5 Power Supplies

Power supply (Power supply unit or PSU) is a device or system that supplies electrical or other types of energy to an output load or group of loads.

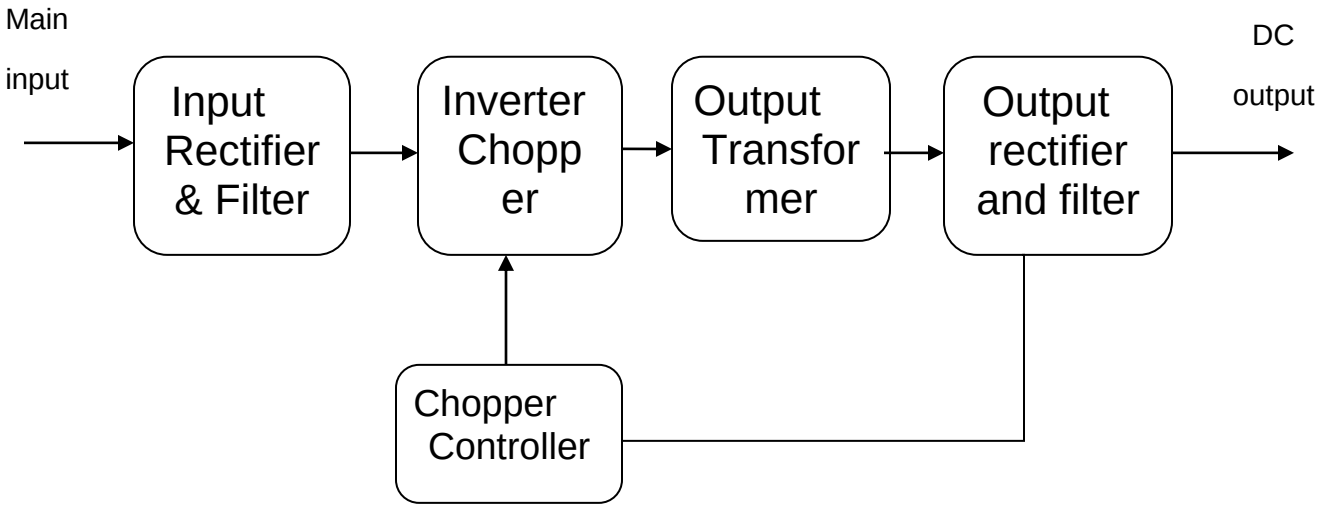
Power supply provides the alternating current (AC) and the direct current (DC).

There are three types of power supply

1. Linear power supply(LMPS)
2. Switch Mode Power Supply(SMPS)
3. UPS (Uninterrupted Power Supply)

Switch Mode Power Supply (SMPS)

Block Diagram and Working of SMPS



Input Rectifier and Filter Stage

- The process of converting AC to DC is called Rectification. SMPS converts AC to DC
- The rectifier produces an unregulated DC voltage which is then sent to a large filter capacitor.

Inverter Chopper Stage

- The inverter “Chopper” stage converts DC (whether directly from the input or from the rectifier and filter stage described above) to AC by running it through a power oscillator.

- Power oscillator has a very small output transformer with few windings of kilohertz (kHz).

Output transformer

The transformer converts the voltage up or down to the required output level.

Output Rectifier and Filter

The AC output from the transformer is rectified and converted to DC

Chopper Controller

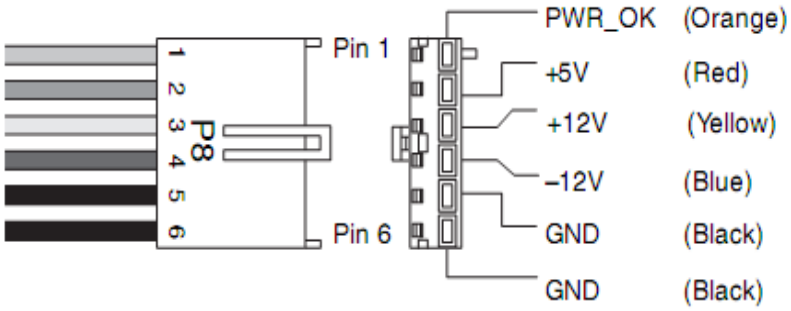
- A feedback circuit monitors the output voltage and compares it with a reference voltage.
- If there is an error in the output voltage the feedback circuit compensates using MOSFETS.
- This part of power supply is called switching regulator.
- Chopper Controller performs the function of switching regulator

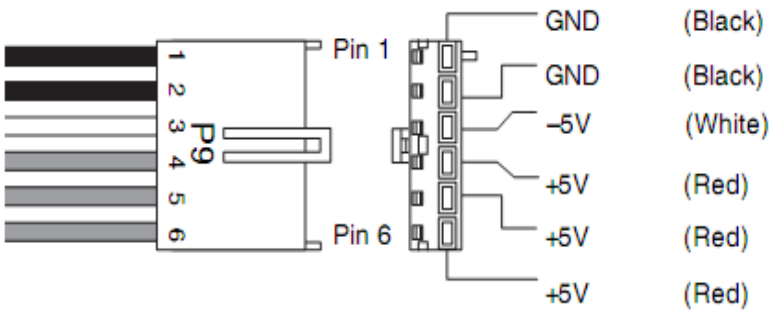
Power Signal Description and Pinout of AT and ATX (Power Supply Form Factor)

The power supply form factors are

1. AT **2.ATX/NLX**

AT Style SMPS





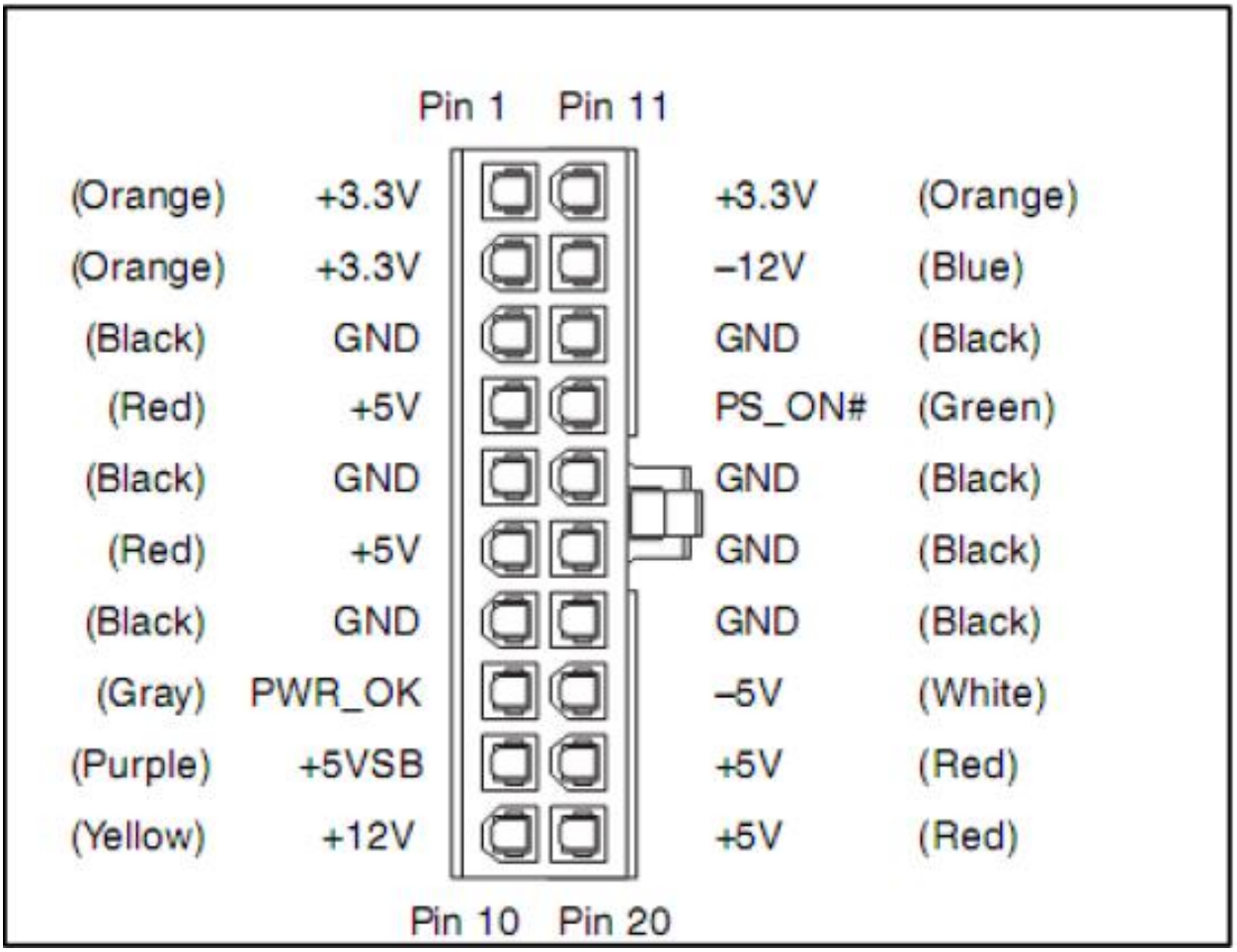
a) At style computer cases had a power button that was directly connected to the system computer power supply(PSU)

b) The AT-style SMPS provides DC output on two 6-pin connectors

c) The two 6-pin connector carry DC power connections to the motherboard. It carries +5V,-5V,+12V and -12V voltages and a PGS signal(power Good Signal)

d) **The PGS is a special signal to the CPU, indicating that the output voltages are stable and usable by the CPU. In absence of the PGS signal CPU remains reset.** .

2. ATX/NLX Style SMPS



Color	Signal	Pin14	Pin	Signal	Color
Orange	+3.3V	11	1	+3.3V	Orange
Blue	-12V	12	2	+3.3V	Orange
Black	GROUND	13	3	GROUND	Black
Green	PS_On	14	4	+5V	Red
Black	GROUND	15	5	GROUND	Black
Black	GROUND	16	6	+5V	Red
Black	GROUND	17	7	GROUND	Black
White	-5V	18	8	Power_Good	Red
Red	+5V	19	9	+5V (Standby)	Purple
Red	+5V	20	10	+12V	Yellow

a) The ATX form factor is called the ATX/NLX form factor

b) The ATX/NLX provides 5 DC voltages +5V,-5V,+12 V, -12 V and +3.3 V through a 20-pin connector.

c) The PW-OK is a power good signal.

- PGS: Power Good Signal –This is a signal generated by the SMPS during booting.
- Uses:
- This is used to check the working of SMPS.
- When all four voltage outputs (+5V, -5V, +12V, -12V) are steady above minimum sense levels for more than 100ms, PGS is generated by SMPS. This can be used to reset the PC during booting.

Power Supply Characteristics

1. **Wattage :**
   - The total, maximum output of the power supply in watts.
   - Typical power ranges are from 200W to 500W.
2. **Efficiency :**

   The efficiency is defined as useful power output divided by the total electrical power consumed. The efficiency of SMPS is 70-85%

   $$\text{Efficiency} = \frac{\text{Useful Power Output}}{\text{Total Electrical Power Consumed}}$$

3. **Regulation :**

   The ability of a SMPS to maintain an output voltage within specified limits under varying of input voltage and output load.

   a. **Load Regulation**:

      This specification refers to the ability of the power supply to control the output voltage level as the load on the power supply increases or decreased.

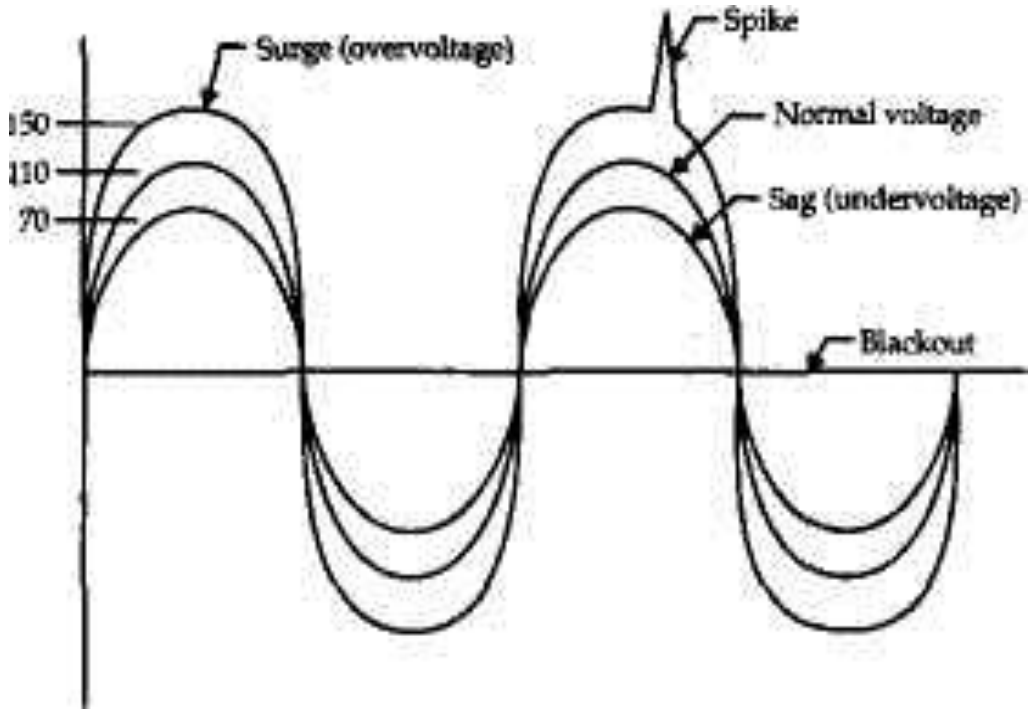
   b. **Line Regulation**:

      The ability of the power supply to control its output levels of the AC input voltage varies from its minimum acceptable level to its maximum acceptable level.

4. **Ripple : (AC Ripple)** simply Noise

   - The Power Supply produces DC outputs from AC input. However the output is not pure DC.
   - There will be some AC components in each signal some of which are conveyed through from the input signal, and some of which are picked up from the components in the power supply.

Power Problems:



Blackouts:

a) A blackout is complete loss of electric power where voltage and current drop to almost 0
b) Blackout are usually caused by physical interruption in the power line due to accidental damage by a person or act of nature.

Brownouts (Sag):

a) The under voltage condition also called brownout or sag.
b) The high load items like air conditioners, welding machine, motor etc draw to much current that the AC voltage level drops.

Surge:

Surge are small over voltage conditions that take place over relatively long periods (usually more than 1 second).
Due to excessive voltage it causes overheating in the supply and therefore damages the power supply.

Spikes:

a) A spike is a large over voltage condition that occurs in the milliseconds.
b) Lightning strikes and high energy switches can cause spikes on the AC line.
c) Heavy equipment like drill machine, grinders, welding equipment etc. can produce power spikes.

Symptoms of Power Problems:

1. Flickering Lights
2. Premature Component Failure
3. Hard Drive Crashes
4. The PC stalls, crashes, or reboots for no apparent reason.
5. You suffer chronic or frequent component failures (for example, modems).
6. You suffer chronic or frequent hard drive failures or file access problems.
7. The CMOS RAM or modem NVRAM periodically looses its contents or becomes corrupted.
8. The PC behaves erratically when other high-energy devices are turned on.
9. The modem regularly looses its connection, or fails data transfers.
10. The monitor display flickers or waves.
11. You encounter frequent or chronic write errors to disks.

Protection Devices

To run a computer system properly requires a steady power supply with clean and noise free power. It achieves through the protection devices.

Surge Suppressor:

- Surge suppresses, are simple and relatively inexpensive devices that are designed to absorb high-voltage produced by lightning and other high-energy equipment.
- Protection is accomplished by clamping voltages above a certain level (usually above 200 volts).

- In the most common type of surge protector, a component called a metal oxide varistor, or MOV, diverts the extra voltage.
- **MOVs(Metal Oxide Varistor)** are often included that can respond quickly and clamp voltages as high as 6000 volts.
- Also, MOVs degrade with each spike. Once they have passed a number of surges, they are destroyed and must be replaced.
- Many protectors show a neon lamp or LED that goes out when the MOV has blown or when the protector is no longer active

Circuit Breaker

- Its purpose was to protect lighting circuit wiring from accidental short-circuits and overloads.
- The circuit breaker must detect a fault condition
- Once a fault is detected, contacts within the circuit breaker must open to interrupt the circuit.
- Small circuit breakers may be manually operated
- Larger units have solenoids to trip the mechanism
- Small circuit breakers are either installed directly in equipment, or are arranged in a breaker panel.

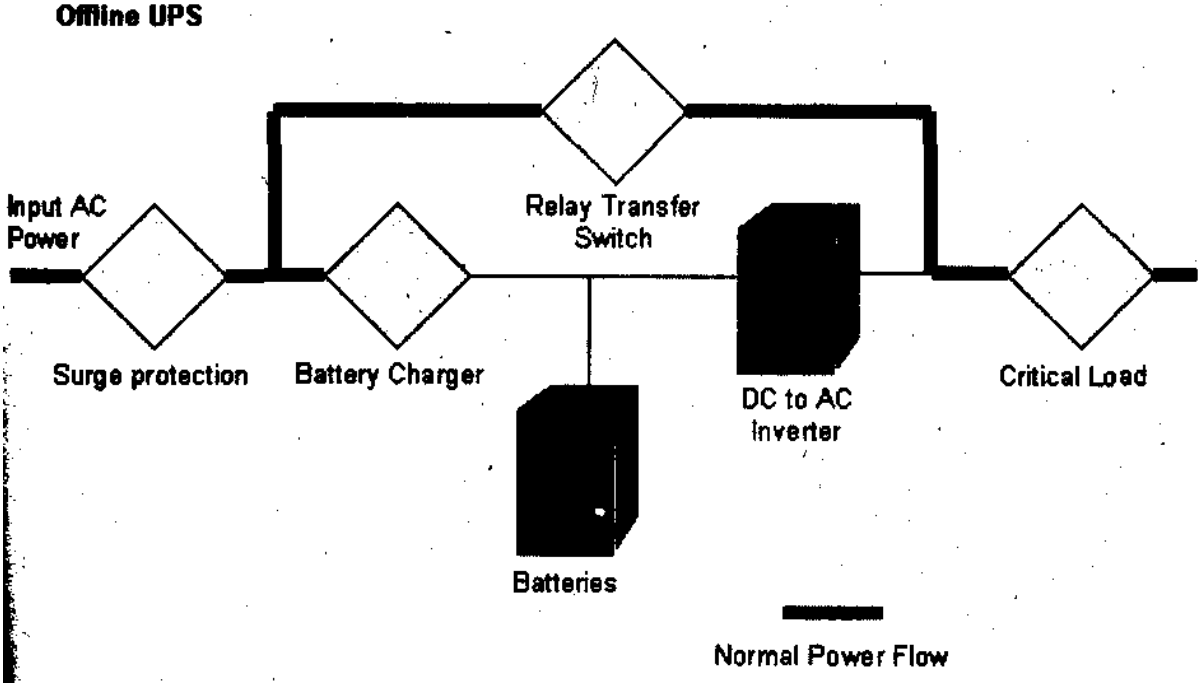
Uninterrupted Power Supply(UPS) :

An UPS provides a back up power supply when there is a power failure from AC mains.

There are two types of UPS :

1. **Standby UPS/ Off-line UPS**
2. **Online UPS**

Offline UPS



Working :

- Most Common type used for Personal Computers.
- Off-line power source.
- Here the primary power source is the AC from the mains and the secondary power source is the UPS Battery.
- If the primary source fails then the transfer switch must operate to switch the load over to the battery /inverter backup power source.
- The inverter only starts when the power fails hence the name Standby.
- A power inverter simply turns the DC power delivered by the battery into 230 volt 65 Hz AC power.
- The battery is charged when AC mains are on and as soon as AC mains are off the battery discharges and supplies power to the PC.

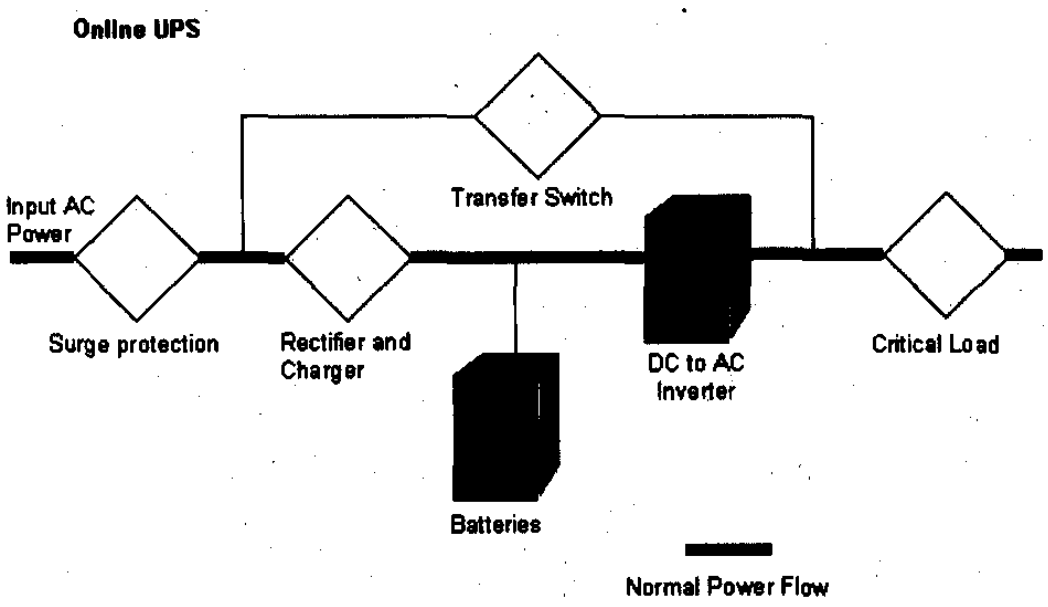
Advantages :

1] High efficiency,
2) Small size and
3) Low cost

Disadvantages:

1) High switching is involved in off-line UPS and power will be available till the battery discharges.
2) It is useful when there is a good power supply
3) Spikes may be generated due to switching

2. On-Line UPS



Working of On-line UPS:

- In the online UPS the primary power source is the UPS's battery and AC mains is the secondary power source.
- It continuously powers the protected load from the batteries. Uses batteries as backup power source.

- It provides protection against all types of power problems in addition to the power failure. So it is also known as **power conditioner and a line conditioner.**
- Provides complete power conditioning.
- Under Normal operation, the online UPS is always running through the battery using its inverter while the line power run the battery charger.
- Here there is no transfer time is needed in the event of a power failure.
- Since there is no switching under normal operation the voltage spikes are not generated.
- Here the transfer switch will act as backup in the event that the inverter fails due to some internal problem

Advantages:

1] High degree of power conditioning

2] Very high efficiency design

3] Provides protection against power problems hence also known as Power Conditioner and Line conditioner

Disadvantages

1. It is costly as compared to Off-line UPS.

MSBTE Questions

1. With suitable block diagram describe the working of SMPS (8M)
2. What is 'Power Good Signal'? What is its use?(2M)(S-14)
3. List and explain power supply characteristics.(4M)(S-14)
4. With neat diagram explain (4M)(S-14)
    i. Surge
    ii. Spike
    iii. Blackout
    iv. Brownout
5. With the help of diagram explain the working of online UPS. Give the advantages of online UPS over offline UPS (8M)(S-14)
6. Define the terms Blackout and Surge(2M)(W-14)
7. Describe any four characteristics of power supply(4M)(W-14)
8. State any four advantages of ON-Line UPS over OFF Line UPS (4M)(W-14)
9. With block diagram describe the working of SMPS.(8M)(W-14).
10. Draw the block diagram of linear power supply.(2M W-15).
11. What are the different factors to be considered while selecting the power supply? (2M W-15)
12. Define the following terms related to power problems: (4M W-15)
    1) Blackouts
    2) Brownouts
    3) Surges
    4) Spikes

13. Draw and explain the block diagram of SMPS.(4M W-15).
14. List any four points of comparison between online UPS and offline UPS(4M W-15)
15. State the meaning of black out and brown out problem in power supply.(2m S-15)
16. Draw the pin out diagram of ATX connector. (4m S-15)
17. Draw and explain the functional block diagram of UPS.(4M S-15)