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.

- 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 (Decrease) 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.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SMPS</th>
<th>Linear PS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size &amp; Weight</td>
<td>Large in size &amp; Heavy in weight</td>
<td>small in size &amp; light in weight</td>
</tr>
<tr>
<td>Efficiency</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Reliability</td>
<td>Depends on the switches</td>
<td>More reliable</td>
</tr>
<tr>
<td>Complexity</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Risk of equipment damage</td>
<td>Very low</td>
<td>High</td>
</tr>
<tr>
<td>Risk of electrical shock</td>
<td>Low</td>
<td>high</td>
</tr>
</tbody>
</table>
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.

-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.

2. 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.

3. 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 Supresser:**
   - 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.
• **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).

• **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.**

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

**Thank You!!!!!!!!!!!!!!!!!!!!!**