MODULE II

Contents

2.1 INTRODUCTION TO COMPUTER HARDWARE

Hardware_represents the physical and tangible components of a computer, i.e., the components that can be seen and touched. It can be electronic, electrical, magnetic, mechanical or optical components.

Examples of hardware are the following –

- **Input devices**- Keyboard, mouse, etc.
- **Output devices**- Printer, monitor, etc.
- **Internal components**- CPU, motherboard, RAM, etc.

Relationship between Hardware and software

- Hardware and software are mutually dependent on each other. Both of them must work together to make a computer produce a useful output.
- Software cannot be utilized without supporting hardware.
- Hardware without a set of programs to operate upon cannot be utilized and is useless.
- To get a particular job done on the computer, relevant software should be installed into the hardware.
- Hardware is a one-time expense.
- Software development is very expensive and is a continuing expense.
- Different software applications can be loaded on hardware to run different jobs.
- Software act as an interface between the user and the hardware.
- If the hardware is the heart of the computer system, then the software is its 'soul'. Both are complementary to each other.

2.1.1 POWER SUPPLY

- There are three major kinds of power supplies: *unregulated, linear regulated, and switching.*

Unregulated Power Supply

- An unregulated power supply exhibits a lot of ripple voltage (i.e. rapidly-varying instability) and other AC ''noise'' superimposed on the DC power.
- If the input voltage varies, the output voltage will vary by a proportional amount.
- It is cheap, simple, and efficient.

Linearly Regulated Power Supply

- A typical linear regulator is designed to output a fixed voltage for a wide range of input voltages, and it simply drops any excess input voltage to allow a maximum output voltage to the load.
- This excess voltage drop results in significant power dissipation in the form of heat.
- If the input voltage gets too low, the circuit will lose regulation, meaning that it will fail to keep the voltage steady.
- It can only drop excess voltage, not make up for a deficiency in voltage from the brute force section of the circuit.
- Switching power supplies work on the principle of rectifying the incoming AC power line voltage into DC, re-converting it into high-frequency square-wave AC through transistor operated as on/off switches, stepping that AC voltage up or down by using a lightweight transformer, then rectifying the transformer's AC voltage output into DC and filtering for final output.
- Voltage regulation is achieved by altering the "duty cycle" of the DC-to-AC inversion on the transformer's primary side.

2.2 DC REGULATED POWER SUPPLY

- Almost all basic electronic circuits need an unregulated AC to be converted to constant DC, in order to operate the electronic device.
- All devices will have a certain power supply limit and the electronic circuits inside these devices must be able to supply a constant DC voltage within this limit.
- That is, all the active and passive electronic devices will have a certain DC operating point (Q-point or quiescent point), and this point must be achieved by the source of DC power.
- The DC power supply is practically converted to each and every stage in an electronic system. Thus, a common requirement for all these phases will be the DC power supply.
- All low power systems can be run with a battery. But, for long time operating devices, batteries could prove to be complicated.

Need for Regulated Power Supply

- There are considerable variations in ac line voltage caused by outside factors beyond our control. This changes the DC output voltage.
- The internal resistance by amount of load current drawn from supply.

Regulated Power Supply

- Regulated power supply is an electronic circuit that is designed to provide a constant dc voltage of predetermined value across load terminals irrespective of ac mains fluctuations or load variations.
- Designed to output a fixed voltage for a wide range of input voltages.
- Drops any excess input voltage to allow a maximum output voltage to the load.
- The DC power supply is practically converted to each and every stage in an electronic system.
- Thus, a common requirement for all these phases will be the DC power supply.

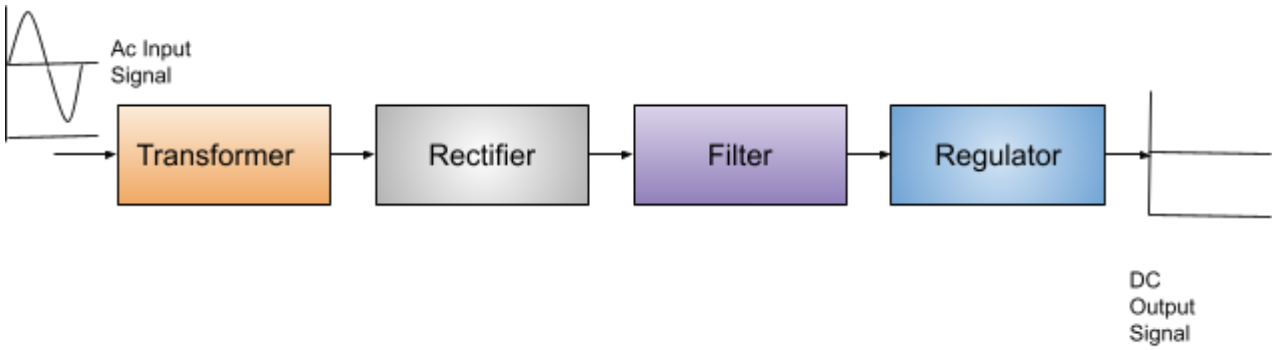
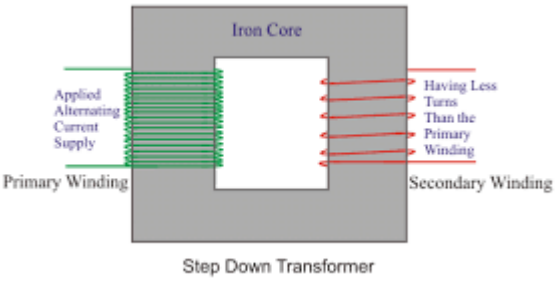


Figure 2.1 Block Diagram of DC Regulated Power Supply

Transformer

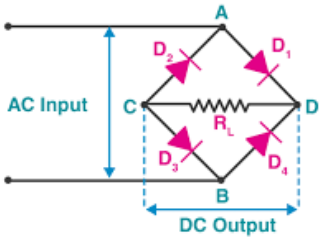
Transformer is used to step-up or step-down (usually to step-down) the supply voltage as per the need of the electronic devices and circuits to be supplied by the dc power supply. It can provide isolation from the supply line.



Rectifier

Rectifier is a device which converts the sinusoidal ac voltage into either positive or negative pulsating dc. P-N junction diode, which conducts when forward biased and practically does not conduct when reverse biased, can be used for rectification *i.e.,* for conversion of ac into dc. The rectifier typically needs one, two or four diodes. Rectifiers may be either half-wave rectifiers or full-wave rectifiers type.

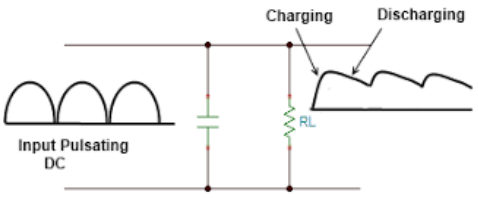
The output voltage from a rectifier circuit has a pulsating character i.e., it contains unwanted ac components (components of supply frequency *f* and its harmonics) along with dc component. To reduce ac components from the rectifier output voltage a filter circuit is required.



Filter

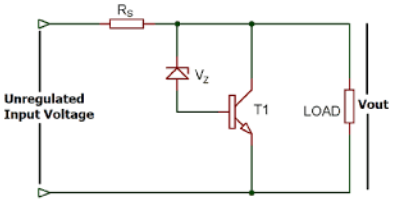
Filter is a device which passes a dc component to the load and blocks ac components of the rectifier output. Filter is typically constructed from reactive circuit I elements such as capacitors and/or indicators and resistors.

The magnitude of output dc voltage may vary with the variation of either the input ac voltage or the magnitude of load current.



Regulator

At the output of a rectifier – filter combination, a voltage regulator is required, to provide an almost constant dc voltage at the output of the regulator. Its main function is to maintain a constant dc output voltage. However, it also rejects any ac ripple voltage that is not removed by the filter.



2.3 CONCEPTS OF SWITCH MODE POWER SUPPLY

- The disadvantages of LPS such as lower efficiency, the need for large values of capacitors to reduce ripples and heavy and costly transformers etc. are overcome by the implementation of Switched Mode Power Supplies.
- SMPS is a switching regulator that transfers power from a source to a load.
- The source can be the main power and load can be a personal computer.
- An SMPS is usually employed to provide a regulated output voltage, typically a level different from input voltage.

Regulated Power Supply → **SMPS** → Unregulated Power Supply

Figure 2.2 Switch Mode Power Supply

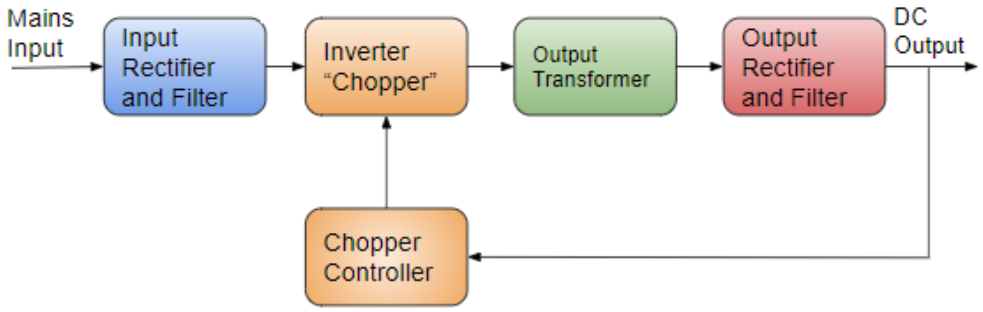


Figure 2.3 Block Diagram of SMPS

Input Rectifier and filter stage

- If the SMPS has an AC input, then the first stage is to convert the input to DC. This is called *rectification.*
- The rectifier produces an unregulated DC voltage which is then sent to a large filter capacitor.

Inverter stage

- The inverter stage converts DC, to AC by running it through a power oscillator. i.e., the input DC supply from a rectifier is fed to the inverter where it is turned on and off at high frequencies of between 20KHz and 200KHz by the switching MOSFET or power transistors.
- MOSEFT is a type of transistor.

Transformer

- The high frequency voltage pulse from inverter is fed to the transformer primary winding.
- This converts the voltage up or down to the required output-
  Level on its secondary winding.

Output Rectifier and filter

The secondary AC output is rectified and smoothed to produce the required DC voltages.

Chopper Controller

A feedback circuit monitors the output voltage and instructs the circuit to adjust the duty cycle to maintain the output at the desired level.

Advantages

The advantages of SMPS include,

- The efficiency is as high as 80 to 90%
- Less heat generation; less power wastage.
- The device is compact and small in size.

- The manufacturing cost is reduced.
- Provision for providing the required number of voltages

Disadvantages

There are few disadvantages in SMPS, such as

- The noise is present die to high frequency switching.
- The circuit is complex.
- It produces electromagnetic interference.

Applications

There are many applications of SMPS. They are used in the motherboard of computers, mobile phone charges, battery chargers, central power distributions, motor vehicles, consumer electronics, laptops, security system, space station, etc.

2.4 INVERTERS

Figure 2.4 INVERTERS

- Converts DC power to AC form.
- The input can be from a 12 volt, 24 volt, or 48 volt battery bank.
- Output can be 110-120 VAC, or 220-240 VAC.
- *Basic principle: use the stored high current inside a DC source (normally a battery) and step it up to a high voltage AC.*

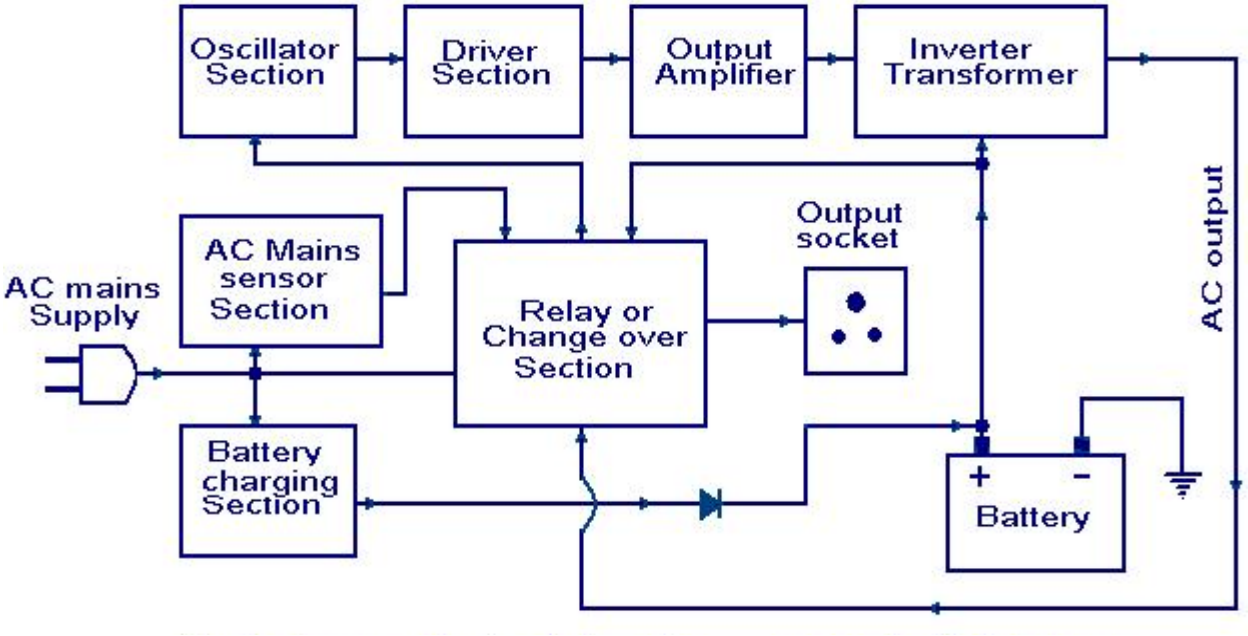


Figure 2.5 Block Diagram of Inverter

To grasp the functioning of an inverter, consider the following situations.

- When the AC mains power supply is available.
- When the AC mains power supply is not available.

When the AC mains power supply is available.

- Mains sensor senses it and the supply goes to the Relay and battery charging section of the inverter.
- AC main sensor activates a relay and this relay will directly pass the AC mains supply to the output socket.
- The load will be driven by the line voltage in this situation.
- The line voltage is given to the battery charging section where the line voltage is converted to a DC voltage(12V DC or 24V DC usually),then regulated and the battery is charged using it.
- There are special circuits for sensing the battery voltage and when the battery is fully charged the charging is stopped.

When the AC mains power supply is not available.

- When the AC mains power supply is not available,an oscillator circuit inside the inverter produces a 50Hz MOS drive signal.
- This MOS drive signal will be amplified by the driver section and sent to the output section. MOSFETs or Transistors are used for the switching operation.

- These MOSFETs or Transistors are connected to the primary winding of the inverter transformer.
- When these switching devices receive the MOS drive signal from the driver circuit,they start switching between ON & OFF states at a rate of 50 Hz.
- This switching action of the MOSFETs or Transistors cause a 50Hz current to the primary of the inverter transformer.
- This results in a 220V AC or 110V AC (depending on the winding ratio of the inverter transformer) at the secondary or the inverter transformer.
- This secondary voltage is made available at the output socket of the inverter by a changeover relay.

Inverter contains various circuits to automatically sense and tackle various situations that may occur when the inverter is running or in standby.This automaton section looks after conditions such as overload,over heat,low battery,over charge etc.Respective of the situation, the automation section may switch the battery to charging mode or switch OFF.The various conditions will be indicated to the operator by means of glowing LEDs or sounding alarms.In advanced inverters LCD screens are used to visually indicate the conditions.

Applications

- Adjustable-speed ac motor drives
- Uninterrupted power supplies (UPS)
- Running appliances of ac used in an automobile battery.
- power transmission industry such as reactive power controllers and adaptive power filters.
- An inverter can be used to control the speed of the compressor motor to drive variable refrigerant flow in a refrigeration or air conditioning system to regulate system performance.

2.5 UPS AND THEIR APPLICATIONS

An **uninterruptible power supply is** an electrical apparatus that provides emergency power to a load when the input power source or main power fails.

A UPS differs from an auxiliary or emergency power system in that it will provide near instantaneous protection from input power interruptions, by supplying energy stored in batteries.

The on-battery runtime of most uninterruptible power sources is relatively short (only for a few minutes) but sufficient to start a standby power source or properly shut down the protected equipment.

Operation

The three general categories of modern UPS system are *on-line, line-interactive and standby.*

Offline/standby UPS

- The offline/standby UPS (SPS)offers only the most basic features, providing surge protection and battery backup.
- The protected equipment is normally connected directly to incoming utility power.
- When the incoming voltage falls below or rises above a predetermined level the SPS turns on its internal DC-AC inverter circuitry, which is powered from an internal storage battery.
- The UPS then mechanically switches the connected equipment on to its DC-AC inverter output.
- The switchover time can be as long as 25 milliseconds depending on the amount of time it takes the standby UPS to detect the lost utility voltage. The UPS will be designed to power certain equipment, such as a personal computer, without any objectionable dip or brownout to that device.
- The line-interactive UPS is similar in operation to a standby UPS, but with the addition of a multi- tap variable- voltage autotransformer. This is a special type of transformer that can add or subtract powered coils of wire, thereby increasing or decreasing the magnetic field and the output voltage of the transformer.
- This type of UPS is able to tolerate continuous undervoltage brownouts and overvoltage surges without consuming the limited reserve battery power.
- It instead compensates by automatically selecting different power taps on the autotransformer. Depending on the design, changing the autotransformer tap can cause a very brief output power disruption, which may cause UPSs equipped with a power-loss alarm to “chirp” for a moment.
- This has become popular even in the cheapest UPSs because it takes advantage of components already included.
- In an online UPS, the batteries are always connected to the inverter, so that no power transfer switches are necessary.
- When power loss occurs, the rectifier simply drops out of the circuit and the batteries keep the power steady and unchanged.
- When power is restored, the rectifier resumes carrying most of the load and begins charging the batteries, though the charging current may be limited to

prevent the high-power rectifier from overheating the batteries and boiling off the electrolyte.

- The main advantage of an on-line UPS is its ability to provide an "electrical firewall" between the incoming utility power and sensitive electronic equipment.

Applications of UPS

- **UPS *for computer:*** *The* main use *of UPS is give power backup to the computers. It protects the computer's from being mislaid if the power goes out.*
- **FOR TV & LCD:** A UPS is used for TV & LCDs to provide regulated voltage. It defends the sensitive electronics from variations in the voltage supplied to them.
- To give backup supply to cordless phones and fish Aquarium Pump, UPS are the best power supply.

Key Differences Between UPS and Inverter

- The UPS is the electric device that has a rectifier for providing the backup power to the system whereas the inverter converts DC into AC.
- The main function of the UPS is to store the electric supply whereas the inverter converts the AC power into DC power.
- During the power outages, the UPS immediately switches over from the main supply to the battery whereas the inverter has a time delay.
- The UPS provides the electrical backup power, and the inverter provides the electronics backup power supply.
- The Offline, Online and Line Interruptive are the types of the UPS whereas the inverter is of two types, i.e., the standby inverter and Grid tie inverter.
- The UPS is directly connected to the home appliances whereas the inverter is first linked to the battery and then attached to the appliances circuit.
- The UPS is more expensive as compared to the inverter.
- The rectifier and battery are inbuilt in the circuit of UPS. The rectifier converts the AC into DC and stores the energy into a battery whereas the inverter has an external battery for storing the DC power.
- The UPS provides the backup supply for a very short duration whereas the inverter supplies the power for an extended period.
- The UPS does not have voltage fluctuation because their input is independent of the output supply whereas the inverter has voltage variation.

- The UPS is used for the domestic purpose, in offices and industries whereas the inverter is used in the office.

The UPS is more efficient as compared to the inverter. The UPS provides the electric backup to the appliances without delay and fluctuation. And, the inverter is a medium between the primary power supply and the battery. The battery helps in storing the energy and during the power outages convert the store AC into DC and provides power to the electrical inverter.

2.6 COMPONENTS OF CPU

CPU consists of six components:

➔ Arithmetic and Logic Unit
➔ Registers
➔ Cache
➔ Buses
➔ Clock
➔ Control Unit

Arithmetic and Logic Unit

- Performs arithmetic and logical operations.
- Logical operation involves decision making.
- Gateway between primary memory and secondary storage.
- Data transferred between them are passed through ALU.

Registers

- Small high-speed memory inside the CPU.
- USed to store small amounts of data during processing.
- General purpose registers
    - Store data
- Special purpose registers
    - Store special information that are used for the execution

Cache Memory

- High speed random access memory (RAM) within the CPU.
- Stores frequently accessed data by the CPU.
- To access data faster.
- Speed is high compared to main memory.
- CPU first checks whether the data is available in the cache memory.
- If the data is found,CPU fetches the data directly from the cache.
- Otherwise, it fetches from main memory and a copy is saved in cache.
- Data which is not used for a long duration will be replaced.

Buses

- High-speed internal connection.
- Used to send control signals and data between the processor and other components.

Address bus

- carries memory addresses from the processor to other components such as primary memory and input/output devices.

Data bus

- Carries the actual data between the processor and other components.

Control bus

- Carries control signals from the processor to other components.
- The control bus also carries the clock's pulses.

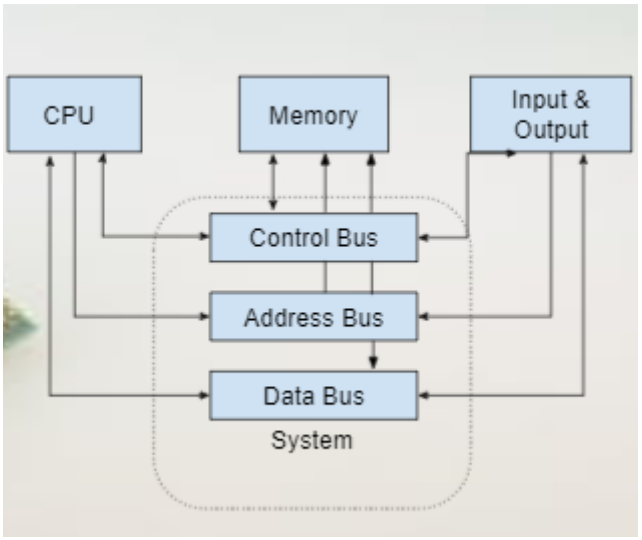


Figure 2.7 Buses

Clock

- Used to coordinate all of the computer's components.
- Sends out a regular electrical pulse which synchronises all the components.
- The frequency of the pulses is known as the clock speed.
- Clock speed is measured in hertz.
    - *The higher the frequency, the more instructions can be performed in any given moment of time.*

In the 1980s, processors commonly ran at a rate of between 3 megahertz (MHz) to 5 MHz, which is 3 million to 5 million pulses or cycles per second.Today, processors commonly run at a rate of 3 gigahertz (GHz) to 5 GHz, which is 3 billion to 5 billion pulses or cycles per second.

Control Unit

The CU provides several functions:

- it fetches, decodes and executes instructions.
- it issues control signals that control hardware.
- it moves data around the system

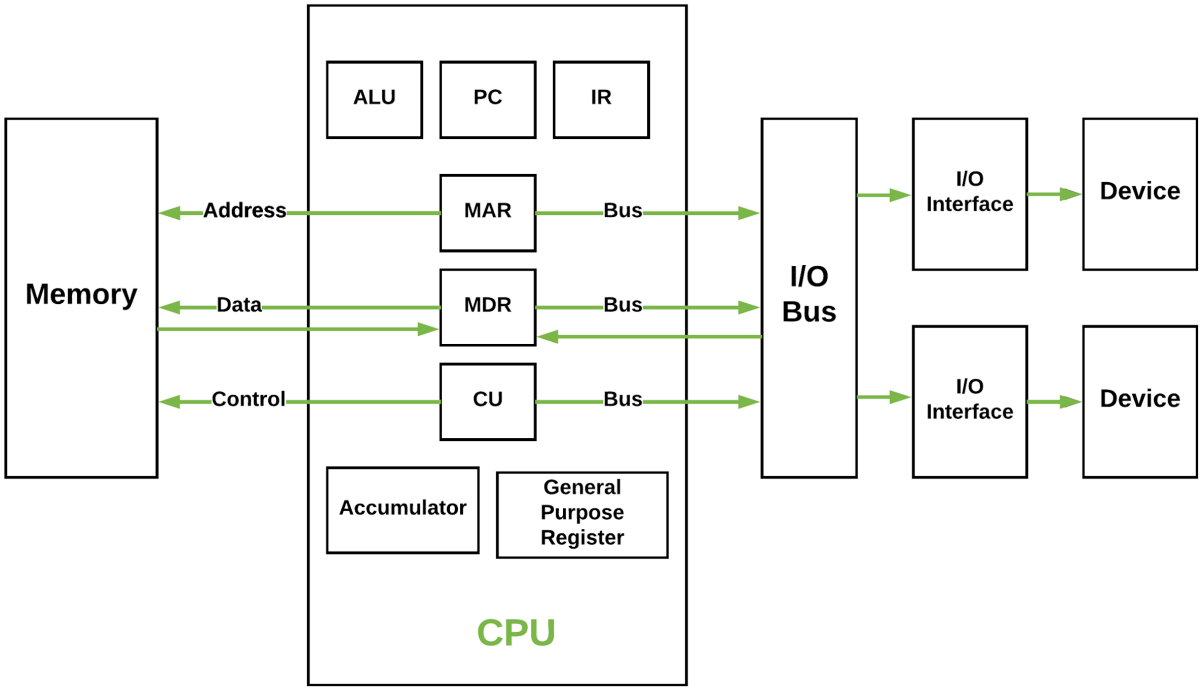


Figure 2.8 Block Diagram of CPU

2.7 COMPONENTS OF MOTHERBOARD[1]

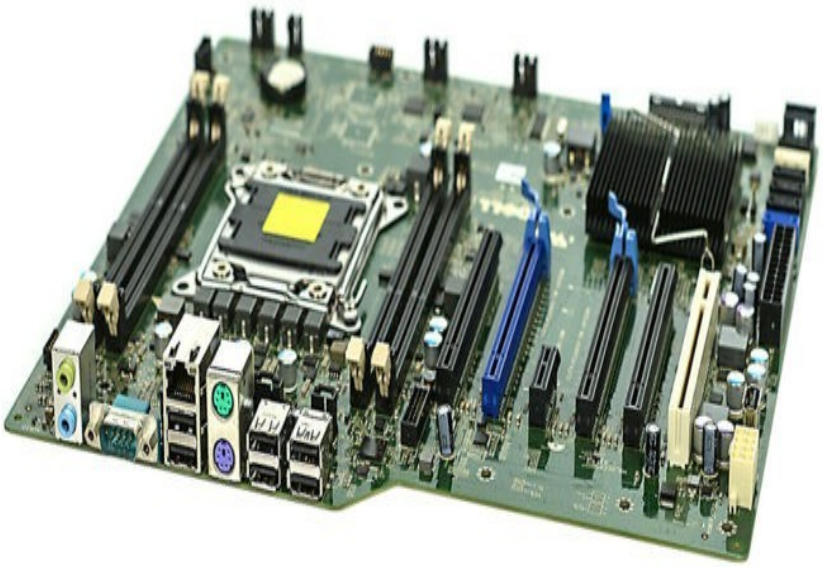


Figure 2.9 Motherboard

Motherboard

- Main circuit board of a micro computer.
- Contains connectors for attaching additional peripherals.

[1] Please refer slide 6 and 7 uploaded in the google classroom

- Contains the microprocessor, memory interfaces, ports,expansion slots, interfaces to connect additional devices, all controllers required to control standard peripheral devices.

Types of motherboard

Integrated motherboards

- Components are built into the board itself.
- All ports and connectors are on the motherboard.
- Most of the laptop are fully integrated motherboards because they have smaller forms.
- Manufactured to save space which is provided.
- Upgrading is not easy.

Non Integrated motherboards

- Bigger in size.
- Uses installable components and expansion cards.
- Has some integrated components.
- Found mostly in desktop computers.
- Usually come with expansion cards and a lot of space for components.
- Durable.
- Easily upgradable.

Form factor

- Shape and layout of the motherboard.
- Refers to the physical dimensions as well as certain connectors, screw hole and other position of the board will fit.
- Form Factor is related to the configuration of PC.

MOTHERBOARD & ITS COMPONENTS

The motherboard is connected directly or indirectly to every part of the PC.

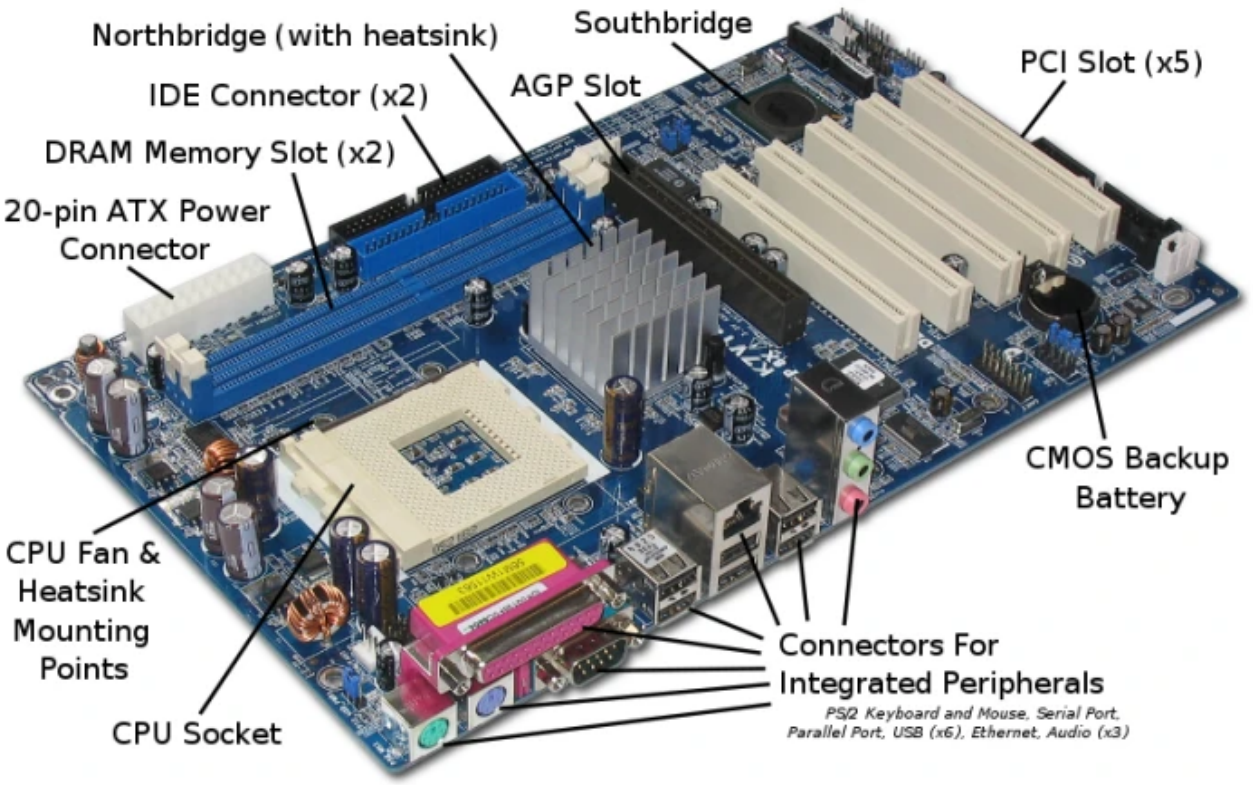


Figure 2.10 Motherboard and its Components

Computer's processor

- Fetches,decodes,executes instructions.
- Performs all mathematical and logical operations.
- The processor chip is identified by the processor type and the manufacturer.
- Usually inscribed on the chip itself.

Computer's memory

- Computer chips that temporarily store dynamic data.
- The working place of computer, where active programs and data are loaded .
- Volatile.
- When a computer shuts down, all data located in RAM is returned to permanent storage on the hard drive or flash drive.
- At the next boot-up, RAM begins to fill with programs automatically loaded during booting.

The BIOS

- Low-level software that controls the system hardware.
- Acts as an interface between the operating system and the hardware.

- The BIOS is stored on a ROM chip.
- ROM retains information even when no power is being supplied to the computer.

CMOS BATTERY

- To keep CMOS RAM alive even when the power is off.
- This prevents reconfiguration when the PC is powered on.

Complementary Metal Oxide Semiconductor Random Access Memory (CMOS RAM)

- Used to store basic information about the PC's configuration.
- Important data kept in CMOS memory is the time and date, which is updated by a Real-Time Clock (RTC).
- Floppy disk and hard disk drive types
- Information about CPU
- RAM size
- Date and time
- Serial and parallel port information
- Plug and Play information
- Power Saving settings

The Computer Chip-sets

- Group of small circuits that coordinate the flow of data to and from a PC's key components.
- Key components include the CPU itself, the main memory, the secondary cache, and any devices situated on the buses.
- Also controls data flow to and from hard disks and other devices connected to the IDE channels.
- Chipset manufacturers include SIS, VIA, ALI, and OPTI.

The NorthBridge

- Also called the memory controller.
- Controls transfers between the processor and the RAM,
- Located physically near the processor.
- It is sometimes called the GMCH, for Graphic and Memory Controller Hub.

The SouthBridge

- Also called the input/output controller or expansion controller.
- Handles communications between slower peripheral devices.
- It is also called the ICH (I/O Controller Hub).

- The term "bridge" is generally used to designate a component which connects two buses**.**

The CPU CLOCK

- The CPU clock synchronizes the operation of all parts of the PC
- Provides the basic timing signal for the CPU.
- Using a quartz crystal, the CPU clock breathes life into the microprocessor by feeding it a constant flow of pulses.
- A "real-time clock," also called the "system clock," keeps track of the time of day and makes this data available to the software.
- A "time-sharing clock" interrupts the CPU at regular intervals and allows the operating system to divide its time between active users and/or applications.

ATX Power connector

- The main power connection for the motherboard, and comes from the Power Supply.

CPU SOCKET

- This is where the CPU will plug in.
- The orange bracket that is surrounding it is used for high end heat sinks.
- Helps to support the weight of the heat sink.
- Contains one or more mechanical components providing mechanical and electrical connections between a microprocessor and a printed circuit board (PCB).

PORTS

- Used by a motherboard to interface with electronics both inside and outside of the computer.
- A port serves as an interface between the computer and other computers or peripheral devices.
- Computer ports have many uses, to connect a monitor, webcam, speakers, or other peripheral devices.

Pci slot

- Peripheral Component Interconnect.
- PCI slots are used to Insert or install Add-on cards, such as LAN cards, Sound cards, Capture cards and TV tuner cards.

- There are usually anywhere from 1 to 6 PCI slots available on the motherboard.

IDE CONNECTORS

- Integrated Drive Electronics (IDE) is a standard interface for connecting a motherboard to storage devices such as hard drives and CD-ROM/DVD drives.

(*Note:For pictures please refer slides 6,7 of Module II uploaded in google classroom)*