Microcomputer Troubleshooting

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PREFACE

Computer is the mostly exposed technical field today. Why? One of the causes is the invention of microcomputer and its distribution among people. Microcomputers are easy to buy, easy to use and easy to troubleshoot. Today even a school boy can buy, use and troubleshoot a microcomputer. This is why it is reaching all the corners of the world and all the classes of people.

Most of the computer problems come from misuse and ignorance. So this technology will spread more if we can spread the knowledge about how it should be used and how the common problems can be solved.

This book contains the discussion about microcomputer and its troubleshooting. Unit 1 to 3 enlights the different components of a microcomputer and unit 4 to 7 covers the common sources of problems and the ways to prevent or remove them.

A microcomputer may have hundred types of components with thousand types of brands and can make million types of troubles. So it is not possible to discuss all of them in a single book. This book enlights only the most common ones.

Microcomputer, its types, components and some performance determining central devices are discussed in unit 1.

Unit 2 discusses about the secondary devices those are used to support the main devices of a microcomputer systems.

Controller devices make a bridge between main and secondary devices. These are discussed in unit 3.

To troubleshoot all types of problems created by a microcomputer, there are some common rules. Those are discussed in unit 4.

Unit 5 discusses about how to troubleshoot and install hard disk drivers and floppy disk drives.

Unit 6 covers the troubleshooting of keyboard, mouse, monitor and printer.

Preventive maintenance discussed in unit 7.

Thanks everybody for all types of cooperation like reviewing, editing, coordinating, publishing and for reading this book.
Unit 1: Introduction and Main Devices

Microcomputer, its types, components and some performance determining central devices are discussed in this unit.

Lesson 1 and 2 are introductory lessons. Lesson 3 to 6 describes the main components of a microcomputer system. A microcomputer has many components. Of them some are main. The control the rest of the components of the computer system. On their performance, the performance of the whole computer system depends. These components are discussed in the last four lessons.

Lesson 1: Microcomputer

1.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ What is a microcomputer
♦ Different types of microcomputer.

1.2. Microcomputer

A computer is an electronic machine that stores, retrieves and manipulates or processes data.

Microcomputers are microprocessor based small computer. The brain of a microcomputer is the microprocessor, a silicon chip containing the necessary circuits to perform arithmetic and logic operations and to control input-output operations. A microprocessor is an integrated circuit consisting of thousands of transistors squeezed onto a tiny chip of silicon. The chip is packaged as a single integrated circuit. Adding input-output capability and a memory to the microprocessor, a microcomputer system is formed.

Early microcomputers had a limited processing potential and limited choice of input-output devices. Present day microcomputers have wider processing capabilities and support a wide range of input-output devices. In addition to general-purpose computations, microcomputers are used for
special purpose applications in automobiles, airplanes, toys, clocks, appliances etc.

High-end super micros are known as workstations. The workstation represents the bridge between the microcomputers and minicomputers. It is a microcomputer with many of the capabilities of larger minicomputers but costing much less. Initially designed for use by engineers and designers, and today they are popular for general uses. These workstations can run more than one application for a user. This is known as multitasking. A workstation is also a multi-user system that can be shared by several users at the same time.

1.3. Different Types of Microcomputers

Today most of the microcomputers are IBM compatible. The microcomputers compatible with the line of IBM personal computers are known as IBM compatible computers.

Compatibility here means that, components (hardware and software) of one ‘IBM computer’ is normally installable in another ‘IBM compatible computer’ and vice-versa. All IBM compatible computers have same line of microprocessor, input-output device, software etc. So it is possible to use one component of a computer in a compatible of that computer.

Different series of IBM compatible computers exist. They are:

- IBM PC
- IBM PC/AT
- IBM PC/XT
- IBM PS/2.

1.3.1. IBM PC

IBM PC was introduced in 1981. It has following characteristics:

- Intel 8088 processor
- 16 KB RAM expandable up to 64 KB
- Monochrome video adapter, incapable of displaying bit-mapped graphics
- Floppy disk drive with 160 KB storage capability
- No hard disk.

‘PC’ is the name of a compatible series of microcomputers. But this name ‘PC’ is also used to refer any microcomputer, where
Introduction and Main Devices

PC means personal computer. In this book where we used the term ‘PC’, it means any microcomputer except in this section.

1.3.2. IBM PC/XT

IBM PC/XT was introduced in 1983. It has following characteristics:

♦ Intel 8088 processor
♦ RAM expandable up to 640 KB
♦ Supports hard disk.

1.3.3. IBM PC/AT

IBM PC/AT was introduced in 1984. It has following characteristics:

♦ Intel 80286 processor
♦ It is approximately 75% faster than PC/XT
♦ AT bus standard was used in many clones.

‘Bus standard’ means the industry standard of connection point and connection organization of different devices connected with the motherboard.

‘Clone’ means a copy of the original one. In computer literature, it means compatibility. For example, ‘AT clone’ means a computer compatible to the IBM PC/AT series.

1.3.4. IBM PS/2

It was introduced in 1987. Different types of Intel processors are used here. It uses MCA (Micro Channel Architecture) bus standard.

1.4. Exercise

1.4.1. Multiple choice questions

a. The brain of the microcomputer is
Microcomputer Troubleshooting

i) RAM
ii) Motherboard
iii) Casing
iv) Microprocessor.
b. Microprocessor is

i) Computer
ii) Microcomputer
iii) Integrated circuit
iv) Input device.

c. Today most of the microcomputers are

i) Apple compatible
ii) IBM compatible
iii) Incompatible
iv) Mainframe compatible.

d. The first series of IBM compatible computers is

i) IBM PC
ii) IBM PC/AT
iii) IBM PC/XT
iv) IBM PS/2.

e. The RAM of IBM PC was

i) 64 MB
ii) 1 MB
iii) 640 KB
iv) 16 KB.

1.4.2. Questions for short answers

a) Write the name of four series of IBM compatibles.
b) What does ‘clone’ means in computer literature?

1.4.3. Analytical questions

a) What is microcomputer?
b) Write the characteristics of different IBM compatible series.
Lesson 2: Basic Parts of the Microcomputer

2.1. Learning Objectives

On completion of this lesson you will be able to describe

- Different parts of a microcomputer
- Function of different parts.

2.2. Introduction

A microcomputer is composed of many separate components. These components can be easily separated from one another and be replaced by a new one. The main job of microcomputer troubleshooting is just the following two steps:

- Find out the faulty component for which the computer is not working properly.
- Replace the faulty component with a new one.

So at first we have to know what the components of a microcomputer.

The components of a microcomputer can be divided in 2 portions:

- Components inside the Casing
- Components outside the Casing.

Casing or chassis is the box, inside which all the main devices of a microcomputer reside.

2.3. Components Inside the Casing

Inside the casing there are a few components:

- Motherboard: Contains the circuit to combine different portions of a microcomputer.
- CPU: It is the central device. It controls the whole computer through the motherboard.
- RAM: It is the Random Access Memory. The CPU stores and retrieves data in RAM.
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- ROM: It is the Read Only Memory. It contains the program that is run during the startup period. It also contains basic routines to control different I/O devices.
- Bus slots: Different external cards are connected with the motherboard through the bus slots.
- Memory card: Random Access Memory available in cards.
- Display card: Controls the display unit.
- Multifunction board: It contains
- Printer port: Printer is connected through this port
- System clock/calendar: Stores information about current date and time
- Serial port (RS-232C port): Mouse, modem etc. are connected through this port.
- Disk controller: It controls the floppy and hard disk.
- Power supply unit: Supplies Power to the Microcomputer.
- Disk drives:
  - Floppy disk drive: Runs floppy disk.
  - Hard disk drive: It contains the hard disk.
  - CD drive: Used to run the CD (Compact Disk)s.

2.4. Components Outside the Casing

The following components are connected externally with the casing.
- Keyboard: Gets input from the user by key pressing.
- Monitor: Displays the output
- Mouse: Is used to point and select different elements displayed by the monitor.
- Printer: Used to get the output in printed form.
- Modem: Connects the computer with the telephone line.
2.5. Exercise

2.5.1. Multiple choice question

a. Personal computers are easy to repair for its

   i) Low cost.
   ii) Separable components
   iii) High speed
   iv) Small size.

2.5.2. Analytical questions

a) What are the different components of a computer?
b) What is the function of different components?
Lesson 3 : Central Processing Unit

3.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ What is the CPU and how it works.
♦ Different criteria of a CPU, that makes a computer different.

3.2. Introduction

The center of the microcomputer is microprocessor. Another name of the microprocessor is CPU (Central Processing Unit). CPU controls the whole computer. For this purpose it gets help from the motherboard. CPU is connected with the motherboard and all other cards and components are directly or indirectly connected with the motherboard.

<table>
<thead>
<tr>
<th>Property name</th>
<th>Explanation</th>
<th>Unit</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU Speed</td>
<td>Number of operations the CPU can do per second</td>
<td>MHz</td>
<td>1 – 500 MHz</td>
</tr>
<tr>
<td>Word size</td>
<td>Size of the largest operand</td>
<td>Bits</td>
<td>8-64 bits</td>
</tr>
<tr>
<td>Numeric coprocessor</td>
<td>It is an optional hardware which can directly perform floating point numeric calculations</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Internal cache</td>
<td>Size of high speed memory that is built in the processor</td>
<td>KB</td>
<td>0 to 512K</td>
</tr>
<tr>
<td>Data path</td>
<td>The number of data pins by which the CPU is connected with the devices external to CPU</td>
<td>Bits</td>
<td>8-64 bits</td>
</tr>
<tr>
<td>Maximum memory</td>
<td>How much memory can the CPU use at most</td>
<td>MB</td>
<td>1-4096 MB</td>
</tr>
<tr>
<td>MMX technology</td>
<td>Does the processor support multimedia instructions</td>
<td>Not available</td>
<td>Not available</td>
</tr>
</tbody>
</table>

Table 3.1: CPU Properties.

Though the CPU controls the computer, but the CPU is controlled by the programs. Programmers write and store their programs in disks (hard, floppy or compact). CPU retrieves the programs form the disks and stores them in the RAM. Then it starts executing the orders (i.e., commands or statements) given in the programs.
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So the top-down structure is the programmer writes the program, program controls the CPU, CPU controls the motherboard and motherboard controls the rest of the devices.

Though CPU is only a part of a computer, CPU performance determines computer performance. CPUs have several properties, which affect their performance. These properties are introduced in Table 3.1.

The processor is a semiconductor device. The main semiconductor portion is secured in plastic or ceramic casing. Pins connected with the semiconductor circuit in the processor, come out from the processor casing. Using these pins, the processor is connected with the motherboard. The processor’s semiconductor circuit is normally a 0.5 to 2 cm square. The plastic or ceramic casing is 4 cm to 10 cm length rectangle or square. A processor has 40 to 300 pins.

Many semiconductor industries today are producing processors. Of them Intel, AMD, Cyrix, Motorola etc. are popular. The processors used for microcomputers are 8085, 8086, 80286, Z80, Pentium, etc.

3.3. CPU Speed

There are many components inside the CPU. The CPU clock keeps the working of the components synchronized. By striking each clock a certain amount of work is done. Heart beat in our body is an example of clock tick in computer.

The unit used for clock speed is megahertz. Hertz means 1 clock tick per second. So ‘Mega’ ‘Hertz’ means 1 million (10^6) clock tick per second.

Megahertz is the measure of speed of the processor. A microcomputer's speed mostly depends on the processor. So a faster clock means a faster computer.

But this is not hundred percent true. A computer's speed depends on various other things such as memory size, motherboard, bus speed etc.

So increasing only CPU speed by 50% does not make an overall increase of computer's speed by 50%, it may increase by 20%.
Nowadays, the slowest computer you may find will be 25 or 33 MHz 386DX. The fastest speed you'll hear may get up around 400 MHz Pentium II.

3.4. Word Size

Word size determines how much big a number the computer can operate in one operation. The larger the word size, the bigger the number. Unit of word size is bit. Today most of the processors support 32-bit word size. The largest integer number that a processor with 32-bit word size can manipulate is $2^{32}-1$. A processor with larger word size is faster than a processor with smaller word size.

![3.1: L2 cache on the Pentium Pro chip.](image)

3.5. Internal Cache Memory

While working the CPU stores its program and data in the RAM. There are 2 main types of RAM – static and dynamic.

- Static RAM or SRAM: Faster and 10-20 times more expensive than DRAM.
- Dynamic RAM or DRAM: Slower and 10-20 times less expensive than SRAM.

To save money, the PC uses a lot of DRAM, but it decreases the PC’s speed. To get some speed, small amount of SRAM is used in to the CPU.

This SRAM is called the cache memory. The size of the cache memory is much smaller than the main memory.
Introduction and Main Devices

The often-used data is stored in this cache memory. Thus the CPU need not access the relatively slow DRAM and the overall speed increases.

There are 2 types of cache memory – internal and external. A PC can have any one or both or none of these two.

- Internal cache memory: This cache memory is built in to the CPU. It is also called level-1 or L1 cache. Size of the internal cache memory is smaller than the external cache memory.
- External cache memory: This cache memory is built on the motherboard. It is also called level-2 or L2 cache.

The Pentium processors normally have 16K internal L1 cache and 256-512K external L2 cache. The Pentium-Pro has all the 2 level cache built in to the processor.

3.6. MMX Technology

For multimedia operations (video, audio etc.) MMX processors can work faster and with improved quality of color and sound. The MMX versions of Intel processors use 57 special purpose instructions. These instructions can work in parallel. These instructions are used to speed up the core algorithms, which are often used for multimedia operations.
3.7. Exercise

3.7.1. Multiple choice questions

a. The heart of a computer is
   i) Motherboard
   ii) RAM
   iii) CPU
   iv) Cache.

b. The unit of CPU speed is
   i) MB
   ii) MHz
   iii) Bit
   iv) KB.

c. Internal cache means
   i) The largest number that can be operated on in one operation
   ii) Size of internal high speed memory that the chip include
   iii) The largest number that can be transported into the chip in an operation
   iv) How much memory can the CPU use at most.

3.7.2. Questions for short answers

a) Does a computer with 300 MHz CPU is always two times faster than a computer with 150 MHz CPU?
b) What is MMX technology?

3.7.3. Analytical question

a) Explain different CPU properties.
Lesson 4: Motherboard and Multifunction Boards

4.1. Learning Objectives

On completion of this lesson you will be able to describe:

✦ The function of a motherboard
✦ Different components of a motherboard and their functions
✦ How motherboard makes a computer easy to upgrade
✦ Multi-function boards.

4.2. Introduction

Microcomputers have usually included most their essential electronics on a single printed circuit board, called the motherboard. It supports the CPU. The CPU controls the whole computer. But it is difficult for the CPU to contact with all other devices of a computer. To solve this problem maximum devices of a computer are connected with the motherboard and the motherboard is connected with the CPU. Thus the CPU orders only the motherboard and the motherboard carries the order to specific devices.

4.3. Components of a Motherboard

A Motherboard has the following components:

✦ CPU: It is the central device. It controls the whole computer through the motherboard.
✦ RAM: It is the Random Access Memory. The CPU stores and retrieves data in RAM.
✦ ROM: It is the Read Only Memory. It contains the program that is run during the startup period. It also contains basic routines to control different I/O devices.
✦ Bus: It is a set of connecting wires. Different devices on the motherboard connect with each other through the bus.
✦ Bus slots: Different external cards are connected with the motherboard through the bus slots.
Fig. 4.1: XT motherboard.

Fig. 4.2: AT motherboard.
4.4. Motherboard Makes a Computer Easy to Upgrade

Upgrading means improving the computer by only changing a portion. Today all the motherboards are standardized. Standard means, these fit in a standard sized case and takes standard boards and drives. To upgrade it, just buy a new motherboard and swap it out for the old one. For example, to upgrade a 66 MHz 486 computer to a 266 MHz Pentium computer, all that you need is a new motherboard with a processor.

4.5. Multifunction Board

A computer has different devices. All of them are not directly controlled by the CPU. For many devices like keyboard, display unit, disk drives there are separate controllers. These controllers are used to decrease the workload of the CPU. For example to write a block in hard disk, the CPU just orders the controller and the controller does everything like rotating disk, writing, error checking etc.

Controller cards contain the circuitry for these controllers. Controller cards that contain many controllers are called multi-function board. A multi-function board may contain controllers for printer, hard disk, floppy disk, mouse etc. Nowadays, many motherboards contain these controllers built-in.
4.5. Exercise

4.5.1. Multiple choice question

i) Microcomputer is easy to upgrade because of the
ii) Casing
iii) programming language
iv) Keyboard
v) Motherboard.

4.5.2. Analytical questions

a) What is a motherboard? What are the components of a motherboard?
b) What is the function of a multi-function board?
Lesson 5: Memory

5.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Different memory hardware
- Different types of memory organization (i.e., SRAM, DRAM, SDRAM).

5.2. Introduction

The PC must have main memory. Main memory is high-speed memory that the CPU can read from or write to. "High speed" means, less than a microsecond to read/write. The other name for such memory is RAM, Random Access Memory—a particular kind of chip on circuit boards.

5.3. Different Memory Hardware

Memory is easy to pick out on a circuit board. It’s packaged either as a “bank” of eight or nine small chips, or it’s a mini-circuit board with several square chip mounted on it, called a SIMM (Single Inline Memory Module). Memory is always organized into banks either eight or nine discrete chips, or a SIMM. Most motherboards have room for four banks of memory. As each SIMM is the equivalent of nine chips built in single independent card, SIMMs make replacing bad memory easier.

RAM chips are distinguished by their following characteristics:

- Package type, which can be:
  
  - DIPs, which are normal looking chips. DIP means Dual Inline Package. It is just a simple IC with two sets of legs inline. These ICs are directly inserted in sockets on the motherboard. Laptop and old 8088 to 386 computers use this package.
  
  - Single Inline Pin Packages, or SIPP (a small circuit board with pins across its bottom).
  
  - Single and Double Inline Memory Modules (SIMMs and DIMMs respectively), which are small circuit boards with an edge connector across the bottom.
PCMCIA cards. This package is used in laptop computers. In this package the memory is built in a card which is inserted in the PCIMCIA slots of laptop computers.

Various proprietary vendor-specific chip packages.

Access speeds, measured in nanoseconds. Common access times are 60, 70, 80, 90, and 100ns for normal memories, and as low as 8 ns for expensive high-speed memories. Lower numbers are faster.

Size, which ranges from 16K to 128MB For memory modules.

Fig. 5.1: SIMM (Single Inline Memory Module).

5.4. Static Versus Dynamic RAM

As computers are built faster and faster, all of the components must get faster and faster. Design a system around a 100 MHz chip, and you need a lot of 100 MHz components including RAM.

Unfortunately, about the fastest type of common (that is, cheap) RAM doesn't come any faster than 20 MHz.

5.4.1. Static RAM

The simplest kind of memory to understand is called static RAM (SRAM). It's called "static" RAM because when you put data into it, the data stays there.

To build that kind of memory, you've got to build about six transistors into each bit storage location. That kind of
memory-SRAM-can be quite fast, but also quite expensive. If we used SRAM for our PC memory, then there'd be no trouble with getting memories that kept up with our CPUs. But, on the other hand, we would be able to afford those computers, as SRAM is about 10 times more expensive than the DRAM that we're used to buying.

5.4.2. Dynamic RAM

The economical answer to SRAM was Dynamic RAM (DRAM). Each DRAM built of a single transistor and a capacitor, in contrast to SRAM's six transistor. DRAM has two problems from the point of view of a PC designer. First, the "dynamic" in its name means that it forgets the data that you give it almost as you can give it the data. That means that DRAM-based systems require refresh circuitry to get around this problem. Second, the way that DRAM is built to be cheaper is that DRAM is organized not simply into a set of addresses; rather, each bit in a DRAM has a row address and a column address.

5.4.3. SDRAM

Synchronous Dynamic Random Access Memory, (SDRAM) is a new variant of DRAM that includes an on-chip burst counter. This burst counter can be used to increment column addresses and helps increase SDRAM the speed of burst accesses.

Aside from the facts that faster is always better and speed is pursued for its own sake, the reason behind the SDRAM is that CPUs are getting faster. With the increasing of speed, they demand faster memory, in order to function at its maximum potential. With SDRAM, the CPU and RAM are locked together same clock. Thus, the speed of the RAM and the CPU are linked, or synchronized.
5.5. **Exercise**

5.5.1. **Multiple choice questions**

a. DIMM is a
   i) Chip package type
   ii) RAM access speed
   iii) Size
   iv) Processor.

b. Laptop computers use
   i) SIMM
   ii) DIMM
   iii) PCMCIA memory card
   iv) SDRAM.

5.5.2. **Questions for short answers**

a) Why memory cards make replacing bad memory easier?

b) Why is SRAM faster than DRAM?

5.5.3. **Analytical questions**

a) Describe different types of memory hardware.

b) Compare different types of RAM.
Lesson 6 : Bus Structure

6.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ What is bus structure
♦ Different types of bus structure
♦ Components of different bus.

6.2. Introduction

Different expansion cards (Display card, Network card etc.) are connected with the motherboard. A card of one company may be connected with a motherboard of another company. So the connection point between the card and the motherboard must be predefined. The predefined structure of connection point is known as the bus standard.

These connectors are also called "expansion slots" as expansion boards must plug into these slots. Some PCs have no slots at all, and so weren't expandable; other machines have three, and most clone-type machines have eight slots. Some machines offer 10 slots.

There are different types of bus structures: PC, ISA, PCI, PCMCIA etc. A card with PCI connection points must be inserted in a PCI expansion slot of the motherboard. Similarly ISA cards are inserted in ISA slots.

6.3. PC Bus

This bus was used in IBM PC. It has 62 lines. These lines are offered to the outside world through a standard connector. Now we shall look at what these 62 lines do.

6.3.1. Data Path

The original PC and XT were based on the 8088 chip. The 8088 had a data path (the "front door") of just 8 bits, so the PC bus only includes eight data lines. That means this bus is "8 bits wide," and so data transfers can only occur in 8-bit chunks on this bus. Expansion slots on a computer with this bus are called "8-bit" slots. Eight of the 62 wires, then, transport data around the computer.
6.3.2. Memory Address

The 8088 processor in PC and XT has 20 address lines. To connect these 20 lines with expansion cards, the PC bus has 20 address lines.

6.3.3. Electronic Overhead

Some bus wires just transport simple electric power; there are +5 volts, -5 volts, +12 volts, and electric ground lines. Why are those lines there? Simple: to power a board plugged into a bus slot.

6.3.4. Control Lines

There are also a few control lines, like Reset, clock signals, and Refresh.

6.3.5. Interrupts and Direct Memory Access Channels

Add-in cards sometimes need to demand the attention of the CPU; they do that via hardware interrupts or IRQ (interrupt request) levels. There are six IRQ levels on the PC bus, labeled IRQ1 through IRQ7. Each gets a wire on the bus. There are also IRQ0 and IRQ1, but they’re not available on the bus.

Some of these add-in cards also need to transfer data to the system’s memory quickly; they can do that via a Direct Memory Access (DMA) channel. There are three DMA channels on the bus, labeled DMA1 through DMA3.

6.4. The AT (ISA) Bus

When developing the AT, IBM saw that it had to upgrade the bus. One reason was because the 80826 is a chip with a 16-bit data path. They certainly could have designed the AT with an 8-bit bus, but it’d be a terrible shame to make a 286 chip transfer data 8 bits at a time over the bus rather than utilize its full 16-bit data path. So they thought that it’d be nice to have a 16-bit bus.

They kept the old 62-line slot connectors and added another 36-wire connector, placing it in line with the older 62-line connector to provide some of these features:

- Eight more data lines, bringing the data bus to 16 bits in width.
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- Four more address lines, bringing the address bus to 24 bits in width.
- Four more DMA channels, 4 through 7.
- Five more IRQ levels: IRQ 10, 11, 12, 14, and 15.

Fig. 6.1: 8 bit and 16 bit slots.

Fig. 6.2: 8 bit board.
Fig. 6.3: 16 bit board
Introduction and Main Devices

These two-slot connectors are called 16-bit slots. You can see these kinds of connectors in Figure 6.1.

For a while, this 16-bit bus was called the AT bus. Since 1988, however, most people have referred to these types of bus slots as Industry Standard Architecture, or ISA, slots. You can tell the difference between an 8-bit and a 16-bit ISA board by looking at the edge connector on the bottom of it (Fig. 6.1).

6.5. PCI: Intel’s High Performance Local Bus

To support the faster processors like 80486 or Pentium Intel designed a newer faster bus slot called PCI, short for Peripheral Component Interconnect. Some features of this bus is given below.

6.5.1. Processor Independence

The PCI bus doesn't directly interface to the CPU. Rather, it communicates with the CPU via a "bridge circuit" that can act as a buffer between a particular CPU and the bus.

It means really good news for non-PC computer users. Macintosh PCs and RISC-based machines like the DEC Alpha are now out with PCI slots. That means a bigger market for PCI boards and an avenue for board makers to reach the PC, Mac, and RISC markets with a single board.

6.5.2. Wider Data Path

PCI distinguishes itself first because it is a 64-bit bus. PCI supports a data path appropriate for the newer Pentium-based computers, which require 64 bits at each clock cycle. PCI also supports a 32-bit data path, however, making it appropriate for use in high-performance 486 systems.

6.5.3. High Speed

The PCI bus runs in 33 to 100 MHz which much higher than the older 5 to 20 MHz buses.

6.5.4. Backward Compatibility

Although ISA boards cannot fit in PCI slots, the chipset that supports PCI also supports ISA. That means that it's easy to build a PC with PCI, and ISA slots all on the same motherboard.
6.5.5. Software Setup

PCI supports the Plug-and-Play standard developed in 1992 by hardware vendors. There will be, in general, no jumpers or DIP switches on PCI boards. To set up a PCI board, you just run the PCI Configuration Program. Reconfiguring a system can be done without popping the top on the computer, a great convenience to users and support people.

6.6. PC Card (PCMCIA): The Portable Bus

This bus standard is used for laptop computers. As the laptop computers take very little volume so it is difficult to use the large expansion cards in laptop computers. This is why PC card or PCMCIA standard was designed.

Let's compare PC Card to the other buses that we've discussed:

- Memory address space: PC Card supports a 64MB addressing ability. This will be adequate for current machines, but will look sparse in a few years, as more demanding operating systems like OS/2 and NT become more popular.

- Bus Mastering: PC Card does not support bus mastering or DMA.

- Plug-and-play setup: PC Card allows and also requires that hardware setups be done with software. Because of the physical size of a PC Card, you'll never see jumpers or DIP switches.

- Number of PCMCIA slots possible in a single system: Most of the other buses support no more than 16 slots. The PC Card standard can, theoretically, support 4080 PC Card slots on a PC.

- Data path: The data path for PC Card is only 16 bits, a real shame but one that will probably be fixed in the next version of the standard.

- Speed: Like other modern bus standards, PC Card is not limited to 33 MHz clock rate. It may go up to 150 MHz.
6.7. Exercise

6.7.1. Multiple choice questions

a. Expansion slot is

i) Where printer is connected
ii) Where Monitor is connected
iii) The motherboard
iv) Where circuit boards are connected.

b. In computer bus is a

i) Human carriage
ii) Expansion slot
iii) Motherboard
iv) A set of wires.

c. The PC bus was used in

i) AT clones
ii) Hard disk
iii) IBM PC
iv) All personal computers.

d. PCI bus is used with

i) 8088
ii) 80286
iii) 80386
iv) 80486.

e. The data path of PCI bus is

i) 8 bit
ii) 16 bit
iii) 32 bit
iv) 64 bit.

f. PCMCIA is designed for

i) Palmtop computers
ii) Laptop computers
iii) Desktop computers
iv) Servers.
6.7.2. Questions for short answers

a. What is bus standard?
b. How many address-lines AT bus contains?

6.7.3. Analytical questions

a. Write name of different bus standards for IBM compatible computers. What are their characteristics?
Unit 2 : Secondary Devices

In this unit the secondary devices of a microcomputer system are discussed. Secondary devices are the devices those are used to support the main devices of a microcomputer system. Most of them are used to enhance the computer’s capability and without most of them the computer can run.

Input devices get input from external world to the computer system. Lesson 1 and 2 contains the discussion about some input devices for the microcomputer.

Output devices deliver output from the computer system to the external world. Lesson 3, 4 and 5 contains the discussion about some output devices for the microcomputer.

Secondary storage devices store data used by the computer system. They are nonvolatile. That means, if the power goes off, then the data in these devices does not vanish. Lesson 6, 7 and 8 contains the discussion about some secondary storage devices for the microcomputer.

Power supply unit converts the AC power to PC acceptable DC power and delivers it to different components of the PC. Lesson 9 contains the discussion about power supply unit.

Lesson 1 : Handy Input Devices

1.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ Different handy input devices
♦ Working principle of different handy input devices.

1.2. Introduction

Input devices get input from the external world to the computer. The input devices, which get input from the motion of the user’s hand, are known as handy input devices. Keyboard, light pen, digitizer, mouse, joystick and trackball, touch screen etc. are handy input devices.
1.3. Keyboard

The most common of all input devices is the keyboard. Several versions of keyboards are available. The best and most expensive of these is the full-stroke keyboard. This is ideal for word processing and other volume data and program entry activities.

Some popular microcomputers offer enhanced keyboard for easy entry of numbers. This is accomplished with a smaller group of keys known as numeric keypad at the right of the keyboard. These keys generally consist of the digits, a decimal point, a negative sign, and an ENTER key. This type of keyboard is ideal for accounting operations, which require a large volume of numbers to be entered.

Keyboards generally utilize integrated circuits to perform essential functions, such as determining the combination of 1s and 0s, or binary code. To send to the CPU, corresponding to each key depressed, switching between shifted and non-shifted keys, repeating a key code if a key is held down for a prolonged period of time, and temporarily storing or "buffering" input when keys are typed too fast.

The keyboard arrangement provided as standard on most keyboards is the QWERTY arrangement. This arrangement was chosen to slow expert typists, since those who typed too fast would cause the keys on a mechanical typewriter to jam. Slowing down the typist was accomplished by scattering the most used letters around the keyboard, making frequently used combinations of letters awkward and slower to type. This QWERTY keyboard arrangement has been used for nearly a century.

1.4. Pointing Systems

Computer users frequently find it easier to point to something on a screen or at an item of text or graphical material they are entering into the computer. A number of devices are available to assist in fulfilling this need.

1.4.1. Mouse

A mouse is a hand-movable device that controls the position of the cursor on a screen. It has a box with buttons on the top and a ball on the bottom. The box is placed on a flat surface, with the user's hand over it. The ball's movement on the surface causes the cursor to move.
Secondary Devices

1.4.2. Joystick and Trackball

Joysticks are used with video games for user input. These devices may also be used to move the cursor around a screen to facilitate input to a graphical display. A trackball is similar in operation to the joystick. It uses a billiard-sized ball to position the cursor. Several keyboard manufacturers have integrated them directly into their keyboards.

1.4.3. Light Pen

The earliest pointing device is the light pen. This device is placed close to a screen or monitor and turned on. A photo sensor inside the light pen detects the scanning beam sweeping back and forth across the screen. Accompanying circuitry converts the pen's reading into the position of the pen on the screen. Light pens are used to select items from a list or menu displayed on the screen. Light pens are used to select items from a list or menu displayed on the screen and to draw graphic displays on the video screen.

1.4.4. Digitizer Pad

A digitized pad looks like a graph pad with a pointer. It functions like a light pen on a display screen except that the pad is mounted horizontally. As the pointer is moved on the pad, the corresponding point on the screen is illuminated. The digitized pad is useful in converting graphic input, such as charts, graphs, and blueprints into patterns that can be manipulated and stored by the computer.

1.4.5. Touch Screen

Touch screen detects the touch of a human finger. One popular technique used to detect the touch of a finger utilizes infrared light beams. In this touch screen technique, infrared light beams shine horizontally and vertically on the face of the screen. A pointing finger interrupts both horizontal and vertical beams, pointing its exact location.
1.5. Exercise

1.5.1. Multiple choice questions

a. Keyboard is a
   i) Handy optical device
   ii) Handy output device
   iii) Handy input device
   iv) Optical input device.

b. Joystick is used with
   i) Programs
   ii) Word processors
   iii) Video games
   iv) Spreadsheets.

c. In QWERTRY keyboard arrangement, keys are scattered to
   i) Speedup typist
   ii) Decrease typist error
   iii) Slow down typist
   iv) Provide easier data entry.

d. Light pens are used
   i) Look in the dark
   ii) Write documents on paper
   iii) Write documents using word processor
   iv) Select items from a list or menu displayed on the screen.

1.5.2. Questions for short answers

a) What is touch screen? How it works?
b) What is a digitizer pad?

1.5.3. Analytical questions

a) What is handy input device?
b) Discuss about different handy input devices.
Lesson 2 : Optical Input Devices

2.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Different optical input devices
- Working principle of different optical input devices.

2.2. Introduction

Optical input devices covert any image to digital form. The object or an image of the object is placed in front of the optical input device. The device then scans the object or its image, convert the scanned image into pixels. Scanner, digital camera etc. are optical input devices. They convert an image to bit-mapped graphics and deliver the graphics image to the computer. This image is then store in the computer in different picture file formats (with BMP, TIF, and JPG etc. extensions). Optical character recognizer is a software package. It recognizes characters from a scanned image that exists in a picture file format.

2.3. Scanner

A scanner scans an image, converts it in bitmapped graphics and delivers to the computer. It is just like the photocopier machine, whereas the photocopier machine delivers the scanned output on paper, and the scanner delivers the scanned output as a packet of digital data, to the computer.

The scanners have a row of light-sensitive diodes. These diodes can convert light with different color and intensity to different voltage. This is moved on the paper from its top to bottom. For each position of the row, a line of pixel is produced from the color and intensity of the reflected light from the paper. These pixels are delivered to the computer.

2.4. Digital Camera

Digital camera gets the image of a still or moving object, converts it to pixels and delivers to the computer. Still and movie both types of digital camera exist. Digital still camera has a light sensitive plate. When light from the object falls upon the plate, the plate supplies different voltage for different color and intensity of the fallen light from different points of the object. From these voltages, a digital image is produced and delivered to the computer. Digital movie camera takes many shots (more than 25 per second) of a
moving object, then converts each shot to a digital image and delivers to the computer.

2.5. Optical Mark Reader

Optical mark readers (OMR) optically read marks on carefully printed forms. Optical mark forms are relatively expensive, as they must be printed with exact tolerances so that the marks will up under the optical sensing devices when read. The most popular use of such devices is optical character readers for scoring examinations in educational institutions.

2.6. Optical Character Recognizer

Optical character recognition (OCR) devices can convert data from source documents to a machine-recognizable form. OCR Current applications of optical scanning include billing, insurance premium notices, and charge sales invoices. At present, on OCR device can reliably read and interpret script or handwriting. However, some can read handwriting provided that certain general guidelines are observed when the data are written. Generally, optical character readers are limited with respect to hand-written characters and can only read handwritten digits and some symbols. Many OCR devices are available for the reading of typed characters, including digits, letters and some special characters. Not all printed characters can be read reliably on OCR readers. Generally, each reader is capable of reading only selected character styles.

Even if the character style and spacing are acceptable, errors can result from reading a character that is not written perfectly. To reduce such errors, OCR devices generally compare the pattern read with the patterns to all acceptable character. The read character is assumed to be the character whose stored pattern most closely matches the read pattern.
Secondary Devices

2.7.  Exercise

2.7.1.  Multiple choice questions

a.  Which one is used for scoring examinations?
   i)  MICR
   ii) OMR
   iii) OCR
   iv) None of them.

b.  An example of image file extension is
   i)  EXE
   ii) DOC
   iii) BMP
   iv) INI.

c.  The following one is an optical input device
   i)  Monitor
   ii) Light pen
   iii) Scanner
   iv) Printer.

d.  OCR is a
   i)  Game
   ii) Programming language
   iii) Software package
   iv) Hardware.

2.7.2.  Questions for short answers

a)  What is the basic difference between OMR and OCR?

b)  What is a scanner in computer system?

2.7.3.  Analytical questions

a)  What is an optical input device?

b)  Discuss about different optical input devices.
Lesson 3 : Monitor

3.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Working principle of display monitors
- Different types of monitor
- Using television as a monitor.

3.2. Working Principle

It is the most commonly used display device. The monitor utilizes a cathode ray tube (CRT). CRT monitors generally produce images by the raster-scan method. In this method, an electron beam varying in intensity is moved back and forth horizontally across the face of the monitor. As the beam is directed to each spot on the phosphor-coated screen, it illuminates the spot in proportion to the voltage applied to the beam. Each spot represents a picture element or pixel. When the electron beam has scanned the entire screens and illuminated each pixel, one can see a complete image. The image that can be seen is the one traced on the retinas of eyes by the light beam. However, this image will fade unless it is refreshed. Thus, the electron beam must scan the screen very rapidly (a minimum of 60 times per second), so that the intensity of the image remains approximately the same and the screen does not appear to flicker.

The number of pixels that make up the screen determines the screen resolution of a particular monitor. Monitors are currently available with 64,000 to more than 2 million pixels per screen. The greater the resolution of a monitor the greater the storage demand on the computer. This is because the image must be stored in memory before it can be displayed. Two techniques used to store computer images are bit-mapped and character-addressable.

In a bit-mapped display, each pixel is uniquely addressable. Information must be stored for each pixel on the screen. This technique needs quite a large computer memory and provides the most detailed display. For graphical applications, such as CAD/CAM, this detail is essential. However, for applications such as word processing, addressable display is appropriate. In a character addressable display, the screen is divided into character positions. Only the characters to be displayed are stored in memory. As each character is retrieved from memory, it is converted into a pattern of dots or pixels by a special character generator module.
3.3. Monochrome or Color

Some monitors display images in only one color, while others are capable of producing images in colors. Monochrome monitors use a single electron beam and display one color, generally green, amber, or white, on a black background. The phosphor composition of the screen determines the color. Color monitors produce multi-color images by combining the red, blue and green colors in varying intensities. Each pixel is made up of three-color dots: red, blue, and green. It will appear to glow in different colors depending on the intensity of each individual dot in the pixel. Color monitors are commonly referred to as RGB monitors since they employ three electron beams, one of each color. Color monitors are categorized as CGA, EGA, VGA and SVGA depending on the resolution. CGA monitors provide the least resolution (approximately 300 * 200 Pixels) and SVGA monitors provide the greatest resolution (1000 * 800 pixels and greater) resolution.

3.4. Monitor Interface

A monitor requires an appropriate interface to communicate with a computer. For example, a color graphics interface board is needed for a color monitor. This interface will generally not work with a monochrome monitor and might even damage it. Dozens of monitor interface boards are available for use with microcomputers. A caution must be exercised to match the interface to both the monitor and the computer.

3.5. Using a Television

Some smaller microcomputer systems can be used with a standard television. The basic difference between a monitor and a television set is that the resolution of a television is substantially less than that with a monitor. Also the television requires the use of a modulator to interface the computer output with the television. The modulator combines the separate audio and visual signals sent by the microcomputer into a single modulated signal as required by a television. Most inexpensive computer systems designed for use with a television set generally have a built-in modulator with a standard television. The basic difference between a monitor and television set is that the resolution of a television is substantially less as television set generally have a built-in modulator.
3.6. Exercise

3.6.1. Multiple choice questions

a. CRT monitors produce image by
   i) Laser beam
   ii) Electron beam
   iii) Light beam
   iv) Ink jet.

b. Each color pixel contains how many fundamental colors?
   i) 1
   ii) 2
   iii) 3
   iv) 4.

c. Greatest resolution monitor is
   i) CGA
   ii) EGA
   iii) VGA
   iv) SVGA.

d. Monitor image is refreshed at least
   i) 1 times/sec
   ii) 50 times/sec
   iii) 60 times/sec
   iv) 100 times/sec.

3.6.2. Questions for short answers

a) What is raster scan?
b) What is the basic difference between a monitor and a television?

3.6.3. Analytical questions

a) How does a monitor works?
b) How does a television can be used as a monitor?
Lesson 4 : Printer

4.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Different types of printers
- Working principle of different types of printers.

4.2. Introduction

The printer is the most common output device. It produces permanent visual record of the data output from a computer. It is capable of producing business reports and documents currently available. Printers are capable of printing from 150 to over 20,000 lines per minute, with each line having up to 150 characters. Thus, a maximum printing speeds of approximately 50,000 characters per second is possible.

Printers print on plain paper or on specially prepared single-or multiple copy forms, such as invoices, stationery, labels, checks, bills and other special-purpose forms used in business and industry. They can print both text and graphics in black and white or in color.

Printers can be subdivided into two broad categories, impact and non-impact.

4.3. Impact Printers

In impact printers, printing occurs as a result of a hammer striking a character form and the character form in turn striking an inked ribbon, causing the ribbon to press an image of the character on paper.

Character printer devices print one character at a time at speeds of about 10 to 500 characters per second. The fastest of these printers is the wire or dot matrix printer. It prints characters made up of a pattern of dots formed by the ends of small wires. By extending certain wires beyond the others, a dot pattern can be created that gives the appearance of numbers, letters or special characters.

These extended wires are pressed against an inked ribbon to print the characters on the paper. Some slower and less expensive matrix printers print a character as a series of columns each one
Microcomputer Troubleshooting

dot wide. It can be used to print special character shapes that can be used with graphics.

For a typewriter-quality output, a special dot matrix or daisy metal print element, similar in appearance to the arrangement of petals on a daisy flower. This element is rotated until the correct character is in position, and then pressed against an inked ribbon. The process is repeated for each character to be printed on a line. Typical for such printers range from 25 to 100 characters per second.

Impact character printers are the common output devices used with personal and small business microcomputer systems. They are significantly cheaper than the line printers.

Impact line printers, capable of printing a whole line at a time, employ print wheels or a moving chain or drum. The print-wheel printer consists of print wheels, each containing a full complement of digits and alphabetic characters in addition to a set of special characters. For printing, all print wheels are positioned to represent the data to be printed on one line. They then impact simultaneously at a speed of about 150 lines per minute.

Impact line printers and the chain and drum printers are commonly used. As the print chain or drum revolves, each character is printed as it comes into position. Up to 150 characters per line can be printed at speeds of up to 2,500 lines per minute. Impact line printers are used almost exclusively to support larger computer systems.

4.4. Non Impact Printers

Non impact line printers using laser, xerographic, electrostatic, or ink jet methods are the fastest printers. Before the development of the ink jet and laser printers, non impact were not heavily used, for several reasons:

♦ Special and more expensive paper was required.
♦ Printed output was not as sharp or as clear as with impact printers.
♦ Only a single-part form can be printed at a time.
♦ Output could not be easily or satisfactorily copied on office copiers.

Electrostatic and xerographic printers place a pattern of the desired character on sensitized paper by means of an electric current or beam of light. The paper then passes through a powdery black substance called toner, which contains dry ink.
Secondary Devices

particles. The ink particles are attracted to the exposed paper and the character becomes visible. These printers can print at speeds of from 3500 to 20,000 lines per minute.

The laser printer form characters by projecting a laser beam of dot matrix pattern on a drum surface. Toner is then attracted to the area exposed by the laser and transferred to the paper. The paper is then passed over a heating element, which melts the toner to form a permanent character.

Many types of ink jet printers are available. The simplest of these contains a series of ink jet nozzles in the form of a matrix. Vibrating crystals force ink droplets, roughly the diameter of a human hair, from selected nozzles to form an image in the same manner as an image is formed by a matrix printer. Different colored inks may be used and combined to form additional colors.

Several hundred nozzles are employed in the more sophisticated ink jet printers to direct a continuous stream of droplets across the page to form an image. These charged ink droplets travel at speeds of up to 40 miles per hour as they move between a set of plates that deflect the droplets. Droplets not needed are attracted away by electrostatic charge from the paper for reuse. A stream of more than 100,000 droplets can form approximately 200 characters per second.
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4.5. Exercise

4.5.1. Multiple choice questions

a. The maximum printing speed by printers is
   i) 150 characters per second
   ii) 20,000 characters per second
   iii) 50,000 characters per second
   iv) 50,000 characters per minute.

b. Ink jet printer is a
   i) Impact printer
   ii) Non impact printer
   iii) Dot-matrix printer
   iv) Laser printer.

c. Before the development of the ink jet and laser printers, non impact were not heavily used because
   i) Non-impact printer technology was not available
   ii) The price of non impact printer was high
   iii) Special and more expensive paper was required
   iv) The made too much noise.

4.5.2. Questions for short answers

a) Discuss the how impact printers work.
b) Write the name of different not impact printers.

4.5.3. Analytical questions

a) What is printer? What are the different types of printers?
b) Discuss about the working principle of different types of printers?
Lesson 5 : Other Output Devices

5.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Different types of flat-panel displays
- Plotters
- Microfilm devices.

5.2. Introduction

Output devices give output from the computer to the external world. Different output devices are:

- Monitor
- Printer
- Flat-panel Display
- Plotter
- Microfilm devices etc.

Of them monitor and printer are discussed in previous lessons. Flat-panel display, plotter and microfilm devices are discussed in this lesson.

5.3. Flat-Panel Displays

For laptop computers more compact, low power, durable monitors are used. A number of flat-panel display technologies are available for this. Of them the plasma and liquid crystal displays are most common.

5.3.1. Plasma Displays

A plasma display consists of ionized neon or argon gas (plasma) sealed between two glass-plates. One plate encases a set of fine horizontal wires and the other a set of vertical wires. Pixels are formed by the intersections of the horizontal and vertical wires. Sending a current through its horizontal and vertical wires can turn on a single pixel. This causes the gas between the wires to produce an amber glow. The images produced by plasma displays are generally very clear, and not subject to the flicker. Plasma displays are generally more expensive than the CRT displays.
5.3.2. Liquid Crystal Displays

Liquid crystal displays (LCD’s) have been used for several years in calculators and digital watches. A thin layer of a liquid crystal substance is suspended between two thin sheets of polarized glass and separated by a wire grid into tiny squares. As current is applied to the wires the liquid crystal substance within the square changes from clear to opaque or black. The thousands of clear and black squares produce patterns of characters.

The disadvantage of LCD displays is lack of brightness and resolution as compared to CRT and plasma displays. The quality of the LCD display depends on the surrounding light and the viewing angle. It is sharpest and clearest when viewed in brightness from the front.

5.4. Plotter

An inexpensive portable plotter capable of generating multicolor plots from data is stored on magnetic tape or disk. Plotters with multicolor capabilities generally use a writing mechanism containing several pens, each capable of producing a different color. Some devices for automated drafting are equipped with plotting surfaces larger than 10 square feet and cost as much as a minicomputer system.

Whether an application is a general one (such as designing, mapping, or plotting schematics) or more specialized (such as three-dimensional data presentation, structural analysis, contouring, or business charts), there are plotters to do the tricks.

5.5. Microfilm Device

Computer output microfilm (COM) devices convert computer output to a human-readable form, stored on rolls of microfilm or as microfilm frames stored on cards called microfilm. At speeds of 10,000 to over 30,000 lines per minute, COM is one of the fastest computer output-techniques. It is more than ten times faster than the fastest impact printer is. A single roll of microfilm can store approximately 2000 frames and costs less than half the cost to print the same amount of data on paper.

Because of the high cost of COM equipment, it is generally only practical for larger businesses or industries generating approximately several thousand documents per day. COM devices are commonly used in libraries, mail-order concerns, defense installations, government agencies, and similar, large operations.
Secondary Devices

5.6. Exercise

5.6.1. Multiple choice questions

a. LCD is a type of
   i) Printer
   ii) Plotter
   iii) Display
   iv) Input device.

b. The disadvantage of LCD display is
   i) High cost
   ii) High power consumption
   iii) Low brightness
   iv) High weight.

5.6.2. Questions for short answers

a) How plasma displays work?
b) What are the limitations of micro-film devices?
Lesson 6 : Floppy Disk Drive

6.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Components of a floppy subsystem
- Working principle of a floppy disk drive.

6.2. Floppy Subsystem

Floppy subsystem is a component of microcomputer system. It has the following components:

- Floppy diskette
- Floppy drive
- Disk controller
- Cable.

6.3. Floppy Disk

The floppy disk is a round plastic disk with iron oxide coating on it. Data is stored in iron oxide coating.

The round disk is stored in a semi-rigid square-sized plastic casing. The casing works as the disk washer. Its inside is lined with a fleecy material. Dust is carried inside the casing and on the disk. When the disk rotates, the fleecy material inside the casing picks up the dust. Thus it works as disk washer.

There is one hole on the plastic casing so that data can be accessed (read or write) from the disk without removing the case.

The casing also has another hole for write protection. If the hole is covered, then write is enabled (i.e., data in disk can be modified), if the hole open then no data can be written.

If the disk has iron oxide coating on both sides, then it can store data on both sides. This type of disks are called ‘Double Sided’ (DS) disks. Similarly if data is stored in double density then normal, then it is called ‘Double Density’ (DD) disk. In a ‘High Density’ (HD) disk the density of data is double than DD disks.

For microcomputers normally two size of floppy disks are available: 3½ inch and 5¼ inch. Among all of these variations, the most popular diskette today is the 3½ inch double-sided high-density disk with data storing capability of 1.44 MB.
Secondary Devices

Structure of the round disk:

- A floppy disk consists of many concentric circles called tracks.
- A track is divided in many semicircles called sectors.
- A sector has many bytes.
- A byte has eight bits.
- Data is stored in Bits.

![Fig. 6.1: Tracks in a floppy disk.](image)

6.4. Floppy Disk Drive

The floppy drive contains the mechanism to rotate the disk inside the case and read/write data on it. The disk is inserted in the drive and then the drive performs these functions.

Data is read or written on the disk by disk head. For the double-sided disks today, the drive contains two heads one for each side.

Two stepper motors control the drive mechanism one rotates the motor and another moves the head from track to track. For example, to read data from sector-3 of track-2 of side-1 the following jobs are performed:

- The head is moved on track-2 by one stepper motor.
- The disk is rotated by another stepper motor, so that the sector-3 comes under the head.
- Head of side-1 reads data from the disk.

The drive has a light. The light glows when one of the following things occur:

- The drive reads data form the disk.
- The drive writes data on the disk.
- The cabling connection of the disk is not proper.

The floppy disk drive has two connection points for cable:

- One connection point has four pins. The power supply cable is connected here.
Another connection point has 34 pins. The flat cable that connects the ‘floppy disk drive’ with the ‘floppy disk controller’ is connected here.

6.5. Disk Controller

Disk controller contains the circuitry to control the floppy disk drive.

- In XT type computers the floppy disk controller is built in a separate card called ‘floppy disk controller card’ which is inserted in the expansion slot of the motherboard.

- In AT type computers, the floppy and the hard disk controllers are built in a single card called ‘disk controller card’. It is also inserted in the expansion slot of the motherboard.

- In the PS/2 type computers and nowadays in the clones the disk controller circuitry is built in the motherboard.

Fig. 6.2: Floppy controller board (XT type).

6.6. Cable

The cable connects the floppy disk drive(s) with the controller. It has normally 3 edge connectors to connect the following devices:

- The floppy drive ‘A:’
- The floppy drive ‘B:’
Secondary Devices

♦ The floppy-drive controller (i.e., today the motherboard).

It is a 34-wire flat cable. One of the wires is marked with dark (red or black) color. It is the wire number-1. The cable has a twist in one end. This end is connected with the floppy drive, which we want to use as drive ‘A’:

![Floppy cable with twist for A: drive.](image)

Fig. 6.3: Floppy cable with twist for A: drive.

6.7. **Exercise**

6.7.1. **Multiple choice questions**

a. A floppy disk drive is connected with

i) 1 cable  
ii) 2 cables  
iii) 3 cables  
iv) 4 cables.

b. The twisted end of cable is connected with

i) Drive A:  
ii) Drive B:  
iii) Drive C:  
iv) Motherboard.

c. The wire-1 on data cable is identified by

i) A dark line  
ii) A twist  
iii) Thickness  
iv) Edge connectors.
Microcomputer Troubleshooting

d. Nowadays in the clones the disk controller circuitry is built in
   i) The disk controller card
   ii) The motherboard.
   iii) The floppy disk drive
   iv) The processor.

6.7.2. Questions for short answers

a) How data in floppy disk is organized?
b) When the floppy drive light glows continuously?
c) Where is the floppy disk drive controller located?

6.7.3. Analytical question

a) Discuss about the components of a floppy subsystem.
Lesson 7 : Hard Disk Drive

7.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Components of a hard disk drive
- Working principle of hard disk drive.

7.2. Hard Disk Drive

Hard disk drive is used to store data and programs. It is one kind of memory. But the information stored in it doesn’t vanish when the computer is off.

7.3. Structure of Hard Disk

- A hard disk consists of many round shape disks called platters.
- A platter consists of many concentric circles called tracks.
- A track is divided in many semicircles called sectors.
- A sector has many bytes.
- A byte has eight bits.
- Data is stored in Bits.

The outer most track is numbered as track-0. On an 80 track platter the inner most track is numbered as track-79. In the figure each of the three platters has a track-0. If we combine all the track-0 of three platters in parallel then it forms a cylinder. The cylinder formed by combining all track-0s is called cylinder-0. Similarly the cylinder formed by combining all track-1s is called cylinder-1.
Heads are used to store and read data from disks. If data is stored on both sides of a platter then two heads are needed for a platter. If there are 3 disks then 6 platters and so on. Heads move from track to track and read data. But all the heads in a hard disk move jointly. That means, if head of first platter is at track-0, then all the other heads are also on track-0 on other platters. Thus all the heads are on cylinder-0. In such a way heads move from cylinder to cylinder.

Fig. 7.2: The relationship between tracks and cylinders.

Fig. 7.3: Tracks and sectors on a platter.
Secondary Devices

The hard disk is continuously rotating. To read data from sector-1 of track-2 of disk-3, at first the head moves to cylinder-2. Thus it comes on track-2. By rotating disk, when the sector-1 comes under the head then the head of disk-3 reads data from sector-1 of track-2 of disk-3.

All the mechanism with disks and heads are sealed in a vacuum casing.

![Reading a particular sector involves two steps](image)

*First, move the head to the desired track.*
*That is called a seek.*

*Then, once the head is over that track, wait for the sector to spin under the head.*
*The wait is called the latency period.*

Fig. 7.4: Reading a sector on a disk.

7.4. Hard Disk Controller

The movement of disks and heads and the transfer of data between computer and hard disk are controlled by a circuitry called hard disk controller. The computer orders everything to the controller and the rest of the controlling is just the controller's headache.

In the older computers the hard disk controller was built in a separate circuit board called disk controller card or I/O card. Nowadays, the hard disk controller is built in the drive itself. The motherboard is connected with the controller by a cable.

To get or store any data in a hard disk, the processor orders the controller. Then the controller supplies the data and controls the hard disk through the cable and the hard disk does the work as ordered.

*The movement of disks and heads and the transfer of data between computer and hard disk are controlled by a circuitry called hard disk controller.*
7.5. Exercise

7.5.1. Multiple choice questions

a. A sector consists of many
   i) Hard disks
   ii) Platters
   iii) Tracks
   iv) Bytes.

b. The cylinder-5 is formed by combining all
   i) Sector-5
   ii) Platter-5
   iii) Track-5
   iv) Track-0.

c. The hard disk rotates
   i) Only when data is read
   ii) Only when data is written
   iii) Always when the hard disk power is on
   iv) Always even the hard disk power is off.

d. All the mechanism with disks and heads are sealed
   i) With air
   ii) With oil
   iii) With water
   iv) In a vacuum casing.

7.5.2. Questions for short answers

a) How does data is written in sector-3 of track-2 of disk-1?
b) How data is organized in the hard disk?

7.5.3. Analytical question

a) Discuss the construction and working principle of hard disk.
Lesson 8 : Hard Disk Drive Interface

8.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ What is hard disk drive interface
♦ Different types of hard disk drive interface.

8.2. Introduction to Drive Interface

Drive interface is the world wide predefined standard by which a controller can talk to its drive. This standard defines the cable and connectors between the controller and the hard disk and the language by which they talk together.

We can get controllers from different industries and also hard disk drives from different industries. But there is no problem because of the interface. For example, if we connect the controller of one industry having IDE interface with a hard disk drive of another industry having IDE interface, they can work together because the interface (i.e., the language) between them is the same.

Different drive interfaces are available. We have discussed here some common interfaces like ST506, ESDI, SCSI and IDE.

8.3. ST506

Here ‘ST’ stands for ‘Shugart Technologies’ because this interface is first defined by this industry. It has the following characteristics:

♦ A 20 wire cable for data signals
♦ Another 30-wire cable for control signals.
♦ 5 Mbps (Meg bit per second) data transmission rate
♦ Supports up to 16 head disks
♦ Short cable length
♦ Prone to noise
♦ Slower controlling method than other interfaces
♦ Can not send drive information (how many platters, tracks etc.) to the controller.
♦ Used in old models of computers.

8.4. ESDI

It is an advanced design of ST506. Some problems of ST506 interface are removed in this modified design. It has the following characteristics:
Microcomputer Troubleshooting

- Cabling same as ST506 (20-wires data and 34-wires control).
- Supports up to 256 head
- 24 Mbps data transfer rate.
- Allows longer cables
- More noise free
- Can send drive information (how many platters, tracks etc.) to the controller.

8.5. SCSI

SCSI stands for Small Computer System Interface. SCSI is pronounced as “scuzzy”. It has the following characteristics:

- SCSI Supports
  - CD-ROM drive
  - WORM (Write Once, Read Many times) optical disks
  - Optical scanners
  - 21 MB+ ‘super’ floppies
  - Bernoulli Box cartridge storage devices
  - Various tape drives

- Up to 7 devices can be connected with the cable
- The newest SCSI standard, SCSI-3, supports 24 MB/s (Mega Byte per second) data transfer rate
- Drive controllers are located with respective drives and another special controller connected with the motherboard called the host adapter controls all the controllers in drives.

8.6. IDE

IDE stands for Integrated Drive Electronics. It is also a modified version of ST506. To get a more reliable but cheaper interface technology, IDE is designed. It has the following characteristics:

- Controller is not connected with the drive by a cable but it is just put on to the drive.
- IDE cable is 40 wire.
- IDE cable runs directly to PC bus, but it is not directly connected to the PC bus. A buffer exists between the PC bus and the 40-pin cable connector.

8.7. EIDE

EIDE stands for Enhanced IDE. It is designed by Western Digital. It has the following characteristics:

- Similar to IDE, the controller is built in the drive.
Secondary Devices

- It supports LBA translation, which supports drives larger than 504 MB. It allows the BIOS to support drives up to 8 GB.
- EIDE offers higher data transfer rate.
- Supports CD-ROM and tape drives.
- EIDE is the most popular drive interface today.

8.8. Exercise

8.8.1. Multiple choice question

a. LBA translation allows the BIOS to support drives up to

i) 504 MB
ii) 2.1 GB
iii) 8 GB
iv) 20 GB.

8.8.2. Questions for short answer

a) What is the difference between IDE and EIDE interface?

8.8.3. Analytical question

a) Write the characteristics of different hard disk drive interface.
Lesson 9: Power Supply Unit

9.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ Different types of power supply
♦ Power supply connections.

9.2. Introduction

Personal computers (at least, desktop PCs) don't come with batteries included. You plug them into the wall socket and they work. The PC itself does not directly use wall current, as this is 220-240 volt alternating current. The PC doesn't need AC; it needs DC, usually 3.3 or 5 volts for its chips, 12 volts for the motors on older drives–newer drive motors run off 5 volts.

Anyway, I just said that the PC uses DC, but the wall sockets provide AC power. How does the PC convert the power? The power supply actually doesn't supply power—it converts it from AC to DC.

9.3. Types of Power Supply

There are two kinds of power supplies, linear power supplies and switching power supplies. The PC's power supply is, in every PC I've ever seen, a switching power supply. Both linear and switching power supplies have their positive and negative aspects.

9.3.1. Linear Power Supply

Linear power supplies are based on transformers. That makes them hot, heavy and impervious to changes in current levels, while rendering them vulnerable to voltage swings. Linear power supplies are an older design than switching power supplies and you still find them on monitors and some external drive cases. Even small linear power supplies generate a relatively large amount of heat, which is why you should never cover the holes atop a monitor; you can fry a monitor quickly that way.

9.3.2. Switch Mode Power Supply

Switching power supplies are digital in nature. They step down voltage by essentially "switching" it on and off, hence their name. Think of how they work in this way: suppose you had a 1000-watt bulb in a light, but you only wanted the lighting value of a 100-watt
Secondary Devices

bulb. You could get 100 watts' worth out of the 1000-watt bulb by switching it on and off, but leaving it off 90 percent of the time. I know it sounds goofy, but if you could switch the light on and off quickly enough, then you'd never see it flicker. (In fact, that's how fluorescent lights work. They're actually very bright, but they flash off and on 60 times per second, too quickly for most eyes to register and they're off over 90 percent of the time.)

Switching power supplies are less sensitive to fluctuations in input voltage, although they are still a problem. These power supplies generate heat, but a lot less of it than linear power supplies.

9.4. Power Supply Connections

On the side of the power supply is the on/off switch for the computer. Sprouting out of the other side are the power connectors. Most power supplies have two connectors that are sometimes labeled P8 and P9 that connect to the motherboard; other nonstandard power supplies use a single connector.

Looking at P8 connected to P9, you might wonder just why IBM designed a power supply interface to the motherboard that can so easily cause troubles; after all, if you reverse P8 and P9, as some of my friends have done in the past, then you irreparably smoke the motherboard. Why didn't IBM use a single larger connector?

Oddly enough, IBM did; the first prototype PC-which never saw production had a single large connector from the power supply to the motherboard. But, in the final days of setting up the new microcomputer for production, the company supplying the connectors went out of business, and the only way to not get behind was to just use two connectors that were readily available from another vendor. Since then, some other companies have gone to a single-connector design, but that hasn't become part of the de facto PC standard, sadly.

Power supplies also sport from two to four identical Molex connectors for attaching to drives (hard disks, floppy disks, and tape drives), and most modern power supplies also include the smaller Berg connectors used to power 3.5-inch floppy drives.

The motherboard receives power through the power strip in the northeastern corner of the board. (This assumes that you are looking at the board so that the memory chips are closest to you and the expansion connectors and the keyboard connector are farthest from you.)
P8 has only five wires, and connects above P9, which has six wires. See Figure 9.1 for a detail of an 8088 motherboard; it’s the same for even the newest Pentium Pro clone motherboard.

The power supply lines – the yellow, blue, and red wires – can be tested against a ground – any of the black wires. If you are actually testing a power supply, all of the black wires should be tested. Table 9.1 gives the specifications for these lines.

Table 9.1: Specifications for PC Power Supply Output

<table>
<thead>
<tr>
<th>Wire Color</th>
<th>Rated Voltage (Volts)</th>
<th>Acceptable Range (Volts)</th>
<th>Current Range (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>yellow</td>
<td>+12</td>
<td>+8.5 – +12.6</td>
<td>0.0 – 2.00</td>
</tr>
<tr>
<td>Blue</td>
<td>2</td>
<td>-8.5 – -12.6</td>
<td>0.0 – 0.25</td>
</tr>
<tr>
<td>Red</td>
<td>+5</td>
<td>+2.4 – +4.2</td>
<td>2.3 – 7.00</td>
</tr>
<tr>
<td>yellow</td>
<td>-5</td>
<td>-4.5 – -5.4</td>
<td>0.0 – 0.30</td>
</tr>
</tbody>
</table>

Fig. 9.1: Power supply connection with the motherboard.
9.5. Exercise

9.5.1. Multiple choice question

a) The power supply unit
   i) Generates power
   ii) Consumes power
   iii) Stores power
   iv) Translates power.

9.5.1. Analytical question

a) Discuss about the power supply connection with the motherboard.
Unit 3 : Controller Devices

Unit 3 contains the discussion about controller devices. These devices exist between main devices and secondary devices. They work as a bridge. They are used to decrease the workload from the CPU. Unit 3 contains the following lessons:

Lesson 1 and 2 contains the discussion about some controller hardware. Lesson 3 to 5 gives an overview of the system software. System software is the software that binds all hardware components together. It controls all controller hardware and application software.

Lesson 1: Video and Graphics Adapter

1.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ What is a microcomputer
♦ Different types of microcomputer.

1.2. Introduction

The PC, like most computers, uses video cathode ray tube (CRT) technology to display information for user reception. To allow the computer to communicate with a display monitor, a display adapter must be inserted in one of the PC’s expansion slots.

1.3. Different Types of Display Adapter

The basic kind of video board you find in the PC world today is called the Video Graphics Array, or VGA. It can display information in a text-only form, or in a graphical form.

For years, graphical standards were created by IBM, video boards with names like MDA, CGA, PGA, 8514, EGA, and VGA.

But the lack of industry centralization has left us with no new standards; instead, there are a lot of video boards that exceed the capabilities of VGA boards, generically called "super VGA" boards. Even though they’re all lumped under the name "super VGA," they’re all different. despite their variation.
1.4. How the Display Adapter Works

Video boards all have several distinct components. The video board contains video memory as you learned earlier in the discussion on memory. The CPU places the video image into the video memory. A video chip on the video board then examines the data in the video memory and creates a digital image signal. That digital signal is then converted to an analog signal by a chip called the DAC, the Digital-to-Analog Converter, another chip on the video board, and the resultant signal goes out the connector on the back of the board, and into your monitor.

Fig. 1.1: Display Adapter Components.

<table>
<thead>
<tr>
<th>Board Type</th>
<th>Resolutions Supported</th>
<th>Colors Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color Graphics Array (CGA)</td>
<td>320 x 200</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>640 x 200</td>
<td>2</td>
</tr>
<tr>
<td>Enhanced Graphics Array (EGA)</td>
<td>CGA resolutions</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>640 x 350</td>
<td></td>
</tr>
<tr>
<td>Video Graphics Array (VGA)</td>
<td>CGA and EGA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>320 x 200</td>
<td>256</td>
</tr>
<tr>
<td></td>
<td>640 x 480</td>
<td>16</td>
</tr>
</tbody>
</table>
Controller Devices

<table>
<thead>
<tr>
<th>Super VGA</th>
<th>CGA, EGA, VGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>640 x 480,</td>
<td>256, 32K 64K or</td>
</tr>
<tr>
<td>800 x 600,</td>
<td>16 million</td>
</tr>
<tr>
<td>1024 x 768,</td>
<td></td>
</tr>
<tr>
<td>1280 x 1024</td>
<td></td>
</tr>
</tbody>
</table>

Table 1.1: Video Board Resolutions.

1.5. Properties of Display Adapter

Video boards are distinguished by their resolution, which is the number of dots (pixels) that they can put on the video screen. More dots means sharper pictures. They're also distinguished by how many different colors they can display on those dots, and by how much work the CPU must do in order to create images.

On most video boards, the CPU must do all of the work of picture creation; it has to place each and every one of the pixels on the computer's screen. But some video boards contain special circuitry called accelerator chips that can speed up video operations considerably.

Table 1.1 shows a summary of resolutions available for common video boards throughout PC history.

1.6. Exercise

1.6.1. Multiple choice question

a. VGA mode supports resolution

i) 640 × 350
ii) 1024 × 768
iii) 640 × 480
iv) 640 × 480

1.6.2. Questions for short answers

a) How a display adapter works?
b) What are the properties of a display adapter?
Lesson 2 : Special System Support Chips

2.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Clock generator and driver (8284)
- Interrupt Controller (8259)
- Peripheral Interface Adapter (8255)
- Timer (8253)
- Floppy Disk Controller Chip (8272).

2.2. Introduction

These devices are used to support the microprocessor. In older computers each of these devices are built in discrete chips but in modern computers, they are combined in one or two chips.

2.3. Clock Generator and Driver (8284)

This IC is used to supply clock pulses to the 8088 processor. In 80186 it is built into the processor itself. It is practically an oscillator. It gets the oscillating input from a crystal or RC oscillator circuit and converts this oscillating input to a rectangular continuous pulse train of 0V and 5V.

2.4. Interrupt Controller (8259)

The CPU is connected with different controller devices like floppy disk drive controller, display controller, keyboard controller etc. These devices ask the service from the CPU by using interrupt pins on the CPU.

Each controller connected with the CPU requires at least one interrupt pin of the CPU; but the CPU has limited number of interrupt pins. To solve this problem interrupt controller is used. It expands the interrupt pins of the CPU. For example the 8259 interrupt controller expands one interrupt pin of the 8088 CPU to 8-64 interrupt pins, each of which can be connected with a separate controller. Interrupt controller is also used to reduce working load of the CPU dealing interrupts.

2.5. Peripheral Interface Adapter (8255)

Peripheral interface adapters are used to make a interface between the CPU and the peripheral devices. It is also known as I/O (Input / output) port. Because the CPU uses these devices to
Controller Devices

get input or give output to the external devices like printer, modem, mouse etc.

For example the Intel 8255A is a general-purpose programmable I/O device designed to use with Intel microprocessors. It has 24 I/O pins, which can be individually programmed in groups of individual sizes.

2.6. Timer (8253)

You may have noticed that when the computer is off, its time counting is not off. The timer IC does this operation. It keeps the timing information of the computer continuously even if the computer is off. It is battery operated when the computer is off. It has several counters, which counts the clock pulses generated by an external oscillator. As this timer IC is connected with the CPU through the data bus so the CPU can collect the counted value of clock pulses from the IC and convert the clock pulse count to seconds and minutes.

The Intel 8253 is programmable counter/timer device designed for use as an Intel microcomputer peripheral. It is organized as 3 independent 16-bit counters, each with a count rate of up to 2.6 MHz.

2.7. Floppy Disk Controller Chip (8272)

Whenever a computer wants to interface with an outside device, it needs a controller board to act as a “go-between” to allow the outside device—a floppy, in this case—to talk with the CPU. XT-type machines generally had a separate controller board. AT-type machines usually put the floppy and hard disk controller function on the same board. Some motherboards (PS/2s, in particular) put the floppy controller function right on the motherboard.

On most modern clones, the floppy controller is integrated on a single add-in card that serves as floppy controller, dual serial port, parallel port, joystick interface, and IDE host adapter.

Whether your floppy controller is a separate board, part of the floppy/hard disk controller, or integrated into the motherboard, the main chip on a floppy controller board is probably the Zilog 765, NEC 765, or Intel 8272.
2.8. Exercise

2.8.1. Multiple choice question

a. The IC used peripheral interface adapter is

i) 8259
ii) 8255
iii) 8253
iv) 8272.

2.8.2. Questions for short answers

a) What is the function of the timer?
b) Give some example of floppy disk controller IC.
Lesson 3: How the System Works

3.1. Learning Objectives

On completion of this lesson you will be able to describe:

- What is system software
- An overview of the booting process
- Different types of boot (cold & warm).

3.2. System Software

System software is the program that controls different devices in the microcomputer. System software has the following components:

- Monitor program or BIOS: The program used to control the basic functions of different devices.
- Operating system: The software responsible for allocating system resources, including memory, processor times, disk space, and peripheral devices such as printers, modems, and the monitor.

3.3. An Overview of the Booting Process

Booting means loading operating system in the memory by the PC itself. Basically, a PC does three things when it boots.

- First, the hardware must work.
- Second, the processor starts up and runs a program in the BIOS called the ‘Power on Self Test.’
- Third, BIOS loads the operating system on the active partition.

Then, assuming that the basic hardware can function, you’ll recall that each PC has a set of software built into a ROM, called the Basic Input Output System, or BIOS. That BIOS is a collection of important programs, programs to control the video board, the disk controller, the keyboard, and the system clock, just to name a few, but perhaps the most important of those programs that starts up the PC.

That program determines what hardware is in the system, does a basic checkout of that hardware, and senses the presence of BIOS-like programs associated with expansion boards in the PC. If those programs exist on the expansion boards, the BIOS will yield control to them so that they can do the initialization.
Once the BIOS startup and checks work out all right, the BIOS then attempts to load the system software from the floppy or hard disk. Once the operating system gets loaded from disk into the computer’s RAM, the BIOS passes control to the operating system, and the computer is ready to use.

3.4. Different Types of Boot

Depending on the boot starting time there are two types of boot:

3.4.1. Cold Boot

Cold boot is the computer startup process that begins when you turn on power to the computer. A cold boot might be needed if a program or the operating system crashes in such a way that you could not continue. If operations are interrupted in a minor way, a warm boot may suffice.

3.4.2. Warm Boot

A reboot performed after the operating system starts running. Warm boot is performed for minor problems such as application execution error. For warm boot memory checking and several other booting operations are not necessary.

3.5. Exercise

3.5.1. Multiple choice question

a. Booting means

i) Shut down the computer
ii) Running application programs
iii) Starting the computer
iv) Loading the operating system in memory.

3.5.2. Questions for short answers

a) What does PC do when it boots?
b) What are the components of system software?

3.5.3. Analytical question

a) What is the difference between cold and warm boot?
Lesson 4: Monitor Program

4.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Monitor program or BIOS
- Different types of BIOS
- Function of BIOS
- How the BIOS works

4.2. Monitor Program in Microcomputer

Monitor program is the program that is used to control the basic functions of different devices. In microcomputers the monitor program is known as BIOS.

BIOS is the acronym for 'Basic Input / Output System' in the PC, a set of instructions, stored in read-only memory (ROM), that let your computer's hardware and operating system communicate with application programs and peripheral devices such as hard disks, printers and video adapters. These instructions are stored in non-volatile memory as a permanent part of your computer. They are always available at specific addresses in memory, so all programs can access them to perform their basic input and output functions.

4.3. Different BIOS Manufacturers

IBM computers contain a copyrighted BIOS that only their computers can use; however, other companies such as Phoenix, Award, and American Megatrends have developed BIOS for other manufacturer's computers that emulate or mimic the IBM instructions without using the same code. If you use a non-IBM computer, the BIOS company's copyright message and BIOS version number are displayed every time you turn on your computer.

4.4. BIOS Extensions

BIOS extensions in the PC are extensions to the main BIOS that enable the computer to work with add-on devices such as hard disk controllers and EGA or VGA adapters. The ROM chips containing these extensions do not have to be located on the motherboard; they can also be on expansion boards plugged into the expansion bus. Any BIOS extensions needed to run these
expansion boards are loaded automatically when you boot your computer.

4.5. BIOS Initialization Process

There are five steps to the BIOS initialization process:

- Test some low memory.
- Scan for other BIOS.
- Yield to other BIOS.
- Inventory the system.
- Test the system.

4.5.1. Test Low Memory

In order for the BIOS to function, it needs some RAM to work with. So for most BIOS, one of the first things that get done is to test the bottom part of the system's RAM. Now, if that test crashes, then most BIOS can't recover.

4.5.2. Scan for Other BIOS

The BIOS in your PC can't support every possible piece of hardware-LAN boards, unusual video boards, you name it—and so the important functions of inventory and initialization have to go somewhere else. That is why many add-on boards have some ROM on them, as you may have noticed when installing boards. What you may not know is that those ROM contain some initialization code for those boards. For example, a hard disk controller ROM might do a quick read of the hard disk—kind of an "are you there?" test. A video board might test the memory on the video board.

The main system BIOS allows the add-on boards to do their inventory and initialization first. Now, before that can happen, the main system BIOS must find those BIOS.

4.5.3. Yield to Other BIOS

Once it has found BIOS on the add-on board, the main system BIOS passes control to that BIOS so that it can do whatever inventory and initialization the add-on BIOS requires.

The main system BIOS allows every add-on card's BIOS to initialize itself before doing its own inventory and initialization. Notice what that means: the software contained in the ROM on an add-in board gets to run before the system BIOS, and it also runs certainly before DOS gets loaded—we haven't gotten near to

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loading DOS yet. For an example, consider a VGA board. It has a BIOS chip on it, one that contains a setup routine. That setup routine announces that the board is up and ready by putting a copyright notice on the screen.

4.5.4. Inventory and Test the System

Once all of the add-in ROMs have gotten their time, and assuming that their programs ran properly and returned control to the main system BIOS, then the main system BIOS will now inventory the items that it will control, items that will vary from system to system. At minimum, one of the items that the system BIOS must inventory and initialize is the system memory. What does "inventory and initialize" mean here? You have seen at least one example of it - the memory test. Ever notice the quick flash of the drive lights on the floppy and hard disk drives? That's the inventorying of the storage devices.

4.5.5. Loading the Operating System

After the BIOS initialization process the microcomputer system is prepared to load the operating system. At first the BIOS loads a portion of the operating system then this loaded potion of operating system starts loading its remaining portion.

4.6. Exercise

4.6.1. Multiple choice question

a. BIOS is stored in

i) RAM
ii) Hard disk
iii) ROM
iv) Floppy disk.

4.6.2. Questions for short answers

a) What is BIOS extension? Where it is stored?
b) When does the operating system starts loading?

4.6.3. Analytical question

a) Describe the BIOS initialization process.
Microcomputer Troubleshooting

Lesson 5: Operating System

5.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ Operating system and its function
♦ Some popular operating systems.

5.2. Introduction

Operating system is the software that is responsible for allocating system resources, including memory, processor time, disk space, and peripheral devices such as printers, modems, and the monitor. All application programs use the operating system to gain access to these system resources, as they are needed. The operating system is the first program loaded into the computer as it boots, and it remains in memory at all times thereafter.

5.3. Some Popular Operating Systems

Popular PC operating systems include MS-DOS, Microsoft Windows, and Unix.

5.3.1. MS-DOS

MS-DOS developed by Microsoft Corporation became the de facto standard for machines designed with Intel processors. IBM selected MS-DOS for its PC's. This established the popularity of MS-DOS.

DOS is helpful to organize disks and use them efficiently. It helps to create and manage files on disks, make copies of them or remove unwanted files from the disks.

MS-DOS 5.0 comes equipped with a graphical user interface (GUI) called the DOS Shell. This interface helps the user with everyday tasks such as starting a program or formatting a floppy disk. With the GUI the desired task can be easily selected and started with the mouse by just pointing to the item on the screen and clicking the mouse button.

The DOS shell also provides an overview of the contents of the hard disk and floppy disk any time. Several programs can be started at once but only single program runs at a time, the others are suspended.
5.3.2. Windows

At first Microsoft Windows was an extension to the DOS operating system but now it can run without DOS. It is a graphical user interface whose features extend far beyond those of the DOS Shell. Several million copies of Windows are in use. Current version of Windows is Windows 98.

Microsoft released Windows in the goal of this graphical user interface is to make the computer friendlier to the users. With Windows applications and related files are presented as symbols (icons) on the screen. Simply pressing a key or clicking the mouse activates a command. Owing to the success of Windows, nearly every software developer generates Windows-compatible versions of their programs.

Also Windows accessory programs are available to accomplish many tasks within Windows itself. Windows permits multitasking whereby several programs can be run at once.

5.3.3. UNIX

It is a multi-user operating system for powerful 16-bit and 32-bit machines. UNIX set the standard for multi-user systems for personal computers. Developed at AT&T's Bell Laboratories in USA, UNIX held monopoly in the multi-user OS market for quite some time before other operating systems were introduced. It was first written in the assembly language. Later in 1973, it was rewritten in the ‘C’ language. This gave it portability i.e.; it could be run easily on different types of machines. This is one important reason for the popularity of UNIX. There are several implementation of this system.

5.4. Exercise

5.4.1. Multiple choice question

a. Operating system remains in memory
   i) Only during startup
   ii) Always
   iii) Only during running a program
   iv) Only end task.

5.4.2. Questions for short answers

a) Write the functions of the operating system.
b) When does the operating system starts loading?

5.4.3. Analytical question

a) Discuss about some popular operating systems.
Unit 4: Troubleshooting Basics

PC is a modular device. Its components are easily separable. This makes the troubleshooting easier. Most of the troubleshooting is just defect the faulty device and replaces with a good one. Among all the troubleshooting ways, there are some rules. These rules are discussed in this unit.

Lesson 1: Troubleshooting Approaches

1.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Troubleshooting steps
- Approaches for fault detection.

1.2. Introduction

Microcomputer system has three main components. Any problem to troubleshoot may come from any of the three sides. The main components are:

- Hardware
- Software
- Human ware.

The main steps to troubleshoot a microcomputer are:

- Identify the source of the problem: Here the cause of the problem i.e., the faulty component (any component of hardware, software or human ware) is detected.
- Troubleshoot the problem: Here the problem is removed by repairing or replacing the faulty component.

1.3. Two Approaches for Fault Detection

The most important job of troubleshooting is finding the source of the problem. After detecting the faulty device, the rest of the work is very simple: just try to repair the faulty device and if repairing is very difficult or impossible, then replace the device with a good one. There are two main approaches to detect the faulty device.

1.3.1. Hardware Approach

Hardware generally refers to the machine or physical equipment
that performs the basic functions of the data processing cycle. In addition to the computer itself, other hardware devices are also required. These devices may be off-line that is detached from the computer and operating independently or they may be on-line that is directly connected to and controlled by the computer. A printer is an off line device and a keyboard is an on-line device.

When hardware is used as the tool for fault detection, then this approach is called hardware approach. For example, one way of the hardware approaches for troubleshooting may be:

♦ Separate probable faulty devices from the troubling PC.
♦ Install each of the devices in a well-running PC.
♦ If the well-running PC shows trouble for any of the probable faulty devices, then the troubling device in the well-running PC is the faulty one.

As the well-running PC is used here as the fault-detecting tool, this approach is hardware approach.

1.3.2. Software Approach

A program is a sequence of instructions, which directs a computer to perform certain functions. A computer must have access to prewritten, stored programs to input and store data, make decisions, arithmetically manipulate and output data in the correct sequence. Programs are referred to as software. Computer system must be supported by extensive software systems.

When software is used as the tool for fault detection, then this approach is called software approach. For example, one way of software approach for troubleshooting is using the diagnostics software. Different ways of software approaches will be discussed later.
1.4. **Exercise**

1.4.1. **Multiple choice questions**

a. Identify the source of the problem means

i) Replacing the faulty hardware  
ii) Replacing the faulty software  
iii) Detecting the faulty device  
iv) Repairing the faulty device.

b. A troubleshooting approach is hardware approach when

i) Trouble of hardware is detected  
ii) Trouble of hardware is repaired  
iii) A faulty hardware is replaced by a good one  
iv) Trouble of a computer is detected by hardware tools.

1.4.2. **Questions for short answers**

a) What are the two approaches for troubleshooting?  
b) Give an example of hardware approach of troubleshooting.

1.4.3. **Analytical question**

a) Distinguish between two types of troubleshooting approaches.
Lesson 2 : General Troubleshooting Rules

2.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ Some rules following which troubleshooting will become easier

2.2. Introduction

Some general rules should be followed during troubleshooting. These are:

♦ Do not panic. Have confidence
♦ Keep note of important troubles and solves
♦ Reboot the PC
♦ Simplify the PC configuration
♦ Think out a line to troubleshoot
♦ Go to the easiest way first.

2.3. Have Confidence

You should have self-confidence about troubleshooting. If you have never opened a PC before, there’s no problem. To learn troubleshooting you have to open the PC. And nobody can open a PC without opening it first time. I found several of my friends were very much afraid about touching inside the PC. If any time I suggested them, they usually said, “Oh! No! No! That will damage my PC”. But after learning troubleshooting I found one of my friends always keeping his PC casing open. I asked him why he does this. He replied, “I don’t call him a Computer Engineer who keeps his casing closed”.

2.4. Keep Note

You should preserve a note of each troubleshooting problem and how it was solved. Then you will be able to solve easily when you fall again in the problem. This writing would be possible to do if you always keep a notebook with yourself during troubleshooting. But if the problem is very easy to solve and you think that you will not forget it later then you need not write this.

It is very much essential to keep a note and a diagram during disassembling a PC. It is further discussed in the lesson: 7 of this unit.
Troubleshooting Basics

2.5. Reboot the PC

Rebooting the PC refreshes the PC components and solves many problems. For example, a voltage transient (high voltage with smaller than $10^{-3}$ sec duration) may change the data in several bytes of RAM and your computer locks up. Rebooting can solve this problem. But it is not safe to immediately reboot in operating systems like Windows, NT and OS/2. At first the running applications should be closed. Then follow the steps suggested by the operating system developers to shut down.

2.6. Simplify the PC Configuration

A PC normally has many driver programs and software for:

- Sound card
- Network card
- Video card
- Mouse
- Screen saver
- Printer
- Scanner
- Modem
- Applications.

Disabling some of the drivers and software you simplify the PC configuration. PC configuration means the list of active devices (hardware and software) in the PC.

In DOS 6.xx, you can simplify the configuration as follows:

- Reboot the PC.
- When the message ‘Starting MS – DOS...” appears press <F5>.

Then CONFIG.SYS and AUTOEXEC.BAT are skipped and your PC boots with simplified configuration.

In Windows 95, you can simplify the configuration as follows:

- Reboot the PC.
- When the message “Starting Windows...” appears press <F8>.
- A menu appears. Select ‘Safe mode’ from the menu.
2.7. **Think out a Line to Troubleshoot**

Every component of a PC is attached to one another. So a fault in one device implies a fault not only in that device, but also in the devices attached to it, and the devices attached to the devices attached to it. For example,

- A printer is attached with the printer cable.
- The cable is attached with the printer port.
- The printer port is attached with the motherboard.
- The motherboard is attached with the software.

So a problem in printing may be caused by a fault in any (or some) of the following:

- The printer
- The printer cable
- The printer port
- The motherboard
- The printing software

But not for a fault in the mouse. To troubleshoot the printing problem you have to do:

- Separate each of the five components from the PC
- Install each component in a well-running PC to check if it is faulty. Thus the faulty component is detected.
- Try to remove the fault in the detected faulty component.
- If you failed to remove the fault, replace the faulty component with a good one.

2.8. **Go to the Easiest Way First**

If you think that the trouble is in one of several components then check the easiest one first. For example, you have found that the display is not working properly. This may happen for the fault in one (or some) of several components:

- The monitor
- The cable
- The video card
- The motherboard.

To detect the faulty component you have to replace each of the four components one by one. But which should be replaced first? The cable, because it is the easiest to replace.
2.9. **Exercise**

2.9.1. **Multiple choice questions**

a. It is not safe to reboot the PC
   
i) When it locks
   
ii) In operating system like DOS
   
iii) In operating system like Windows
   
iv) While running diagnostics software.

b. A PC has driver program for
   
i) Keyboard
   
ii) Floppy disk drive
   
iii) Printer
   
iv) Power supply unit.

c. Simplifying the PC configuration means
   
i) Disabling the keyboard
   
ii) Disabling the power supply unit
   
iii) Disabling the operating system
   
iv) Disabling some of the driver software.

d. In Windows 95 you can simplify the PC configuration by
   
i) Pressing <F5>
   
ii) Just rebooting the PC
   
iii) Rebooting the PC and pressing <F5>
   
iv) Switch of the PC.

2.9.2. **Questions for short answers**

a) How a line to troubleshoot can be thought out? Discuss with an example.

b) When it is necessary to keep a note during troubleshooting?

2.9.3. **Analytical question**

a) Discuss the general rules those should be followed during troubleshooting.
Lesson 3 : Troubleshooting Steps

3.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Steps for troubleshooting
- Checking operator error
- Checking if all the devices are plugged
- Checking new changes.

3.2. Introduction

The following steps should be followed for a successful troubleshooting.

- Check if the operator has mistaken
- Check if all the devices are plugged correctly
- Check if any new change is done
- Check the software
- Check external symptoms
- Use diagnostic programs
- Disassemble the PC, clean the connectors and reassemble.

3.3. Check if the Operator has Mistaken

Many problems are created only for the ignorance of the operator of how to use the computer. So when a program is not working, at first check if the operator uses the program in the proper way. The language of computer confuses people. For example, you may have seen the prompt “Press any key to continue…” many times. Many new users can not understand what does the “any key” means. They look on the keyboard and become puzzled not finding any key named “any key”.

I have heard the story of a computer user. One day he saw the prompt “Insert ‘System Disk 1’ in drive A: and close the door”. He inserted the disk in drive and then closed the office door. Another new user thought the mouse a pedal. He complained that he is pushing the pedal but it is not working.

From many clients, you will get complains like, “I’m doing what the manual says but the computer doesn’t work”. Most often they are not lying. Because after troubleshooting you will find that the fault is not in the computer or in the manual. The fault is in their understanding the manual.
Troubleshooting Basics

3.4. Check if all the Devices are Plugged Correctly

Many problems are happened because of improper connection. Improper connection means:

- A connection is not done.
- A connection is done but it becomes loose.
- A connection is done and it is not loose but it is done in wrong direction.

So, check if all the external connections are plugged tightly with proper direction.

One day I found that a PC was not working though it was working little moment before. I checked all the connections and they were plugged `properly. AT last I found that the PC is plugged in the voltage stabilizer and the stabilizer is connected in the wall socket properly but the stabilizer is off.

3.5. Check if any New Change is Done

If the PC was working properly before some time and now it is making trouble, then check if any change has been made between this period. This change may be responsible for the problem. So undoing the change will remove the problem.

For example, some early PC programs like ‘Infocom’ games do not run in more than 512K RAM. If you add some RAM after 512KB then Infocom game will prompt “Illegal operation” and reboot the PC. From this prompt it is not possible for you to find out the fault. By ‘checking if any new thing is done’ you will find that before adding the RAM the game was working properly, but after adding it fails. So the problem is in RAM addition.

To ‘check if any new thing is done’ you should check:

- Any new hardware added
- Any hardware setup changed
- Any new software added
- Any software setup changed.
3.6. Exercise

3.6.1. Multiple choice questions

a. Early PC programs like ‘Infocom’ games dust run
   i) in more than 512 K RAM
   ii) in more than 312 K RAM
   iii) in more than 712 RAM
   iv) in more than 712 K RAM.

b. Many problems are happened because of
   i) proper connection
   ii) improper connection
   iii) AC connection
   iv) PC connection.

3.6.2. Analytical questions

a) Describe about the troubleshooting steps.
b) What do you mean by improper connection?
Lesson 4 : Checking Software and Symptoms

4.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ Checking the software
♦ Checking external symptoms.

4.2. Check the Software

Most of the microcomputer problems are software problems. A separate book can be written on troubleshooting one software. (For example, Windows, NT, OS/2, LINUX etc.) Software problems have several causes:

♦ Operator’s fault
♦ Bug in the device driver
♦ Bug in the software
♦ Virus.

4.2.1. Operator’s Fault

Many problems are created only for the ignorance of the operator of how to use the computer. So when a program is not working, at first check if the operator uses the program in the proper way.

4.2.2. Bug in the Device Driver

Device driver is the software that is used to drive specific device. They support the operating system. If the device driver has a bug or not installed properly, then it will not do its job correctly.

For example, in Windows 98 environment the device driver for printer ‘HP LaserJet 4L’ drives the ‘HP LaserJet 4L’ printer. When any application wants to print a document:

♦ The application supplies printing request to the Windows 98.
♦ If the attached printer is ‘HP LaserJet 4L’, Windows 98 delivers the printing request to the device driver software for ‘HP LaserJet 4L’.
♦ The device driver performs most of controlling of the ‘HP LaserJet 4L’ printer and delivers the printing request to the printer.
The printer prints the document as ordered by the device driver.

If there is a bug in the device driver for ‘HP LaserJet 4L’ or it is not installed properly then it will not be able to print the document. Just reinstalling solves most of the device driver problems.

4.2.3. Bug in the Software

The bug in the software is the source of many PC troubles. Much popular software do not work properly in the situation of insufficient memory, full disk or some other situation that the developer did not consider. The solution of software bug is not in the user’s hand. He can just inform the manufacturers and the coworkers in his company.

4.2.4. Virus

Viruses are special programs. They have following characteristics:

- These are very small programs
- They hide themselves
- Make disturbance to computer users
- They can make new copies and distribute these copies to other computer.

Virus can be removed by running anti-virus software. Different popular antivirus software are TOOLKIT, Norton Anti Virus, McAffee Anti Virus etc.

4.3. Check External Symptoms

A faulty device may show some symptoms. By checking any abnormal behavior you can detect the source of trouble. One important thing in troubleshooting is detecting the faulty component. External symptoms can help here. Example symptoms are:

- The floppy disk light is continuously on
- The hard sounds too much
- The monitor image becomes bent
- Some peripheral device hums.
4.4.  Exercise

4.4.1.  Multiple choice question

a.  Computer virus is a

i)  Animal

ii)  Hardware

iii)  Program.

4.4.2.  Questions for short answers

a)  Discuss about different software problem and troubleshooting.

b)  Give some example of external symptoms.
Lesson 5: Using Post and After Boot Diagnostics Software

5.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ Power on self test
♦ Some diagnostics software package.

5.2. Introduction

Diagnostic programs are used to detect PC problems. Different types of diagnostics programs are:

♦ The power on self test (POST)
♦ After boot diagnostics software
♦ ROM based diagnostics tools.

Some components of the PC should run to run the diagnostics software. These are:

♦ The motherboard (including CPU and RAM). Because if they do not run, no other devices will run
♦ The monitor and the video card should run interact with the user.
♦ The keyboard should run to get user input
♦ The floppy drive should run to load the program.

5.3. The Power on Self Test (POST)

Every time the PC is powered-on this program is run. It checks if the basic hardware (CPU, RAM etc.) exists and tests the memory. The checking done by IBM PC-1 BIOS is discussed here. Checking done by other BIOS is nearly similar. POST in IBM PC-1 BIOS checks the following things sequentially:

♦ CPU registers and flags. If faulty then halts.
♦ ROM checksum. If faulty then halts.
♦ DMA controller. If faulty then halts.
♦ Interrupt controller. If faulty then POST makes a long beep and a short beep and then halts.
♦ Timer and its speed. If faulty then POST makes a long beep and a short beep and then halts.
♦ BASIC ROM. If faulty then makes a long beep and a short beep and then halts.
Troubleshooting Basics

- Video controller. If faulty then it makes a long beep and a short beep and then halts.
- Installed adapters. If okay then let them (the adapters) initialize.
- CRT Interface lines. If okay then blinks the cursor.
- All system RAM.
- Keyboard. If faulty then makes a short beep but does not halt.
- Cassette interface. If faulty then makes a short beep but does not halt.
- Diskette adapter and drive ‘A:’. If faulty then makes a short beep but does not halt.
- Determines how many printers, serial ports and game ports are connected. Then makes a short beep and starts booting.

5.4. After Boot Diagnostics Software

We have many diagnostics software as application package. They are run after the booting of the operating system. They can be used for the following functions:

- Making a list of active devices
- Run the PC continuously
- Finding addresses of interrupt, DMA, I/O etc.
- Initialize some devices.

Several diagnostics packages are Chekit, QAPlus, PC-Technitian, Displaymate, SpinRite etc.

5.4.1. Listing Active Devices

These programs detect and display a list of all active devices in a computer. Using these diagnostics software, many problems can be detected. For example, you have installed a LAN card in your computer, but the list does not show any LAN card. Then you can say that, the LAN card or the device driver of the LAN card has some problem.

5.4.2. Run the PC Continuously

Some problems can not be detected if the PC does not run continuously for several days. Simple diagnostics programs are not sufficient for this purpose because the need many user inputs different times to perform a job. Special diagnostics packages are available which do not need any intermediate user response for continuous operating. They keep an error-log file and print all the errors happened between this long running period.
5.4.3. Finding Address Mapping

Some troubles are happened for interrupt, DMA or I/O address conflict. For example, if two expansion boards are configured to use the same interrupt address, none of them will work properly. Using some diagnostics software, the interrupt address used by the boards can be displayed and any interrupt conflict can be detected.

5.4.4. Initialize Some Devices

Some diagnostics packages are used to initialize some devices. For example, many packages are available to partition and format the hard disks or performing low level format on the older hard disks.

5.5. Exercise

5.5.1. Multiple choice question

a. If the BASIC ROM is faulty then the post sounds

i) Two short beep
ii) Two short and one long beep
iii) One short and one long beep
iv) One long beep and one short beep.

5.5.2. Analytical question

a) How after boot diagnostics software can be used for PC troubleshooting?
Lesson 6: Using ROM Based Diagnostics Software

6.1. Learning Objectives

On completion of this lesson you will be able to describe:

- ROM based diagnostics tools
- IBM error code table

6.2. ROM Based Diagnostics Tools

It is a small circuit board containing a ROM and some other electronics. It is installed in the motherboard by replacing the BIOS ROM. It allows booting and checks the chips separately. In this ROM based diagnostics software, another card with some LED is inserted in the expansion slot of the motherboard. For a specific fault, the set of LED glows in a specific way. By observing the on/off positions of the LED, the fault is detected.

These ROM based diagnostics software needs no running monitor, floppy drive or keyboard. Just need the following devices running (running means, it is not necessary that they are completely okay, they may have slight problems but they can run):

- CPU
- Motherboard
- RAM
- Power supply unit.

6.3. IBM Error Code Table

The POST and some ROM based diagnostics tools inform about the detected fault by emitting sound and displaying number. Many of them use the IBM error code table for this purpose.

Table 6.1: POST Audio Messages

<table>
<thead>
<tr>
<th>SIGNAL</th>
<th>PROBABLE CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No beep, nothing happens</td>
<td>Power supply bad or not plugged in</td>
</tr>
<tr>
<td>Continuous beep</td>
<td>Power supply bad or keyboard stuck</td>
</tr>
<tr>
<td>Repeating short beep</td>
<td>Power supply bad</td>
</tr>
<tr>
<td>1 long beep, 1 short beep</td>
<td>System board failure</td>
</tr>
<tr>
<td>1 long beep, 2 short beeps</td>
<td>Failure or lack of display adapter/cable</td>
</tr>
</tbody>
</table>
1 short beep, blank screen Failure or lack of display adapter/cable
1 short beep, no boot Floppy drive adapter failure
2 short beeps (PS/2) Configuration error

Table 6.2: Hardware Diagnostic/POST Messages

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>01x</td>
<td>Undetermined problem errors</td>
</tr>
<tr>
<td>02x</td>
<td>Power supply errors</td>
</tr>
<tr>
<td>1xx</td>
<td>System board errors</td>
</tr>
<tr>
<td>101</td>
<td>Interrupt failure</td>
</tr>
<tr>
<td>102</td>
<td>Timer failure</td>
</tr>
<tr>
<td>103</td>
<td>Timer interrupt failure</td>
</tr>
<tr>
<td>104</td>
<td>Protected mode failure</td>
</tr>
<tr>
<td>105</td>
<td>Last 8042 command not accepted</td>
</tr>
<tr>
<td>106</td>
<td>Converting logic test</td>
</tr>
<tr>
<td>107</td>
<td>Hot NMI test</td>
</tr>
<tr>
<td>108</td>
<td>Timer bus test</td>
</tr>
<tr>
<td>109</td>
<td>Direct Memory Access test error</td>
</tr>
<tr>
<td>121</td>
<td>Unexpected hardware interrupts occurred</td>
</tr>
<tr>
<td>131</td>
<td>Cassette wrap test failed</td>
</tr>
<tr>
<td>161</td>
<td>AT battery failure</td>
</tr>
<tr>
<td>162</td>
<td>AT setup into incorrect (rerun SETUP)</td>
</tr>
<tr>
<td>163</td>
<td>Time and date not set (run SETUP)</td>
</tr>
<tr>
<td>164</td>
<td>Memory size error (run SETUP)</td>
</tr>
<tr>
<td>165</td>
<td>PS/2 does not know how to configure board</td>
</tr>
<tr>
<td>199</td>
<td>User indicated configuration not correct</td>
</tr>
<tr>
<td>2xx</td>
<td>Main memory (RAM) errors</td>
</tr>
<tr>
<td>201</td>
<td>Memory test failed</td>
</tr>
<tr>
<td>202</td>
<td>Memory address error</td>
</tr>
<tr>
<td>203</td>
<td>Memory address error</td>
</tr>
<tr>
<td>3xx</td>
<td>Keyboard errors</td>
</tr>
<tr>
<td>301</td>
<td>Keyboard error. If followed by a number the number is the scan code of the key in question.</td>
</tr>
<tr>
<td>302</td>
<td>User indicated error from keyboard test or AT key lock locked</td>
</tr>
<tr>
<td>303</td>
<td>Keyboard or system unit error</td>
</tr>
<tr>
<td>304</td>
<td>CMOS does not match system</td>
</tr>
<tr>
<td>4xx</td>
<td>Monochrome monitor errors</td>
</tr>
<tr>
<td>401</td>
<td>Adapter memory, horizontal sync frequency test, or video test failed</td>
</tr>
<tr>
<td>408</td>
<td>User indicated display attributes failure</td>
</tr>
<tr>
<td>416</td>
<td>User indicated character set failure</td>
</tr>
<tr>
<td>424</td>
<td>User indicated 80 x 25 mode failure</td>
</tr>
<tr>
<td>432</td>
<td>Parallel port test failed</td>
</tr>
<tr>
<td>5xx</td>
<td>Color monitor errors</td>
</tr>
<tr>
<td>501</td>
<td>Color adapter memory, horizontal sync frequency test</td>
</tr>
</tbody>
</table>
or video test failed
508  User indicated display attributes failure
516  User indicated character set failure
524  User indicated 80 x 25 mode failure
532  User indicated 40 x 25 mode failure
540  User indicated 320 x 200 mode failure
548  User indicated 640 x 200 mode failure
6xx  Diskette drive/controller failures
601  Adapter or drive failed POST
602  Diskette test failed: boot record is not valid
606  Diskette verify function failed
607  Write-protected diskette
608  Bad command diskette status returned
610  Diskette initialize failed
611  Timeout
612  Bad NEC chip on diskette controller
613  Adapter failed DMA test
621  Bad seek
622  Bad CRC found
623  Record not found
624  Bad address mark
625  Bad NEC seek
626  Diskette data compare error
7xx  8087 or 80287 math coprocessor errors
9xx  Printer adapter errors
1101 Asynchronous (RS232) adapter failure (COM1)
1201 Asynchronous (R5232) adapter failure (COM1)
13xx Game port failure
1301 Adapter test failed
1302 Joystick test failed
14xx Printer errors
1401 Printer test failed
1402 Dot matrix printer test failed
15xx SDLC adapter (mainframe connection) failure
1510 Failure of 8255 port B
1511 Failure of 8255 port A
1512 Failure of 8255 port C
1513 8253 timer 1 did not reach terminal count
1514 8253 timer 1 stuck on
1515 8253 timer 0 did not reach terminal count
1516 8253 timer 0 stuck on
1517 8253 timer 2 did not reach terminal count
1518 8253 timer 2 stuck on
1519 8273 port B error
1520 6273 port A error
1521 8273 command/read timeout
1522 Interrupt level 4 failure
1523 Ring indicate stuck on
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1524</td>
<td>Receive clock stuck on</td>
</tr>
<tr>
<td>1525</td>
<td>Transmit clock stuck on</td>
</tr>
<tr>
<td>1526</td>
<td>Test indicate stuck on</td>
</tr>
<tr>
<td>1527</td>
<td>Ring indicate not on</td>
</tr>
<tr>
<td>1528</td>
<td>Transmit clock not on</td>
</tr>
<tr>
<td>1531</td>
<td>Data Set Ready not on</td>
</tr>
<tr>
<td>1532</td>
<td>Carrier Detect not on</td>
</tr>
<tr>
<td>1533</td>
<td>Clear to Send not on</td>
</tr>
<tr>
<td>1534</td>
<td>Data Set Ready not on</td>
</tr>
<tr>
<td>1536</td>
<td>Clear to Send stuck on</td>
</tr>
<tr>
<td>1537</td>
<td>Level 3 interrupt failure</td>
</tr>
<tr>
<td>1538</td>
<td>Receive interrupt results error</td>
</tr>
<tr>
<td>1539</td>
<td>Wrap data miscompare</td>
</tr>
<tr>
<td>1540</td>
<td>DMA channel 1 error</td>
</tr>
<tr>
<td>1541</td>
<td>Error in 8273 error check or status reporting</td>
</tr>
<tr>
<td>1547</td>
<td>Stray interrupt level 4</td>
</tr>
<tr>
<td>1548</td>
<td>Stray interrupt level 3</td>
</tr>
<tr>
<td>1549</td>
<td>Interrupt presentation sequence timeout</td>
</tr>
<tr>
<td>16xx</td>
<td>Terminal emulation errors (32xx, 5520, 525x)</td>
</tr>
<tr>
<td>17xx</td>
<td>Hard disk/disk controller errors</td>
</tr>
<tr>
<td>1701</td>
<td>POST error</td>
</tr>
<tr>
<td>1702</td>
<td>Adapter failure</td>
</tr>
<tr>
<td>1703</td>
<td>Drive failure</td>
</tr>
<tr>
<td>1704</td>
<td>Drive or adapter failure: can not be determined</td>
</tr>
<tr>
<td>1780</td>
<td>Drive 0 failure (drive C:)</td>
</tr>
<tr>
<td>1781</td>
<td>Drive 1 failure (drive D:)</td>
</tr>
<tr>
<td>1782</td>
<td>Adapter failure</td>
</tr>
<tr>
<td>1790</td>
<td>Drive 0 failure (couldn't read the LAST cylinder-probably misspecified drive)</td>
</tr>
<tr>
<td>1791</td>
<td>Drive 1 failure</td>
</tr>
<tr>
<td>18xx</td>
<td>Expansion Chassis failures</td>
</tr>
<tr>
<td>1801</td>
<td>POST error code</td>
</tr>
<tr>
<td>1810</td>
<td>Extender card failure</td>
</tr>
<tr>
<td>1811</td>
<td>Extender card failure</td>
</tr>
<tr>
<td>1812</td>
<td>Address or wait state failure</td>
</tr>
<tr>
<td>1813</td>
<td>Address or wait state failure</td>
</tr>
<tr>
<td>1816</td>
<td>Extender card failure</td>
</tr>
<tr>
<td>1819</td>
<td>Wait request switch set incorrectly</td>
</tr>
<tr>
<td>1820</td>
<td>Receive card failure</td>
</tr>
<tr>
<td>1821</td>
<td>Receiver card failure</td>
</tr>
<tr>
<td>19xx</td>
<td>3270 PC communications controller failures</td>
</tr>
<tr>
<td>20xx</td>
<td>BSC adapter (mainframe connection) failures</td>
</tr>
<tr>
<td>2010</td>
<td>Failure of 8255 port B</td>
</tr>
<tr>
<td>2011</td>
<td>Failure of 8255 port A</td>
</tr>
<tr>
<td>2012</td>
<td>Failure of 8255 port C</td>
</tr>
<tr>
<td>2013</td>
<td>8253 timer 1 did not reach terminal count</td>
</tr>
<tr>
<td>2014</td>
<td>8253 timer 1 stuck on</td>
</tr>
<tr>
<td>2015</td>
<td>8253 timer 0 did not reach terminal count</td>
</tr>
</tbody>
</table>
Troubleshooting Basics

2016  8253 timer 0 stuck on
2017  8253 timer 2 did not reach terminal count
2018  8253 timer 2 stuck on
2019  8273 port B error
2020  8273 port A error
2021  8273 command/read timeout
2022  Interrupt level 4 failure
2023  Ring indicate stuck on
2024  Receive clock stuck on
2025  Transmit clock stuck on
2026  Test indicate stuck on
2027  Ring indicate not on
2028  Receive clock not on
2029  Transmit clock not on
2030  Test indicate not on
2031  Data Set Ready not on
2032  Carrier Detect not on
2033  Clear to Send not on
2034  Data Set Ready not on
2036  Clear to Send stuck on
2037  Level 3 interrupt failure
2038  Receive interrupt results error
2039  Wrap data miscompare
2040  DMA channel 1 error
2041  Error in 8273 error check or status reporting
2047  Stray interrupt level 4
2048  Stray interrupt level 3
2049  Interrupt presentation sequence time out
21xx  Alternate BSC adapter failures
2110-49  (Same as above, but with 21 prefix rather than 20)
2201  PC wiring cluster adapter failure
2401  EGA/VGA failure: may show text
2901  Color dot matrix failures
330t  Compact printer failures
86xx  Mouse error
6.4. Exercise

6.4.1. Multiple choice questions

a. The ROM based diagnostics software needs
   i) Monitor
   ii) Keyboard
   iii) RAM
   iv) Hard disk drive.

b. 86xx in IBM error code table means
   i) Error in 8273
   ii) EGA/VGA failure
   iii) Write protected diskette
   iv) Mouse error.

6.4.2. Questions for short answer

a) How ROM based diagnostics tools works?
Lesson 7 : Precautions for Disassembling

7.1. Learning Objectives

In this lesson you will find:

♦ The advises to disassembly the PC
♦ The precautions for disassembling.

7.2. You Should Have Sufficient Space

You need sufficient space to keep the PC casing, monitor, disassembled components, disassembly instruments etc. At least a large tabletop fully should be used for this purpose. If air conditioner is available, raise the air humidity to approximately 50%.

7.3. Store All the Small Parts In a Safer Place

Use a pot or bag to store the small components such as screws and small pieces of hardware. If these are just left on the table, then may fall down and you may lost them.

7.4. Backup the CMOS Configurations

All the modern personal computers store the important hardware information in a small chip call CMOS. If you disassemble the computer, the information stored in CMOS may be lost.

Steps to write CMOS configuration:

♦ Restart the computer
♦ Press <Delete> when a prompt like “Press Del to run CMOS” appears on the screen.
♦ A menu specifying different CMOS properties will appear. Go to different options in the menu and write down the configurations stored there.
♦ Using the menu option like “Exit without save”, exit from CMOS.

7.5. Turn the PC and Associated Peripherals Off

Before disassembling the PC and other peripherals should be turned off. Because if anybody touches inside the PC during its power is on then he may get shock.
7.6. Remove the Monitor from the PC Top

To open the desktop casings the monitor should be removed from the top and placed on the table. For tower casings it is not necessary.

7.7. Remove the Casing Top

On the backside of the PC you will find four screws connected with the casing top. Open these screws and then remove the casing top. There you will find some other screws connected with the power supply unit. Don’t open these.

Fig. 7.1: Removing the cover of a tower case.

7.8. Draw Diagram

You should draw diagram of the components before disassembling. It may seem very easy to disconnect the components. But you may fall in trouble during reassembling. If there is no distinct marking on a cable you should mark it by a marker. The purpose of your diagram drawing is that, during reassemble you can build the machine as you found before disassembly. You should pay special attention on the following things:
7.8.1. Ribbon Cable

These are flat cables where several wires are connected parallel. These are connected to the upright pins on the circuit board. You will find a dark line on the cable on one side. Note down the direction of the dark line during connection. Is it towards the power supply or towards the speaker?

7.8.2. Board and Cable Placement

During disassembling the cables and expansion boards note from which slot you disconnect it.

7.8.3. Jumpers

You will find jumpers on the motherboard and hard disk. Jumpers are connectors connecting two neighboring pins. You should draw the position of jumpers on the motherboard.

7.8.4. Motherboard Connections

You will find many connections on the motherboard like power supply, speaker, and key lock etc. connections. These connections should also be noted.

Power supply connections: These are two plastic connectors labeled P8 and P9. Be careful about these two connectors because placing them in wrong order may burn the whole motherboard.

Speaker connection: This connects the motherboard with the speaker. It generally has two wires: one yellow and one black.

Key lock connection: some systems provide key lock. If you can’t connect them properly, it may not work.

Disk lights: There are two connections for disk lights - one for hard disk and another for floppy. These lights glow when the disks active. You should also note where these connections go and the directions of these connections.
7.9. Exercises

7.9.1. Multiple choice question

a. To write in COMS configuration you should press

i) F1
ii) Spacebar
iii) Enter
iv) Del.

7.9.2. Analytical question

a) Discuss about precautions for disassembling a microcomputer.
Lesson 8: Disassembling the PC

8.1. Learning Objectives

On completion of this lesson you will be able to describe disassembling steps of a PC that is:

- How to remove expansion boards
- How to remove the drives
- How to remove the power supply unit
- How to remove the motherboard.

8.2. Remove the Boards

First remove all the connectors from the board. During this you have to draw the position and direction of the cables connected with the board. After removing the boards you have to distinguish between them. At first they will look similar but if you carefully look on them you can distinguish between them. For example you can distinguish by the numbers on the ICs on the boards. You need not the function of a board. You need only to note from which slot it comes and how it’s connected to other components so that you do not fall in problems during reassembling the components.

Fig. 8.1: Removing a circuit board.
8.3. Remove the Drives

There are normally three main types of drives in the computer:

- Floppy disk drives
- Hard disk drives
- CD drives.

Each of these drives has the following connections with the computer:

- Connections with the power supply unit through power cable.
- Connection with the motherboard through flat cable.
- Connection with the chassis (casing) through screws.

The following steps should be followed to remove the drives:

8.3.1. Removing Drive Screws

The drives are connected with the casing using screws. Normally each drive holds four screws - two on one side and two on other side. After removing the screws it is possible to move the drive and disconnecting the cable becomes easier.
Troubleshooting Basics

8.3.2. Disconnect the Cables

Each drive has two cables - one for power and another for data.

8.3.2.1 Power Cable

The power cable is connected with the power supply unit. These power cables are normally labeled as P10, P11 or P12. Each of them has four wires.

![Image of power connectors]

**Fig. 8.3: Two types of power connectors.**

8.3.2.2. Data Cable

These are usually flat ribbon cables. They have normally the following number of wires:

- Floppy disk drive: 34 wires
- Hard disk drive: 40 or 50 wires
- CD drive: 40 or 50 wires.

A dark line on one side marks these cables. While the cable is connected with the drive, note the direction of the dark line, if it towards the power cable or in opposite direction.

8.4. Remove the Power Supply

In the previous steps motherboard and drive connections with the power supply unit are disconnected. Now the screws those hold the power supply unit with the chassis should be removed. There are four screws in the back of the chassis. The on-off switch of the power supply unit is at the front side of the chassis. To remove the power supply unit from the chassis this switch should also be removed.
8.5. Remove the Motherboard

The motherboard lies flat in the bottom of the chassis. To remove the motherboard you should do:

- Remove the expansion boards and cables (This is done in previous steps).
- Remove the screws and plastic spacers that hold the motherboard with the chassis.
- Lift the motherboard out of the chassis.

In some cases the motherboard is connected with a steel plate and the plate is connected with the chassis by some screws. For this type of chassis it is better to remove the plate from the chassis first then open the motherboard from the plate.

8.6. Remove the RAM Cards

You will find one or some RAM cards in their slots on the motherboard. There are two clips on each end of a RAM slot. Push the clips and then remove a card from its slot.

8.7. Remove the Processor

In most of the computers you will find the processor on a large socket on the motherboard. The socket has a handle. These types
of sockets are called ZIF (Zero Insertion Force) sockets. Pull up the handle and then open the processor from the socket. In some motherboards there is no socket for the processor. Here the processor is soldered with the motherboard. Removal of processor motherboard is not possible in these computers.

Fig. 8.5: Removing the power supply from a tower case.
Fig. 8.6: AT motherboard with detailing connection points.

Fig. 8.7: How to remove a motherboard.
8.8. Exercise

8.8.1. Multiple choice question

a. The Molex connector has

   i) 40 wires
   ii) 8 wires
   iii) 4 wires
   iv) 1 wire.

8.8.2. Questions for short answers

a) Discuss the steps to remove a circuit board.
b) What is ZIF socket?
Lesson 9 : Assembling the PC

9.1. Learning Objectives

On completion of this lesson you will be able to:

♦ Assembling a disassembled PC
♦ Solve some common problems while assembling.

9.2. Assembling a Disassembled PC

Reassembling a PC is just the reverse order of disassembling. The steps are:

♦ Place the power supply unit and its on/off switch at proper location.
♦ Insert processor in the ZIF socket of the motherboard with proper direction
♦ Insert the RAM card in its slots of the motherboard.
♦ Place the Motherboard on the steel plate of the chassis and connect the plate with the chassis.
♦ Connect the connectors of turbo switch, speaker, disk lights etc. and the power supply cable P8 and P9 with the motherboard. Be careful about the proper position of the two power connectors.
♦ Insert the disk drives at their locations and connect them to the I/O card (or motherboard in newer PCs) and power supply unit with cables.
♦ Insert the expansion cards in the slots of the motherboard.
♦ Close the casing.

9.3. Connecting Cables

Connecting the cables is an important step of assembling, because it is possible to place the connectors in opposite directions and then the PC will not work.

9.3.1. Finding the Wire-1 on a Cable

The cable connection becomes easier if the wire-1 can be found. Most of the flat cables (cable that has many parallel wires) has a dark line wire. This is the wire-1. The cable should be connected with the I/O card (or motherboard in modern computers) or disk drives in such a way that cable’s wire-1 connects with motherboard or disk drive’s connector’s pin-1.
9.3.2. Finding the Pin-1

To find the pin-1 of the connector slot of the motherboard (or I/O card) look carefully on the side of the slot. In most of the motherboards you will find a ‘1’ marked near the slot. The near most pin with this ‘1’ mark is the pin-1.

The disk drives have two slots – one for power and another for data. Power cable is easy to insert because to insert it in opposite direction is not possible. To insert the data cable you need to find the pin-1 in data cable slot. The pin of the data cable slot, which is near most to the power cable slot, is the pin-1. So you have to insert the data cable in such a way that the dark line on the cable (i.e., wire-1) is near the power slot.

9.4. Common Reassembling Mistakes

Many mistakes may happen during assembling process. If you assemble the components with patience and have a good diagram then most of the problems can be avoided. Some common mistakes during assembly are discussed here.

9.4.1. Forgetting to Connect the Power Cables P8 and P9

This isn’t actually common, but it’s important. If you forget to connect the motherboard power connectors P8 and P9 to the motherboard, the power supply may actually explode when you turn the machine on.

9.4.2. Bad Motherboard Seating

Pay special attention when reseating the motherboard on its plastic spacers. Notice that the spacers are designed with a top disk and a bottom disk, and a bit of space between. Then notice that the motherboard has raised metal slots with a V shape. The spacers are supposed to sit so that the V is between the upper and lower disk. Get a flashlight and check the spacers. Another way to test motherboard seating is to insert a circuit board-if it doesn’t fit right, your motherboard is probably seated wrong.

In a related issue, make sure that the motherboard isn’t string right on the metal case; there must be a bit of airspace between it and the case, or you short-circuit the board for sure.

9.4.3. Reversed Data or Control Cables

"Let's see, which side does this blue line go on?" very common. If you don’t diagram carefully, you may find yourself having trouble
trying to figure out how a ribbon cable connects to, say a drive. Well, if you didn't diagram carefully, use the Pin 1 Rule to help you.

9.4.4. Mishandled Boards

Don't stack boards. Lay them out separately. Occasionally rough handling can scratch and remove a circuit board trace. This can be repaired by soldering a short (as short as possible!) wire across the cut in the trace. If unsure (traces can be faint or thin to begin with), use your ohmmeter. Set to low ohms (Rx1 on the dial), then put the probes on either side of the suspected cut. The meter should read "0" if everything's okay.

9.4.5. Forgetting to Attach Power

This one's good for a heart attack. You forget to attach that Molex or Berg connector to the hard disk, and you get disk boot failure.

9.4.6. Forgetting the Speaker, Keylock, and Battery Connection

The first two are minor, the last annoying. Forget to reconnect the battery; and you won't be able to configure the system.

9.5. Exercise

9.5.1. Multiple choice question

a. The dark wire on the cable is

i) wire 10
ii) wire 40
iii) wire 1
iv) last wire.

9.5.2. Questions for short answers

a) Which problems are created by mishandled board?
b) How pin-1 can be found on a connector on the motherboard?
Unit 5 : Troubleshooting Specific Devices - I

Most of the microcomputer problems come from the secondary, storage devices like hard disk and floppy disk drives. This unit contains the discussion about those problems created by these secondary storage devices and their troubleshooting.

Lesson 1 : Troubleshooting Hard Disk

1.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ An overview of hard disk drives troubleshooting.
♦ Steps in hard disk drive installation.

1.2. Introduction

Hard disks make normally the following types of troubles:

♦ Some sectors of the hard disk become incapable of storing and retrieving data. To recover from this problem any disk scanning software can be used. Scandisk, Norton Disk Doctor etc. are this kind of software. They mark these sectors as bad sectors and then the programs do not use them for reading and writing.

♦ The hard disk is not installed properly. This problem can be recovered by reinstalling the hard disk.

♦ The hard disk is crashed. It is normally not recoverable. The solution is to leave the old and buy a new hard disk and install it.

So when any body knows hard disk installation he can solve the common hard disk problems.

To run a hard disk in your computer, the hard disk should be connected to your computer by proper cabling and configured properly. It is called hard disk installation. There are different types of hard disks with different interfaces. Most of the hard disks available today are with IDE interface. So in this lesson we have specially discussed how to install an IDE hard disk.
1.3. Steps in Hard Disk Drive Installation

- Collect compatible hardware for a hard disk subsystem: disk, disk interface card and cable.
- Set master/slave jumper
- Place the drive in PC chassis
- Connect the cable
- Configure CMOS
- Partition the drive
- Format the drive

1.4. Collect Compatible Hardware

Compatible hardware means a set of hardware, members of which set can work together. For example, an IDE hard disk and a motherboard is compatible they can be connected by a cable and work together. So, to install a hard disk we at first need a set of compatible hardware.

For an IDE hard disk, we need:

- The IDE hard disk itself
- Motherboard or I/O card that supports IDE interface
- IDE interface cable

For a SCSI hard disk, we need:

- The SCSI hard disk itself
- SCSI host adapter card
- Motherboard that supports SCSI interface
- SCSI interface cable

1.5. Jumper Settings

1.5.1. Primary and Secondary

Normally a motherboard with IDE interface supports at most four hard drives. It supports 2 IDE interface cables and each cable supports 2 drives. The 1st cable of the 2 is called the primary and the 2nd is called the secondary. Similarly the 2 hard drives connected with the 1st cable are called primary hard drives and the other 2 connected with the 2nd cable are called secondary.

How the motherboard knows which is the primary cable and which is the secondary? There are 2 IDE slots on the motherboard. One is numbered as IDE1 and the another is numbered as IDE2. The cable and the 2 hard drives connected with the IDE1 slot are...
called the primary cable and hard drives. Similarly the cable and
the 2 hard drives connected with the IDE2 slot are called the
secondary cable and hard drives.

1.5.2. Master and Slave

We have known that each cable connects 2 hard drives. One is
called the master and another – the slave. So the 4 hard drives
that IDE interface supports are named as

♦ Primary Master
♦ Primary Slave
♦ Secondary Master
♦ Secondary Slave.

How a motherboard knows which of the 2 hard disks in a cable is
master or slave? The motherboard knows this from jumper setting
on the drive. Setting the jumper as master an IDE hard drive
becomes master. If we connect a hard drive configured as master
with the primary cable than it becomes the primary master. Similar
for the slave.

IDE hard drive has a set of pins and a jumper to make it master or
slave. The jumper connects any two pins on the set. In which
position of jumper, a hard disk becomes master or slave is printed
on most of the hard drives.

1.6. Place the Drive in the PC Chassis

You will find normally two slots in the PC chassis to place hard
drives. Insert the hard drive in a slot and hold it with 4 screws - 2
on one side and 2 on another side.
1.7. Exercise

1.7.1. Multiple chose questions

a. The hard disk drive commented with the primary cable is

i) Master
ii) Slave
iii) None of the above
iv) Any one of the above.

b. IDE interface supports

i) 1 HDD
ii) 2HDD
iii) 4HDD
iv) 8HDD.

1.7.2. Questions for short answers

a) Which troubles are nor-mally made by a hard disk drive.
b) What is the common solution of hard disk drive troubles?
c) What are the steps in hard disk drive installation?
Lesson 2 : Cable Connection

2.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ The cabling method for IDE hard drives.

2.2. Cabling

IDE interface cable is 40-wire cable. This cable normally has 3 slots – one to connect it with the motherboard, two others are to connect it with two hard drives (master and slave).

2.2.1. Connecting Cable to Motherboard

To install a hard disk as primary master, connect one end of the cable to IDE1 slot of the motherboard. Look for a 40-pin slot on the motherboard. You will find normally 2 such slots. For IDE1 slot, a ‘IDE1’ is printed by the side of the slot. If no sign indicating slot number is printed on the motherboard, then get the motherboard’s manual. In the manual you will find which is the IDE1 slot. In figure 2.1 the IDE1 slot is on the lower right corner of the motherboard.

During cabling you should be careful about connecting the cable to the motherboard in such a way that the pin-1 of cable connects with the pin-1 of slot. The pin-1 of cable is the dark lined wire. The pin-1 of IDE1 slot is marked by a ‘1’. In the figure 2.1 the lower right pin of each IDE1 slot is the pin-1. A ‘1’ is marked on the motherboard near this pin.

2.2.2. Connecting Cable to Hard Disk

Two hard disks can be connected with a cable : one master and another slave. Again there are 2 slots on a cable for hard drives. Any hard drive (master or slave) can be connected to any one of the 2 slots of the cable. The motherboard distinguishes between them by their configuration. So if one hard disk on a cable is configured (by jumper setting) as master then the other must be configured as slave.

During cabling we should be careful about connecting the cable to the hard disk in such a way that the pin-1 if cable connects with the pin-1 of the data slot of hard disk. Recall that the pin-1 of cable is the dark lined wire.
Fig. 2.1: Layout of Octek GXi Media Motherboard.

An IDE hard disk has 2 slots - one for power and another for data. Power cable is easy to insert because to insert it in opposite direction is not possible. To insert the data cable you need to find the pin-1 in data cable slot. The pin of the data cable slot, which is near most to the power cable slot, is the pin-1. So you have to insert the data cable in such a way that the dark line on the cable (i.e., wire-1) is near the power slot. If you insert the data cable in wrong direction then the hard disk will not work and the disk light of hard disk will glow continuously.
2.3. Exercise

2.3.1. Multiple choice question

a. An IDE hard disk drive has

   i) 1 connector
   ii) 2 connectors
   iii) 40 connectors
   iv) 44 connectors.

2.3.2. Questions for short answers

a) Which hardware we need to use an IDE hard disk drive?
b) Discuss the cabling method of IDE hard disk drive.
Lesson 3 : Configuring CMOS

3.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ How to configuring CMOS by Plug and Play BIOS
♦ How to configuring CMOS by Non Plug and Play BIOS.

3.2. Configuring CMOS

To install a new hard disk, BIOS should be informed about the arrival of a new hard disk. BIOS is given this information by storing the configuration (size, no of heads, tracks, sectors etc.) of hard disk in the CMOS.

BIOS is the operating system which works before any other operating system or program is loaded. BIOS works directly with the hardware. Operating system (DOS, Windows etc.) gets hardware information (which hardware with which configuration is installed in the computer) from the BIOS. BIOS stores this hardware information in CMOS.

Different BIOS are available today for PCs. For example: AMI, Award etc. Among different BIOSes Award is a popular and easier one. In this lesson we have discussed about how to configure an Award BIOS for hard disk installation. Configuring any other BIOS is almost similar.

Here two methods to configure CMOS is discussed. One for ‘plug and play’ BIOS and another for non-‘plug and play’ BIOS.

Plug and play BIOS means, a BIOS which can automatically detect a new hardware and get configuration information form the hardware automatically, during startup or installation of the hardware. Today most of the BIOS are plug and play. Some older BIOS (for example, BIOS of 386 and some old versions of 486 based computers) does not support plug and play.

3.2.1. Configuring CMOS by Plug and Play BIOS

Steps to configure Award ‘plug and play’ BIOS for hard disk installation:

♦ Restart the computer.
♦ Press <Delete> when the prompt: “Press DEL to enter SETUP” appears.
Now the “CMOS SETUP UTILITY” comes. If it asks for password, give the password.

Now you can access the main menu of CMOS setup utility. Select the “STANDARD CMOS SETUP” option.

A screen like the figure 3.1 appears. It shows four options for four hard disks:

- Primary Master
- Primary Slave
- Secondary Master
- Secondary Slave.

Select the option as which you want to install the hard disk.

![Figure 3.1: Standard CMOS setup.](image)

For example, to install a new hard disk as primary slave, go to “Primary Slave” in the “HARD DISKS” column and then go to and “TYPE” “MODE” column of the “Primary Slave” row.

- If there is an “AUTO” in the “TYPE” and “MODE” column of “Primary Slave” row then no change is necessary. Otherwise change the mode and type to “AUTO” using <PageUp> or <PageDown> key. Setting the mode of primary slave to auto means that, every time your computer starts it will collect the hard disk configuration (size, no of heads, tracks, sectors etc.) from the hard disk automatically.

- Press <Esc>.
- The prompt: “Save options and exit?” appears.
- Press <y>.
- Again the computer reboots but now with your hard disk installed.
Microcomputer Troubleshooting

If one time all the modes of your four hard disks are changed to auto and saved, then it is not necessary to change the mode to auto again, while installing another hard disk. Just connect the hard disk and restart the computer, but changing CMOS configuration is not necessary.

3.2.2. Configuring CMOS by Non Plug and Play BIOS

Steps to configure a non ‘plug and play’ BIOS for hard disk installation:

♦ During startup go to ‘CMOS setup utility’ by pressing <DEL>
♦ Go to ‘hard disk auto detection’.
♦ BIOS will show the detected configurations of your hard disks.
♦ If you agree with these detected configurations, press <Y> for yes.
♦ Exit from CMOS setup utility by saving newly detected configurations.

3.3. Exercise

3.3.1. Multiple choice question

a. To auto detect the primary master, the type and mode column should be set to

i) Normal
ii) LBA
iii) User
iv) Auto.

3.3.2. Questions for short answers

a) What does play and play means?
b) Write the name of different of BIOS.
Lesson 4 : Partitioning and Formatting

4.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ How to partition a hard disk drive
♦ How to format a hard disk drive.

4.2. Hard Disk Partitioning

Partitioning a drive means dividing a hard drive in several independent portions so that each portion works as an independent hard disk. We can make more than one drives in one hard disk using partitioning. For example, if we install one hard disk in the PC chassis, by partitioning we can make 3 drives named as C:, D: and E: in the one disk.

DOS 6 supports hard drive of maximum size 2.1 GB. DOS does not support more than 2.1 GB size of hard drive. So we can not use a 5.1 GB drive directly in DOS. To use it in DOS it should be partitioned in several portions so that each portion is not larger than 2.1 GB. So to use the 5.1 GB Hard disk in DOS environment it may be partitioned to 3 drives with size of:

♦ Drive C: 2.1 GB
♦ Drive D: 2.1 GB
♦ Drive E: 0.9 GB

Some times two operating systems may not reside in one drive. They may require one separate drive for each operating system. To run all these operating systems in one hard disk, the disk should be partitioned.

To make a disk usable it should be partitioned. Even if we make only one drive from a hard disk, then it should also be partitioned.

Some reasons of partitioning:

♦ Making a hard disk usable
♦ Dividing a disk to get several drives
♦ Dividing a large disk in smaller size so that DOS can support it.
♦ Running several operating systems in one hard disk.
4.3. Physical and Logical Drive

By partitioning a physical drive as divided in one or may logical drive(s). Physical drive is the hard disk hardware itself. Logical drives are the virtual drives those are created in a physical drive.

In the previous 5.1 GB hard disk example, the 5.1 GB hard disk is the physical drive and the 3 partitioned hard disks (2.1 GB C:, 2.1GB D: and 0.9 GB E:) are logical drives.

4.4. Overview of How to Partition

Partitioning a hard disk means chopping it in to several parts. Steps required in partitioning a hard disk.

- At first a primary DOS partition should be made. Its maximum size is 2.1 GB:
- If any part of the hard disk remains outside the primary DOS partition, then an extended DOS partition should be made using the remaining portion.
- One or more than one logical drives should be made in the extended DOS partition so that, size of each drive is not more than 2.1 GB.

Figure 4.1 shows how a 5.1GB hard disk can be partitioned into several logical drives. Steps required in partitioning an example 5.1 GB hard disk in to 3 logical drives, of which 2 has the maximum allowable size by DOS:

![Diagram of hard disk partitioning](image-url)
Troubleshooting Specific Devices –I

- Making a primary DOS partition with maximum allowable size 2.1 GB (Figure 4.1a)
- Making an extended DOS partition with the rest of the hard disk 3.0GB (Figure 4.1a)
- Dividing the extended DOS partition in 2 logical drives with size 2.1 and 0.9 GB (Figure 4.1c)

4.5. Using Partitioning Software: FDISK

We can use FDISK to partition a hard disk. In this section we shall discuss how to partition a 5.1 GB hard disk in 2.1, 2.1 and 0.9 GB drives. Using this example you can partition any hard disk to any size. Remember that, partitioning a hard disk erases all data in it. So before partitioning, be sure that there is no important data in the hard disk, which should not be erased.

- Copy all-important data from the hard disk to another one. If the hard disk to partition is an older one then copying is necessary. For a new hard disk, copying is not necessary because it is blank.

- Insert a floppy containing ‘FDISK.EXE’ in the floppy drive. You will find this software with MS-DOS.

- Run FDISK.

- A menu named “Fixed Disk Setup Utility” with the following 5 choices comes:
  1. Create DOS partition or logical DOS drive.
  2. Set the active partition
  3. Delete partition or logical DOS drive.
  4. Display partition information.
  5. Change current fixed disk drive

Press <1> to select choice-1.

- A menu named “Create DOS Partition or Logical DOS Drive” with the following 3 choices appears:
  1. Create Primary DOS Partition
  2. Create Extended DOS Partition
  3. Create Logical DOS Drive(s) in the extended DOS partition

Press <1> to select choice-1.

- Now a screen named “Create Primary DOS Partition” appears. It asks, if the primary DOS partition will be of the maximum size. Press <Y> (for ‘yes’), to create the primary DOS partition with the maximum allowable size (2.1GB).
After creating primary DOS partition, you are again at the main menu: “Fixed Disk Setup Utility”. Again press <1> to go to “Create DOS Partition or Logical DOS Drive” menu.

On the “Create DOS Partition or Logical DOS Drive” menu, press <2> to create extended DOS partition.

Now a screen titled “Create Extended DOS Partition” appears. This screen contains a prompt: “Enter partition size in Mbytes or percent disk space (%) to create an Extended DOS Partition”. This prompt shows the size of the rest of the hard disk, which is approximately 3000 MB (or 3GB).

Press <Enter> to select this 3GB as size of the extended DOS partition.

“Create Logical DOS Drive in the Extended DOS Partition” → 2100MB.

“Create Logical DOS Drive in the Extended DOS Partition” → 900MB.

4.6. Formatting the Partitioned Drives

After partitioning the logical drives should be formatted. Formatting prepares a disk ready to use. Formatting makes the following 3 things in a logical drive:

- DOS boot record: This program contains a program that is used during booting (computer startup).
- FAT (File Allocation Table): This table contains the mapping of the files on the logical drive.
- Root directory: It is the root of the tree structured file system

To format a drive in DOS you have to use the FORMAT command. To format any drive (for example C:), you have to follow the following steps:

- Insert a disk containing the file FORMAT.COM
- On the DOS prompt enter the command: “FORMAT C:”
- When the warning prompt like: “All data will be lost. Proceed with format (Y/N)” appears press <Y>
- You are asked to give the volume label. Enter the name, that you want to give the logical drive.
Use these steps to format all other logical drives, except use the command “FORMAT D:” and “FORMAT E:” to format the drives D: and E: respectively.

Now the physical drive is ready to use with 3 logical drives.

4.7. Exercise

4.7.1. Multiple choice questions

a. If a hard disk is divided into two partitions then the name of each partition becomes

i) A: and B:
ii) B: and C:
iii) C: and D:
iv) D: and E:

b. The Software used to partition a hard disk drive is

i) FDISK
ii) FORMAT
iii) SYS
iv) XCOPY.

4.7.2. Analytical questions

a) What does hard disk partitioning mean? Discuss the method of using any hard disk partitioning software.
b) Discuss the way of formatting a hard disk.
Lesson 5: Installing Floppy Disk Drive

5.1. Learning Objectives

On completion of this lesson you will be able to describe:

- How to install floppy disk drives.

5.2. Introduction

Different types of floppy drives are available today. Installation method of different types of floppies (3 ½, 5 ¼ etc.) in different types of computers (AT, PS/2, clone etc.) are slightly different. Of them, installing method of a 3 ½ drive in a modern clone is discussed here. It is discussed here because it is the most popular type of computer in our country. Other types of installations are nearly similar.

The steps to install a 3 ½ inch floppy disk drive as drive 'A:' are as follows:

- Place the drive in PC chassis
- Connect the cables
- Configure CMOS.

5.3. Place the Drive in PC Chassis

The steps to place a 3 ½ inch floppy disk drive are as follows:

- Open the computer casing.
- Insert the floppy disk drive in the 3 ½ inch wide drive bay of the chassis.
- Insert the screws in the screw holes on both the sides of the drive.

5.4. Connecting the Cables

Two cables are connected with a floppy disk drive power and data.

Power cable is a 4-wire cable. It comes out from the power supply unit. It is connected with the power cable-connecting slot of the floppy disk drive. It is not possible to connect the power cable in opposite direction.

Data cable is a 34-wire cable with 3 connectors and a twist at one end. The opposite end of the twist is connected with the floppy drive.
disk controller (or the motherboard, because nowadays the floppy disk controller is built in the motherboard). If we have two floppy drives then one should be drive ‘A:’ and the other should be drive ‘B:’. The drive, which we want to use as drive ‘A:’, is connected with the twisted end of the cable. Now only one connection point on the cable is left. It is the middle connection point. If we have another drive it is connected with the middle (non-twisted) connection point of the cable to use this drive as drive ‘B:’.

While connecting the cable, we should careful about proper direction. The wire-1 of the cable should be connected with the pin-1 of the motherboard (i.e., floppy disk controller) and pin-1 of the floppies. The method of identifying wire-1 of the cable and pin-1 of the motherboard and the floppy drives is discussed below:

- Identifying wire-1 on the cable: The wire-1 on the cable is marked by a dark line.

- Identifying pin-1 on the motherboard: We have to look for a 34-pin slot on the motherboard. You will find one such slot. Normally a ‘FDD’ sign is printed by the side of the slot. If no sign indicating slot number is printed on the motherboard, then get the motherboard’s manual. In the manual you will find which is the ‘FDD’ or ‘Floppy Disk Drive’ slot.

- Identifying pin-1 on the drive: In the 34-pin slot of the floppy driver, the pin nearest the power cable slot is the pin-1. So you have to insert the data cable in such a way that the dark line on the cable (i.e., wire-1) is near the power slot. If you insert the data cable in wrong direction then the hard disk will not work and the disk light of hard disk will glow continuously.

After identifying the wire-1 and pin-1, connect the cable in the proper direction. The figure 5.1 shows the cabling scheme of floppy disk drives.

![Fig. 5.1: Cabling floppy disk drives.](image-url)
5.5. Configuring CMOS

To install a new floppy disk drive, BIOS should be informed about the arrival of a new floppy disk drive. BIOS is given this information by storing the configuration (physical size if the drive and the capacity of the disk it can drive) of the floppy disk drive in CMOS.

Different BIOS are available today for PCs. Among different BIOSes Award is a popular and easier one. In this lesson we have discussed about how to configure an Award BIOS for floppy disk drive installation. Configuring any other BIOS is nearly similar.

Steps to configure Award BIOS to install a 3 ½ inch 1.44 MB floppy disk drive as drive ‘A:\'

- Restart the computer.
- Press <Delete> when the prompt: “Press DEL to enter SETUP” appears.
- Now the “CMOS SETUP UTILITY” comes. If it asks for password, give the password.
- Now you can access the main menu of CMOS setup utility. Select the “STANDARD CMOS SETUP” option.
- A screen like the figure 5.2 CMOS appears. It shows options for two floppy disk drives. Using arrow keys go to the options for drive ‘A:\'

![Fig. 5.2: Standard CMOS setup.](Image)

- Using the ‘Page Up’ and ‘Page Down’ keys, you can select any one of the 6 options for drive ‘A:\’. The 6 options for drive ‘A:\’ are:
  - None
  - 360K, 5.25 in.
Troubleshooting Specific Devices – I

- 1.2M, 5.25 in.
- 720K, 3.5 in.
- 1.44M, 3.5 in.
- 2.88M, 3.5 in.

Select the ‘1.44M, 3.5 in.’ option for drive A:

- Press <Esc>.
- The prompt: “Save options and exit?” appears.
- Press <y>.
- Again the computer reboots but now with your floppy disk drive installed.

5.6. Exercise

5.6.1. Multiple choice questions

a. The twisted end of floppy disk drive cable is connected with the drive

i) A:
ii) B:
iii) C:
iv) D:

b. The data cable has

i) 4 wires
ii) 8 wires
iii) 34 wires
iv) 40 wires.

c. Capacity of a 3.5 inch floppy disk drive is

i) 360 KB
ii) 1.2 MB
iii) 1.44 MB
iv) 1.44 GB.

5.6.2. Analytical question

a) Discuss the installation process of a 3.5 inch 1.44 MB floppy disk drive.
Lesson 6: Floppy Drive Maintenance and Troubleshooting

6.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ Floppy drive maintenance
♦ Troubleshooting floppy disk drive.

6.2. Floppy Drive Maintenance

Many problems of floppy disk drive can be avoided by preventive maintenance. The maintenance includes cleaning the drive head, protecting the disk from over heat, cold, dust, smoke, bending etc.

6.2.1. Clean the Heads

Floppy drives have electromagnetic read/write head, which performs reading and writing operations. While accessing the diskette may get some of the coating of the diskette onto itself. To remove it from the head, cleaner can be used.

The floppy cleaner is floppy-shaped cotton. It rubs away the coating, collected on the head. Some cleaners are abrasive. The wear the head after each use. These types of cleaner should be avoided. Instead of this, cotton cleaners are safe for floppy drive head.

Cleaning is necessary only when the drive can not read or write. It is not necessary to use it periodically or once a week.

6.2.2. Defending Diskettes

Diskettes should be protected from excessive temperature, dust, smoke and dirt and bending. Vendors claim that diskettes should never be stored below 50 degrees and above 125 degrees. Smoking near the computer should be avoided, because it is bad for the drive. Permanent and electromagnetic magnets can cause loss of data on the disk. Bending it while carrying may damage the diskette also.

If the diskettes are left unused for a long time then it may infected by fungus. After long time when the disk is run in the drive then many bad sectors may be found. To prevent this the disks should be run in the driver periodically at least after each two weeks.
6.3. Troubleshooting

The troubleshooting method of floppy disk drive is just to find out the faulty component and swap it with a good one. Troubleshooting in the mechanical components and electronic circuitry of the drive is very difficult, time consuming and almost unprofitable. Some floppy drive problems and corresponding troubleshooting is discussed here.

6.3.1. Disk Light Glows Continuously

If the data cable (34-wire) is connected in opposite direction, then the disk light glows continuously. To solve this problem, just change the direction of cable connection with the floppy disk drive.

6.3.2. The Drive Refuses to Read or Write

There may be a lot of causes when a drive can not read or write. Example causes are:

- The drive has failed
- The cable has failed
- The controller has failed

Steps for troubleshooting are:

- Clean the drive with disk cleaner.
- Open the PC casing. Reseat the cable on the motherboard (or controller card) and drive tightly.
- If the drive does not work properly after the previous steps, then swap the cable with a working cable from another computer. If the drive works properly after replacing the cable then it can be said that the trouble is in the cable. So it should be replaced permanently.
- Swap the drive with a good one. If after replacement, it works properly, then replacement should be made permanent.
- If after replacing both the drive and cable, it does not work, then it can be said that the problem is in the controller (or motherboard). So it should be replaced.

6.3.3. Bad Power Delivered by the Power Supply Unit

A floppy drive may not work properly even after the replacement of the complete subsystem by a good one. This may be happened for a bad power supply unit. At the back of the drive you will find four solder points those connect the power cable connector with the floppy. They may be labeled as “+12V GND GND +5V”. These
lines can be tested by a multi-meter during the drive is operating. Put the black probe of the multi-meter on the GND and the red probe on the 5V or 12V pin. If it shows the voltage is between 4.8-5.2 V on the 5V pin and between 11.5-12.6 on the 12 V pin, then the power supply is good. Otherwise it is faulty and should be replaced.

6.3.4. The On-Drive Electronics have Failed

On each floppy there is a PCB (Printed Circuit Board). If this board become defective then he floppy will not work. You can collect the replacement of this PCB from old dead floppies.

6.4. Exercise

6.4.1. Multiple choice question

a. If the data cable is connected in the opposite direction then

i) The drive sounds.
ii) The drive makes no trouble.
iii) The drive is damaged.
iv) The drive light continuously glows.

6.4.2. Analytical question

a) Discuss some common troubles and corresponding troubleshooting for a floppy disk drive.
Unit 6 : Troubleshooting Specific Devices – II

This unit contains the discussion about the problems and the troubleshooting of the devices external to the computer. Lesson 1 to 3 contains the discussion about keyboard, mouse and monitor. Troubleshooting and maintenance of different types of printers is discussed in lesson 4 and 5.

Lesson 1: Troubleshooting Keyboard

1.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ The keyboard interface hardware
♦ Troubleshooting the keyboard.

1.2. The Motherboard Keyboard Interface

The interface between the keyboard cable and the system, unit. This is a DIN plug which has five pins, all numbered oddly. Figure 1.1 shows the connector on the system unit side.

![Keyboard interface connector](image)

Fig. 1.1: Keyboard interface connector.

1.3. The Keyboard Connector

The keyboard cable runs from a DIN connector, which attaches to the system unit to a flat-jaw, type connector inside the keyboard housing. The cable has five wires, and can be checked for
continuity quickly with an ohmmeter: disconnect the cable inside the keyboard and test each line.

1.4. Troubleshooting the Keyboard

The easiest way of troubleshooting the keyboard is buying a new one by approximately 350 taka and replacing the old one. A new keyboard normally makes no trouble in about 2 or 3 years.

On the other hand if you want to go inside the keyboard, then you’re kind of making a choice: do you really want to spend four hours playing around inside a keyboard, four hours that may be totally fruitless, or do you just spend 350 taka on a new keyboard?

You can check the following things for keyboard troubleshooting:

1.4.1. Is It Plugged In

On the back of many computers there is a keyboard port. Unplugging or plugging loosely the keyboard into the port will not work.

1.4.2. Is It One Key or All Keys

If only one key is malfunctioning, check that key’s spring. Remove the key by grabbing it with your fingers and pulling up. For the tough keys, fashion a hook from a paper clip or, again, use a chip puller. Under the key you will see a spring. Replace the key cap and see if the problem goes away. If not, try pulling the spring out just a little. Then replace the key cap.

1.4.3. Checking the Cable Continuity

Next, test continuity of the cable. Turn the keyboard upside down so that the cable is coming out of the back of the keyboard, to the right. Remove the two screws. The bottom plate will swing back and up to remove.

You will now see the cable splits to a single wire, which is grounded to the bottom plate, and a cable with a flat-jaw connector. Push apart the jaws of the connector to release. You can then test each of the five wires for continuity with your ohmmeter.

1.4.4. Completely Disassembling the Keyboard

Remove the main assembly from the keyboard case. With a vise, or C-clamps, set up a support for the keyboard assembly on the
sides. If you don’t support it on the sides, all hell will break loose when you remove the back metal plate. (Remember those springs on each paddle?)

Alternatively, you can make your life easier by removing all the key tops. But, again, don’t do it unless you’ve got another keyboard that you can use as a guide to replacing the key tops.

A printed circuit board with capacitive pads on it is held against a metal plate by 10 metal tabs—five above, five below—and a hex screw. You must use a pliers to unbend the tabs enough to remove the plate. Position the assembly so that the plate is on top (not the printed circuit board), then remove the metal plate.

The plate has been holding dozens of plastic paddles against the printed circuit board, one for each key. These are small, flat, easily-broken pieces of plastic shaped like the outline of a castle turret, or the rook symbol in Chess. What you are looking for is a broken paddle. Replace any broken paddles and replace the metal plate.

The other reason to attempt this is if you’ve poured hot coffee into the keyboard. Very carefully remove all of the paddles and clean them as well as the bracket that they sit in. Then use alcohol to clean the capacitive PC board. Then reassemble.

Replacing the metal plate is a bit difficult. Position it correctly, then use clamps to hold one side together while you bend the tabs on the other side into place. Again, it is very easy to damage paddles at this point. Where do you get replacement paddles? No one sells them, that I know of. Get them from the first keyboard that dies: it’s good for 101 replacement paddles.

1.5. **Exercise**

1.5.1. **Multiple choice question**

a. The keyboard cable has

i) Berg connector
ii) Molex connector
iii) DIN connector
iv) RJ-45 connector.

1.5.2. **Questions for short answers**

a) What is the easiest way keyboard troubleshooting?
b) What should you do if only one key malfunctions?
Lesson 2 : Troubleshooting Mouse

2.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Different types of mouse
- Mouse maintenance
- Troubleshooting mouse.

2.2. Introduction

Mice are in some ways simpler devices than keyboards; after all, they've only got two or three buttons, to the average keyboard's 101. But mice have some moving parts that can go seriously wrong.

2.3. Mouse Types

Basically, mice work in this way: you move them, they figure out somehow how much you've moved them, and then they transmit that information to the computer. The "how they figure out how much you moved them" and the "transmit the data to the computer" part is how mice vary.

2.3.1. Mouse Positioning Methods

Most mice are mechanical, meaning that they use some mechanical method for detecting motion. The mechanical part is a ball on the bottom of the mouse. Take the mouse apart (there's a retaining ring; turn it and the ball falls out, rolling under something), and you'll see three little wheels that turn when the ball moves against them.

Two of those wheels are monitored electronically; when they turn, they transmit how much they turned to the computer. The two wheels are perpendicular to one another, so one tracks X-axis motion and one tracks Y-axis motion. The third wheel is just a wheel.

The other kind of mouse positioning mechanism is the optical mouse. This has no moving parts. The mouse has optical sensors on the bottom of it; planted on grid on a special mouse pad. As you move the mouse, its sensors see the grid lines running across the pad and report them to the PC.
2.3.2. Mouse Interfaces

Most mice connect to a PC via a serial port. Some use a proprietary interface.

There have been several proprietary mouse interfaces over the years, but the most common are the Microsoft bus mouse interface and the IBM PS/2-type interface, which is very like yet another Microsoft interface, the InPort interface. All three interfaces use a miniature DIN connector as a plug.

2.4. Mouse Cleaning and Maintenance

On a mechanical mouse, the little wheels get gunk in them, so clean them. Just remove the mouse ball and examine the wheels. I've used rubbing alcohol and a Q-tip to get the gunk off the wheels. Clean the mouse about twice a year, unless your desk is covered with dirt or dust, as dirt and dust are just gunk in its fetal stages.

On an optical mouse, just clean the sensors often just polish them with a soft cloth. Keep the mouse pad clean as well so that the grid-lines are visible to the sensors.

2.5. Mouse Troubleshooting

First, check the driver. Is the mouse driver set up correctly? Is it there in the first place? Next, clean the mouse.

Second, check the interface. If it's a serial port, then check the serial port. If it's a direct mouse port of some kind, then double-check that it's not installed with an interrupt conflict.

If the mouse doesn't work after these steps then buy a new one by approximately 400 taka and make replacement.
2.6. Exercise

2.6.1. Multiple choice question

a. Most mice are

i) Optical
ii) Electromagnetic
iii) Mechanical
iv) Thermal.

2.6.2. Questions for short answers

a) Classify different types of mouse.

b) Discuss the mouse cleansing method.
Lesson 3 : Troubleshooting Monitor

3.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ Monitor troubleshooting common rules
♦ Some common monitor problems and their troubleshooting.

3.2. Common Troubleshooting Rules

Once you have a system in place, how do you attack video problems? Here are a few suggestions.

Some of the dumbest monitor problems are the easiest to resolve. Is it turned on?

♦ Is the brightness or contrast turned down?
♦ Is everything plugged in? Is it plugged into the right place?
♦ If you are using a multiple display board, are the DIP switches and jumpers set for a mono display or RGB? If you set it for RGB and plugged in mono, throw away the mono monitor.
♦ Has someone cleverly convinced DOS to display black letters on a black background? Reboot.
♦ Did you hear one long and two short beeps indicating a bad video card?
♦ If using an old multi-speed XT computer, is it in Turbo mode? The display memory may not be fast enough in the higher speed mode. Drop back to the lower speed. If the problem goes away you’ll probably have to replace the memory on the display board.
♦ There are non-video reasons for a display "malfunction." Such as when the power supply has killed the computer. If the display is dead, do you hear the power supply fan? Try typing DIR blind. If the computer is okay but the display is bad, you will see the drive light come on. Use a sound-emitting program to see if the computer is functioning.
♦ Are the motherboard DIP-switches set correctly for your display adapter?

The quickest test is a monitor swap. If that does nothing, swap the display cards, then the cable.

If the display card is the problem, does the usual easy stuff: check the seating of the socketed chips. Clean the edge connector and the video connectors. Try again.
Don't try to service the monitor. It is dangerous because you can hurt yourself doing that.

Use VGA mode to troubleshoot display problems. Modern GUI operating systems require video drivers to support the variety of modern video boards. Sad to say some of those drivers are quite buggy. If your operating system is failing in mysterious ways, or if you're seeing strange video behavior, then try just loading the VGA driver; if the problems go away then it was a driver problem. Similarly, many boards support a mode called VESA, which is another standard, but of higher resolution. That may work.

Speaking of drivers, sometimes you'll see a case where you reboot your operating system, only to lose synchronization-the screen turns into moving bands. That probably means that you told your video board to exceed the capabilities of the monitor; drop back a bit in resolution and you'll be okay.

3.3. Troubleshooting Some Common Problems

If the display screen remains dark after the system is turned on:

- Make sure that the monitor’s power switch is on.
- Check that one end of the monitor’s power cord is properly attached to the monitor and the other end is plugged into a working AC outlet. If necessary try another outlet.
- Check that the video input cable is properly attached to the monitor and the system's display adapter.
- Adjust the brightness of the display by turning the monitor’s brightness control knob.

The picture seems to be constantly moving:

- The monitor has lost its vertical sync. Adjust the monitor's vertical sync.
- Move away any objects, such as another monitor or fan that may be creating a magnetic field around the display.
- Make sure your video card's output frequencies are supported by this monitor.

The screen seems to be constantly wavering:

- If the monitor is close to another monitor the adjacent monitor may need to be turned off. Fluorescent lights adjacent to the monitor may also cause screen wavering.
3.4. Exercise

3.4.1. Multiple choice question

a. If the picture seems to be constantly moving then
   i) The monitors power switch is off.
   ii) The video input cable is not properly attached.
   iii) The adapter cased is not properly inserted.
   iv) The monitor has lost its vertical sync.

3.4.2. Analytical questions

a) Discuss the common troubleshooting rules for a monitor.

b) Discuss some common monitor problems and there troubleshooting.
Lesson 4: Printer Maintenance

4.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ An overview of the printer problems
♦ Maintenance of different types of printers.

4.2. Introduction

Printers can be a real maintenance headache. As they produce tangible results (pieces of paper), malfunctions with printers can be more upsetting than their wholly electronic brethren. For example, try telling Windows that you’ve got a Hewlett-Packard laser printer configured as a PCL5 device when you actually have a PostScript HP printer, then print a graph. The printer will start spewing out pages, as if angry for being misrepresented.

Most of the printer problems are software-related issues. The hardware problems more often seem to be cable or printer interface problems, now that the old daisy wheel printers are pretty much gone and forgotten. I use mainly laser printers.

4.3. Components

As with other peripheral troubleshooting, start your diagnosis from the three main pieces: a controller (the parallel or serial interface board), a cable, and a printer. The parallel port is simple enough that it is commonly included on other expansion boards (although it’s undergone some changes over the years).

4.4. Maintenance

A few things can be done to maintain printers of all types. Vacuum out the paper chaff periodically from the inside of the printer. Determine if there is a belt tightening mechanism for the printer – usually a motor moves the print head via a belt. Find the correct tension values. Keep a replacement belt on hand.

If you’re using an impact printer like a dot matrix or daisy wheel printer use a dry, soft cloth to clean both the paper path and the ribbon path. Most manufacturers suggest cleaning every six months, as the ribbon path can build up a film of inky glop, which causes the ribbon to jam. To do this, go to a drag store and buy a dispenser box of 100 clear plastic gloves. Use them when working on the printer (but not chips and boards—that plastic can build up...
some mean static) so that you don’t have to wash your hands for hours to remove the ink.

Most printers do not need to be lubricated in everyday use. In fact, oil can do considerable damage if applied to the wrong places. If you thoroughly disassemble the printer then you will probably have to lubricate various points as you reassemble it. If you intend to do this, I strongly recommend that you get a maintenance manual from the manufacturer.

Here’s a tip that will extend the life of both your ribbon and your head: put some WD40 lubricant on a used ink ribbon. Let it soak overnight. It’ll produce good output the next day and you won’t damage the print head. WD40 is a good lubricant for print heads. Let me stress, however, that this only applies to ink ribbons. If you have a thermal transfer printer like an IBM Quietwriter or an Okidata 20, this will not work.

4.4.1. Dot Matrix Printers

The expensive part of a dot matrix printer, which dies, is the print head. Print for too long a time and the head just burns up. This is not as much of a problem for the newer printers as it was for the old Epsons and Okis. The models out today have a thermistor which shuts down the printer temporarily if the print head overheats. If the thermistor becomes ill, the printer shuts down regularly. Generally thermistors are pretty robust, but if such a thing happens try changing the thermistor first; it’s a lot cheaper than a print head.

On older Epson printers I am told that replacing print head is not really a reasonable fix, as the print heads usually take the circuit boards with them when they burn up.

Replacing print heads is not economical on many printers because of the high price that manufacturers charge for replacements; often it is a significant percentage of the entire cost of the printer.

Dot matrix printers are, in general; very reliable, but keeping the print head cool is vital. Don’t stack things on or around the printer.

4.4.2. Ink Jet Printers

A variation on the typical dot matrix printer is the ink jet printer. Rather than hammering at a ribbon, the ink jet squirts a narrow jet of ink at the paper. This is very quiet, but the jets tend to clog, leaving partial letters on the page. The answer here is simple:
remove the cartridge and push on the ink sack with a long thin tool, like a straightened-out paper clip. The ink will push out the small holes, unclogging them. With the HP ThinkJet, it's a pretty regular procedure. The Seiko color ink jet has the same problem.

4.4.3. Laser Printers

The laser printer is very similar to a copy machine. Having said that, it's amazing that they are as reliable as they are.

The most common laser engine is made by Canon. The HP LaserJet, the AppleWriter the Canon Al/A2, the QMS Kiss, and others are all built around the Canon engine. These need no maintenance except for a new cartridge every 3000 copies or so. The cartridges cost in the neighborhood of Tk-3000, and, according to HP contain all that is needed for routine maintenance. So, you are performing routine maintenance every time that you change your cartridge.

It's okay to recharge cartridges. Make sure your refill company completely rebuilds the insides, including replacing the photoelectric drum. Avoid the "drill and fill" vendors, as they don't replace the insides, and using that kind of refill will lead to a lower quality print image and may damage the laser printer.

Lasers require proper ventilation and a fair amount of power. Other than that, don't pour any Cokes in them and they last a long time. Never ship a laser with a toner cartridge in place. It can open up and cover the inside of the laser with toner.

4.5. Exercise

4.5.1. Multiple choice question

a. Most of the printer problems are

i) Paper related
ii) Ink related
iii) Software related
iv) Print head related.

4.5.2. Analytical question

a) Discuss about different types of printers, and their maintenance.
Lesson 5: Troubleshooting Printers

5.1. Learning Objectives

On completion of this lesson you will be able to describe:

✦ Different types of printer problems
✦ Solution to different problems.

5.2. Introduction

It's hard to discuss printer troubleshooting without delving too deeply into the specifics of the thousands of models out there. I haven't got the space to do that (or, truthfully the time to get to know all of those printers), but there are some generic pieces of advice.

5.3. Isolate the Problem

As always, try to isolate the problem: something in the computer or its software? The printer interface? The cable? Is the printer plugged in, cabled and on-line? The steps should be:

✦ Check if it is on-line, plugged in, has paper, and is turned on.
✦ Cycle power switch on printer, reboot, and retry.
✦ Use printer self-test mode to see if the test page prints correctly.
✦ Check that the software is configured for the printer.
✦ Swap cable to test it.
✦ Swap printer to test it. (Use the same type of printer.)

The first thing to try would be to cycle the power switch and restart the software. Also check the ribbon on the printer. Is it worn out in one spot, near the head? Does the ribbon move – check the ribbon transport mechanism. Make sure it isn’t jammed. Is the paper clamp engaged? The paper clamp should be disengaged if you are using tractor feed, or engaged otherwise.

5.4. Cable Lengths

The role of cable lengths in noise and interference is very important. But another problem is overly long cables. Serial cables aren't supposed to be made up longer than 50 feet, and parallel cables should not exceed six feet. If you're using long cables and getting mysterious errors, the cables may be the culprits.
5.5. Setup DIP Switch Problem

Generally, printers must be configured. The most common configuration problem is the AUTO LF or automatic line feed. This says, "every time you get a carriage return, assume that there's a line feed with it." If your computer sends line feeds anyway, everything comes out double-spaced. This is generally adjustable with a DIP switch. Another configuration option – a more and more common one – is emulation mode. Many printers nowadays will emulate a Hewlett-Packard LaserJet of some kind. Unfortunately, some vendors' idea of "Hewlett-Packard compatible" is a blend of fact and fantasy. Anyway, if you've got your Acme Laser Printer set up for HP emulation, don't tell your software you've got an Acme – tell it you've got an HP. This final one is an indication of how international the electronics business is. Many printers speak foreign languages. If you set up your printer For British, you may get the pounds sterling sign rather than a dollar sign. Oh, and by the way, most printers nowadays don't have DIP switches; they support some kind of software setup.

5.6. Software Problems

Is the program configured for the printer? If you just replaced your old Qume daisy wheel with a HP LaserJet, then the software won't work unless you tell it that you have a LaserJet.

On the DOS disk there is a program called GRAPHICS.COM. It allows you to use the ‘Print Screen’ key even when a graphic image is on the screen. (The original PC, without GRAPHICS, will simply ignore graphic data.) Don't install GRAPHICS unless you have an Epson or IBM printer. It won't work. This is because graphic printing commands vary widely among printer types. If you own a HP LaserJet, an Okidata or some other non-IBM printer, you will need replacement software. Contact the manufacturer for it. Laser printers under Windows have some fairly abstract setup options. It's pretty easy to make a printer seem dead or disabled with the wrong driver settings.

5.7. The Mysterious Time Out

Sometimes the computer will sense that the printer is ignoring it: the printer will "time-out". When the computer says, Abort, Retry, Ignore? You choose ‘Retry’ and it works fine. How can you address this problem? Simply add the following DOS command to your AUTOEXEC.BAT: MODE LPT1:, , P

This instructs the computer to retry forever. This means, of course, that you must be sure to have a printer connected, or the
first attempt to print will lock up the computer. If you're using Windows, then look to the Control Panel to modify your printer time out values. Double-click Printers, then your printer’s interface, (like LPT1: or COM1:), and you’ll see a time out value. Set that value to 999, which is similar to the “infinite” value.

5.8. Exercise

5.8.1. Multiple choice question

a. Parallel cable should not exceed

i) 3 feet
ii) 6 feet
iii) 20 feet
iv) 50 feet.

5.8.2. Questions for short answers

a) What are the steps in printer troubleshooting?
b) What is the DIP switch problem? Discuss its troubleshooting.
Unit 7: Preventive Maintenance

The most effective way to save money is preventive maintenance. Many problems in personal computer only happen because of ignorance and inattention, which decrease PC's life. In this chapter a few factors are discussed which can make troubles if their prevention is avoided:

Lesson 1: Heat and Thermal Shock

1.1. Learning Objectives

On completion of this lesson you will be able to describe:

- How excessive heat troubles the computer
- How can we prevent the computer from heat.

1.2. Introduction

Integrated circuit chips get power for its operation. But more than 50% of this power is wasted as heat. This heat can destroy or shorten the lifetime of a chip. So the electronic devices are built in such a way that they can dissipate heat as quickly as possible.

The heat can be prevented in the following ways:

- Install fan where necessary
- Design the box providing good ventilation
- Replace dead fans
- Use heat sensor device
- Use PC in a harmless temperature
- Do not use over the duty cycle
- Prevent from thermal shock
- Prevent from direct sunlight.

1.3. Cooling Fan

Cooling fan can be used to remove extra heat from over heated devices. The following devices can be hotter than others can. So it is better to use cooling fan to prevent them from over heating:

- Power supply unit
- CPU
- Memory
- Drive motors in hard disks, floppy disks and CD ROMs
- Some misdesigned circuit boards.
1.4. Ventilation System

The PC casing should be chosen in such a way that it provides proper ventilation system. Without proper ventilation, the air cannot go out and the PC inside becomes hot. To provide proper ventilation, the back of the casing should have sufficient slots to enable airflow.

1.5. Replace Dead Fans

Sometimes the cooling fan with a device becomes burnt and dead. Then the device becomes excessively hot. But from outside the casing it is difficult to recognize this fault. So it is necessary to check all the fans inside the casing periodically so that if any one is damaged, it can be detected and replaced immediately.

1.6. Heat Sensor Devices

It is always not possible to detect any heating problem inside the CPU immediately. This can be solved by heat sensor devices. They are placed inside the casing and inform about increase of heat beyond safety range.

An example heat sensor device is ‘110 Twin alert’. It is a circuit board that is plugged into the floppy’s connector. Its size is like a business card. When the PC’s inside temperature becomes 110 °F then it marks an annoying noise. At 118 °F it just shuts the computer down. Its cost is approximately Taka 2000/-. Network servers should have one of this.

1.7. Work in Safe Temperature

If the room is cooler then the PC is also cooler. IBM suggests the PC can safely work in the range of 60-85°F room temperature. This is because, the circuit boards can be 125 °F hot. But a normal PC inside can be 40 °F hotter than outside. So 85 °F (= 125 °F minus 40 °F) is the suggested maximum room temperature. This temperature can be provided by air conditioning system.

1.8. Duty Cycle

Devices have duty cycle. It is expressed in percentage (%). Duty cycle is the proportion of time that a device can work without burning up. For example, if a circuit has 60% duty cycle, it can be active 60% of time. Floppy disk drive motors have less duty cycle. Running a floppy motor continuously may burn the motor. But hard disk motors run continuously and they have 100% duty cycle.
Preventive Maintenance

1.9. Thermal Shock

Thermal shock means rapid and large change in temperature. For example, if you bring a running laptop from an air-conditioned room to outside, it may get a sudden increase in temperature. Thermal shock can damage your computer due to expansion/contraction damage because materials expand/contract by the change in temperature.

1.10. Sunbeam

Do not put the PC under direct sunlight. If anybody sits under the sun for a short time he will not feel any problem. But if a metal is left under the sun for say one hour, you will find that it becomes too hot so that it is difficult to touch though the air temperature is reasonable there. So a PC or any device should not be put under the direct sunlight.

1.11. Exercise

1.11.1. Multiple choice questions
a. Duty cycle of hard disk drive motor is

i) 1%
ii) 33%
iii) 66%
iv) 100%.

b. PC can satchy work in the range of

i) $60^\circ - 85^\circ$ F
ii) $0^\circ - 60^\circ$ F
iii) $100^\circ - 150^\circ$ F
iv) $40^\circ - 80^\circ$ F.

c. Cooling fan should be used with

i) Keyboard
ii) Computer operator
iii) Printer
iv) Power supply unit.

1.11.2. Analytical question

a) Discuss how heat and thermal shock can be prevented.
Lesson 2 : Dust

2.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ The sources of dust
♦ Evils by dust
♦ Preventing the PC from dust.

2.2. Sources of Dust

Everywhere in the air we find dust. It consists of

♦ Tiny sand particles
♦ Fossil skeletons of minuscule (very little) creatures
♦ Dead skin
♦ Paper perform
♦ Tiny crustaceans called dust mites
♦ Ash particles.

Some sources of dust are unavoidable. For example, the CRT displays attract dust for their electrostatic charge and some of the dust gets sidetracked and goes into the floppy drive and casing.

Some sources are avoidable if we are careful about them. For example, one fertile source of dust is ash particles. Smoking is too much harmful for computer. A study by the United States Government Occupation Safety and Hazard Administration (OSHA) estimated that, smoking at a computer decreases its life by 40 percent.

2.3. Evils by Dust

Dust does several damages to the computer. For example:

♦ It produces thermal insulation over heat producing devices
♦ It can clog ventilation holes and prevent airflow.

2.3.1. Thermal Insulation

Dust sticks the circuit board inside the computer. As dust builds up, the circuit board can be coated with a sheath of dust, which makes thermal insulation. Thermal insulation is bad for the computer. Because it minimizes the thermal radiation from the components and they can be over heated.
Preventive Maintenance

2.3.2. Clogging Space

Dust can clog space like:

- The air intake area to the hard disk or power supply unit
- The space between the floppy disk and disk drive head

2.4. Dust Cleaning

To avoid the damage by dust, it should be removed from inside the computer periodically. This cleaning should be done once in a year in a house and once after six months in an office. Several tools are available for dust cleaning. For example:

- Compressed air
- Vacuum cleaner
- Wetted cloth
- Air conditioning.

2.4.1. Compressed Air

Compressed air is available in can for cleaning purpose. Though it is called compressed air; it is not really that. It is practically compressed gas. A lot of it is Freon or some other Chlorinated FluoroCarbon (CFC). This CFC harmful for the ozone layer. So while buying, we should look for an ozone-friendly alternative. One of compressed air that is harmless for ozone layer is marketed by ‘Chemtronics’.

While cleaning we should be aware about not to hold the circuit board over the PC chassis. It should be separated away from the PC chassis and then cleaned. If the dust is blown with compressed air keeping the board inside the chassis, and then this dust does not go away – just remains in the chassis.

2.4.2. Vacuum Cleaner

Vacuum cleaner is another tool, which can be used for PC cleaning. It creates air vacuum and sucks the dust inside the vacuum. Vacuum cleaner is better to use with compressed air. The compressed air should blow out the dust and vacuum cleaner sucks it.

2.4.3. Wetted Cloth

A dust free cloth wetted with water and ammonia (few drops) can be used for PC cleaning purpose. But it is not good for circuit
boards. It should be used only for case and brackets. Instead of water, some specialized liquids are also available for PC cleaning.

2.4.4. Air Conditioning

If the air is filtered before entering the room, a lot of dust can be prevented. To prevent the computers from ash particles, the computer room should be declared as no smoking area.

2.5. Exercise

2.5.1. Multiple choices question

a. OSHA estimated that, smoking at a computer
   i) increase its life by 40%
   ii) increase its life by 10%
   iii) Decrease its life by 40%
   iv) Decrease its life by 10%.

2.5.2. Questions for short answers

a) Discuss some evils caused by dust
b) How dust can clog space?

2.5.3. Analytical question

a) Discuss some methods of dust cleansing.
Lesson 3 : Liquid and Corrosion

3.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ How liquids and water can damage computer components
♦ Prevention and cure against this damage
♦ Corrosion, its causes, prevention and cure.

3.2. Water and Liquids

Water and Liquids are introduced into a computer system in one of several ways:

♦ Operator spills
♦ Flooding
♦ Leaks.

3.2.1. Operator Spills

Spills create problem mainly for the keyboard. To prevent this, some people use clear flexible plastic covers on the keyboard. ‘Merit Computer Products’ in Dallas offers such type of plastic covers called ‘SafeSkin’.

If there is no cover on the keyboard and somebody spill a Coke or any liquid in the keyboard, as quickly as possible disconnect the keyboard and flash it out a nearby sink. Then dry it properly and it will be good. It is better to use de-ionized filter water for this purpose.

3.2.2. Flooding

Flooded computers are not destroyed normally. Disassemble the computer and clean the contacts and edge connectors in the boards. To clean the connectors you can use connector-cleaning fluid. Blow out the crevices with compressed air.

Prevention should be taken before flood. Do not keep electrical devices on the floor.

3.2.3. Leaks

Sometimes water may leak from improper roofing. Be aware about not to install PCs under suspicious stains on the ceiling. The PC should also be kept far from the window to avoid rainfall.
3.3. Corrosion

Corrosion oxidizes circuit contacts. When a connector becomes oxidized, the device connected with the connector may not work. Liquids and gases are responsible for the corrosion of PC components. Some corrosive agents are:

- Salt in sweat
- Water
- Carbonic acid and tannic acid
- Cleaning fluids.

Connector cleaner liquids or hard white erasers can clean connectors subjected to corrosion. Pencil erasers should be avoided, because they are acidic. ‘Texwipe’ is a popular vendor for connector cleaning products.

3.3.1. Salt in Sweat

Salt in body sweat can do corrosion. So you should be careful about this. Try to avoid touching edge connectors. Some firms advertise components with gold edge connectors. Corrosion can not affect gold.

3.3.2. Water

Water can come in contact with PC components in several ways (discussed in previous section). We should be careful about this, because water is corrosive element.

3.3.3. Carbonated Liquids

Carbonated liquids contain carbonic acid. Coffee and tea contain tannic acid. These can make corrosion to components. So drinking should be avoided near the computer.

3.3.4. Cleaning Fluids

Some cleaning fluids contain corrosive element. Somebody uses window cleaner to clean the monitor glass. We should be careful about this so that it does not spill inside the PC. If the floor is mopped everyday, the mopping liquid can get into the PC.
3.4. Exercise

3.4.1. Multiple choice question

a. Which one is a corrosive agent?

i) Heat
ii) Electromagnetic interference
iii) Water
iv) Power noise.

3.4.2. Analytical questions

a) Discuss how liquid cans damage computer components. What is its prevention?

b) Discuss about different causes of corrosion.
Lesson 4: Magnetism and Electromagnetic Interference

4.1. Learning Objectives

On completion of this lesson you will be able to describe:

♦ The sources of magnetic and electromagnetic interference
♦ Prevention of these interference.

4.2. Magnetic Interference and Prevention

Secondary data storage of computers (floppy disk, hard disk, and tape) is magnetic device. Data is stored in magnetic oxide coating on these disks. If this magnetic storage is brought near a magnet (permanent or electromagnet), the magnet can change the magnetic orientation in the disks and data can be lost. So it is suggested not bring these magnetic oxide coated devices near a magnet. Some common sources of magnet are:

♦ Electric motors
♦ Phones which ring or chirp
♦ Stereo speakers
♦ Magnets to put notes on a file cabinet
♦ Magnetic paper clip holder
♦ Word processing copy stand with magnetic clip
♦ Magnetic screw driver
♦ CRT display
♦ X-ray machines (#in airports)
♦ Metal detectors.

4.3. Electromagnetic Interference

Electromagnetic interference is caused when unwanted electromagnetism is radiated anyhow and interferes on PC components. Two common types of electromagnetic interference are:

♦ Cross talk
♦ Radio frequency interference.

4.4. Cross Talk

Two physically closed wires transmit electromagnetic wave among themselves. This electromagnetic wave produces cross talk.
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Bundles of data cables are stored in close buildings and they are subjected to cross talk.

4.4.1. Cause of Cross Talk

An electricity-carrying wire does electromagnetic interference on a neighboring wire because:

- Electricity-carrying wires contain electric pulses
- Electric pulses produce magnetic fields
- The neighboring wire is crossed by the magnetic field
- Magnetic fields crossing a wire produce electronic pulses in the wire.

4.4.2. Solutions to Cross Talk

Cross talk can be minimized in several ways:

- Make a distance between the cross-talking wires. (It is not always possible).
- Use twisted pair because it reduces cross talk.
- Use shielded cable. It also reduces cross talk.
- Do not run ribbon cable over six feet.
- Use fiber optic cable. As it is not electromagnetic, there is no cross talk.
- Run cables from a reasonable distance of fluorescent lights. Because these lights emit electromagnetic noise.

4.5. Radio Frequency Interference

Radio frequency has the frequency higher than 10 K Hz. It is generated from different sources. We have radio frequency all around us. When radio frequency interferes different devices it is called Radio Frequency Interference (RFI). RFI is creates problem by interfering high-speed digital devices.

4.5.1. Sources of RFI

Some common sources of RFI are:

- High speed digital circuits (for example, circuits in computer)
- Radio transmitting station
- Cordless telephone
- Cordless keyboard
- Power-line intercoms
- Electric motors (for example, motors in hair dryers, electric razors, electric pencil sharpeners, printers etc.).
4.5.2. PC as a Source of RFI

PC has high speed digital circuits inside. So it generates RFI. According to RFI PC should meet ‘Class B’ specifications defined by FCC. FCC requires that a device at a distance of 3 meters from the PC should not receive more than the following RFI:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Max Field Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-88 MHz</td>
<td>100</td>
</tr>
<tr>
<td>89-216 MHz</td>
<td>150</td>
</tr>
<tr>
<td>217-1000 MHz</td>
<td>200</td>
</tr>
</tbody>
</table>

Table 4.1: Permitted RFI Output (FCC Class B Specification)

4.5.3. How RFI Harms PC

RFI is received by antenna. If we want to receive a signal of a particular frequency, the length of the antenna should be one-fourth of the signal’s wavelength. For example a 7.5 meter antenna picks up a 30 meter wavelength signal. Suppose there is some radio frequency floating around PC and the length of the cable from the PC to the printer is one-fourth of the wavelength of floating around radio frequency, then the cable will receive this RFI. As result of this, printer makes trouble.

4.5.4. Preventing RFI

If the PC is designed in such a way that it generates very little RFI than it also receives little RFI. So the PC should not leak RFI. Any holes in the casing provide RFI leakage. The brackets, supplied with the PC, should be used to cover the unused expansion slots on the back of the casing. The case should fit correctly and tightly.
4.6. Exercise

4.6.1. Multiples choice question

a. Which one of the following devices does not cause magnetic interference?

i) Electric motor
ii) Stereo speaker
iii) Keyboard
iv) Monitor.

4.6.2. Analytical questions

a) Discuss about the sources and prevention of RFI.
b) What is cross fall? How it is caused? Discuss its prevention.
Lesson 5: Power Noise

5.1. Learning Objectives

On completion of this lesson you will be able to describe:

- Different types of power problems
- Solution to these problems.

5.2. Introduction

Power problems can be divided in the following category:

- Power-up power surge
- Transients: spikes and surges
- Over and under voltage.

5.3. Power-up Power Surge

PC user creates this problem. Every time the user power-on the PC it gets surge. When a device is turned on, it draws power up to 4 to 6 times than its normal power. For example if a PC consumes 300-Watt power, during startup it consumes at least 1200-Watt power. This is not good for a PC. In our practical life, we can find several other examples. For example if a light bulb is turned on and off many times in a minute, then it may burn. But keeping it on for a long time there will be no problem.

So the solution of this power-on surge is to keep the PC on as much time as possible. But several other things can be done during the non-working period to increase the PC life and decrease power consumption. For example, turn the monitor off or turn the screen intensity down or use any screen saver program and turn the printer off.

- Keeping the PC turned on for all the time is a good thing only if:
  - The PC is cooled enough. Make sure that the inside temperature of the PC never crosses 125 °F even during the weekend when the cooling system is shut down.
  - Necessary surge protection is available.
  - The AC power supply is reliable. If the main power goes out several times in a week, then the PC is automatically off and on there is no profit of keeping the PC on. Moreover when the
Preventive Maintenance

power comes again after blackout, it is noise-filled, which is harmful for the PC.

5.4. Transients

Transient is spike (much change for a little moment) of voltage. It may be one of the following types:

- Sags: Momentary under voltage
- Surges: Momentary over voltage.

Transients may have a high frequency so that it crosses the protective capacitors of PC power supply unit and damages the chips in the circuit boards inside the PC. Transients affect the chips cumulatively. For example, after the first 500 transients nothing happened. Just the 501st transient damages the IC.

5.5. Over Voltage

We say that we have an "over voltage condition" when we get more than the rated voltage for a period greater than 2.5 seconds do. Such a voltage measurement is done as a moving average over several seconds.

Chronic over voltage is just as bad for your system as transient over voltage: the chips can fail as a result of it.

5.6. Under Voltage

Summer in much of the country means air conditioners are running full blast, and the power company is working feverishly to meet the power demands that they bring. Sometimes it can't meet the full needs, however, and so announces a reduction in voltage called a brownout.

Brownouts are bad for large motors, such as you'd find in a compressor for refrigeration. They make your TV screen look shrunken. And they confuse power supplies. A power supply tries to provide continuous power to the PC. Power equals voltage times current. If the voltage drops and you want constant power, what do you do? Simple: draw more current. But drawing more current through a given conductor heats up the conductor. The power supply and the chips get hot, and may overheat.

Surge protectors can't help you here. A power conditioner can – it uses a transformer to compensate for the sagging voltage.
5.7. Exercise

5.7.1. Multiple choice question

a. Keeping the PC turned on all the time is good if the PC never crosses

i) 50°F
ii) 80°F
iii) 100°F
iv) 125°F.

5.7.2. Question for short answer

a) How transients can damage a PC.

5.7.3. Analytical question

a) Discuss about different types of power problems. What is the solution to these problems?
Answers to MCQs

Answers to MCQs:

Unit 1:

Lesson 1:
a. iv), b. iii), c. ii),
d. i), e. iv)
Lesson 2:
a. ii)
Lesson 3:
a. iii), b. ii), c. iv)
Lesson 4:
a. iv)
Lesson 5:
a. ii), b. iii)
Lesson 6:
a. iii), b. iv), c. i),
d. iv), e. ii), f. ii)

Unit 2:

Lesson 1:
a. iii), b. iii), c. iv)
Lesson 2:
a. ii), b. iii), c. ii),
d. iv)
Lesson 3:
a. ii), b. ii), c. iv),
d. iii)
Lesson 4:
a. iii), b. ii), c. i)
Lesson 5:
a. iii), b. iii)
Lesson 6:
a. ii), b. ii), c. i),
d. ii)
Lesson 7:
a. iv), b. iii), c. iii),
d. iv)
Lesson 8:
a. iii)
Lesson 9:
a. iv)

Unit 3:

Lesson 1:
a.. iii)
Lesson 2:
a. ii)
Lesson 3:
a. iv)
Lesson 4:
a. iii)
Lesson 5:
a. ii)

Unit 4:

Lesson 1:
a. iii), b. iv)
Lesson 2:
a. iii), b. iii), c. iv)
d. iii)
Lesson 3:
a. i), b. ii)
Lesson 4:
a. iii)
Lesson 5:
a. iv)
Lesson 6:
a. iii)
Lesson 7:
a. iv)
Lesson 8:
a. iii)

Unit 5:

Lesson 1:
a. iv), b. iii)
Lesson 2:
a. ii)
Lesson 3:
a. iv)
Lesson 4:
a. iii), b. i)
Lesson 5:
a. i), b. iii), c. iii)
Lesson 6:
a. iv)

Unit 6:

Lesson 1:
a. iii)
Lesson 2:
a. iii)
Lesson 3:
a. iv)
Lesson 4:
a. iii)
Lesson 5:
a. iii)

Unit 7:

Lesson 1:
a. iv), b. i), c. iv)
Lesson 2:
a. iii)
Lesson 3:
a. iii)
Lesson 4:
a. iii)
Lesson 5:
a. iv)
Further Reading


MICROCOMPUTER TROUBLESHOOTING

DCA 3302

Fundamental of a computer is introduced in a self learning style of distance education under Open University system. This book covers the basic components of a microcomputer and its troubleshooting. The book is sailable for a self learner, for students and professionals.

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