CHAPTER 5. POWER SUPPLY

Introduction:-

- Power supply is a system that provides electrical power to an output load or group of loads.
- It converts AC to DC (needed for PC).
- A computer power supply converts 110V-220V AC current (mains) to several low voltage DC power outputs.

Types of Power Supply:-

- There are three types of power supply :
  - Linear Power Supply
  - Switch mode power supply (SMPS)
  - Uninterrupted power supply (UPS)

1. LINEAR POWER SUPPLY

- A simple AC supply uses transformer to convert o/p power to lower voltage.

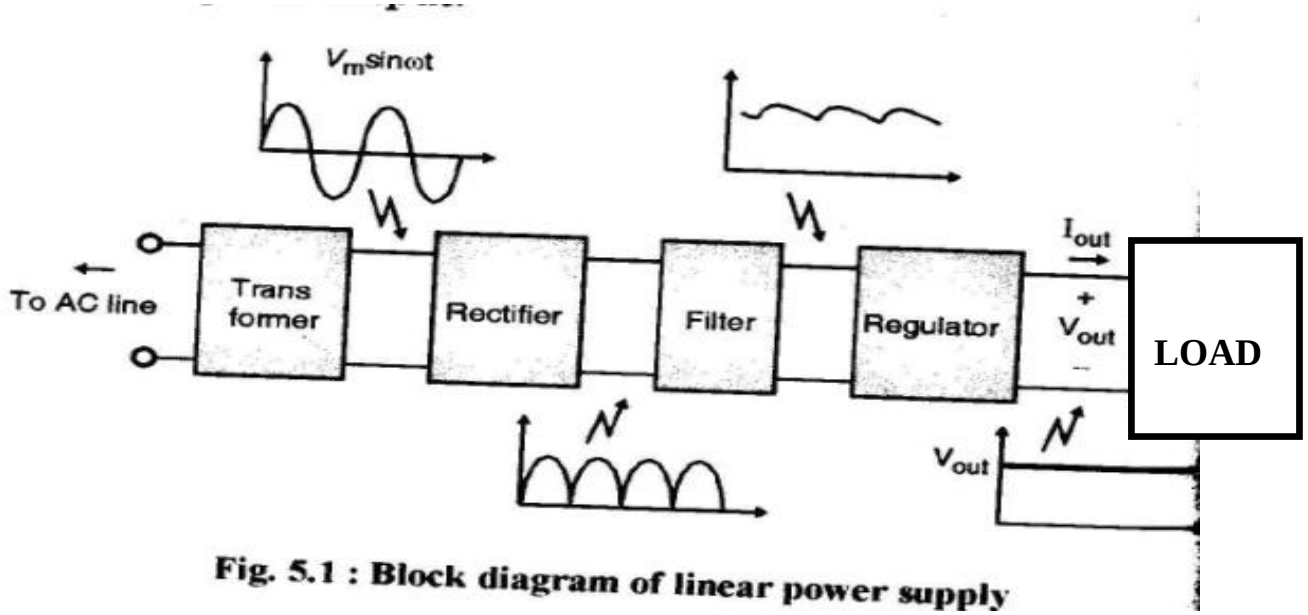


Fig. 5.1 : Block diagram of linear power supply

- Power supply converts AC to DC.
- It consists of
  - **Transformer**
  - **Rectifier**
  - **Filter**
  - **Regulator**

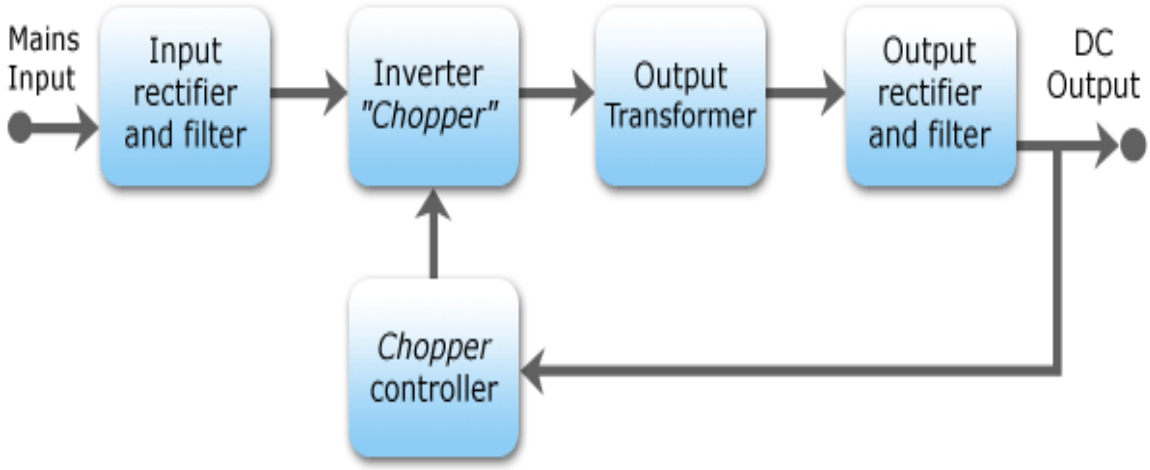
- **Transformer:** Converts AC line voltage into smaller peak voltages.
- Transformer is the main reason to transmit and distribute power in AC instead of DC, because Transformer not works on DC.

- The main application of Transformer is to Step up (Increase) or Step down (Decries) the level of Voltage.
- **Rectifier:** It rectifies the AC signal.
- It converts the AC voltage at the transformer output into DC voltage.
- **Filter:** Smooth out the rectified waves from rectifier.
- It rectifies the AC voltage first to DC voltage.
- Then it smooth out the part of pulses giving a type of DC voltage.
- Still it contains some smaller pulses in the signal known as "Ripples".
- **Regulator:** For a constant DC o/p ripples should be avoided from the signal. The regulation to the signal avoids these small ripples from the signal.
- Finally the current is then passed to the load, depending on the requirement of load the, linear regulator may be used.

2. SMPS(SWITCH MODE POWER SUPPLY):-

- It incorporates a switching regulator.
- The input DC voltage is chopped at a high frequency (10-100Khz.) using an active device & the converter transformer.
- The transferred chopped waveform is rectified & filtered.
- A sample o/p voltage is used as feedback signal for the drive circuit. For the switching transistor to achieve regulation.
- Use of feedback mechanism to alter the o/p voltages as per requirement of load. Hence SMPS is more efficient than linear power supply.

Block Diagram of SMPS:-



- **1. Input Rectifier & Filter Stage**
  - The SMPS has AC i/p then it has to be converted to DC. This is called as rectification.
  - The rectifier produces an unregulated DC voltage which is then sent to the Filter Capacitor.

- For a i/p range switch, the rectifier works in the range of 120V to 240V.
- If range switch is not used then full wave rectifier is used.

2. Inverter Chopper Stage

- It converts DC to AC. The DC current may be from direct mains or from the rectifier & filter stage.
- The o/p voltage is coupled to the input & is very tightly controlled.
- The switching can be implemented as a multistage MOSFET amplifier.

3. Output Transformer

- If the o/p is required to be isolated from i/p , the inverted AC is used drive the primary winding of a high freq. transformer.
- This converts the voltage up or down to the required o/p level on its secondary.

4. Output Rectifier & Filter

- If a DC o/p is reqd. then AC o/p from transformer is rectified.
- The rectifier elements may be Diodes depending upon the o/p voltages.
- The rectified o/p is smooth out by using filters.

5. Chopper Controller

- It is a feedback circuit which monitors the o/p voltage & compares it with a **reference voltage,** which is set manually or electronically to the desired output.
- The chopper controller is used as a switching regulator to generate accurate o/p DC voltages.

- **Advantages of SMPS**
  - Smaller size.
  - Less heat emission.
  - Better power efficiency.
- **Disadvantages of SMPS**
  - More complex than linear power supply.
  - May generate high freq. electrical noise.

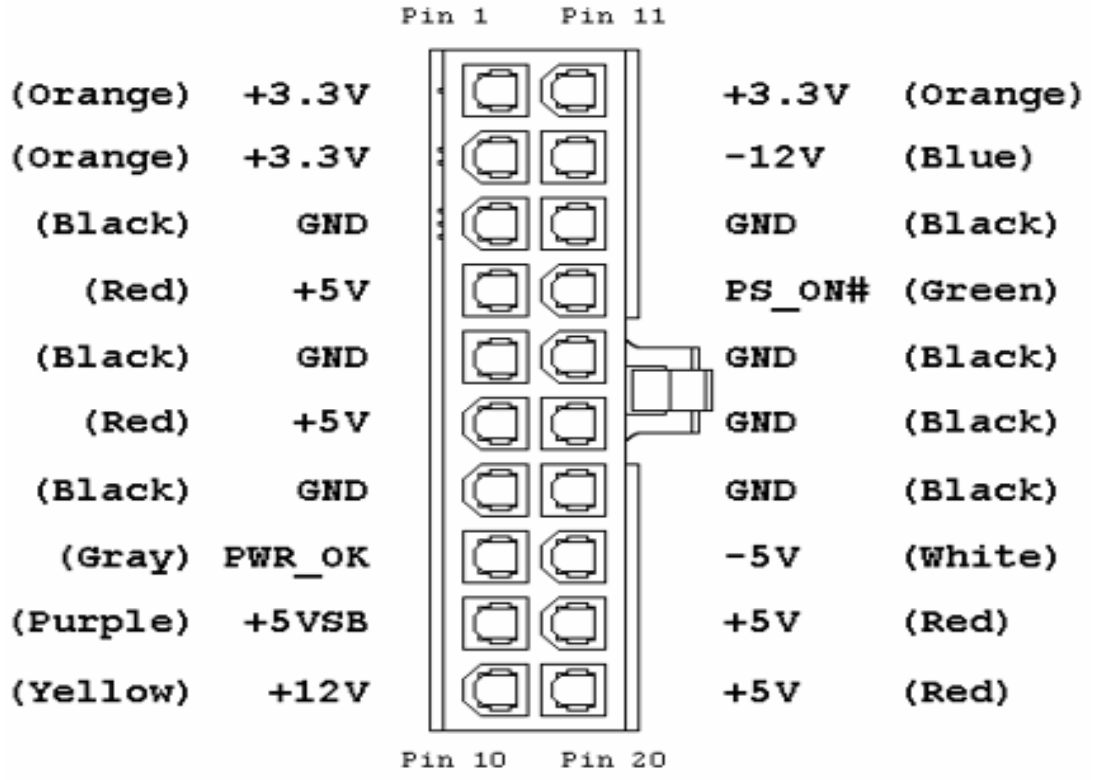
Q. Differences between SMPS & Linear PS.

Parameter	SMPS	Linear PS
Size & Weight	Large in size & Heavy in weight	small in size & light in weight
Efficiency	More	Less
Reliability	Depends on the switches	More reliable
Complexity	More	Less
Risk of equipment damage	Very low	High
Risk of electrical shock	Low	high

Q. Give the signal voltages for the following colors of ATX connector. Red, Black, Orange, Purple.

ATX/ NLX style SMPS:-

- It is not directly connected to the system power button instead it allows the system to turn off via s/w.
- The ATX provides 5 DC voltages +5V,-5V,+12V,-12V & +3.3V through a 20 pin connector.
- It has 3 special 3 connectors :
  - PS-ON
  - 5VSB
  - PW-OK.



- The PS-ON is an i/p signal to SMPS only when it is active low.
- 5V SB is a stand by voltage which supplies power to special circuits even when the system power is off.
- PW-OK is a power OK signal.

-12V:

- Used for serial ports this requires both +-12V.
- It is not widely used in recent systems.

-5V:

- Used in older systems for floppy controllers & circuits used by ISA bus cards.

0V(GND):

- It is the ground voltage. It is used to complete circuits with the other voltages.

+3.3V:

- Provided by most modern power supplies, introduced at ATX style form factor.
- It is used to run most new CPU's as well as some types of system memories & AGP video cards.

Power Good Signal:

- When power is applied the DC voltage gets applied.
- If the proper power is not applied, strange results could occur (restart).
- It takes a half second or more to stabilize the power which is not sustainable for a 2GHZ processor.
- To prevent this, the power supply puts out a signal to the m/b called "POWER GOOD SIGNAL".(power Ok or PWR OK.).
- It checks the internal components & determines that power is ready for use.

Q. Power Supply Characteristics:-

1. **Wattage:** Total max o/p of the power supply in watts.
   Typical power ranges are from 200w to 500w.
2. **Efficiency:**
   It is defined as useful power o/p divided by the -total electrical power consumed.(max 75-85%)
3. **Regulation:**
   It is the ability of SMPS to maintain an o/p voltage within specified limits under varying/changing i/p voltages & o/p loads.
4. **Ripples/noise:**
   The power supply produces DC o/p from AC i/p. However the o/p is not pure DC signal there will be some AC components in each signal some of which are picked up from the components of power supply.

Q. Load Regulation/voltage load regulation:-

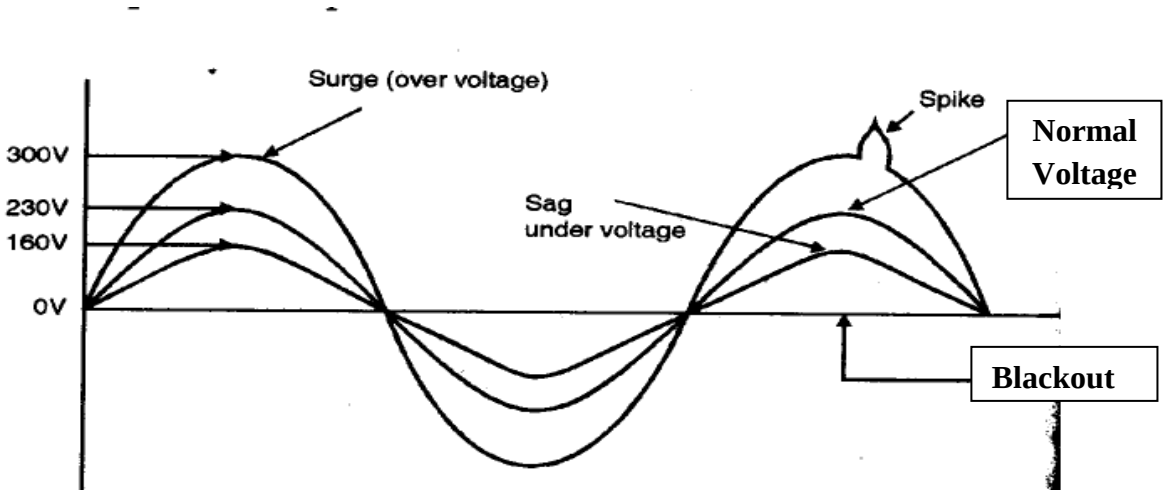
- It refers to the ability of power supply to control the o/p voltage level as the load on the power supply increases or decreases.
- The voltage of a DC power source tends to decrease as its load increases &vice – versa.
- Its typical values are 3% to 5% (1% is good).

Q. Line Regulation:-

- It is the complement of load regulation.
- It defines how the power supply control it's o/p levels when the i/p AC voltage changes from its minimum acceptable level to its maximum acceptance levels.
- Its typical value is +/- 1% to 2%.

Power Problems

Q. Explain four power Problems.



1. Blackouts (0V):-

- A blackout is a complete loss of electrical power. Voltage & current drop to almost zero.
- It is usually caused by a physical Interruption in the power line due to accidental damage by a person or act nature.
- a loss of AC will shut down a computer in milliseconds. Losing power may cause the loss of valuable data.
- In extremely rare cases, a sudden &complete power loss can corrupt a hard drive file.
- A backup power supply (BPS) or an uninterrupted power supply (UPS) can be used where frequent power loss issues are faced.

1. Brownouts/Sag under Voltage:-

- The under voltage condition also called sag or Brownouts.
- It can be caused by fault in electrical wiring or excessive electrical load.
- The AC voltage goes down due to high-load Items such as air conditioners, welding machine, motor etc.
- System hang, random memory errors occur.

2. Surge(Over Voltage):-

- Surges are small over-voltage conditions that take place over relatively long periods (>1 Seconds).
- To regulate the power excess energy must be switched (in SMPS).
- Excess voltage may create overheating in supply & eventually will destroy it.
- Some power supplies are designed to shut down in the event of voltage overloads.

3. **Spikes:-**
    - A spike is large overvoltage conditions that occur in milliseconds.
    - **Causes**: lightening strikes & high energy switches.
    - Heavy equipments like drill press, grinders, welding m/c etc. can produce tremendous power spikes when switched on or off.
    - The spike can damage the power supply.
    - Spikes can also pass along the telephone line & can damage your modem.

Q. What are the symptoms of Power Problems?

- The following are the symptoms of power problem:-
- The monitor display flicker or waves.
- Errors in data transmissions between nodes.
- Unexplained components lockup.
- Premature component failure.
- Hard Drive crashes.
- Corrupt or loss of data in CMOS & other EPROM chips.
- Disc Drive write errors.
- Flickering lights.

Power Protection Devices:-

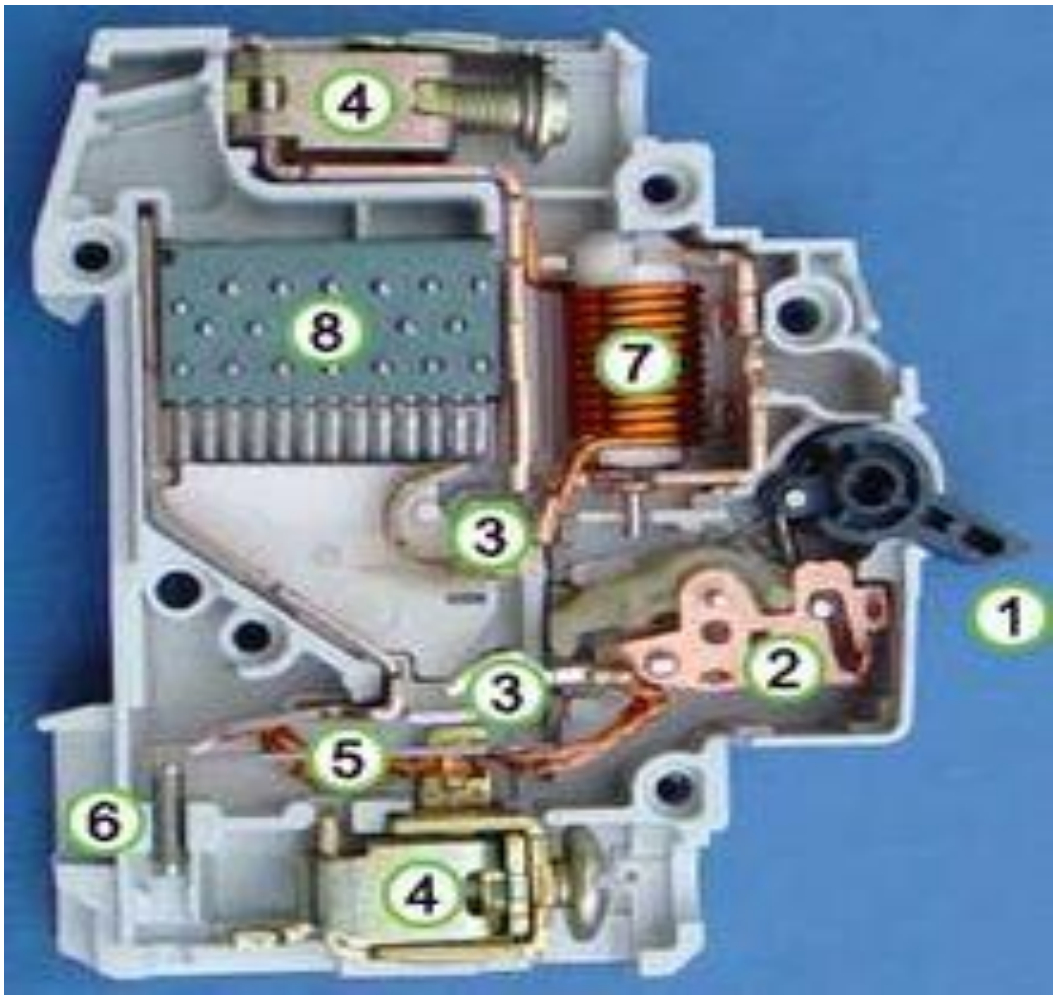
Q. Enlist Different Protection Devices.

- To run a system stable & noise free power supply is needed.
- It can be achieved using protection devices.

1. **Surge & Spike Suppresser:-**
    - It is also called a "surge Protector".
    - It is a small box with several utility outlets, a power switch & a 3 wire cord plugging into a wall outlet.
    - It is the simplest & inexpensive device which is designed to absorb high voltage transients produced by lightening & other high energy equipment.
    - It is inserted in the AC to prevent damage to electronic components.
    - A surge suppresser prevents the peak AC voltage from going above a certain threshold such as +/-200V.
    - Used with all semiconductor based electronic & computer Hardware including peripherals such as printers, monitors, modems.

2. **Circuit Breaker:-**
    - It is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit.
    - Unlike a fuse which operates only once a circuit breaker can be reset to resume normal operation.
    - Circuit breakers can be made for an individual household device or for a large switch gear designed to protect high voltage circuits.

Q. Enlist Components Name of Circuit Breaker.

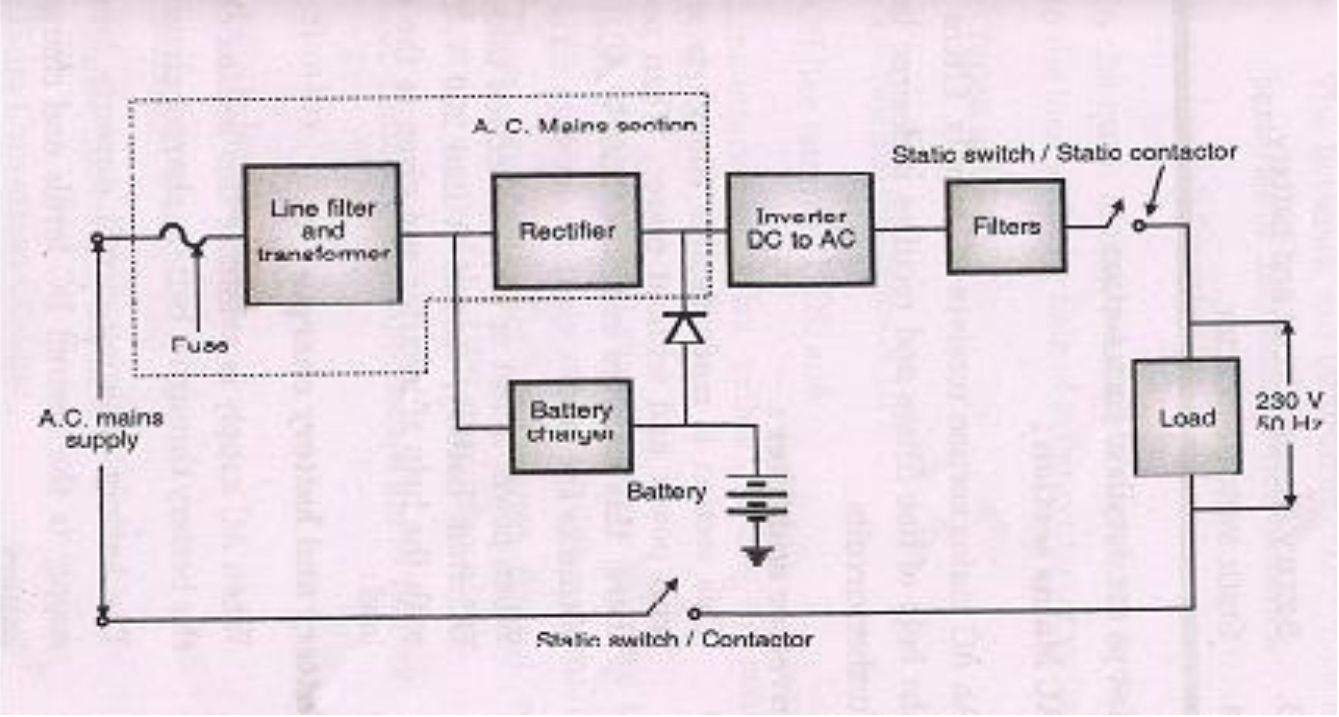


1. **Actuator lever**: - it used to manually trip & reset the Circuit Breaker.
   Also include status of it. (ON or OFF).
2. **Actuator mechanism**: - forces the contacts together.
3. **Contacts:** - allow current to flow when touching & break the flow of current.
4. **Terminals**
5. **Bimetallic Strip**
6. **Calibration Strip**
7. **Solenoid**
8. **Arc Divider**

3. UPS(Uninterrupted Power Supply):-

- It is connected between primary power source & PC.
- When primary power is not there, it provides power from a separate source.
- An alternative power source is usually a set of batteries.
- UPS is also known as an Uninterruptible power source or battery backup is a device which maintains a continuous supply of electric power to connected equipment.

- **A UPS generally protects a computer against 4 power problems:**
  i. Voltage surges & spikes.
  ii. Voltage sags.
  iii. Total power failure.
  iv. Frequency difference.



The block diagram consists of following blocks

- AC mains section containing filter, transformer & rectifier.
- Inverter & filter
- Battery charger circuit & battery.
- Static switch / contactor.

1. AC mains Section:

- Receives AC supply, filters it with the help of line filters & rectifies it to desired level for further circuits.

2. Inverter & Filter:

- Can work with or without power.
- When power is present, it delivers constant 230V, 50Hz o/p to load.
- When power is off, it takes 12V DC from battery, convert it to 230V with the help of inverter & provides to the o/p load.

3. Battery & Battery Charger:

- When AC supply is available it charges the battery through battery charger circuit.
- It converts i/p AC supply to desired DC levels & charges the battery.
- It also prevents batteries from overcharging.

- The batteries can be ordinary 12V / 10 AH car batteries.

4. Static Switch / Contactor:

- In case of power failure the inverter is connected to the load with the help of static \contactor switches.

Q. Advantages of UPS over Normal Voltage stabilizer.

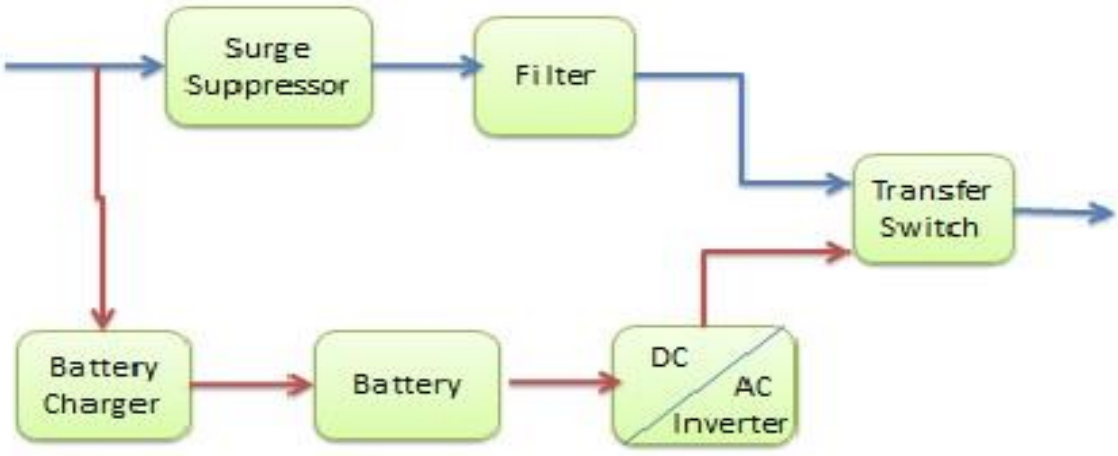
- Provides power backup even AC fails.
- Provides surge protection, short circuit protection.
- It stabilizes the power.
- Maintains constant 230V, 50 Hz frequency.
- Avoids data loss by providing you enough time to save your work.

Types of UPS:-

- 1. Stand by UPS / Offline UPS
- 2. Online UPS / True UPS

1. Off Line UPS

- It uses a transfer switch to select the power supply.
- When AC mains supply fails, the transfer switch must operate to switch the load over to the battery or inverter backup.
- The inverter only starts when the power fails hence the name "stand by".
- It provides adequate noise filtration & surge suppression.
- When main supply gets failed / gets below the reqd. level, offline UPS very quickly (5 milliseconds or less) turns on a power supply from inverter.
- In offline UPS the battery is charged when AC mains are ON & as soon as AC mains are off the battery discharges & supplies the power to the PC. Hence high switching is involved.
- **Block diagram of stand by UPS/ Off Line UPS.**



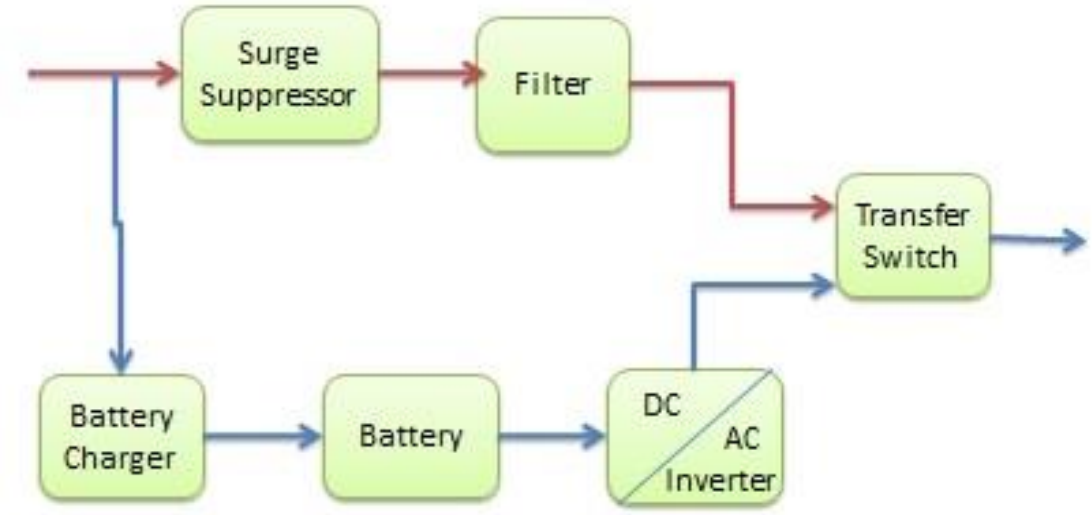
Block diagram of stand by UPS/ Off Line UPS.

- **Advantages of Off Line UPS**
  - Low Cost than online UPS.

- **Disadvantages of Off Line UPS**
  - High switching is required, otherwise there is possibility that cut in power & needs to reboot your system.

2. On Line UPS

- In this primary power source is UPS battery & the utility power is the secondary power source.
- In this power to the system is supplied continuously from batteries.
- Thus switching is not involved so spikes are not generated.
- When line power goes off, the UPS does not have to convert from one power source to another. It just stops the battery charging.
- No transfer time in case of power failure.
- Typically used for large servers, data centers.
- Available in sizes of 5000VA to thousands of VA (KVA).



Block diagram of Online UPS/ True UPS

- **Advantages of On Line UPS**
  - No switching is involved hence avoids spikes & resetting of system.
  - Computer is isolated from AC line problems.
  - UPS provides large protection by breaking down & re-asserting the power.
- **Disadvantages of On Line UPS**
  - Inefficient.
  - Much of the power is dissipated as heat. (All the power going to load is converted from AC to DC [for battery] & back to AC.)
  - Cost.
  - Batteries require more frequent replacement.

- UPS running its inverter all the time results in a lower efficiency.

Q. Comparison between Online & Offline UPS.

Sr. No.	Online UPS	Offline UPS
1	Online UPS are the Complex & Expensive.	Offline UPS are the Simplest & Least expensive.
2	The battery is continuously charged & then delivers DC power to inverter for converting to AC & supplying to the PC.	Battery is charged when AC mains are ON & as soon as AC Mains are OFF, battery discharges & supplies power to the PC.
3	Switching is not Involved	Switching is Involved
4	It is at high speed so as to avoid resetting of PC.	It is not at high speed therefore resetting may occur some times.
5	Spikes are not generated	Spikes are generated.

Thank You!!!!!!!!!!!!!!!!