

## Unit 7                      Power Supplies and Power Management

### Structure:

- 7.1 Introduction
  - Objectives
- 7.2 Switching Regulations
- 7.3 Potential Power Problems
  - Recognizing the problems
  - Dealing with the power problems
  - Upgradation
- 7.4 Power Management in windows OS
- 7.5 Troubleshooting
  - Switching power supplies
  - Power management
- 7.5 Summary
- 7.6 Glossary
- 7.7 Terminal Questions
- 7.8 Answers

### 7.1 Introduction

In Unit 6 you have seen how BIOS plays an important role in starting a computer while in the previous Unit 5 we discussed how CMOS performs the function of checking. For all these tasks to be performed you need to switch on the computer which in turn requires power supply. A commercial AC (Alternate Current) is converted into one or more levels of DC (Direct Current) by power supply which is used by electronic and electromagnetic devices. A faulty power supply may cause damage to the keyboard, CMOS settings, BIOS, data loss, or may even cause motherboard damage. In the past few years Power has become a very vital resource. Power management is also as important as power supply.

This unit not only explains the simple operation of switching on power supply but also offers guidelines for selecting and upgrading the supply, and also offers solutions for the problems arising from it. Moreover, you will learn how to review the power management schemes of desktops and laptops, how to use these schemes and how to troubleshoot the troublesome power management problems.

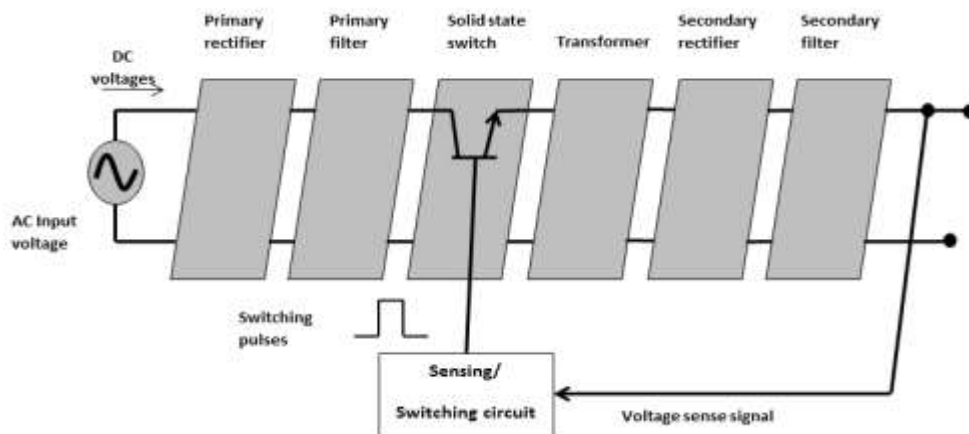
**Objectives:**

After studying this unit you will be able to:

- Explain the concepts of switching regulations
- Recognize the potential power problems
- Perform the upgrading of the power supply
- Identify the power management problems
- Resolve the problems through troubleshooting.

**7.2 Switching Regulations**

The power wastage in the regulator can be reduced by supplying the enough energy needed to the regulator. This achieves and maintains a stable output voltage which increases the efficiency of the power supply to a greater extent. Therefore, rather than wasting the excess of input energy, the same energy can be circulated to a feedback loop. The *feedback loop* is the path that leads to the initial energy generator point of the feedback signal to the subsequent modification of that event. This feedback signal maintains a check on the output voltage provided to the load and turns the AC switch on or off as per requirement and maintains the normal level of the output without creating much heat. This prevents loss of energy in the form of heat. The working of the switching power supply is as shown in figure 7.1.



**Figure 7.1: Block diagram of a switching power supply**

In the figure you will observe that AC voltage is given as input and is immediately converted into to DC. This pulsating DC voltage is passed

through primary filters to give primary DC voltage. Primary DC voltage is the voltage generated from the primary filters through which the DC pulse passes. Here, these are switching pulses and unlike linear power supply AC is not transformed before rectifying the requirement of the pulse. Therefore, DC voltage can easily pass till 170 volts because the maximum capacity of the DC pulse through the filters is 170 volts. We need to note that in many a case DC level is more than AC voltmeter.

After you start the power supply the switching transistor is turned on and off at high frequency and long duty cycle. In the overall cycle there may be sequence of signal getting off and on. Duty cycle is the amount of time that a signal is “on (active or logic 1)” The duty cycle is a fraction of time refers to how long a system can keep operating before it needs a rest. The adjustment to the duty cycle is done continuously with the help of switching circuits. The transistor acts as a chopper which breaks the pulsating DC into chopped DC which forms the first signal for the step-down transformer. Here, the duty cycle is responsible for affecting the AC voltage. Long duty cycle which is large is the output voltage especially used for heavy loads while Short duty cycle is the output voltage is a low signal. This cycle is especially suited for light loads. You can set and adjust the switching circuits as well as view these signals and chopped DC (the DC which is spread across the circuit) with the help of oscilloscope. Oscilloscope is a electronic equipment that provides visual images of varying electrical quantities and allows observation of constantly varying signal voltages, usually as a two-dimensional graph with function of time in x axis and electrical potential differences in the y axis.

Though the transformer’s secondary wiring that passes through secondary filters does not produce the AC voltage with pure sine wave or sinusoid is a mathematical function that describes a smooth repetitive oscillation, it allows the use of the remaining power supply. It is again passed through filters to obtain a secondary DC voltage that is applied to the load. Secondary DC voltage is the voltage that is generated by the secondary filters. The voltage is once again chopped and adjusted by the switching circuits. There is more consumption of power on the secondary circuit when there is an increase in the load and so naturally the voltage drops. This is then increased by boosting the duty cycle which results in voltage being regulated. Similarly

when the load on the circuit decreases, the power consumption is less. In this case the voltage is regulated by normalizing the duty cycle.

**Advantages of switching power circuit**

- When the switching transistor is on, the current is drawn in the primary circuit. Therefore, power wastage is very less in the primary circuit.
- The secondary circuit provides just enough power to keep the load voltage regulated. Therefore, power wastage is very less in the secondary rectifier, filter and switching circuit.
- This concept can reach a higher efficiency than linear supplies.
- Components are small in size and packed tightly.

**Disadvantages**

- It acts as radio transmitters and causes problems in radio and television reception.
- The shield on the switching circuit needs to be replaced very often, whenever power supply is repaired.
- Strong electromagnetic spectrum can easily disturb the working of the logic circuit.
- There is not enough noise in the circuit to interfere with the load as all the noise has been removed by the filter which is designed with care. The output voltage will always have some amount of high frequency ripple.
- Troubleshooting is very difficult as it contains many components.

In actual practice, an integrated circuit has sensing and switching functions. AC line voltage is transformed into DC line which is then rectified and filtered by the single chip regulator. The chip is responsible for chopping the primary DC into chopped DC and the output voltage is sent back to the switching chip which continuously sets and adjusts the duty cycle based on the requirement.

**Self Assessment Questions**

1. \_\_\_\_\_ is the path that leads to the initial energy generator point of the feedback signal to the subsequent modification of that event.
2. AC line voltage is rectified and filtered by \_\_\_\_\_.

3. \_\_\_\_\_ is the amount of time that a signal is “on” compared to overall cycle.
4. State whether the following statements are true or false
  - a. Switching power circuit components are large in size and difficult to pack inside.
  - b. Switching power circuit acts as radio transmitter.

### 7.3 Potential Power Problems

Power supply is referred to as the ‘lifeblood’ of the PC. Therefore, it is very important for you to identify the basic power problems and check if there is any need for upgradation of the power supply. You must be very cautious in dealing with power systems as AC can be very dangerous if dealt with carelessly.

#### 7.3.1 Recognizing the power problems

Proper identification of power problems is very important which can be done through a simple procedure. The basic indication of power problem is that if there is any malfunction in the power supply then booting the PC will not be possible. Less voltage or low power supply typically results in error indication in the POST board. When you identify the problem then it is a matter of troubleshooting the problem or replacing the device. This is a simple enough solution if the problem occurs when the PC is started. However, most problems occur midway when the PC starts working. Consequently, the power supply will not be able to provide sufficient energy to keep the PC running. There are some general problem indicators by which you can recognize the problem. The chronic problems listed below will help you to identify the power supply problem which might arise midway in the course of working:

- *The computer freezes midway of the system working.* However, this does not always mean that there is a power problem as most times the system freezes due to some problem in software applications or if there is a configuration fault. Power problem can only be suspected when the PC freezes for no reason several times in an hour or several times in a day
- *Random memory errors:* memory error message does not always indicate power problem. However, when you suddenly see a memory

error message or when you have just finished upgrading the device driver and face trouble, you could attribute it to power problem. There could be more chances of power problems whenever you shift the system to a different location.

- *Hard drive data is lost or corrupted:* this problem may occur due to many factors like losing data cable or getting operator error. Therefore, it is essential to confirm that there is proper connectivity. If you find a problem in drive reading or writing to the disk, then check the power before attempting disk back up or running any diagnostics. Because if you do so without rectifying the power problem you might end up causing still more severe damage. If your check returns no error then you can continue disk diagnostics. The problem of hard drive data being lost or corrupted could be caused when you install another drive or when you expand the motherboard.
- *Trouble in communicating with modems or peripherals:* when using modem and mouse you might come across a number of communication errors like modem driver missing, mouse not connected, etc. Therefore, you must first ensure that all the peripherals are connected and configured properly. The systems which are ready and working may develop problems midway or difficulties may occur while working with a printer which could be due to power problems.
- *Hardware failures:* The characteristic of this type of problem is its recurrence.. For example, when you see memory error, you will replace the memory and after few days the same error may recur. This means that there are some spikes in the power supply AC line. Sometimes power problems could cause the whole system to crash yet the real problem might not be apparent. In extreme cases, a severe power problem can damage one or more chips on the motherboard, expansion boards, or drives.

### 7.3.2 Dealing with Power problems

Now that you are equipped with the knowledge of detecting power problems, you can take steps to rectify them. The chronic problems listed above would have given you an idea that power problems should not always be attributed to power supply fault. It is very important to keep in mind that before switching the PC on, you should always check for AC line voltage.

- **Check for AC:** Although oscilloscopes are used to measure and view the voltage they are very expensive to measure smaller Hz of memory. Therefore, you can follow below steps to test the AC:
  - *You can check for AC voltage for providing the right amount of voltage.* You can use multi-meter to measure the output at wall outlet. Check for any obstruction in the circuit that causes low supply of voltage.
  - Check if any other device like air cooler which draws high energy, exists in the same line. Then try to switch off all the devices and restart your PC. When you want to use those devices again make sure that your PC is shut down completely.
  - If there are no other devices then you must check for a line for proper outlet or get one line with the help of an electrician, ensuring that there is proper grounding.

When you are satisfied that all the above conditions are met and still the problem persists then you could conclude that there is a problem in the power supply to the PC.
- **Suspect the Supply:** when you suspect that there is some problem in computer power supply, then there may be a problem in the hardware installed. You could use a good quality surge protector between AC outlet and AC cord and also check on another AC line to avoid spikes. Connect a multi-meter inside the PC to check the voltage level at each supply. The table 7.1 given below will give you an idea on power supply wire assignments:

**Table 7.1: Index of Power supply pin assignments**

Color of the wire	Voltage indicator
Black	Ground
Blue	-12Vdc
Yellow	+12Vdc
Brown	+3.3 V Sense (This signal is used to detect the voltage level of the +3.3 V signal being provided to the motherboard. This allows the power supply to "fine tune" the +3.3 V output in the event of excessive voltage drop between the supply and the components that use +3.3 V.)
Orange	+3.3Vdc in ATX and NLS machines

Purple	+5 Vdc Standby Voltage (max 10mA) 500mA or more typical
Red	+5 Vdc
White	-5 Vdc
Orange	Power Good in AT style supplies (+5Vdc)
Green	Power supply ON
Gray	Power OK

You must ensure that the +12Vdc and +5Vdc are correct. If you find that the output voltage is low then it means that many other devices are using the same line and the system is overloaded. You can also disconnect the new device if you have recently upgraded the computer and try starting the power supply to check. This can verify that the problem existed is due to the device upgraded or not. Then you start upgrading the power supply. However, if you find that the problem persists then you must repair the power supply by troubleshooting or replacing it.

### 7.3.3 Upgradation

Generally, when a new system is purchased, more importance is given to specification with respect to CPU speed, memory capacity, or motherboard configuration but least thought is given to specifying the power supply. It is important to ensure that proper power supply is provided that support the new devices like hard drive, CD drive, internal modem, etc.

**When you choose a power supply you must consider two important factors:**

- *Power capacity of the new supply:* The power capacity of the new supply which is measured in watts is the maximum amount of power supplied safely to a load. Choosing a proper power rating for an upgraded supply is always measured in approximation. Usually you can calculate the rating by adding 50W to the original power supply. For example, when upgrading an IBM AT supply, the actual power supply would be 192W but it is taken to be the next rating as 242W (192W+50W).
- *Physical dimensions:* The physical dimension of the power supply device also plays a very important role. The device must fit into the space given in the PC. You should be able to bolt the device into the place and see that the mounting holes are aligned with the original



supply. The new supply must have a connector which must be compatible with motherboard. You should always ensure that it has correct connector for the particular motherboard.

When you test the power supply upgradation it is very vital to ensure that is carefully handled. While installing new upgraded power supply, you must always ensure that the computer is switched off then locate the line voltage selector switch and ensure that it is set appropriately. Till you ensure that power supply is installed correctly, remove any expansion boards connected to it. After verification you can power down the PC and reinstall the peripherals and expansion boards. Charge your PC for 48 hours and your system will be ready for use.

**Activity 1:**

Suppose you find the system is not switching on how do you suspect power supply problem?

**Hint:** Refer Section 7.3.1 dealing with problems

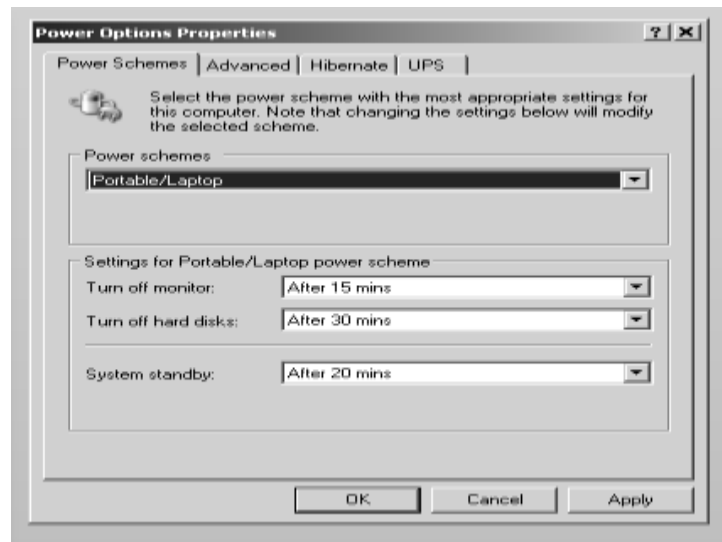
**Self Assessment Questions**

5. The basic indication of power problem is that if there is any malfunction in the power supply then it will \_\_\_\_\_ the PC.
6. What can be suspected when the PC freezes for no reason at all several times in an hour or several times in a day?
7. What is the indication of gray color wire in the computer in power supply pin assignments?
8. The important factors to be considered when choosing a power supply are \_\_\_\_\_ and \_\_\_\_\_.

**7.4 Power Management in Windows OS**

Power Management is an important component of the system performance that helps in directing the power supply efficiently to other parts of the components. Power Management can be achieved when the BIOS, chipset, operating system and other devices cooperate to reduce power demands of an idle computer. The system can be left open without use in a sleep mode or power saving mode. In that way system will only use 5W of the power which leads to less electricity bills and lower cost in running a PC.

The operating system is responsible for supporting the controls and dialogs needed for selecting the power management scheme. Windows is considered to be a premiere operating system and you can configure any power management settings of the system through power management properties dialog box. One of the examples of power management dialog box in Windows XP is as shown in the figure 7.2.



**Figure 7.2: the power Management dialog box in Windows XP**

The first step in power management under Windows is selecting a power scheme. This scheme acts as the controller for hardware devices which control the power-down timing. The power saving modes are of three types:

- *Basic conservation:* In this mode the monitor can automatically go to sleep mode or LCD (Liquid Crystal Display) backlight can be switched off after the system has been idle for more than the specified time while the rest of the system is running. This saves the energy that is consumed by the monitor.
- *Standby:* when your system is idle or you are busy for certain period of time and intend to work on the system later then you can put the system into standby mode. Standby mode makes the monitor and hard drives switched off and power down in some of the components of the system. When you come back to the work on the system switches on and resumes the same state quickly as you had left it. It saves the battery power in laptop computers.

- *Hibernation*: this mode is when you keep your system idle for longer period say more than a day then it automatically switches off by turning off the hard drive and monitor first and then shutting down the computer.

There are a number of schemes which are used to control power management in Windows. Some of them are given below:

- *Selecting a power scheme*: In order to enable standby mode you need to select a power scheme. To do this follow the steps below:

Click start → settings

Click Control panel

Double click on Power Management icon

You will get a power management dialog box as shown in figure 7.2.

Click the Power schemes drop-down menu

Select from the available choices according to the use of your system .

You will generally have options like *Always ON*, *Home/Office Desk* and *Portable/Laptop*.

After selecting the scheme the settings like *System Standby*, *Turn-off Monitor*, and *Turn-off hard disks* will be updated to their default values. You can tweak the values according your need. Suppose you want to give more time before turning off the monitor when the system is in idle mode then you can set the values under “Turn-off Monitor”. After making the changes *click apply and click ok*.

- *Saving/Deleting a Power scheme*: when you set the timer values according to your need and want to save under a unique name, then you can *click Save As* and enter the name of your new scheme. This will be added to your power schemes drop-down list. If you want to delete the existing power scheme or do not want any of the power scheme names in the drop down list you can simply select the intended scheme and *click delete*.
- *Manually invoking the standby mode*: If you want to put your computer into standby mode manually then you can use the shutdown dialog box as shown in the figure 7.3 and click standby.



**Figure 7.3: Shut down dialog box in windows XP**

This can also be done by setting this mode on when the computer power is on or when you close the laptop display. To do this follow the same step given in selecting a power scheme section in the earlier paragraphs (refer figure 7.2)

Click the advanced tab

You will get the dialog box as shown in figure 7.4

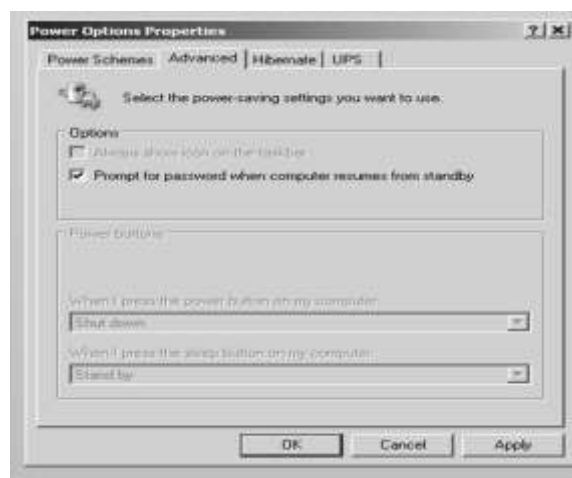
Find the drop down list labelled “When I press the power button on my computer”

Select the “standby” in the list

Click apply and click OK.

- *Manually invoking the Hibernation mode:* As you know Hibernation mode helps in restoring all the files and folders when it is turned on again. In order to select this mode you need to (refer figure 7.2)

Click the Hibernate tab

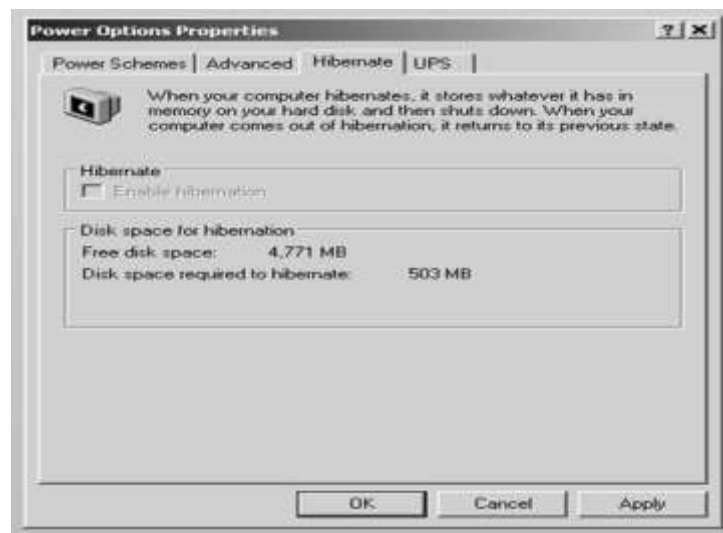


**Figure 7.4: the advanced Power management Properties under windows XP**

You will get the dialog box as shown in figure 7.5

Select the check box labelled “Enable hibernate support”.

You can also click on advanced tab and look for the entry labelled “When you press the power button on my computer” as shown in figure 7.4 and then click Hibernate. If this tab is not found in your dialog box then that means your computer is not supported with hibernate feature.



**Figure 7.5: Enabling the Hibernate power saving mode in windows XP**

- *Incoming call in Standby mode:* when a modem receives an incoming call during standby then it comes back to its active mode immediately and attends the call. This will happen when the external modem is on and the communication modem software is open. During the call duration the system should come out of standby mode and after the call the system should go to standby mode automatically.
- *Passwords in Standby or Hibernation:* Any one can move the cursor to get the system out from the standby mode or hibernate mode. In order to prevent this and safeguard your system from external users you can invoke password when it is in standby or hibernate mode.

Follow the same steps as mentioned above You will see power management dialog box as shown in figure 7.2.

Click advanced tab

Click on check box labelled “Prompt for password when computer goes off standby”. You can use your Windows password (system password) for both standby and hibernate mode.

- *Configuring Battery Warnings:* you can configure your system to give warnings at the time of low or variation battery conditions and suggest the PC to act according to the conditions. To do this you need to click on the UPS tab and configure the settings.

### Self Assessment Questions

9. \_\_\_\_\_ is responsible for supporting the controls and dialog needed for selecting the power management scheme.
10. The three power saving modes are basic conservation, standby and \_\_\_\_\_.
11. \_\_\_\_\_ is the mode that switches off the computer automatically when it is in idle state for a long period.

#### Activity 2:

Set the hibernate mode in your computer and set the password to come out of hibernate mode.

**Hint:** Refer section 7.4 power management in windows OS

## 7.5 Troubleshooting

### 7.5.1 Switching Power Supplies

Troubleshooting a switching power supply is not an easy task. It requires more time and extra effort to perform the task. The problem in the power supply comes in a number of ways which has no standard technique to trouble shoot. However, if you follow some of the basic tips you may avoid the problem to a maximum extent.

1. As heat is basically released from the battery and power supply device cooling is very important. Therefore, you need to have clean fan blades and open ventilators.
2. The AC line voltage switch must be set correctly for the connected region.

3. Secure power supply connectivity is very important. You should ensure that the motherboard and hard drives are connected with the power supply in a secure manner.
4. Always avoid using Y-adapter all over the system especially hard disk drive. Because Y-adapter sometimes has problem in the splitter. Y-adapter allows you to connect two devices to one power cord. Therefore, when such a problem arises you should try connecting directly.
5. Ensure the output voltage is always in tolerance. It is usually +/-5 percent.
6. When a new device is added during the upgradation there may be a chance of overloading and possibility of errors occurring.. If that happens you should remove the device and test the power supply. If it works properly then try upgrading the power supply and then reinstall.

### **7.5.2 Power Management**

The main use of power management component is to direct the supply in a controlled manner. Ideally, when the system goes to idle state it must consume very little power. This also avoids data corruption and system crash since the BIOS, chipset, devices and OS are in idle state. But due to BIOS incompatibilities buggy drivers (the drivers which are faulty) and noncompliant hardware devices creates negligible issues that may result in power management problems. The troubleshooting of these depends on the part of the system where the problem has occurred. A general way of starting your computer on such an occasion is as follows:

1. Start your computer in Safe mode
2. Click Start → settings → control panel
3. Double-click the system icon
4. Click the device manager tab
5. On the resources tab clear the Use Automatic Settings check box and Click Interrupt Request
6. In the Resource Type column, Click Change setting
7. Give the value in the value box.
8. Close the Control Panel and reboot the system in normal mode.

**Activity 3:**

1. If you encounter a write data error when using a CD-RW under Windows XP how will you trouble shoot it?

**Hint:** Refer troubleshooting power management in the book on troubleshooting, maintaining, and repairing PCs by S. J. Bigelow

**Self Assessment Questions**

12. State whether the following statements are true or false:
  - a. Fan blades must be clean to release excess of heat out of the system
  - b. It is compulsory to use Y- adapter all over the system especially in connecting HDD.

**7.6 Summary**

Power supply plays an important role in PC operation and its components. It converts AC into one or more levels of DC that can be used by electronic devices inside the computer. Though you might not be willing to give more importance to it, in reality any fault in the power supply can create severe problems in the stability issues, data loss, and also result in damage to motherboard or drives. You can always prevent the use of power by the system while in idle state. In this unit you have seen the working of the typical switching power supply and got to know reliable guidelines for selecting and upgrading a power supply. Major power management techniques for computers on Windows operating system were also reviewed. You also saw how to use those schemes and to troubleshoot many of the power supply and power management problems.

**7.7 Glossary**

Term	Description
RMS	Root Mean Square is the measure of AC voltage which produces the same volts as DC voltage without showing the loss of energy
Oscilloscope	electronic equipment that provides visual images of varying electrical quantities and allows observation of constantly varying signal voltages, usually as a two-dimensional graph with function of time in x axis and electrical potential differences in the y axis.



Vdc	Volts dc is the measure of amount of voltage passing in the input or output line. Usually it is dc because AC line voltage is transformed into dc voltage.
Switch	Switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another

### 7.8 Terminal Questions

1. Explain the typical working of switching power supply with a neat diagram.
2. How will you recognize a power problem?
3. What are the different schemes in power management?
4. List the tips for troubleshooting switch power supply.

### 7.9 Answers

#### Self Assessment Questions

1. Feedback loop
2. Single chip regulator
3. Duty cycle
4. a. False  
b. True
5. Not boot
6. Power problem
7. Power OK
8. Capacity or the new supply, physical dimensions
9. Operating system
10. Hibernate mode
11. Hibernate
12. a. True  
b. False

#### Terminal Questions

1. Refer Section 7.2, Switching regulations
2. Refer Section 7.3.1, recognizing the problem
3. Refer Section 7.4, Power management in Windows OS
4. Refer Section 7.5.1, Switch power supplies.

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