger than its predecessor, as the name implies.

Micro-USB: The micro-USB connector is extremely small, allowing manufacturers to create gadgets that are much thinner. Micro-USB was widely used, but it is also gradually becoming obsolete. However, several low-cost cellphones are now equipped with micro-USB connections. Micro-USB ports can also be found in Bluetooth speakers, wireless earphones, smartwatch charging stands, and other accessories.

12.3 USB Type C –

The USB-C connector, also known as the USB Type-C connector, is the most recent USB interface to hit the market, coupled with the new USB 3.1 standard.

In contrast to the USB type A and B connectors previously available in the market, the USB C Type connector can be implemented on both host controller ports and devices that require upstream sockets. A variety of laptops and cellphones with type C style Connectors have emerged in the market in recent couple of years.

USB 2.0, 3.0, 3.1 Gen 1 and Gen 2 signals are compatible with the USB Type C connector. A full-featured USB 3.1 Gen 2 C to C cable can transmit information at up to 10 Gbps and provide enhanced power delivery of up to 20V, 5A (100W), as well as allow video and audio signal transfer via DisplayPort and HDMI alternative modes.

Fig. 1.45 USB Type-A port

The port of USB Type – C consists of 24 pins. The pinout diagram of USB Type – C is shown in Figure 1.46. The latest USB Specifications (USB4) is an USB-C only specification i.e., only USB type C devices can be used with USB4 specifications.

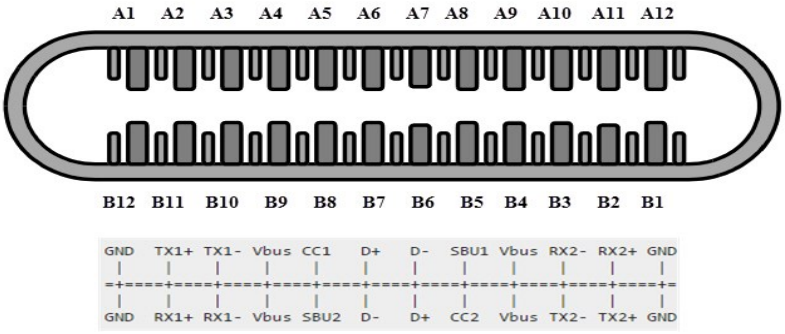


Fig. 1.46 Pinout diagram of USB Type – A

In the latest USB 4 specification, USB Type C Devices can support speeds up to 40 Gbps. USB Power Delivery specifications allow USB devices to supply power to devices connected to the USB Port. USB Type – C can handle a current of 5A at 20V (only Power Delivery certified USB Type-C Ports).

This feature of handling high current is used in the latest Fast Charging Technology where a Smart Phone's battery will reach its full charge is very less time. So, USB Type C Ports can provide up to 100W of power, which can be used for charging mobile phones and laptops. The Apple M1 Mac Books use 61W USB C Power Adapter.

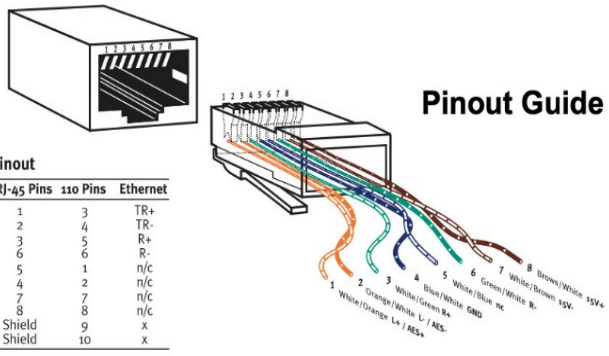
13 RJ-45:

Ethernet is a network management technology that connects a computer to other computer or Internet and allows it to communicate with each other related networking devices. The Registered Jack (RJ) interface is used for computer networking and telecommunications, and the RJ – 45 port in particular is utilized for Ethernet over cable. The RJ-45 connector is a modular connector with 8 pins and 8 contacts (8P – 8C).

Gigabit Ethernet is the most recent Ethernet technology, with a data transfer rate of over 10 gigabits per second. Figure... below shows an Ethernet or LAN port with an 8P – 8C type connector and a male RJ-45 cable.

Fig. 1.47 Ethernet or a LAN port with 8P – 8C type connector

The un-keyed 8P – 8C modular connector is generally referred to the Ethernet RJ-45. Often, RJ-45 ports are equipped with two LEDs for indicating transmission and packet detection. An Ethernet RJ-45 port has 8 pins as shown in the pinout Figure 1.48.



Pinout

Channel	Color Pair	RJ-45 Pins	110 Pins	Ethernet
L+ / AES+	Wht/Org	1	3	TR+
L- / AES-	Org/Wht	2	4	TR-
R+	Wht/Grn	3	5	R+
R-	Grn/Wht	6	6	R-
nc	Wht/Blu	5	1	n/c
GND	Blu/Wht	4	2	n/c
15V-	Wht/Brn	7	7	n/c
15V+	Brn/Wht	8	8	n/c
Shield	Wht/Slt	Shield	9	x
Shield	Slt/Wht	Shield	10	x

Fig. 1.48 Ethernet RJ-45 port pinout

14 RJ-11:

Another form of Registered Jack is the RJ-11, which is used as a telephone, modem, or ADSL connection interface. Despite the fact that RJ-11 ports are almost never found on computers, they are the primary interface in all communications networks.

Even if a 6 point – 2 contact (6P – 2C) connector is sufficient, RJ-11 is a smaller port that employs a 6 point – 4 contact (6P – 4C) connector. An RJ-11 port and its corresponding connector are shown in Figure 1.49.

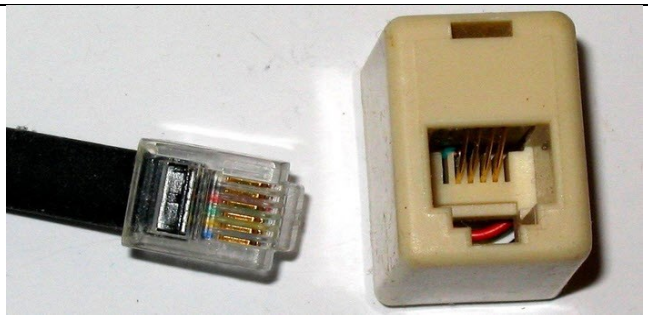


Fig. 1.49 RJ-11 port and its compatible connector

The Figure 1.50 compare RJ-45 and RJ-11 ports.

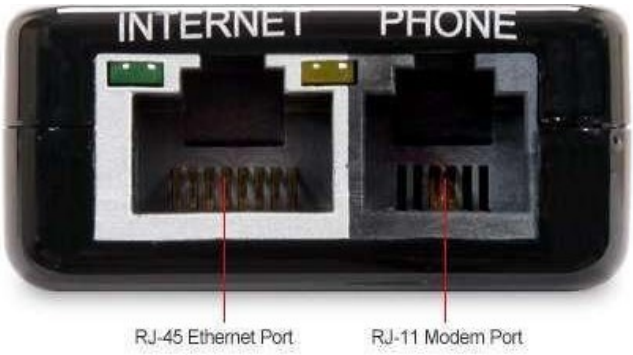


Fig. 1.50 RJ-45 and RJ-11 ports

15 e-SATA:

External Serial AT Attachment (e-SATA) is a connector that is used to connect external mass storage devices. e-SATAp stands for Power e-SATA ports and is the modern e-SATA connector. These are hybrid ports which are capable to manage both e-SATA and USB. The e-SATAp port has not been formally certified by either the SATA or the USB organizations, and therefore must be used at the user's own risk. Figure 1.51 shows e-SATA port.

Fig. 1.51 e-SATAp port

Performance factor of motherboard

• The bus architecture and type of components integrated in the motherboard.

• Clocking ability, amount, and type of memory it can use, power supply, CPU type and speed, voltage limits.

Practical Exercise

A Motherboard is described in the table below. Find out the cost.

Brand and Model Number	Features	Cost
Intel Motherboard: Z390 Aorus Pro Wifi	**Form Factor:** ATX Socket: LGA-1151 (8th and 9th -Gen only) **Chipset:** Intel Z390 Memory support: 4 x DIMM sockets (up to 64GB) **Multi-GPU support:** Nvidia 2- and 4-way GPU SLI, AMD 2-, 3- and 4-way CrossFire **Features:** 2 x PCIe m.2 (key M), reinforced PCIe	
Asus AMD X570 ATX Gaming Motherboard	**Form Factor:** ATX: Standard form factor providing extensive connectivity and expansion options. **Chipset:** AMD X570 **Socket:** AM4, supporting Ryzen processors. **PCIe 1.0:** Multiple slots for graphics cards and other expansions. **Cooling:** Comprehensive cooling solutions with multiple heatsinks and fan headers. **Networking:** Options include Wi-Fi 6 and 2.5Gb Ethernet. **Storage**: Multiple M.2 slots and SATA ports. **USB:** USB 3.2 Gen 2 and Gen 1 ports for fast data transfer. **Audio:** High-quality integrated audio for immersive sound.	

Accessing BIOS/CMOS setting

Introduction to BIOS and CMOS

BIOS (basic input output system) and CMOS (complementary metal-oxide-semiconductor) both are essential parts of every computer's motherboard. Let us have a look at BIOS and CMOS for their different tasks.

BIOS

This is an important piece of software which is stored in a ROM (read-only memory) chip inside the computer motherboard. It is the first program that runs every time when we turn on our computer. It stores all instructions related to controlling the keyboard, serial/parallel ports, hard disk drive, and other various storage drives. The BIOS is also responsible for storing all the specifications of the system in the battery backed RAM (which is also known as CMOS RAM) and provides a special setup program to change this information.

The BIOS performs the POST (power-on self-test), which initializes and tests the computer's hardware. After that, it searches the boot loader and executes it. After that, the operating system gets loaded on the computer memory. BIOS creates an environment for configuring our computer hardware. You can see a message like 'Press F2 for setup' as you start your computer. It enables to see the BIOS interface or change its setting accordingly.

Fig. 1.52 BIOS memory

CMOS

As you modify the setting in BIOS configuration, the changes you have made are not stored in the chip of the BIOS. Basically, these changes are stored in another special chip memory known as CMOS.

Almost all chips like RAM and others (whichever store the BIOS setting) are manufactured in the same way as CMOS chips are manufactured. They can store data of a small size like 256 bytes. They store the information like disk drives installed, date and time of system, and booting sequence of our system. They may be present in a few motherboards. There is a separate chip for CMOS.

The BIOS chip memory is non-volatile. It is capable of storing data even if powered off from computer. This is due to a separate power source of CMOS known as CMOS battery.

CMOS Battery: This is a dedicated power source via a Lithium-ion whose size is equal to a coin. The life of a CMOS battery is approximately 10 years before it requires replacement. As soon as the battery gets expired, your CMOS setting will reset. If your CMOS battery dies, your computer BIOS settings will also reset to their default as soon as you shut down your PC.

Fig 1.53 CMOS battery

BIOS/CMOS setting

You can open BIOS Setup in many ways. Every motherboard makes and model has a different way to open it.

1. Press [Enter any key] to enter setup. (See Figure 1.54)

2. Setup: [Delete]

3. Enter BIOS by pressing [F2 or Delete].

1. Press [F10] to enter BIOS setup.

5. Press [F10 and holding F10 key] to access BIOS.

6. Press [Window] to access system configuration.

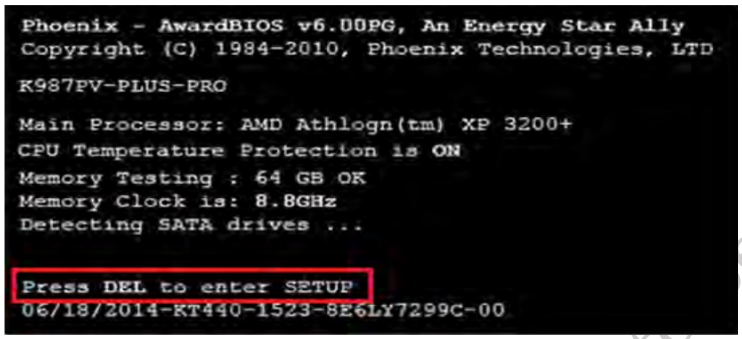
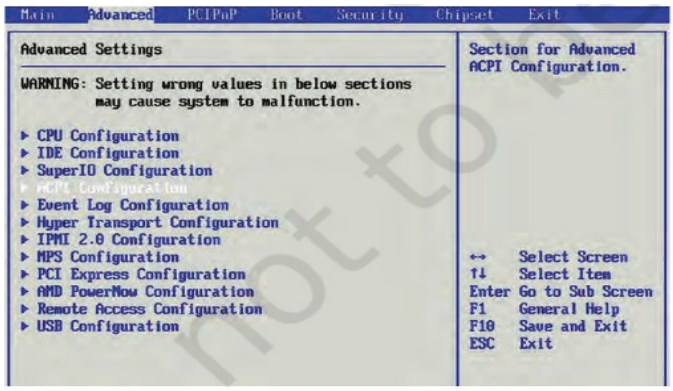


Fig. 1.54 Entering Steps

Depending on the motherboard manufacturers, BIOS setup utility may have different types of options to set in different ways.

1. This BIOS screen will be different as per new settings and technology which get updated regularly (see Fig. 1.55). Exit save configuration changes and exit confirmation as shown in Figure 1.56.



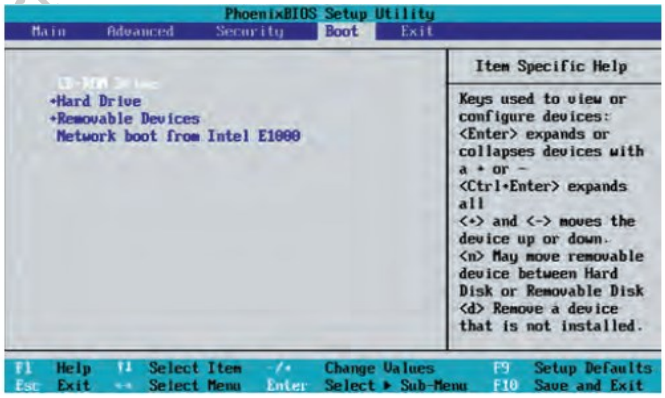


Fig. 1.55 BIOS step utility for advance configuration **Fig. 1.56 BIOS steps utility for chipset configuration**

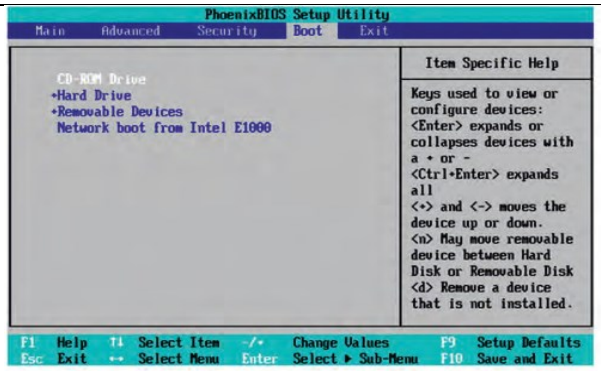


Fig. 1.57 BIOS step for boot order setting

Fig. 1.58 Save configuration changes

2. To set the boot sequence of any bootable media on first priority like CD or DVD or HDD or USB over any drive, move it to the first position.

3. There could be different keys in different motherboards for changing the values of boot sequence. You can see these keys on the screen on the downside or right hand side.

4. After making necessary changes, save the setting by pressing F10 Key (or any other key as shown in your BIOS setup) and exit the BIOS setup utility.

5. Your computer will then restart with the new settings.

BIOS utility

BIOS hardware configuration has a lot of setting options. You can change these settings as per your need and requirement. After modification and saving, the computer will restart with the respected changes.

These changes instruct the hardware to function as per the new settings.

There are a few common things which you can do in almost all BIOS systems:

- change the boot sequence/order (To install operating system).
- default BIOS setup loading.
- set a new BIOS password or remove it.
- adjust the date and time.
- change HDD, FDD, CD/DVD settings.
- display or hide the computer logo.
- activate or deactivate the quick power-on self-test (POST).
- enable or disable the CPU internal cache.
- change CPU settings.
- change memory settings.
- enable or disable onboard USB, IEEE1394, audio.
- change power-on settings.

Practical Exercise

1. Start your computer and note down the key be which you can enter the step.

2. Change the date and time of your computer using BIOS steps utility.

3. Change the boot order sequence to DVD and USB flash drive for Windows installation.

Check Your Progress

A. Multiple choice questions (MCQs)

1. What is the main function of a motherboard in a computer? (a) To store data (b) To connect all the computer components and allow communication between them (c) To power the computer (d) To provide input devices
2. Which of the following is NOT a type of motherboard form factor? (a) ATX (b) Micro ATX (c) Mini ITX (d) USB
3. What is the purpose of the CMOS battery on a motherboard? (a) To power the CPU (b) To store system settings and time when the computer is turned off (c) To connect input devices (d) To provide backup power to the hard drive
4. Which port would you use to connect an RCA cable to a motherboard? (a) USB port (b) HDMI port (c) Audio/Video port (d) Ethernet port
5. What are BIOS primarily responsible for during the computer startup process? (a) Loading the operating system (b) Managing power consumption (c) Performing hardware initialization and self-tests (d) Storing user data

B. Fill in the blank questions

1. The _____ is the main printed circuit board in a computer, connecting all components and allowing them to communicate.
2. Common types of motherboards include ATX, Micro ATX, and _____.
3. The _____ battery on the motherboard is used to maintain the system clock and BIOS settings when the computer is turned off.
4. Input/output ports on a motherboard are used to connect devices such as keyboards, mice, and _____.
5. The BIOS utility allows users to configure hardware settings and manage system _____ during the boot process.

C. True or False

1. The motherboard is the main circuit board that connects all the components of a computer.
2. There is only one type of motherboard form factor, which is used in all computers.
3. The CMOS battery is used to keep the BIOS settings and system clock running when the computer is powered off.
4. Input/output ports on a motherboard are only used for connecting output devices, such as monitors and printers.
5. The BIOS utility allows users to configure hardware settings and manage system resources during the boot process.

D. Short Questions

1. What are the primary functions of a motherboard in a computer system?
2. What are the different types of motherboards, and how do they differ in terms of size and compatibility?
3. List and describe at least three basic components found on a motherboard.
4. What role does the CMOS battery play on a motherboard, and what happens if it fails?
5. Explain the purpose of the BIOS utility and how it can be accessed during the computer startup process.

Session 2. Install the CPU or Processor on the Motherboard

The processor is commonly known as central processing unit or CPU. It is an electronic circuit which executes computer programs containing a processing unit and a control. A central processing unit (CPU) processes the instructions by performing the basic arithmetical, logical, and input/output operations of the system. Although the form and design of CPUs is changing with generation but its main working principle remains the same.

CPU Basics

In 1971, the first microprocessor Intel 4004 was invented. It was a 4-bit calculation device with a speed of 108 kHz. A microprocessor is also known as a central processing unit in which a number of peripherals are fabricated on a single chip.

Architecture of Microprocessor

A microprocessor is a single integrated circuit (IC) chip. A number of useful functions are integrated and fabricated on a single silicon semiconductor chip.

The system bus consists of data bus, address bus, and control bus for transfer of data and instructions in a proper manner. The central processing unit consists of arithmetic

logic unit (ALU), registers, and control unit. Based on the registers, the generations of microprocessors can be classified. A microprocessor consists of general-purpose registers and special types of registers to execute instructions and to store the address or data while running the program. The ALU computes all arithmetic as well as logic operations on data and specifies the size of microprocessor like 16 bit or 32 bits.

The memory unit holds the program as well as data and is divided into processor, primary, and secondary memory. The input and output unit interface the I/O peripheral devices to microprocessor for accepting and sending information.

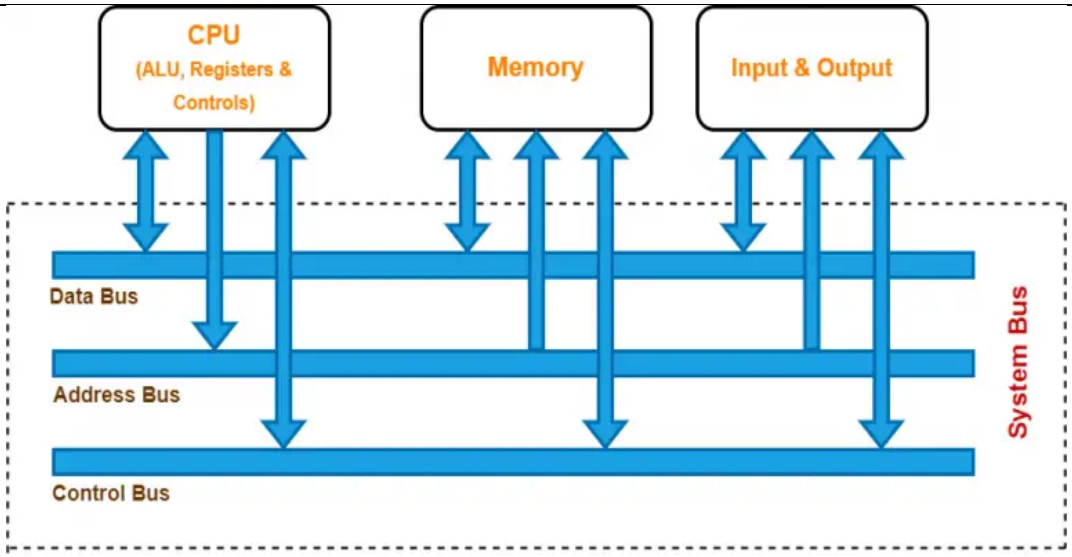


Fig. 2.1 Architecture of CPU

Generations of Microprocessors

1st generation: This was the period during 1971 to 1973 of microprocessor's history. In 1971, INTEL created the first microprocessor 4004 to run at a clock speed of 108 KHz.

2nd generation: During the period from 1973 to 1978 very efficient 8-bit microprocessors were implemented like Motorola 6800 and 6801, INTEL-8085, and ZilogsZ80 which were of this generation.

3rd generation: During the period from 1979 to 1980, 16-bit processors were designed using HMOS technology. INTEL 8086/80186/80286 and Motorola 68000 and 68010 were developed. Speeds of these processors was four times better than the 2nd generation processors.

4th generation: From 1981 to 1995, 32-bit microprocessors were developed by using HCMOS fabrication. INTEL-80386 and Motorola's 68020/68030 were the processors of this generation.

5th generation: From 1995, high-performance and high-speed processors that make use of 64-bit processors were designed. Such processors include Pentium, Celeron, dual and quad core processors. Some of the fifth generation of processors with their specifications, are briefly explained below:

Intel Celeron

This was introduced in April 1998. It refers to a range of Intel's X86 CPUs for value personal computers. It is based on Pentium 2 and can run on all IA-32 computer programs.

Fig 2.2 Intel Celeron processor

Pentium

This was introduced on March 2 in 1993 after Intel 486, the 4 here in 486 indicates the fourth generation. Pentium refers to Intel's single core x86 microprocessor which is based on the fifth-generation micro-architecture. This processor's name was derived from the Greek word 'penta' meaning 'five'. The Pentium MMX with a data bus of 64 bits was developed in 1992. More improved versions of pentium processors were designed from the year 2000.

Fig. 2.3 Pentium processor

Xeon

This is a 400 MHz Pentium processor from Intel for use in workstations and enterprise servers. This processor is designed for multimedia applications, engineering graphics, internet, and large data base servers.

Fig. 2.4 Xeon processor

Functions of a CPU

A CPU or processor carries out certain instructions and manipulates data. The main function of a CPU is to execute a sequence of stored instructions called a program. It can execute only machine code and fetches the machine coded instructions from memory and executes them. CPU processes instructions in four steps—fetch, decode, execute, and write back.

Fetch: The CPU reads data and instruction from memory.

Decode: The data and instructions are decoded to determine what action is required.

Execute: The instructions are executed by performing arithmetic or logical operation on data.

Write: The result of an execution is written to memory or an I/O module.

Concept of program execution

The instructions to be executed by a computer are loaded in sequential locations in its main memory. To execute instructions, the CPU fetches one instruction at a time and performs the functions specified. Instructions are fetched from successive memory locations until the execution of a branch or a jump instruction.

The CPU keeps track of the address of the memory location where the next instruction is located through the use of a dedicated CPU register, referred to as the program counter (PC). After fetching

an instruction, the contents of the PC are updated to point at the next instruction in sequence.

For simplicity, let us assume that each instruction occupies one memory word. Therefore, execution of one instruction requires the following three steps to be performed by the CPU:

1. fetch the contents of the memory location pointed out by the PC (program counter).

The instructions are stored in the instruction register (IR).

2. increment the contents of the PC by 1.

3. carry out the actions specified by the instruction stored in the IR.

The first two steps are the fetch phase and step three is the execution phase. Fetch cycle involves reading of the next instruction from the memory into the CPU and updating the contents of the program counter. In the execution phase, it interprets the opcode and performs the indicated operation. The instruction fetch and execution phase together are known as the instruction cycle. The instruction cycle is shown in the Figure 2.5.

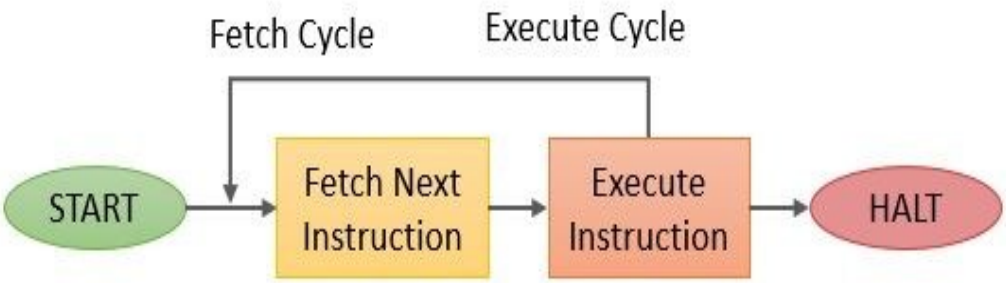


Fig. 2.5. Basic instruction cycle

In cases where an instruction occupies more than one word, step one and step two can be repeated as many times as necessary to fetch the complete instruction. In these cases, the execution of an instruction may involve one or more operands in memory, each of which requires a memory access. Further, if indirect addressing is used, then additional memory accesses are required.

Major components of the CPU

The three major components of the CPU are— arithmetic and logic unit (ALU), control unit (CU), and registers.

Arithmetic and logic unit (ALU)

This performs arithmetic and logical operations. For example, it can add together two binary numbers either from memory or from some of the CPU registers.

Control unit

This controls the action of the other computer components so that instructions are executed in the correct sequence.

Registers

These are temporary storage inside the CPU. It is internal memory of CPU which can read and write at a high speed. It is used to hold data and instructions temporarily while processing. It also holds the location of the last instruction. With this it can find the location of the next executable instruction.

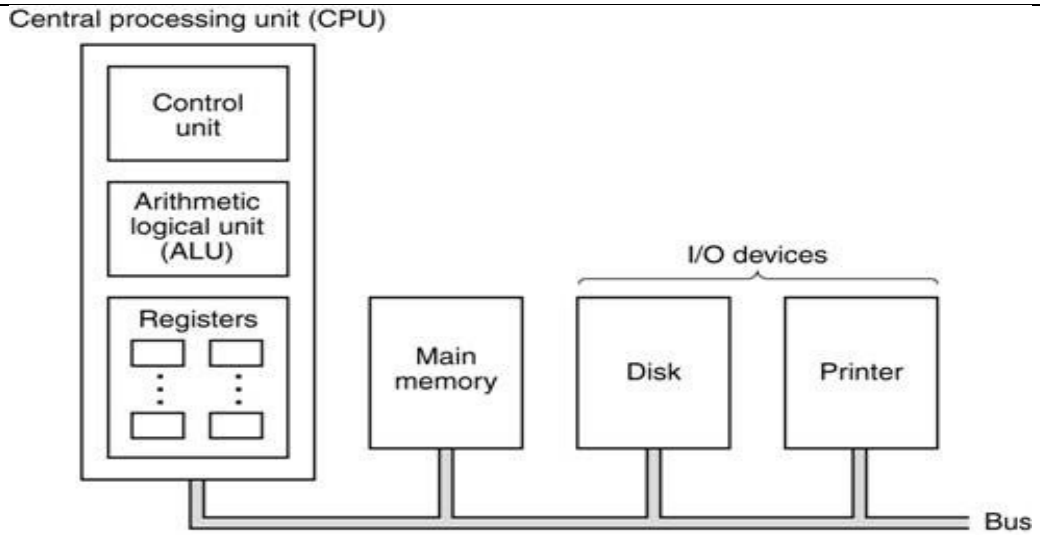


Fig. 2.6 Major components of the CPU

Register organization

There are a variety of CPU registers to control the operation of the CPU. The four most commonly used registers, essential for instruction execution are listed below.

Program counter (PC)

It contains the address of an instruction to be fetched. The program counter is updated by the CPU after each instruction fetched so that it always points to the next instruction to be executed. A branch or skip instruction will also modify the contents of the PC.

Instruction register (IR)

It contains the instruction most recently fetched. The fetched instructions are loaded into an IR, where the opcode and operand specifiers are analyzed.

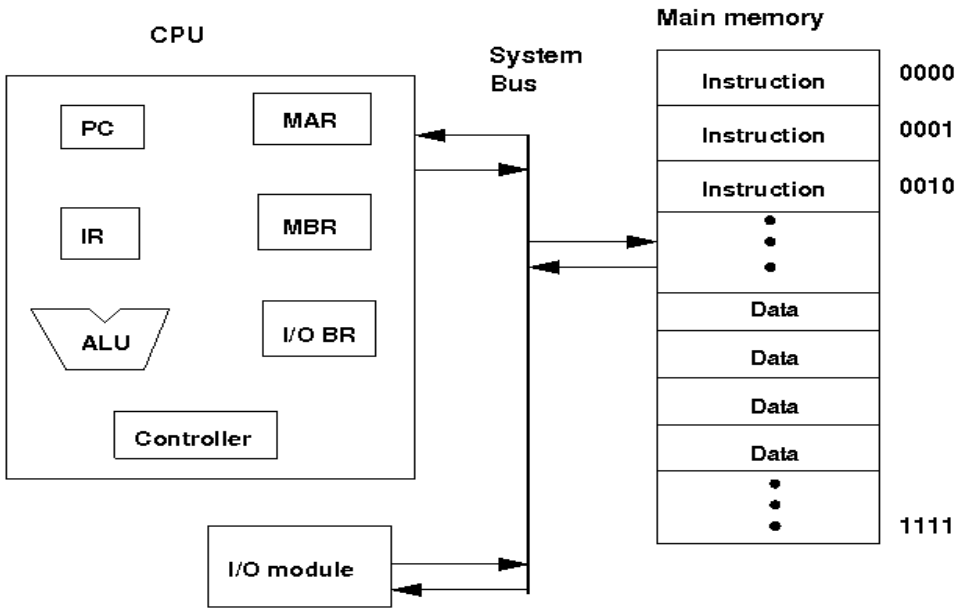


Fig. 2.7 Instruction register (IR)

Memory address register (MAR)

It contains the address of a location of main memory from where information has to be fetched or stored. Contents of MAR are directly connected to the address bus.

Memory buffer register (MBR)

It contains a word of data to be written to memory or the word most recently read. Contents of MBR are directly connected to the data bus. It is also known as memory data register (MDR).

Apart from these specific registers, we may have some temporary registers which are not visible to the user. As such, there may be temporary buffering registers at the boundary to the ALU; these registers serve as input and output registers for the ALU and exchange data with the MBR and user visible registers.

System bus

The CPU is connected to the rest of the system through system bus. Through system bus, data, or information gets transferred between the CPU and the other components of the system. The system bus may have three components:

Data bus

This is bidirectional, used to transfer the data between main memory and CPU. It determines the size of the data transferred between the processor and memory or I/O device. It refers to the size of the data bus in bits.

Address bus

This is unidirectional and used to access a particular memory location by putting the address of the memory location. It determines the size of the memory addressable by the processor

Control bus

This is used to provide different control signals generated by the CPU to the different parts of the system.

It indicates the type of action taking place on the system bus. For example, memory read is a signal generated by the CPU to indicate that a memory read operation has to be performed. Through the control bus, this signal is transferred to the memory module to indicate the required operation. As shown in Figure 2.8 shows the internal organization of the CPU.

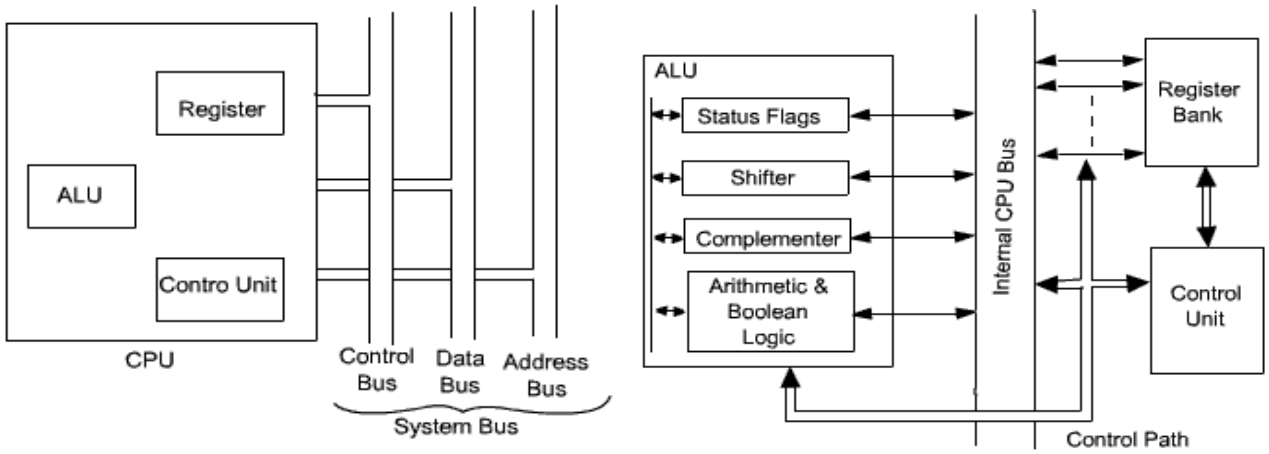


Fig. 2.8 Internal organization of CPU Features

There are many features that influence the performance of a processor:

Processor speed/clock rate

The clock speed of a processor is the number of instructions it can process in one second. It is the speed of the clock that drives the processor. The first processor 8088 was released at 4.77 MHz. Modern processors run at speeds of 2 GHz or greater. A CPU with a clock speed of 3.0 GHz can process three billion instructions per second. A faster CPU uses more energy and generates more heat.

CPU cores

A CPU can contain one or more processing units. Each unit is called a core. Modern PC processors are multicore. CPUs with multiple cores have more power to run multiple programs at the same time. Each core is fully functional, meaning each core contains an ALU, control unit, and registers. A dual core has two cores, quad core has four cores.

For example, Intel Core i7 chips perform better than i5 chips which perform better than i3 chips. Intel Core i3 processors are dual core processors, while i5 and i7 chips are quad core processors.

Cache

This is a small memory of CPU closer to the CPU than RAM. It is used to temporarily hold instructions and data that the CPU is likely to reuse. The CPU control unit automatically checks cache for instructions before requesting data from RAM. This save fetching the instructions and data repeatedly from RAM. RAM is a relatively slow memory than cache. Cache memory is fast and takes less time to transfer data and instructions to the CPU. More cache can hold more data to make the processing in the CPU faster. There are three types of cache memory—Level 1 (L1), Level 2 (L2), and Level 3 (L3).

Level 1 (L1) is the part of the CPU chip itself. It is the smallest and the fastest to access. Its size is often restricted to between 8 KB and 64 KB. Level 2 (L2) and Level 3 (L3) caches are bigger than L1. They are extra caches built between the CPU and the RAM. Sometimes L2 is built into the CPU with L1. L2 and L3 caches take slightly longer to access than L1. A computer with more L2 and L3 cache memory can run faster. Modern CPUs have 512 KB L1 cache built in and 1024 KB or 2048 Kb(2 Mb) of L2 cache memory.

Cache is more expensive than RAM. It is allocated less physical space than RAM which is usually larger and less expensive. Each CPU core has its own L1 cache, but may share L2 and L3 caches.

Bandwidth of data bus

The data bus connects the CPU to memory as well as all the storage, input/output, and communication devices. The processor uses data bus to transfer data between itself and the system memory (RAM and ROM) and the secondary devices. The size in bits determines how many characters are needed to transfer at a time. They are usually 8, 16, or 32-bits wide. An 8-bit data bus transfers one character at a time, a 16-bit data bus transfers two characters at a time, and a 32-bit data bus transfers four characters at a time. Thus, performance of a CPU also depends on the size of the data bus.

Memory

This is the area where the computer stores data and instructions. It provides the CPU with instructions. There are different types of memory and each one plays an important role in the running of a computer system. It is sometimes called primary memory or main memory or RAM. More amount

of RAM can run the computer faster and also can handle the large programs. It is the main place for storing instructions and data when a program is being executed. Program data is copied into RAM before the CPU can run the program.

Word size

The word size of the machine is how many bits the CPU can manipulate in one go. Each unique memory location in RAM holds one word of information. Every memory location has a unique address. RAM also has a word size measured in bits to indicate the size of the memory location.

Types of CPU

CPU can be categorized on the basis of its processing power as 32 bit or 64 bit and can also be classified on the basis of brands (Intel and AMD).

32 bit and 64-bit CPU

CPUs are identified as either 32 bit or 64 bits. The amount of data that a CPU can manipulate with one machine code instruction or transfer over a bus is measured in bits. The CPU specification is 32-bit, 64 bit, or 128 bits. A CPU with a 64-bit word size can process 64 bits using one single machine code instruction. This is twice as many bits as a 32 bit CPU. Increase in the word size means more data can be manipulated at a greater speed. It also means that the CPU can keep track of a larger range of memory locations.

A 32 bit CPU supports a 32 bit address bus and can address 232 memory locations or 4 GB of RAM. A 64 bit CPU supports a 64 bit address bus and can address 264 memory locations.

Operating systems and applications that are 64 bit specific cannot run on a 32 bit processor. The 64 bit operating systems can run only on 64 bit CPUs.

If you want to directly address more than 4 GB of RAM, you need both a 64 bit CPU and a 64 bit operating system.

Intel and AMD Processors

There are two primary manufacturers of computers: Intel and Advanced Micro Devices (AMD).

Intel

It is the largest seller of CPUs, selling about 80 percent to 85 percent of all CPUs. It manufactures other products as well, including chipsets, motherboards, memory, and SSDs.

AMD

It is the only significant competition to Intel for CPUs and it sells about 10 percent to 15 percent of all CPUs. It also manufactures other products including graphics processors, chipsets, and motherboards.

Processor technologies

These might be used by AMD only, by Intel only, or by both vendors. These technologies are used to help distinguish different processors from each other in terms of performance or features.

When we talk about processor technologies, we can classify them into:

Overclocking: For most motherboards and processors, you can override the default frequencies by changing a setting in BIOS setup. Running a motherboard or processor at a higher speed than the manufacturer suggests, is called overclocking. This is not

recommended because the speed is not guaranteed to be stable. Also, know that running a proces-

sor at a higher than recommended speed can result in overheating, which can damage the processor. Dealing with overheating is a major concern when overclocking a system.

VRM: A CPU is a collection of transistors. These transistors work at a specific voltage level. If excessive voltage is supplied to the transistor, it will burn off. Hence, the motherboard manufacturers have to take special care of the CPU voltages.

Throttling: Most motherboards and processors offer some protection against overheating so that if the system overheats, it will throttle down or shut down to prevent the processor from being affected.

Hyper-threading (HT Technology): It is a technology developed by Intel for processing two execution threads within a single processor. Essentially when HT Technology is enabled in the system, BIOS and the processor is running a multi-threaded application and the processor is emulating two physical processors.

Processor difference

Although Intel and AMD processors share two common architectures— x86 (used for 32-bit processors and for 64-bit processors, running in 32-bit mode) and x64 (an extension of x86 that enables larger files, larger memory sizes, and more complex programs), these processor's family differ in many ways from each other, including:

1. Different processor sockets
2. Different types of microcode
3. Differences in dual-core and multi-core designs
4. Cache sizes
2. Performance versus clock speed

The various activities that a microprocessor performs, such as storing data, doing arithmetic calculations (addition, subtraction, multiplication, division, etc.), are the result of instructions given to the CPU in the form of sequences of 0s and 1s. Microprocessors are designed to carry out a large number of instructions and all the instructions may be represented by different sequences of 0s and 1s. Each instruction is represented by a unique set of 0s and 1s.

The internal structure of a typical CPU consists of circuits which form a number of registers (the typical number is 16), an arithmetic unit for carrying out arithmetic operations, a logic unit, and a control unit.

Practical activity

Installation of CPU

The CPU and motherboard are sensitive to electrostatic discharge. So, place them on a grounded anti-static mat and wear an anti-static wrist strap while handling the CPU. When handling a CPU, do not touch the CPU contacts at any time. The CPU is secured to the socket on the motherboard with a locking assembly.

Thermal compound which is used to conduct heat away from the CPU is applied on top of the CPU. In case of an old CPU, first clean the top of the CPU and then apply the thermal compound. Clean the top of the CPU and the base of the heat sink with isopropyl alcohol and a lint free cloth. This removes the old thermal compound. Then apply a new layer of thermal compound.

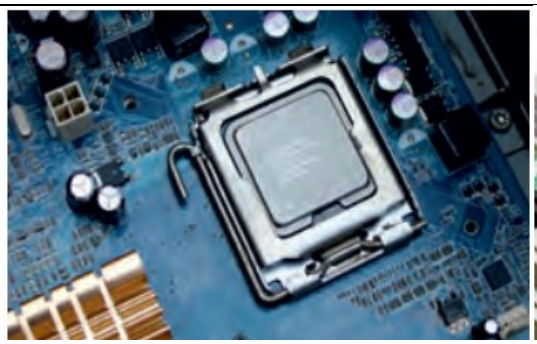


Fig. 2.9 Installing CPU on the motherboard

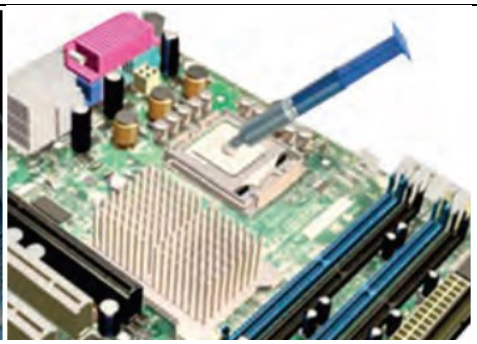


Fig. 2.10 Applying thermal compound on CPU

CPU heat sink

This is an important component in the modern computer. It is an attachment for a chip that prevents the chip from overheating. The components that generate the most heat in your computer are the CPU (central processing unit) and the power supply. These components need to

be kept within a specified temperature range to prevent overheating, instability, malfunction, and damage leading to a shortened component lifespan. They always have some cooling usually in the form of a fan.

A heat sink is a device that incorporates either a fan or some other means, to keep a hot component such as a processor, cool. It is made from metal, which serves as the thermal conductor that carries heat away from the CPU. It uses either copper, aluminum, or a combination of the two in order to move heat from the base of the cooler through heat pipes to the heat sink. A fan then blows air through the heat sink to move the heat into the air, and then out of the system, effectively keeping the CPU within safe operating temperatures.

A liquid cooling system essentially applies the same idea but replaces the copper heat pipes with tubes filled with a thermally conductive liquid that is pumped to a radiator. Copper is a very good thermal conductor with a thermal conductivity of 400 W/mK. Aluminum has a thermal conductivity of 235 watts per Kelvin per meter (W/mK), but is lighter than copper. A heat sink is attached to the motherboard, its weight puts stress on the motherboard. The light weight of an aluminum heat sink puts a little weight and stress on the motherboard.

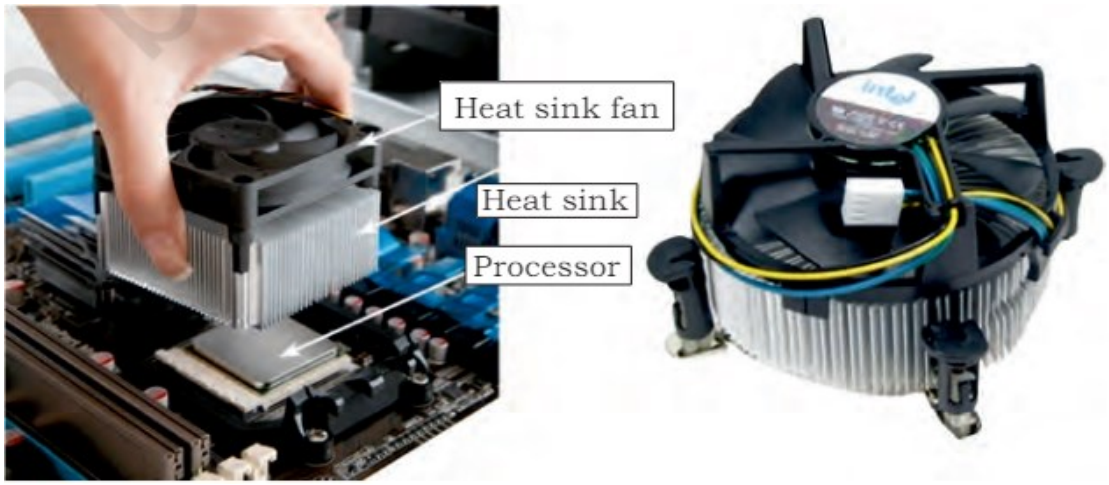


Fig. 2.11 Heat sink with cable and connector

A heat sink is designed to increase the surface area in contact with the cooling fluid surrounding it, such as the air, thus allowing it to remove more heat per unit time. Other factors which improve the thermal performance of a heat sink are the approach air velocity, choice of material, usually an aluminum alloy due to its high thermal conductivity values (229 W/m°K), fin (or other protrusion) design, and surface treatment.

The heat conducted from the processor goes out through the heat sink. A fan inside the computer moves air across the heat sink and out the computer. Most computers also have an additional fan installed directly above the heat sink to help properly cool the processor. Heat sinks with these additional fans are called active heatsinks, while those with the single fan are called passive heat sinks. The most common fan is the case fan, which draws cool air from outside the computer and blows it through the computer, expelling the hot air out of the rear.

Practical Activity

Installation of heat sink

Heat sink and fan assembly

Heat sink is a cooling device. The heat sink draws heat away from the CPU. The fan moves the heat away from the heat sink. The assembly has a 3-pin power connector. Figure 2.12 shows the cable and the motherboard connector for the heat sink.

Fig. 2.12 Screwing the heat sink

To install a CPU fan and heat sink, follow these steps:

- align the heat sink and fan assembly with the holes on the motherboard.
- screw in the heat sink.

Check Your Progress

A. Multiple choice questions (MCQs)

1. What is the primary function of a CPU (Central Processing Unit)? (a) To store data (b) To perform calculations and execute instructions (c) To connect peripheral devices (d) To manage power supply
2. Which of the following is NOT a generation of microprocessors? (a) First generation (b) Second generation (c) Fourth generation (d) Super generation
3. The Arithmetic and Logic Unit (ALU) is responsible for which of the following tasks? (a)

Managing memory (b) Performing arithmetic and logical operations (c) Communicating with input/output devices (d) Storing instructions

4. What is the purpose of a CPU heat sink? (a) To increase CPU speed (b) To provide power to the CPU (c) To dissipate heat generated by the CPU (d) To connect the CPU to the motherboard
5. Which of the following describes register organization in a CPU? (a) The arrangement of memory chips (b) The layout of input/output ports (c) The internal structure for storing temporary data and instructions (d) The design of the CPU case

B. Fill in the blank questions

1. The _____ is known as the brain of the computer, responsible for processing instructions and executing commands.
2. The _____ is a part of the CPU that performs arithmetic calculations and logical operations.
3. Microprocessors have evolved through different _____, with each generation introducing new technologies and capabilities.
4. Registers in a CPU are used to store data temporarily and allow for quick access to _____.
5. A _____ is an essential component used to dissipate heat from the CPU, preventing it from overheating during operation.

C. True or False

1. The CPU is often referred to as the "brain" of the computer because it processes instructions and performs calculations.
2. Microprocessors have only one generation, which means they have not evolved over time.
3. The Arithmetic and Logic Unit (ALU) performs both arithmetic operations and logical comparisons.
4. Registers are used in a CPU to store data and instructions temporarily for quick access.
5. A CPU heat sink is used to increase the temperature of the CPU to improve its performance.

D. Short Questions

1. Describe the basic architecture of a microprocessor and identify its main components. How does each component contribute to the overall function of the CPU?
2. What are the primary functions of a CPU, and how do these functions influence the performance of a computer system?
3. Discuss the different generations of microprocessors. What are some key features that distinguish one generation from another, and how have these advancements impacted computing power?
4. What is the role of the Arithmetic and Logic Unit (ALU) in a CPU? Provide examples of operations that the ALU can perform.
5. Explain the purpose of register organization within a CPU. How do registers differ from cache memory, and what advantages do they offer for processing data?

Session 3. Installing RAM on Motherboard

The basic purpose of memory is to remember the information for a period of time. Humans have their memory in their brains, which is a part of the human body. Computers also have memory as a part of the computer system. Computer memory is the storage space in the computer, to store data and instructions. The memory is divided into a large number of small parts called cells. Computer has internal as well as external storage. The internal storage is known as primary or main memory while external storage is known as secondary storage. There are different types of memory and each one plays

an important role in the running the computer system. In this Session, we will mainly understand the primary memory, RAM and its types. Installation of RAM modules in the computer is also demonstrated in this Session.

Importance of memory in computers

Memory is one of the most essential components of a computer. The CPU is constantly using memory right from the startup to shut down of the computer. When you turn on the computer, the computer loads data from read-only memory (ROM) and performs a

power-on self-test (POST) to make sure that all the major components are functioning properly. Memory controller checks all the memory addresses with a quick read/write operation to ensure that there are no errors in the memory chips. Read/write means that data is written to a bit and then read from that bit.

The computer loads the Basic Input/output System (BIOS) from ROM. The BIOS provides the most basic information about storage devices, boot sequence, security, plug and play capability, and a few other items.

The computer loads the operating system (OS) from the hard drive into the system's RAM. Generally, the critical parts of the operating system are maintained in the RAM as long as the computer is on. This allows the CPU immediate access to the operating system, which enhances the performance and functionality of the overall system.

When you open an application, it is loaded into RAM. After loading an application, any files that are open for use in that application, are loaded into RAM. When you save a file and close the application, the file is written to the specified storage device and then the file and applications are removed from the RAM.

In the above process, RAM is used as a temporary storage so that the CPU can access that information more easily. The CPU requests the data from RAM, processes it, and sends the output back to RAM in a continuous cycle. In computers, this shuffling of data between the CPU and RAM happens millions of times per second. The outputs are saved permanently on the storage device. If the output is not saved to a permanent storage device, the data is lost.

Classification of memory

Computer memory is classified as either internal or external memory:

Internal memory

It is also called as main or primary memory. It refers to memory that stores small amount of data,

that can be accessed quickly while the computer is running.

External memory

It is also called secondary memory. It refers to a storage device that can retain or store data persistently. There are internal or removable storage devices. Examples include hard disk or solid-state drives, USB flash drives, and compact discs (CD).

There are basically two kinds of internal memory— ROM and RAM.

ROM

It is read-only memory. It is non-volatile, which means it can retain data even without power. It is used mainly to start or boot up a computer. The data in ROM can only be read by CPU but it cannot be modified. The CPU cannot directly access the ROM memory, the data has to be first transferred to the RAM and then the CPU can access that data from the RAM.

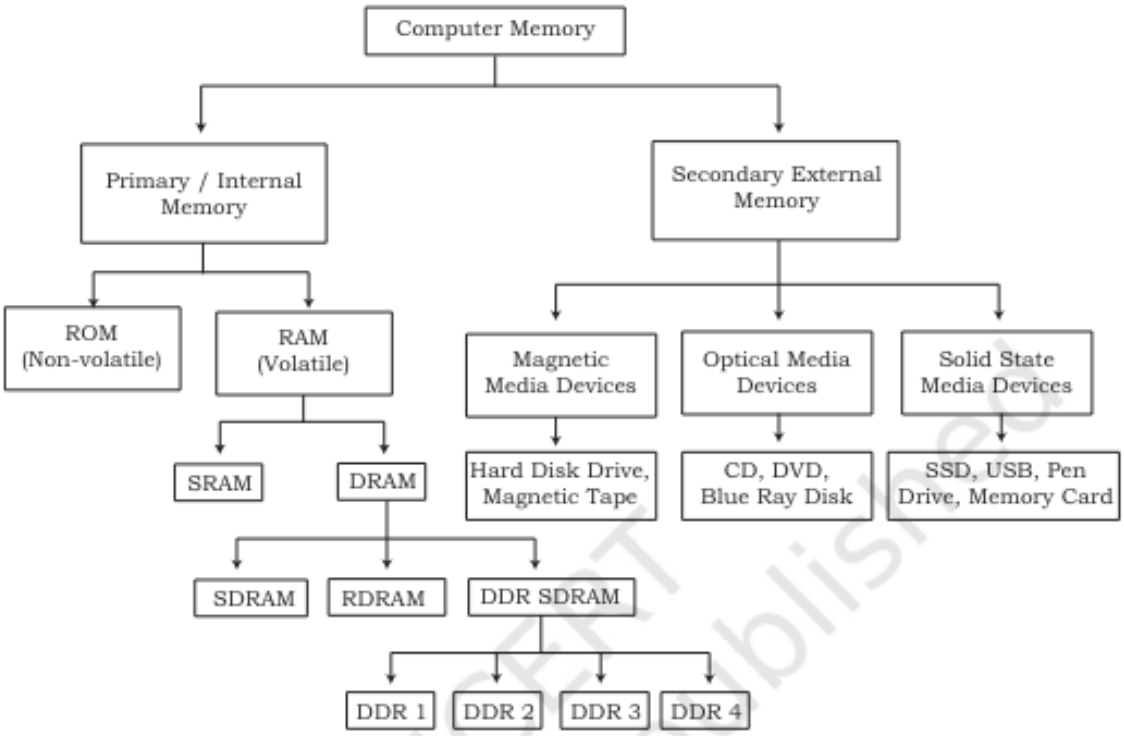


Fig. 3.1 Different types of memory

ROM stores the instructions requires during a process of booting up of the computer (bootstrapping). The content in ROM cannot be modified and the data inside the ROM is retained even after the CPU is switched off. The capacity of ROM is comparatively smaller than that of RAM, it is slower and cheaper than RAM. There are many types of ROM as given below:

PROM (Programmable read-only memory):

It can be programmed by a user. Once programmed, the data and instructions in it cannot be changed.

EPROM (Erasable Programmable read-only memory):

It can be reprogrammed. To reprogram it, one has to erase all the previous data. Data can be erased by exposing it to ultraviolet light.

EEPROM (Electrically Erasable Programmable read only memory):

Only portions of this chip can be erased by applying an electric field.

RAM

It is random access memory, it means the CPU can directly access any address location of RAM memory. It is quickly accessible memory of the computer and its speed is measured in nanoseconds (billionths of a second).

It is a read-write memory of the computer. The processor can read the instructions from RAM and write the result to the RAM.

It is fast and volatile which means it stores the data temporarily till the power is switched ON while the CPU is executing other tasks. It is therefore important to save data to the storage device before the system is turned off. Modern computers have RAM ranging from 2 GB to 16 GB.

There are two main types of RAM—Dynamic RAM (DRAM) and Static RAM (SRAM).

Dynamic random-access memory (DRAM)

It is widely used as a computer's main memory. Each DRAM memory cell is made up of a transistor and a capacitor within an integrated circuit. It uses one capacitor and one transistor to store each bit (binary digit) of information. The capacitor needs to be regularly refreshed to hold the charge. This configuration uses very few components per bit, keeping the cost low but the constant refresh reduces the speed.

Static random-access memory (SRAM)

It does not need to be periodically refreshed. It uses switching circuitry instead of capacitors and can hold the charge without constant refresh. It requires more components to store data per bit, so it is more expensive. It is faster, has lower density, and uses less power than DRAM. Due to its speed, SRAM is commonly used for CPU cache but not as the primary RAM due to its higher cost. It is widely used in portable gadgets such as cell phones, where minimum power consumption is important.

Common types of DRAM

1. Synchronised dynamic random access memory (SDRAM): It was the first type of memory to run in sync with the processor bus, the connection between the processor and other components on the motherboard. It is synchronised with a clock for faster speed. Typical SDRAM transfers data at speeds up to 133 Mhz. Almost all primary DRAM used in computers today is SDRAM. Most 168 pin DIMM modules use SDRAM memory. To determine whether a DIMM module contains SDRAM memory, check its speed markings. SDRAM memory is rated by bus speed. PC66 equals 66 MHz bus speed, PC100 equals 100 MHz bus speed, and PC133 equals 133 MHz bus speed.

2. Rambus dynamic random access memory (RDRAM): It takes its name after the company that made it, Rambus. It was popular in the early 2000s and was mainly used for video game devices and graphics cards, with transfer speeds up to 1 Ghz.

3. Double data rated synchronous dynamic random access memory (DDR SDRAM): It is a type of synchronous memory that nearly doubles the bandwidth of a single data rate. DDR SDRAM performs two transfers per clock cycle. 184 pin DIMM memory modules use DDR SDRAM chips. It is rated in Mhz and by throughput (MBps). The speeds for DDR SDRAM are PC1600 (200MHz/1600Mbps), PC2100 (266MHz/2100Mbps) PC2700 (333MHz/2700 Mbps), and PC3200 (400MHz/ 3200Mbps).

(a) DDR1 SDRAM: It has been succeeded by DDR2, DDR3, and most recently, DDR4 SDRAM. Although operating on the same principles, the modules are not compatible with the earlier modules of RAM. Each generation delivers higher transfer rates and faster performance. The latest DDR4 modules feature fast transfer rates at 2133/2400/2666 and even 3200 MT/s.

Fig. 3.2 DDR1 SDRAM

(b) DDR2 SDRAM: It runs its external data bus at twice the speed of DDR SDRAM and features a four-bit pre-fetch buffer, enabling faster performance. DDR2 SDRAM memory has greater latency than DDR SDRAM memory. Latency is a measure of how long it takes to receive information from memory— the higher the number, the greater the latency. 240 pin memory modules use DDR2 SDRAM. Common speeds for DDR2 SDRAM modules includes PC2-3200 (DDR2-400; 3200Mbps throughput); PC2-5300 (DDR2-667); PC2- 6400 (DDR2-800); and PC2-8500 (DDR2- 1066).

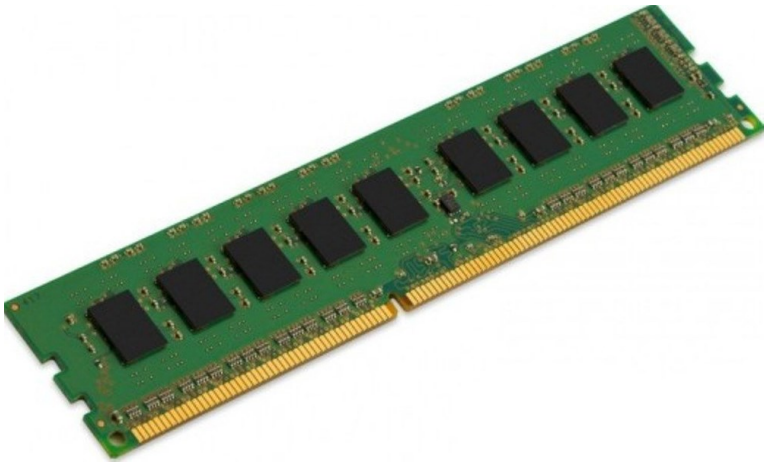


Fig. 3.3 DDR2 SDRAM

(c) DDR3 SDRAM: It runs on lower voltages, has twice the internal banks and most versions run at faster speeds than DDR2. It also has an 8 bit prefetch bus with greater latency than DDR2. Although DDR3 modules also use 240 pins, their layout and keying are different than DDR2, and they cannot be interchanged. The common speeds for DDR3 SDRAM modules include PC3-8500 (DDR3-1066; 8500MBps throughput); PC3-12800 (DDR3-1600); and PC3-17000 (DDR3-2133).

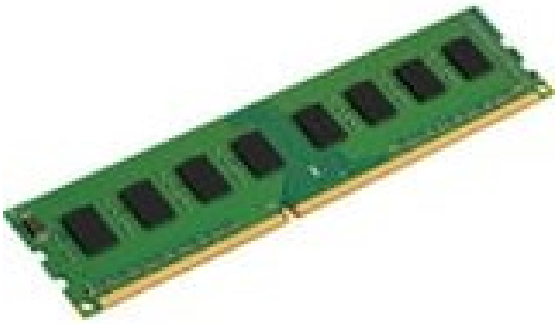


Fig. 3.4 DDR3 SDRAM

(d) DDR4 SDRAM: It was introduced alongside Intel's X99 chipset for Core i-series processors in August 2014 and is the fourth generation of DDR memory. It runs on lower voltage (1.2V) and supports density up to 16 Gb per chip (twice the density of DDR3), twice the memory banks and uses bank groups to speed up access to memory, but uses the same eight-bit prefetch as DDR3. Data rates range from 1600 Mbps to 3200 Mbps, compared to 800 Mbps to 2133 Mbps for DDR3.

Fig. 3.5 DDR4 SDRAM

(e) DDR5 SDRAM:

DDR5 was introduced in 2021, and is the most recent generation of memory technology, marking a revolutionary jump in architecture. It's arguably the biggest jump in memory technology we've seen since SDRAM.

DDR5 brings better channel efficiency, improved power management, and optimized performance - enabling next-generation multi-core computing systems. DDR5 launch speeds deliver nearly double the bandwidth of DDR4. It also allows scaling memory performance without degrading channel efficiency at higher rates. These results aren't just during testing but under real-world conditions.

DDR5 memory standard is a denser memory stick and equates to more memory capacity in your system. In comparison, the DDR4 stopped at 16-gigabit memory chips, but DDR5 offers up to 64-gigabit memory chips. Crucial DDR5 memory will operate at 4800MT/s at launch, 1.5x the maximum standard DDR4 speed.

Fig. 3.6 DDR5 SDRAM

Comparing RAMs in numbers

	DRAM	DDR	DDR2	DDR3	DDR4	DDR5
Prefetch	1 – Bit	2 - Bit	4 - Bit	8 - Bit	Bit per Bank	16 - Bit
Data Rate (MT/s)	100 - 166	266 - 400	533 - 800	1066 - 1600	2133 - 5100	3200 - 6400
Transfer Rate (GB/s)	0.8 - 1.3	2.1 - 3.2	4.2 - 3.4	8.5 - 14.9	17 - 25.6	38.4 - 51.2
Voltage (V)	3.3	2.5 - 2.6	1.8	1.35 - 1.5	1.2	1.1

Types of DRAM packages

(i) Single in-line memory module (SIMM): These modules were widely used from the late 1980s to 1990s, and are now obsolete. They typically had 32-bit data bus and were available in two physical types – 30 and 72 pin.

(ii) Dual in-line memory module (DIMM): Current memory modules come in DIMMs. 'Dual in-line' refers to pins on both sides of the modules. These moduless originally had a 168-pin connector supporting a 64-bit data bus, which is twice the data width of SIMMs. The wider bus means that more data can pass through a DIMM, translating to faster overall performance. Latest DIMMs are based on fourth generation double data rate (DDR4). SDRAM have 288 pin connectors for increased data throughput.

(iii) DIMM and SODIMM: RAM comes on cards plugged into the slots in the motherboard. They are smaller than expansion cards and technicians commonly call them memory cards, sticks. The two most common types of memory sticks are DIMM and SODIMM.

Dual in-line memory module (DIMM) is the circuit board that holds the memory chips. They are long and are used in desktop computers. DIMM have 168, 184, or 240 pins all supporting 64-bit data transfer.

Small outline dual in-line memory module (SODIMM) chips are smaller and are used in smaller devices such as laptop computers and printers. SODIMM have 72, 100, 144, or 200 pins. The 100-pin package supports 32-bit data transfer, while the 144 and 200 pin packages support 64-bit data transfer.

RAM configurations

Almost all systems can be used with a variety of memory sizes. However, systems that are designed to access two or more identical modules as a single logical unit (multichannel) provide faster performance than systems that access each module as a unit.

Single and multichannel memory modes: Many motherboards and CPUs support single-channel,

dual channel, and triple-channel memory architectures. Each single channel represents a separate 64-bit line of communication that can be accessed independently. With dual channel, the system can access 128 bits at a time; triple channel gives access to 192 bits at a time. Using dual and triple channels provides an additional performance enhancement to DDR, DDR2, and DDR3 in addition to double pumping and other enhancements provided by the DDR versions.

If you use a dual-channel motherboard with DDR3, it doubles the throughput of DDR3, providing 16 times more data throughput than SDRAM. If you are upgrading a computer's memory, it is important to understand these channels. You can purchase DIMMs in matched pairs. Where you install each DIMM, determines how many channels your system will use and can affect the performance of RAM.

(i) Single-channel (asymmetric) mode: Originally, all systems that used SDRAM were single-channel systems. Each 64-bit DIMM or SODIMM module was addressed individually. This mode provides single-channel bandwidth operations and is used when only one DIMM is installed or when the memory capacities of more than one DIMM are unequal. When using different speed DIMMs between channels, the slowest memory timing is also used.

(ii) Dual-channel mode: The DDR memory technology supports dual-channel operation. When two identical (same size, speed, and latency) modules are installed in the proper sockets, the memory controller accesses them in interleaved mode for faster access. Dual-channel motherboards are very common. This mode offers higher memory throughput and is enabled when the memory capacities of both DIMM channels are equal. When using different speed DIMMs, the slowest memory timing is used. If you look at a dual-channel motherboard, you see that it has four memory slots, two slots of one colour and two slots of another colour. Figure 9.8 shows a diagram of four memory slots labelled for a motherboard using an Intel based CPU. Slots 1 and 3 are of one color and slots 2 and 4 are of another color.

(i) Slots: Each slot can accept one DIMM.

(ii) Banks: A bank is composed of two slots. Bank 0 includes slots 1 and 3 and these two slots are normally blue. Bank 1 includes slots 2 and 4 and these slots are normally black. This is standard for Intel CPU based another board.

(iii) Channels: Each channel represents a separate 64-bit communication path. Slots 1 and 2 make up one channel, and slots 3 and 4 make up the second channel.

You can install a single DIMM in slot 2 as shown in Figure 9.8 and the system will have a single-channel RAM. You can purchase DIMMs in matched pairs and it is important to know in which slots to install them. For the best performance, you should install matching DIMMs in the same bank. Install the matched pair of DIMMs in slots 2 and 4 (Bank 1) as shown in Figure 9.9 leaving slots 1 and 3. The system will take advantage of the dual-channel architecture by using two separate 64-bit channels. To achieve dual-channel mode, the following conditions must be met:

- same memory size: 1 GB, 2 GB, 4 GB
- matched DIMM configuration in each channel.
- matched in symmetrical memory slots.

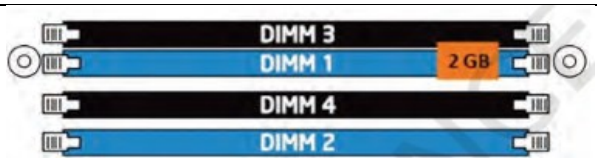


Fig. 3.7: Single-channel with one DIMM

Fig. 3.8: Dual-channel with two DIMMs

The motherboard uses the same colour for each bank. For Intel-based motherboards, Bank 0 includes slots 1 and 3 with the same colour (black). Bank 1 includes slots 2 and 4 with different colour (blue).

In AMD motherboards, slots 1 and 2 make up Bank 0 and slots 3 and 4 make up Bank 1. Channel 1 includes slots 1 and 3 and channel 2 includes slots 2 and 4. AMD motherboards also use one color for Bank 0 (slot 1 and 2), and another colour for Bank 1 (slot 3 and 4).

(iii) Triple-channel mode: On some motherboards, there are six DIMM slots instead of four. This indicates the system supports triple-channel memory usage. Triple-channel interleaving reduces overall memory latency by accessing the DIMM memory sequentially. Data is spread through the memory modules in an alternating pattern. Triple channel mode is enabled when identical matched memory modules are installed in each of the three blue memory slots.

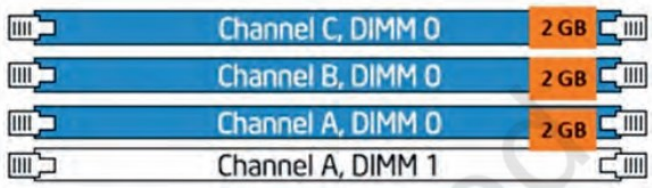


Fig. 3.9: Triple-channel mode

(iv) Quad-channel mode: This mode is enabled when four (or a multiple of four) DIMMs are identical in capacity and speed, and are put in quad-channel slots. When two memory modules are installed, the system operates in dual-channel mode. When three memory modules are installed, the system operates in triple-channel mode.

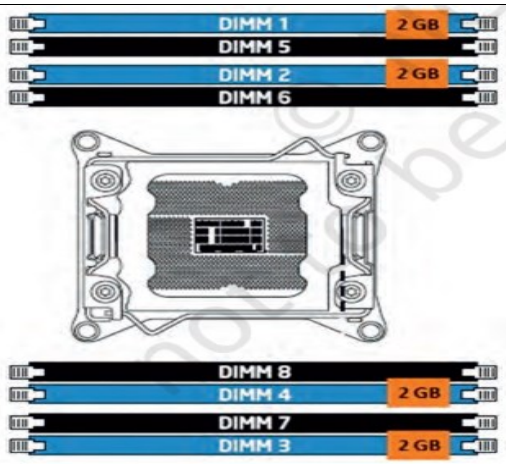


Fig. 3.10: Quad channel with four DIMMs

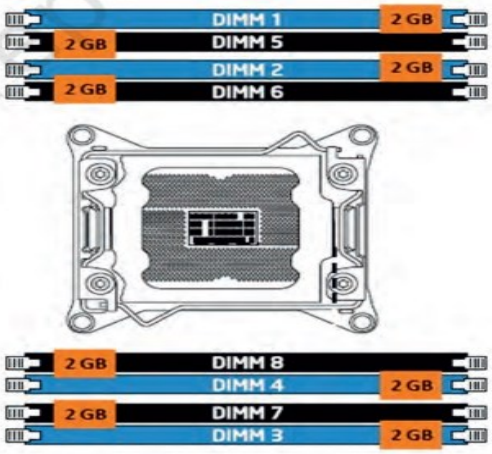


Fig. 3.11: Quad channel with eight DIMMs

RAM speed

RAM is accessed by the CPU via the front-side bus (FSB) and the memory bus. The high-quality RAM is likely to operate with close to 100% reliability, significantly above the bus speed for which it is rated. The following table shows some comparisons of peak memory performance.

Table 3.1 Performance of various memory modules

Types of RAM	PC rating	RAM speed in MHz	Peak throughput in MB/sec
SDRAM	PC100	100	800
SDRAM	PC133	133	1100
RIMM	PC800	400	1600
RIMM	PC1066	533	2100
DDR	PC1600	200	1600
DDR	PC2100	266	2100
DDR	PC2700	366	2700
DDR	PC3200	400	3200
Dual channel RIMM	PC800	400	3200
Dual channel RIMM	PC1066	533	4200
Dual channel DDR2	PC2-3200	400	6400
Dual channel DDR2	PC2-4200	533	8400
Dual channel	PC2-5300	667	10600

DDR2			
Dual channel DDR2	PC2-6400	800	12800
Dual channel DDR3	PC3-1600	800	12800
Dual channel DDR3	PC3-1866	933	14900
Dual channel DDR3	PC3-2133	1066	17000
Dual channel DDR3	PC3-2400	1200	19200

Practical Activity: Installation of RAM

- First, open the computer cabinet. To open the case, remove the screws of the left side cover and slide the side cover. Pull the latch to release the side panel. Then lift the side cover out from the chassis.
- To install the RAM, first ensure its compatibility with the motherboard. If DDR3 is mentioned on the motherboard, then DDR3 RAM may be fixed in the memory slot.
- Press down the side locks of the memory slot. Align the notches on the RAM module to the keys in the slot and press down on the both ends of RAM module until the side lock gets locked.

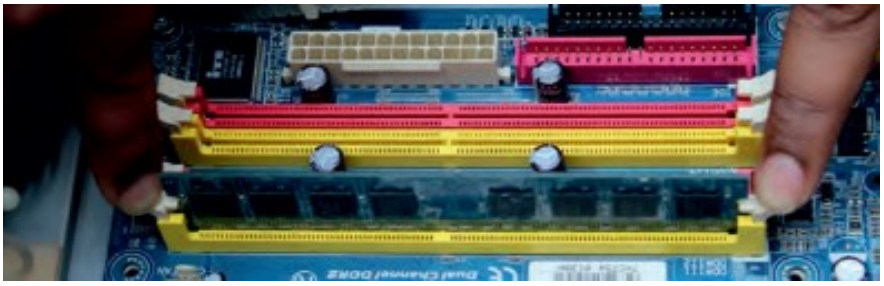


Fig. 3.12 Press down the memory in slot

- Make sure that the side tabs have locked the RAM module.
- Repeat the above steps to install additional RAM modules.

Fig. 3.13 Lock the RAM module

Install the Graphics Card and Sound Card on the Motherboard

Graphics Card

A personal computer, commonly known as a PC, requires several components for proper functioning. It includes the CPU, processor, motherboard, RAM, etc. One such component of a PC build is the graphics card. The graphics card for PC has a very important role. It is displaying the information that the computer is presenting to the user via the monitor, which is an output device. All that you seed on the monitor is generated by the graphic card. So, even this article that you are reading currently is being sent to your monitor via the graphic card. That is if you are on a computer. So, it should be pretty clear that the graphic card is undoubtedly a very important component in a PC.

But, what about computers that do not have a graphic card. They display information on the monitor. Well, it is done via a GPU (Graphics Processing Unit). Every graphic card consists of a GPU, and it is the main part of a graphic card. Certain processors come with integrated GPU, and in such cases for displaying the data sent by the computer, you do not need a separate graphics card. However, for processors that do not have an integrated GPU, you would need a graphic card.

Important of graphic card

The true importance of a powerful graphic card lies in its performance. By performance, we mean frame rates that it produces in games, and also various graphic designing, especially those that require 3D modeling, etc.

This is to say that if you are a gaming enthusiast, a graphic designer, or even someone that works with animation, 3D, CAD modeling, etc. Then, you must have a powerful graphic card, as this is the component on which most of these tasks depend. If the graphic card is not up to the mark, then the results in the above-mentioned situations would certainly not be up to par.

Importance of GPU in productivity, designing

If you are a photo or video editor, designer, or use a lot of graphics-oriented tasks, then a powerful graphics card is a must. All the filters, effects, renders, etc. are done much quicker than they would be done on a weaker graphic card or the integrated GPU of your CPU. For this reason, designers always opt for high-end graphic cards.

Importance of GPU in regular usage and multimedia

When it comes to regular usage and media consumption it is not necessary to opt for a powerful graphic card at all. If all you are going to do on the PC is surf the web, watch some videos, use some basic software, or programs, etc. Then, you absolutely do not need a powerful graphic card. For most of these cases, the integrated GPU would be more than enough. When it comes to some high-resolution videos, there might be certain glitches, stutters, etc. with the integrated GPU, however, it should be fine for the most part. And, in case your CPU does not have the integrated GPU, then you can just get a basic, dedicated graphic card such as the NVIDIA GT 210/610/710, etc.

Hardware Installation

Now that you have prepared your computer, you are ready to install your graphics card.

Step 1. Locate the PCI Express x16 slot. If necessary, remove the cover from this slot; then align your graphics card with the PCI Express x16 slot, and press it in firmly until the card is fully seated.

Fig. 3.14

Make sure that the gold edge connector of the graphics card is securely inserted.

Step 2. Replace the screw to fasten the card in place, and replace the computer cover.

If there are power connectors on your card, remember to connect the power cable to them, or the system will not boot. Do not touch the card when it's operating to prevent system instability.

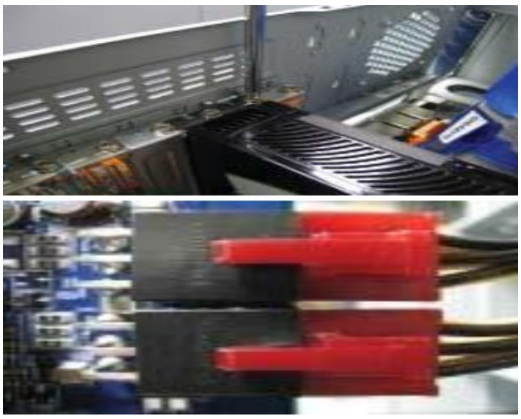


Fig. 3.15

Step 3. Connect the appropriate cable to the card and the display. Finally, turn on your computer.

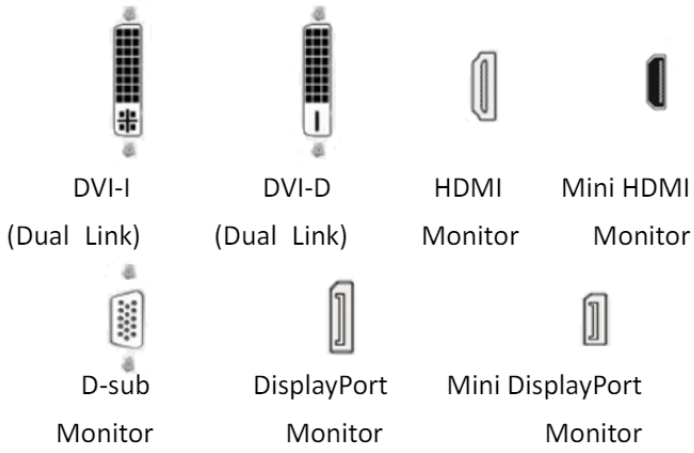


Fig. 3.16

Preparing your PC for the new GPU

Need to make sure that your PC case will fit your new GPU. If you want to know for sure your PC case will fit whatever you can throw at it, you can also pick up one of the biggest cases in the world, like the HYTE Y70 Touch. However, if you have a normal-sized case or want to try to fit a large GPU in mid-tower or smaller, you might need to mount your GPU vertically. There are a lot of factors that go into how to mount your GPU, but we have a guide to help you know if a vertical-mounted GPU is right for you. Also, if you're going to go with a vertical-mounted GPU, make sure to check out the best cases for vertical mounts.

Fig. 3.17

Comparing the RTX 4090 Founders Edition to an Intel Arc A770, both are lengthy GPUs, but it's obvious to see just how much thicker the 4090 is. Also, it's important to note that the RTX 4090 Founders Edition from NVIDIA is one of the smaller 4090s on the market. For many cases, and to prevent the GPU from sagging, the bigger 3090, 4080, 4090, and their perspective TI versions benefit from vertical mounting.

Before you install the new card, you need to make sure older drivers for the card you're replacing are uninstalled. If you're installing a new GPU and do not already own a dedicated card, you can skip this section.

Installing the new graphics card:

Step 1. Power down the PC.

Fig. 3.18

Step 2. Hit the switch on the back of the PC to turn off supply to the PSU.

Step 3. Extract the side panel (usually held on by two screws on the rear).
(If you do not already have a GPU installed, skip to Step 3.)

Step 4. Remove the screws holding the GPU in on the rear bracket.

Fig. 3.19

Step 5. Unlock the PCI-e slot clip.

Step 3. Remove the GPU by lightly pulling on the card.

Step 7. Hover the new GPU over PCI-e slot.

Fig. 3.20

Step 8. Push down on the GPU to slide the connector into the slot.

Step 9. Ensure the secure lock clicks into place.

Step 10. Screw the rear bracket down to secure the card to the chassis.

Step 11. Connect any required PSU cables.

Fig. 3.21

Step 12. Reattach the side panel.

So, all you need to do is plug in the display connectors on the rear of the case, whether they're Display-Port, HDMI, DVI, or VGA. After that, hit the PSU power switch and boot up Windows. If the

PC does not turn on or no signals get sent to the monitor, we'll need to double-check that all cables are connected correctly (both inside and on the rear of the PC), and that the GPU is seated properly in the PCIe slot.

Installing required drivers

Before the GPU can be used for intensive workloads like gaming, you need to get new drivers installed so Windows and software can effectively communicate with the card. Download and install drivers for a new NVIDIA or AMD card.

Sound Card

A sound card is a computer expansion card that is fixed on the motherboard to support audio input and output. It is also known as a PC sound card, audio card, or audio interface. It converts digital signals from computers to analog signals to be played on the speakers. Computer sound cards can be internally built within the motherboard or they can be external for more professional audio production.

The main features of a sound card are CODEC, audio input/output, digital signal processor, and amplifier among other components. An audio card is used to convert digital signals to audio signals and vice versa. The main advantage of using the card are the improved quality of sound and more features than the inbuilt sound card.

Functions of sound card

The main purpose of the audio card is to convert the digital signal to analog that can be outputted on the speakers. Other functions of the card are:

Allows for audio input and output: the card has ports that allow a microphone for sound input and a speaker port for sound output.

Enhance sound quality: the cards are designed to improve the quality of the sound that the system produces. For professional audio producers, the external audio card can even offer better-quality sound.

Convert audio from digital to analog and vice versa for playback and recording.

Features of an audio card

Analog-to-Digital Converter (ADC): the component converts analog audio signals to digital signals for recording. Most current cards have a combination of ADC and DAC to create a CODEC which performs the function of both components.

Digital-to-Analog Converter (DAC): Converts digital audio signals to analog signals for playback to the speakers.

Audio Input and Output Ports: a standard sound card at least has an input connection for a microphone and an output for the speaker or headphones.

Motherboard to card connector: for the card to be able to communicate with the computer processor it requires a connection interface through the computer motherboard. The most common audio card-to-motherboard connectors are ISA and PCI, or PCIe interfaces.

Digital Signal Processor (DSP): some advanced sound cards have a processor built within that can do most of the processing. This is similar to how we have a graphics processor in graphic cards. This makes the processing of audio data fast. They perform digital signal processing tasks such as audio mixing and sound enhancement.

Memory: sound cards have a small capacity RAM that can be used to speed up audio data processing.

Amplifier: it is used to boost the audio signals to the output device such as a speaker or headphones.

Firmware ROM: this is the memory that stores basic data such as card drivers that control the card. It also helps the sound card to initialize when booting for the first time.

Uses of sound card

PC audio playback: Without the sound card your computer would not be producing any sound. So, the components are used to play music, movies, and other audio content on all types of personal computers.

Audio recording: the card comes with an input port for the microphone that can be used to record voice, musical instruments, and other sounds.

Voice recognition systems: to be able to use a voice recognition system that can help visually challenged users, they should have an audio interface. The card helps the user to input sound as input to instruct the computer.

Sound for gaming: for the best experiences when playing games users can even use an external audio card to improve positional audio and surround sound.

Music production: Using external sound cards music producing companies can improve their production. It can also be used by individuals who want to start personal music production. They can be used either for a starter or professional music production.

Voice over IP (VoIP) communication: devices that are used for online communication require to have a sound card. They can be used for making voice calls over the internet, and used in video conferencing devices among other online communications.

Advantages of using a sound card

Improved audio quality: sound card improves the quality of audio produced by devices compared to if they don't have them. For even better-quality users can go for external sound cards that have more features. They have lower noise, more detail, and a better soundstage.

Additional audio features: Sound cards often come with features such as equalization, surround sound, and noise reduction. This means users have more control over the kind of audio they produce.

Better compatibility: the cards are compatible with a variety of audio devices and musical instruments. This means users can use any instrument to produce the best audio.

Disadvantages of an audio card:

Extra cost: external sound card is expensive depending on the type and features that it has.

Additional hardware: expansion card requires space on the computer or laptop to be fixed on. Some computers may not have enough space and if they have they make the computer bulky.

Sound card motherboard connector compatibility issues: depending on the types of connectors that the computer has will determine the type of card to be used. Connectors can be PCI, PCIe, or ISA among others.

Sound drives installation: To use the device your computer should have audio card drivers. Drivers come as part of the package or users can download them online. For optimum benefit from the

card, the user should also be able to configure the card with the best practice setting.

Early computers needed to have sound cards installed in order to connect speakers, but most new computers have full sound functionality built-in already. If you do a lot of audio production or want the best possible sound quality for high-end speakers, installing a sound card will get you the sound you need.

Things You Should Know

Many modern computers have a sound card built into the motherboard, but you may need to open the case if you have an older computer.

If you have an older computer, you'll see PCI slots where you can insert new sound cards.

Finally, install the associated drivers and check that your sound card works by plugging in speakers.

Opening Your Case

Ensure that you need a sound card. Nearly all modern computers have a sound card built into the motherboard. You can double-check that you have a sound card built-in by looking for speaker jacks on the back of the computer. Sound cards are really only necessary for audiophiles and recording studio computers, or for very old computers that don't have built-in sound.

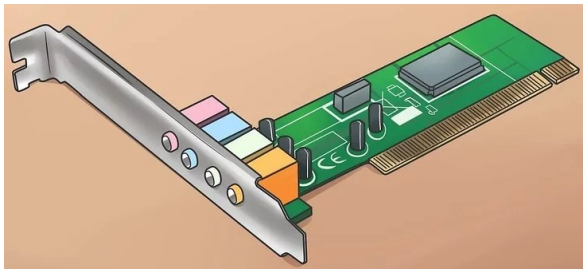


Fig. 3.22

Power down your computer and remove all the cables. This will allow you to move your computer to a place that allows you to easily access it. Place the computer on its side on a table, with the ports on the back closest to the table. The ports are connected to the motherboard, so having them closest to the table will ensure that you can get to the motherboard when the case is open.

Avoid laying the computer on carpet.

Fig. 3.23

Remove the side panel on your computer. Most newer cases have thumbscrews, but you may need a Phillips-head screwdriver. The screws run down the back of the computer. Remove the panel on the opposite side of the motherboard and set it aside.

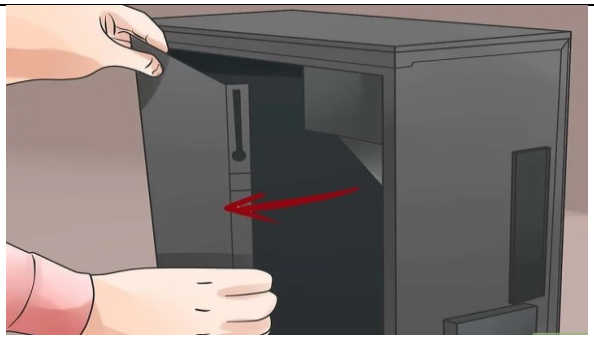


Fig. 3.24

Ground yourself. You should always ground yourself when working inside your computer. You can use an electrostatic wrist strap or touch a metal water tap to discharge any electrostatic buildup. If you don't ground yourself, you run the risk of damaging your components with electrostatic discharge.

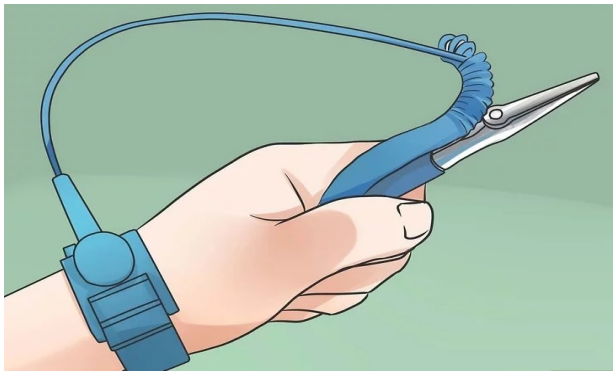


Fig. 3.25

Clean out any dust. Since your computer is open, you should take this opportunity to clean out the dust that has built up inside the case. Too much dust can lead to overheating, which can lead to your components failing.

Use compressed air to remove as much dust and debris as possible. Make sure to get in all of the nooks and crannies.

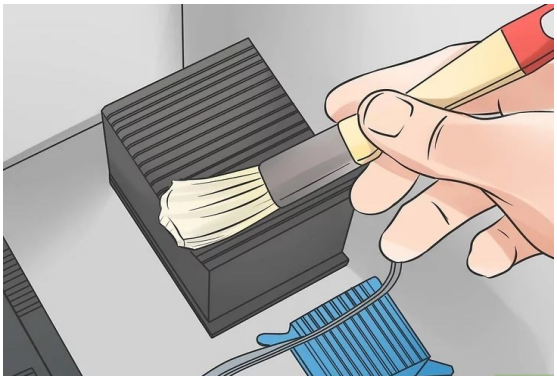


Fig. 3.26

Installing the Card

Locate the PCI slots. These are the slots that you can install expansion cards into. PCI slots are

typically white, and you may have 1-5 of them. The slots line up with the removable panels on the back of the case.

If you're having difficulty identifying the PCI slots, check your motherboard's documentation. You can look this up online if you have the motherboard's model number.

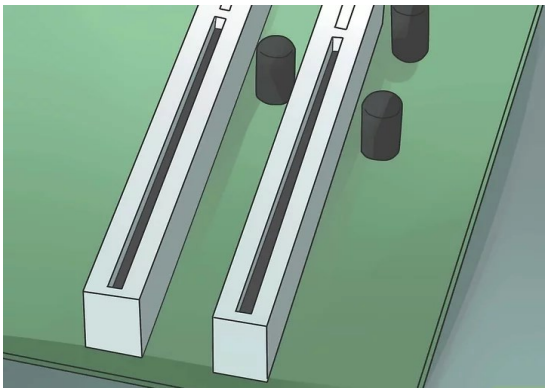


Fig. 3.27

Remove the existing sound card (if necessary). If you are replacing an old card, remove the old card first. Having two cards installed will lead to hardware conflicts. Remove the screw securing the card to your case and pull the card directly out of the slot.

You may need to disconnect the sound card from your CD/DVD drive.

Make sure that any speakers connected to the old sound card are disconnected before you remove the old card.

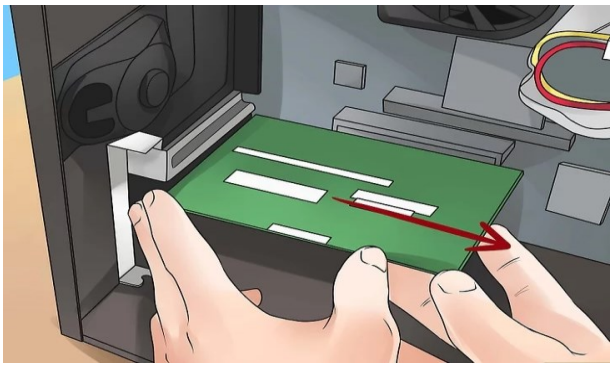


Fig. 3.28

Insert the new card. Remove the corresponding dust guard panel from the back if you are installing the new card. Make sure that the notches in the slot line up with the card, and press the card straight down firmly. Don't force the card into the slot, and ensure that the ports on the back line up with the with the bay opening.

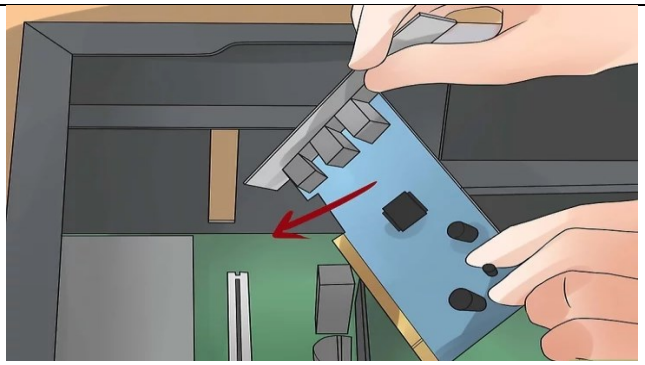


Fig. 3.29

Secure the card with a screw. Screw a single screw into the metal tab that secures the card to the computer chassis. Don't overtighten, but ensure the card is snugly fastened to the case.

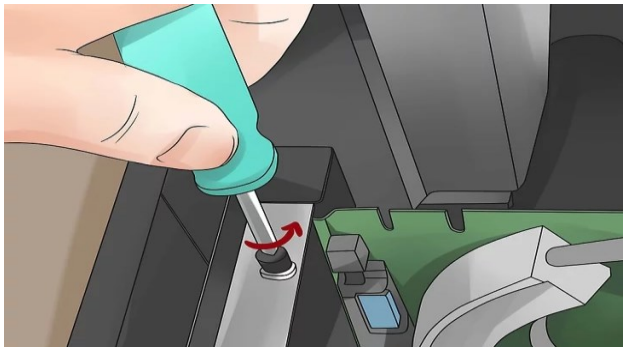


Fig. 3.30

Connect the sound card to the CD/DVD drive (optional). Some older sound cards may connect to the CD/DVD drive with a small cable. This is optional on virtually all newer computers, as this connection is now handled by the hardware.

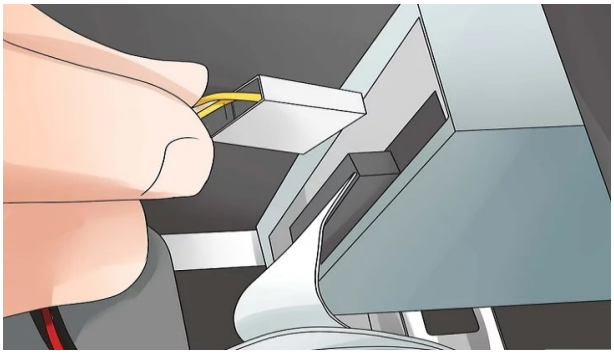


Fig. 3.31

Close the case. Return the side panel to the computer and secure it. Place the computer back at your desk and plug the cables back in.

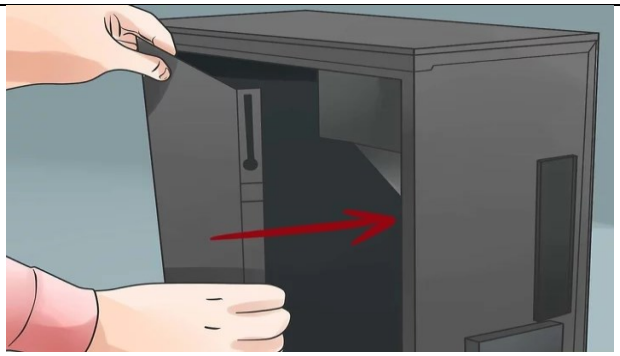


Fig. 3.32

Plugging in Your Speakers

Place your speakers. Set up your speakers around your computer. Ensure that the left and right channels are on the correct sides. Avoid placing the subwoofer in a corner or up against the wall.

Fig. 3.33

Connect the speakers to the sound card. Examine the ports on the sound card. These ports are color-coded and should match the colors of your speaker cables.

Pink- Microphone input.

Light blue- Line level input.

Lime green- Left and right stereo output or headphones.

Orange- Center and subwoofer output.

Black- Surround sound left and right output.

Grey- Surround sound rear left and right output.

Yellow- Digital output.

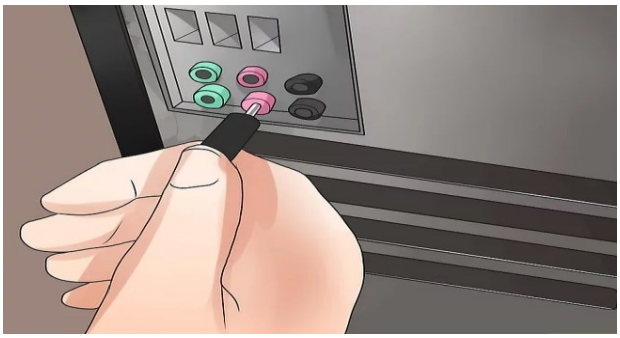


Fig. 3.34

Turn on the computer. Wait for Windows to load. Your sound card should be detected by Windows automatically, and the drivers will be automatically installed.

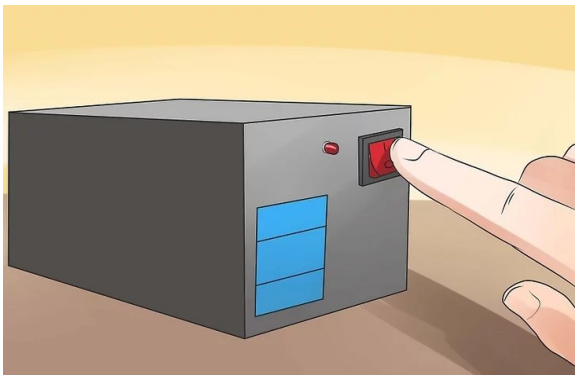


Fig. 3.35

Install the sound card drivers. If Windows cannot install the correct drivers of your sound card, you will need to install the drivers manually. Use the disc that came with the drive, or download the drivers from the manufacturers.

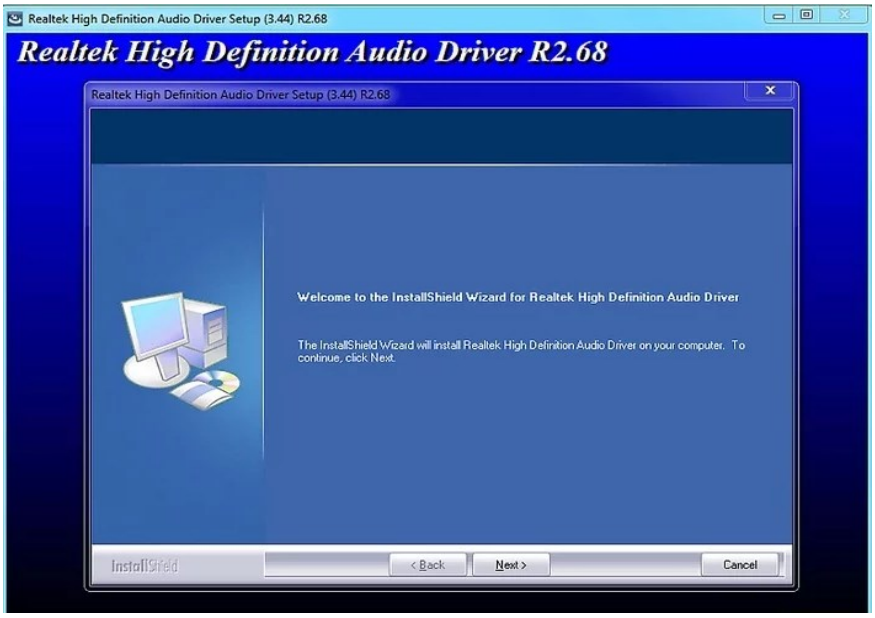


Fig. 3.36

Test the speakers. Make sure that your speakers are turned on and the volume is up. Click the Volume icon in your System Tray. When you use the slider to set the volume, a test sound will play out of your speakers. If there is no Volume icon, your sound card may not be properly installed. Make sure that the drivers were installed correctly.

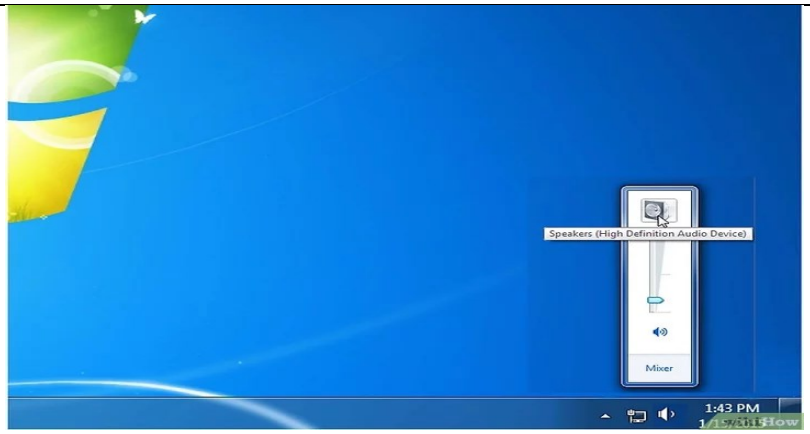


Fig. 3.37

Install CMOS Battery on the Motherboard

A dying CMOS battery can cause issues with the BIOS and time settings of your PC. Here's how you can replace your old CMOS battery with a new one.

Fig. 3.38

The CMOS battery on the motherboard is responsible for preserving the date, time, and BIOS settings when your PC is powered off. Just like any other battery, it has a fixed lifespan and will get depleted even if you don't use your system very often.

Fortunately, modern motherboards come with a CR2032 CMOS battery that's pretty affordable and easy to replace. This guide contains everything you need to know to change the CMOS battery in your PC.

Need to tools for replace the CMOS battery

Require some tools to replace the CMOS battery.

A Phillips screwdriver is necessary to remove the bottom panel of your laptop. It's also useful if you need to remove the GPU and/or some expansion cards to access the CMOS battery slot. Since you're dealing with the fragile components of your system, it's a good idea to get an anti-static wristband to prevent static electricity from damaging the motherboard. A new CMOS battery that you can slot into your system. Most ATX and Micro-ATX mother-boards are compatible with a CR2032 lithium coin cell regardless of whether they support Intel or AMD chipsets. CR2032 batteries are available on most online retailers and hardware stores. Meanwhile, Mini-ITX motherboards and some laptops have a CMOS battery that's wrapped in black plastic with a cable plugged into the motherboard. In fact, some laptop motherboards use the CR1220 variant instead of the usual CR2032 coin battery, so you should consult the laptop's manual before ordering a new CMOS battery for your laptop.

Replace the CMOS battery

The most common symptom of a dead CMOS battery is your date and time settings resetting every time you reboot your system. However, it can also cause errors like the following:

- CMOS Read Error
- CMOS Checksum Error
- CMOS Battery Failure
- System battery voltage is low

If your PC frequently displays an error message about the BIOS settings being cleared, there's a high chance your CMOS battery has been depleted. CMOS coin cells typically have a lifespan of three to five years, so even the best gaming motherboards will need their CMOS batteries replaced after a few years.

Replacing the CMOS battery is also one of the most preliminary troubleshooting tricks when your system fails to boot past the BIOS or the debug LED lights on your motherboard continue to flash after pressing the power button of your PC.

How to replace the CMOS battery in your PC

Once you've grabbed your tools and the new CMOS battery, it's time to swap out the old one. To do so,

Step1. Shut down your system and unplug its AC power adapter.

Step 2. Press and hold the power button for half a minute to drain any remaining charge from the motherboard's capacitors.

Step 3. Unmount the front panel of your PC after loosening the thumb screws and securing it in place.

If you're on a laptop, use the Phillips screwdriver to unfasten the screws on the underside of the laptop and gently detach the back cover with the help of a spudger tool. Be sure to disconnect the actual battery of the laptop before you change the CMOS battery.

Step 4. For most ATX and Micro-ATX motherboards, the old CMOS battery can be released by pressing down on the latch on the CMOS battery slot.

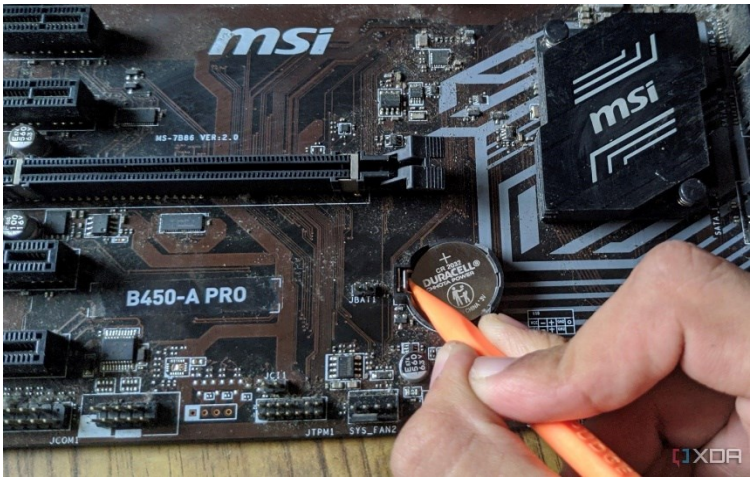


Fig. 3.39

Step 5. If you're having trouble locating the CMOS battery, you'd want to unmount the GPU as most ATX and Micro ATX motherboards have the CMOS battery slot located around the PCI-e slots.

Fig. 3.40

Most Mini-ITX motherboards have the CMOS coin cell located around the IO ports. You can remove the old battery by unplugging its connector from the motherboard.

Step 3. To install the new CMOS cell, place it on the CMOS battery slot with the positive side up (the side with the company name) and push it down until it settles into the slot. Mini-ITX motherboard owners can simply insert the cable connector of their new CMOS battery into the motherboard.

Step 7. If you've unmounted the GPU, install it into the motherboard, and lock the front panel/back cover in place using the screws you removed earlier. When you power on your PC, you'll see a notification stating the BIOS settings have been cleared. You can ignore the message and restart your system normally, or restore any changes you had made to the default BIOS settings before replacing the CMOS battery. You'll also need to set the proper data and time settings once you boot into the OS.

Check Your Progress

A. Multiple choice questions (MCQs)

1. What is the primary purpose of memory in a computer? (a) To provide a user interface (b) To store data and instructions for quick access (c) To manage power supply (d) To connect peripheral devices
2. Which of the following is a type of volatile memory? (a) ROM (b) Flash memory (c) RAM (d) Hard disk
3. What does RAM speed determine? (a) How quickly data can be read from or written to the RAM (b) The capacity of the storage device (c) The size of the RAM module (d) The type of motherboard used
4. What is the main function of a graphics card in a computer? (a) To enhance audio output (b) To process and render images and videos (c) To store data (d) To connect to the internet

5. Why is it important to install the required drivers for a graphics card or sound card? (a) To increase the physical size of the card (b) To ensure compatibility and optimal performance of the hardware (c) To reduce the cost of the hardware (d) To improve the battery life of the computer

B. Fill in the blank questions

1. The importance of memory in computers is that it allows for the _____ of data and instructions, enabling the CPU to access information quickly.
2. There are two main classifications of memory: _____ memory, which retains data without power, and volatile memory, which loses data when powered off.
3. ROM stands for _____, and it is used to store firmware that is not meant to be modified frequently.
4. RAM configurations can vary in size and type, such as _____, which is commonly used in desktops, and SO-DIMM, which is used in laptops.
5. To ensure optimal performance of a graphics card, it is necessary to install the appropriate _____ provided by the manufacturer.

C. True or False

1. Memory in a computer is essential because it allows for the temporary storage of data that the CPU needs to access quickly.
2. ROM (Read-Only Memory) is a type of volatile memory that loses its data when the power is turned off.
3. RAM speed affects how quickly data can be read from or written to the memory, which influences overall system performance.
4. A graphics card is primarily used to enhance audio output in a computer system.
5. Installing the required drivers for hardware components, such as sound cards and graphics cards, is necessary for proper functionality and performance.

D. Short Questions

1. Why is memory considered a critical component in computers, and how does it affect overall system performance?
2. What are the main classifications of memory, and how do they differ in terms of volatility and usage?
3. Explain the purpose of ROM in a computer system. What kind of data is typically stored in ROM, and why is it important?
4. What are the different configurations of RAM, and how do they impact the performance of a computer?
5. What are the main functions of a sound card, and what advantages does it provide over integrated audio solutions? Additionally, how do you properly connect speakers to a sound card?

Module 3 Installation and Configuration of Computer Hardware and Peripherals

Module Overview

Installing and configuring computer hardware and peripherals involves several key steps. Begin by ensuring the computer is powered off and unplugged. Open the case to access the motherboard. Install the CPU, ensuring it's properly seated, and then attach the CPU cooler. Insert RAM modules into the designated slots and secure them. Install the power supply and connect it to the motherboard, CPU, and other components.

Next, insert the storage devices like SSDs or HDDs into their respective bays and connect them with the appropriate cables. Attach the graphics card into the PCIe slot if needed. Once all internal components are installed, close the case.

For peripherals, connect devices like keyboards, mice, monitors, and printers to the appropriate ports. Power on the computer and enter the BIOS to configure hardware settings. Finally, install the necessary drivers for all hardware components and peripherals to ensure they function correctly.

Learning Outcomes

After completing this module, you will be able to:

- Understand the role of the Power Supply Unit in a computer system, including its different types (e.g., ATX, SFX).
- Identify different types of peripherals, such as printers, scanners, external drives, and audio devices.

Module Structure

Session 1: Install the Power Supply Unit (PSU)

Session 2: Installing Computer Peripherals

Session 1: Install the Power Supply Unit (PSU)

PSU (Power Supply Unit)

A Power Supply Unit (PSU is an internal IT hardware component. Despite the name, Power Supply Units (PSU) do not supply systems with power - instead they convert it. Specifically, a power supply converts the alternating high voltage current (AC) into direct current (DC), and they also regulate the DC output voltage to the fine tolerances required for modern computing components. Most power supplies are switched-mode (SMPS), which has both efficiency advantages and makes designing for multiple voltage inputs easier.

Fig. 1.1 Power supply unit

A power supply is a device that receives power from a power source through a power cord and converts it into the type and voltage required by electronic components for effective operation. It regulates electric current and voltage, protecting components from power fluctuations and ensuring reliable performance. Some key characteristics that define a power supply include:

- It accepts power from either an AC or DC source like a wall outlet, battery, generator etc.
- Performs operations like rectification, filtering, and regulation to convert the input power suitably.
- Has connectors or terminals to deliver regulated power to various components internally or externally.
- Includes safety features to prevent overloading or electric shocks.

Need a PSU

The power supply unit is a crucial part of any server. Without it, your IT infrastructure would not work. It's no surprise, then, that most systems include a power supply upon purchase.

However, there is an alternative to the PSU that can be used in some instances. By choosing Power over Ethernet (PoE), electrical power can be carried within network cables without being tethered to an electrical outlet. This is ideal for systems that need more flexibility; PoE can provide wireless access points to wherever is most convenient, and less space is taken up by wiring.

Choose right PSU in my system

Firstly, when choosing a power supply unit, it is important to make sure it is compatible with the form factor of your server case and motherboard. This will ensure it fits within your server.

Secondly, wattage is an important factor to consider. The higher the wattage rating, the more power the unit can provide to your system, meaning that you need to evaluate how much power your components require to run effectively. For instance, if the components in your system require 600V, it would be ideal to buy a 1200V power supply unit, as most power supplies have the highest efficiency at ≈50% load. This also allows for room to expand your system with further components if needed.

Lastly, when replacing or upgrading a PC power supply unit, it is important to take brands into consideration. The choice often comes down to personal preference, compatibility with your system, and what you are using the power supply for (e.g. gaming, a small or large business, or personal use). One piece of advice is to look out for an 80 Plus Platinum rating, as this has great

energy efficiency and can minimize power costs.

Efficient of power supply

80 Plus power supplies have a scale of efficiency, going from 80 Plus and 80 Plus Bronze all the way to Titanium. '80 Plus' means that power supplies in this range will always operate at 80% efficiency at a minimum, and as you go up the scale towards 80 Plus Platinum and Titanium, you can experience up to 94% efficiency (when at 50% load).

The latest 80 Plus PSUs require high wattage in order to run most effectively, and so the 80 Plus Gold, Platinum and Titanium supplies (up to 94%) are ideal for large data centres. 80 Plus Silver power supplies and below (a maximum efficiency of 88%) are more suitable for PCs and desktops.

It is important to remember that the difference between a 90% efficiency rating and a 92% efficiency rating will make a massive difference in terms of energy utilised within large scale data centres.

Need more than one PSU

In short, a server will always need at least two power supplies. There are different modes of operation for this, depending on how much redundancy you need in your system. One option is to have a fully redundant power supply system, which means that one PSU is always switched off and there is an emergency fall back in case of downtime. The other option is to have shared power supplies, where both are on at the same time and share the workload. We recommend that you provide double the amount of wattage than you actually need, to ensure optimum uptime.

For maximum redundancy, it is also a good idea to have an Uninterrupted Power Supply (UPS), which enables your computer to run for a limited time if power is lost. There are three types: online, offline and line-interactive. Online Uninterrupted Power Supplies ensure the quality of power remains constant, whereas offline UPSs start running when power is lost and there will be a slight delay when it takes over. Line-interactive is a combination of the two and provides more power protection thanks to its line conditioning.

Working and Operation of PSU

Because efficiency is so important, most of today's computers (including laptops and mobile devices) use switch mode power supplies (SMPS). These supplies make use of a switching element or regulator (normally a power transistor) to generate the desired voltage. Switching power supplies incorporate electronic components that continuously switch ON and OFF at a very high frequency. This switching action connects and disconnects energy-storing devices (inductors or capacitors) to and from the input source voltage or the output load. SMPS design results in a smaller power supply since the size of the power transformers, inductors, and capacitors is inversely proportional to the switching frequency. Switch-mode operation also reduces the power consumption because when a switch is OFF, its current is almost zero. When a switch is ON, its voltage is very small. Therefore, at either condition the power consumption is almost zero. A switching power supply is more efficient than a linear power supply because in a linear power supply the excess power is wasted (in form of heat) whereas in a SMPS all the power is used to convert input power into output power. The switching elements, normally inductors, capacitors, or transistors operating in cut-off or saturation, have no dissipating resistance so no waste of power occurs.

The inner workings and operations within a basic power supply can be explained through the following power supply block diagram:

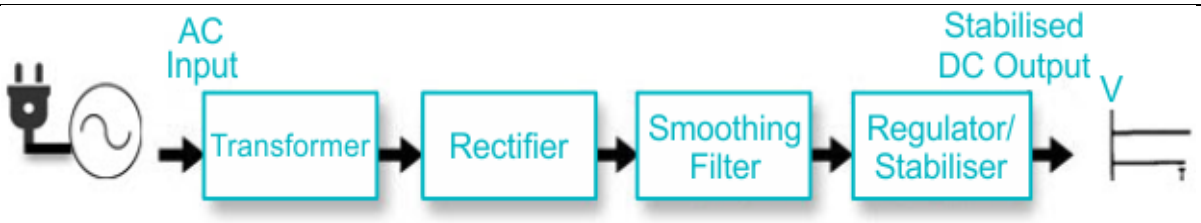


Fig. 1.2 Power supply Block Diagram

It consists of the following key components and processes:

- **Input Transformer:** Steps down high AC mains voltage to a lower level for further processing.
- **Rectifier:** Converts the stepped down AC to pulsating DC using diodes in a bridge configuration.
- **Filter Capacitor:** Smoothens the pulsating DC waveform from the rectifier into a continuous DC signal.
- **Regulator:** Regulates and maintains a steady output DC voltage, even with variation in load current or input voltage.
- **Output:** Provides a stable DC power to electronic components as required. Protection devices like fuses are also incorporated.

Use of A Power Supply

Given below are some key applications of power supplies:

- **Desktop computers, laptops, servers** - Converts AC mains to various DC levels like 5V, 12V required by different components.
- **Communication systems** - Provides steady DC to sensitive circuits in routers, switches, cellular towers etc.
- **Industrial equipment** - Ensures reliable operation of machines, automation systems with large power requirements.
- **Medical devices** - Delivers precise voltage levels for instruments, monitors, and implants avoiding fluctuations.
- **Transportation** - Popular in electric vehicles, aircraft, boats for efficient energy distribution.
- **Backup power** - UPS solutions provide temporary power during outages via batteries to save data, and prevent downtime.

Features and Specification of PSU

Description	Specification
3000-W AC Power Supply	
Type	Auto ranging input with power factor corrector.
Voltage	100 to 240 VAC (+ or - 10%).
Current rating	16 A maximum at 100 to 120 VAC and 1451-W output. 16 A maximum at 200 to 240 VAC and 3051-W output.

	For current ratings of plugs, see Figure 6-3 on page 6-154 .
Frequency	50 to 60 Hz (nominal) (+ or - 3 Hz for full range).
Output capacity	1451 W maximum (100 to 120 VAC, 1400W available to chassis) 3051 W maximum (200 to 240 VAC, 3000W available to chassis)
Output voltage at 110/120	3.4V (+/- 4%) at 15A; 50V(+/- 4%) at 28A.
Output voltage at 200/240	3.4V (+/- 4%) at 15A; 50V(+/- 4%) at 28A
Efficiency	>94% at 50% load
ITHD	<5.1% at 50% load
3500-W High Voltage AC/DC Power Supply (SAN192C-6 and SAN384C-6)	
Type	Auto Ranging input with power factor corrector.
Input Voltage Range	120 VAC nominal low-line mode (85 to 132 VAC) 240 VAC nominal high-line mode (170 to 264 VAC) 277 VAC nominal high line mode (188 to 305 VAC) 240 VDC nominal high-line mode (192 to 288 VDC) 380 VDC nominal high-line mode (260 to 400 VDC)
Input Current	20A service, 16A maximum at nominal line voltage (240 or 277 VAC) 20A service, 16A maximum at nominal line voltage (240 or 380 VDC)
Input Frequency	47 to 63 Hz
Output capacity	1500 W maximum (100 to 120 VAC) 3100 W maximum (200 to 210 VAC) 3500 W maximum (215 to 240 and 277 VAC) 3100 W maximum (200 to 215 VDC) 3500 W maximum (220 to 380 VDC)

Practical Activity 1.1 Procedure for installation of PSU in Computer

Material Required: Power Supply Unit (PSU), Computer Case, Screws (typically provided with the PSU or case), Screwdriver, Anti-static wrist strap (optional but recommended), Cable ties

Procedure

Step 1. Prepare the Work Area: Ensure you have a clean, static-free workspace. Wear an anti-static wrist strap if available.

Step 2. Open the Computer Case: Unscrew or unlatch the side panel of the computer case to access the interior.

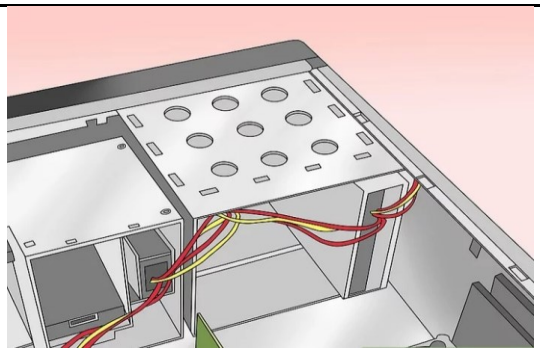


Fig. 1.3 Open the Computer Case

Step 3. Position the PSU: Locate the PSU mount area at the back of the case. The PSU is usually installed at the top or bottom.

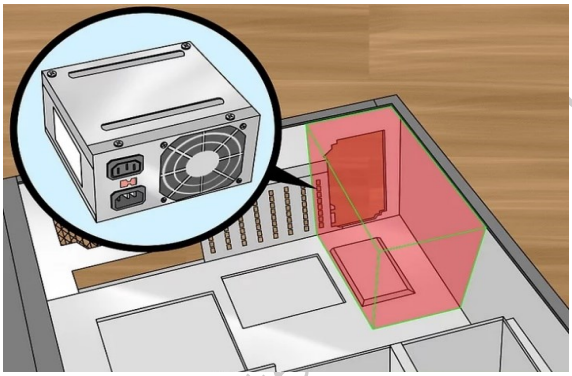


Fig. 1.4 Position the PSU

Step 4. Insert the PSU: Slide the PSU into the mount area, aligning the screw holes on the PSU with those on the case.

Fig. 1.5 Insert the PSU

Step 5. Secure the PSU: Use screws provided with the PSU to secure it to the case. Ensure it is firmly in place.

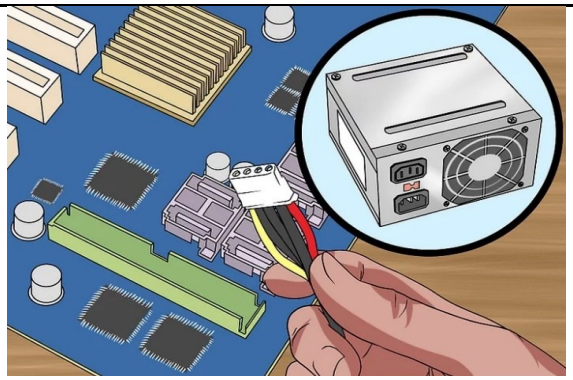


Fig. 1.6 Secure the PSU

Step 6. Connect Power Cables: Attach the power cables from the PSU to the corresponding components:

- **24-pin ATX connector** to the motherboard.
- **4/8-pin CPU connector** to the motherboard near the CPU.
- **PCIe connectors** to the graphics card (if applicable).
- **SATA/Molex connectors** to storage devices and other peripherals.

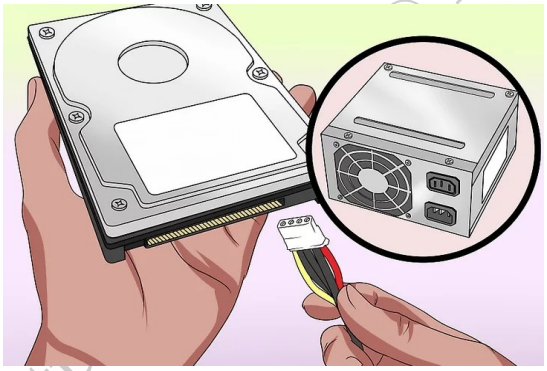


Fig. 1.7 Connect power cable

Step 7. Cable Management: Organize and secure the cables to ensure they don't obstruct air-flow or other components. Use cable ties if necessary.

Fig. 1.8 Cable Management

Step 8. Close the Case: Reattach the side panel of the case and secure it with screws or latches.

Step 9. Connect External Power: Plug the PSU's power cord into an electrical outlet and switch on the PSU (usually at the back of the unit).

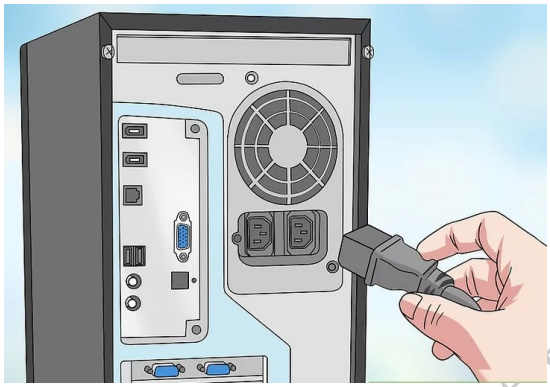


Fig. 1.9 Connect External power

Step 10. Power on the Computer: Turn on your computer to ensure the PSU is functioning correctly and all components receive power.

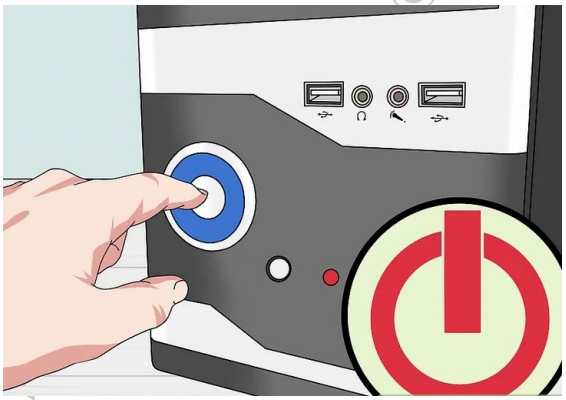


Fig. 1.10 Power in the computer

Check Your Progress

A. Multiple choice questions (MCQs)

1. What is the primary function of a Power Supply Unit (PSU) in a computer? (a) To store data (b) To provide electrical power to the computer components (c) To process information (d) To connect peripheral devices
2. Which of the following is NOT a common specification to look for in a PSU? (a) Wattage (b) Efficiency rating (c) Cooling type (d) Screen resolution
3. What does the term "modular PSU" refer to? (a) A power supply that can be modified for different voltages (b) A power supply with detachable cables for better cable management (c)

A power supply that comes with built-in cooling fans (d) A power supply that is designed for mobile devices

4. Which component of a PSU is responsible for converting AC power from the wall outlet to the DC power used by the computer? (a) Transformer (b) Rectifier (c) Capacitor (d) Inductor
5. What is the significance of the 80 PLUS certification for a PSU? (a) It indicates the power supply is environmentally friendly. (b) It signifies the efficiency of the PSU at different load levels. (c) It shows the PSU has a warranty of at least 80 months. (d) It means the PSU can support 80 different devices.

B. Short Questions

1. What are the key components of a Power Supply Unit (PSU), and how does each component contribute to its overall function?
2. Explain the working principle of a PSU. How does it convert AC voltage from the wall outlet into DC voltage for use by computer components?
3. What specifications should be considered when selecting a PSU for a computer build? Include factors such as wattage, efficiency, and cable management.
4. What is the difference between a non-modular, semi-modular, and fully modular PSU? How does this affect cable management and installation?
5. How does the efficiency rating of a PSU impact both performance and energy consumption in a computer system? Why is it important to choose a PSU with a high efficiency rating?

Session 2. Installing Computer Peripherals

In previous Session, we covered how to choose and install your computer components and how to install the internal system components for your computer from the motherboard to the CPU and heatsink/fan combo. In this tip we cover the installation of peripherals including monitor, keyboard, mouse and so on. Installing peripherals is just about the easiest task you will tackle when building a computer. Check the list below for the peripherals we will be covering in this Session.

- Keyboard
- Mouse
- Monitor
- Speakers
- Webcam
- Printer
- Scanner

Note: If your computer doesn't have an operating system installed yet, you will want to stop after you install your mouse and keyboard, install your operating system, and then resume the installation of your peripherals

Computer Peripherals

The peripheral devices are those devices which are connected to the computer and it helps the computer function. These devices contain both the input devices, which are used to give command to the computer and the output devices, which help computer showing the result to the user. The computer works with many peripheral devices so it's important to know that how much these devices can be installed in the computer and how can a persona configure them. Following are the devices which are used by the computer and the ways they can be configured;

Input devices: The device which are connected to computer and they are used to send the data to the computer internally, are known as the input devices. Following are some important input devices;

Mouse: Mouse is the one of the most common devices that one would find in a desktop. It is normally plugged with the USB connection. It would be connected through the PS/2 port which is located on the back of the computer. In older system, one might find the serial port which was used to move the move around. The old mouse contained ball inside of it which helped it move. But nor the trend has changed the mouse that one uses contains some LED light. They are called the laser mouse. The LED light now emits out of the mouse sensing that where the mouse is being moved. The installation of mouse is easy, one can just plug the mouse and the drivers would be searched by windows itself. The mouse can be configured from the control panel where the speed of it can be improved.

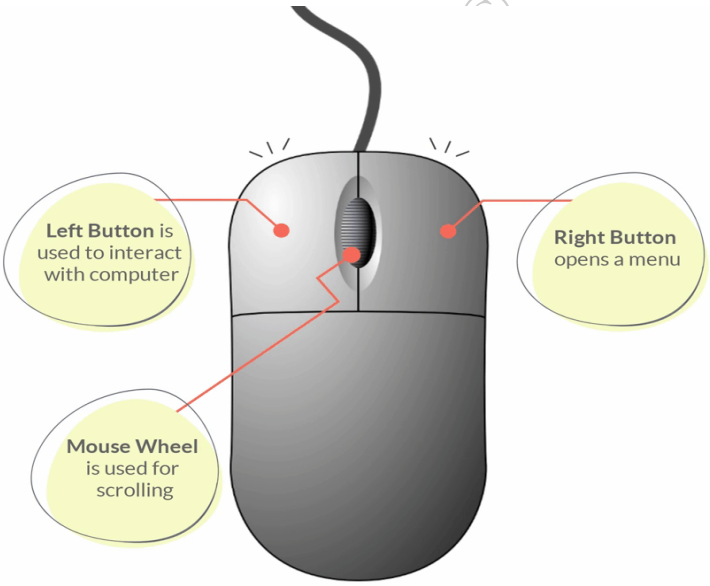


Fig. 2.1 Mouse

Keyboard: it is the famous device that is being used today and it is connected through a USB connection at the back of the computer. Old keyboards used to have the Mini DIN PS/2 connection with them; one would have to go through the manufacturer's website to know that what are the drivers for the keyboard and then can get them installed when he connects the keyboard with the computer.

Fig. 2.2 Keyboard

Touch screen: Touch screen is becoming common as well. They are normally used on the mobile phones and other smart devices. Also, the tablets also contain this feature. Now it is even common to find a computer's large screen which works with the touch screen system. It makes it very easy to type and navigate and one can bring the keyboard on the screen and type it there as well hence one doesn't have to install the keyboard. The configurations and the installation of the touch screen are also done in a display when it is bought.

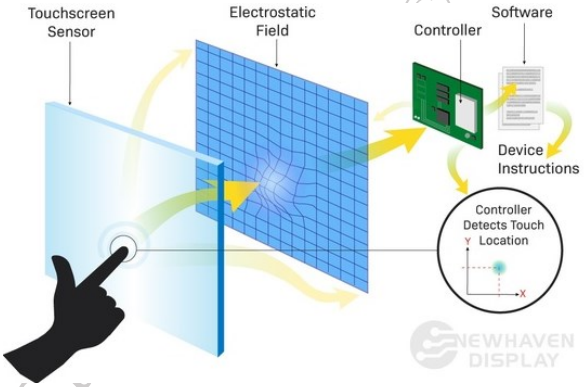


Fig. 2.3 Touch Screen

Scanner: At a time, the fax machines were widely used by the people and till now, they use it. But now the tables have turned and people tend to use the scanners. The scanners have the ability to turn the paper's image into a digital one hence sending the data from one place to another while keeping the same paper with us is now an easy task and the data can be sent more easily through the internet. The scanners are now used a lot and one can simply scan a paper and save it in any format he wants to.

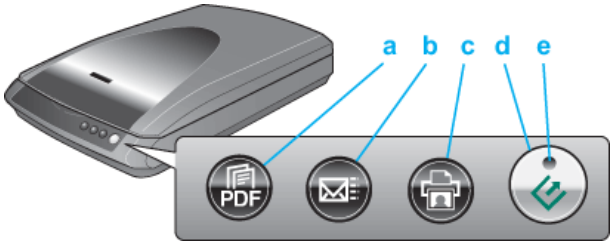


Fig. 2.4 Scanner

Barcode reader: If one goes to some super market or the retail environment, one would see the barcode. It's a machine that is used to read the code which is printed at the back of the products. The connection of the bar code is normally made through the USB connection. Some old versions of the bar codes also use the PS.2 connections to get connected to the computer. The barcodes use the laser technology to read the barcode. The light comes and goes when the code is exposed to the barcode reader. This eye can directly damage one's eye as well so one has to be careful while using this machine. The barcode contains a specific driver when it is connected, the driver is detected by the windows and hence it can work properly.

Fig. 2.5 Barcode reader

Biometric devices: These devices are used as the security tools. They are mostly used on some portable devices which tend to go away from one. If one tries to use the laptop, he might find there is a finger print reader there and hence it is protected since only the administrator who has set it up can log in to the computer.

Fig. 2.6 Biometric device

Game pads: Game pad is the wonderful thing for the gamers. It allows the gamers to have some control over the gaming experience.

Joysticks: It is the gaming input which is widely used. It is a stick which has many buttons on it.

Fig. 2.7 Joysticks

Digitizer: The digitalizing pad has some specialized pins that allow the user to draw on it very carefully and accurately. They are for those who have got some artistic abilities and they are installed with the driver.

Fig. 2.8 Digitizer

Multimedia devices: Multimedia devices have become so common these days and now they are an important part of our lives. Following are a few devices which are as follows;

Digital cameras: The digital cameras are the standalone cameras which are used by the individuals. These days almost everyone has got a digital camera and they are even embedded into the mobile phone where they can be used to take picture. The digital cameras when connected to the PC for transfer of pictures require the driver to get installed and that driver comes with the accessories.

Fig. 2.9 Digital Cameras

Microphone: If one wants to do some conferences or the voice chat, he would be meeting the microphone. They are available as the separated ones as well which can be easily used. They are normally connected through some USB connection and there is the digital connector which is associated with it to provide the high quality.

Fig. 2.10 Microphone

Webcam: Having a video is now a great need of the everyday life. Now it is very common to find some built in cameras into the displays which are being used these days. Specially, they are so common in the laptop and if they are not present, it is pretty common to get it connected and it is done pretty cheap amount. One can also enjoy the live video if it is plugged through the 802.11 wireless connections which go into the USB connection in the computer.

Fig. 2.11 Webcam

Camcorder: Most of the video conference has to be recoded and hence one needs the camcorders. They are normally done for some live videos. Normally those people, who upload videos on the video sharing websites like YouTube etc., use this tool to record the videos and then can upload them on the PC, were after editing, they can upload it on the website. They are not only into the digital cameras but they can be found easily on every laptop and almost every mobile phone so one can record anything anytime without any hustle. The video is stored in the flash memory. There is mostly having the large storage capacities in the digital cameras so that the videos can be recorded no matter how big they are. For transferring the videos off the camera, one would need a Firewire, it is a kind of direct HDMI connection and it can be used to display the video immediately on some display.

Fig. 2.12 Camcorder

MIDI enabled devices: MIDI stands for the Musical Instrument Digital Interface. It is actually a device which is musical one and can digitalize all of the information and can transfer it to the computer in some really standard way. Many of the application which contains these capabilities of the music use this midi as the standard format so that the information can be getting in and out of the computer. It is common to get these devices plugged into the computers with the help of some Ethernet cables and even the USB cables. While on the different side there in instrument is coated, the large din connections are used to get connected between the commuter and the device.

Fig. 2.13 MIDI enable devices

Output devices: Output devices are those devices which do not send the data into the computer, in fact through these devices, the computer communicates with the user. They contain the devices like displays, printers etc. Since they are very vital part of the computer system, so one should have enough knowledge about them. Some of these output devices are as follows:

Display devices: One of the most integral parts of the PC is the display devices which are used. The human beings need to see that what's going on the operating system and to get in touch with the interface, they must have some display device which can show them the appropriate amount of data. Normally the display devices re pretty thin and one has many options for the display devices and they vary in prices range as well. These devices can be both non-touchable and the touchscreen. These display devices are not just connected to the computers; instead they are connected to the mobile phones as well. Also, the Tablets contain some display devices as well. These displays show us what is exactly going on there and how we can control the computer.

Fig. 2.14 Display devices

Printers: If one has the data in the computer, it is obvious that he has to take it out of the computer. There are several ways for it and one of them is the painters. These printers are available not only in the office environment and in some retail environment, but at the homes as well. One might need the printer to take out the prints of the important information he finds on the

internet or the assignment which he creates. At office, many important documents are sent and received in the digitalized format and they have to be converted to the hard copy so they can be read easily. At the shops, one might find the painters which are used for printing out the receipts which are handed over to the customers. Hence printers are used in every aspect of the busy life. Printers have various types and the laser printers are the most famous type since they print really good. For printers there is much software and one must install the appropriate drivers to get them work. The configuration of the pinner can be done manually once it is connected to the computer.

Fig. 2.15 Printer

Speakers: Many of the features which are used by us are mainly related to the audio. Doesn't matter whether one listens to the podcasts or plays music, He would need the audio to be heard. Even while watching the movie or some educational video, hearing the voice is really important part and for that purpose, one needs the speakers. The laptop contains the right left speakers which are located at these both sides. There is also a subwoofer which can be used for the mixing of the voice. Also, one can have some advanced computer speaker which can be plugged into the computer externally for the sake of better quality of the sound. The laptops have various options which ate provided to user so that he can hear the sound with different options.

Fig. 2.16 Speakers

Hence, the computer is made up of many parts and each part plays some really vital role so one should know all the parts of the computer so that he can get the knowledge about how they work, how they are installed and how they can be configured once they are connected to the computer/laptops.

Installing and connecting Computer Peripherals

1. Monitor

Installing a monitor (also known as a "display") requires a free power outlet for A/C power and identifying the connection type you will use to connect the monitor to your graphics card. Both DVI and VGA connections are still very common in today's market and many monitors and graphics cards include both types of connections.

For the best picture quality possible, use the digital DVI port on your graphics card and display if they are available. Most all graphics cards now support multiple monitors and they typically include the adapters required to change a DVI connection to VGA for older displays. Once you have the display plugged in, simply connect it to the appropriate connector on your video card and you are ready to go. Drivers are not typically required for displays, but once again consult the manufacturer's instructions for details.

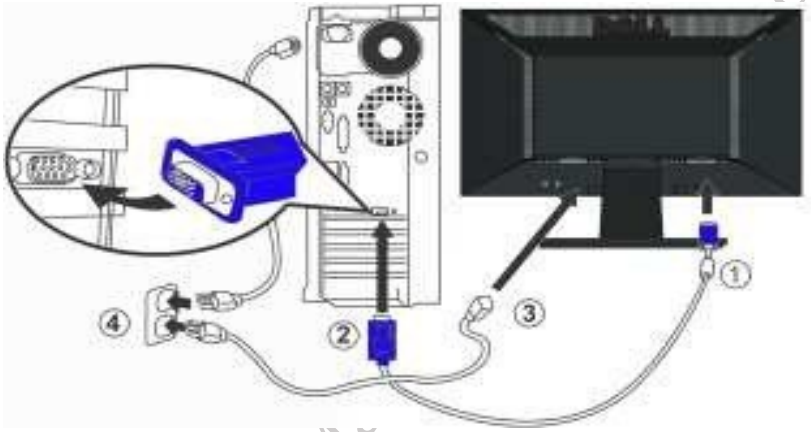


Fig. 2.17 connecting Monitor

1. Connect the monitor to the computer using the data cable provided with the monitor. There are several types of monitor port (or socket) including HDMI, DisplayPort, DVI & VGA, and you will need to look at the ports on both the monitor and the computer to see where the cable needs to be plugged in. See below for an illustration of the different types of port.

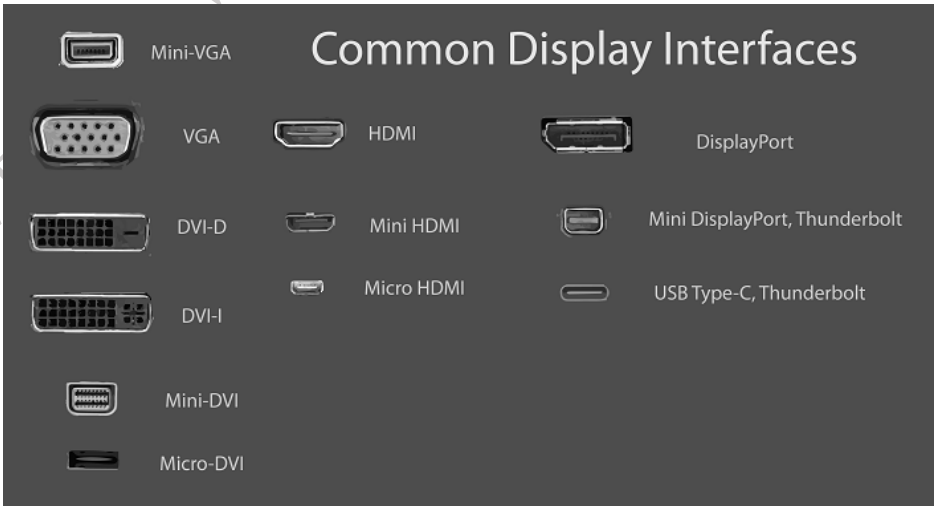


Fig. 2.18 common display interfaces

2. Connect the monitor to a power supply using the power cable provided with the monitor and switch the monitor on.

3. If the monitor is a 2nd or additional monitor, you may need to tell the computer how it is to be configured, which will usually be to extend the main display.

2. Keyboard

Installing a (non-wireless) keyboard is very straight forward and easy to do, but first you need to determine if the keyboard uses a PS/2 or USB connector. The PS/2 connector for keyboards is round and typically colored purple to match the connection on your computer although not all connectors are color coordinated. If your keyboard has a USB connector, the connector will be flat and rectangular in shape.

Every motherboard on the market that I have seen or heard of still has PS/2 ports; however, the vast majority of newer keyboards you find these days will have USB connections. Either style will work, but if you don't want to use up a USB port for the keyboard, adapters are available that will convert USB keyboard connections to PS/2.

Once you match your connection type to the port on your computer, you are ready to go and installing the keyboard is as easy as plugging it into the chosen port. A word of caution however, do not install your keyboard while your computer is powered on and do not unplug your keyboard while your computer is running. If you do either of these things, you run the risk of locking up your computer with possible data loss. Always be sure to read and follow the manufacturer's instructions before installing the keyboard on your system.

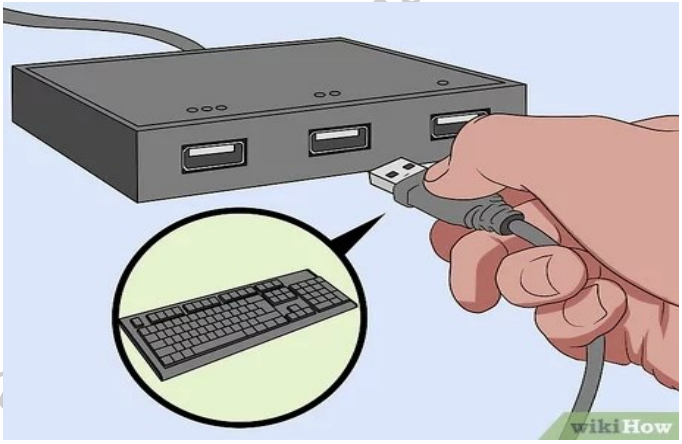


Fig. 2.19 Connecting Keyboard

1. Identify Your Keyboard Type

- Wired Keyboard: Connects via USB cable.
- Wireless Keyboard: Connects via Bluetooth or a USB wireless dongle.

2. Connect the Keyboard

Wired USB Keyboard:

- Locate a USB Port: Find an available USB port on your computer.
- Plug in the Keyboard: Insert the keyboard's USB connector into the USB port on your computer.

Wireless Keyboard with a USB Dongle:

- Locate a USB Port: Find an available USB port on your computer.
- Insert the USB Dongle: Plug the wireless dongle into the USB port.

Bluetooth Wireless Keyboard:

- Turn on the Keyboard: Ensure the keyboard has fresh batteries or is charged.
- Enable Bluetooth on Your Computer:

  Go to Settings > Devices > Bluetooth & other devices. Turn on Bluetooth.

Pair the Keyboard:

Click on "Add Bluetooth or other device," select "Bluetooth," and choose your keyboard from the list.

3. Install Keyboard Drivers (If Necessary)

Automatic Installation: Most keyboards will be automatically recognized by the operating system, and the necessary drivers will be installed.

Manual Installation:

- If the keyboard came with a CD or website link for driver software, insert the CD or download the drivers and follow the installation instructions.
- Follow on-screen instructions to complete the driver installation process.

4. Test the Keyboard

Open a text editor like Notepad (Windows) and start typing to ensure all keys are working correctly.

5. Troubleshooting (If Needed)

Wired Keyboard Not Working: Try a different USB port or check the cable for damage.

Wireless Keyboard Not Connecting: Ensure batteries are fresh, the dongle is inserted properly, or try re-pairing via Bluetooth.

Driver Issues: Visit the manufacturer's website to download the latest drivers.

6. Restart the Computer (Optional)

If you experience any issues, restarting your computer can help reset the connection.

3. Mouse

Installing a mouse is very similar to installing a keyboard. You will still find mice with either USB or PS/2 connectivity, although most of the newer mice will use a USB connection, especially if you are using a mouse for gaming. Just like the keyboard, you can also use an adapter to change a USB connection to PS/2. If you are going to have a lot of USB peripherals, you may want to consider using adapters for your mouse and keyboard or perhaps using a USB hub for some of your peripherals. To complete the installation, simply plug the mouse into the proper port.

It is important to mention the need to follow the manufacturer's instructions. Some computer mice require that you install the software before you plug the mouse in. The instructions or owner's manual included with the mouse will tell you how to install it.

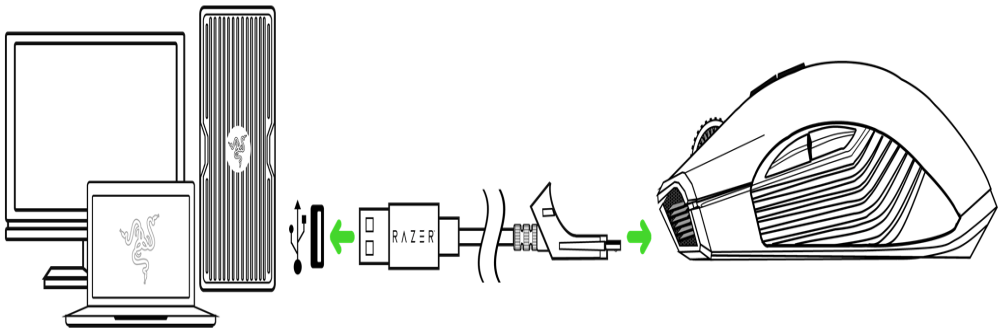


Fig. 2.20 Connecting Mouse

4. Printer

Most printers on the market today will also use a USB connection; however, parallel port printers are still fairly common. You can also set up a printer over the network if you have another computer on a local area network (LAN) with a printer attached and shared. This method is beyond the scope of this article. Typically, you will either be connecting your printer via USB or parallel line printer (LPT) ports.

Again, you will want to read the installation instructions to be sure that you are following the correct installation method. Printer installation typically requires that you install the drivers first then plug the printer in via USB or parallel port. The OS (operating system) will finish up the install for you after that.

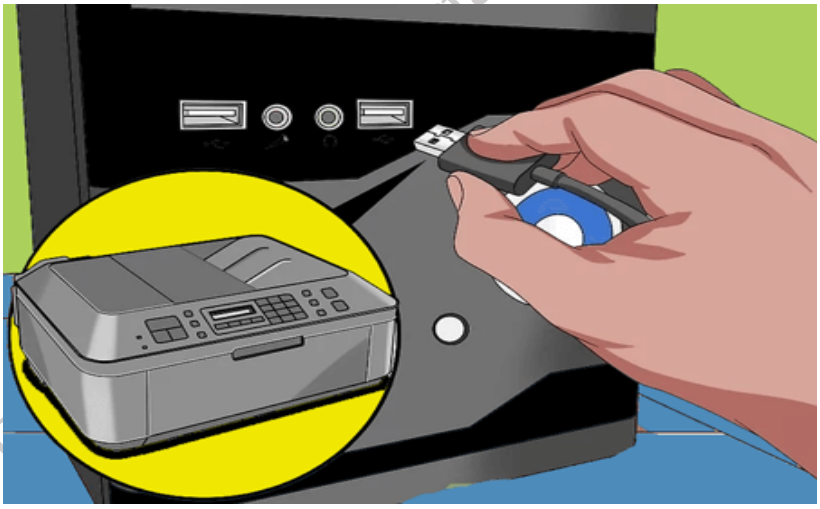


Fig. 2.21 Connecting Printer

Installing a Scanner

Installing a scanner is almost identical to installing your printer, though I have only seen USB scanners in the last few years. Again, you will simply need to install the drivers and then plug the USB cable in. Read the manufacturer's instructions for more details on this installation process.

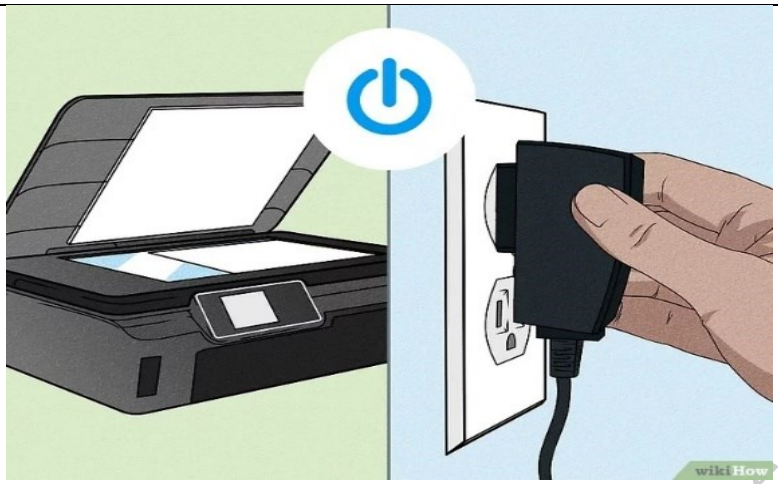


Fig. 2.22 Connecting Scanner

Connect a Printer and Scanner to a PC

- On Windows, connect your scanner. Open "Settings" → "Devices" → "Printers or Scanners" → "Add a printer or scanner".
- On Mac, connect your scanner. Click the Apple logo → "System Preferences" → "Printers or Scanners" → "+" → Add your scanner.
- Your scanner and computer must be on the same Wi-Fi network.

Check Your Progress

A. Multiple choice questions (MCQs)

1. Which of the following is NOT considered an input device? (a) Keyboard (b) Mouse (c) Monitor (d) Gamepad
2. What is the primary function of a gamepad? (a) To display graphics (b) To input commands through buttons and joysticks for gaming (c) To print documents (d) To store data
3. Which type of device is a multimedia keyboard classified as? (a) Output device (b) Input device (c) Storage device (d) Network device
4. Which of the following is an example of an output device? (a) Scanner (b) Microphone (c) Printer (d) Webcam
5. When installing a new peripheral, what is the first step that should typically be taken? (a) Plug in the device (b) Install the required drivers (c) Turn on the computer (d) Configure the settings

B. Fill in the blank questions

1. A device that allows users to enter data into a computer is called an _____ device.

2. Game pads are commonly used for _____, providing a more immersive gaming experience.
3. Multimedia devices, such as speakers and microphones, enhance the _____ experience on a computer.
4. An example of an output device is a _____, which produces hard copies of digital documents.
5. When installing a peripheral, it is important to ensure that you have the correct _____ for the device to function properly.

C. True or False

1. A keyboard is considered an input device because it allows users to enter data into the computer.
2. Game pads can only be used with gaming consoles and cannot be connected to a computer.
3. Multimedia devices include speakers, microphones, and webcams, which enhance audio and visual capabilities of a computer.
4. A monitor is an input device that allows users to see the output from the computer.
5. Properly installing and connecting computer peripherals typically requires downloading specific drivers for them to function correctly.

Module 4 Computer Assembly and Disassembly

Module Overview

Computer assembly is a process in which all the internal components of the computer system are fitted to make the computer functional. The main component involves CPU, motherboard, memory, disk drives, etc. There is a proper process of attachment and installation of each and every component. An installation technician should be competent to disassemble and reassemble the computer system. In this Unit, we will understand the step by step process of computer assembly and disassembly as a whole. The assembly and disassembly of the desktop as well as of a laptop computer is demonstrated. Tools are an essential part of computer assembly and maintenance. It is also important to handle the tools carefully and safely. While installation a computer and its peripherals, you should follow the basic safety guidelines to prevent cuts, burns, electrical shock, and damage to eyesight. The technician has to take care of the tools as well as personal safety. Safe working practice helps to prevent injury to people and damage to computer equipment. In this Unit, we will learn to use various tools required for installation of a computer and peripherals. We will also understand and follow the basic safety precautions while handling tools and equipment during the installation process.

Learning Outcomes

After completing this module, you will be able to:

- Assemble and dismantle a desktop computer, identifying key components and following safety protocols.
- Understand how to assemble and dismantle a laptop computer, including handling compact components and maintaining proper care.

Module Structure

Session 1: Assemble and Dismantle the Desktop Computer

Session 2: Assemble and Dismantle the Laptop Computer

Session 1. Assemble and Dismantle the Desktop Computer

Computer assembly is an essential job of a computer installation technician. The technician has to work in a logical, methodical manner while handling various computer components and peripherals. The technician can improve the computer assembly skills with practice. Computer assembly is a process in which all the internal components required for the computer system are fitted so as to make the computer functional. There is a proper sequence of attachment of each and every component into the computer system. To establish proper connectivity, one has to use the tools. Proper handling of tools is also required by the technician. It is required that students learn the steps of installation of each component. The main component involves installing CPU, motherboard, drives, video, graphics card, sound card, modem and adapter, and connectors, and system panel connector.

In this Session, we will understand the step-by-step process of assembling a computer system. It also covers the need for adequate system resources to efficiently run the customer's hardware and software.

Computer Assembly

As we know, computer assembly is a systematic process. First, arrange all the computer parts. The sequence for assembly and working of the computer is as below:

- Open the case.
- Install the power supply.
- Attach the components to the motherboard.
- Install the motherboard.
- Install internal drives.
- Connect all internal cables.
- Install motherboard power connections
- Connect external cables to the computer.
- Boot the computer for the first time.

Prepare the workspace before starting installation of the computer. There should be adequate lighting, good ventilation, and a comfortable room temperature. The workbench or table should be accessible from all sides. Avoid cluttering the surface of the workbench or table with tools and computer components. An anti-static mat on the table will help to prevent physical and electrostatic discharge (ESD) damage to equipment.

Small containers can be used to hold small screws and other parts as they are being removed.

Material Required

- Computer case, with power supply installed
- Motherboard
- CPU
- Heat sink/fan assembly
- Thermal compound
- RAM module(s)

• Motherboard standoffs and screws

• Anti-static wrist strap and anti-static mat

• Tool kit

Procedure

Step 1: Open the case

• The first step in assembling a computer is to open the computer case (see Figure 1.1). There are different methods for opening cases.

Fig. 1.1: Unscrew cabinet

Fig. 1.2: Pull cabinet side cover

• The computer comes with various types of cabinets. The method for opening the case is different based on the manufacturer.

• To open the case, first remove the screws of the left side cover and slide the side cover.

Step 2: Install the power supply

The next step is to install a power supply (see Figure 1.3 and 1.4). There are usually four screws that attach the power supply to the case. Power supplies have fans that can vibrate and loosen screws that are not secured. When installing a power supply, make sure that all of the screws are used and that they are properly tightened.

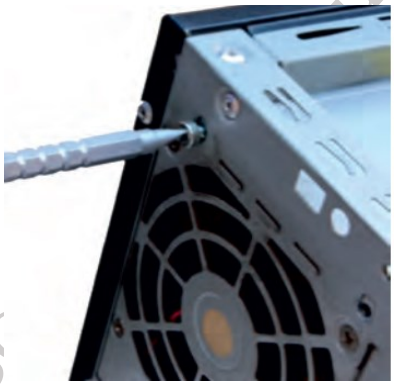


Fig. 1.3: Unscrew bolts

Fig. 1.4: Insert power supply

Insert the power supply into the case.

• Align the holes in the power supply with the holes in the case.

• Secure the power supply to the case using the proper screws.

Step 3: Attach the components to motherboard

The motherboard has to be prepared before its installation. To prepare the motherboard, you first need to install the CPU, then the heat sinks on the CPU and CPU fan.

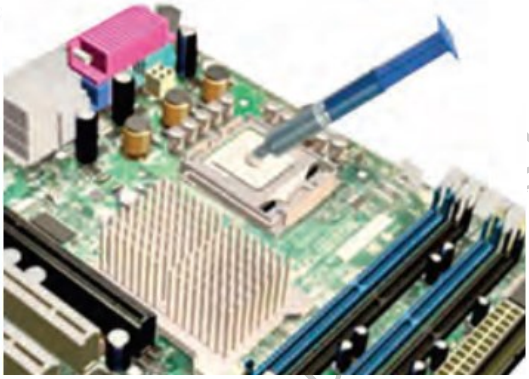


Fig. 1.5: Installing CPU on the motherboard Fig. 1.6: Applying thermal compound on CPU

CPU

The CPU and motherboard are sensitive to electrostatic discharge. So, place them on a grounded anti-static mat and wear an anti-static wrist strap while handling the CPU. When handling a CPU, do not touch the CPU contacts at any point. The CPU is secured to the socket on the motherboard with a locking assembly (see figure 1.5). Thermal compound which is used to conduct heat away from the CPU is applied on the top of CPU (see figure 1.6). In case of an old CPU, first clean the top of the CPU, and then apply the thermal compound. Clean the top of the CPU and the base of the heat sink with isopropyl alcohol and a lint-free cloth. This removes the old thermal compound. Then apply a new layer of thermal compound (see Figure 1.6).

Heat sink and fan assembly

Heat sink and fan assembly is a two-part cooling device. The heat sink draws heat away from the CPU. The fan moves the heat away from the heat sink. The assembly has a 3-pin/4pin power connector. To install a CPU and heat sink and fan assembly, follow these steps:

- First, open the CPU load plate. Align the CPU orientation so that the notches on the CPU are aligned with the orientation keys on CPU socket.
- Place the CPU gently into the socket.
- Close the CPU load plate.
- Close the load lever.
- Apply a small amount of thermal compound to top of the CPU (see Figure 1.6). Place the Heat sink/Fan gently and tighten the screw properly (see Figure 1.7 and 1.8).

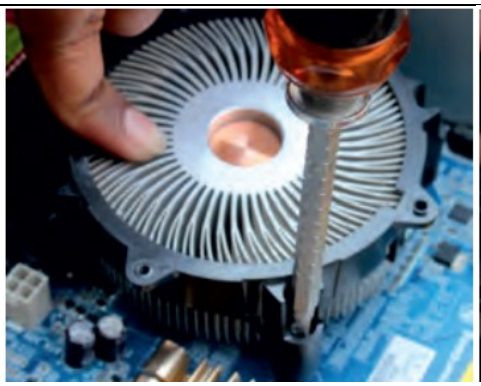


Fig. 1.7: Screw the heat sink

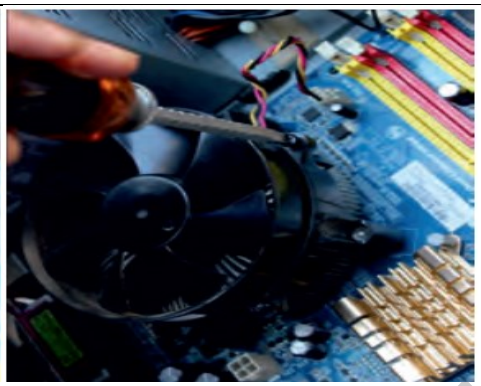


Fig. 1.8 Screw the heat sink fan assembly

Installation of RAM

It is better to install the RAM first on the motherboard and then fix the motherboard in the case. To install RAM, first ensure its compatibility with the motherboard. If DDR3/DDR4 is mentioned on the motherboard, then DDR3/DDR4 RAM may be fixed in the memory slot. To install RAM, follow these steps.

- Press down the side locks of the memory slot (see Figure 1.9). Align the notches on the RAM module to the keys in the slot and press down on both ends of RAM module until the side lock gets locked.
- Make sure that the side tabs have locked the RAM module.
- Repeat the above steps to install additional RAM modules.

Fig. 1.9: Memory slot

Step 4: Install motherboard

After preparing the motherboard, you can install the computer case, as shown in Figure 1.10. Plastic and metal standoffs are used to mount the motherboard and to prevent it from touching the metal portions of the case. To install the motherboard, follow these steps:

- Lay the motherboard over the standoffs to mount it on the holes.
- Align the screw holes of the motherboard with the standoffs.
- Then screw the board using a standard screwdriver.
- Tighten all the motherboard screws.
- Connect the 4-pin ATX power connector from the power supply to the motherboard.

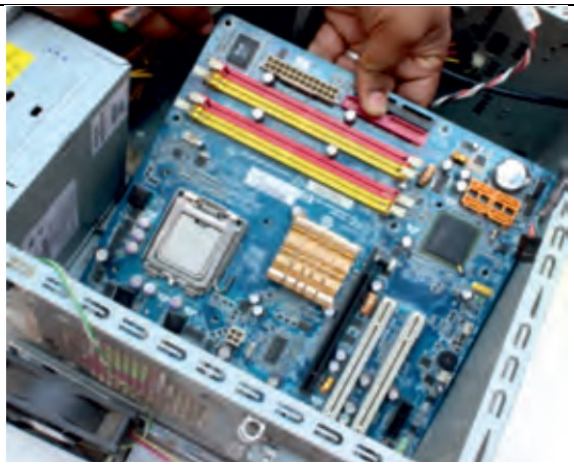


Fig. 1.10: lay the motherboard over the standoffs Fig. 1.11: Tighten all the motherboards screws

Step 5: Install internal drives

Hard drive

The hard drive is the device which stores all the data. It is 3.5-inch-wide and needs to be mounted so that access to the cable connections on the back is gained. Drives that are installed in internal bays are called internal drives. A hard disk drive (HDD) is an example of an internal drive. To install HDD, follow these steps:

- Position the HDD so that it aligns with the 3.5-inch drive bay.
- Insert the HDD into the drive bay so that the screw holes in the drive line up with the screw holes in the case (see Figure 1.12).
- Secure the HDD to the case using proper screws (see Figure 1.13).

Fig. 1.12: Insert hard disk **Fig. 1.13: Tighten screw of HDD**

Optical drive

- Position the optical drive so that it aligns with the 5.25-inch drive bay.
- Insert the optical drive into the drive bay so that the optical drive screw holes align with the screw holes in the case (see Figure 1.14).
- Secure the optical drive to the case using the proper screws (see Figure 1.15).
- Connect the power cable coming from the SMPS to the power socket of optical drive.

• Connect SATA data cable from optical drive socket to the motherboard socket.

Fig. 1.14: Insert optical drive

Fig. 1.15: Tighten screws of optical drive

Step 6: Connect all internal cables

Power cables are used to distribute electricity from the power supply to the motherboard and other components. Data cables transmit data between the motherboard and storage devices, such as hard drives.

Fig. 1.16: Connect cable IN to HDD

Fig. 1.17: Press cable socket for proper connection

Step 7: Install motherboard power connections

Just like other components, motherboards require power to operate. The Advanced Technology eXtended (ATX) main power connector will have either 20 or 24 pins. The power supply may also have a 4-pin or 6-pin auxiliary (AUX) power connector that connects to the motherboard. A 20-pin connector will work in a motherboard with a 24-pin socket. Follow these steps for motherboard power cable installation:

• Align the 20-pin ATX power connector with the socket on the motherboard.

• Gently press down on the connector until the clip clicks into place (see Figure 1.18).

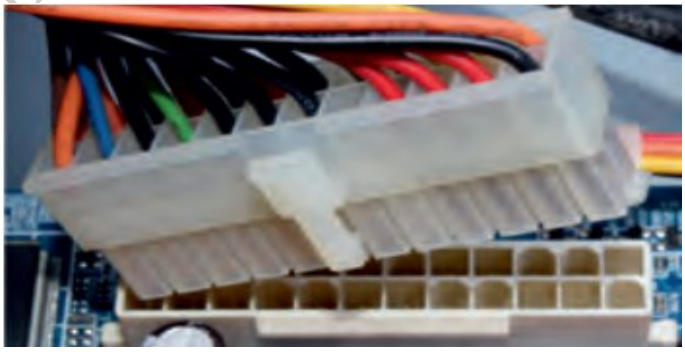


Fig. 1.18: Plug-in 20-pin ATX power connector to motherboard

• Align the 4-pin AUX power connector with the socket on the motherboard.

• Gently press down on the connector until the clip clicks into place (see Figure 1.19).

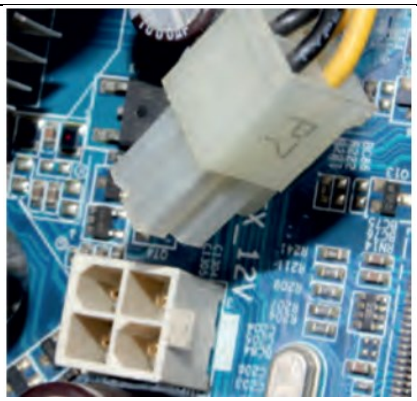


Fig. 1.19: Plug-in 4-pin AUX power connector to motherboard

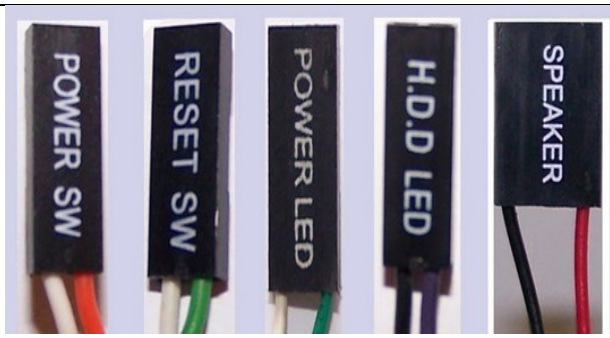
SATA power connectors

SATA power connectors use a 15-pin connector (see Figure 1.20). Serial advanced technology attachment (SATA) power connectors are used to connect to hard disk drives, optical drives, or any devices that have a SATA power socket.

Fig. 1.20: Plug-in 15-pin connector to HDD

Step 7a Connecting Front Panel connectors

To connect front panel connections, take care about all the wires which you can see in cabinet depends on the manufacturer. In most of the cabinets, you will find Power SW, Reset SW, Speaker, Power LED, HDD LED, Front USB connector etc (see figure x1). Few motherboards have built in speaker separately. Now a days one single combined connector is also available which have all in one to connect for front panel.



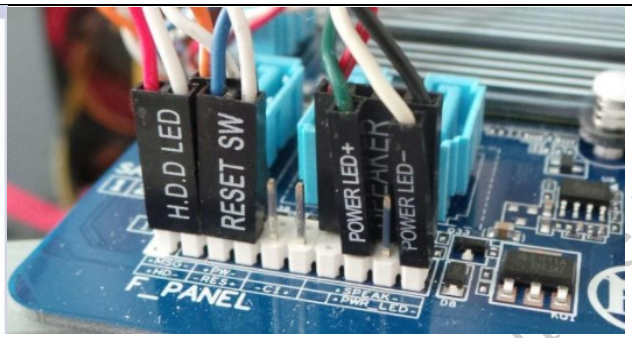


Fig. x1. Front Panel Connectors **Fig. x2 Connecting F Panel Connectors**

Step 8: Connect external cables to the computer

Setting up the computer system involves the complete process of establishing the proper connectivity of various parts of the computer system—input and output devices, connectivity of computer with the surge power supply. Reattach the side panels to the case. The process of connecting the external cables given below:

Locate the monitor cable

Locate the two-power cable and one VGA cable or monitor cable (see Figure 1.21). The VGA cable is used to connect to monitor and another point on to the back side of the cabinet. If you are having trouble finding these, refer to the instruction manual of or the computer. You can skip to 'Step 3', in case of all-in-one computer that is built into the monitor.

Connecting monitor

Connect one end of the cable to the monitor port on the back of the computer case and the other end to the monitor. In case of VGA cable as shown in Figure 1.22 tighten the screws on the monitor cable to secure it. The cables will only fit in a specific way. If the cable does not fit, do not force it, otherwise the connectors might get damaged. Make sure the plug aligns with the port, then connect it. So, first identify all the cables, ports, and connectors.

Fig. 1.21: Display cable and ports

Connecting keyboard

Unpack the keyboard and determine whether it uses a USB (rectangular) connector or a PS/2 (round) connector. If they have colour coded plugs that are light green and lavender, plug them into the corresponding colour-coded ports, it is more likely if they use round PS/2 connectors. If it uses a USB connector, plug it into any of the USB ports on the back of the computer. The following Figures 1.23 and 1.24 shows connecting keyboard in PS/2 connector and USB connector.

Fig. 1.23: Connecting keyboard in PS/2 port

Fig. 1.24: Connecting keyboards in USB port

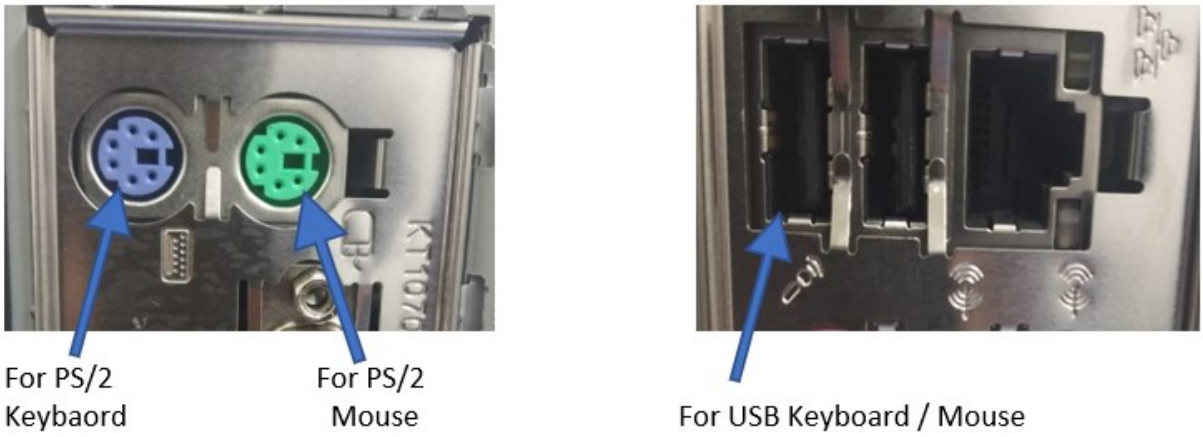
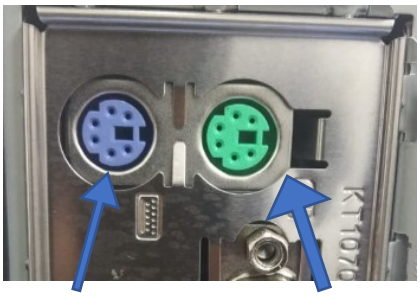


Fig. 1.23-1.25 Connecting Keyboard / Mouse in PS/2 or USB Port

Connecting mouse

Unpack the mouse and determine whether it uses a USB or PS/2 connector. If it uses a USB connector, plug it into any of the USB ports on the back of the computer. If it uses a PS/2 connector, plug it into the green mouse port on the back of the computer.

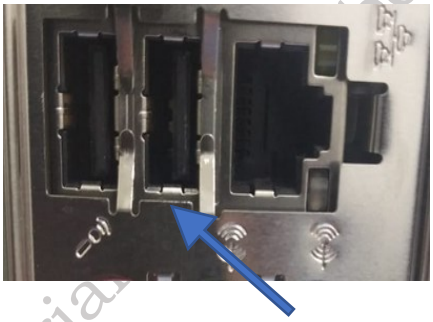
In case of Wireless mouse or keyboard, connect a Bluetooth dongle (USB adapter) in one of the USB ports of the computer. However, it is not necessary to connect an adapter for the modern computers which have built-in Bluetooth.



For PS/2 Keybaord

For PS/2 Mouse

Fig. 1.25: (a) Connecting mouse in PS/2 port



For USB Keyboard / Mouse

Fig. 1.25: (b) Connecting mouse in USB port

Connecting headphones or speakers, and microphone

Connect the external speakers or headphones, to computer's audio port (either on the front or back of the computer case). The modern computers have colour-coded ports.

Speakers or headphones connect to the green port, and microphones connect to the pink port.

The blue port is the line-in, which can be used with other types of devices. They can be also connected to the USB port. Some speakers, headphones, and microphones have USB connectors instead of the usual audio plug. Connect them to any USB port. Some computers have speakers or microphones built into the monitor.

Fig. 1.26 Connecting in Back panel

Fig. 1.27 Connecting in Front panel

Connect the computer to a power supply

Locate the two power supply cables that came with the computer. Plug the first power supply cable into the back of the computer case and then into a surge protector. Then, using the other cable, connect the monitor to the surge protector. It is better to use an uninterruptable power supply (UPS), which acts as a surge protector and provides the back up when the power goes off.

UPS (uninterruptible power supply)

While working on computer, its power supply should not be interrupted. UPS is like a power bank which gives power to the computer system. So, make sure to plug power cable of monitor and cabinet into the UPS power output socket. Ensure the connection is proper.

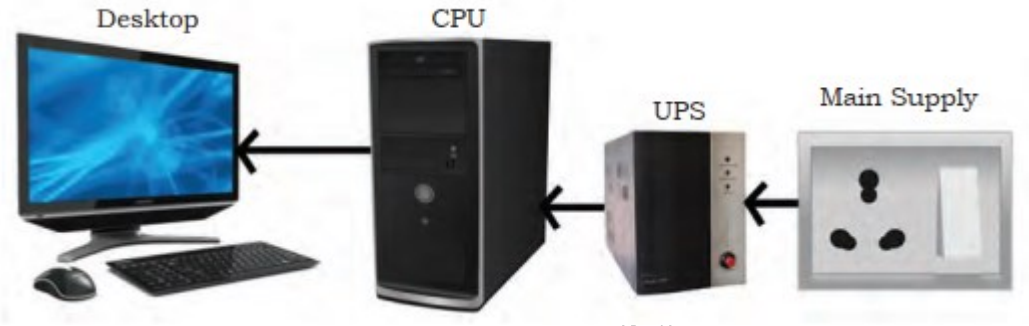


Fig. 1.28: Power connection (CPU through UPS)

Plug the surge protector

Plug the surge protector into a wall outlet after finishing the connectivity of all the parts and peripherals, plug the surge protector into the main power supply and turn it on when you are ready.

Fig. 1.29: Plug the surge protector into a wall outlet

Connecting printer, scanner, webcam

To connect the peripherals such as printer, scanner, webcam, identify the respective connectors of the cable and port on the cabinet. Now a days almost all such devices are USB based and you can easily plug these in USB port. Correctly plugging in will recognise the peripherals as they are plug and play devices.

It may be required to install their software drivers for them to function properly. Most of the time the respected driver gets automatically installed as you plug in the device. Use the instructions included with the device to install them if necessary. Installation of peripherals is optional, and it be can added at any time; it may not be required during the initial setup of your computer.

Checklist the following before starting the computer:

- VGA cable of monitor is connected to the cabinet or not.
- Power cable of monitor and cabinet has been plugged into the UPS power output socket. Make sure monitor is connected to the power supply or not.
- Keyboard and mouse both are connected to their proper ports.

Step 9: Starting the computer

To start the computer, it is necessary to follow the correct sequence to start up. Now push the power button on the CPU to start the computer. Practically when we start our vehicle, we always check that the light or air conditioner (AC) is off. Otherwise it will consume more power compared to normal start up.

Always remember that the first step is to push power button of the CPU than the monitors. Because the monitor consumes more electricity when powered on. An operating system or system software like Window or Linux will start loading as shown in Figure 1.30, 1.31, and 1.32 and the home window will appear as shown in Figure 1.33, 1.34, and 1.35. Now your computer is ready to use.

Fig. 1.30: Starting window of Windows 10 Fig. 1.31: Starting window of Windows 7 Fig. 1.32: Starting window of Ubuntu

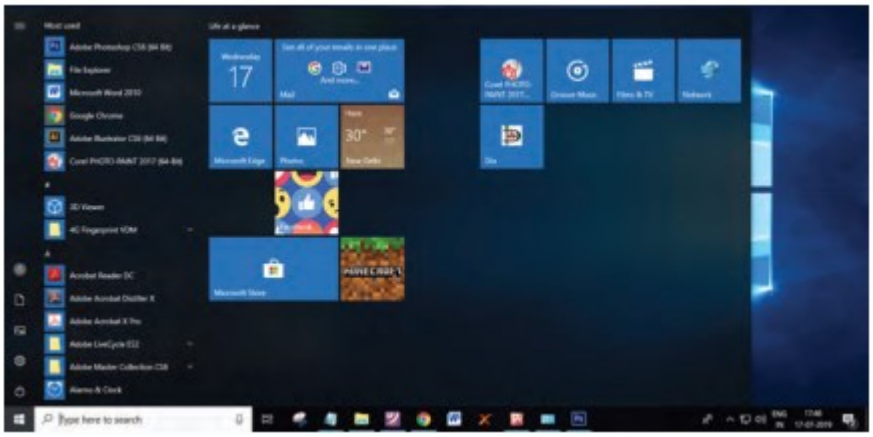


Fig. 1.33: Home windows of windows 10

Fig. 1.34: Home window of windows 7

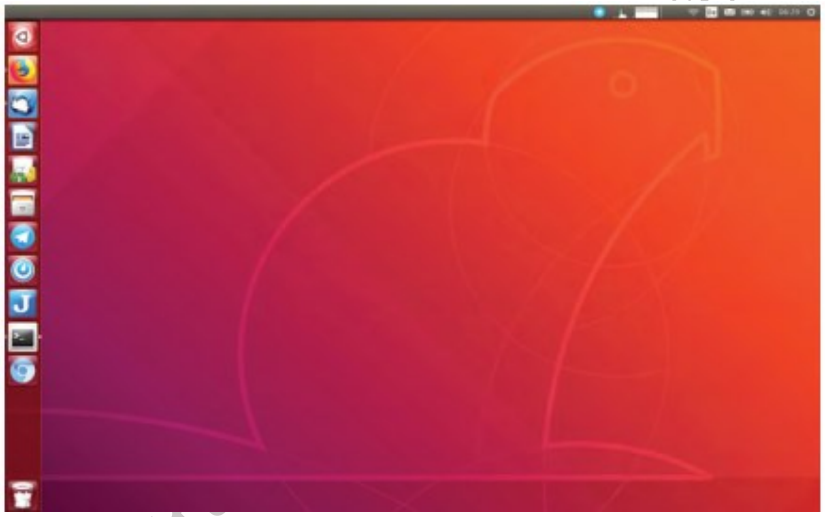


Fig. 1.35: Home windows of Ubuntu

Computer Disassembly

Disassembly is the process of breaking down a device into separate parts. Disassembly of any device is required to determine a problem, to replace a part, or take the parts and use them in another device. A computer is also an electronic device which requires disassembly for such issues. For example, if a RAM gets dysfunctional in a computer, then it requires disassembling the computer to take out the dysfunctional RAM and replace it with new RAM chips. As we know, computers have standard internal components, but the way of placement may vary as per the PC tower case and different brands of computer.

The best way is to refer to the manufacturer instructions manual. But in general, there is a standard process of computer disassembly, which is demonstrated in this session. Just like computer assembly, the disassembly is a standard process. The process involves unplugging of all the cords and cables connecting a component to other components, then removing the part from the case or frame. Components can be attached to the case with special clips, screws, or by insertion into a holder.

A small amount of force is required to remove each part of the computer system.

Material Required

- One working PC
- An anti-static wrist strap
- An anti-static mat
- Anti-static bags of various sizes
- Technician's toolkit
- A plastic cup or box to organize screws, nuts, and bolt

Fig. 1.36 CPU

Procedure

The disassembly procedure of computer is demonstrated as below.

Step 1: Unplugging

- Unplug the power cord from the PC and from the wall socket to prevent any injuries and damage of the PC from electrostatic discharge (ESD).
- Unplug all the peripherals attached to the computer, such as the keyboard, mouse, monitor, headphones, and any external drives.
- Wear a grounding strap to discharge any static electricity.

Step 2: Open the case

The computer comes with various types of cabinets. The methods of opening the case are different based on the manufacturer.

- To open the case, first remove the screws of the left side cover and slide the side cover.
- Pull the latch to release the side panel. Then lift the side cover out from the chassis.

To remember connectivity of internal cables, take the photographs of internal circuitry. It will help to assemble back the system.

Fig. 1.37: Unscrew cabinet

Fig. 1.38: Pull cabinet side cover

Step 3: Disconnect all the connectors

Disconnect all the connectors connected to the motherboard. These include SATA power cable and data cable of HDD as well as SATA cable of optical drive. 20 or 24 Pin, 4 Pin connectors from Motherboard etc.

Fig. 1.39: Unplug 15-pin connector from HDD

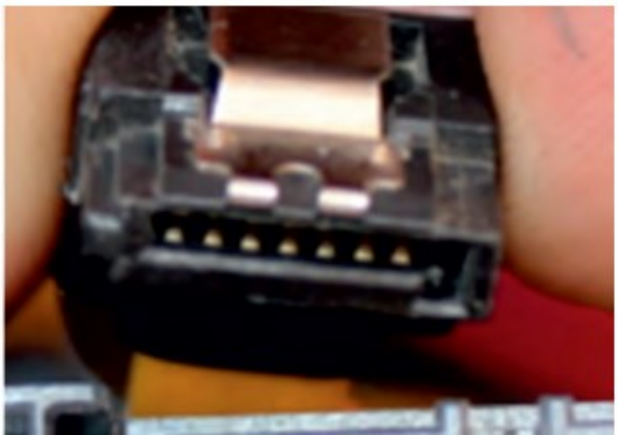


Fig. 1.40: Unplug 7-pin connector from HDD

Step 4: Remove the fan

Remove the fan now. Most computers have two fans—the system fan and CPU fan. The system fan is located at the back side of the computer to blow air into the computer. The CPU fan is located on top of the CPU heat sink. The fans and its connectors are labelled with their names.

Fig. 1.41: Unscrew fan

Fig. 1.42: Remove the system fan

To remove the system fan, first, disconnect its connector from the motherboard. Then, unscrew it from the outside of the back of the case and lift the fan out of the system (see Figure 1.43). To remove the CPU fan from the heat sink, first, disconnect its connector from the motherboard. Then remove the four screws securing it (see Figure 1.44).

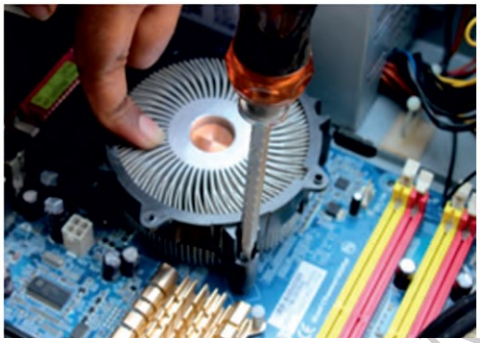


Fig. 1.43: Unscrew heat sink

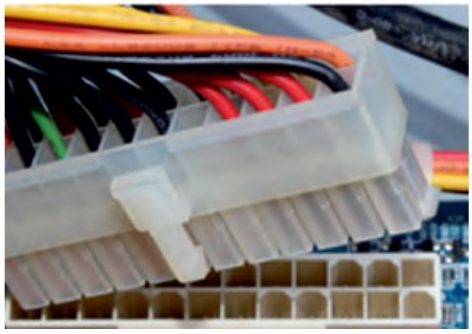


Fig. 1.44: Unplug 20-pin ATX

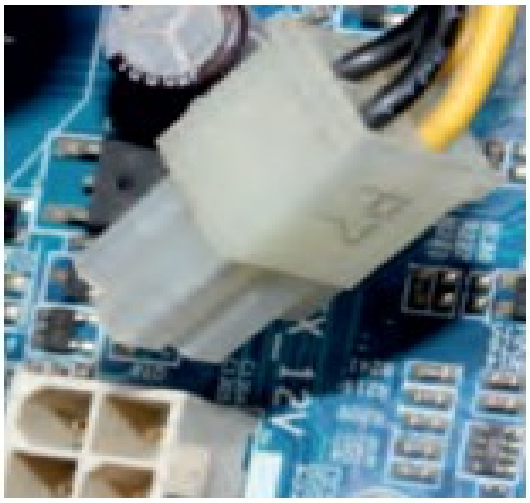


Fig. 1.45: unplug 4-pins AUX power connector from power connector from motherboard

Fig. 1.46: Unplug SATA cables from motherboard

Step 5: Remove the power supply

The power supply is connected to the motherboard by a 20-pin connector and 4-pin connector. It is also connected to hard disk drive and the optical drive. Firstly, disconnect hard disk drive and the optical drive connectors from the motherboard (see Figure 1.46).

• Disconnect the power cable of the hard disk and optical drive which connects to the SMPS (see Figure 1.47).

Fig. 1.47: Unplug power cable from optical drive and HDD

Fig. 1.48: Remove the screws

Fig. 1.49: Unscrew the SMPS and remove it from cabinet

• Remove the screws that secure the power supply unit to the chassis (see Figure 1.48).
• Carefully lift the power supply out of the chassis (see Figure 1.49).

Step 6: Removing HDD and optical drive

Remove the SATA cable connecting to the HDD and motherboard.

Then unscrew the four screws securing it in place and pull out the HDD (see Figure 1.50).

Fig. 1.50: Unscrewing of HDD

Fig. 1.51: Remove HDD

Step 7: Remove RAM (random access memory) modules

RAM allows for the transfer of information to and from the CPU. Computer runs fast with more RAM. Most computers have four RAM slots, and two RAM chips. To remove the RAM, push down on both tabs holding the RAM in place, which are located at both ends of the RAM. It will cause the module to pop up for easy removal.

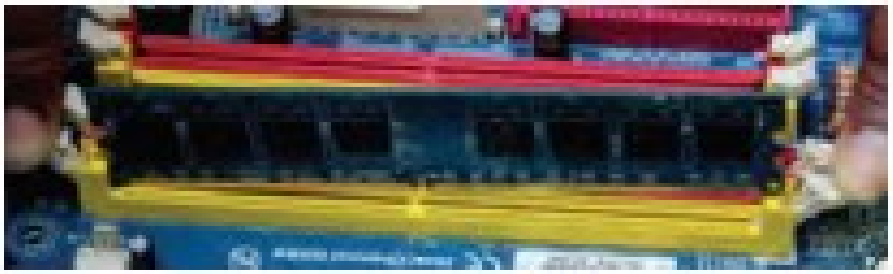


Fig. 1.52: Unplug the RAM from slot

Step 8: Remove expansion cards

The modern motherboards are integrated with the audio, video and network cards. However, if your computer has the expansion card as shown in Figure 1.53, insert into the expansions slot to increase the functionality. The expansion card is screwed with a single screw on top of expansion card slot.

- To remove the expansion cards, disconnect the cables attached to it.
- Remove the screws securing the card in the slot.
- Carefully take out the card from the slot.

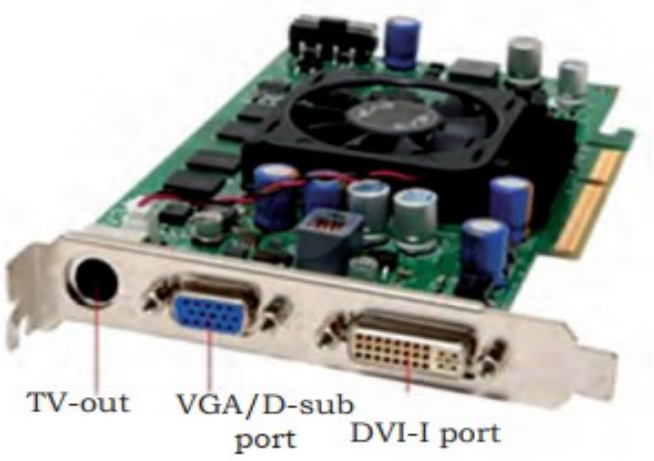


Fig. 1.53: Expansion card

Step 9: Remove motherboard

Every part of the computer is attached to the motherboard. The CPU, RAM, and expansion cards are directly attached to the motherboard. To remove the motherboard, disconnect all the cables from the motherboard. It has seven screws holding it to the frame. Remove these screws and then lift the motherboard out of the frame.

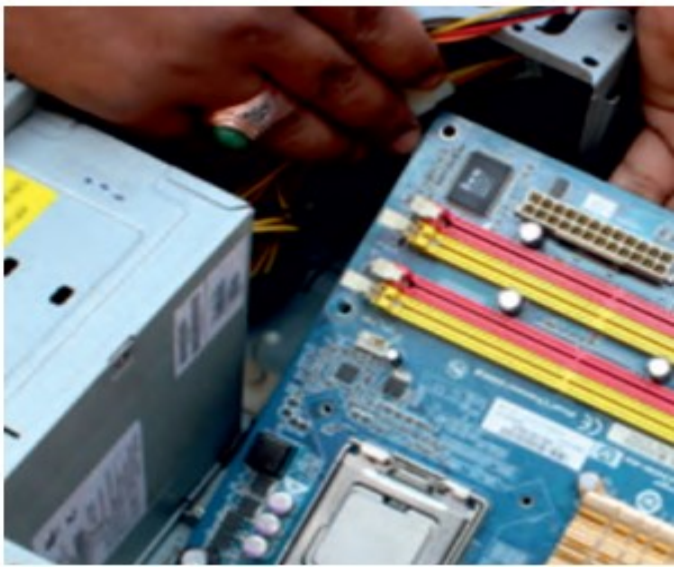


Fig. 1.54: Removing the motherboard

Step 10: Reassemble the components

• Identify every component and take its photograph.

• After identification of each component, put all the components back in their place and ensure that all cables and wires are connected at the right place to avoid further troubleshooting.

• Close the case and put the screws back in their place.

• Lastly, connect every external device such as the keyboard, mouse, monitor, etc., and turn on the computer to see everything is working fine after assembled.

Practical Exercise

Identify and list the various internal components of the computer system:

• Form a group of 35 students.
• Take any old computer system.
• Disable the computer system as per the procedure.
• Identify and name the various internal components of the computer system.
• Identify their brands and list the specifications.
• Test the compatibility of the components with the motherboard.

Check Your Progress

A. Multiple choice questions (MCQs)

1. What is the primary function of the CPU in a computer system? (a) To store data (b) To execute instructions and process data (c) To provide power to components (d) To display graphics
2. When installing RAM, what should you align it with on the motherboard? (a) The CPU socket (b) The power connectors (c) The RAM slot notches (d) The optical drive
3. Which of the following is used to connect hard drives and optical drives to the motherboard? (a) USB cables (b) Ethernet cables (c) HDMI cables (d) SATA cables
4. What is the purpose of a UPS (Uninterruptible Power Supply)? (a) To cool the CPU (b) To provide a backup power source during outages (c) To enhance graphics performance (d) To connect peripheral devices
5. When disassembling a computer, which of the following should be done first? (a) Disconnect the power supply (b) Remove the hard drive (c) Take out the RAM (d) Remove the CPU

B. Fill in the blank questions

1. The _____ is often referred to as the brain of the computer, where most calculations and processing take place.
2. When installing RAM, it is important to ensure that the notches on the RAM module align with the _____ in the motherboard slot.
3. A _____ is a device that stores data permanently and can be used to save files, programs, and the operating system.

4. An _____ drive allows users to read and write data from optical discs, such as CDs, DVDs, and Blu-ray discs.
5. To provide backup power to a computer during an outage, users can connect it to a _____.

C. True or False

1. The CPU (Central Processing Unit) is responsible for executing instructions and processing data within the computer.
2. RAM (Random Access Memory) is a permanent storage device used to hold data and files when the computer is powered off.
3. Optical drives are used to read and write data on CDs, DVDs, and Blu-ray discs.
4. SATA power connectors are only used for connecting the monitor to the computer.
5. A UPS (Uninterruptible Power Supply) provides backup power to the computer in case of a power outage, allowing you to save work and shut down safely.

D. Short Questions

1. What precautions should be taken before disassembling a computer?
2. How do you safely disconnect the CPU from the motherboard?
3. What is the correct procedure for installing a hard drive into a computer case?
4. What are the steps for connecting a mouse to a computer?
5. How can you ensure proper functionality when connecting speakers or a microphone to a computer?

Session 2. Assemble and Dismantle the Laptop Computer

Assembling of laptop

Assembling a laptop means putting all the main parts together to make the laptop work. It starts with the laptop case, where we fit the motherboard—the main circuit board that connects everything. Next, we attach the CPU (processor), which is the brain of the laptop. After that, we install the RAM (memory) and the storage device like an SSD or hard drive, which stores files. We then connect the keyboard, screen, battery, and other parts like the Wi-Fi card. Finally, we check if all the wires are connected properly, and once everything is secure, we close the case and turn it on to see if the assembly was successful.

Material Required

Laptop
Mini screwdriver
Anti-static
Wrist
strap
Magnifying glass

Procedure

Step 1: Keep track of screws

There are several types of small screws that are used throughout the laptop. Place these in small envelopes and write the component name on the envelope. Be organized and keep track of all the screws. We have to figure out how to remove the back panel.

Fig. 2.1: Back panel of a laptop

Step 2: Installation of processor

First component to be installed is the processor. Take extreme care not to touch the pins in the socket during the process (see Figure 2.2 and 2.3).

Fig. 2.2: Unscrew the socket

Fig. 2.4: Fit processor in the socket

Step 3: Pop in the video card

First, find the baggie with three larger silver screws and two small black screws to install the graphics card. Hold the card at about a 30-degree angle as you insert its edge connector into the video-card slot near the center of the motherboard. Press the card in and downward, and then use the two small black screws to secure it in place.

Step 4: Set up the drive

The motherboard SATA connectors are along the front, right edge, and under the lip of the laptop's

shell. Drop the drive into place and then carefully use your thumb to push the drive into the SATA connectors. Now use the remaining two screws to secure the drive-in place.

Step 5: Add memory

To install memory, locate the memory slots on the motherboard. Align the notches on the memory module with the ridge in the slot. Firmly push the module until the clips on the side of the slot snap into place.

Step 6: Final assembly

Now that all the hardware components are installed, find the four screws you removed from the ACE door, slide the door back into place, and replace the screws. To prepare for power up, pop in the notebook's battery pack, connect the power brick and plug it into a wall outlet. Finally, open the laptop's cover with one hand, use your other hand to press the power button.

Disassembly of laptop

Procedure

Step 1: Removal of battery

Start the disassembly process by removing the battery (see Figure 2.5). Remove one screw securing the optical CD/DVD drive. Pull out the optical drive and remove it. Remove all the screws securing the bottom case. There are two screws hidden under the two laptop bottom feet. Remove the bottom screws. Peel off the bottom from the case to access the hidden screws. Remove the hidden screws from both sides of the notebook.

Fig. 2.5: Remove battery and optical drive

Step 2: Separation of palm rest

Using a plastic case opener, separate the palm rest from the bottom case as shown in Figure 2.6.

Fig. 2.6: Separate plan rest from bottom case

Step 3: Removal of bottom case

Turn the notebook upside down and remove the bottom case.

Step 4: Disconnecting the hard drive cable from the motherboard

Remove the three screws fixing the hard drive bracket to the case. Disconnect the hard drive cable from the motherboard.

Fig. 2.7: Remove screw from the hard drive and disconnect it

Fig. 2.8: Open the connector and release hard drive cable

Step 5: Remove the hard drive

Remove the hard drive assembly from the notebook. If you are going to replace it with another hard drive or SSD, you will have to transfer the mounting bracket and the SATA cable.

Fig. 2.9: Remove hard drive assembly **Fig. 2.10: Disconnect SATA cable**

Step 6: Removal of RAM

A notebook PC motherboard has two memory slots. Remove both RAM modules if necessary.

Fig. 2.11: Remove RAM memory modules

Step 7: Disconnection of cable

Remove the one screw fixing the USB LED status board. Disconnect the cable from the motherboard.

Step 8: Removal of USB LED status board

Remove the USB LED status board.

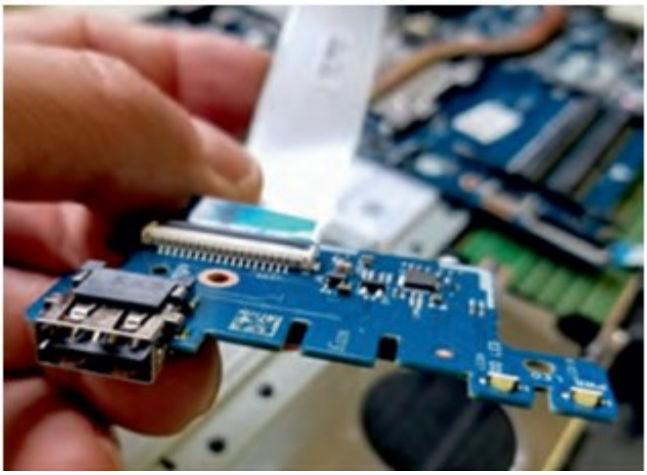


Fig. 2.12: Remove USB LED status board

Fig. 2.13: Remove optical CD DVD drive connector board

Step 9: Removal of screw fixing the optical CD/ DVD drive connector board

Remove the one screw fixing the optical CD/DVD drive connector board. Disconnect the cable from the motherboard.

Step 10: Removal of the cooling fan

Remove the two screws fastening the cooling fan to the case. Unplug the fan cable from the motherboard and remove the cooling fan (see Figure 2.14).

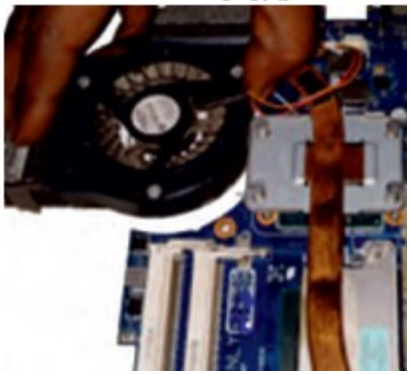


Fig. 2.14: Remove cooling fan

Step 11: Removal of DC power jack

In a notebook PC, the DC power jack is mounted under the hinge. Remove it. Disconnect the Wi-Fi antenna cable from the wireless card. Disconnect the DC power jack harness from the motherboard. Move all cables aside and remove the two screws from the display hinge. Open up the hinge and remove the DC power jack.

Step 15: Removal of screw securing the board

The power button board is also mounted under the same hinge. Remove the one screw securing the board and unplug the cable from the motherboard.

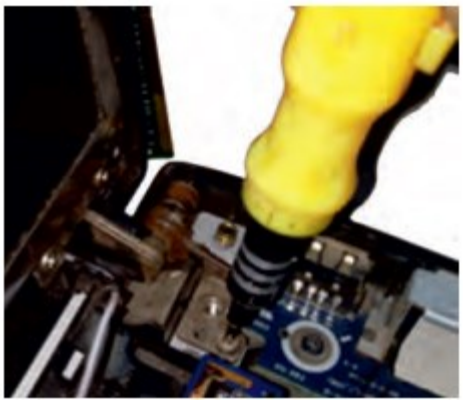


Fig. 2.15: Remove screws fastening display hinge

Fig. 2.15: Open the hinge and remove DC power jack

Fig. 2.16: DC power jack mounted under display hinge

Fig. 2.17: Disconnect Wi-Fi Module

Step 12: Removal of motherboard

Separate the motherboard from the top case and remove it. The other side of the motherboard is shown in Figure 2.18.

In a notebook PCs, the keyboard is permanently attached to the top case with rivets. When the keyboard fails, it is necessary to replace the top case. The touchpad is glued to the top case but the touchpad button board can be removed.

Fig. 2.18: Disconnect cable from motherboard and remove screws

Fig. 2.19: Remove the motherboard from notebook case

Fig. 2.20: Keyboard permanently attached to top case

Laptop LCD Screen Removal

Procedure

It is possible to disassemble the LCD screen of a laptop independently. Previous steps are not required for disassembling the display, you only need to disconnect the battery before you start.

Fig. 2.21: Notebook PC LCD screen removal

Step 1: Separate the display bezel from the back cover. You will have to wiggle the bezel to unfasten it from the cover. Start on the top and move to the sides for the display assembly.

Step 2: On the bottom, the bezel is attached to the LCD screen with adhesive tape. Carefully separate it from the screen.

Step 3: Remove the bezel completely.

Step 4: Remove the four screws securing the LCD screen to the side brackets (see Figure 12.77).

Fig. 2.22: Remove the four screws securing LCD screen

Fig. 2.23: Remove screen bezel

Step 5: Separate LCD screen from the back cover and place it the front side down on the keyboard.

Fig. 2.24: Separate LCD screen from back cover

Step 6: Now you can access the video cable connector (see Figure 2.25).

Fig. 2.25: Disconnect video cable from screen

Step 7: Peel off the grounding tape from the screen.

Step 8: Peel off the clear tape securing the connection and unplug the video cable from the screen.

Step 9: Remove the LCD screen completely and replace if necessary (see Figure 2.26).

Fig. 2.26: Remove and replace LCD screen

Step 10: You can find a new LCD screen using the model number from the original one.

Check Your Progress

A. Multiple choice questions (MCQs)

1. What is the first step in disassembling a laptop? (a) Removing the battery (b) Disconnecting the hard drive (c) Taking out the RAM (d) Unscrewing the LCD screen
2. Which tool is commonly used to open a laptop casing? (a) Hammer (b) Flathead screwdriver (c) Pliers (d) Phillips screwdriver
3. To safely remove the LCD screen from a laptop, you should first: (a) Remove the keyboard (b) Disconnect the LCD cable (c) Turn on the laptop (d) Remove the battery
4. What is the purpose of grounding yourself before disassembling a laptop? (a) To clean the components (b) To prevent scratches (c) To avoid static electricity damage (d) To improve performance
5. After removing the LCD screen, what should you do with the screws? (a) Throw them away (b) Keep them in a safe place for reassembly (c) Use them to hold other components (d) Leave them inside the laptop case

B. Short Questions

1. What are the essential tools needed for assembling or disassembling a laptop?
2. What steps should be followed to safely disassemble a laptop?
3. How can you identify the screws that need to be removed to access the laptop's LCD screen?
4. What precautions should you take when handling the LCD screen to avoid damage during removal?
5. What is the correct procedure for reconnecting the LCD screen after it has been removed?

Glossary

Resistor: A passive electronic component that limits or regulates the flow of electrical current in a circuit.

Capacitor: A device that stores electrical energy in an electric field, commonly used in circuits to smooth voltage fluctuations.

Multimeter: A measuring instrument used to measure voltage, current, and resistance in electrical circuits.

Soldering Iron: A hand tool used to melt solder, allowing it to flow into the joint between two workpieces to create a solid electrical connection.

PCB (Printed Circuit Board): A board used to mechanically support and electrically connect electronic components using conductive pathways.

ESD (Electrostatic Discharge): The sudden flow of electricity between two electrically charged objects caused by contact, which can damage electronic components.

Diode: A semiconductor device that allows current to flow in only one direction, used in rectifying circuits.

Motherboard: The primary circuit board in a computer that houses the CPU, memory, and essential connectors for other components.

Chipset: A set of electronic components in an integrated circuit that manages data flow between the processor, memory, and peripherals.

BIOS (Basic Input/Output System): Firmware used to perform hardware initialization and provide runtime services for the operating system.

CMOS Battery: A small battery on the motherboard that powers the BIOS firmware, maintaining the system clock and configuration settings when the computer is powered off.

RAM (Random Access Memory): A type of volatile memory used by a computer to store data that is actively being used or processed.

PCIe (Peripheral Component Interconnect Express): A high-speed interface standard used to connect hardware components such as graphics cards and SSDs to the motherboard.

Heatsink: A passive component that draws heat away from the CPU or other components to prevent overheating.

Peripheral: External devices connected to a computer, such as a keyboard, mouse, printer, or external storage.

USB (Universal Serial Bus): A standard interface used to connect peripherals to a computer, enabling data transfer and power supply.

Driver: A software component that allows the operating system to communicate with hardware devices, ensuring they function correctly.

I/O Ports: Input/output interfaces on a computer that allow peripheral devices to connect and communicate with the system.

HDD (Hard Disk Drive): A storage device that uses spinning magnetic disks to store and retrieve digital information.

SSD (Solid State Drive): A storage device that uses flash memory for faster data access compared to HDDs.

Monitor: A display screen that allows users to view the graphical output of a computer system.

Chassis: The metal frame that holds all the components of a computer, including the motherboard, drives, and power supply.

CPU (Central Processing Unit): The main processor of a computer, responsible for executing instructions and processing data.

Thermal Paste: A conductive paste applied between the CPU and its heatsink to improve heat transfer.

Power Supply Unit (PSU): A device that converts AC power from the wall into DC power to run the computer's components.

SATA (Serial ATA): A standard for connecting storage devices like hard drives and SSDs to the motherboard.

Fan: A cooling device that helps to regulate the temperature inside the computer by circulating air.

Disassembly: The process of carefully removing components from a computer system for maintenance, repair, or upgrades.

Answer Key

Module 1. Basic Electronics, Tools and Equipment

Session 1. The Basic Concepts of Electronics

A. Multiple choice questions (MCQs)

1. (a) 2. (d) 3. (b) 4. (c) 5. (b)

B. Fill in the blank questions

1. Conductors, Insulators 2. Resistance 3. Passive, Active 4. Transformer 5. Semiconductor

C. True or False

1. (F) 2. (T) 3. (F) 4. (T) 5. (T)

Session 2. The Electronic Circuit Components

A. Multiple choice questions (MCQs)

1. (c) 2. (b) 3. (a) 4. (b) 5. (d)

B. Fill in the blank questions

1. Analog, Digital 2. AND 3. Computers 4. Volts, Watts 5. Switched-Mode Power Supply

C. True or False

1. (T) 2. (F) 3. (F) 4. (F) 5. (T)

Session 3. Use Tools, Equipment and Measuring Instruments

A. Multiple choice questions (MCQs)

1. (b) 2. (b) 3. (a) 4. (b) 5. (b)

B. Fill in the blank questions

1. Wrenches 2. Multimeter 3. Powered off 4. Protective 5. Environment

Module 2. Installation and Configuration of Motherboard and Its Components

Session 1. Install the Motherboard

A. Multiple choice questions (MCQs)

1. (b) 2. (d) 3. (b) 4. (c) 5. (c)

B. Fill in the blank questions

1. Motherboard 2. Mini ITX 3. CMOS 4. Printers 5. Resources

C. True or False

1. (T) 2. (F) 3. (T) 4. (F) 5. (T)

Session 2. Install the CPU and Processor on the Motherboard

A. Multiple choice questions (MCQs)

1. (b) 2. (d) 3. (b) 4. (c) 5. (c)

B. Fill in the blank questions

1. CPU 2. ALU 3. Generations 4. Instructions 5. Heat sink

C. True or False

1. (T) 2. (F) 3. (T) 4. (T) 5. (F)

Session 3: Installing RAM on Motherboard

A. Multiple choice questions (MCQs)

1. (b) 2. (c) 3. (a) 4. (b) 5. (b)

B. Fill in the blank questions

1. Storage 2. Non-volatile 3. Read-Only Memory 4. DIMM 5. Drivers

C. True or False

1. (T) 2. (F) 3. (T) 4. (F) 5. (T)

Module 3. Installation and Configuration of Computer Hardware and Peripherals

Session 1. Install the Power Supply Unit (PSU)

A. Multiple choice questions (MCQs)

1. (b) 2. (d) 3. (b) 4. (d) 5. (b)

Session 8. Installing Computer Peripherals

A. Multiple choice questions (MCQs)

1. (c) 2. (b) 3. (b) 4. (c) 5. (a)

B. Fill in the blank questions

1. Input 2. Gaming 3. Audio 4. Printer 5. Drivers

C. True or False

1. (T) 2. (F) 3. (T) 4. (F) 5. (T)

Module 4. Computer Assembly and Disassembly

Session 9. Assemble and Dismantle the Desktop Computer

A. Multiple choice questions (MCQs)

1. (b) 2. (c) 3. (d) 4. (b) 5. (a)

B. Fill in the blank questions

1. CPU 2. Connectors 3. Hard drive 4. Optical 5. UPS

C. True or False

1. (T) 2. (F) 3. (T) 4. (F) 5. (T)

Session 10. Assemble and Dismantle the Laptop Computer

A. Multiple choice questions (MCQs)

1. (a) 2. (d) 3. (b) 4. (c) 5. (b)