Experiment 1: PC Hardware Components

1.1 OBJECTIVES

- Describe how the PC (Personal Computer) works.
- Identify the major internal and external components of a PC.
- Identify the different connectors and cables on a typical PC system unit.
- Assemble and Disassemble a PC.

1.2 INTRODUCTION

This experiment examines the fundamental organization and operations of a personal computer system. As a technician, you should know and be able to identify the components found in a typical personal computer (PC) system. As shown in Figure 1.1, the PC is modular by design. It is called a system because it includes all the components required to have a functional computer.

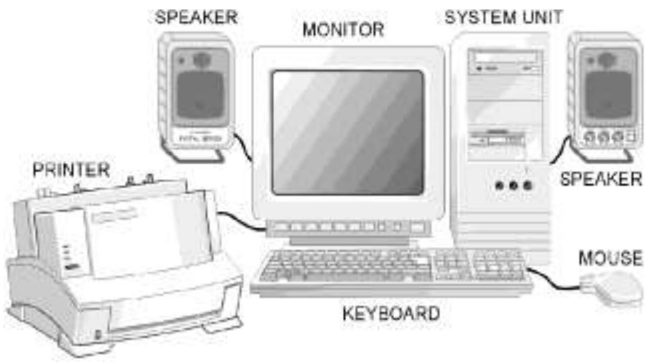


Figure 1.1 A typical personal computer system.

- **System unit**—The main computer cabinet housing containing the primary components of the system. This includes the main logic board (system board or motherboard), disk drive(s), switching power supply, and the interconnecting wires and cables.
- ***Keyboard***—The most familiar computer input device, used to introduce characters and commands into the system. This is accomplished by incorporating a standard typewriter key layout with the addition of other specialized control and function keys.
- ***Mouse***—A popular input device used with graphical user interfaces to point to, select, or activate images on the video monitor. By rolling the mouse along a surface, the user can cause a cursor on the display to move in a corresponding manner.
- ***Video monitor***—A visual output device capable of displaying characters and graphics on a screen. Also, a name for a CRT computer display
- ***Character printer***—A hard copy output device that applies data to paper. Any printer that prints one character at a time. Normally, a dot-matrix, ink-jet, or a laser printer.
- ***Speakers***—Audio output devices used to deliver voice, music, and coded messages.

1.3 INSIDE THE SYSTEM UNIT

The system unit is the main portion of the microcomputer system and is the basis of any PC system arrangement. The components inside the system unit can be divided into four distinct subunits: a switching power supply, the disk drives, the system board, and the options adapter cards, as illustrated in Figure 1.2. Inside a desktop system unit, as depicted in Figure 1.3, the arrangement of its major components can be seen.

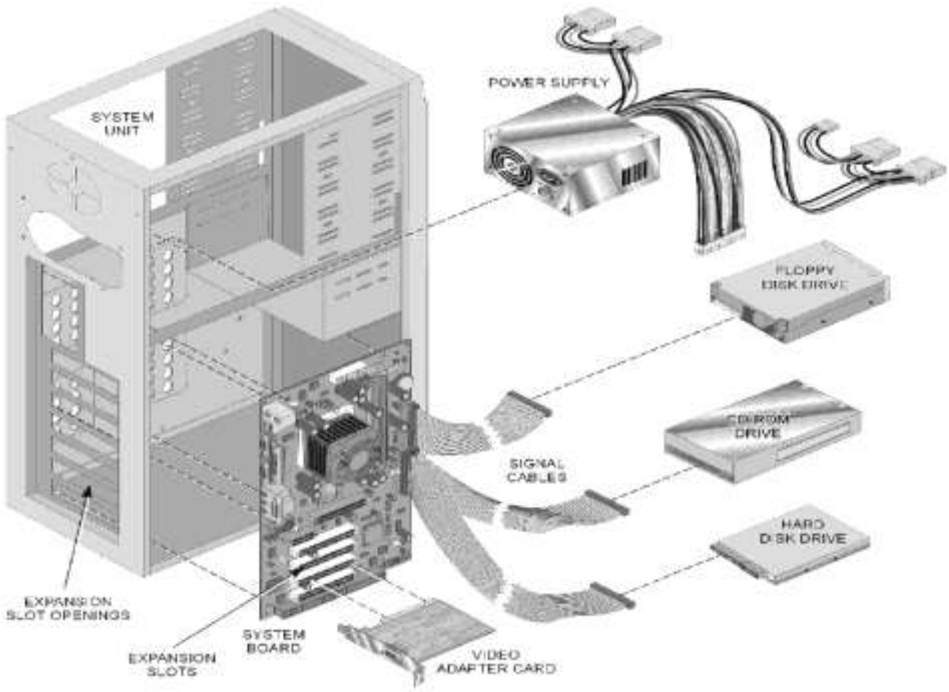


Figure 1.2 Internal system unit components.

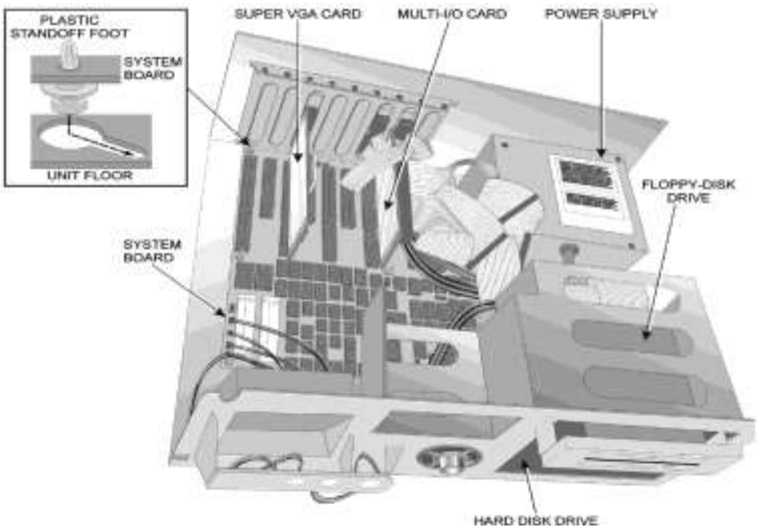


Figure 1.3 Inside a desktop unit.

The major components of interest in a PC system are

- ***System board***—The main component of a personal computer. It contains the major structures that make up a computer system.
- ***Power supply***—The component in the system that converts the AC voltage from the commercial power outlet to the DC voltages required by the computer circuitry.
- ***Disk drives***—The system's mass storage devices that hold data for an extended time, even when the power is removed from the system. Disk drives include floppy drives, hard drives, and CD-ROM drives.

- ***Adapter cards***—Interface cards used to enhance the basic system with additional functions. Examples of common adapter cards include video display adapters, modems, and Local Area Network cards.
- ***Signal cables***—connecting cables, typically configured in a flat ribbon format, that pass control signals and data between system components such as the disk drives and the system board.
  Two common form factors for desktop and tower computers currently exist. These form factors provide specifications for system board and adapter card sizes, mounting hole patterns for system boards and power supplies, microprocessor placement, and airflow. The ATX specification includes provisions for a software switch that enables users to turn off the system's power supply through software.
- ***AT-Style***—the older form factor standard derived from PC-XT and PC-AT specifications.
- ***ATX-Style***—a newer form factor standard that has been introduced to overcome problems found in the AT-Style designs.

For the most part, the component specifications for the AT and ATX form factors are incompatible. However, adapter cards from one system will fit in the other, and the basic I/O connection hardware is the same.

1.4 SYSTEM BOARDS

The system board is the center of the PC-compatible microcomputer system. It contains the circuitry that determines the computing power and speed of the entire system. In particular, it contains the microprocessor and control devices that form the brains of the system. System boards are also referred to as motherboards and as planar boards. A typical system board layout is depicted in Figure 1.4.

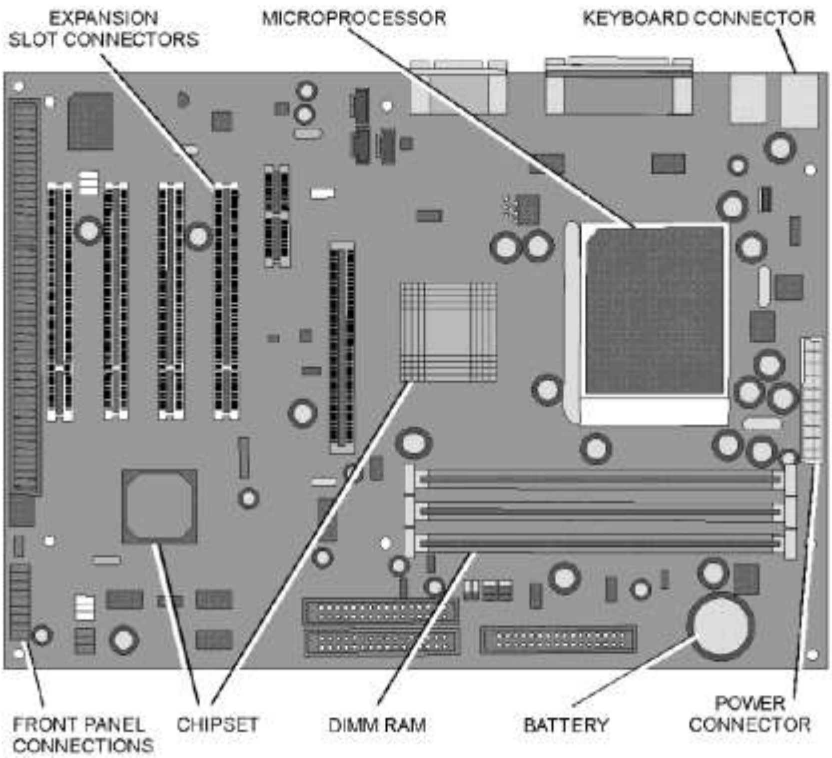


Figure 1.4 Parts of a typical system board.

The major components of interest on a PC system board are

- ***Microprocessor/CPU***—The brains of the system. This component performs mathematical and logical computations at incredible speeds.

- ***Primary Memory***—The system's primary memory elements.
  1) ***RAM***—*Random Access Memory (RAM)* is quick enough to operate directly with the microprocessor and can be read from and written to as often as desired. RAM is a volatile type of memory—its contents disappear when power is removed from the memory.
  2) ***ROM***—*Read-Only Memory* (*ROM*) contains the computer's permanent startup programs. ROM is nonvolatile—its contents remain with or without power being applied.
  3) ***Cache memory***—An area of special high-speed RAM reserved for improving system performance by holding information that the microprocessor is likely to use. Blocks of often used data are copied into the cache area to permit faster access times.

ROM devices store information in a permanent fashion, and are used to hold programs and data that do not change. RAM devices retain only the information stored in them as long as electrical power is applied to the IC. Any interruption of power will cause the contents of the memory to vanish. This is referred to as volatile memory. ROM, on the other hand, is nonvolatile.

- *Expansion slot connectors*—Connectors mounted on the system board into which the edge connectors of adapter cards can be plugged to achieve system expansion. The connector interfaces the adapter to the system's I/O channel and system buses. Therefore, the number of slots available determines the expansion potential of the system.
- *Chipset*—Microprocessor support ICs that coordinate the operation of the system.

1.5 MICROPROCESSORS

The microprocessor is the major component of any system board. It can be thought of as the brains of the computer system because it reads, interprets, and executes software instructions, and it also carries out arithmetic and logical operations for the system. The original PC and PC-XT computers were based on the 8/16-bit 8088 microprocessor from Intel.

The Microprocessor also called Central Processing Unit *(CPU).* Modern CPUs generate a lot of heat and thus require a cooling fan and heat sink assembly to avoid overheating. A heat sink is a big slab of copper or aluminum that helps draw heat away from the processor. The fan then blows the heat out into the case. You can usually remove this cooling device if you need to replace it, although some CPU manufacturers have sold CPUs with a fan permanently attached.

Although only a few manufacturers of CPUs have existed, those manufacturers have made hundreds of models of CPUs. Some of the more common models made over the past few years have names such as Core 2, Core i7, Celeron, Athlon, and Phenom. Finally, CPUs come in a variety of packages. The package defines how the CPU looks physically and how it connects to the computer. Intel CPUs currently use a package type called *land grid array* (*LGA*), and AMD likes *pin grid array* (*PGA*). Every CPU package type has a number of versions and each type is designed to fit into a particular connection called a socket. Sockets have such names as Socket AM3 or Socket B.

1.6 POWER SUPPLIES

The system's power supply unit provides electrical power for every component inside the system unit. In older AT-style systems, it also passed the commercial alternating current (AC) through the On/Off switch to the display monitor. The power supply delivers power to the system board and its expansion slots through the system board power connectors. The ATX system board connector is a 20-pin keyed connector. Figure 1.5 shows the wiring configuration diagram of an ATX system board power connector. Notice that it is keyed so that it cannot be installed incorrectly.

This connection contains a signal line that the system board can use to turn off the power supply. This is a power saving feature referred to as a soft switch.

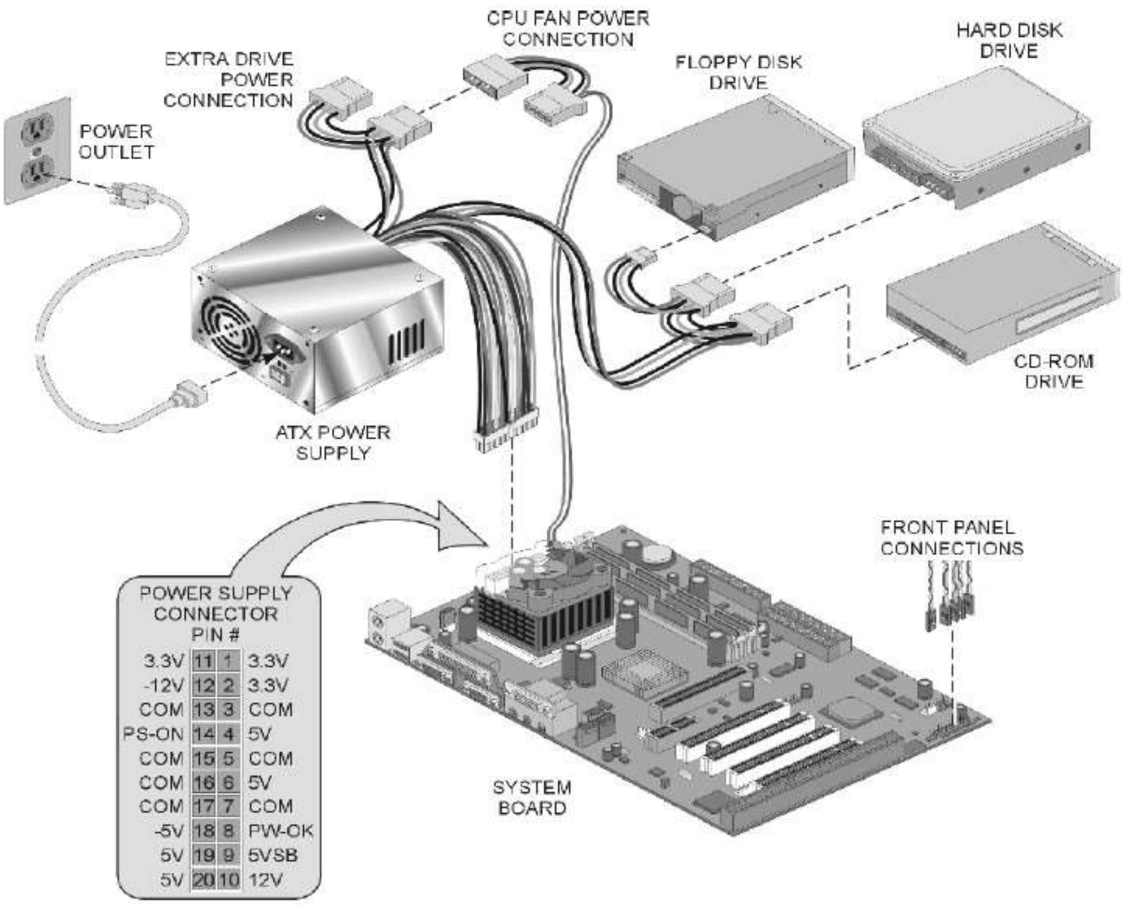


Figure 1.5 The ATX system board power connector.

Note: The power supply voltage switch is a small switch located on the back of the power supply. This small switch is used to set the input voltage to the power supply to either 110v/115v or 220v/230v. Setting the power supply voltage switch to the incorrect input voltage could damage the power supply and possibly other parts of your computer.

If your tests agree that it’s time to replace the power supply, make sure the replacement will

 Have the same power supply connectors as the original.

 Have the same form factor (shape, size, and switch location).

 Have the same or higher wattage rating; a higher wattage rating is highly desirable.

 Support any special features required by your CPU and motherboard. For example, motherboards that support the Pentium 4 processor use a 4-pin connection known as the ATX-12V connector as well as the standard 20-pin ATX connector.

It’s also desirable to select a power supply that has enough Molex (large four-wire) and floppy drive (small four- wire) connectors to support the drives and case fans you plan to use in the system (see Figure 1.6). If your power supply doesn't have enough connectors, you can add Y-splitters to divide one power lead into two, but these can short out and can also reduce your power supply's efficiency.

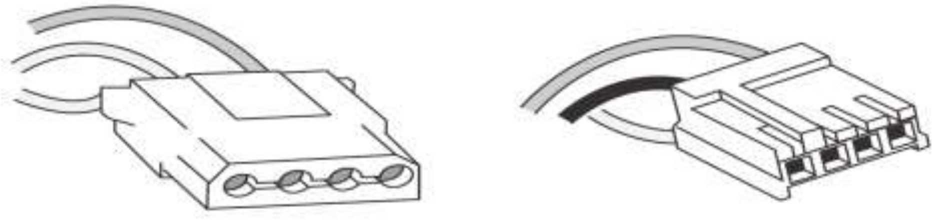
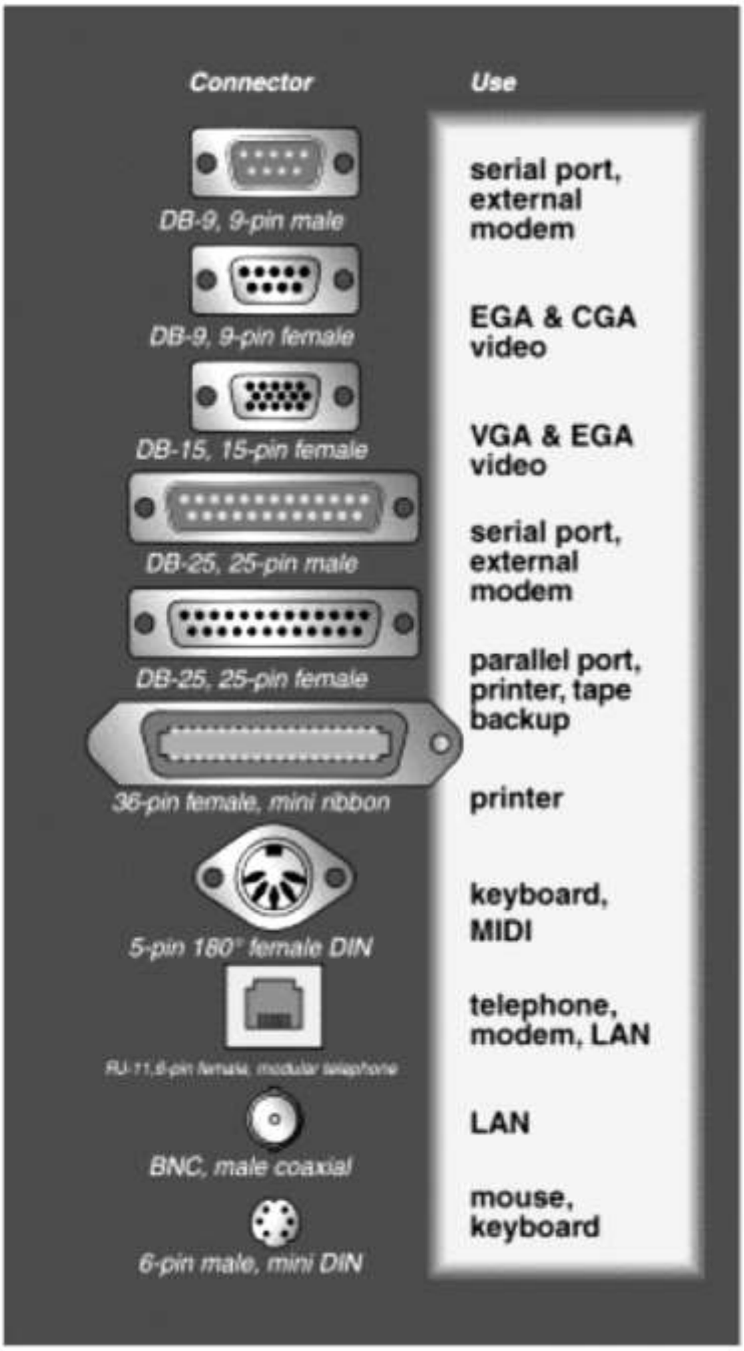


Figure 1.6 Molex (left) and small (right) drive power connectors.

1.7 PORTS

Port is a socket on an interface card or on a motherboard, used to connect a peripheral device via a special cable. There are different types of ports or connectors (see Figure 1.7):



1.8 References

- LABTECH experiment manuals.

Experiment 2: MOTHERBOARD

2.1 PRELAB

1. What are the components of the CPU cooling system, List it by order?
2. What are the difference between PCI, PCIe and AGPbuses?
3. List three types of "CPU sockets"?

2.2 OBJECTIVES

On completion of this experiment, you are expected:

1. To recognize the parts of a motherboard.
2. To be able to find physical non-conformity parts of the motherboard.
3. To acknowledge different kinds of motherboard card slots (PCI, PCIe and AGP).
4. To be able to determine a proper motherboard based on the needs.

2.3 INTRODUCTION

A motherboard is the central printed circuit board (PCB) in many modern computers and holds many of the crucial components of the system, while providing connectors for other peripherals. The motherboard is sometimes alternatively known as the main board, system board, or, on Apple computers, the logic board.

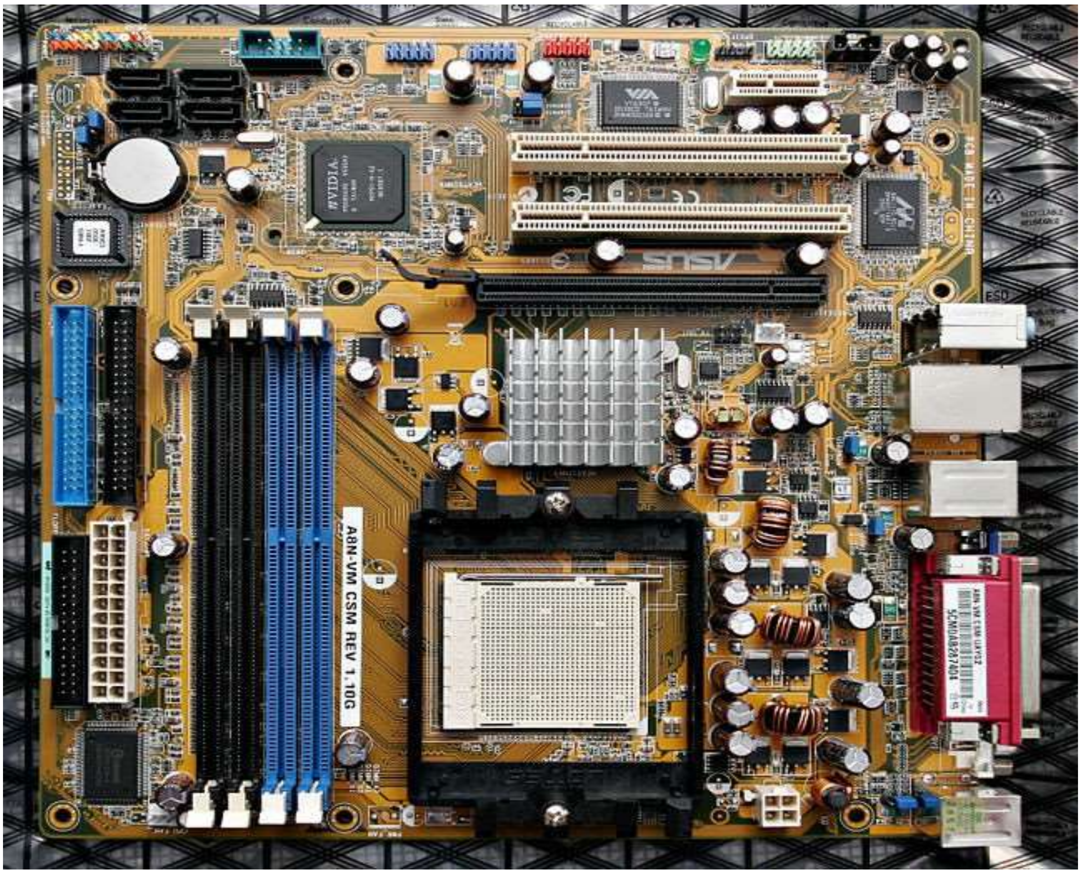


Figure 2.1: Motherboard components.

Most computer motherboards produced today are designed for IBM-compatible computers, which currently account for around 90% of global PC sales. A motherboard, like a backplane, provides the electrical connections by which the other components of the system communicate, but unlike a backplane, it also connects the central processing unit and hosts other subsystems and devices.

A typical desktop computer has its microprocessor, main memory, and other essential components connected to the motherboard. Other components such as external storage, controllers for video display and sound, and peripheral devices may be attached to the motherboard as plug-in cards or via cables, although in modern computers it is increasingly common to integrate some of these peripherals into the motherboard itself.

An important component of a motherboard is the supporting chipset of the microprocessor, which provides the supporting interfaces between the CPU and the various buses and external components. This chipset determines, to an extent, the features and capabilities of the motherboard.

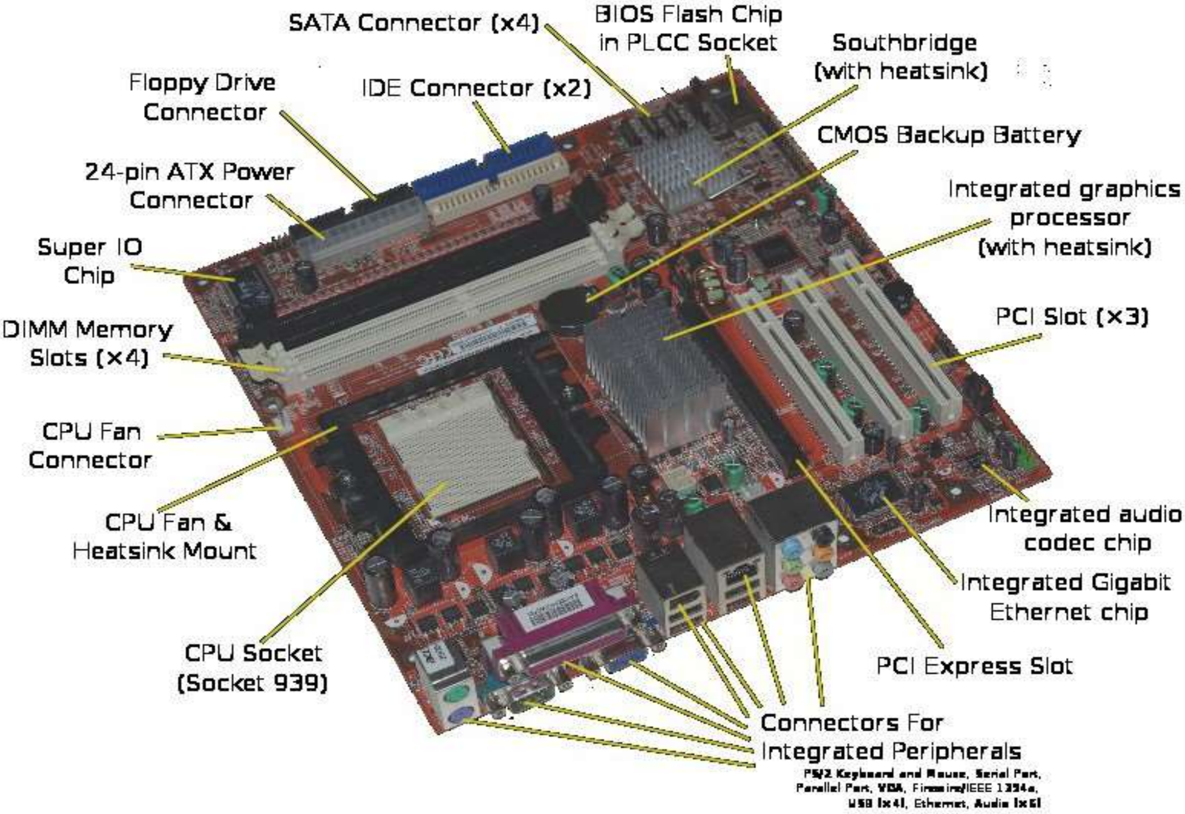


Figure 2.2: Motherboard components.

Modern motherboards include, at a minimum:

1. Sockets (or slots) in which one or more microprocessors may be installed
2. Slots into which main memory of the system is to be installed (typically in the form of DIMM modules containing DRAM chips)
3. A chipset which forms an interface between the front-side bus of the CPU, main memory, and peripheral buses
4. Non-volatile memory chips (usually Flash ROM in modern motherboards) containing the firmware or BIOS of the system.

5. A clock generator which produces the system clock signal to synchronize the various components.
6. Slots for expansion cards (these interface to the system via the buses supported by the chipset).
7. Power connectors, which receive electrical power from the computer power supply and distribute it to the CPU, chipset, main memory, and expansion cards.

Additionally, nearly all motherboards include logic and connectors to support commonly used input devices, such as PS/2 connectors for a mouse and keyboard. Early personal computers such as the Apple II or IBM PC included only this minimal peripheral support on the motherboard. Occasionally video interface hardware was also integrated into the motherboard; for example, on the Apple II and rarely on IBM-compatible computers such as the IBM PC Jr. Additional peripherals such as disk controllers and serial ports were provided as expansion cards. Given the high thermal design power of high-speed computer CPUs and components, modern motherboards nearly always include heat sinks and mounting points for fans to dissipate excess heat.

2.4 COMPONENTS ON THE MOTHERBOARD

2.4.1 CPU sockets

With the steadily declining costs and size of integrated circuits, it is now possible to include support for many peripherals on the motherboard. By combining many functions on one PCB, the physical size and total cost of the system may be reduced; highly integrated motherboards are thus especially popular in small form factor and budget computers.

2.4.2 Chipsets

A *chipset* is a collection of chips or circuits that perform interface and peripheral functions for the processor. This collection of chips is usually the circuitry that provides interfaces for memory, expansion cards, and onboard peripherals and generally dictates how a motherboard will talk to the installed peripherals.

Chipsets can be made up of one or several integrated circuit chips. Intel-based motherboards typically use two chips, whereas the SiS (Silicon Integrated System Corporation) chipsets typically use one. To know for sure, you must check the manufacturer's documentation. The functions of chipsets can be divided into two major functional groups, called Northbridge and Southbridge. Let's take a brief look at these groups and the functions they perform.

Northbridge

The *Northbridge* subset of a motherboard's chipset is the set of circuitry or chips that performs one very important function: management of high-speed peripheral communications. The Northbridge subset is responsible primarily for communications with integrated video using AGP and PCIe, for instance, and processor-to-memory communications. Therefore, it can be said that much of the true performance of a PC relies on the performance of the Northbridge chipset and the communications between it and the peripherals it controls.

The communications between the CPU and memory occur over what is known as the *frontside bus (FSB)*, which is just a set of signal pathways between the CPU and main memory. The *backside bus*, on the other hand, is a set of signal pathways between the CPU and Level 2 cache memory (if present). The Northbridge chipsets also manage the communications between the Southbridge chipset and the rest of the computer. Finally, if a motherboard has onboard video circuitry (especially if it needs direct access to main memory), that circuitry will be found within the Northbridge chipset.

Southbridge

The *Southbridge* chipset is responsible for providing support to the onboard peripherals (PS/2, Parallel, IDE, and so on), managing their communications with the rest of the computer and the resources given to them. Most motherboards today have integrated PS/2, USB, Parallel, and Serial ports. Some of the optional features handled by the Southbridge include LAN, audio, infrared, and FireWire (IEEE 1393). The Southbridge chipset is also responsible for managing communications with the other expansion buses, such as PCI, USB, and legacy buses. Figure 2.3 shows an example of a typical motherboard chipset (both Northbridge and Southbridge) and the components they interface with. Notice which components interface with which parts of the chipset.

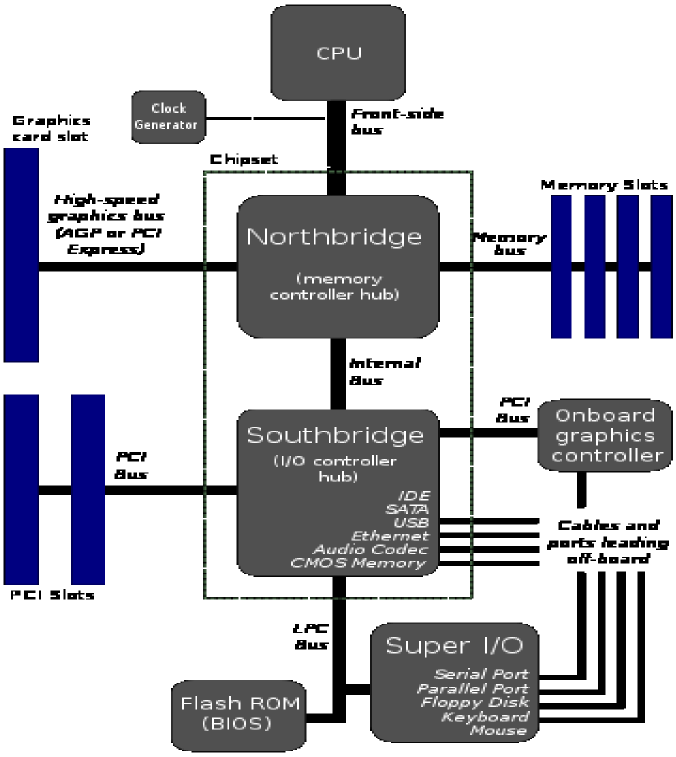


Figure 2.3: motherboard chipsets.

2.4.3 Memory Slots

Memory or random access memory (RAM) slots are the next most prolific slots on a motherboard, and they contain the modules that hold memory chips that make up primary memory, the memory used to store currently used data and instructions for the CPU, i.e. active programs. Many and varied types of memory are available for PCs today. In the next experiment we will explore primary memory concepts and their types in details.

2.4.4 Expansion Slots (Expansion BUS)

Expansion slots have been part of the PC from the very beginning. Way back then, IBM created the PC with an eye to the future; the original IBM PC had slots built into the motherboard—called expansion slots—for adding expansion cards and thus new functions to the PC. The slots and accompanying wires and support chips on the first PC and on the latest and greatest PC are called the expansion bus.

The expandability enabled by an expansion bus might seem obvious today, but think about the three big hurdles a would-be expansion card developer needed to cross to make a card that would work successfully in an expansion slot. First, any expansion card needed to be built specifically for the expansion slots that would require the creation of industry standards. Second, the card needed some way to communicate with the CPU, both to receive instructions and to relay information. And third, the operating system would need some means of enabling the user to control the new device and thus take advantage of its functions. Here's the short form of those three hurdles:

- Physical connection
- Communication
- Drivers

PC Bus

On first-generation IBM PCs, the 8088 CPU had an 8-bit external data bus and ran at a top speed of 4.77 MHz. IBM made the expansion slots on the first PCs with an 8-bit external bus connection. IBM wanted the bus to run as fast as the CPU, and even way back then, 4.77 MHz was an easy speed to achieve. IBM settled on a standard expansion bus speed of about 7 MHz—faster than the CPU! (This was the only occurrence in the history of PCs when the expansion bus was faster than the CPU.) This expansion bus was called the PC bus or XT bus.

ISA

When Intel invented the 286 processor, IBM wanted to create a new expansion bus that took advantage of the 286's 16-bit external data bus, yet also supported 8-bit cards. IBM achieved this by simply adding a set of connections to the end of the PC bus, creating a new 16-bit bus . Many techs called this bus the AT bus after the first system to use these slots, the 286-based IBM Advanced Technology (AT) computer. The AT bus ran at the same speed (approximately 7 MHz) as the earlier PC bus Even though IBM allowed third parties to copy the PC and AT expansion bus architecture, they never released the complete specifications for these two types of expansion buses. In the early 1980s, a number of clone makers pooled their combined knowledge of the PC/XT and AT buses to create the Industry Standard Architecture (ISA). The ISA bus enabled manufacturers to jump the first of the three hurdles for successful expansion cards, namely connectivity. If a company wanted to build a new kind of adapter card for the PC, they simply followed the specifications in the ISA standard.

PCI

Intel introduced the peripheral component interconnect (PCI) bus architecture (Figure 3.11) in the early 1990s, and the PC expansion bus was never again the same. Intel made many smart moves with PCI, not the least of which was releasing PCI to the public domain to make PCI very attractive to manufacturers. PCI provided a wider, faster, more flexible alternative than any previous expansion bus. The original PCI bus was 32 bits wide and ran at 33 MHz.

When PCI first came out, you could buy a motherboard with both PCI and ISA slots. This was important because users could keep their old ISA cards and slowly migrate to PCI. Equally impressive was that PCI devices were (and still are) self-configuring, a feature that led to the industry standard that became known as plug and play. Finally, PCI had a powerful burst-mode feature that enabled very efficient data transfers The original PCI expansion bus has soldiered on in PCs for over ten years. Recently, more advanced forms have begun to appear. Although these new PCI expansion buses are faster than the original PCI, they're only improvements to PCI, not entirely new expansion buses.

AGP

One of the big reasons for ISA's demise was video cards. When video started going graphical with the introduction of Windows, ISA buses were too slow and graphics looked terrible. PCI certainly improved graphics when it came out, but Intel was thinking ahead. Shortly after Intel invented PCI, they presented a specialized, video-only version of PCI called the accelerated graphics port (AGP). An AGP slot is a PCI slot, but one with a direct connection to the Northbridge. AGP slots are only for video cards—don't try to snap a sound card or modem into one. Figure 3.12 shows a typical AGP slot.

PCI-X

PCI Extended (PCI-X), available in such systems as the Macintosh G5, is a huge enhancement to current PCI that is also fully backward compatible in terms of both hardware and software. PCI-X is a 64-bit-wide bus. Its slots will accept regular PCI cards. The real bonus of PCI-X is its much enhanced speed. The PCI-X 2.0 standard features four speed grades (measured in MHz): PCI-X 66, PCI-X 133, PCI-X 266, and PCI-X 533. The obvious candidates for PCI-X are businesses using workstations and servers, because they have the "need for speed" and also the need for backward compatibility. Large vendors, especially in the high-end market, are already on board. HP, Dell, and Intel server products.

PCI Express

PCI Express (PCIe) is the latest, fastest, and most popular expansion bus in use today. As its name implies, PCI Express is still PCI, but it uses a point-to-point serial connection instead of PCI's shared parallel communication.

A PCIe device has its own direct connection (a point-to-point connection) to the Northbridge, so it does not wait for other devices. A PCIe connection uses one wire for sending and one for receiving. Each of these pairs of wires between a PCIe controller and a device is called a lane.

2.5 TEMPRETURE AND RELIABILITY

Motherboards are generally air cooled with heat sinks often mounted on larger chips, such as the Northbridge, in modern motherboards. If the motherboard is not cooled properly, it can cause the computer to crash. Passive cooling, or a single fan mounted on the power supply, was sufficient for many desktop computer CPUs until the late 1990s; since then, most have required CPU fans mounted on their heat sinks, due to rising clock speeds and power consumption. Most motherboards have connectors for additional case fans as well. Newer motherboards have integrated temperature sensors to detect motherboard and CPU temperatures, and controllable fan connectors which the BIOS or operating system can use to regulate fan speed. Some computers (which typically have high-performance microprocessors, large amounts of RAM, and high-performance video cards) use a water- cooling system instead of many fans.

2.6 FORM FACTOR

Motherboards are produced in a variety of sizes and shapes called computer form factor, some of which are specific to individual computer manufacturers. However, the motherboards used in IBM-compatible commodity computers have been standardized to fit various case sizes. As of 2007, most desktop computer motherboards use one of these standard form factors—even those found in Macintosh and Sun computers, which have not traditionally been built from commodity components. The current desktop PC form factor of choice is ATX. A motherboard case and PSU form factor must all match, though some smaller form factor motherboards of the same family will fit larger cases. For example, an ATX case will usually accommodate a microATX motherboard.

Laptop computers generally use highly integrated, miniaturized and customized motherboards. This is one of the reasons that laptop computers are difficult to upgrade and expensive to repair. Often the failure of one laptop component requires the replacement of the entire motherboard, which is usually more expensive than a desktop motherboard due to the large number of integrated components.

2.7 BOOTSTRAPPING USING THE BIOS

Motherboards contain some non-volatile memory to initialize the system and load an operating system from some external peripheral device. Microcomputers such as the Apple II and IBM PC used ROM chips, mounted in sockets on the motherboard. At power-up, the central processor would load its program counter with the address of the boot ROM and start executing ROM instructions, displaying system information on the screen and running memory checks, which would in turn start loading memory from an external or peripheral device (disk drive). If none is available, then the computer can perform tasks from other memory stores or display an error message, depending on the model and design of the computer and version of the BIOS.

Most modern motherboard designs use a BIOS, stored in an EEPROM chip soldered to the motherboard, to bootstrap the motherboard. (Socketed BIOS chips are widely used, also.) By booting the motherboard, the memory, circuitry, and peripherals are tested and configured. This process is known as a computer Power-On Self Test (POST) and may include testing some of the following devices:

1. floppy drive
2. network controller
3. CD-ROM drive
4. DVD-ROM drive
5. SCSI hard drive
6. IDE, EIDE, or SATA hard disk
7. External USB memory storage device

3.8 PC Test and upgrading training station

Now we will work with "PC Test and upgrading training station". This trainer will provide the knowledge and practical instructions for choosing and installing the motherboard and components depend on its needs and its specification. In the trainer, there are components that will be changed to the other components with the other specification and capacity.

COMPONENTS OF THE TRAINER

A. Base Station Trainer, consists of:

1. The Base Station.
2. Power Supply, ICUTE 450 WATT, ATX-450 (brand and type model are subjects to change).
3. LED MONITOR 19.5 INCH, VGA, K202HQL, ACER (brand and type model are subjects to change).

A. Optional components of the trainer:

1. Motherboard, INTEL CHIPSET ASROCK H310CM-HDV (brand and type model are subjects to change).
2. Processor, INTEL 3.7 Ghz G5400 (brand and type model are subjects to change).
3. Random Access Memory, 4 GB DDR4, CURCIAL 2400 Mhz / 2666 Mhz *The Smallest Size Of DDR4 RAM (brand and type model are subjects to change).
4. Harddisk, SATA HDD 500GB, 720OR, TOSHIBA (brand and type model are subjects

to change).

5. Optical Drive, DRW-24D3ST 24X DVDRW OEM, ASUS (brand and type model are subjects to change).
6. Sound Card, ASUS XONAR SE PCI-E 5-1Ch, Entry level PCIe x1
   (brand and type model are subjects to change).
7. USB Keyboard, K120, LOGITECH (brand and type model are subjects to change).
8. USB MOUSE, M100r, LOGITECH (brand and type model are subjects to change).
9. Graphic Card, ZOTAC GT710 2G, Entry level PCIe x16 (brand and type model are subjects to change).
10. Wireless LAN Card, TP-LINK 802.11 b/g/n, TL-WN781ND (brand and type modelare subjects to change).
11. ADAPTER, USB 2.0 A, FEMALE TO PS2 MALE.
12. SOFTWARE BECHMARKING, PC MARK 10 ADVANCED EDITION

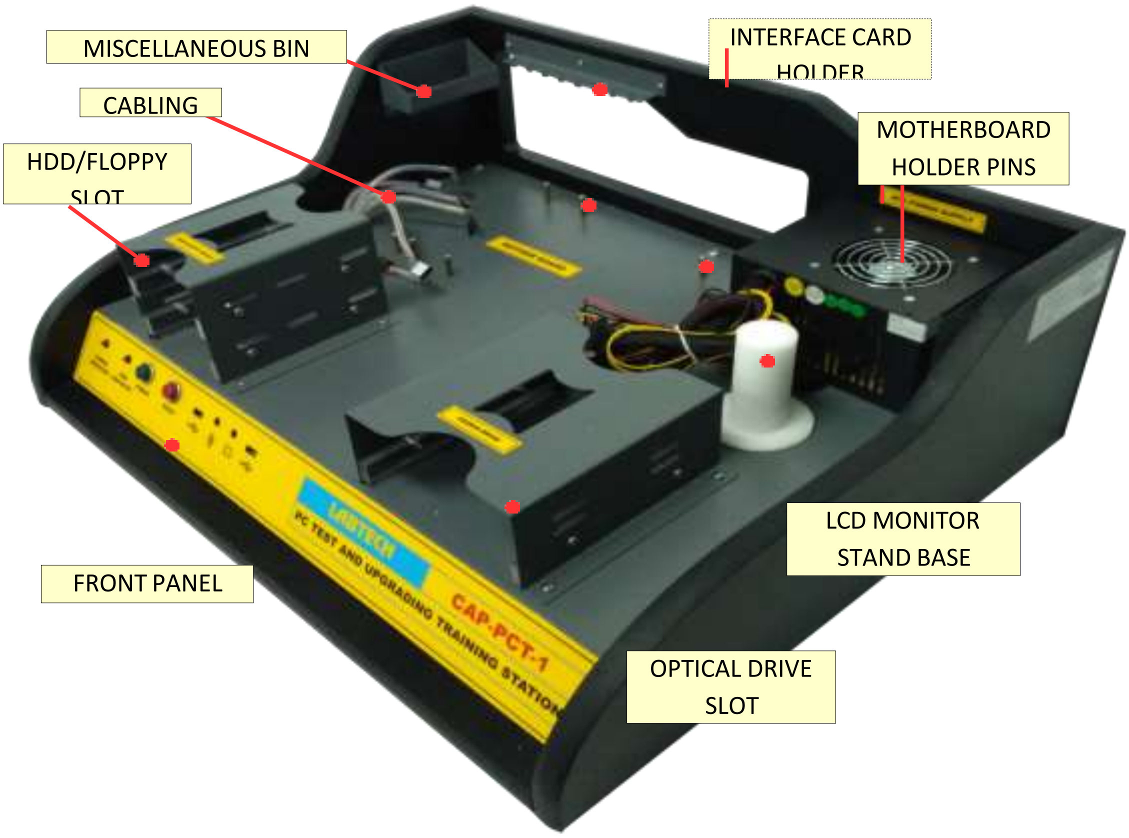


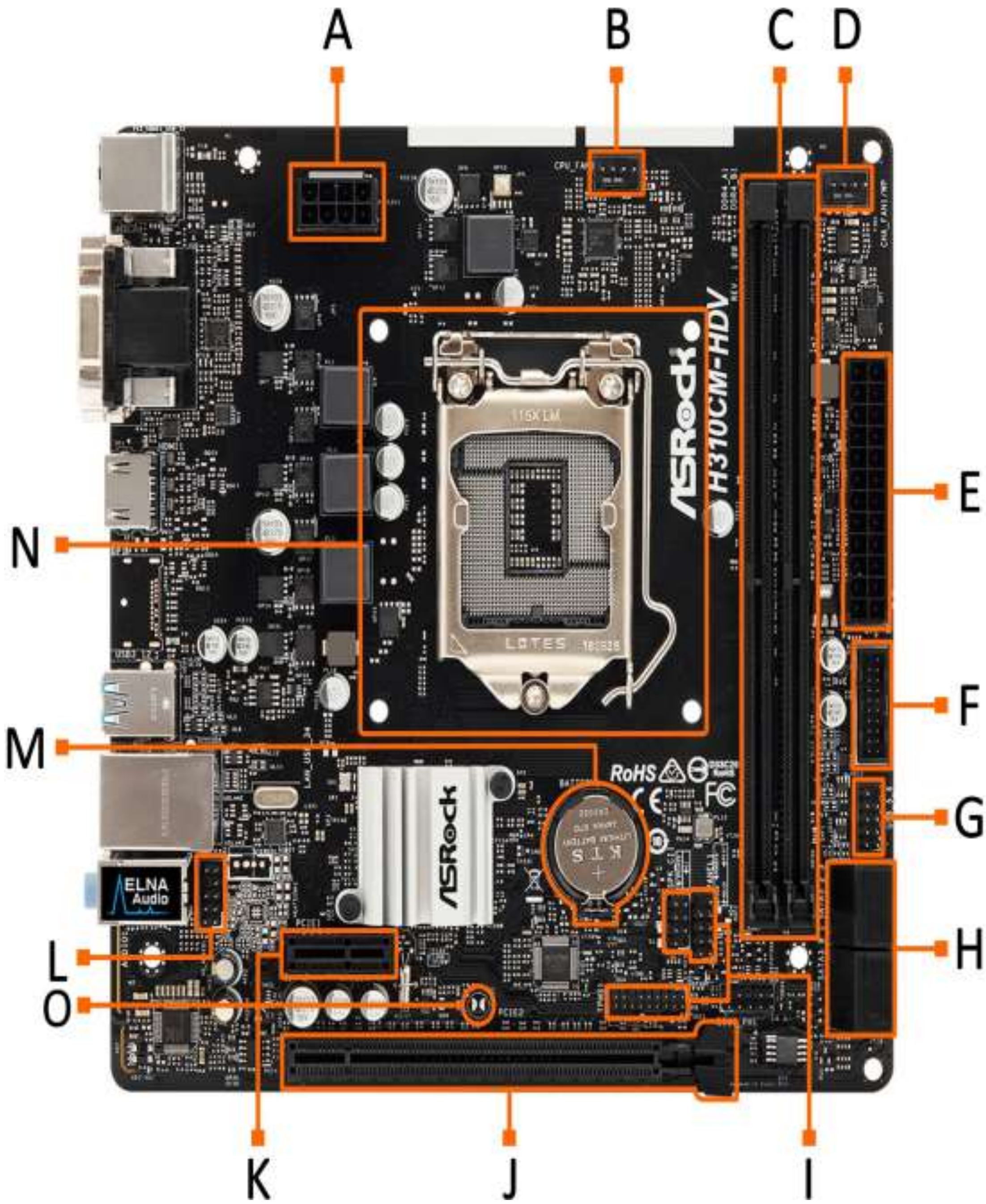
Figure 3.1 The Base Station

3.9 PROCEDURE

1. Prepare the motherboard trainer.

   The motherboard is the main circuit board inside your PC. Every component at some point communicates through the motherboard, either by directly plugging into it or by communicating through one of the motherboard ports.

2. Look at the picture below, fill in the table below by referring it to the picture.



Letter	Name	Explanation
A		
B		
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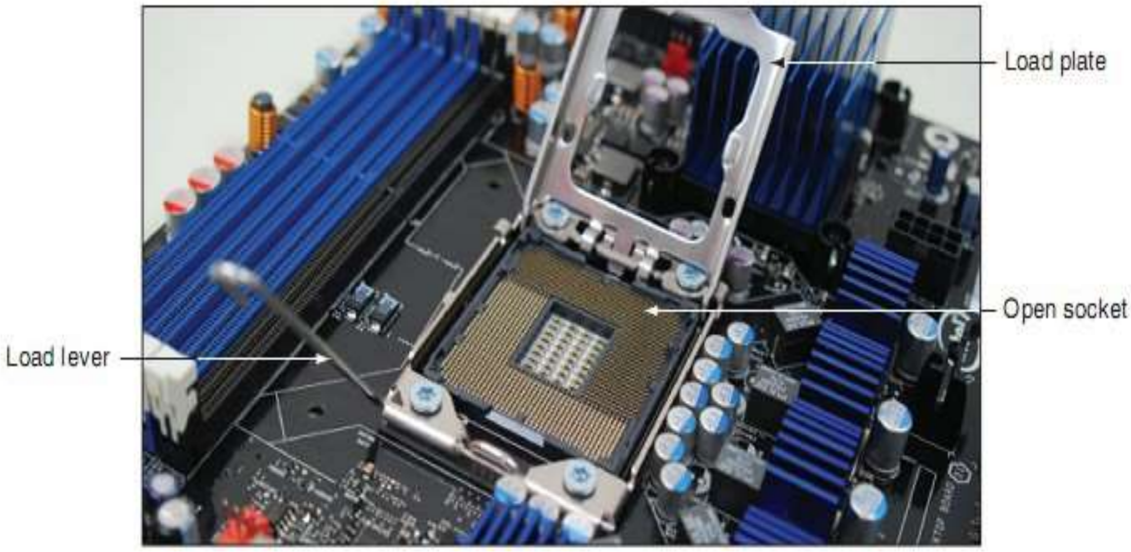
3. Now pay your attention to the motherboard, part by part. You will check the part of the motherboard to detect any possible unconformity part on the motherboard. We will check only some important parts of motherboard, because the detailed check will be run in further experiment.
4. Look at the socket part, observe the motherboard and compare with the picture, find and jot down any unexpected different things (like broken parts, broken pin, PCB burnt-up).



5. Look at the North and South parts, observe the motherboard and compare with the picture, find and jot down any unexpected different parts.

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6. Look at the Port Part, observe the motherboard and compare with the picture, find and jot down any unexpected different parts.

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7. Look at the front side of motherboard, observe the motherboard and compare with the picture, find and jot down any unexpected different parts.

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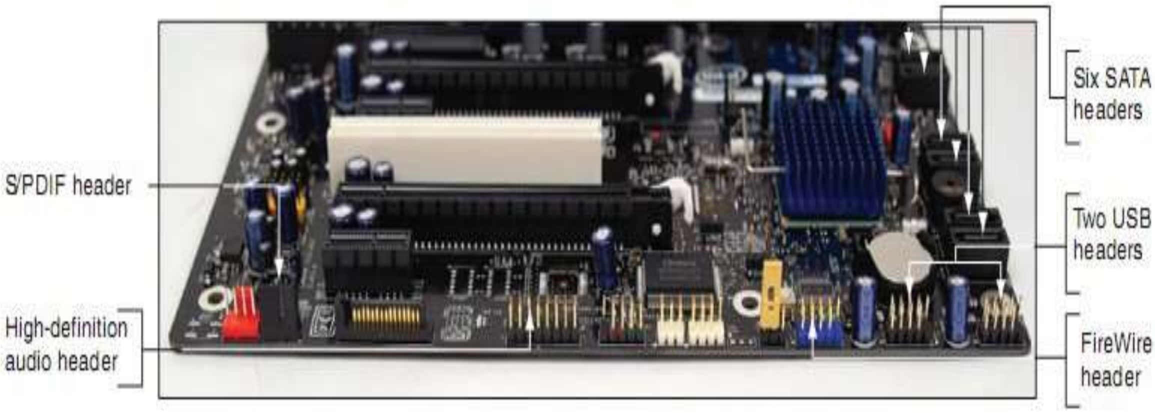

8. Look at battery power of CMOS RAM side, observe the motherboard and compare with the picture, find and jot down any unexpected different parts.

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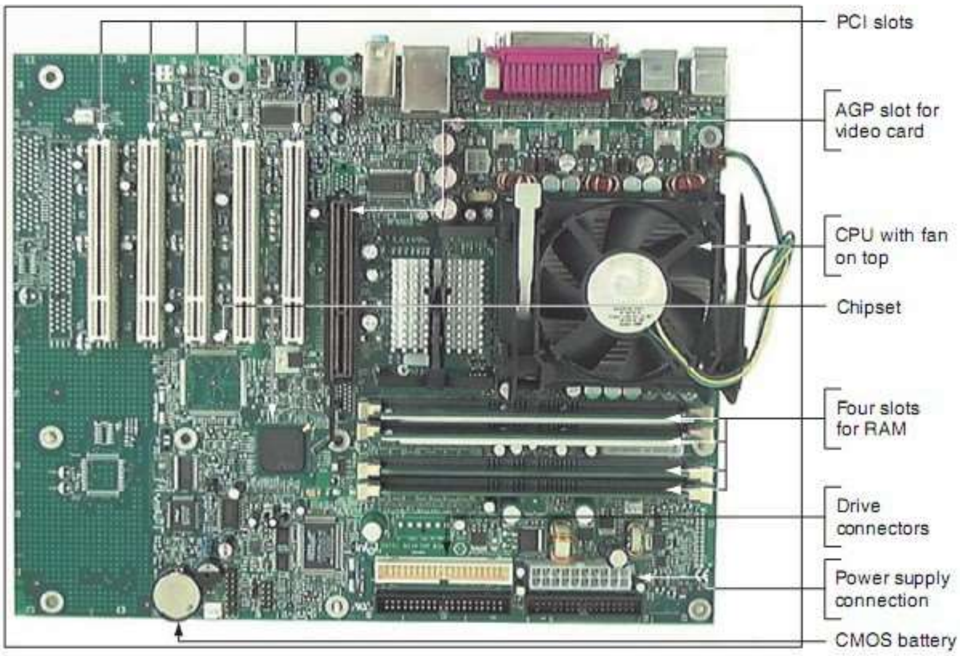
9. Look at the slots in the motherboard, you will distinguish PCI, PCIexpress and AGP slots.



10. Look at the picture below, give your comment on four possible types of expansion slots

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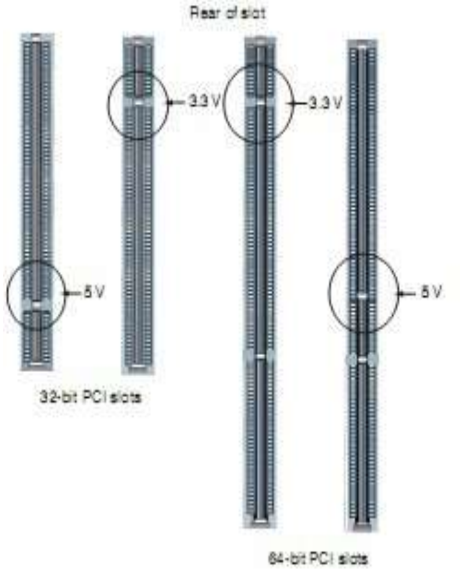

Conventional PCI

The first PCI bus had a 32-bit data path, supplied 5 V of power to an expansion card, and operated at 33 MHz. It was the first bus that allowed expansion cards to run in sync with the CPU. PCI Version 2.x introduced the 64-bit, 3.3-V PCI slot, doubling data throughput of the bus. Because a card can be damaged if installed in the wrong voltage slot, a notch in a PCI slot distinguishes between a 5-V slot and a 3.3-V slot. A Universal PCI card can use either a 3.3-V or 5-V slot and contains both notches

11. Look at the PCI and PCIe slots in the motherboard, observe the slots and compare it with each picture, find and jot down any unexpected different parts.

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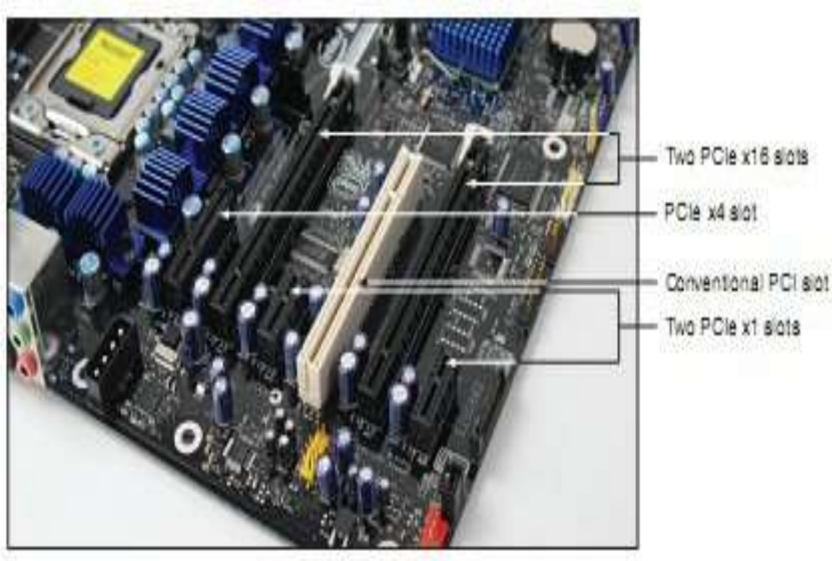

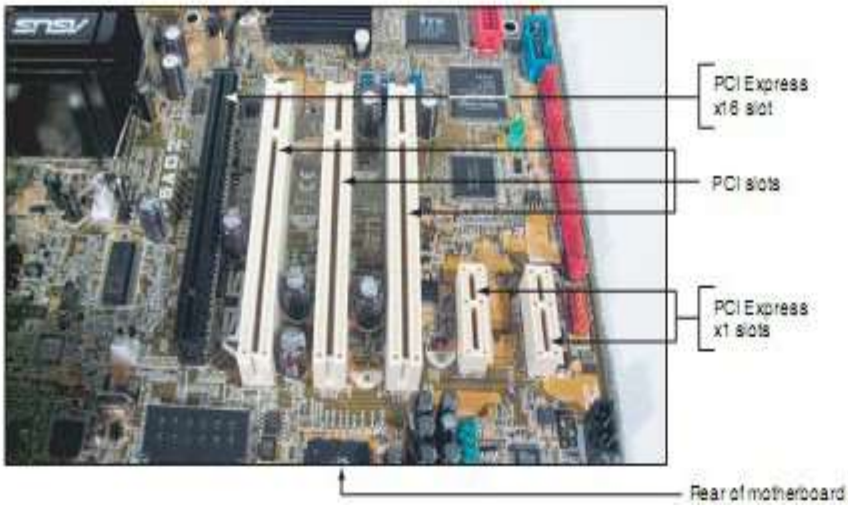

PCI Express

PCI Express (PCIe) uses an altogether different architectural design than conventional PCI and PCI-X; PCIe is not backward compatible with either. PCI Express will ultimately replaces both these buses as well as the AGP bus, although it is expected PCI Express will coexist with conventional PCI for some time to come. Whereas PCI uses a 32-bit or 64-bit parallel bus, PCI Express uses a serial bus, which is faster than a parallel bus because it transmits data in packets similar to how an Ethernet network, USB, and FireWire transmit data. A PCIe expansion slot can provide one or more of these serial lanes.

12. Look at the AGP bus slot in the motherboard, observe the slot and compare with the picture, find and jot down any unexpected different parts.

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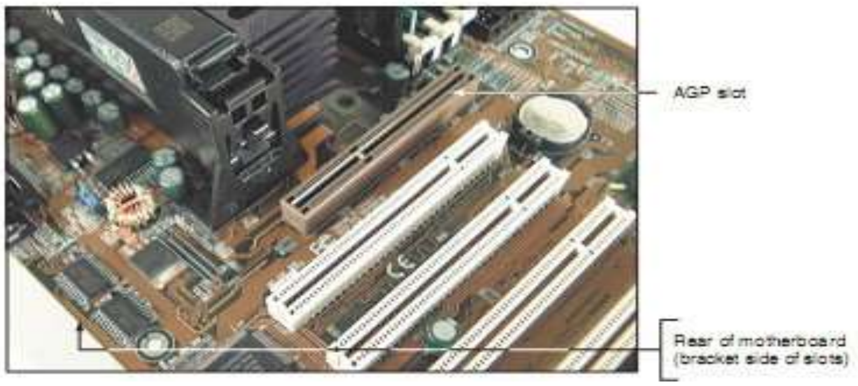

The AGP Buses

Motherboard video slots and video cards used the Accelerated Graphics Port (AGP) standards for many years, but AGP has mostly been replaced by PCI Express. Even though AGP is a dying technology, you still need to know how to support it. A motherboard will have a PCI Express x16 slot or an AGP slot, but not both.

13. Look at the table, give the summary about the difference between PCI, PCIe

and AGPbuses

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Bus	Bus Type	Data Path in Bits	Address Lines	Bus Frequency	Throughput
System bus	Local	64	32 or 64	Up to 1600 MHz	Up to 3.2 GB/sec
PCI Express Version 2	Local video and local I/O	Serial with up to 32 lanes	Up to 32 lanes	2.5 GHz	Up to 500 MB/sec per lane in each direction
PCI Express Version 1.1	Local video and local I/O	Serial with up to 16 lanes	Up to 16 lanes	1.25 GHz	Up to 250 MB/sec per lane in each direction
PCI Express Version 1	Local video and local I/O	Serial with up to 16 lanes	Up to 16 lanes	1.25 GHz	Up to 250 MB/sec per lane in each direction
PCI-X	Local I/O	64	32	66, 133, 266, or 533 MHz	Up to 8.5 GB/sec
PCI	Local I/O	32 or 64	32 or 64	33, 66 MHz	133, 266, or 532 MB/sec
AGP 1x, 2x, 3x, 4x, 8x	Local video	32	NA	66, 75, 100 MHz	266 MB/sec to 2.1 GB/sec
FireWire 400 and 800	Local I/O or expansion	1	Serial	NA	Up to 3.2 Gbps (gigabits per second)
USB 1.1, 2.0, and 3.0	Expansion	1	Serial	3 MHz	12 or 480 Mbps (megabits per second) or 5.0 Gbps (gigabits per second)

2.8 References

LABTECH experiment manuals

Experiment 3 : Processor and BIOS.

3.1 PRELAB

1. What do you know about the function of a Processor?
2. Can Processor work alone without other components?
3. What do you know about BIOS Setting?
4. What parameter can you set through BIOS Setting?

3.2 OBJECTIVES

On completion of this experiment, you are expected:

1. To recognize Processor and its parts.
2. To be able to find the physical non-conformity parts.
3. To be able to determine a proper Processor based on the needs.
4. To be able to determine a proper Processor based on the Motherboard.

3.3 PART 1: PROCESSOR

3.3.1 INTRODUCTION

The processor (CPU, for Central Processing Unit) is the brain of the computer. It allows the numeric data processing, meaning information entered in binary form, and the execution of instructions stored in memory. The first microprocessor (Intel 4004) was invented in 1971. It was a 4-bit calculation device with a speed of 108 kHz. Since then, microprocessor power has grown exponentially. So what exactly are these little pieces of silicone that run our computers?

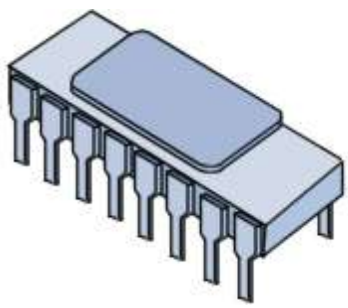

Figure 1

3.3.2 Operation

The processor (called CPU, for Central Processing Unit) is an electronic circuit that operates at the speed of an internal clock thanks to a quartz crystal that, when subjected to an electrical current, send pulses, called "peaks". The clock speed (also called cycle), corresponds to the number of pulses per second, written in Hertz (Hz). Thus, a 200 MHz computer has a clock that sends 200,000,000 pulses per second. With each clock peak, the processor performs an action that corresponds to an instruction or a part thereof. A measure called CPI (Cycles Per Instruction) gives a representation of the average number of clock cycles required for a microprocessor to execute an instruction.

3.3.3 Instructions

An instruction is an elementary operation that the processor can accomplish. Instructions are stored in the main memory, waiting to be processed by the processor. An instruction has two fields:

The operation code, which represents the action that the processor must execute;

The operand code, which defines the parameters of the action. The operand code depends on the operation. It can be data or a memory address. The number of bits in an instruction varies according to the type of data (between 1 and 4 8-bit bytes).
Instructions can be grouped by category, of which the main ones are:

1. Memory Access: accessing the memory or transferring data between registers.
2. Arithmetic Operations: operations such as addition, subtraction, division or multiplication.
3. Logic Operations: operations such as AND, OR, NOT, EXCLUSIVE NOT, etc.
4. Control: sequence controls, conditional connections, etc.

3.3.4 Registers

When the processor executes instructions, data is temporarily stored in small, local memory locations of 8, 16, 32 or 64 bits called registers. Depending on the type of processor, the overall number of registers can vary from about ten to many hundreds. The main registers are:

1. The accumulator register (ACC), which stores the results of arithmetic and logical operations;
2. The status register (PSW, Processor Status Word), which holds system status indicators (carry digits, overflow, etc.);
3. The instruction register (IR), which contains the current instruction being processed;
4. The ordinal counter (OC or PC for Program Counter), which contains the address of the next instruction to process;
5. The buffer register, which temporarily stores data from the memory.

3.3.5 Cache Memory

Cache memory (also called buffer memory) is local memory that reduces waiting times for information stored in the RAM (Random Access Memory). In effect, the main memory of the computer is slower than that of the processor. There are, however, types of memory that are much faster, but which have a greatly increased cost. The solution is therefore to include this type of local memory close to the processor and to temporarily store the primary data to be processed in it. Recent model computers have many different levels of cache memory:

1. Level one cache memory (called L1 Cache, for Level 1 Cache) is directly integrated into the processor. It is subdivided into two parts:
    a. The first part is the instruction cache, which contains instructions from the RAM that have been decoded as they came across the pipelines.
    b. The second part is the data cache, which contains data from the RAM and data recently used during processor operations.

    Level 1 caches can be accessed very rapidly. Access waiting time approaches that of internal processor registers.
2. Level two cache memory (called L2 Cache, for Level 2 Cache) is located in the case along with the processor (in the chip). The level two cache is an intermediary between the processor, with its internal cache, and the RAM. It can be accessed more rapidly than the RAM, but less rapidly than the level one cache.
3. Level three cache memory (called L3 Cache, for Level 3 Cache) is located on the motherboard between the main memory (RAM) and the L1 and L2 caches of the processor module.

All these levels of caches reduce the latency time of various memory types when processing is transferring information. While the processor works, the level one cache controller can interface with the level two controller to transfer information without impeding the processor.

3.3.6 Control Signals

Control signals are electronic signals that orchestrate the various processor units participating in the execution of an instruction. Control signals are sent using an element called a sequencer. For example, the Read / Write signal allows the memory to be told that the processor wants to read or write information.

3.3.7 Functional Units

The processor is made up of a group of interrelated units (or control units). Microprocessor architecture varies considerably from one design to another, but the main elements of a microprocessor are as follows:

1. A control unit that links the incoming data, decodes it, and sends it to the execution unit: The control unit is made up of the following elements:
    - Sequencer (or monitor and logic unit) that synchronizes instruction execution with the clock speed. It also sends control signals;
    - Ordinal counter that contains the address of the instruction currently being executed;
    - Instruction register that contains the following instruction.

2. An execution unit (or processing unit) that accomplishes tasks assigned to it by the instruction unit. The execution unit is made of the following elements:
    - The arithmetical and logic unit (written ALU). The ALU performs basic arithmetical calculations and logic functions (AND, OR, EXCLUSIVE OR, etc.);
    - The floating point unit (written FPU) that performs partial complex calculations which cannot be done by the arithmetical and logic unit.
    - The status register;
    - The accumulator register.

3. A bus management unit (or input-output unit) that manages the flow of incoming and outgoing information and that interfaces with system RAM;

The diagram below gives a simplified representation of the elements that make up the processor (the physical layout of the elements is different than their actual layout):

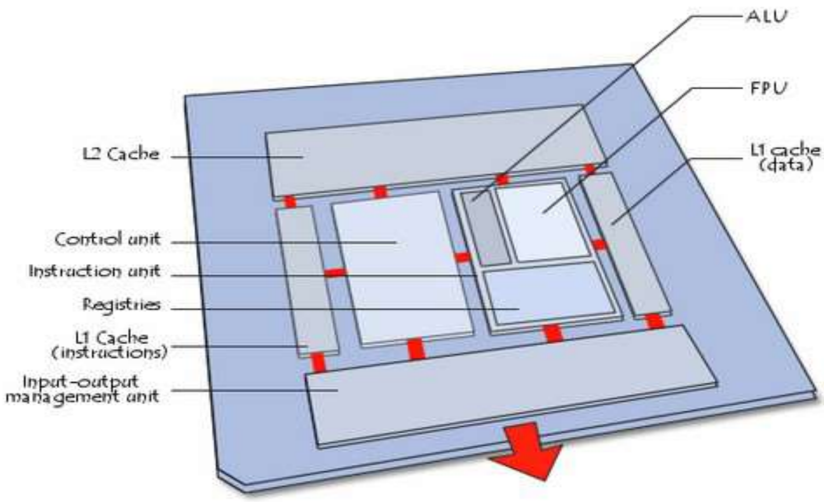

Figure 2

3.3.8 Transistor

To process information, the microprocessor has a group of instructions, called the "instruction set", made possible by electronic circuits. More precisely, the instruction set is made with the help of semiconductors, little "circuit switches" that use the transistor effect, discovered in 1947 by John Barden, Walter H. Brattain and William Shockley who received a Nobel Prize in 1956 for it.

A transistor (the contraction of transfer resistor) is an electronic semi-conductor component that has three electrodes and is capable of modifying current passing through it using one of its electrodes (called control electrode). These are referred to as "active components", in contrast to "passive components", such as resistance or capacitors which only have two electrodes (referred to as being "bipolar").

A MOS (metal, oxide, silicone) transistor is the most common type of transistor used to design integrated circuits. MOS transistors have two negatively charged areas, respectively called source (which has an almost zero charge) and drain (which has a 5V charge), separated by a positively charged region, called a substrate). The substrate has a control electrode overlaid, called a gate, that allows a charge to be applied to the substrate.

3.3.9 PROCEDURE

1. Prepare the trainer.

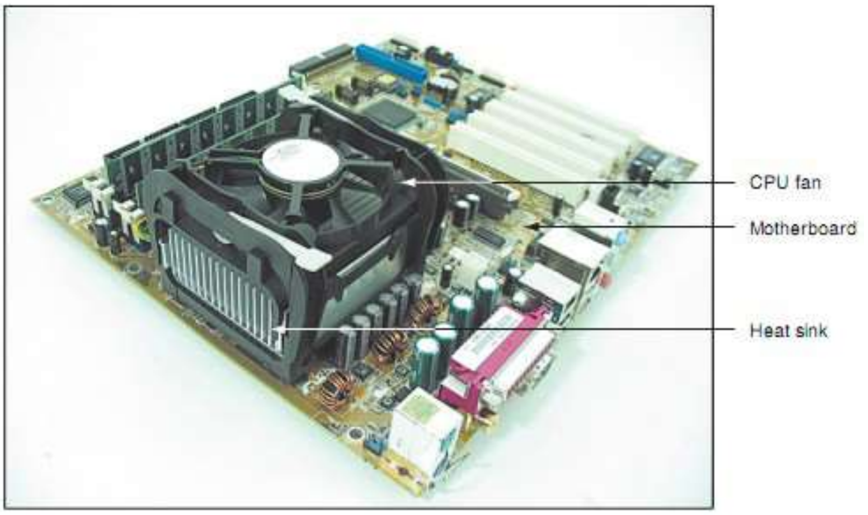

Figure 3

2. Look at Figure 3 above; you will study the components of a processor. We will see ALU as the first component.
    - What does ALU stand for?
    - What is the function of ALU?
    - What is the difference between Arithmetic and Logical operations in ALU?
3. We will see Memory Unit as the second component. Each Memory cell inside Processor called "Register"
    - What is the function of register? And how many registers are in processor?
    - What is the relationship between ALU and Register?
4. We will see Control Unit as the third component.
    - What is the function of Control Unit?

   Until this step, you have achieved the first point of the objectives
5. Look at the Processor on the trainer, compare it with the one in the picture in Figure 4 below, find any unconformity parts, and write it down.

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Figure 4

To select the best processor, you have to pay attention to the steps below:

- Read the motherboard documentation; find out what processors the motherboard supports, what socket the motherboard uses, and the frequencies the Front Side Bus can use.
- Fill in the table below with the information that you got from the documentation.

Table 1

No.	Parameter	Information on Documentation
1	What kind of Processors the Motherboard Supports?	
2	What Socket the Motherboard uses ?	
3	What frequencies the Front Side Bus can use?	

6. INSTALLING PROCESSOR

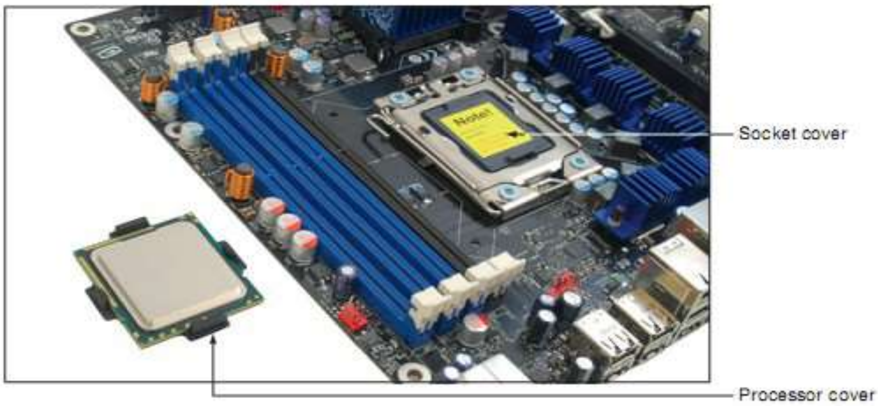

Figure 5

- Use a ground bracelet to protect the processor, motherboard, and other components against Electrostatic Discharge (ESD).
- Open the socket as shown in Figure 5 by pushing down the socket lever and gently pushing it away from the socket to lift the lever (See Figure 6).

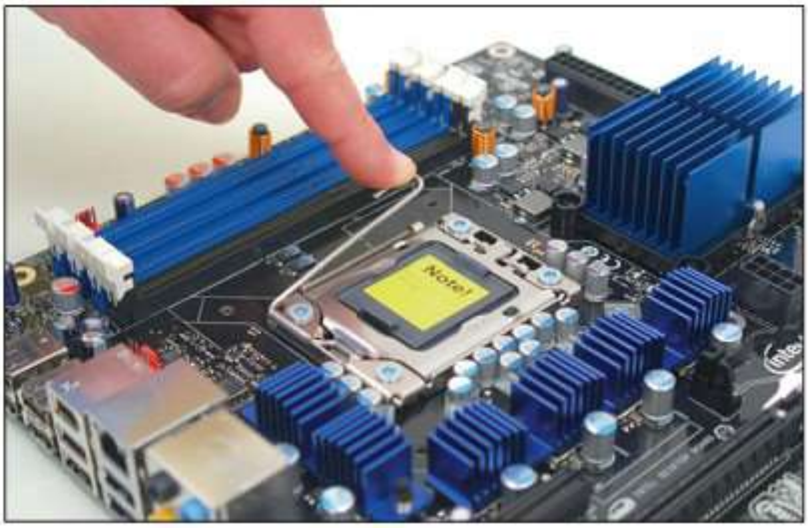

Figure 6

- Lift the socket load plate.
- Remove the socket protective cover (See Figure 7).

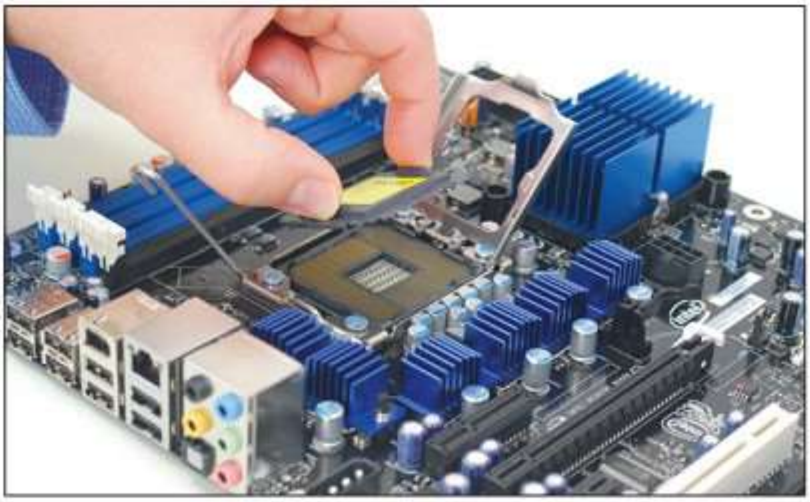

Figure 7

- Hold the processor with your index finger and thumb and orient the processor so that the notches on the two edges of the processor line up with the two posts on the socket (See Figure 8).

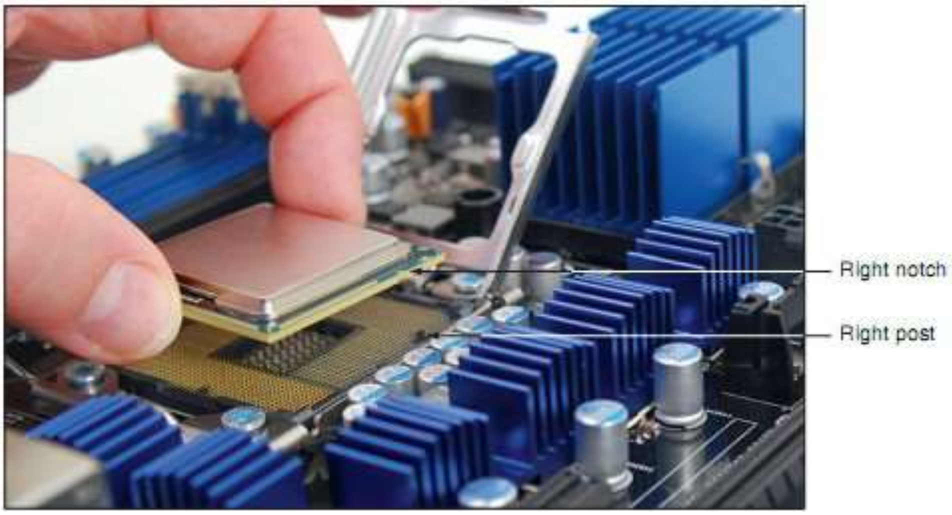

Figure 8

- The motherboard has four holes to anchor the cooler. Examine the cooler posts that fit over these holes and the clips, screws, or wires that will hold the cooler firmly in place. Make sure you understand how this mechanism works.
- If the cooler has thermal compound preapplied, remove the plastic from the compound. If the cooler does not have thermal compound applied, put a thin layer of compound on top of the processor or on the bottom of the cooler. Don’t use too much just enough to create a thin layer.
- Verify the locking pins that are turned perpendicular to the heat sink and which is as far as they will go in a counterclockwise direction.
- Align the cooler over the processor so that all four posts fit into the four holes on the motherboard and the fan power cord can reach the fan header on the motherboard (See Figure 9).

Figure 9

- Push down each locking pin until you hear they pop into the hole (See Figure 10).

Figure 10

To help keep the cooler balanced and in position, push down two opposite pins and then push the remaining two pins in place.

- Connect the power cord from the cooler fan to the motherboard power connector near the processor (See Figure 11).

Figure 11

After the processor and cooler are installed, make sure cables and cords do not obstruct airflow, especially airflow around the processor and video card. Use cable ties to tie cords and cables up and out of the way. Make one last check to verify that all power connectors are in place and other cords and cables connected to the motherboard are correctly done.

- Give the Summary.

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3.4 PART2: BIOS SETTING

3.4.1 INTRODUCTION

The BIOS of PC software is built into the PC, and the first code run by a PC when powered on ('boot firmware'). The primary function of the BIOS is to load and start an operating system. When the PC starts up, the first job for the BIOS is to initialize and identify system devices such as the video display card, keyboard and mouse, hard disk, CD/DVD drive and other hardware. The BIOS then locates the software held on a peripheral device (designated as a 'boot device'), such as a hard disk or a CD, and loads and executes that software, giving it control of the PC. This process is known as booting, or booting up, which is short for bootstrapping.

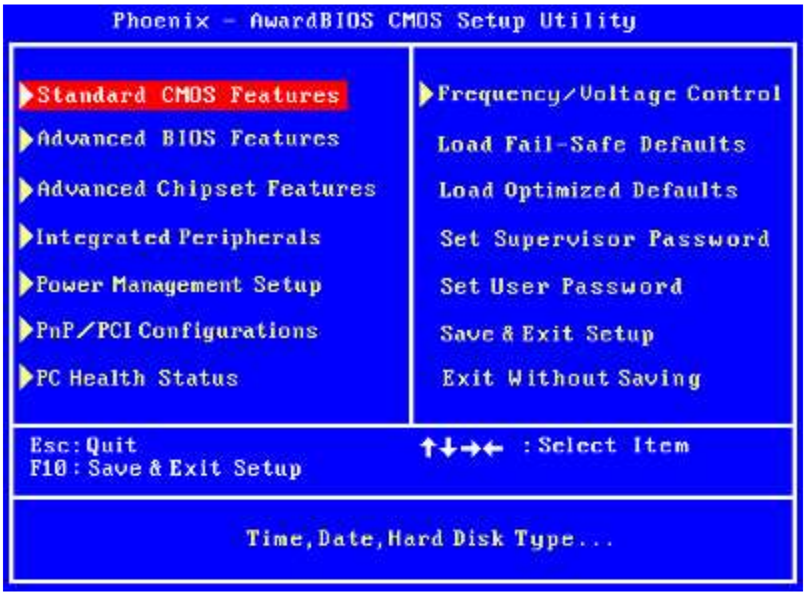

Figure 12

BIOS software is stored in a non-volatile ROM chip built into the system on the motherboard. The BIOS software is specifically designed to work with the particular type of system, including having a knowledge of the workings of various devices that make up the complementary chipset of the system. In modern computer systems, the contents of BIOS chip can be rewritten, allowing BIOS software to be upgraded.

A BIOS will also have a user interface (or UI for short). Figure 12 shows a typical BIOS menu system accessed by pressing a certain key on the keyboard when the PC starts. In the BIOS UI, a user can:

- Configure hardware
- Set the system clock
- Enable or disable system components
- Select which devices are eligible to be a potential boot device
- Set various password prompts, such as a password for securing access to the BIOS UI functions itself and preventing malicious users from booting the system from unauthorized peripheral devices.

The BIOS provides a small library of basic input/output functions used to operate and control the peripherals such as the keyboard, text display functions and so forth, and these software library functions are callable by external software. In the IBM PC and AT, certain peripheral cards such as hard-drive controllers and video display adapters carried their own BIOS extension ROM, which provided additional functionality. Operating systems and executive software, designed to supersede this basic firmware functionality, will provide replacement software interfaces to applications.

The role of the BIOS has changed over time; today BIOS is a legacy system, superseded by the more complex **Extensible Firmware Interface (EFI)**, but BIOS remains in widespread use, and EFI booting has only been supported in x86 Windows since 2008. BIOS is primarily associated with the 16-bit and 32-bit architecture eras (x86-32), while EFI is used for some 32-bit and most 64-bit architectures. Today BIOS is primarily used for booting a system, and for certain additional features such as power management (ACPI) and video initialization (in X.org), but otherwise is not used during the ordinary running of a system, while in early systems (particularly in the 16-bit era), BIOS was used for hardware access – operating systems (notably MS-DOS) would call the BIOS rather than directly accessing the hardware. In the 32-bit era and later, operating systems instead generally directly accessed the hardware using their own device drivers. However, the distinction between BIOS and EFI is rarely made in terminology by the average computer user, making BIOS a catch-all term for both systems.

3.4.2 PROCEDURE

When you first turn on a PC, startup BIOS on the motherboard is in control until the operating system is loaded and takes over. In this part of the experiment, you'll learn what startup BIOS does to boot up the system, check and initialize critical hardware components, find an OS, begin the process of loading that OS, and then turn over control to the OS. The purpose of this part is to help you understand how startup BIOS controls the boot. Later, you'll learn how to use it.

1. Connect the power plug into power source. Turn ON the PC.
2. Access the BIOS setup program by pressing a key or combination of keys during the boot process. Below in Figure 13 is the list of the keystrokes to access the BIOS.

BIOS	Key to Press During POST to Access Setup
AMI BIOS	Del
Award BIOS	Del
Older Phoenix BIOS	Ctrl+Alt+Esc or Ctrl+Alt+s
Newer Phoenix BIOS	F2 or F1
Dell computers using Phoenix BIOS	Ctrl+Alt+Enter
Compaq computers such as the ProLinea, Deskpro, Deskpro XL, Deskpro XE, or Presario	Press the F10 key while the cursor is in the upper-right corner of the screen, which happens just after the two beeps during booting.*

Figure 13

4. Press the appropriate key or keys, a setup screen appears like in Figure 14 below:

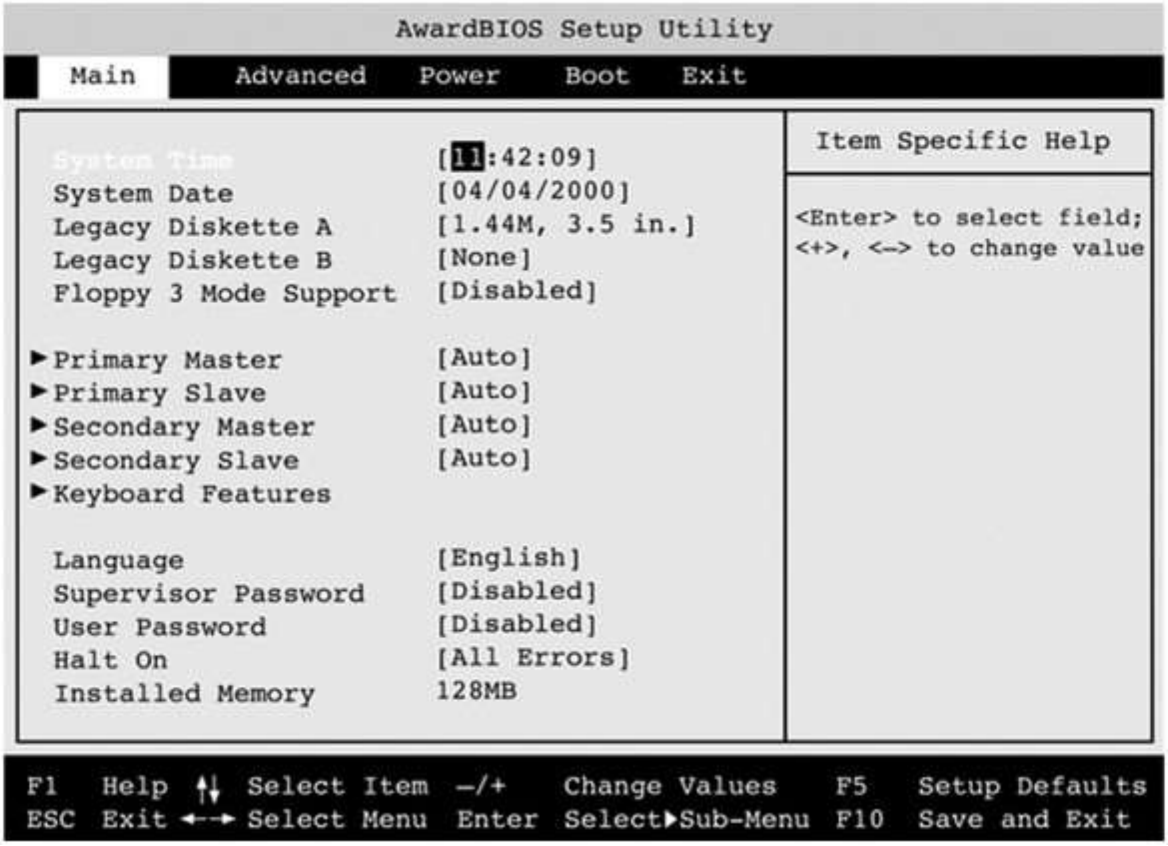

Figure 14

Notes:

- Access to a computer can be controlled using a startup password, sometimes called a user password or power-on password.
- If the password has been enabled in BIOS setup, the startup BIOS will ask for the password before looking for the OS. If the password is keyed incorrectly, the boot process will terminate. The password is stored in CMOS RAM and is changed by accessing the setup screen. (This password is not the same as the OS password). Many computers also provide jumper to reset the password, just in case you have to.

No.	Menu	Function
1	Main	For changing the basic system configuration
2	Advance	For changing the advanced system settings
3	Power	For changing the advanced power management (APM) configuration
4	Boot	For changing the system boot configuration
5	Tools	For configuring options for special functions
6	Exit	For selecting Exit

Figure 15 BIOS menus

5. Select an item on the menu bar (See Figures 15 and 16), by pressing the right or left arrow key on the keyboard until the desired item is highlighted.

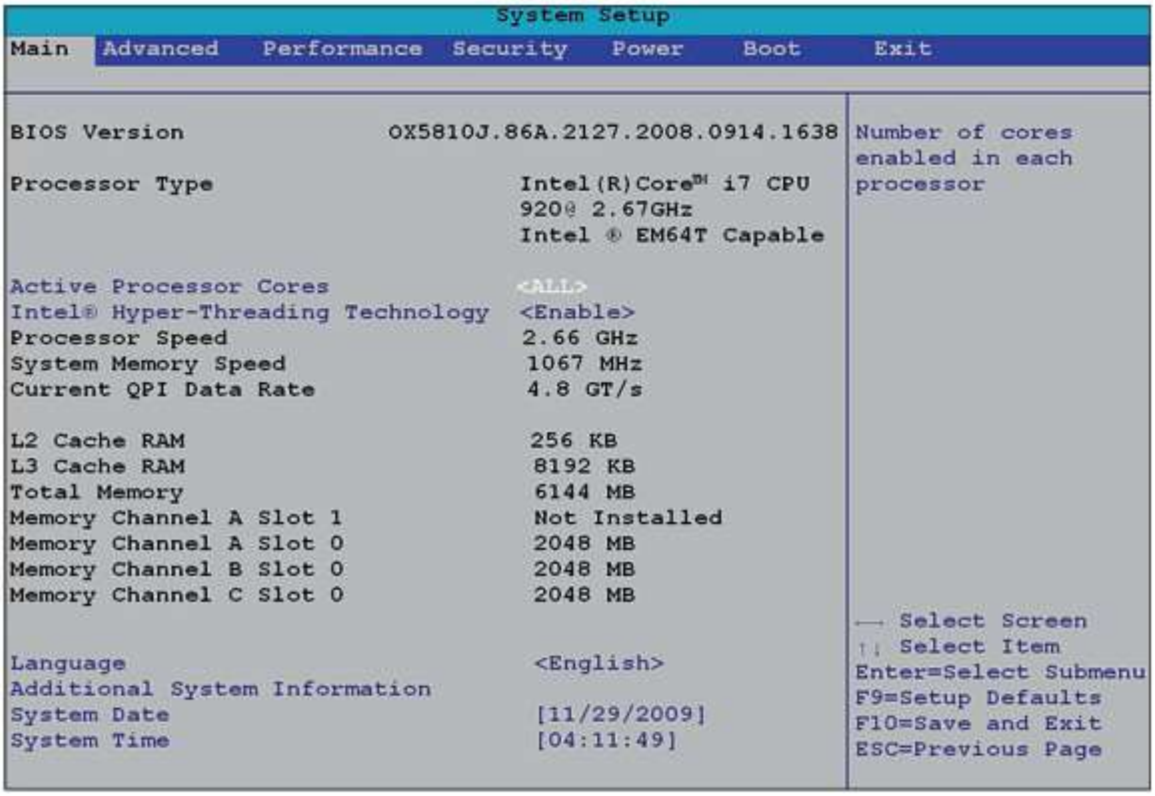

Figure 16

6. Look at your screen, the processor is identified automatically by the BIOS, ensure that the setup is set correctly.

7. Look at your screen, the Harddisk is detected automatically by the BIOS, ensure that the setup is set correctly (See Figure 17).

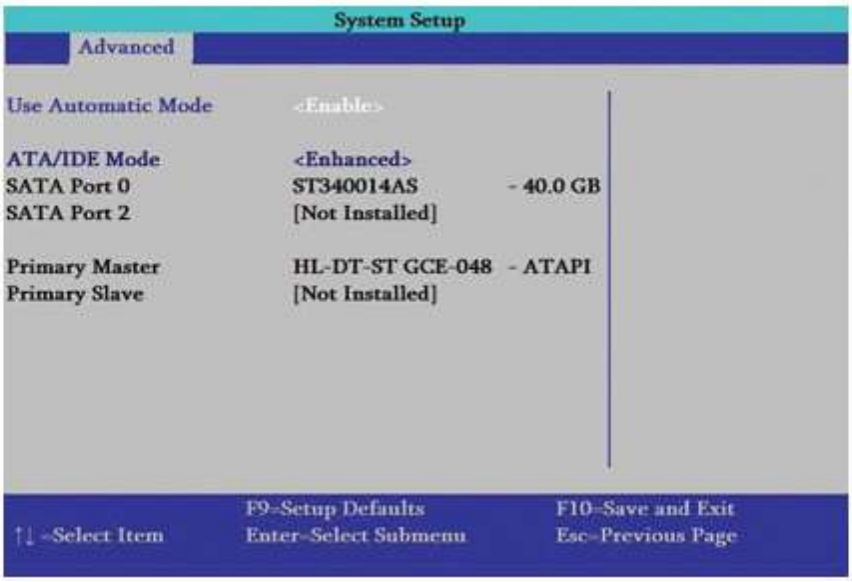

Figure 17

8. Set the boot order, in which the system tries to boot from certain devices (called the boot sequence).

   Most likely when you first install a hard drive or an operating system, you will want to have the BIOS attempts to first boot from a CD and, if no CD is present, turn to the hard drive. After the OS is installed, to prevent accidental boots from a CD or other media, change BIOS setup to boot first from the hard drive (See Figure 18).

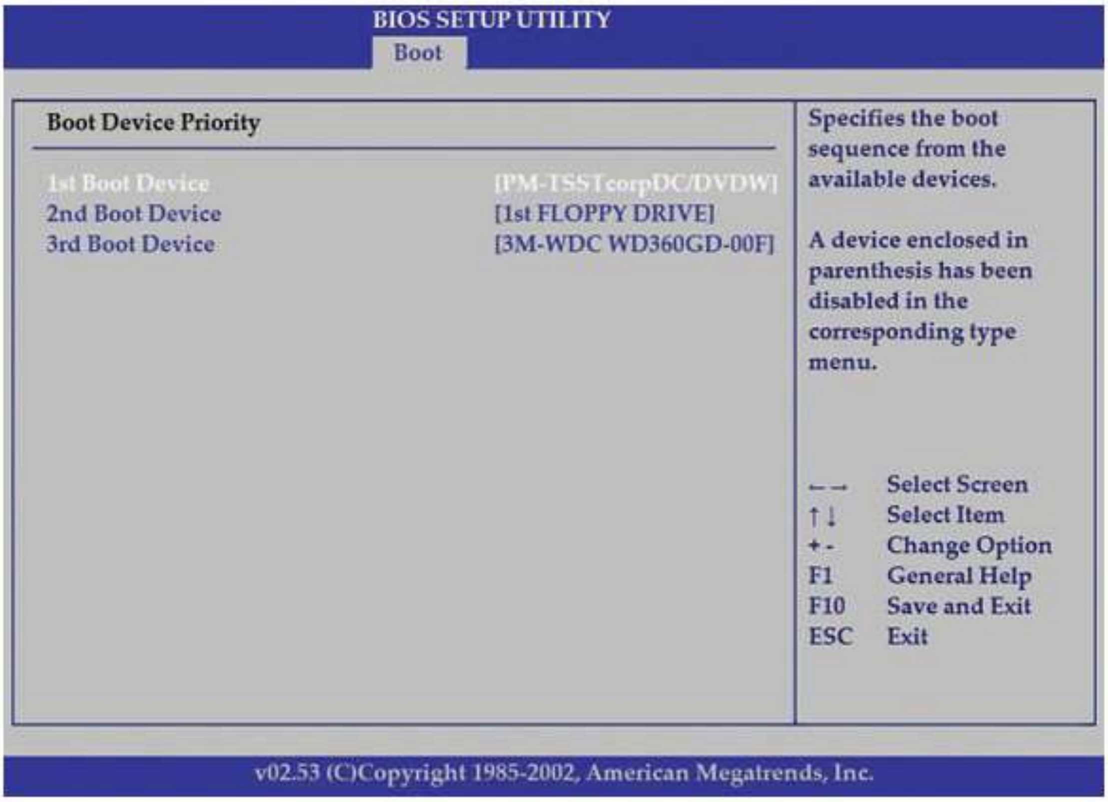

Figure 18

9. Check available ports on the motherboard, such as sound, video, USB 1.1, USB 2.0, serial, IEEE 1394, parallel, network, modem, and PS/2 ports. Enable or disable such ports as you require. If you’re having a problem with a port, check BIOS setup to make sure the port is enabled (See Figure 19).

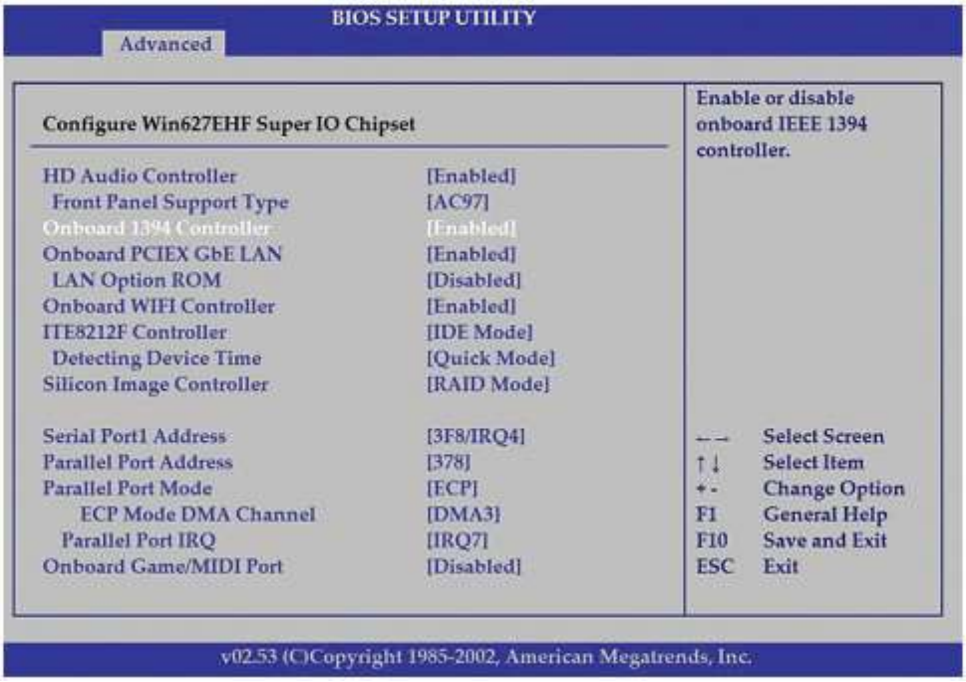

Figure 19

10. Press ESC to Exit menu (See Figure 20).

- Choose the Load Setup Defaults.
- Then choose Exit Save Changes, the computer will restart automatically.
- Write down your Summary.

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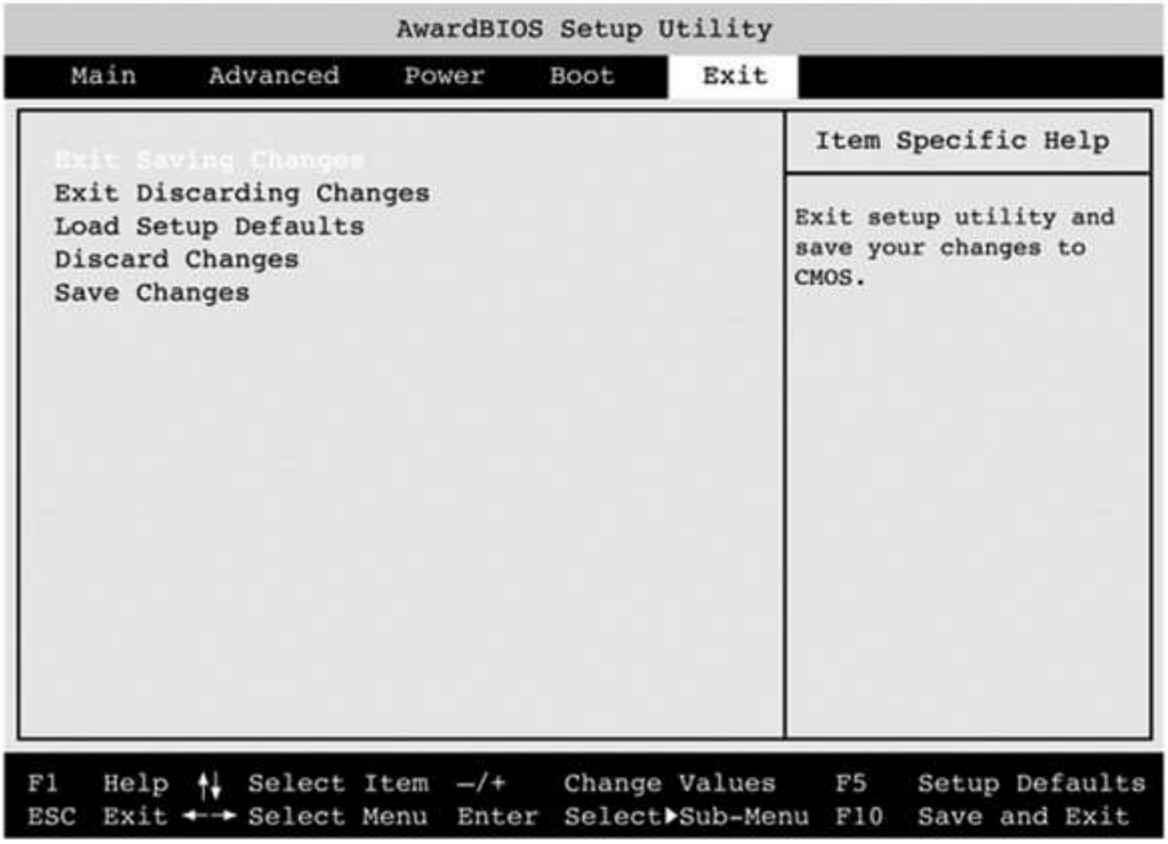

AwardBIOS Setup Utility
Main
Advanced
Power
Boot
Exit
Exit Saving Changes
Exit Discarding Changes
Load Setup Defaults
Discard Changes
Save Changes
Item Specific Help
Exit setup utility and save your changes to CMOS.
F1 Help Select Item -/+ Change Values F5 Setup Defaults
ESC Exit Select Menu Enter Select▶Sub-Menu F10 Save and Exit
Figure 20

3.5 PART 3: PROCESSOR TESTING USING BIOS

3.5.1 PROCEDURE

1. Start the computer. Access the BIOS by pressing [Del] or some key or combination keys during the boot process. Below in Figure 21 is the list of the keystrokes to access the BIOS.

BIOS	Key to Press During POST to Access Setup
AMI BIOS	Del
Award BIOS	Del
Older Phoenix BIOS	Ctrl+Alt+Esc or Ctrl+Alt+s
Newer Phoenix BIOS	F2 or F1
Dell computers using Phoenix BIOS	Ctrl+Alt+Enter
Compaq computers such as the ProLinea, Deskpro, Deskpro XL, Deskpro XE, or Presario	Press the F10 key while the cursor is in the upper-right corner of the screen, which happens just after the two beeps during booting.*

Figure 21

2. The processor is identified automatically by the BIOS. It's shown below:

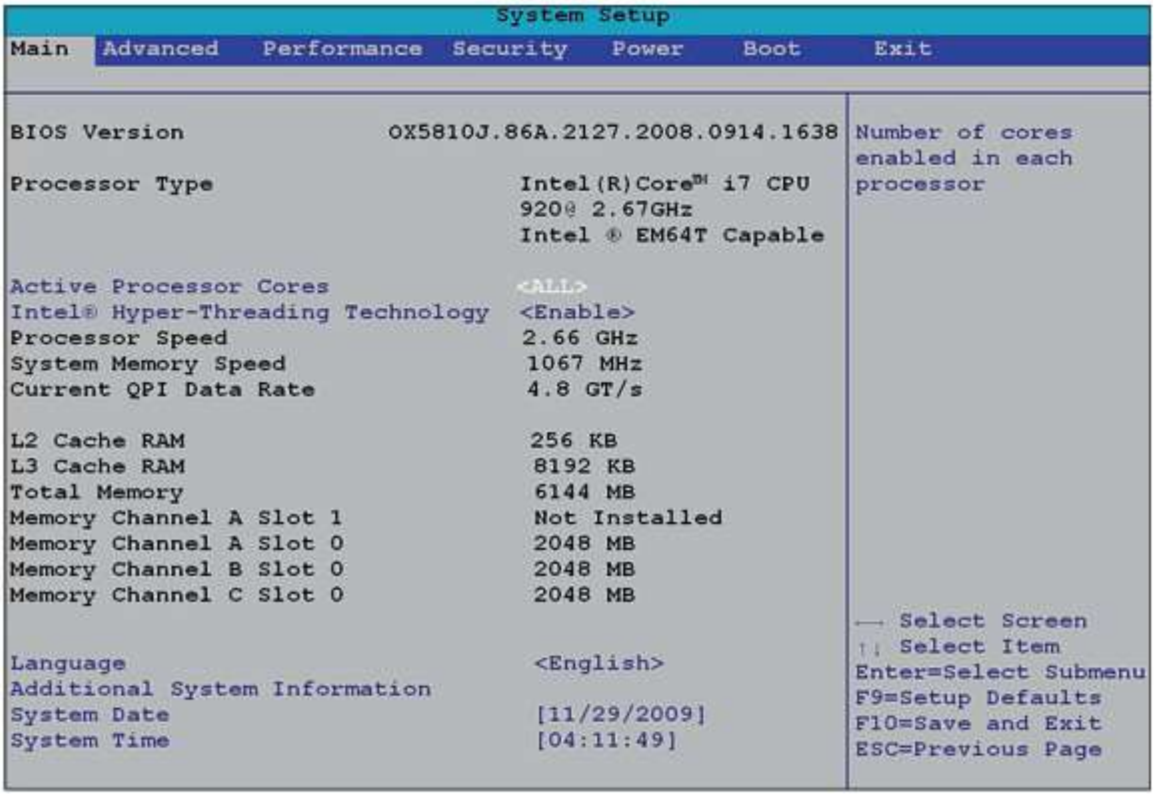


Figure 22

3. Now, check every technical parameter shown by the BIOS.
4. Use the table below to deepen your understanding about the Processor.

Table 2

Parameters	BIOS detected	Description
Manufacturer	Intel	A Company that manufactures the CPU.
Brand	Intel	
Type	Core 2 Duo E8400 Wolfdale	
Bit Architectures	32-bit / 64 -bit	
Clock Speed	GHz	
Front Side Bus Speed	MHz	
Number of cores		
Hyper-Threading		
Socket type		
L1 Cache		
L2 Cache		
L3 Cache		
Capabilities / CPU Features		

5. Fill as many fields as possible in the table above with the information you got from the BIOS setup.
6. Find the technical detail regarding the processor through Processor box / catalog / brochure, or even from the Internet.
7. Compare it with the information on the table above. Is there any difference?

   ____

8. What information the BIOS cannot detect?

   ____

   ____

9. What does the Processors Speed mean?

10. What Number of QPI Data Rate that view in your BIOS?

    ____

11. What is the QPI Data Rate mean?

3.6 References

- LABTECH experiment manuals.

Experiment 4: Computer Troubleshooting Trainer

4.1 PRELAB

Q1: Fill the table below with the error code and symptoms for missing RAM, VGA, CPU in PC's and laptops?

	Missing RAM	Missing VGA	Missing CPU
Error code (beeps, text, light)			
Error symptoms			

4.2 OBJECTIVES

- Identify the major internal and external components of "Computer Troubleshooting Trainer".
- Use the Computer Troubleshooting Trainer fault simulator.
- Check and measure the voltage of Power Supply outputs to Motherboard and other devices.
- Troubleshoot faults simulations in the VGA circuit.
- Identify the major components of "Laptop Troubleshooting Trainer".
- Use the Laptop Troubleshooting Trainer fault simulator.

4.3 INTRODUCTION

Labtech Computer Troubleshooting Trainer continually keep up to the trends on PC market for new designs, CPU types, Hard-disk and RAM sizes, as well as other features. Fundamental aspects remain much the same and the computer can be used for many years with high performance training results.

Labtech Computer Troubleshooting Trainer comes complete with all standard components and peripherals for a PC system. The unit has an electronic fault system to cause selected malfunctions on the computer, which will enable the student to troubleshoot the problem. The faults consist of common faults, which can occur in PCs.

4.4 Computer Troubleshooting Trainer Hardware

The Computer Troubleshooting Trainer consists of several components that can be divided into two main parts: the CPU (Central Processing Unit) and the Input-Output (Keyboard, Mouse, and Monitor). Figure 4.1 below will show you the components and parts of Computer Troubleshooting Trainer.

Figure 4.1 Computer Troubleshooting Trainer Hardware.

Components of the trainer

1. A Complete set of CPU
2. LCD Monitor
3. Keyboard
4. PS 2 Mouse and USB Mouse (according to the motherboard)

5. Multimedia stereo PC speaker
6. Driver disk for Motherboard and VGA card.
7. Motherboard instruction manual
8. AC power cords

4.4.1 USING THE COMPUTER TROUBLESHOOTING TRAINER FAULT SIMULATOR

Labtech Computer Troubleshooting Trainers have a unique fault simulation system that makes troubleshooting more interesting and understandable to the student. This troubleshooting system consists of fault selector switches, which are electronically selected using the fault switches. The selected fault is indicated by the corresponding LED on the fault panel board or they can be hidden to test the student's trouble shooting skills.

To operate the fault simulator system, follow procedure below:

1. Before making any connections make sure that Computer Troubleshooting Trainer is in OFF condition and power cable is unplugged from power source.
2. Select the fault by pressing the miniature push button of the fault insertion points. The fault will be activated and the problem is displayed on the fault indicator by the LED lighting up. The results of the fault activation are readily detectable on the PC monitor, keyboard, mouse or speaker.
3. The fault LED indicator can be turned off in order to test the students trouble-shooting ability. This is done by pressing "LED CONTROL" button. After this feature is activated, any selected faults will not be shown on the fault display board and then to show the LED indicators during the fault activation press and hold "LED CONTROL" again.
4. To return the system to normal operation, press "RESET" button and the system will be set to normal.

4.4.2 PROCEDURE

4.4.2.1 PART 1: Measuring the Power Supply output

1. Set the Digital multimeter measurement range to 20VDC in the DC Voltage mode. See Figure 4.2.
2. Switch on the power switch and then turn on the Computer by pressing the Power button of CPU. Allow Windows 10 to complete its starting session.
3. Connect the black lead multimeter to GND test point and red lead multimeter to TP1 test point.

Figure 4.2 Voltage mode setting on multimeter.

4. Observe the Digital Multimeter and then record the measurement result.
   The voltage on the TP1 is _________________ Volt
5. Move the red lead multimeter to TP2, observe the Digital multimeter
   The voltage on the TP2 is ________________ Volt
6. Move the red lead multimeter to TP3, observe the Digital multimeter
   The voltage on the TP3 is ________________ Volt
7. Move the red lead multimeter to TP4, observe the Digital multimeter
   The voltage on the TP4 is _______________ Volt
8. Move the red lead multimeter to TP5, observe the Digital multimeter
   The voltage on the TP5 is _______________ Volt
9. Move the red lead multimeter to TP6, observe the Digital multimeter
   The voltage on the TP6 is _______________ Volt
10. Shut down the Computer.
11. Disconnect multimeter leads and turn off the multimeter.
12. Compare all results to the Test Point list in the Appendix found in the end of this experiment.

4.4.2.2 PART 2: Troubleshooting the VGA

1. Turn on the Computer. Allow Windows 10 to complete its starting session. Use the oscilloscope and then measure RED signal at TP8.
2. Activate RED SIGNAL fault simulator by pressing the corresponding fault button. The RED SIGNAL fault indicator will light.

3. Observe the PC screen and record the fault effect. Did the monitor function properly? ___________________. What color is missing? ____________________________

   Fault symptom is ____
4. Reset the fault by pressing the RESET button.
5. Use the oscilloscope and then measure BLUE signal at TP10.
6. Activate BLUE SIGNAL fault simulator by pressing the corresponding fault button. The BLUE SIGNAL fault indicator will light.
7. Observe the PC screen and record the fault effect. Did the monitor function properly? ___________________. What color is missing? _________________________Fault symptom is ____
8. Reset the fault by pressing the RESET button.
9. Use the oscilloscope and then measure GREEN signal at TP9.
10. Activate GREEN SIGNAL fault simulator by pressing the corresponding fault button. The GREEN SIGNAL fault indicator will light.
11. Observe the PC screen and record the fault effect. Did the monitor function properly? ___________________. What color is missing? ____________________________ Fault symptom is ____
12. Reset the fault by pressing the RESET button. Activate GREEN SIGNAL, BLUE SIGNAL and RED SIGNAL fault simulations altogether by pressing the corresponding fault buttons.
13. Observe the PC screen and record the fault effect. Did the monitor function properly? ___________________. What color is missing? _________________________________

   Fault symptom is ____

14. Green, Blue and Red are three main colors used to create a color image in the computer screen. The signal is called RGB signal which produced by the video graphic adapter. What happened if this RGB signal is missing? _____________________________

   ____
15. Reset the fault by pressing the RESET button.
16. Activate HORIZONTAL SYNC fault simulator by pressing the corresponding fault button. The HORIZONTAL SYNC fault indicator will light.
17. Observe the PC screen and record the fault effect. Did the monitor function properly? ___________________. What is the problem? ____________________________________
18. Reset the faults and then shut down the computer troubleshooting trainer.
19. Activate the Graphic card fault and then turn on the Computer troubleshooting trainer.

Note: The Graphic card fault cannot be activated if Computer troubleshooting trainer is already on.

20. Observe and listen the fault effect.

    Did the computer start normally? ____

    Listen the beep sound, how many beeps do you hear?

    ____________long beep and ____________shorts beep.

21. Compare your experiment result with the fault symptom list that you prepare in prelab.
22. Your conclusion on this fault is :

    ____

    ____

23. After completing the experiment close all programs and shut down your computer. Turn off monitor power switch.

4.5 Laptop Troubleshooting Trainer

4.5.1 INTRODUCTION

Labtech Laptop Troubleshooting Trainer is a flexible and modular trainer that is designed to teach students about the advanced skills in Laptop architecture, component module functions, troubleshooting and diagnostics. The trainer comes complete with all standard components and peripherals to form a completed operational Laptop system. The student is able to practice advanced troubleshooting and diagnostic techniques covering how to evaluate, isolate and identify common malfunctions down to the board and module level.

Electronic Fault Insertion & Test Points

A unique fault insertion and removal (FIRM) system is built into the trainer for student instruction purposes. This causes malfunctions on the laptop which will enable the student to troubleshoot and diagnose the problems. The faults consist of common faults which occur in Laptop PCs. Also, the student can perform system upgrades on the trainer to learn how to enhance laptop performance such as memory and hard disk.

4.5.2 Laptop Troubleshooting Trainer Components

The Trainer is a versatile and powerful system, supporting a mainstream performance CPU. The computer uses a state-of-the-art bus architecture, which improves system efficiency and helps the system support varied multimedia and software applications.

The Trainer has standard laptop I/O (input/output) interfaces such as HDMI port, USB ports, and microphone, line-out jacks, RJ 45 LAN port, and memory card reader. The Trainer can also support Wireless LAN and Bluetooth.

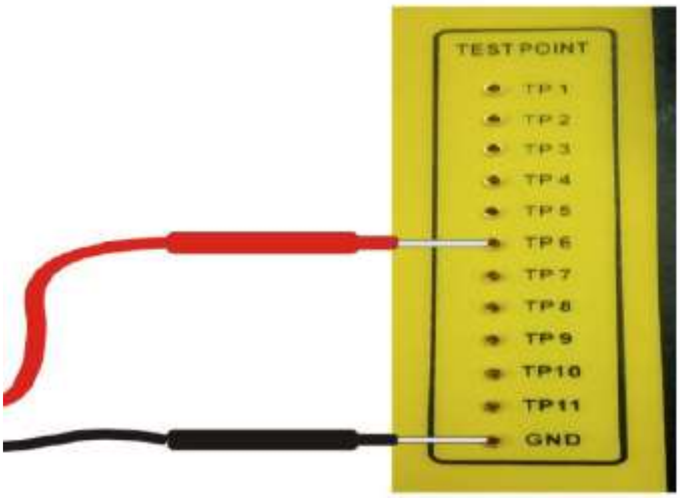
Figure 4.3 Laptop Troubleshooting Trainer Hardware.

4.5.3 PROCEDURE

BATTERY CHARGER TROUBLESHOOTING

1. Prepare the required equipment on your workbench.
2. Plug the AC power cord of Laptop trainer into the AC power source.
3. Turn ON the Power Switch of Laptop Troubleshooting Trainer panel.
4. Turn ON the Laptop and wait until start-up process finished.
5. Measure DC voltage at test point 6 as shown below. Test Point 6 is the Laptop power adapter voltage output.

How much is the DC voltage? ____



Measuring on TP 6

6. Observe power icon on the tray-icon as shown below. What icon is shown? AC mode or battery mode? ____

7. Observe power status on your laptop trainer. What is indicated by power status? AC mode or battery mode? ____

8. Activate battery charger fault simulator by pressing the button.

9. Measure voltage at test point 6 again. How much the voltage? ___________________

10. How is the brightness of your laptop screen now? __________________________

11. Again observe power icon on the tray-icon. What is indicated by the icon? AC mode or battery mode? _______________ _____________________________________

12. Again observe power status on your laptop trainer. What is indicated by power status? AC mode or battery mode? ____

13. Based on the result of your experiment, write conclusions about the effect of this fault on a laptop!

____

14. Normalize the fault by pressing the Reset button as shown below.

15. After completing the experiment, turn off the laptop trainer and remove all unnecessary connections.

4.6 References

- LABTECH experiment manuals.

APPENDIX

TEST POINTS LIST

TP	TEST POINT NAME	MEASUREMENT
1	+3.3 volt power supply output	+ 3.3 volt
2	+5 volt power supply output	+5 volt
3	+5 volt VSB power supply output	+5 volt
4	**ATX 12V** power output	+12 volt
5	-12 volt power supply output	-12 volt
6	+12 volt VRM power supply output	+12 volt
7	PS ON controlling power supply	0 volt
8	RED signal VGA output	Video signal
9	GREEN signal VGA output	Video signal
10	BLUE signal VGA output	Video signal
	GND	GND
	GND	GND

Experiment 5: Computer Memory

5.1 Prelab

Q1. How do you check the size and type of the RAM on your PC or laptop?

a. List all steps you used to check the size of the RAM and what version of windows you have.

Q2. How much RAM do you have on your PC or laptop?

Q3. For the RAM you have on your PC or laptop, list:

a. Its type (i.e. DDR2 or DDR3 or DDR4, etc.)

b. Its speed:

c. Slots used:

d. Form factor:

e. Hardware reserved:

Q4. Provide a screenshot of the RAM information you listed above for your PC or laptop?

Q5. How much memory can be accessed by a 32-bit PC?

Q6. Why there are multiple levels of memories in the computer system and not just a single level?

Q7. What is the main purpose of the MMU unit?

Q8. List one of the main differences between primary and secondary memories?

Q9. What questions you should ask yourself before upgrading the RAM of your computer?

5.2 OBJECTIVES

On completion of this experiment, you are expected:

1. To understand the Computer Memory types and characteristics.
2. To recognize several kinds of Random Access Memory.
3. To be able to determine the Random Access Memory based on the needs.
4. Troubleshoot faults simulations in the DDR SDRAM built in the motherboard.
5. To perform the Memory Testing using BIOS.
6. To perform the Memory Testing using 3rd party software.

5.3 INTRODUCTION

Computer data storage, often called storage or memory, refers to computer components and recording media that retain digital data used for computing for some interval of time. Computer data storage provides one of the core functions of the modern computer for information retention. It is one of the fundamental components of all modern computers, and coupled with a central processing unit (CPU, a processor), implements the basic computer model used since the 1940s.

In contemporary usage, memory usually refers to a form of semiconductor storage known as random-access memory, typically DRAM (Dynamic-RAM) but many times other forms of fast but temporary storage. Similarly, storage today more commonly refers to storage devices and their media not directly accessible by the CPU (secondary or tertiary storage) — typically hard disk drives, optical disc drives, and other devices slower than RAM but more permanent. Historically, memory has been called 'main memory', 'real storage' or 'internal memory'; while storage devices have been referred to as 'secondary storage', 'external memory' or 'auxiliary/peripheral storage'.

In practice, almost all computers use a variety of memory types, organized in a storage hierarchy around the CPU, as a trade-off between performance and cost. Generally, the lower a storage is in the hierarchy, the lesser its bandwidth and the greater its access latency is from the CPU.

5.4 HIERARCHY OF STORAGE

a. Primary storage

Primary storage (or main memory or internal memory), often referred to simply as memory, is the only one directly accessible to the CPU. The CPU continuously reads instructions stored there and executes them as required. Any data actively operated on is also stored there in uniform manner.

Historically, early computers used delay lines, Williams tubes, or rotating magnetic drums as primary storage. By 1954, those unreliable methods were mostly replaced by magnetic core memory. Core memory remained dominant until the 1970s, when advances in integrated circuit technology allowed semiconductor memory to become economically competitive.

This led to modern random-access memory (RAM). It is small-sized, light, but quite expensive at the same time. (The particular types of RAM used for primary storage are also volatile, i.e. they lose the information when not powered). As shown in the diagram, traditionally there are two more sub-layers of the primary storage, besides main large-capacity RAM:

1. Processor registers are located inside the processor. Each register typically holds a word of data (often 32 or 64 bits). CPU instructions instruct the arithmetic and logic unit to perform various calculations or other operations on this data (or with the help of it). Registers are technically among the fastest of all forms of computer data storage.
2. Processor cache is an intermediate stage between ultra-fast registers and much slower main memory. It is introduced solely to increase performance of the computer. Most actively used information in the main memory is just duplicated in the cache memory, which is faster, but of much lesser capacity. On the other hand it is much slower, but much larger than processor registers. Multi-level hierarchical cache setup is also commonly used—primary cache being smallest, fastest and located inside the processor; secondary cache being somewhat larger and slower.

Main memory is directly or indirectly connected to the central processing unit via a memory bus. It is actually two buses (not on the diagram): an address bus and a data bus. The CPU firstly sends a number through an address bus, a number called memory address that indicates the desired location of data. Then it reads or writes the data itself using the data bus.

Additionally, a memory management unit (MMU) is a small device between CPU and RAM recalculating the actual memory address, for example to provide an abstraction of virtual memory or other tasks.

As the RAM types used for primary storage are volatile (cleared at start up), a computer containing only such storage would not have a source to read instructions from, in order to start the computer. Hence, non-volatile primary storage containing a small startup program (BIOS) is used to bootstrap the computer, that is, to read a larger program from non-volatile secondary storage to RAM and start to execute it. A non-volatile technology used for this purpose is called ROM, for read-only memory (the terminology may be somewhat confusing as most ROM types are also capable of random access).

Many types of "ROM" are not literally read only, as updates are possible; however it is slow and memory must be erased in large portions before it can be re-written. Some embedded systems run programs directly from ROM (or similar), because such programs are rarely changed. Standard computers do not store non-rudimentary programs in ROM, rather use large capacities of secondary storage, which is non-volatile as well, and not as costly.

b. Secondary storage

Secondary storage (also known as external memory or auxiliary storage), differs from primary storage in that it is not directly accessible by the CPU. The computer usually uses its input/output channels to access secondary storage and transfers the desired data using intermediate area in primary storage. Secondary storage does not lose the data when the device is powered down—it is non-volatile. Per unit, it is typically also two orders of magnitude less expensive than primary storage. Consequently, modern computer systems typically have two orders of magnitude more secondary storage than primary storage and data is kept for a longer time there.

In modern computers, hard disk drives are usually used as secondary storage. The time taken to access a given byte of information stored on a hard disk is typically a few thousandths of a second, or milliseconds. By contrast, the time taken to access a given byte of information stored in random access memory is measured in billionths of a second, or nanoseconds. This illustrates the very significant access-time difference which distinguishes solid-state memory from rotating magnetic storage devices: hard disks are typically about a million times slower than memory. Rotating optical storage devices, such as CD and DVD drives, have even longer access times. With disk drives, once the disk read/write head reaches the proper placement and the data of interest rotates under it, subsequent data on the track are very fast to access. As a result, in order to hide the initial seek time and rotational latency, data are transferred to and from disks in large contiguous blocks.

Some other examples of secondary storage technologies are: flash memory (e.g. USB flash drives or keys), floppy disks, magnetic tape, paper tape, punched cards, standalone RAM disks, and Iomega Zip drives.

The secondary storage is often formatted according to a file system format, which provides the abstraction necessary to organize data into files and directories, providing also additional information (called metadata) describing the owner of a certain file, the access time, the access permissions, and other information.

Most computer operating systems use the concept of virtual memory, allowing utilization of more primary storage capacity than is physically available in the system. As the primary memory fills up, the system moves the least-used chunks (pages) to secondary storage devices (to a swap file or page file), retrieving them later when they are needed. As more of these retrievals from slower secondary storage are necessary, the more the overall system performance is degraded.

5.5 RAM: AN OVERVIEW

In this section we will have an overview about RAM memory, its types, its packaging and memory modules, and the main technologies of it. Then some performance issues related to memory in general will be explored, that is memory speed and latency measures, in addition to the techniques used to verify that the retrieved data from memory is correct.

There are two types of RAM (note that there are more types but here we will focus on the basic types only):

- **DRAM (Dynamic RAM):** uses capacitors to hold the data, each bit is stored on one capacitor. Those capacitors need to be charged and discharged periodically, this process is called refreshing. DRAM is used for the RAM memory on motherboard (in new PCs the SDRAM is what used, more about this later). For this purpose, we will focus on DRAM in this experiment. DRAM can operate either asynchronously or synchronously with the system bus. In synchronous operation the memory keeps operation with the bus and retrieved the data as it arrives (asynchronous is the opposite). So, synchronous DRAM (SDRAM) is faster and for this purpose it is used nowadays for memory design.

- **SRAM (Static RAM):** uses transistors, or sometimes called latching circuitry, to store the data. It does not need refreshing like DRAM since no capacitors exist. So, it does not lose its data as quickly as DRAM and for this reason it is much faster than DRAM. SRAM are used mainly for the processor caches since they are faster than DRAM.

5.5.1 RAM Packaging

RAM packaging refer to the way RAM is packaged and placed on the motherboard. Sometimes they refer to packaging as the memory module form. Over years, hardware developments, especially the CPU, require parallel developments in memory to get faster and larger memory cards. New memory designs require new packaging. Types of RAM packaging (or memory modules):

- **SIMM (Single Inline Memory Module):** is the early technology used during the 1980s and 1990s. it has a 32-bit data path and common access speed of 60, 70, or 80 ns. Memory pins on both sides of the chip are redundant. SIMM can support either 246 KB or 1 MB of memory.
- **DIMM (Dual Inline Memory Module):** came after SIMM technology, an example of a DIMM RAM is shown in Figure 5.1. It has 64-bit data path and it has independent pins on both sides. For this purpose it can hold larger RAM size than SIMM. Many enhancements and improvements were added later to promote the performance of DIMM such as DDR, DDR2, buffered, registered, dual channel DIMM, etc. Computers nowadays are using DIMM technology for RAM. DIMM can come into two types:
  - **Single sided DIMM:** memory ICs are placed on one side of the RAM chip, can support memory sizes of 32, 64, and 128 MB.
  - **Double sided DIMM:** memory ICs are placed on both sides of the RAM chip, can support memory sizes of 32, 64, 128, and 512 MB, 1 GB, 2 GB, 4 GB, etc.

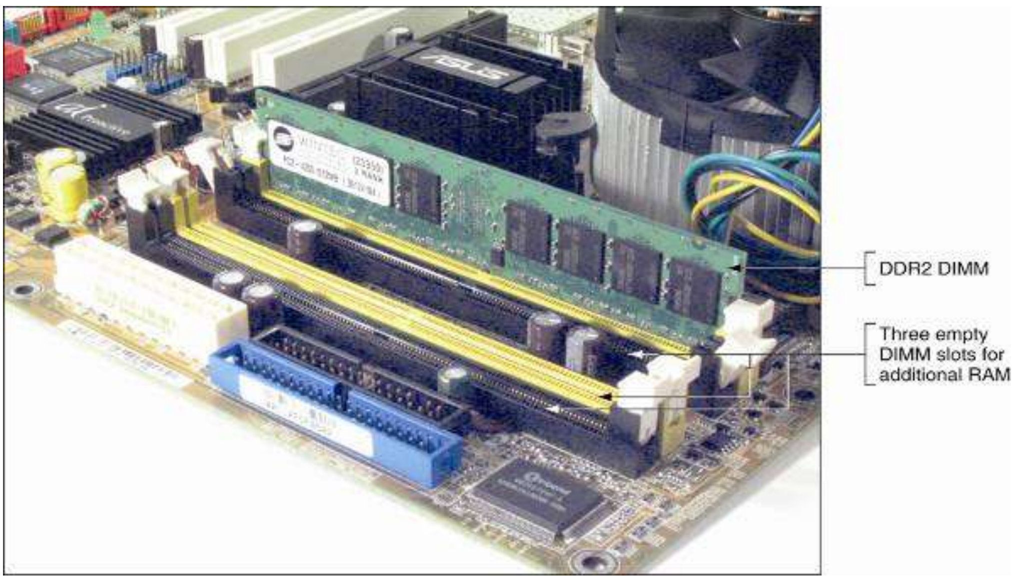


Figure 5.1: A DRAM stored in a DIMM.

- **RIMM (Rampus Inline Memory Module):** Came after DIMM but failed to replace it since RIMM is more expensive, slower, and produce more heat than DIMM. RIMM got its name from the company it has developed it, i.e. Rampus Company. In RIMM data is transferred on both the rising and falling edge of the clock, which is called double data rate. However, also this technique is used with new generations of DIMM.

Figure 5.2; exhibits various RAM technologies.

Description of Module	Example
288-pin DDR4 DIMM is currently the fastest memory.It can support two channels or be installed as Single DIMM.and requires lower power consumption than DDR3 DIMM.	
240-pin DDR3 DIMM can support triple or dual channels or be installed as a single DIMM.It has an offset notch farther from the center than a DDR2 DIMM.	
240-pin DDR2 DIMM can support dual channels or be installed as a single DIMM. Has one notch near the center of the edge connector.	
184-pin DDR DIMM can support dual channels or be installed as a single DIMM. Has one offset notch.	
168-pin SDRAM DIMM has two notches on the module.The positions of these notches depend on the memory features the DIMM uses.	
RIMM has 184 pins and two notches near the center of the edge connector.	
72-pin SIMM must be installed two modules to a bank of memory.	
30-pin SIMM must be installed four modules to a bank of memory.	

Figure 5.2: RAM types.

5.5.2 Memory Performance Measures

The performance of the memory is measured by its speed. That is, larger memory speed means better memory. RAM technologies use different measurement units/terms to express the memory speed. These units are:

- **Nanosecond:** express the memory access time, used with SIMM.
- **MHz:** this is a measure of the memory clock rate. As the rate is larger this means faster memory. Memory latency is measured in terms of clock cycles needed to program the read/write operation. So, when the clock rate is higher the period of the clock cycle is smaller. This unit is used by SDRAM, DDR, DDR2, and RIMM.
- **PC Rating:** used by some DIMM and RIMM types. The PC rating is the data transfer rate between the memory and the CPU

CAS or RAS latency:

Also, there are other important quantities that may express the speed of memory. CAS stands for Column Access Strobe and RAS stands for Row Access Strobe. The internal design of RAM is in the form of rows and columns of transistors/capacitors. Where each cell (which represent a transistor or a capacitor) hold one bit of data. To write or read a specific bit you need first to access the required row and then access the required column. The row and column are selected based on the address of the required memory location via multiplexers. The time delay required to access the row is called RAS and the time delay required to access the column is called CAS. As those delays are smaller this means better memory, i.e. memory with higher speed.

The overall memory speed is affected by the following factors:

- **Size of RAM:** larger RAM means faster PC memory (and also faster computer). Remember that RAM is used to store the active data/programs in use. If the size of this data is larger than the RAM then the OS is forced to replace the data very often (swap the data between the hard disk and the RAM). Such situation causes the CPU to wait for a long time to get the required data.
- **The used memory technology:** some technologies are faster than others, i.e. more enhanced. Example: DDR2 is faster than DDR, and DDR4 is faster than DDR3.
- **The speed of memory** in ns, MHz, or in PC rating.
- **ECC/Parity or non ECC/Parity memory:** memories that do not support error checking/correction are faster than those who support ECC or parity check. But what about reliability??
- **CL (CAS latency) and RL (RAS latency):** the lower the better is the memory.
- **Dual channelling:** in dual channelling the memory Controller communicates with 2 DIMMs at same time which results in wider data path from the memory. Example: two 64-bit DIMMs form 128-bit data path. To use this feature, install two identical DIMMs in each pair of channel slots.

5.6 Lab Work: Memory Installation, Upgrading, and Troubleshooting

In this section, you will examine the basic concepts associated with upgrading, installing, and troubleshooting memory. Memory upgrading is adding more RAM modules to the computer to solve the following problems:

- Slow performance
- Applications refusing to load
- An unstable system

Most motherboards come with empty memory slots that can be exploited for the addition of new RAM chips, i.e. new DIMM or RIMM. Also, sometimes you need to replace a corrupted memory chip. In both cases we are talking about memory cards installation which depends on the memory types you have. Finally, you will be introduced to some basic concepts to handle memory problems and failures.

5.6.1 Memory Upgrading

Before upgrading the computer memory you must answer the following questions:

- **How much memory do I need?**

The answer of this question depends on your needs. For example: the requirement of the OS you are using or want to install, requirements of some special heavy applications you are using (such as graphic design applications, video games, etc.).

- **How much RAM is currently installed in my system?**

Before starting you must determine the memory amount you have. To do this; enter Msinfo32.exe in Run dialog box. This will exhibit the size of both physical and virtual memory your system has. Also you can use the task manger to view these information.

- **How many memory modules and what kind of memory modules can be installed?**

To answer this question you need to examine your hardware. Remove the case cover and have a look at the motherboard to know the answer. See how many empty slots you have, the type of the memory, i.e. SIMM, DIMM, or RIMM. Try to get a new RAM that is identical to what you already have. To get more precise information read the motherboard documentation. This tells you all about this stuff.

- **How much memory and what kind of memory can I fit on my motherboard?**

This depends on:

- The free memory slots you have,
- The memory type the motherboard can support,
- The max memory size and speed the motherboard can support.

Avoid mixing speeds on the motherboard. If you have two memory cards with different speeds your system will run at the slowest speed. If you do not have free slots you can replace a small size memory card with a larger one. In general, it is recommended to use the fastest memory that your motherboard can support. Other than the type and size factors you must pay attention to the method used to detect the memory card by the system (remember that when you boot your computer the BIOS tell you how much memory you have installed on your system). There are two methods:

PPD (Parallel Presence Detect): uses resistors to communicate the type of memory presence.

SPD (Serial Presence Detect): store the information about the memory type in an EPROM.

The new memory card must support the method used by your system, again see the motherboard documentation to know the method used by your system. If no information found assume PPD.

- **How do I select and purchase the right memory?**

You must first decide the manufacturer; it is preferred to be the same as for the memory card that are already installed on the motherboard. Then get information regarding speed, size, and technology from the manufacturer and select the one that matches your needs.

5.6.2 Memory Installation

Some guidelines to be considered when installing a new memory chip:

- New installations are generally uncomplicated.
- Usually involves just placing memory on motherboard.
- Older computers may need change to CMOS setup.
- If new memory not recognized, check the memory installation.
- Follow safety procedures when installing RAM. Example: always use a ground bracelet as you work.

Installing DIMM:

- As shown in Figure 5.4, pull out the supporting arms on the sides of the slot.
- Use notches on the DIMM edge connector as a guide.
- Insert the DIMM straight down into the slot.
- Ensure that supporting arms lock into position.

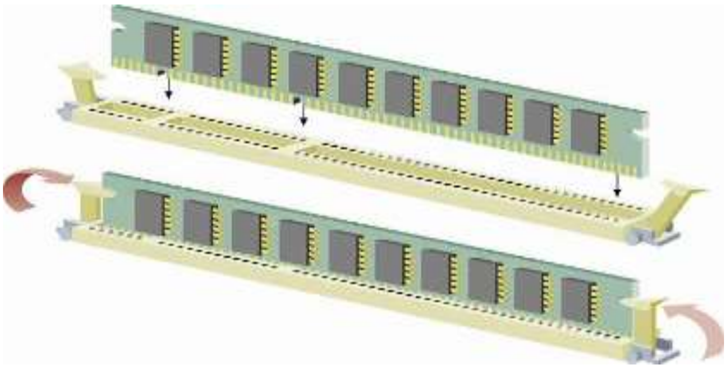


Figure 5.4: DIMM installation.

5.6.3 Memory Troubleshooting Basics

When installing new memory cards some problems may occur which avoid your system from starting properly. Such problems include the following:

- Boot failure
- A system that hangs, freezes, or becomes unstable
- Intermittent application errors
- General Protection Fault (GPF) errors: Caused by memory errors in Windows

Upgrade Problem:

Problems that caused by unsuccessful memory upgrade. To handle such problem it is recommended to the following:

- Remove and reinstall the module
- Check for the suitability of the module for the board
- Ensure that the module is the correct size
- Remove the module and check for error message
- Test the module in another socket
- Clean the module edge connectors
- Try flashing BIOS

5.7 Lab Work: Troubleshooting on DDR SDRAM

1. On the "Computer Troubleshooting Trainer". Switch ON the power and then activate the DDR SDRAM fault by pressing the fault button.

Note: The DDR SDRAM fault cannot be activated if the Computer troubleshooting trainer is turning on.

2. Turn ON the Computer troubleshooting trainer.
3. Observe the fault effect.
4. Will the Computer troubleshooting trainer be on? ___________________________
5. Can the Computer troubleshooting trainer boot? __________________________________
6. Listen to the beeping sound.

How many beep do you hear, ____________long beep and ______________short beeps.

7. Reset the fault by pressing RESET button.
8. Diagnose possible circuit malfunctions according to the fault symptoms and suspect possible fault locations.
9. Your conclusion on this fault is:

____

____

____

____

10. After completing the experiment close all programs and shut down your computer. Turn off monitor power switch.

5.8 Lab Work: memory testing using BIOS.

1. Go to BIOS setup.
2. Look at your screen (as shown in Fig. 5.5), the RAM is automatically identified by the BIOS, ensure that the setup is set correctly.

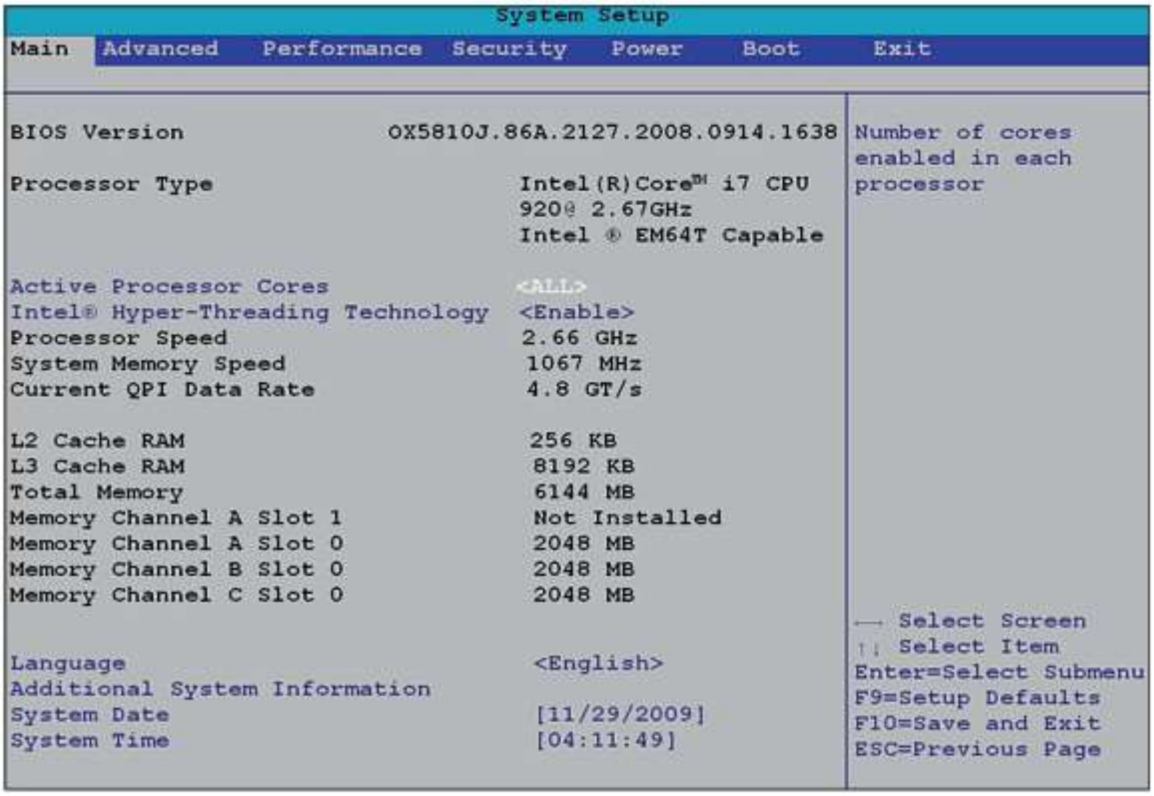


Figure 5.5:BIOS screen.

3. Now, check every technical parameter shown by the BIOS.
4. Check the Memory size, write it down in table 5.1 below.

Parameters	BIOS detected	Description
Manufacturer		A Company that manufactures the CPU.
Brand	Kingstone	
Type	DDR2	
Module Name		
Size	GB	
Memory Clock	200 MHz	
I/O Bus Clock	400 MHz	
Data Rate	800 MT/s	
Transfer Rate	MB/s	
Parity / ECC		

Table5.1: Memory Testing Results.

5. Check some others technical detail regarding the Memory. Use this table below to get to know to the Memory deeper.
6. Find the technical detail regarding the Memory through its box / catalog / brochure, or even from the Internet.
7. Compare it with the information on the table above. Is there any difference?

   ____

8. Find which parameters that the BIOS does not provide.

   ____

   ____

5.9 Lab Work: Memory testing with 3rd party program

A. Perform the Memory Testing

1. Run the “Burn-InTest”.
2. A “Burn-InTest” window will appear shortly. Below in Fig. 5.6 is part of the window.

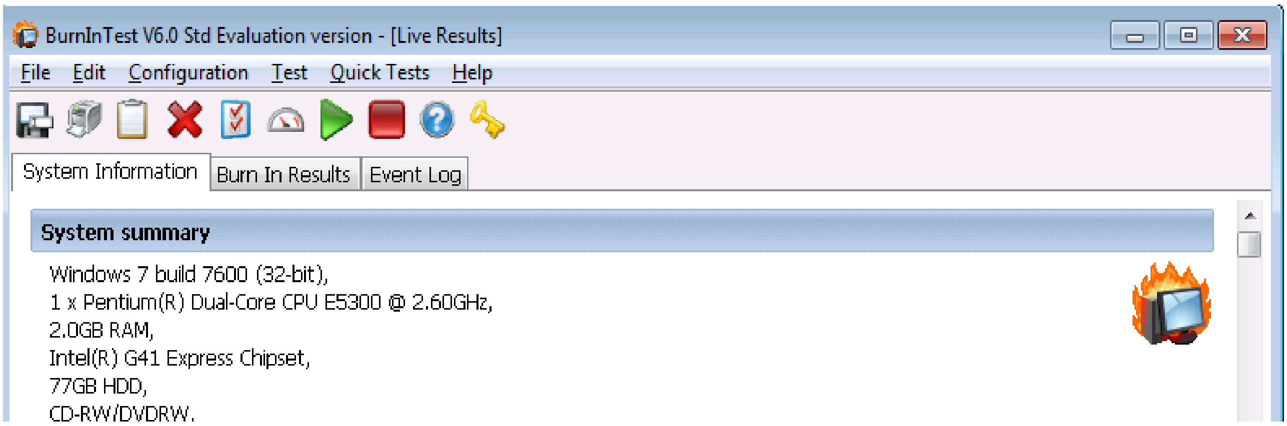


Figure 5.6

3. Click and drag the vertical bar down, until you find "Memory" test results as in Fig.5.6 below.

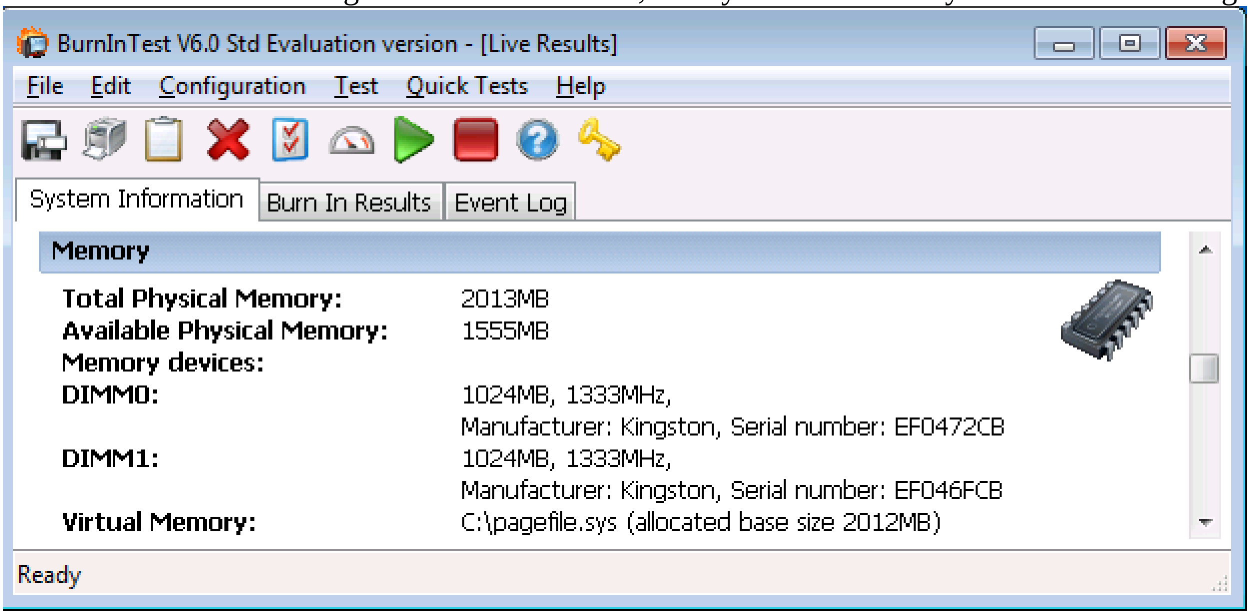


Figure 5.7

4. Check the detail. How many piece of memory detected, what size the Memory, what the clock speed is.
5. Fill in and complete the table 5.2 below.

Parameters	BIOS detected	BurnInTest Software
Manufacturer		
Brand	Kingstone	
Type	DDR2	
Module Name		
Size	GB	
Memory Clock	200 MHz	
I/O Bus Clock	400 MHz	
Data Rate	800 MT/s	
Transfer Rate	MB/s	
Parity / ECC		

Table5.2: Memory Testing (using BurnInTest) Results.

6. Compare the results with the one you did with BIOS. Is there any difference?

7. Should you find any difference, jot it down and find out why.

   On our case, they are different since it used different computer system.

8. Find any information that the software cannot provide.

B. Perform the Memory Burning Testing

1. Go to the “Burn-InTest” window (Fig.5.8).

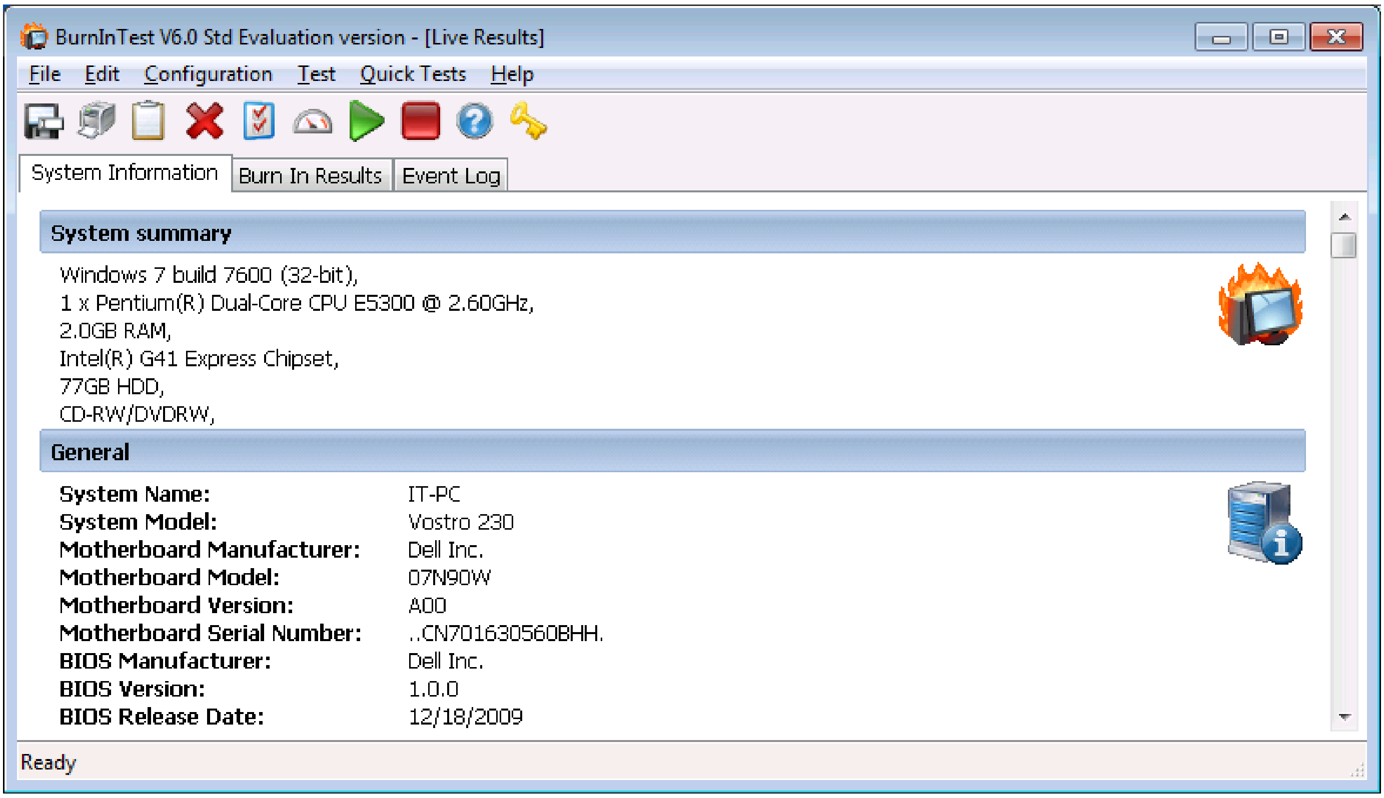


Figure 5.8

2. Click Configuration > Test Selection & Duty Cycles...

   The Test selection & duty cycles window appears.

3. Check on "RAM" and other subjects unchecked. The window becomes (see Fig.5.9):

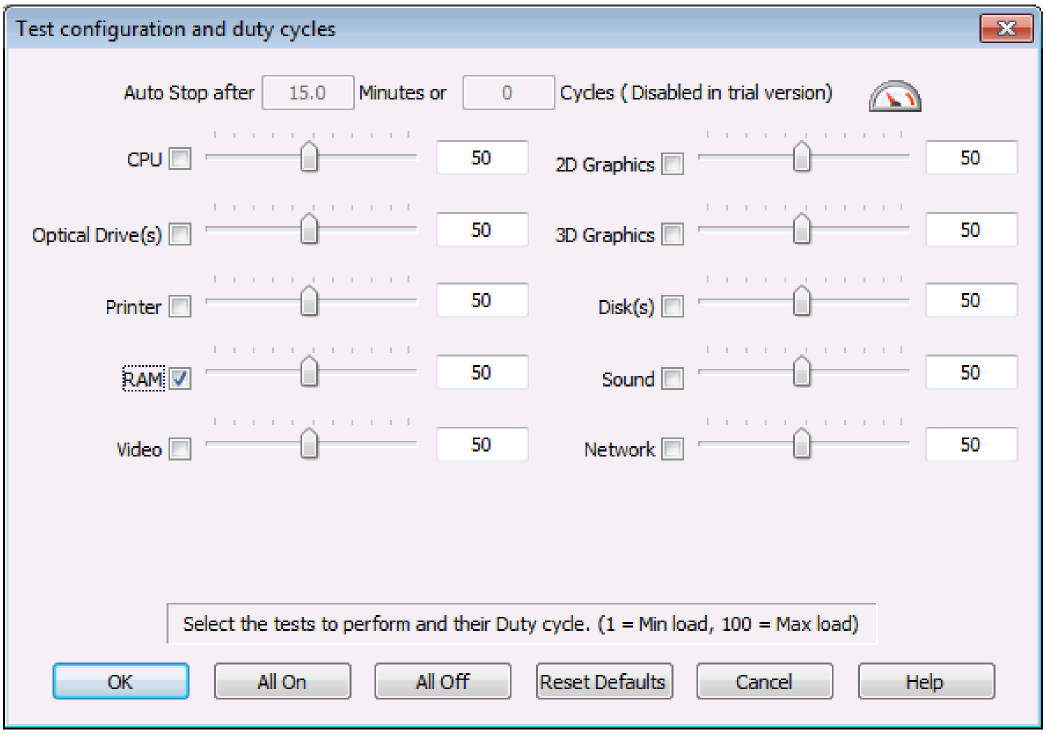


Figure 5.9

4. Leave the load as “50” for the first test, you can add up to 100 (max) there after.
5. Click [OK]. The Test selection & duty cycles window (Fig.5.10), with “Burn In Results” tab will be prompted.

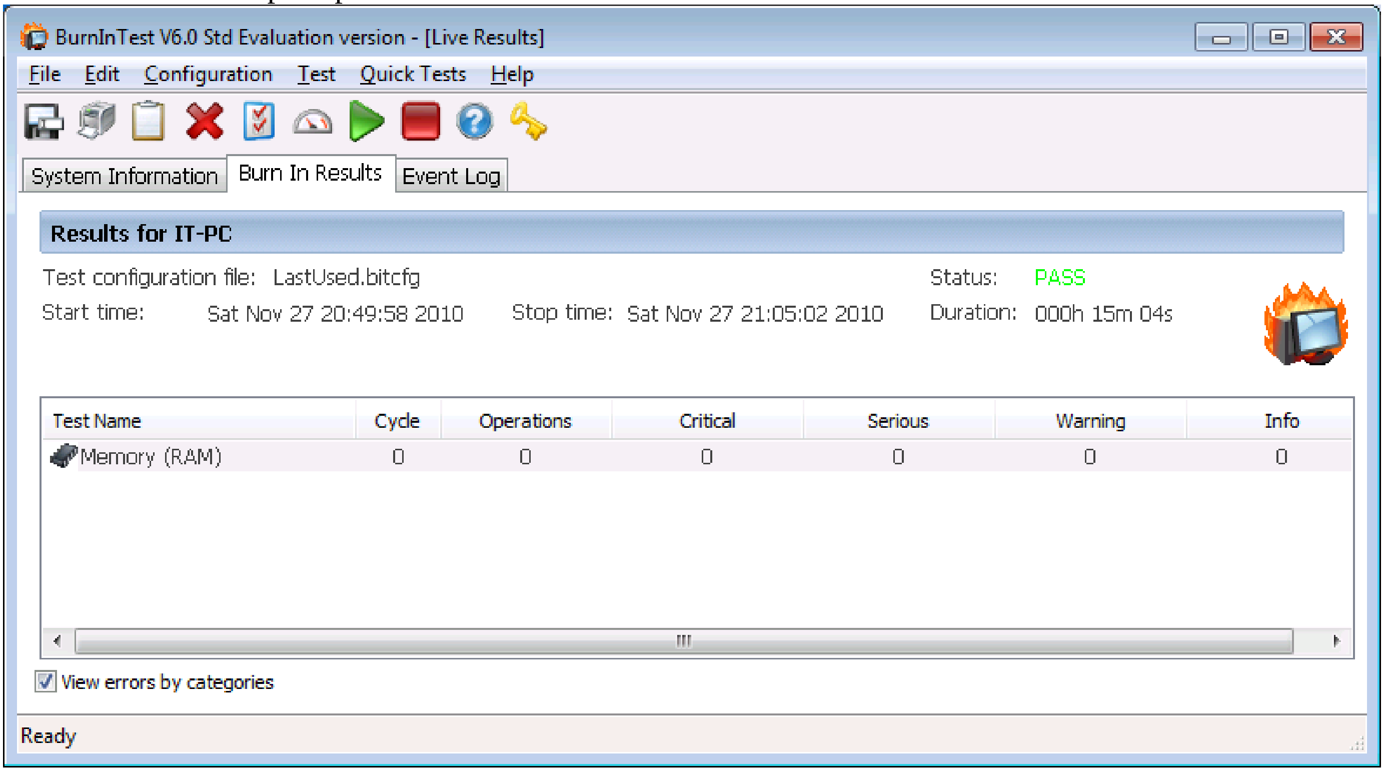


Figure 5.10

6. Click Test > Start Test Run to start the testing routine.

   A testing window will appear as below (Fig.5.11):

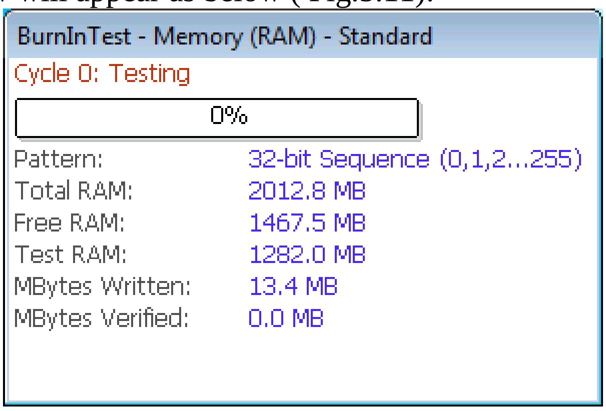


Figure 5.11

   It will take approximately 15 minutes.

7. When the status result appears (Either “Passed” or “Failed”), click [OK].

The testing result appears, like below in Fig.5.12 (depends on your machine condition):

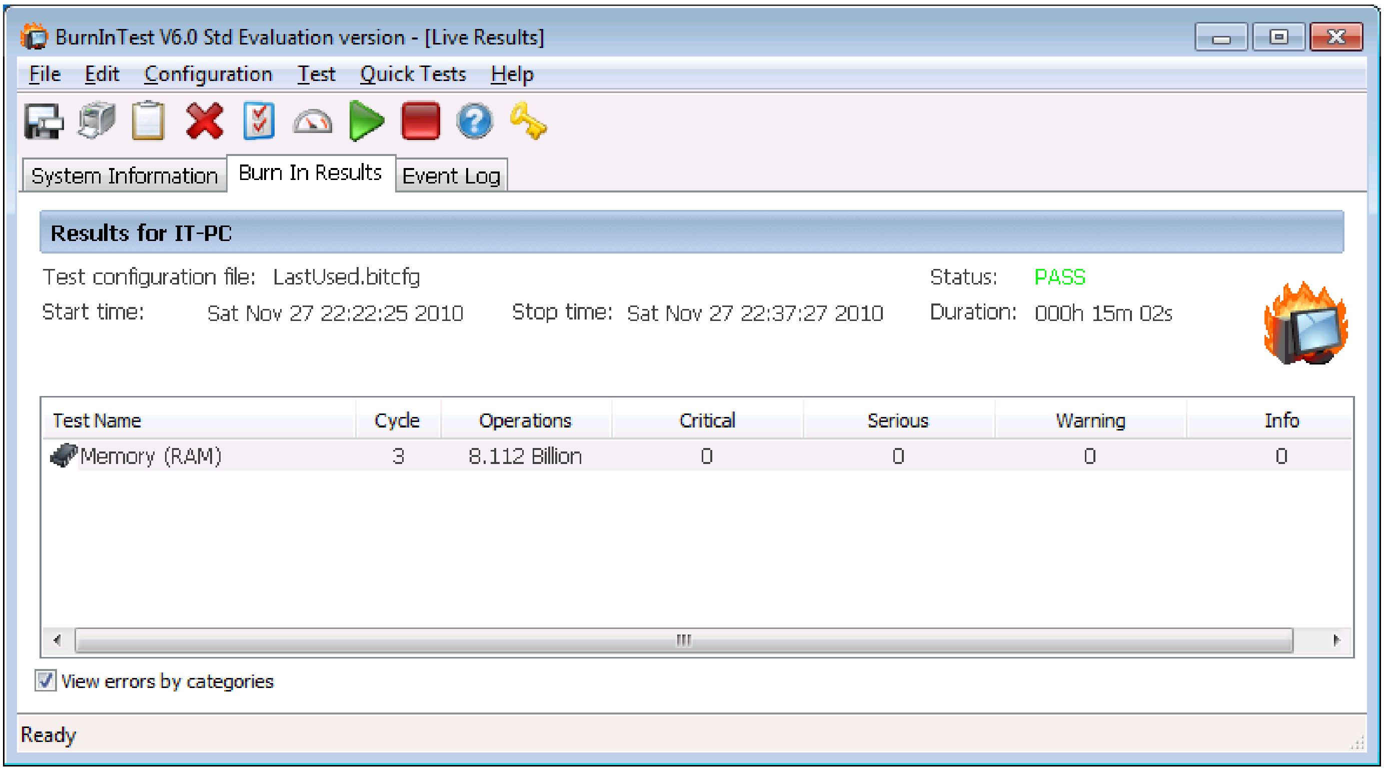


Figure 5.12

The Memory passed the Burning test with 50% load after perform 3 Cycles and 8,112 Billion of Operations in 15 minutes.

C. Perform the Burning Test with more Load.

1. Go to step 2, repeat the procedure till step 4. Raise the load to 75 or 100.
2. Perform steps 5 to 7, till you got the status result, Fail or Passed.
3. Compare the result with the 50 Load. Analyze the results.

   When the load is raised 50% from the previous test, what happen to the Cycle?

   ____

   Does it raise 50% as well?

   ____

4. What about the Operations? Does the operations multiplied as same as the Load?

   ____

5. Give your summary about Load, Cycle and Operations of the CPU burning test.

NOTE: "Windows Memory Diagnostic" is another tool built-in with Windows, can be used to check the memory.

5.9 References

- LABTECH experiment manuals.
- Maintenance lab manual (2020).

Experiment 6: Secondary Storage

6.1 Prelab

-Read the whole experiment and use the necessary resources from the internet to answer the following questions. Print this page and answer the questions (by your hand).

1. What is the harddisk? Please describe!

2. What is the function of Actuator?

3. What is the function of ReadWrite Head?

4. Fill in the table below, based on your knowledge about capacity of CD, DVD and Blue Ray.

Kind	Number of Side	Number of Layer	Capacity (Giga)
CD			
DVD			
Blue Ray			

5. Fill in the table below, based on your knowledge about Standards Supported by CD and DVD.

Standard	Description
CD-ROM	
CD-R	
CD-RW	
DVD-ROM	
DVD-R	
DVD-R DL	
DVD + R	
DVD - RAM	

Experiment 6: Secondary Storage

6.2 OBJECTIVES

On completion of this experiment, you are expected:

1. Learn about types of storage systems, magnetic, optical and flash memory system.
2. To understand the parts of Hard disk drive.
3. To understand the standard hard drive interface.
4. To be able to determine the proper harddisk based on the needs.
5. Identify some flash-memory-based storage devices and media and explain how they are used today.
6. How to install hard disk and CD/DVD ROM.
7. Simulate the Harddisk Drive circuit malfunction.

6.2 INTRODUCTION

As you remember, the RAM on the motherboard is called primary storage. Primary storage temporarily holds both data and instruction as the CPU processes them. These data and instructions are also permanently stored on devices such as CDs, and hard drives, in locations that are remote from the CPU. Data and instructions cannot be processed by the CPU from this remote storage (called secondary storage), but must first be copied into primary storage (RAM) for processing.

The most important difference between primary and secondary storage is that the secondary storage is permanent. When you turn off your computer, the information in secondary storage remains intact. The most popular secondary storage devices are hard disks, CDs, DVDs, and USB flashs.

Section 6.3.1 focuses on how hard drives work, beginning with the internal layout and organization of the hard drive. You'll look at the different types of hard drives used today (PATA, SATA, and SCSI), how they interface with the PC, and how to install them properly into a system. The section covers how more than one drive may work with other drives to provide data safety.

The CD- and DVD-media discs and drives come in a variety of flavors and formats, enabling you to back up data, record music, master a home video, and much, much more. Generically, we call them *optical-media discs* and the drives that support them *optical drives.*

The next sections examine CD-media and DVD-media, finishing with the details about installing both types of drives.

6.3 Magnetic Disk

Common types of magnetic disks: floppy disk and hard disk.

6.3.1 Hard Disk

A hard disk drive is a non-volatile storage device for digital data. It features one or more rotating rigid platters on a motor-driven spindle within a metal case. Data is encoded magnetically by read/write heads that float on a cushion of air above the platters.

Hard disk manufacturers quote disk capacity in SI-standard powers of 1000, wherein a terabyte is 1000 gigabytes and a gigabyte is 1000 megabytes. With file systems that report capacity in powers of 1024, available space appears somewhat less than advertised capacity.

The first HDD was invented by IBM in 1956. They have fallen in cost and physical size over the years while dramatically increasing capacity. Hard disk drives have been the dominant device for secondary storage of data in general purpose computers since the early 1960s. They have maintained this position because advances in their areal recording density have kept pace with the requirements for secondary storage. Form factors have also evolved over time from large standalone boxes to today's desktop systems mainly with standardized 3.5-inch form factor drives, and mobile systems mainly using 2.5-inch drives. Today's HDDs operate on high-speed serial interfaces, i.e., Serial ATA (SATA) or Serial attached SCSI (SAS).

The presentation of an HDD to its host is determined by its controller. This may differ substantially from the native interface drive particularly in mainframes or servers.

HDDs record data by magnetizing ferromagnetic material directionally, to represent either a 0 or a 1 binary digit. They read the data back by detecting the magnetization of the material. A typical HDD design consists of a spindle that holds one or more flat circular disks called platters, onto which the data is recorded. The platters are made from a non-magnetic material, usually aluminum alloy or glass, and are coated with a thin layer of magnetic material, typically 10–20 nm in thickness — for reference, standard copy paper is 0.07–0.18 millimetre (70,000–180,000 nm) thick — with an outer layer of carbon for protection. Older disks used iron(III) oxide as the magnetic material, but current disks use a cobalt-based alloy the platters are spun at very high speeds. Information is written to a platter as it rotates past devices called read-and-write heads that operate very close (tens of nanometers in new drives) over the magnetic surface. The read-and-write head is used to detect and modify the magnetization of the material immediately under it. In modern drives there is one head for each magnetic platter surface on the spindle, mounted on a common arm. An actuator arm (or access arm) moves the heads on an arc (roughly radially) across the platters as they spin, allowing each head to access almost the entire surface of the platter as it spins. The arm is moved using a voice coil actuator or in some older designs a stepper motor.

Architecture

A hard disk is a sealed unit containing a number of platters in a stack. Hard disks may be mounted in a horizontal or a vertical position. In this description, the hard drive is mounted horizontally.
Electromagnetic read/write heads are positioned above and below each platter. As the platters spin, the drive heads move in toward the center surface and out toward the edge. In this way, the drive heads can reach the entire surface of each platter.

Making Tracks

On a hard disk, data is stored in thin, concentric bands. A drive head, while in one position can read or write a circular ring, or band called a track. There can be more than a thousand tracks on a 3.5-inch hard disk. Sections within each track are called sectors. A sector is the smallest physical storage unit on a disk, and is almost always 512 bytes (0.5 kB) in size.

Figure 6.1 below shows a hard disk with two platters.

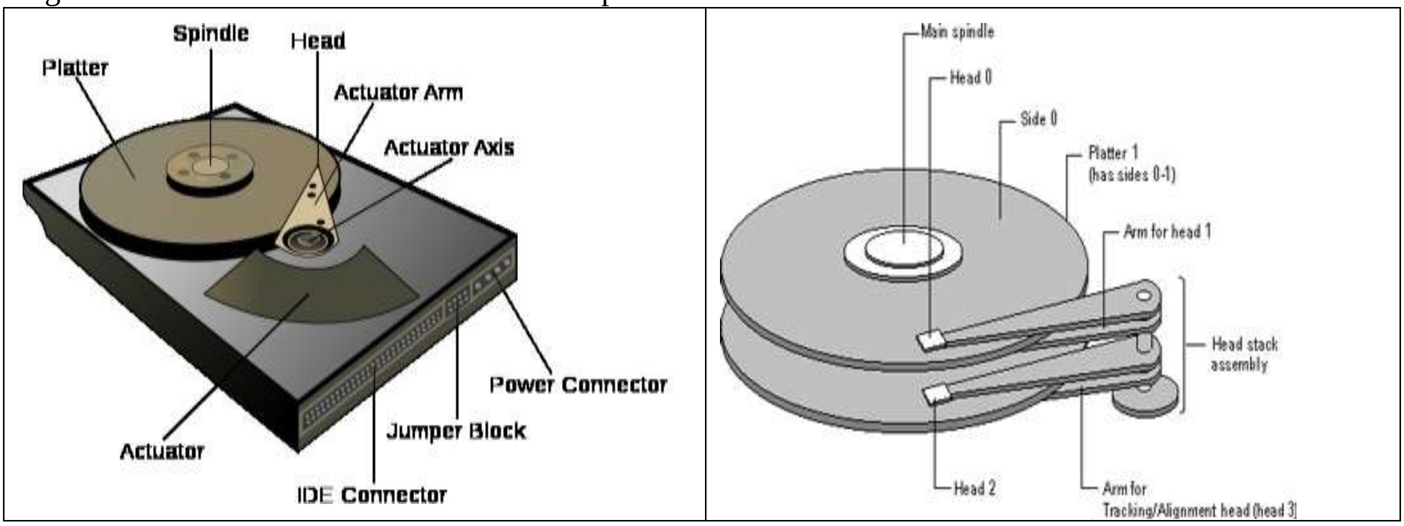


Figure 6.1: Parts of a Hard Drive.

The structure of older hard drives (i.e. prior to Windows 95) will refer to a cylinder/ head/sector notation. A cylinder is formed while all drive heads are in the same position on the disk. The tracks stacked on top of each other form a cylinder. This scheme is slowly being eliminated with modern hard drives. All new disks use a translation factor to make their actual hardware layout appear continuous, as this is the way that operating systems from Windows 95 onward like to work.

To the operating system of a computer, tracks are logical rather than physical in structure, and are established when the disk is low-level formatted. Tracks are numbered, starting at 0 (the outermost edge of the disk), and going up to the highest numbered track, typically 1023, (close to the center). Similarly, there are 1,024 cylinders (numbered from 0 to 1023) on a hard disk.

The stack of platters rotates at a constant speed. The drive head, while positioned close to the center of the disk reads from a surface that is passing by more slowly than the surface at the outer edges of the disk. To compensate for this physical difference, tracks near the outside of the disk are less-densely populated with data than the tracks near the center of the disk. The result of the different data density is that the same amount of data can be read over the same period of time, from any drive head position.
The disk space is filled with data according to a standard plan. One side of one platter contains space reserved for hardware track-positioning information and is not available to the operating system. Thus, a disk assembly containing two platters has three sides available for data. Track-positioning data is written to the disk during assembly at the factory. The system disk controller reads this data to place the drive heads in the correct sector position.

Sectors and Clusters

A sector, being the smallest physical storage unit on the disk, almost always 512 bytes in size because 512 is a power of 2 (2 to the power of 9). The number 2 is used because there are two states in the most basic of computer languages - on and off.
Each disk sector is labelled using the factory track-positioning data. Sector identification data is written to the area immediately before the contents of the sector and identifies the starting address of the sector.
The optimal method of storing a file on a disk is in a contiguous series, i.e. all data in a stream stored end-to-end in a single line. As many files are larger than 512 bytes, it is up to the file system to allocate sectors to store the file's data. For example, if the file size is 800 bytes, two 512 byte sectors are allocated for the file. A cluster is typically same or larger than the size of the sector. These two sectors with 800 bytes of data are called two clusters. They are called clusters because the space is reserved for the data contents. This process protects the stored data from being over-written. Later, if data is appended to the file and its size grows to 1600 bytes, another two clusters are allocated, storing the entire file within four clusters.

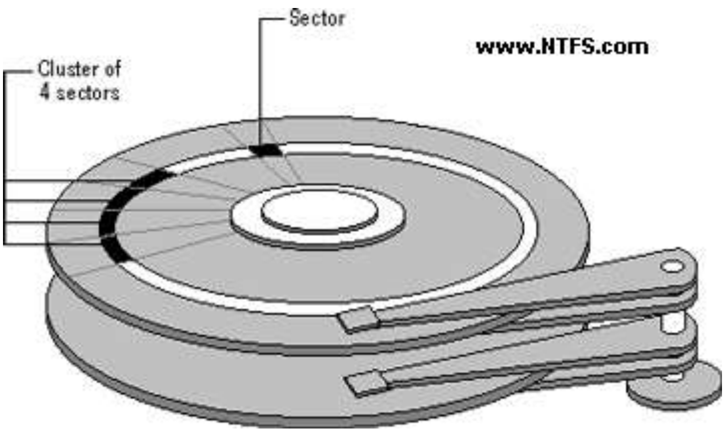


Figure 6.2 Sectors and Clusters

If contiguous clusters are not available (clusters that are adjacent to each other on the disk), the second two clusters may be written elsewhere on the same disk or within the same cylinder or on a different cylinder - wherever the file system finds two sectors available. A file stored in this non-contiguous manner is considered to be fragmented. Fragmentation can slow down system performance if the file system must direct the drive heads to several different addresses to find all the data in the file you want to read. The extra time for the heads to travel to a number of addresses causes a delay before the entire file is retrieved.

Cluster size can be changed to optimize file storage. A larger cluster size reduces the potential for fragmentation, but increases the likelihood that clusters will have unused space. Using clusters larger than one sector reduces fragmentation, and reduces the amount of disk space needed to store the information about the used and unused areas on the disk.

Most disks used in personal computers today rotate at a constant angular velocity. The tracks near the outside of the disk are less densely populated with data than the tracks near the center of the disk. Thus, a fixed amount of data can be read in a constant period of time, even though the speed of the disk surface is faster on the tracks located further away from the center of the disk.
Modern disks reserve one side of one platter for track positioning information, which is written to the disk at the factory during disk assembly. It is not available to the operating system. The disk controller uses this information to fine tune the head locations when the heads move to another location on the disk. When a side contains the track position information, that side cannot be used for data. Thus, a disk assembly containing two platters has three sides that are available for data.

Hard drives have different ways to interface with the computer. Some standards compete with others and each type of interface standards has evolved over time. This can make a confusing-mess of standards. The three current methods used by internal hard drives are Parallel ATA (PATA), Serial ATA (SATA), and SCSI.

Parallel ATA or EIDE Drive Standards

Parallel ATA, also called the EIDE (Enhanced IDE) standard or, more loosely, the IDE (Integrated Drive Electronics) standard, allows for one or two IDE connectors on a motherboard, each using a 40-pin data cable. These ribbon cables can accommodate one or two drives.

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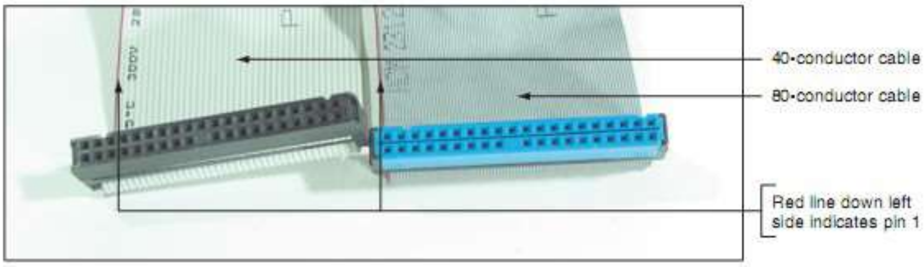


Figure 6.3: A Hard drive subsystem using parallel ATA data cable, 80-conductor cable and 40-conductor cable

Serial ATA Standards

SATA uses a serial data path rather than the traditional parallel data path. (Essentially, the difference between the two is that data is placed in a serial cable one bit following the next, but with parallel cabling, all data in a byte are placed in the cable at one time).

6.4. Optical Disks

CDs and DVDs are everywhere these days. Whether they are used to hold music, data or computer software, they have become the standard medium for distributing large quantities of information in a reliable package. Compact discs are so easy and cheap to produce that America Online sends out millions of them every year to entice new users. And if you have a computer and CD-R drive, you can create your own CDs, including any information you want.

6.4.1 CD

A CD is a fairly simple piece of plastic, the *thickness* of a CD can vary between 1.1 and 1.5mm. Most of a CD consists of four layers:

- The biggest part is clear polycarbonate (nominally 1.2mm)
- There is a very thin layer of reflective metal (usually aluminum) on top of the polycarbonate
- Then a thin layer of some protective material covering the reflective metal
- A label or some screened lettering on top of protective material

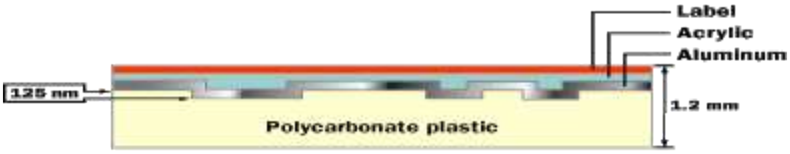


Figure 6.4: cross section of a CD

A CD has a single spiral track of data, circling from the inside of the disc to the outside. The fact that the spiral track starts at the center means that the CD can be smaller than 4.8 inches (12 cm) if desired, and in fact there are now plastic baseball cards and business cards that you can put in a CD player. CD business cards hold about 2 MB of data before the size and shape of the card cuts off the spiral.

You know, in the magnetic media (like floppy/hard disk) the surface is arranged into concentric circles called “tracks”; in the CD there is one single track, starts at the center of the disk and spirals out to the circumference of the disk. This track is divided into sectors of equal size.

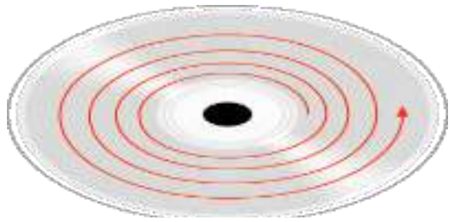
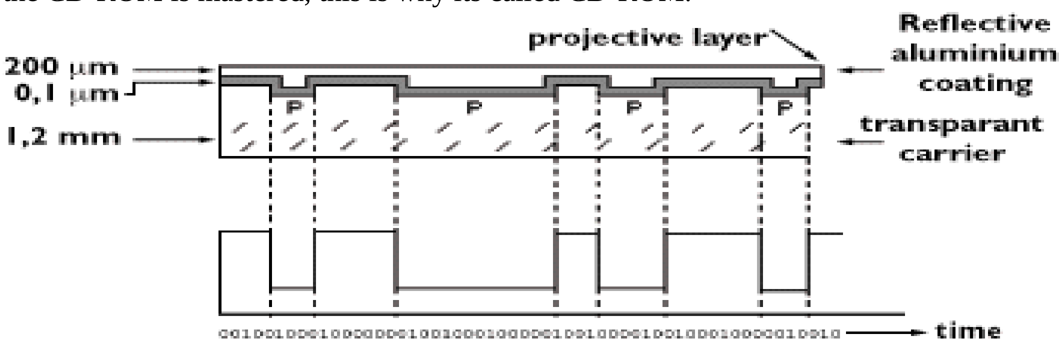


Figure 6.5: The spiral layout of sectors on a CD surface

CD Data Recording

Information is recorded on a CD using a series of bur looking like pits in the polycarbonate layer. The disk is read from the bottom, through the transparent polycarbonate (the pits appear as bumps to the scanning laser), the unmarked areas between pits are called "lands”(Lands are flat surface areas). The information is stored permanently as pits and lands on the CD-ROM. It cannot be changed once the CD-ROM is mastered, this is why its called CD-ROM.



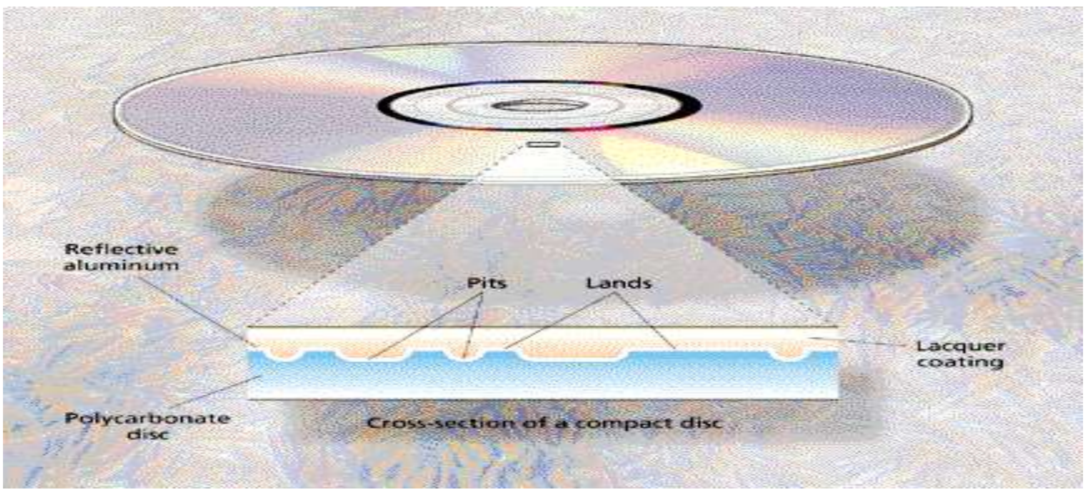


Figure 6.6: pits and land on a CD

How the CD Drive Works

A motor rotates the CD; the rotational speed varies so as to maintain a Constant Linear Velocity (the disk is rotated faster when its inner "SPIRALS" are being read). Then a laser beam is shone onto the surface of the disk, the light is scattered by the pits and reflected by the lands, these two variations encode the binary 0's and 1's. A light sensitive diode picks up the reflected laser light and converts the light to digital data.

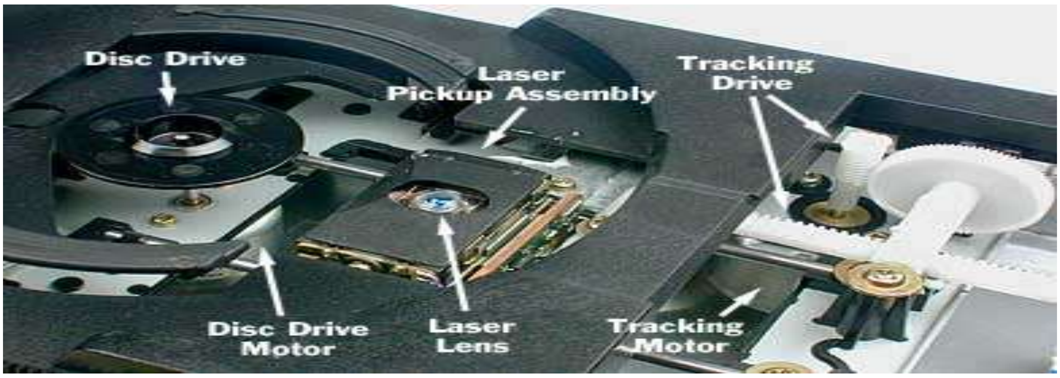


Figure 6.7: inside a CD player

CD-ReWritable (CD-RW)

It is essentially CD-R allows discs to be written and re-written up to 1000 times. The storage capacity is the same as that for CD-R. The recording layer is a mixture of silver, indium, antimony and tellurium.

CD-RW Recording Process

The recording layer is polycrystalline and the laser heats selected areas of the recording track to the recording layer's melting point of 500 to 500 degrees Celsius.

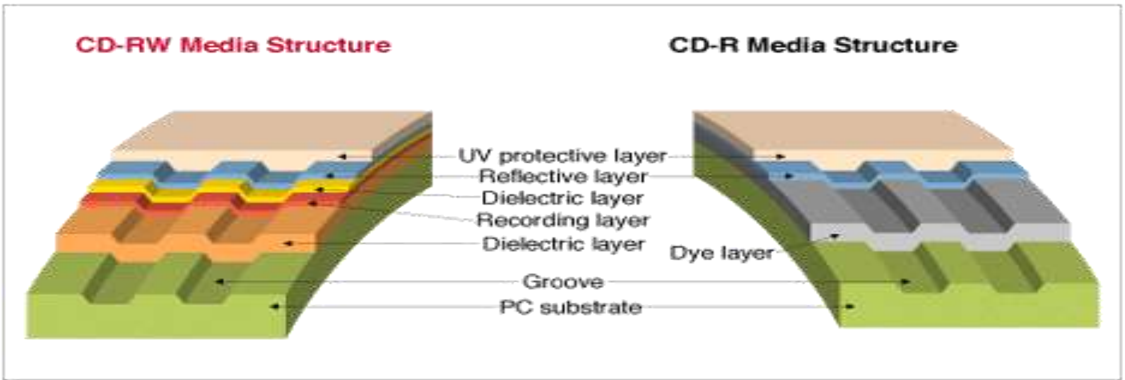


Figure 6.8: Different between CD-RW and CD-R structures

The laser beam melts the crystals and makes them non-crystalline (amorphous phase).The medium quickly cools, locking in the properties of the heated areas, then the amorphous areas have a lower reflectivity than the crystalline areas. This creates a pattern which can be read as pits and lands of the traditional CD. To erase a CD-RW disc, the recording laser turns the amorphous areas back into crystalline areas.

6.4.2 DVD

DVD, also known as Digital Video Disc or Digital Versatile Disc, is an optical disc storage media format, and was invented and developed by Philips, Sony, Toshiba, and Time Warner in 1995. Its main uses are video and data storage. DVDs are of the same dimensions as compact discs (CDs), but are capable of storing just under seven times as much data.

Variations of the term DVD often indicate the way data is stored on the discs: DVD-ROM (read only memory) has data that can only be read and not written; DVD-R and DVD+R (recordable) can record data only once, and then function as a DVD-ROM; DVD-RW (re-writable), DVD+RW, and DVD-RAM (random access memory) can all record and erase data multiple times. The wavelength used by standard DVD lasers is 550 nm; thus, the light has a red color.

DVD vs. CD

DVDs are of the same diameter and thickness as CDs, and they are made using some of the same materials and manufacturing methods. Like a CD, the data on a DVD is encoded in the form of small pits and bumps in the track of the disc.

You know that a DVD is very similar to a CD, but it can store large amounts of data than a CD because there is the following different between them:

- DVD uses a tighter spiral (track or helix) with only 0.54 microns between the tracks (1.5 microns on CDs)
- DVD recorders use a laser with a smaller wavelength, 535nm or 550 nm (visible red light) vs. 580nm (infrared) for CDs
- DVD has smaller "burns" (pits) in the translucent dye layer (0.4 microns minimum vs. 0.83 microns minimum on CDs)

Figure 6.9: Different between CD and DVD

A DVD is composed of several layers of plastic, totaling about 1.2 millimeters thick. Each layer is created by injection molding polycarbonate plastic. This process forms a disc that has microscopic bumps arranged as a single, continuous and extremely long spiral track of data. For standard single-sided DVDs store up to 4.5GB of data, in the dual-sided discs hold about 8.5GB of data (9.4GB for back-to-back layers dual-sided discs) In back-to-back layers discs, it must be turned over to access the data on the reverse side.

6.5 Flash memory

Flash memory is a non-volatile computer storage technology that can be electrically erased and reprogrammed. It is primarily used in memory cards, USB flash drives, and solid-state drives for general storage and transfer of data between computers and other digital products. It is a specific type of EEPROM (electrically-erasable programmable read-only memory) that is erased and programmed in large blocks; in early flash the entire chip had to be erased at once. Flash memory costs far less than byte-programmable EEPROM and therefore has become the dominant technology wherever a significant amount of non-volatile, solid state storage is needed. Example applications include PDAs (personal digital assistants), laptop computers, digital audio players, digital cameras and mobile phones. It has also gained popularity in console video game hardware, where it is often used instead of EEPROMs or battery-powered static RAM (SRAM) for game save data.

Since flash memory is non-volatile, no power is needed to maintain the information stored in the chip. In addition, flash memory offers fast read access times (although not as fast as volatile DRAM memory used for main memory in PCs) and better kinetic shock resistance than hard disks. These characteristics explain the popularity of flash memory in portable devices. Another feature of flash memory is that when packaged in a "memory card," it is extremely durable, being able to withstand intense pressure, extremes of temperature, and even immersion in water.

6.5.1 Memory card

A memory card or flash card is an electronic flash memory data storage device used for storing digital information. They are commonly used in many electronic devices, including digital cameras, mobile phones, laptop computers, MP3 players, and video game consoles. They are small, re-recordable, and they can retain data without power.

Figure 6.10: memory cards

The most common type of memory card in use today is the SD card, which comes in capacities of up to 2 TB. In addition to these and other types of memory cards, there are also non-solid-state memory cards that do not use flash memory, and there are different types of flash memory.

6.5.2 USB flash drive

A USB flash drive consists of a flash memory data storage device integrated with a USB (Universal Serial Bus) 1.1, 2.0, 3.0, 3.1, 3.2, or 4.0 interfaces. USB flash drives are typically removable and rewritable, and physically much smaller than a floppy disk. Most weigh less than 30 g (1 oz). Storage capacities in 2010 can be as large as 255 GB with steady improvements in size and price per capacity expected. Some allow 1 million write or erase cycles and have a 10-year data retention cycle.

USB flash drives are often used for the same purposes as floppy disks were. They are smaller, faster, have thousands of times more capacity, and are more durable and reliable because of their lack of moving parts. Until approximately 2005, most desktop and laptop computers were supplied with floppy disk drives, but most recent equipment has abandoned floppy disk drives in favor of USB ports.

Nothing moves mechanically in a flash drive; the term drive persists because computers read and write flash-drive data using the same system commands as for a mechanical disk drive, with the storage appearing to the computer operating system and user interface as just another drive. Flash drives are very robust mechanically.

Most USB flash drives draw their power from the USB connection, and do not require a battery. Some devices that combine the functionality of a digital audio player with flash-drive-type storage require a battery for the player function.

USB Features

The Universal Serial Bus has the following features:

- The computer acts as the **host**.
- Up to **125 devices** can connect to the host, either directly or by way of USB hubs.
- Individual USB cables can run as long as 5 meters; with hubs, devices can be up to 30 meters (six cables' worth) away from the host.
- With USB 2.0, the bus has a maximum data rate of **480 megabits per second**.
- A USB cable has two wires for power (+5 volts and ground) and a twisted pair of wires to carry the data.
- On the power wires, the computer can supply up to 500 milliamps of power at 5 volts.
- Low-power devices (such as mice) can draw their power directly from the bus. High-power devices (such as printers) have their own power supplies and draw minimal power from the bus. Hubs can have their own power supplies to provide power to devices connected to the hub.
- USB devices are **hot-swappable**, meaning you can plug them into the bus and unplug them any time.
- Many USB devices can be put to **sleep** by the host computer when the computer enters a power-saving mode.
- The devices connected to a USB port rely on the USB cable to carry power and data.

Figure 6.11: Inside USB cable

6.6 Lab Work:

6.6.1 Installing a Serial ATA Drive

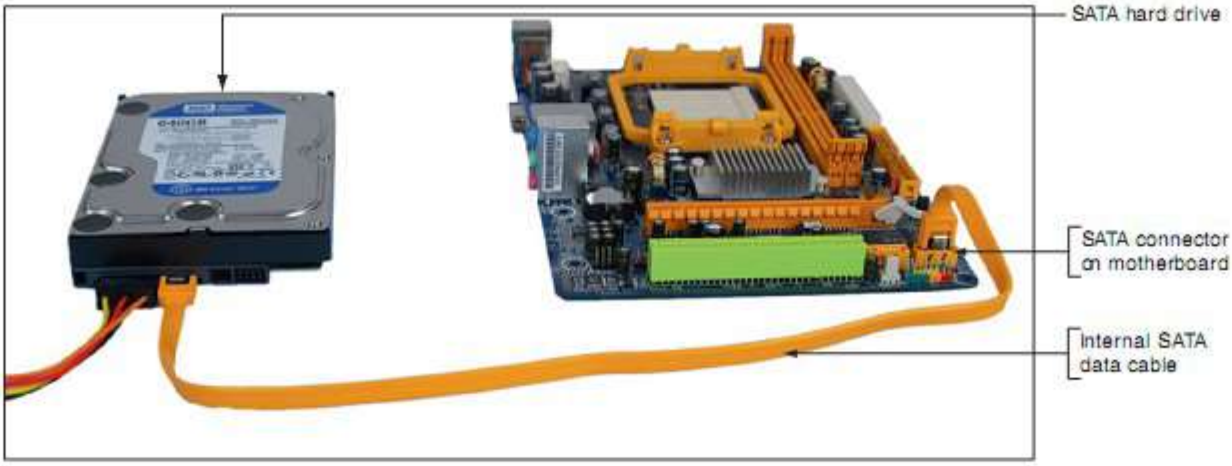


Figure 6.12: SATA HDD connections.

The picture (Figure 6.14) above shows how to install a hard disk drive to the motherboard using SATA cable.

1. Plug the SATA cable connector into the SATA slot on motherboard.
2. Connect Data Cable from Motherboard to Hard Disk Drive.
3. Connect Power Cord from Power Supply to Hard Disk Drive.
4. Check all your connections and power up the system
5. Give the Summary.

____

____

6.6.2 Installing a Parallel ATA Drive.

Figure 6.13: IDE. Harddisk interfaces.

Following the PATA or EIDE standard, a motherboard can support up to four EIDE devices using either 80-conductor or 40-conductor cables. The motherboard offers two IDE connectors.

1. Look at the IDE Channel First that supports the Master and Slave drive using a single EIDE cable.

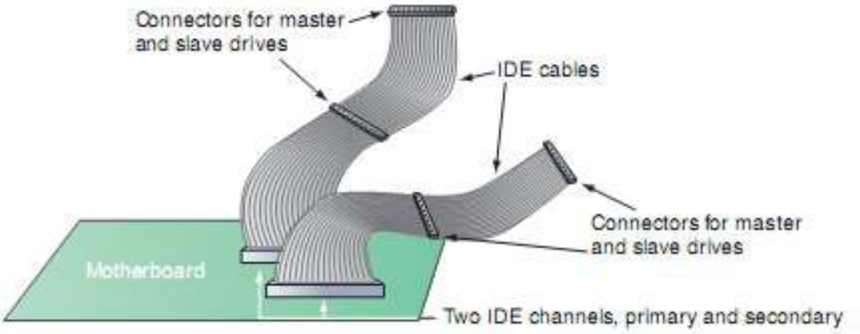


Figure 6.14: EIDE cable.

2. What are the differences of functions between Master and Slave drives?

____

____

____

3. Plug the IDE cable connector into the IDE slot.
4. Set the Jumper in the Drive, depend on your needs. See Figure 6.17.

   The jumper should be set to Master, which the default is setting for a new HDD. Any other device sharing the same IDE cable should be set to Slave. Different HDD has different jumper settings.

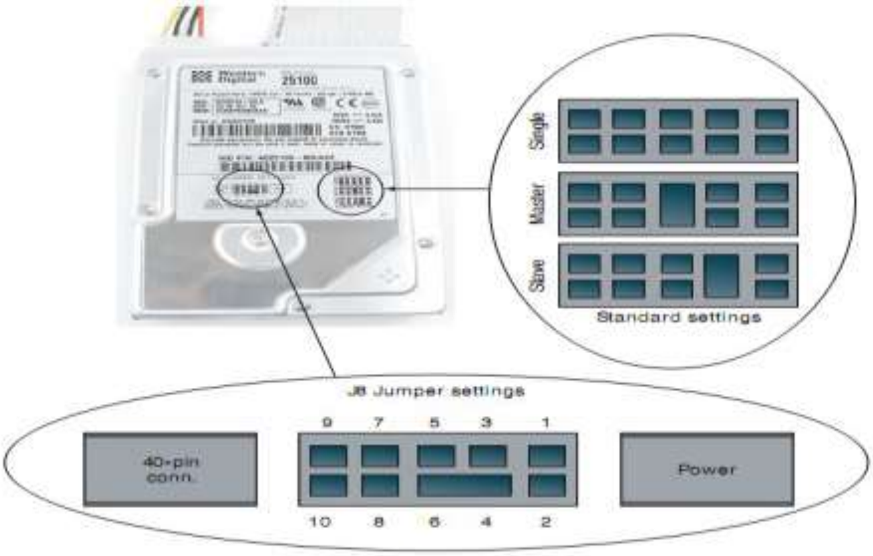


Figure 6.15: HDD jumpers.

5. Insert the data cable into the IDE connector of the HDD. Make sure the pin 1 on the cable is connected to pin 1 on the HDD connector. Pin 1 is the red or pink strip on the edge of an IDE cable. Most new IDE/ATA cables are designed so that it will only go in one way which will correspond to pin 1.
6. Connect Power Cord from Power Supply to Hard Disk Drive.
7. Place your hard drive into the HDD mounting slot of your case; make sure the IDE/ATA connector is facing outwards. Screw the HDD to the case using screws provided with the HDD or the ATX case.
8. Check all your connections and power up the system.
9. Give the Summary.

____

____

6.6.3 Installing Optical Disk Drive

Internal optical drives use a SCSI, PATA, or SATA interface for EIDE. There are four choices for installing the drive: primary master, primary slave, secondary master, and secondary slave.

- If the drive will be the second drive installed with the cable, then set the drive to slave.
- If the drive is the only drive to be installed with the cable, choose master, because single is not a choice. The cable select setting is used if a special EIDE cable-select cable determines which drive is master or slave.
- If the optical drive shares an IDE channel with a hard drive, make the hard drive the master and the optical drive the slave.

1. Look at the front and rear sides of optical drive.

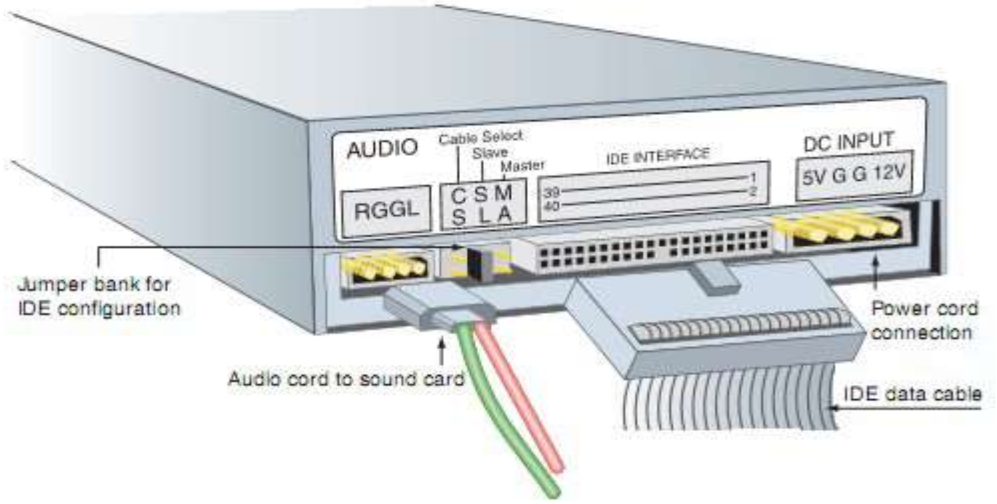


Figure 6.16: Optical Drive connections.

2. For a PATA interface, set the jumper on the rear of the drive.
3. Connect a power cord to the drive.
4. Connect Data Cable to Motherboard, if they are:

   a. EIDE drives, connect the 40-pin cable to the IDE motherboard connector and the drive. Be careful of following the pin-1 rule: Match the edge color of the cable to pin 1 at both the adapter card and the drive. Generally, the colored edge is closest to the power connector.

   b. SATA drives, connect a SATA cable to the drive and to a SATA connector on the motherboard.
5. If the drive has an audio connector, attach one end of the audio cord to the drive and the other end to the sound card or, for onboard sound, to the motherboard audio header.
6. Check all connections and turn on the power. Press the eject button at the front of the drive. If it works, then you know the power is getting in the drive. Put the case cover back on.
7. Check all your connections and power up the system.
8. Give the Summary.

6.6.4 Troubleshooting the Harddisk Drive Circuit

1. Turn on the "Computer Troubleshooting Trainer". Allow Windows 10 to complete its starting session.
2. Open windows explorer program by clicking the Icon on the Desktop.
3. Click local disk (C :) by clicking mouse right button, click Properties, choose Tools, choose check now and then click start.
4. When the disk checking is being progressed, observe computer troubleshooting trainer block diagram.
5. Activate HDD fault simulator by pressing the fault button. The fault indicator will light.
6. Wait and observe fault effect on the screen. Was Scandisk completed successfully?

________. Did the windows program still run properly? ____________________

7. Restart the system
8. Did the computer boot up when turned on? _____________________________________
9. Was there any HDD Controller Failure message displayed? __________. If your answer is

   Yes, then it is indicating a failure to verify hard disk setup by system configuration file error.
10. Was there any A C, or D Fixed Disk Drive Error message displayed? __________. If your answer is Yes, then it is indicating a hard disk CMOS setup failure. Check the CMOS for SATA devices
11. Reset the fault by pressing the RESET button.

    Note: If the system is not responding after resetting the fault, you need to restart the computer.
12. Is now the harddisk functioning properly? ________________
13. Your conclusion on this fault is :

    ____

    ____

    ____
14. After completing the experiments shut down your computer and turn off monitor power switch.

6.7 References

- LABTECH experiment manuals.
- Maintenance lab manual (2020).

Experiment 7: Input and Output Ports.

7.1 Prelab: Observe the ports/interfaces in Figure 7.1 below and fill in your results in Table 1.

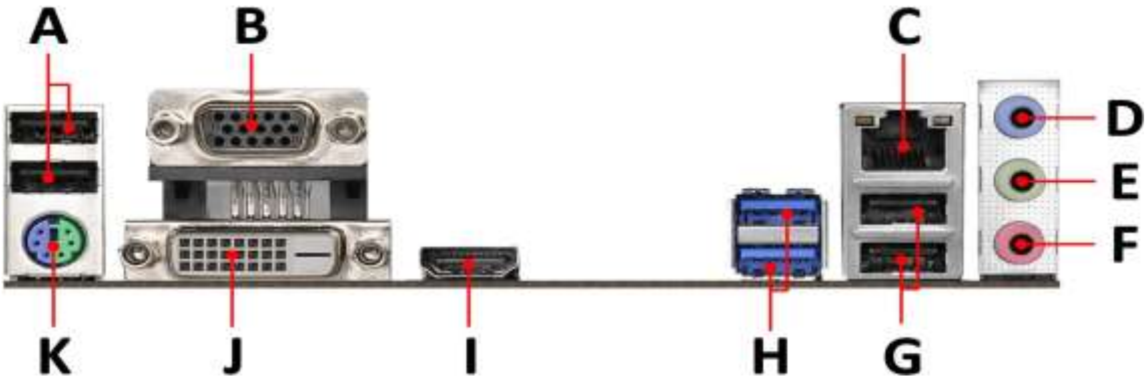


Figure 7.1 I/O Ports view in the computer (General Ports)

Table 7.1 Ports names of the computer motherboard

Port name		Supported Device	Type of connector
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			
K			

7.2 OBJECTIVES

- Identify and explain the main features, concepts, and functions of ports and expansion slots and buses.
- Introduce the basic well known ports: Serial, parallel, USB, etc.
- Understand and be familiar with Communication port as plug and play device in the computer.
- Troubleshoot faults simulations in the USB port.

7.3 INTRODUCTION

Peripheral devices are attached to the system through I/O port connections. Ports offer standard hardware connection and logical inter-face schemes that permit I/O device manufacturers to develop their products to predefined standards. PCs offer a wide variety of different port types to accommodate as many diverse device types as possible.

Some peripheral devices interact with the basic system architecture through adapter cards that plug in to the system board's expansion slots. The peripheral devices connect to the adapter cards through expansion slot openings in the back of the system unit. The physical port connector on the back of the computer might be located directly on the adapter card where the port circuitry is, or it might be connected to the port circuitry through an internal signal cable. As long as there are open expansion slots or other standard I/O connectors in a PC, it is possible to add compatible devices to the system. Over time, many different types of connector have been used to implement different physical I/O port connections. Most I/O port connectors have become standardized. Typical I/O port connectors used with the PCs are shown in Figure 7.2.

This experiment examines the different connection methods that have been devised to be used with different common PC-compatible peripheral devices and ports. These methods include older parallel and serial ports as well as newer high-speed USB, Fire-wire, and IrDA port specifications. In the process of discussing the different port standards, the experiment also covers cabling specifications associated with those ports. After completing the experiment, you should be able to identify the types of ports used by common PC-compatible I/O devices and locate standard I/O port connections in computer systems.

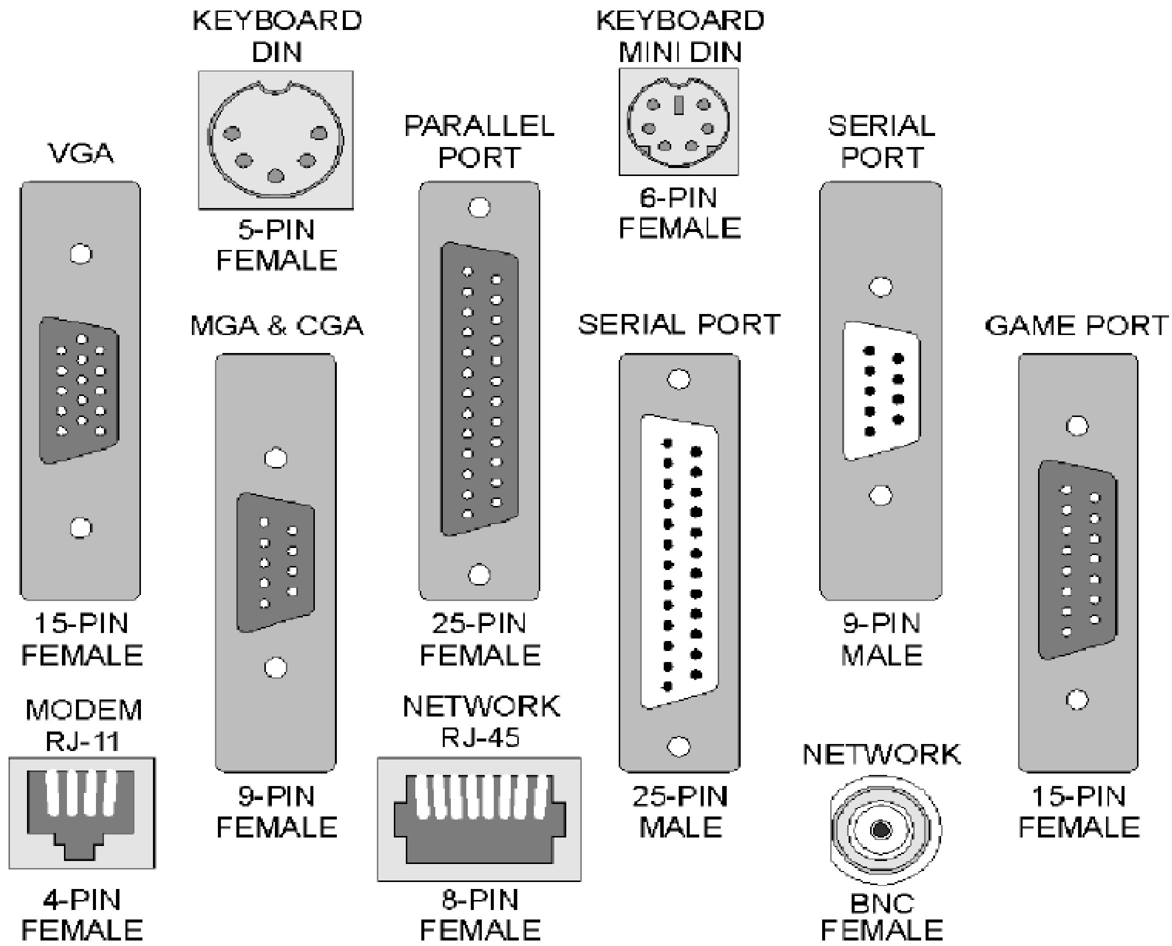


Figure 7.2 Typical I/O port connectors.

7.4 Standard I/O ports

Although many different methods have been developed to connect devices to the PC compatible system, there are three ports that have been standardized since the original PCs were introduced. These are:

- The IBM versions of the Centronics parallel port
- The RS-232C serial port
- The IBM game port

Two connection types have become standards for connecting networked computers together. These are:

- RJ-45 (Registered Jack) Ethernet connectors
- BNC (British Naval Connector) Coaxial connectors

7.4.1 ATX Ports

In an ATX system, the I/O port connections have been integrated into a vertical stack form factor located at the rear of the board. Figure 7.3 illustrates typical connectors that found on the back of an ATX-style system.

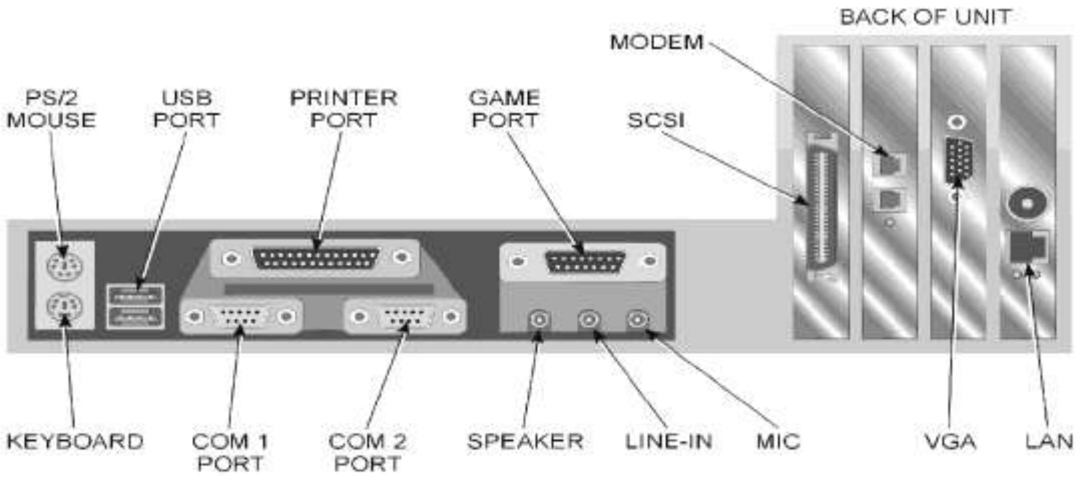


Figure 7.3 ATX back panel connections.

The ATX specification employs two 6-pins mini-DIN connectors (also referred to as PS/2 connectors) for the mouse and keyboard. Of course, the fact that both connections use the same type of connector that can lead to problems if they are reversed. The standard computer also provides for two USB port connections, a DB-25F D-shell parallel printer port connector , two RS-232 serial COM ports implemented in a pair of DB 9M D-shell connectors, a DB-15F D-shell Game port, and a RCA audio port. Unlike the AT-style integrated I/O connections, these port connections require no system board connecting cables that can become defective. The ATX system still makes provisions for a number of adapter cards to be used with the system. The physical ports connectors on these cards conform to the I/O standards are adopted by the PC community. Table 7.2 summarizes the types of connectors as typically found on the back panel of both AT and ATX system units, along with their connector and pin count information.

TYPICAL I / O PORTS		
PORT	**AT**	**ATX**
Keyboard	5-pin DIN	Ps/2 6 pin mini-DIN
Mouse	xxxxxxx	Ps/2 6 pin mini-DIN
COM 1	DB-9M	DB-9M
COM 2	DB-25M	DB-9M
LPT	DB-25F	DB-25F
VGA	DB-15F (3 row)	DB-15F (3 row)
Game	DB-15F (2 row)	DB-15F (2 row)
Modem	Rj-11	Rj-11
LAN	BNC mini-jacks	BNC mini-jacks
Sound	RCA mini-jacks	RCA mini-jacks
SCSI	Centronics 50-pin	Centronics 50-pin

Table 7.2: AT and ATX ports.

7.4.2 Parallel ports

A parallel port is characterized by two rows of small holes that accept the rows of small pins on the cord, and there usually is a screw hole on each side of the port so that the cord can be securely fastened to the computer. The port is often referred to as a printer port and sometimes as a Centronics port, from the 1970 Centronics Model 101 printer that included the first parallel interface for printers. Parallel ports often are identified within the computer's system as "LPT1" and "LPT2."

Parallel ports became popular because they were able to transmit data in parallel at a faster rate than was standard at the time. Data sent over a parallel connection moved eight bits at a time, often through eight pin connectors. These connectors were plugged into a socket generally found on the back of the computer. Developers and manufacturers quickly adapted the technology to their own products, leading to the introduction of many new printers and peripherals.

In 1994, the Institute of Electrical and Electronics Engineers (IEEE) released a set of standards to unify the technology within the industry somewhat. The standard is known as "IEEE 1284" and sets forth the parameters that define bi-directional parallel communication between peripherals and computers.

With the standardization of connection came more printers, zip drives, scanners, external modems, webcams, gamepads and joysticks that made use of parallel interface. Developers manufactured adapters to run SCSI devices by parallel ports. Through the evolution of parallel communication, the Universal Serial Bus (USB) and Ethernet interfaces were developed, and they have effectively replaced the parallel port. Most computer manufacturers consider the parallel port computer science history and no longer include a parallel interface.

7.4.3 Serial ports

Serial ports are a type of computer interface that complies with the RS-232 standard. They are 9-pin connectors that relay information, incoming or outgoing, one byte at a time. Each byte is broken up into a *series* of eight bits, hence the term *serial* port.

Serial ports are one of the oldest types of interface standards. Before internal modems became commonplace, external modems were connected to computers via serial ports, also known as communication or "COM" ports. Computer mice and even keyboards also used serial ports. Some serial ports used 25-pin connectors, but the 9-pin variety was more common. Serial ports are controlled by a special chip call a UART (Universal Asynchronous Receiver Transmitter).

Serial ports differ from 25-pin parallel ports in that the parallel ports transmit one byte at a time by using eight parallel wires that each carry one bit. With data traveling in parallel, the transfer rate was greater. A parallel port could support rates up to 100 kilobytes per second, while serial ports only supported 115 kilobits per second (kbps). In traditional computers, serial ports were configured as follows:

SerialPorts	Interrupt	Memory Address
COM 1	IRQ 4	0x3f8
COM 2	IRQ 3	0x2f8
COM 3	IRQ 4	0x3e8
COM 4	IRQ 3	0x2e8

Devices configured to use serial ports COM 1 and COM 3 could not be active at the same time, as they shared interrupt IRQ 4. The same was true of COM 2 and COM 4 port devices. Often this led to manually reconfiguring the serial ports, which frequently caused more trouble than it was worth.

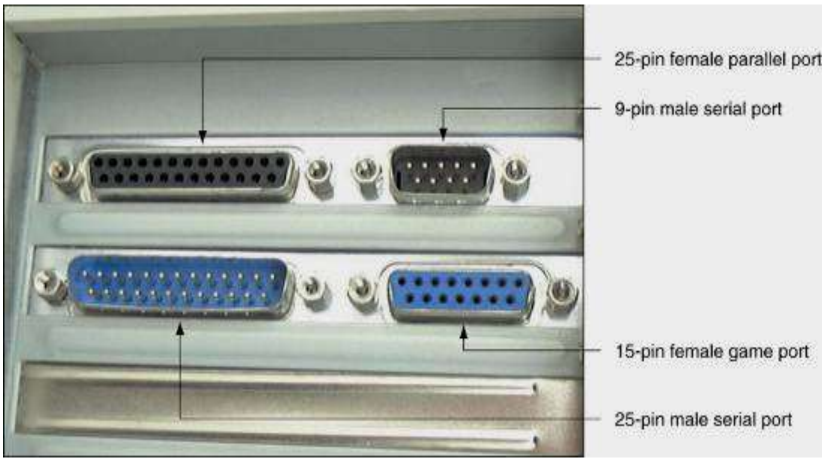


Figure 7.4: Serial, parallel, and game ports

7.4.4 Universal serial bus

USB (Universal Serial Bus) is the most popular connection used to connect a computer to devices such as mouse, keyboard, flash drives,digital cameras, printers, scanners, and external hard drives. USB is a cross-platform technology that is supported by most of the major operating systems. On Windows, it can be used with Windows 98 and higher. USB is a hotswappable technology, meaning that USB devices can be added and removed without having to restart the computer. USB is also "plug and play". When you connect a USB device to your PC, Windows should detect the device and even install the drivers needed to use it.

USB transfer speeds

• USB 1.x is an external bus standard that supports data transfer rates of 12 Mbps and is capable of supporting up to 127 peripheral devices.

• USB 2.0, also known as hi-speed USB, was developed by Compaq, Hewlett Packard, Intel, Lucent, Microsoft, NEC and Phillips and was introduced in 2001. Hi-speed USB is capable of supporting a transfer rate of up to 480 megabits per second (Mbps), or 60 megabytes per second (MBps), and is backwards compatible, meaning it is capable of supporting USB 1.0 and 1.1 devices and cables.

• USB 3.0, also known as SuperSpeed USB, was first made available in November 2009 by Buffalo Technology, but the first certified devices weren't available until January 2010. USB 3.0 improved upon the USB 2.0 technology with speed and performance increases, improved power management and increased bandwidth capability (providing two unidirectional data paths for receiving and sending data at the same time). USB 3.0 supports transfer rates up to 5.0 gigabits per second (Gbps), or 640 megabytes per second (MBps), and following the release of USB 3.1, has been renamed to USB 3.1 Gen1 (for marketing purposes). The first certified devices included motherboards from ASUS and Gigabyte Technology. Dell began including
USB 3.0 ports in their Inspiron and Dell XPS series of computers in April 2011.

• USB 3.1, also known as SuperSpeed+, was made available as of July 31, 2013 and is the latest version of the USB protocol. USB 3.1 is capable of transfer rates of up to 10 Gbps, putting it in line with the first generation of Apple's Thunderbolt channel. Today, many devices use the USB 3.0 and 3.1 revisions for improved performance and speed.

• USB Type-C was developed around the same time as USB 3.1 and is a reversibleplug, 24-pin, double-sided connector for use with USB devices.

USB cables - Length and Type

USB cables are available in multiple lengths, from around 3 feet to just over 16 feet in length. The maximum length of a USB cable is 16 feet 5 inches (5 meters) for high-speed devices and 9 feet 10 inches (3 meters) for low-speed devices. These maximum lengths are due to data transfer timing and the risk of data loss if using longer cable lengths. However, by using USB hubs, you can connect two USB cables together to effectively extend the distance between the two devices being connected.

There are different types of USB cables as well. As mentioned above, there are different transfer speeds (2.0 and 3.0) for USB. Similarly, there are different types of USB cables to match with those speeds. You can get a USB 2.0 cable for use with a device using USB 2.0 or a USB 3.0 cable for use with a device using USB 3.0.

There are also USB extension cables that can connect to one end of a USB cable (typically the end that would connect to the computer) to extend the length of the cable. However, you should still avoid extending the cable beyond the 16 feet 5 inches total maximum length limit, unless using a USB hub to connect another USB cable.

USB connector variations

USB connectors come in many shapes and sizes as there are many different devices that utilize them. Every version of USB connector including standard, Mini, and Micro have two or more variations of connectors.

• USB A-Type

Found on host controllers in computers and hubs, the A-style connector is a flat, rectangular interface.

Figure 7.5: USB Type A connector.

USB B-Type

The B-style connector is designed for use on USB peripheral devices. The B-style interface is squarish in shape, and has slightly beveled corners on the top ends of the connector.

Figure 7.6: USB Type B connector.

USB C-Type

The USB-C or USB Type-C connector is the newest USB connector on the market. The USB-C connector has a reversible/symmetrical design and can be plugged into any USB-C device using either end. A USB-C cable is capable of carrying USB 3.1, USB 3.0, USB 2.0, and USB 1.1 signals. The

USB-C is commonly paired with the USB-A, USB-B, USB Micro-B, and other USB connectors when supporting previous versions of the USB specification. USB-C can be adapted to work with each of these legacy connectors.

Figure 7.7: USB Type C connector.

Micro-USB A

Recognized by the USB-IF, this connector can be found on newer mobile devices such as cellphones, GPS units, PDAs and digital cameras. Micro-USB A offers a connection physically smaller in size to a USB Mini-b, while still supporting the high speed transfer rate of 480 Mbps and On-The-Go features. The connection can be easily identified by its white-colored receptacle and compact 5 pin design.

Figure 7.8: Micro USB type A connector.

Micro-USB B

Similar with micro-USB A with different shape

Figure 7.9: Micro USB type B connector

USB Mini-b (5-pin)

One drawback to the B-style connector is its size, which measures almost a half inch on each side. This made the B-style interface unsuitable for many compact personal electronic devices such as PDAs, digital cameras, and cellphones. As a result, many device manufacturers began the miniaturization of USB connectors with this Mini-b. This 5-pin Mini-b is the most popular style of Mini-b connector, and the only one recognized by the USB-IF. By default, a Mini-b cable is presumed to have 5 pins. This connector is quite small, about two-thirds the width of an A-style connector. It is also specified for use in the newer standard called USB On-The-Go which allows peripheral devices to communicate with the presence of a host controller.

Figure 7.10: Mini B 5 pin USB Connector

• USB Mini-b (4-pin)

Instead of the typical 5-pin Mini-b, this unofficial connector is found on many digital cameras, especially certain Kodak® models. It resembles the shape of a standard B-style connector, with beveled corners; however it is much smaller in size.

Figure 7.11: Mini B 4 pin USB Connector.

• **USB 3.0 A-Type**

Known as "SuperSpeed", this A-style connector is commonly found on host controllers in computers and hubs, the A-style connector is a flat, rectangular interface. This interface holds the connection in place by friction which makes it very easy for users to connect and disconnect. Instead of round pins, the connector uses flat contacts which can withstand continuous attachment and removal very well. The A-socket connector provides a "downstream" connection that is intended for use solely on host controllers and hubs. This connector is similar in size and shape to the A-Type connector used in USB 2.0 & USB 1.1 applications. However, the USB 3.0 A-type has additional pins that are not found in the USB 2.0 & USB 1.1 A-Type. The USB 3.0 connector is designed for USB SuperSpeed applications; however, it will carry data from slower speed connections, and it is backwards compatible with USB 2.0 ports. USB 3.0 A connectors are often blue in color to help identify them from previous versions.

Figure 7.12: USB 3.0 type A connector

USB 3.0 B-Type

The USB 3.0 B-Type connector is found on USB 3.0 devices. This connector is designed to carry data and power in USB SuperSpeed applications. Cables with this connector are not backwards compatible with USB 2.0 or USB 1.1 devices; however USB 3.0 devices with this connection type can accept previous USB 2.0 and 1.1 cabling.

Figure 7.13: USB 3.0 Type B Connector

· **USB 3.0 Micro B**

The USB 3.0 Micro B connector is found on USB 3.0 devices. This connector is designed to carry data and power in USB SuperSpeed applications. Cables with this connector are not backwards compatible with USB 2.0 or USB 1.1 devices.

Figure 7.14: USB 3.0 type Micro B connector.

7.4.5 Firewire

While the USB specification was being refined for the computer industry, a similar serial interface bus was developed for the consumer products market. Apple Computers and Texas Instruments worked together with the IEEE (Institute of Electrical and Electronic Engineers) to produce the Firewire (or IEEE-1394) specification. This bus offers a very fast option for connecting consumer electronics devices, such as camcorders and DVDs, to the computer system. The Firewire bus is similar to USB in that devices can be daisy chained to the computer using a single connector and host adapter. It requires a single IRQ channel, an I/O address range, and a single DMA channel to operate. Firewire is also capable by using a special high-speed Isochronous transfer mode, “Motherboards,” to support data transfer rates up to 400Mbps. This actually makes the Firewire bus superior to the USB bus (of course for the old USB versions, and not for the new versions such as USB 3.0). Its high-speed capabilities make Firewire well suited for handling components, such as video and audio devices, which require real-time, high-speed data transfer rates. A single IEEE-1394 connection can be used to connect up 63 devices to a single port. However, up to 1023 Firewire buses can be interconnected. PCs most commonly use a PCI expansion card to provide the Firewire interface. Although audio/visual (A/V) equipment typically employs 4- pin 1394 connectors, computers normally use a 6-pin connector, with a 4-pin to 6-pin converter. Figure 7.15 depicts the Firewire connector and plug most commonly used withPCs.

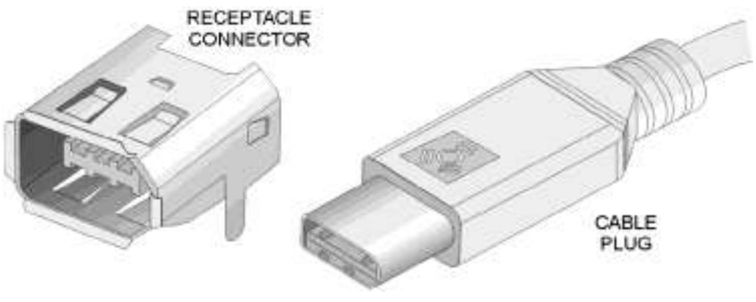


Figure 7.15 Firewire plug and connector.

The IEEE-1394 cable is composed of two twisted pair conductors similar to those used in the local area networks. Like USB, it supports both PnP and hot swapping of components and provides power to the peripheral devices through one pair of the twisted conductors in the interface cable. Firewire is supported in both the Windows 9x and Windows NT/2000 operating systems. Both operating systems support advanced Firewire operations by including support for specifications that define the way Firewire interfaces to a PC, the details for controlling specific audio-video devices over the IEEE-1394 bus, and standard ways of encapsulating device commands over 1394 and it is essential for DVD players, printers, scanners, and other devices. In addition, a new Home AV Interoperability (HAVi) standard is directed by making Firewire devices plug-and-play capable in networks where no PC host is present. A proposed version of the IEEE-1394 standard (titled P1394b) provides an additional electrical signaling method that permits data transmission speeds of 800Mbps and greater. This proposal also supports new transport media including glass and plastic optical fiber, as well as Category 5 copper cable. Along with the new media comes extended distances (for example, 100 meters over Cat-5 cable).

7.5 Troubleshooting Port

Figure 7.16 illustrates the components involved in the operation of the serial, parallel, and game ports. Failures in these devices tend to end with poor or no operation of the peripheral. Generally, there are only four possible causes for a problem with a device connected to an I/O port:

- The port is defective.
- The software is not configured properly for the port.
- The connecting signal cable is bad.
- The attached device is not functional.

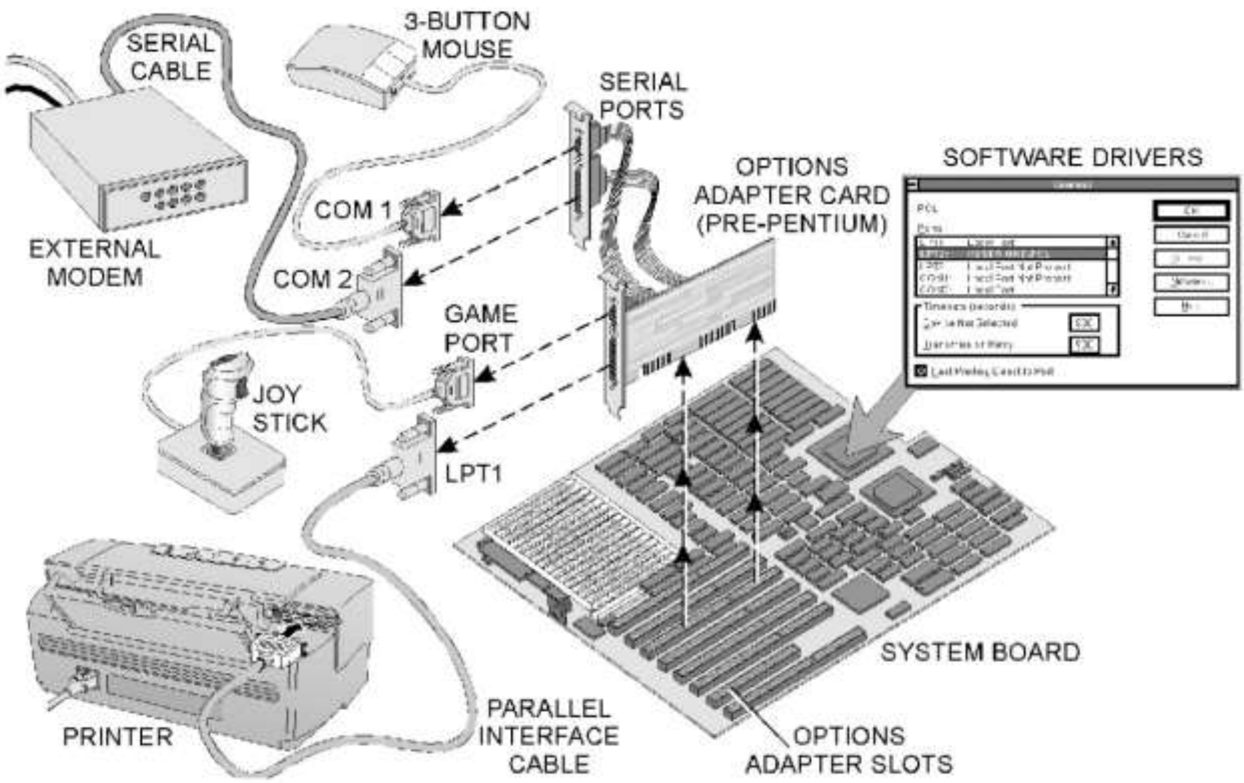


Figure 7.16: Components associated with I/O ports.

Typical symptoms associated with serial, parallel, or game port failures include; device not found error message displays, or you have an unreliable connection.

Basic Port Checks

With the old Pentium systems, you must check the advanced CMOS setup to determine whether the port in question has been enabled, and, if so, whether it has been configured correctly. Check the PC board that contains the I/O port circuitry (and its user guide) for configuration information. This normally involves LPT, COM, and IRQ settings.

Occasionally, you must set up hexadecimal addressing for the port addresses; however, this is becoming rare as PnP systems improve. For example, a modern parallel port must be enabled and set to the proper protocol type to operate advanced peripherals

If serial or parallel port problems are occurring, the CMOS configuration window is the first place to look. Read the port assignments in the boot-up window. If the system has not detected the presence of the port hardware at this stage, none of the more advanced levels will find it either. If values for any of the physical ports installed in the system do not appear in this window, check for improper port configuration. Because the system has not loaded an operating system at the time the configuration window appears, the operating system cannot be a source of port problems at this time. If all configuration settings for the ports appear correct, assume that a hardware problem exists.

7.6 Lab Work

7.6.1 The Communication Port (COM1)

Open the device manager and check the Properties of COM1. The Windows Properties will be appeared as in Figure 7.17 below.

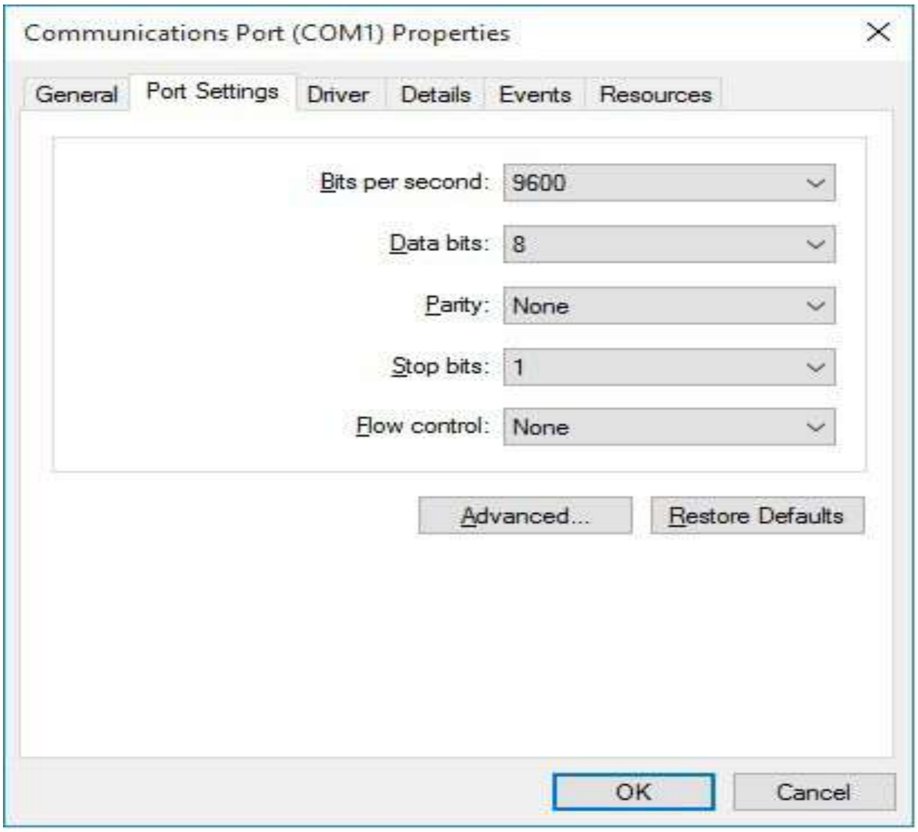


Figure 7.17 Windows Properties window of COM1

- What is the highest speed you can set for the “Bits per second” on your COM1?

____

- What are the options of Data Bits you can select for the “Data bits” on your COM1?

____

- What are the options of Parity you can select for the “Parity” on your COM1?

____

- What are the options of Flow Control you can select for the “Flow control” on your COM1?

____

- What are the options of Stop Bits you can select for the “Stop bits” on your COM1?

____

7.6.2 Troubleshooting the USB Port

1. Set Up the "Computer Troubleshooting Trainer”.

2. Disconnect the PS/2 Mouse connector and then connect the USB Mouse cable into USB1 port or USB2 port on the front side of CPU.

3. Turn on the Computer. Allow Windows 10 to complete its starting session.

4. Activate ***Front USB port*** fault simulator by pressing the fault button. The ***Front USB port*** fault indicator will light.

5. Move the mouse pointer. Does the mouse function correctly? _______________

6. Observe fault symptom of The ***Front USB port*** faulty The fault symptom is
____

7. Close all programs and Restart the computer.

8. Check the CMOS setting for USB configuration. Is the USB function already enabled? _____________.

The current USB function setting is _________________________________

If the USB function is disabled, then enable it and save the new CMOS setting.

9. Allow Windows 10 to complete its starting session. From the Device Manager, open the Universal Serial Bus Properties and check for the resources. Is there any “conflict "condition? ____________

10. Are the mouse USB cable and connector installed properly? _______________

11. Up to this point if everything is OK, then it is indicating that the fault relates to hardware problems which can be the USB cable, connectors, USB internal Hub, USB host controller circuitry or the USB mouse device.

12. Reset the fault by pressing the RESET button.

13. Are you able to use the USB mouse? _________________

14. Your conclusion on this fault is:
____
____

15. After completing the experiment, close all programs and shut down your computer. Turn off monitor power switch.

7.7 References

- LABTECH experiment manuals.

Experiment 8: Operating System

8.1 PRELAB

Q1. Using your PC or Laptop; submit screenshot views for the following information about your system.

- Windows Edition
- Processor; type, speed
- Installed memory (RAM)
- System Type
- Windows Installation Status: whether it is activated/genuine or not?

Q2. List the "Minimum hardware requirements" for Windows 10?

8.2 OBJECTIVES

- Learn about the components, functions, and terminology related to operating systems.
- Install Windows 10 operating system.

8.3 INTRODUCTION

The operating system (OS) controls almost all functions on a computer. All computers rely on an operating system (OS) to provide the interface for interaction between users, applications, and hardware. The operating system boots the computer and manages the file system. The operating system has four main roles:

- Control hardware access
- Manage files and folders
- Provide user interface
- Manage applications

In this experiment, you will learn about the components, functions, and terminology related to the operating systems, then you will perform the installation of Windows 10 operating system.

8.3.1 Characteristics of an Operating System

- **Multi-user** – Two or more users have individual accounts that allow them to work with programs and peripheral devices at the same time.
- **Multitasking** – The computer is capable of operating multiple applications at the same time.

- **Multiprocessing –** The operating system can support two or more CPUs.
- **Multithreading –** A program can be broken into smaller parts that are loaded as needed by the operating system. Multithreading allows individual programs to be multitasked.

8.3.2 Processor Architecture

32-bit vs. 64-bit (x86 Processor vs. x64 Processor)

There are three main differences between 32-bit and 64-bit operating systems. A 32-bit operating system, such as the old Windows XP Home edition, is capable of addressing only 2^{32} = 4 GB of RAM, while a 64-bit operating system can address much more than 4 GB (e.g. 128 GB) of RAM. Memory management is also different between these two types of operating systems, resulting in enhanced performance of 64-bit programs. A 64-bit operating system, such as Windows 10 64-bit and Windows 7 also have additional security features.

There are two common architectures used by CPUs to process data: x86 (32-bit architecture) and x64 (64-bit architecture). x86 uses a Complex Instruction Set Computer (CISC) architecture to process multiple instructions with a single request. Registers are storage areas used by the CPU when performing calculations. x86 processors use fewer registers than x64 processors. x64 architecture is backward compatible with x86 and adds additional registers specifically for instructions that use a 64-bit address space. The additional registers of the x64 architecture allow the computer to process much more complex instructions at a much higher rate.

32-bit and 64-bit Compatibility in Windows OS

Windows Operating System	32-bit	64-bit
Windows 7 Starter	X	
Windows 7 Home Premium	X	X
Windows 7 Professional	X	X
Windows 7 Ultimate	X	X
Windows Vista Home Basic	X	X
Windows Vista Home Premium	X	X
Windows Vista Business	X	X
Windows Vista Ultimate	X	X
Windows XP Professional	X	X
Windows XP Home	X	
Windows XP Media Center Edition	X	

Figure 8.1: 32-bit and 64-bit Compatibility in Windows OS.

8.3.3 Types of Operating Systems

There are two distinct types of operating systems: desktop operating systems and network operating systems. A desktop operating system is intended for use in a small office/home office with a limited number of users. A network operating system (NOS) is designed for a corporate environment serving multiple users with a wide range of needs.

Common Desktop operating systems are; Microsoft Windows: Windows 10 and Windows 7, Macintosh: Mac OS X, Linux, UNIX.

Common NOS include: Microsoft Windows Server, Linux, UNIX, Mac OS X Server.

Desktop Operating System	Network Operating System
• Supports a single user	• Supports multiple users
• Runs single-user applications	• Runs multi-user applications
• Shares files and folders	• Robust and redundant
• Shares peripherals	• Provides increased security
• Used on a small network	• Used on a network

Figure 8.2: Types of Operating Systems.

8.3.4 Customer Requirements for an Operating System

An operating system should be compatible with all applications that are installed on a computer. Before recommending an OS to your customer, investigate the types of applications that your customer will be using. If the computer will be part of a network, the operating system must also be compatible with the operating systems of the other computers in the network.

To select the proper operating system for a customer first determine:

- Budget constraints
- Compatibility with current hardware
- Compatibility with new hardware
- How the computers will be used
- Compatibility with existing applications
- Types of new applications to be used

Determine minimum hardware requirements and compatibility with the OS platform

Operating systems have minimum hardware requirements that must be met for the OS to install and function correctly.

Identify the equipment that your customer has in place. If hardware upgrades are necessary to meet the minimum requirements for an OS, conduct a cost analysis to determine the best course of action. In some cases, it may be less expensive for the customer to purchase a new computer than to upgrade the current system.

- Possible hardware upgrades:
- RAM capacity
- Hard drive size
- CPU
- Video card memory and speed
- Motherboard

It is important to mention that the Microsoft Compatibility Center does not support old operating systems such Windows XP, but only provides support for recent OS's such as Windows 7, 10 and 11. Figure 8.3 below lists the minimal hardware compatibility (HCL) requirements for different versions of Windows 7. The HCL for other OS's that can be found on manufacturer's websites.

Windows 7 Professional	1 GHz or faster 32-bit (x86) or 64-bit (x64) processor	1 GB RAM (32-bit GB RAM (64-bit)
Windows 7 Ultimate	1 GHz or faster 32-bit (x86) or 64-bit (x64) processor	1 GB RAM (32-bit GB RAM (64-bit)
Windows 7 Enterprise	1 GHz or faster 32-bit (x86) or 64-bit (x64) processor	1 GB RAM (32-bit GB RAM (64-bit)

Figure 8.3 : Minimum HCL for Windows 7 .

8.4 Operating system installation

The installation and initial booting of the operating system is called the operating system setup. Although it is possible to install an operating system over a network from a server or from a local hard drive, the most common installation method is with CDs and DVDs, and recently through USB drives. To install an OS from a CD or DVD or USB, first configure the BIOS setup to boot the system from the CD or DVD or USB.

Custom Installation Options

Windows operating system in general, has several different types of custom installations.

- **Network Installation** - Requires all setup files to be copied to a network server

- **Reboot Execution Environment (PXE) Installation** - Uses a PXE boot program and a client's network card to access the setup files
- **Unattended Installation** - Uses a network distribution point that uses an answer file
- **Image-based Installation** - Uses Sysprep and a disk-imaging program, that copies an image of the OS directly to the hard drive with no user intervention
- **Remote Installation** - Downloads the installation across the network.

8.4.1 Disk Formatting

Two formatting procedures are required before you can write user data to a disk:

- Physical, or low-level formatting
- Logical, or high-level formatting

A hard disk, however, requires two separate formatting operations. Moreover, a hard disk requires a third step, between the two formatting procedures, to write the partitioning information to the disk. Partitioning is required because a hard disk is designed to be used with more than one operating system. Using multiple operating systems on one hard drive is possible by separating the physical formatting in a procedure that is always the same, regardless of the operating system used and the high-level format (which is different for each operating system). Partitioning enables a single hard disk drive to run more than one type of operating system, or it can enable a single operating system to use the disk as several volumes or logical drives. A volume or logical drive is any section of the disk to which the operating system assigns a drive letter or name.
Consequently, preparing a hard disk drive for data storage involves three steps:

1. Low-Level Formatting
2. Partitioning
3. High-Level Formatting

Low-Level Formatting

During a low-level format, the formatting program divides the disk's tracks into a specific number of sectors, creating the inter sector and inter track gaps and recording the sector header and trailer information. The program also fills each sector's data area with a dummy byte value or a pattern of test values. For hard disks, the number of sectors per track depends on the drive and the controller interface.

Partitioning

Creating a partition on a hard disk drive enables it to support separate file systems, each in its own partition.
Each file system can then use its own method to allocate file space in logical units called clusters or allocation units. Every hard disk drive must have at least one partition on it and can have up to four

partitions, each of which can support the same or different type file systems. Three common file systems are used by PC operating systems today:

- FAT (file allocation table). The standard file system supported by DOS and Windows 9x/Me. FAT partitions support filenames of 11 characters maximum (8 characters + a 3-character extension) under DOS, and 255 characters under Windows 9x (or later). The standard FAT file system uses 12- or 16-bit numbers to identify clusters, resulting in a maximum volume size of 2GB.

- FAT32 (file allocation table, 32-bit). An optional file system supported by Windows 95 OSR2 (OEM Service Release 2), Windows 98, Windows Me, and Windows 2000/XP. FAT32 uses 32-bit numbers to identify clusters, resulting in a maximum single volume size of 2TB or 2,048GB.

- NTFS (Windows NT File System). The native file system for Windows NT/2000/XP that supports filenames up to 256 characters long and partitions up to (a theoretical) 16 exabytes. NTFS also provides extended attributes and file system security features that do not exist in the FAT file system.

Up until the release of XP, FAT32 was by far the most popular file system. Because NTFS is native to XP, NTFS is now more popular in newer systems. Still, the FAT file system is accessible by nearly every operating system, which makes it the most compatible in a mixed OS environment. FAT32 and NTFS provide additional features but are not universally accessible by other operating systems.
Partitioning normally is accomplished by running the disk partitioning program that comes with your operating system or you can download free Disk Mangers. You usually should have as few partitions as possible, and many people try to stick with only one or two at the most. This was more difficult before FAT32 because the maximum partition size for a FAT16 partition was only 2GB. With FAT32, though, the maximum partition size can be up to 2048GB.

High-Level Formatting

During the high-level format, the operating system writes the structures necessary for managing files and data on the disk. For example, FAT partitions have a Volume Boot Sector (VBS), two copies of a file allocation table (FAT), and a root directory on each formatted logical drive. These data structures enable the operating system to manage the space on the disk, keep track of files, and even manage defective areas so they do not cause problems.

High-level formatting is not really a physical formatting of the drive, but rather the creation of a table of contents for the disk. In low-level formatting, which is the real physical formatting process, tracks and sectors are written on the disk. As mentioned, the DOS and Windows 9x/Me FORMAT command can perform both low-level and high-level format operations on a floppy disk, but it performs only the high-level format for a hard disk. Low-level formats of ATA and SCSI hard disk drives are performed by the manufacturer and should almost never be performed by the end user. Low-level format for ATA or SCSI drives may be used to repair a format that has become damaged (parts of the disk become unreadable) or in some cases when wipes away all data on the drive.

8.4.2 Install the Operating System

When a computer boots up with the Windows installation CD, the Windows 7 or other OS's installation process starts with three options:

- **Install now** - Sets up and installs the Windows 7 OS.
- **What to know before installing Windows** - Opens Help.
- **Repair your computer** - Opens the System Recovery Options.

Under **Install now** three options are available:

- **Upgrade** - Upgrades Windows but keeps your current files, settings, and programs. You can use this option to repair an installation.
- **Custom (advanced) - Installs a clean copy of Windows in your choice of location and** allows you to change disks and partitions. It is also known as a clean installation.
- **Quit** - Exits Setup.

8.4.3 Start-up Modes

You can boot Windows in one of many different modes. Pressing the F8 key (for Windows 7) during the boot process opens the Windows Advanced Startup Options menu, which allows you to select how to boot Windows.

- **Safe Mode –** Starts Windows but only loads drivers for basic components, such as the keyboard and display.
- **Safe Mode with Networking Support –** Starts Windows identically to Safe Mode and also loads the drivers for network components.
- **Safe Mode with Command Prompt –** Starts Windows and loads the command prompt instead of the GUI interface.
- **Last Known Good Configuration** – Enables a user to load the configurations settings of Windows that was used the last time that Windows successfully started. It does this by accessing a copy of the registry that is created for this purpose.

8.4.4 Multi-boot Procedures

Multiple OS can be installed on one computer. To create a dual-boot system in Microsoft Windows:

- Must have more than one hard drive or a hard drive with more than one partition.
- Install the oldest OS on the primary partition or the hard drive marked with an active partition.
- Install the second OS on the second partition or hard drive.
- The boot files are automatically installed in the active partition.

During the dual-boot process:

- The BOOTMGR file indicates that more than one OS is present.
- You are prompted to choose the OS that you want to load.

8.5 LAB WORK

Install Windows 10

Step 1

- Insert the Windows 10 installation DVD into the DVD-ROM drive or plug the USB flash drive into a USB port.
- When the system starts up, watch for the message "Press any key to boot from CD or DVD.". Please see Figure 8.4.

If the message appears, press any key on the keyboard to boot the system from the DVD. If the press any key message does not appear, the computer automatically starts loading files from the DVD.

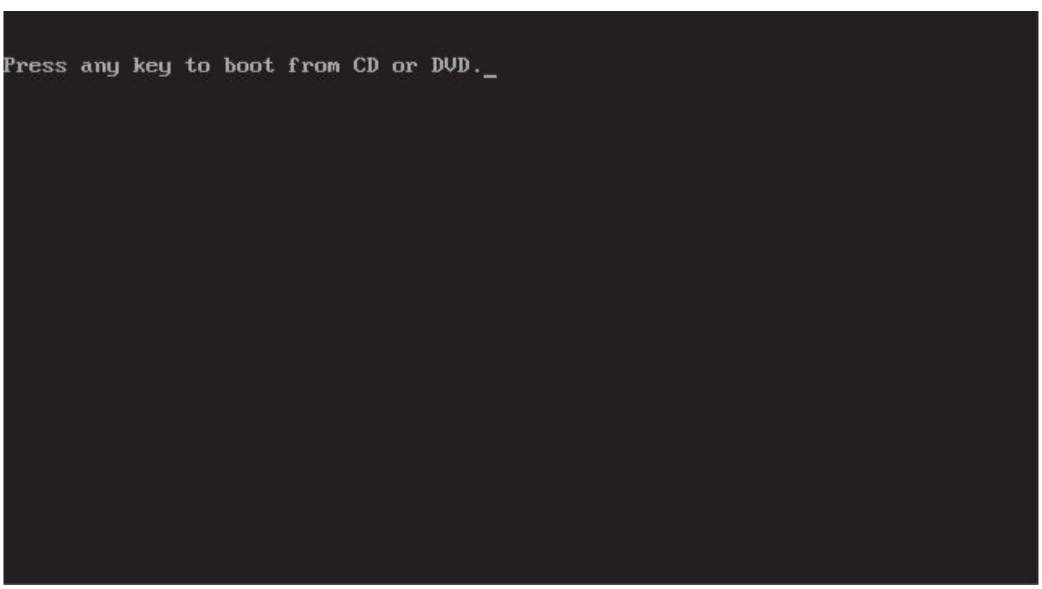


Figure 8.4

The computer starts loading files from the DVD or USB flash drive.

Step 2

The "Windows 10 boot" screen appears.

Step 3

Select your language preferences, and click/tap on Next. (See Figure 8.5 below)

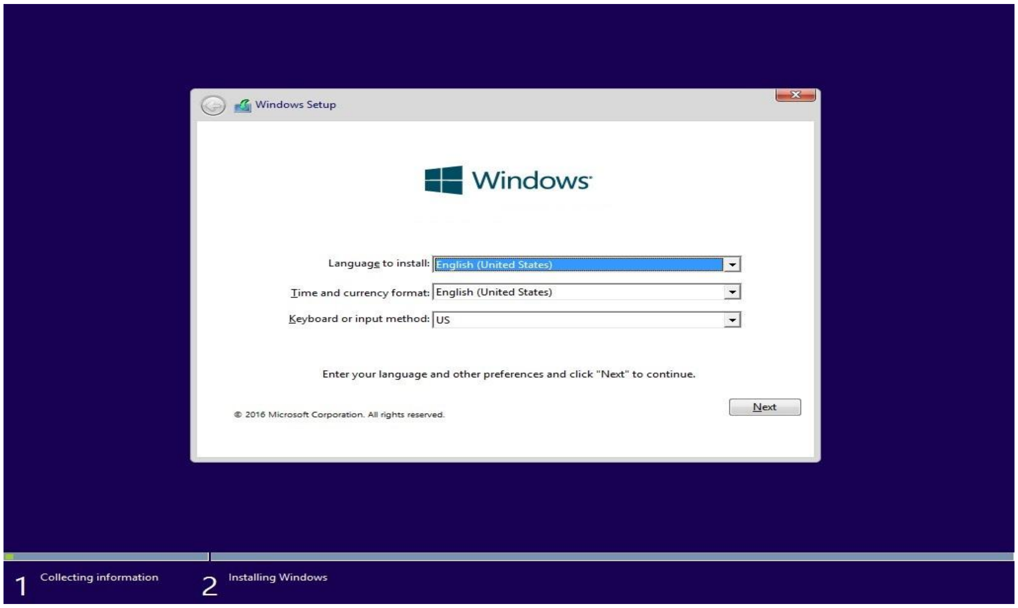


Figure 8.5:

Step 4

Click/tap on the Install Now button to start the installation. (See Figure 8.6below).

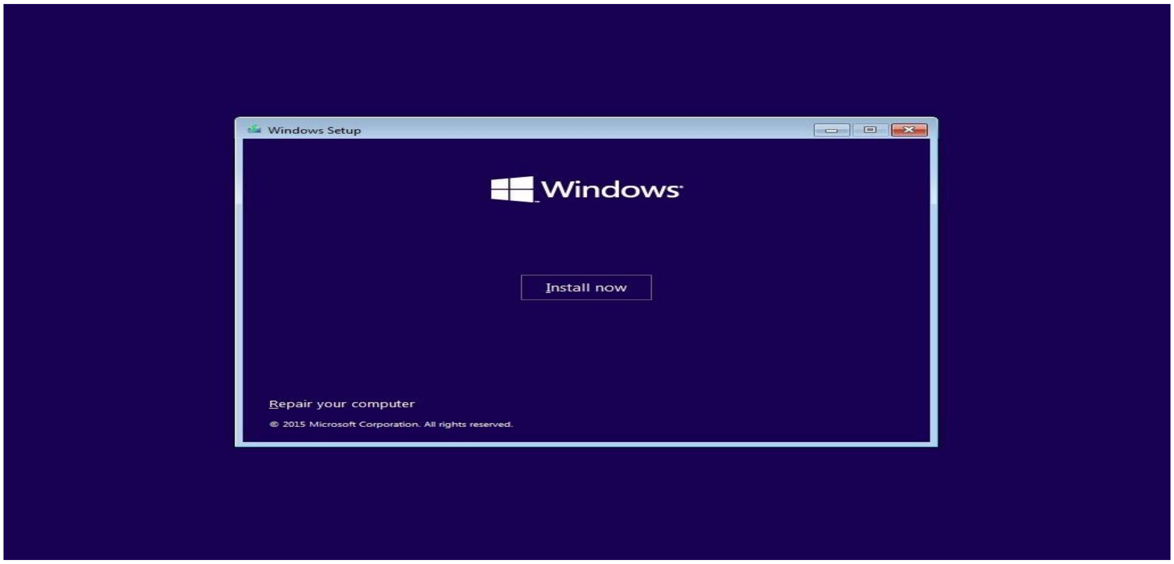


Figure 8.6:

Step 5
Enter your Windows 10 product key to activate Windows 10 with, and click/tap on Next. (See Figure 8.7 below)

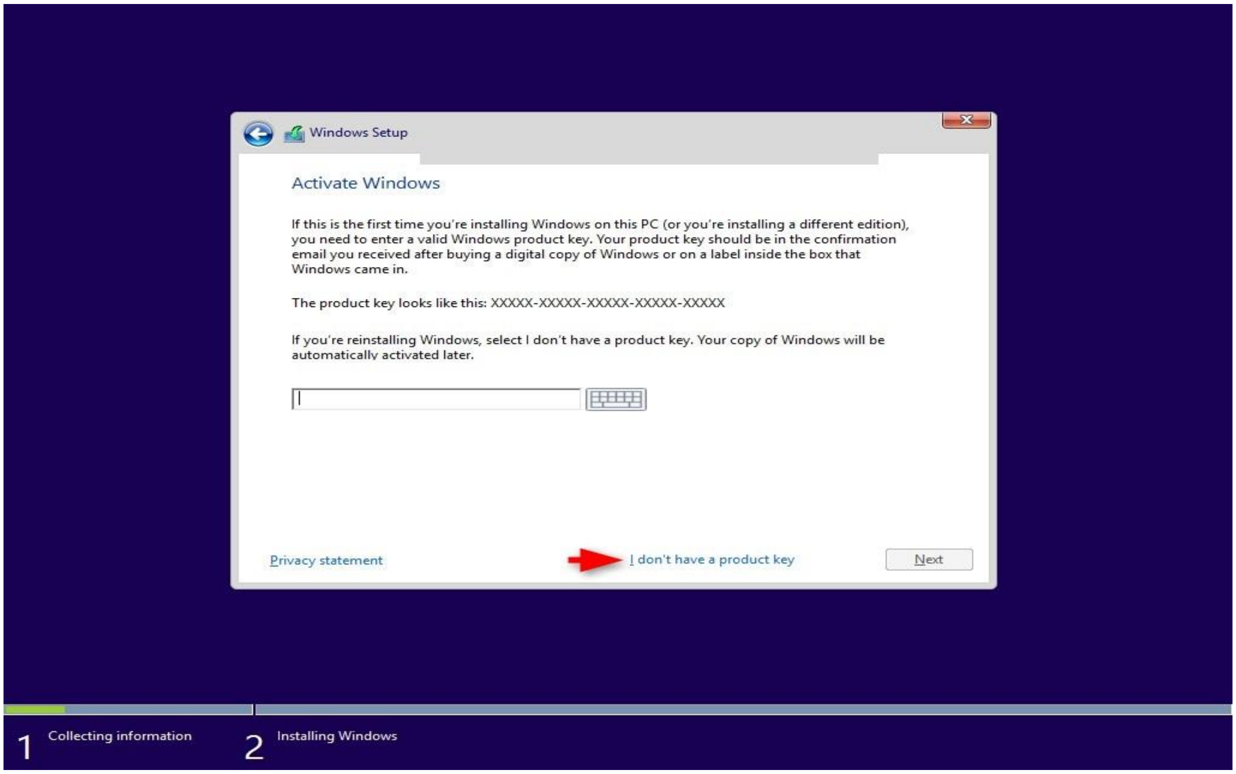


Figure 8.7

Step 6

Check the "I accept the license terms box", and click/tap on Next. (See Figure 8.8 below)

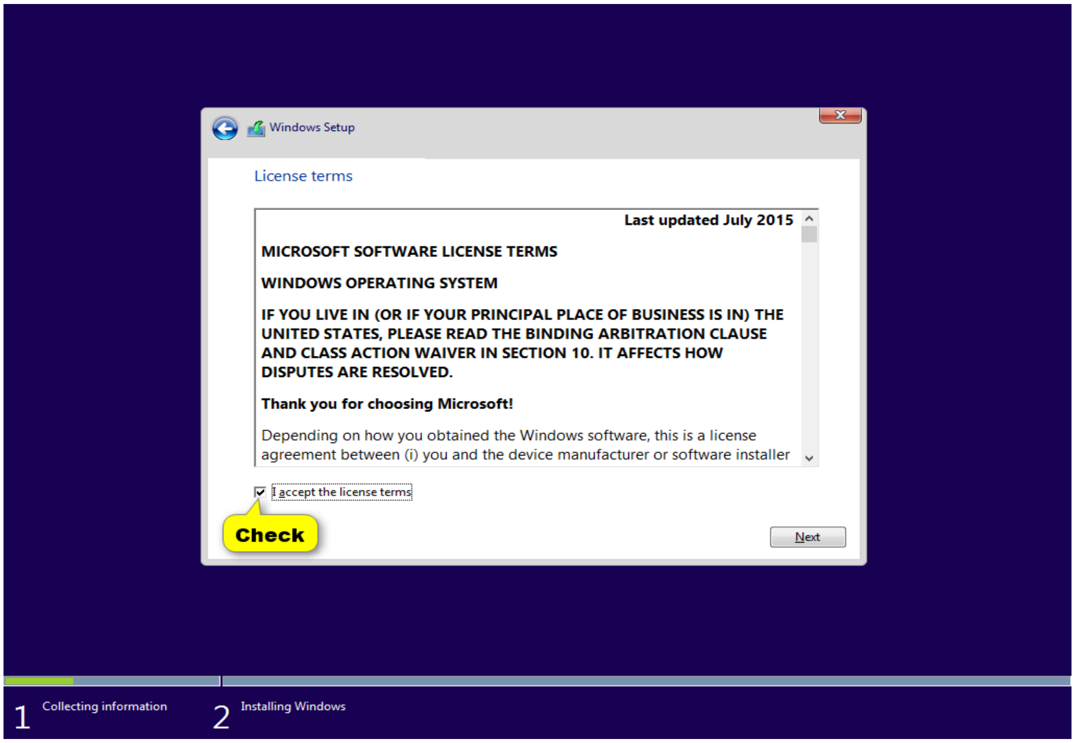


Figure 8.8

Step 7

Click/tap on the Custom: Install Windows only (advanced) option. (see Figure 8.9 below)

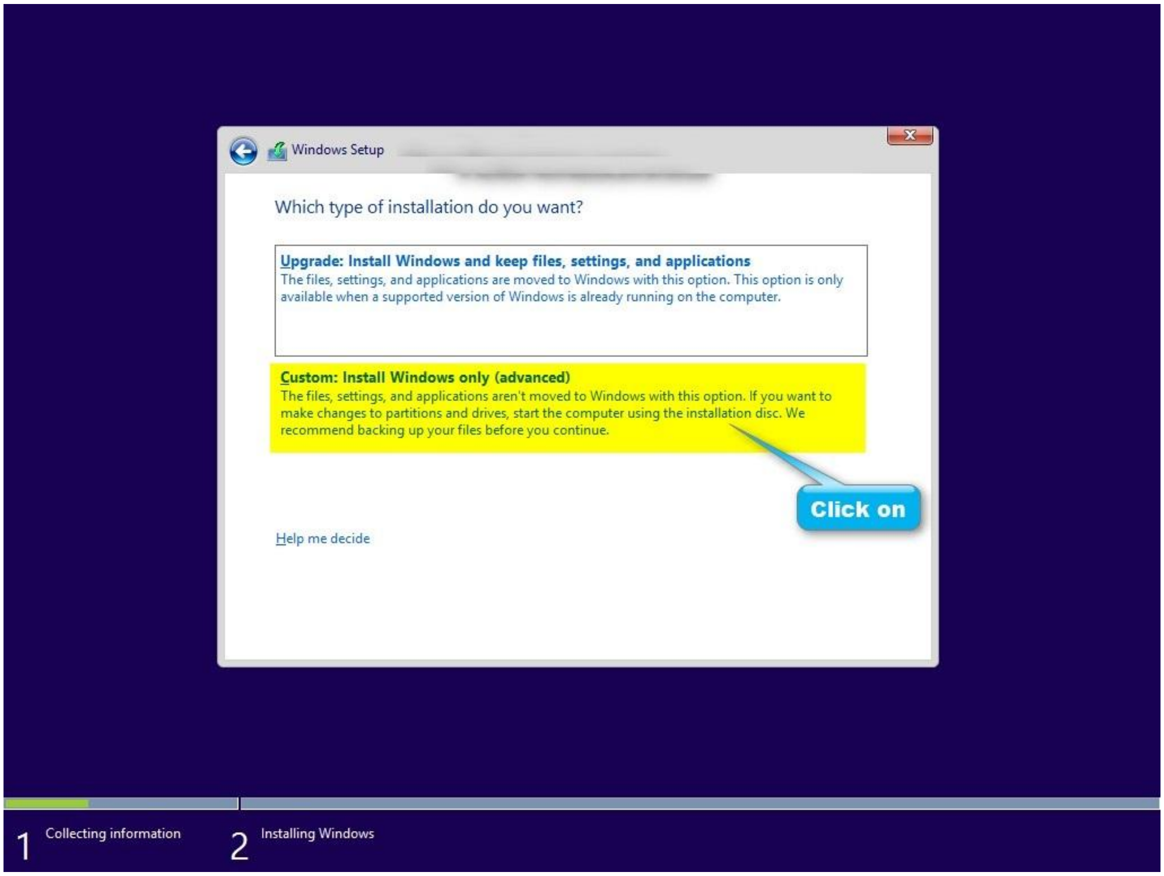


Figure 8.9

Step 8

Select a hard drive or partition that you want to do a clean install of Windows 10 on, do one of the options for how you want to install Windows (see Figure 8.10 below)

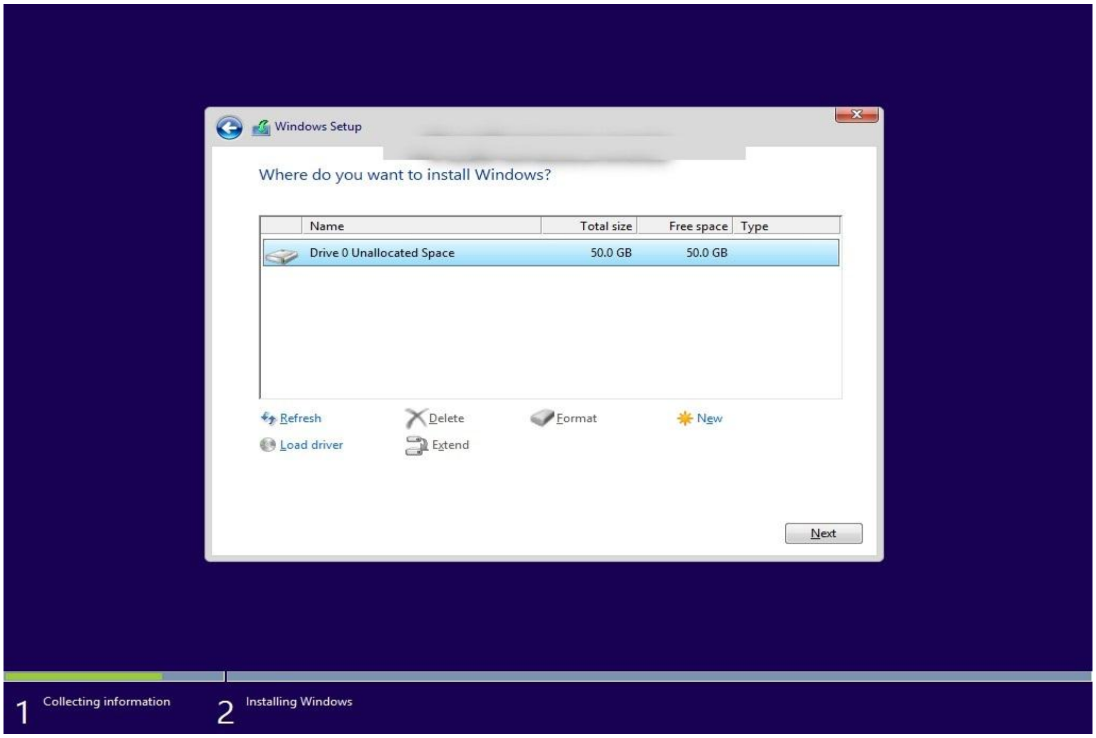


Figure 8.10

Drive options (advanced)

If you only have one partition for a Drive # (hard drive) listed that you wanted to install Windows on, then select the disk # and click on the Delete option if not grayed out to make it unallocated space.

If you have more than one partition for Drive # (hard drive) listed and wants to install Windows on only one of the partitions and keep the other partitions with that disk #, then only select the partition that you want to install Windows on the Format option.

If you have more than one partition for a Drive # (hard drive) listed and want to get rid of all of them to make that disk # one single partition drive again, then select a partition with that disk # and click on the Delete option for each partition with the same Drive # until there is only one "unallocated space" with that Drive # left as in the screenshot below.

To shrink an existing partition to create another partition to install Windows on instead, select the partition that you want to shrink and click on the Extend option. Type in how much in MB (1 GB = 1024 MB) that you want to shrink it by. Now select the new extended partition.

Figure 8.11 below lists the default created partitions while installing Windows 10.

Note

If you receive a **"Windows can't be installed on drive 0"** warning, you will still be able to as long as you can click/tap on the **Next** button.

Windows Setup will automatically create the 4 partitions below on the drive, and install Windows 10 on the primary partition.

- Partition 1 - **Recovery**
- Partition 2 - **System** - The EFI System partition that contains the NTLDR, HAL, Boot.txt, and other files that are needed to boot the system, such as drivers.
- Partition 3 - **MSR** - The Microsoft Reserved (MSR) partition that reserves space on each disk drive for subsequent use by operating system software.
- Partition 4 - **Primary** - Where Windows is to be installed to.

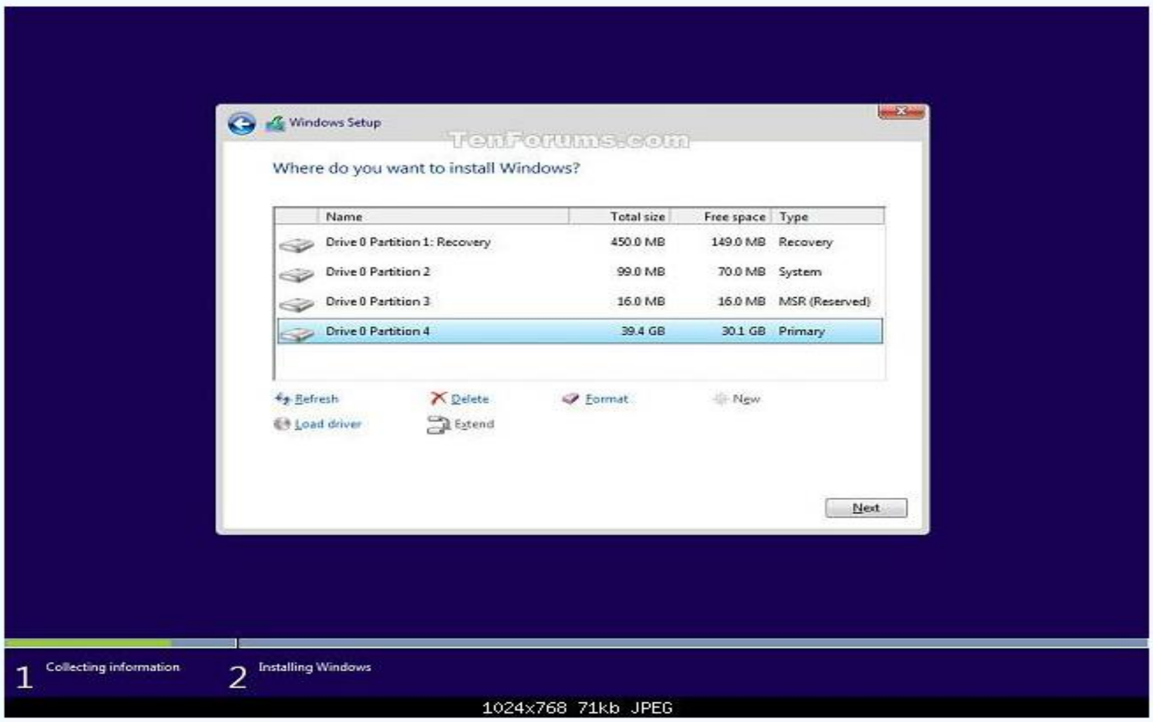


Figure 8.11

Step 9

The installation of Windows 10 will now begin. (See Figure 8.12 below)
NOTE: During the installation process, your screen may flash and computer will restart a few times.

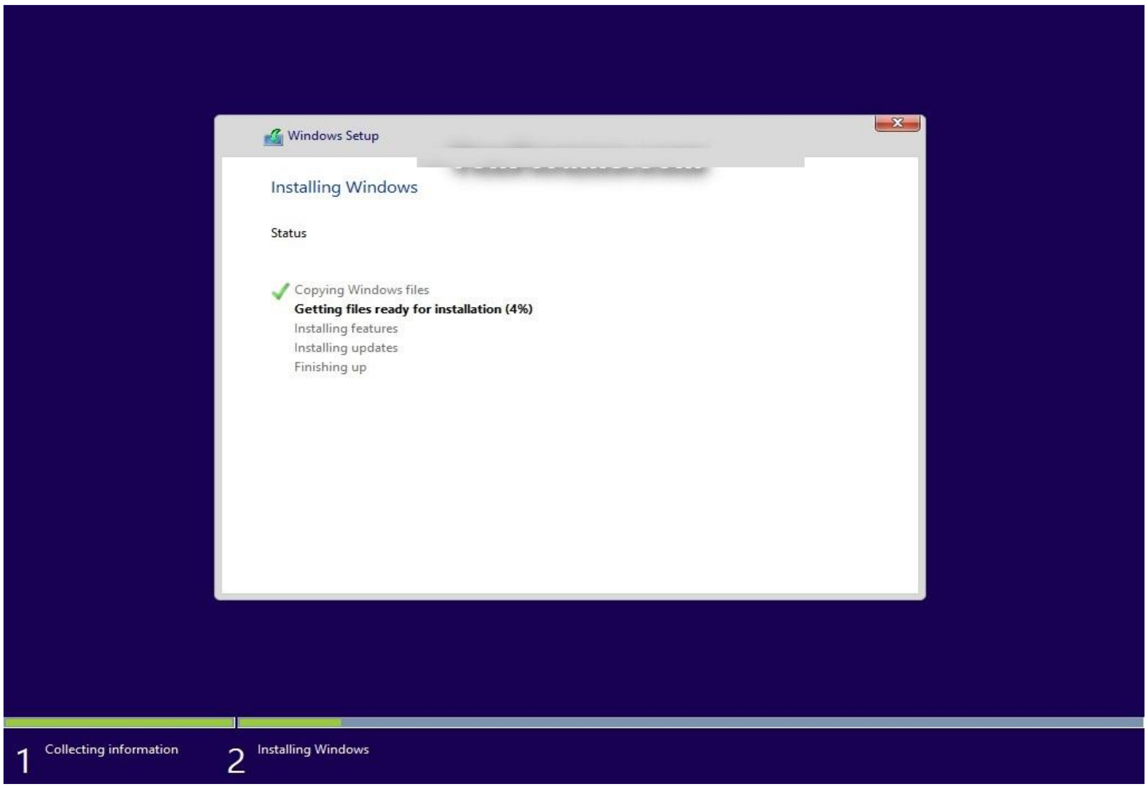


Figure 8.12

Step 10

If you have a wireless network adapter, then you can setup and connect to your wireless network by selecting the wireless network, entering its password, and click/tap on Next.

Step 11

Click/tap on the Use Express settings or Customize button for how you want to set these settings (see Figure 8.13 below).

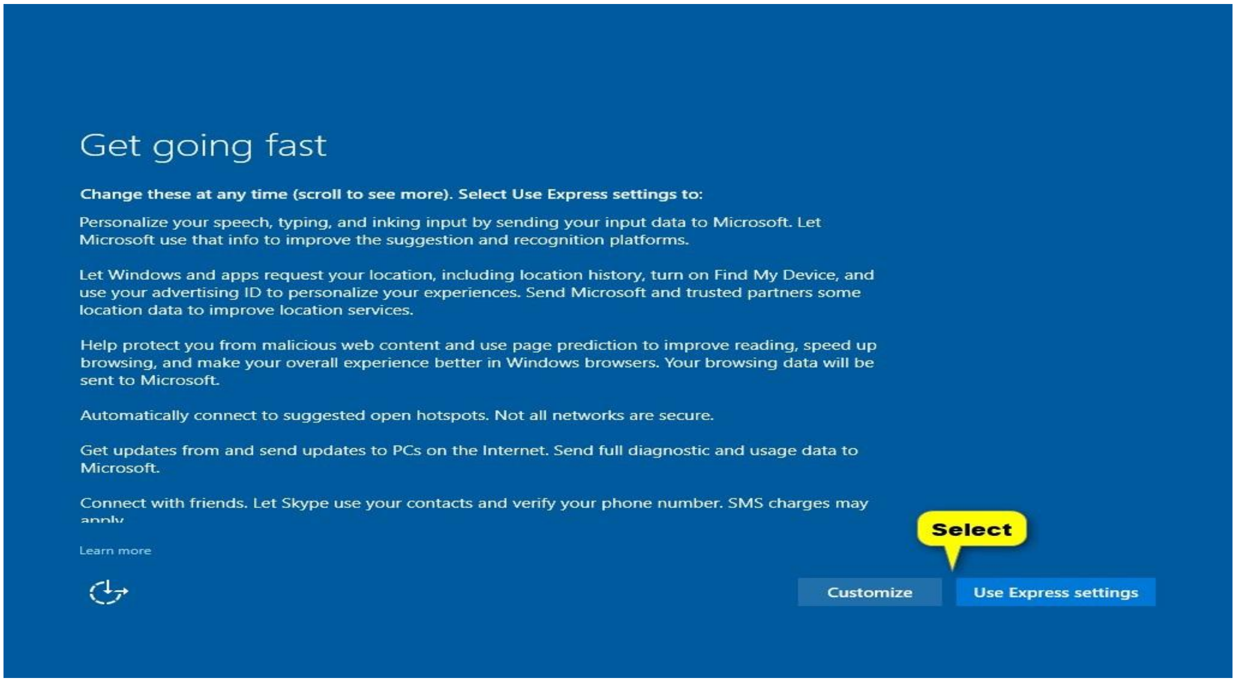


Figure 8.13

Step 12

Turn On or Off the Personalization and Location settings you would like, and click/tap on Next. (see Figure 8.14 below).

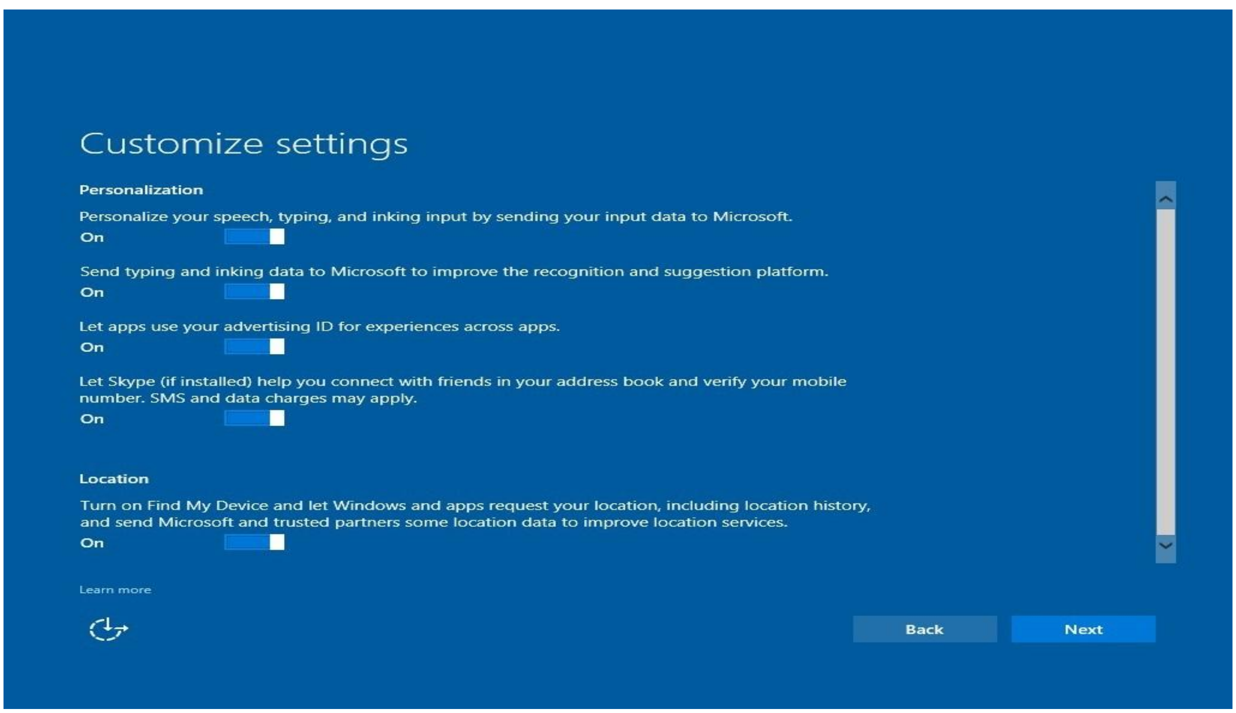


Figure 8.14

Step 13

Turn On or Off the Connectivity and error reporting settings that you want, and click/tap on Next.

Step 14

Turn On or Off the Browser, protection, and update settings that you want, and click/tap on Next.

Step 15

Windows will now check for an internet connection.

Step 16....

After completing installing Windows 10 operating system, home screen will appear and your Windows is ready to be used, but it may still be activated (provided you have an internet connection).

8.6 REFERENCES

- https://www.netacad.com/courses/it-essentials/.

Experiment 9: Data Backup and Recovery && Create a Partition in Windows 10

9.1 PRELAB

On you own words

Q1., Describe why "Backup" is important?
Q2. Describe why make a "Restore point " is important?

9.2 OBJECTIVES

- Perform a data backup and recovery in windows 10.
- Create a partition in Windows 10.
- Identify the differences between the FAT32 format and the NTFS format.

9.3 INTRODUCTION

In the first part of this experiment you need to recover files, you have the ability to restore data from Windows backup. In the second part of this experiment you will create a FAT32 formatted partition on a disk. You will convert the partition to NTFS. You will identify the differences between the FAT32 format and the NTFS format.

LAB WORK

9.4 Part one: Windows 10 Backup & Restore

The following explains how to create a backup and restore data from your backup.
Log on to the computer as an administrator.

- Create a text file on the desktop called **Backup File One**. Open the file and type the text “**The text in this file will not be changed.**”
- Create another text file on the desktop called **Backup File Two**. Open the file and type the text “**The text in this file will be changed.**”

Note: Remove all extra folders and files from the computers Desktop. This will help to reduce the length of time to complete the backup for this lab.

9.4.1 Setting up your Backup

1 Click the Start button (See Figure 1).
2 Click Settings (See Figure 1).

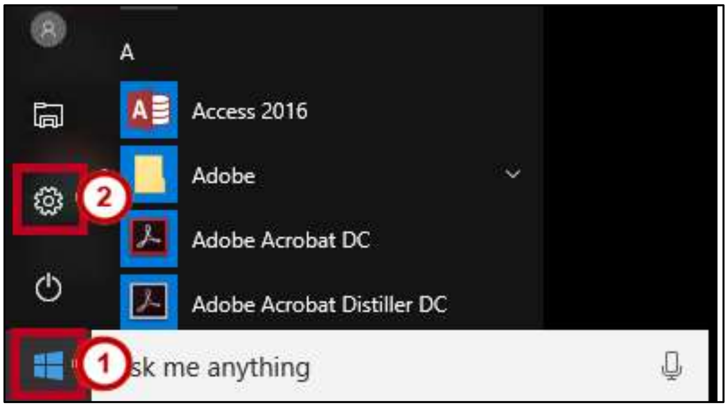


Figure 1 – Settings

3. Click **Update & security**.

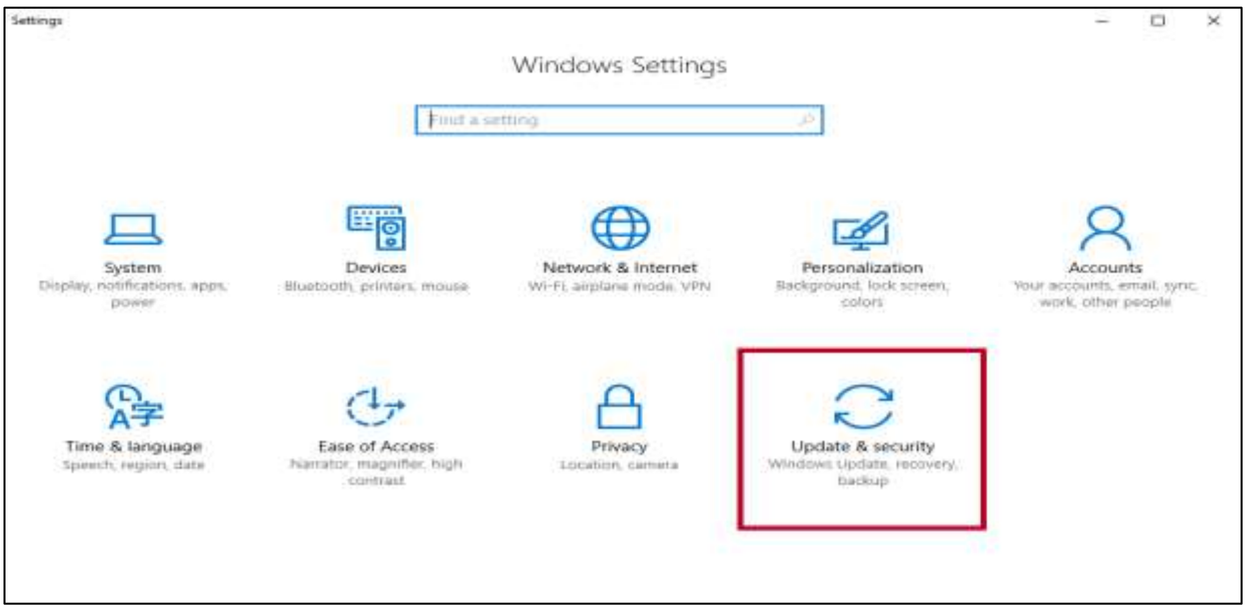


Figure 2 - Update & Security

4. Click **Backup**.

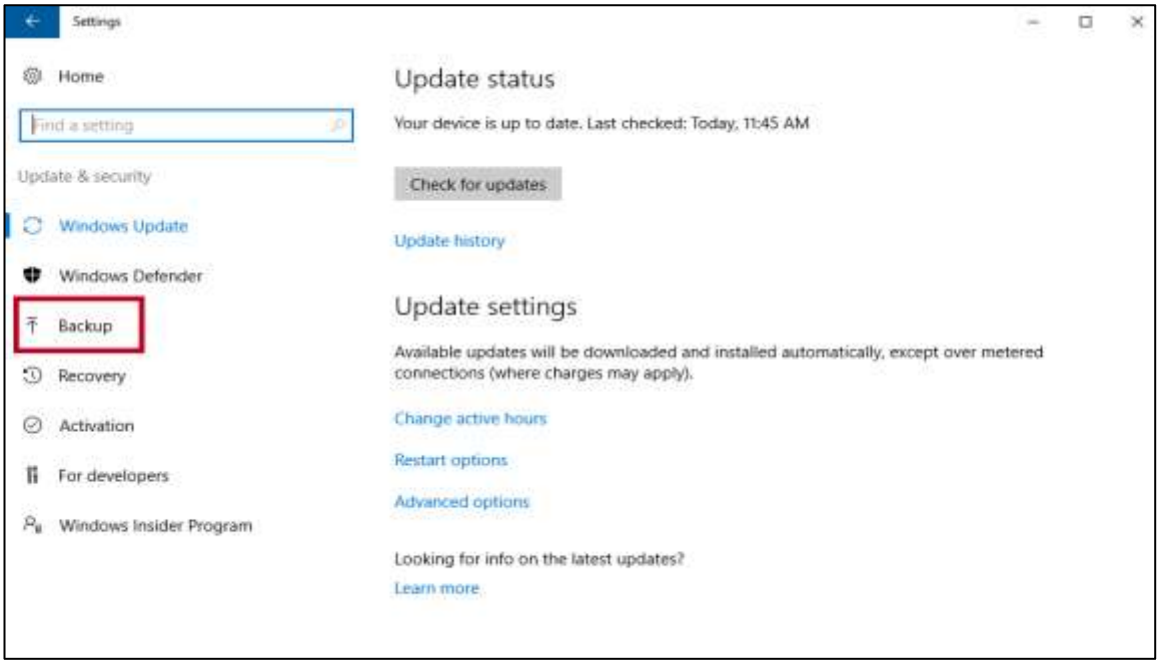


Figure 3 - Backup

5. Click **Add a drive**.

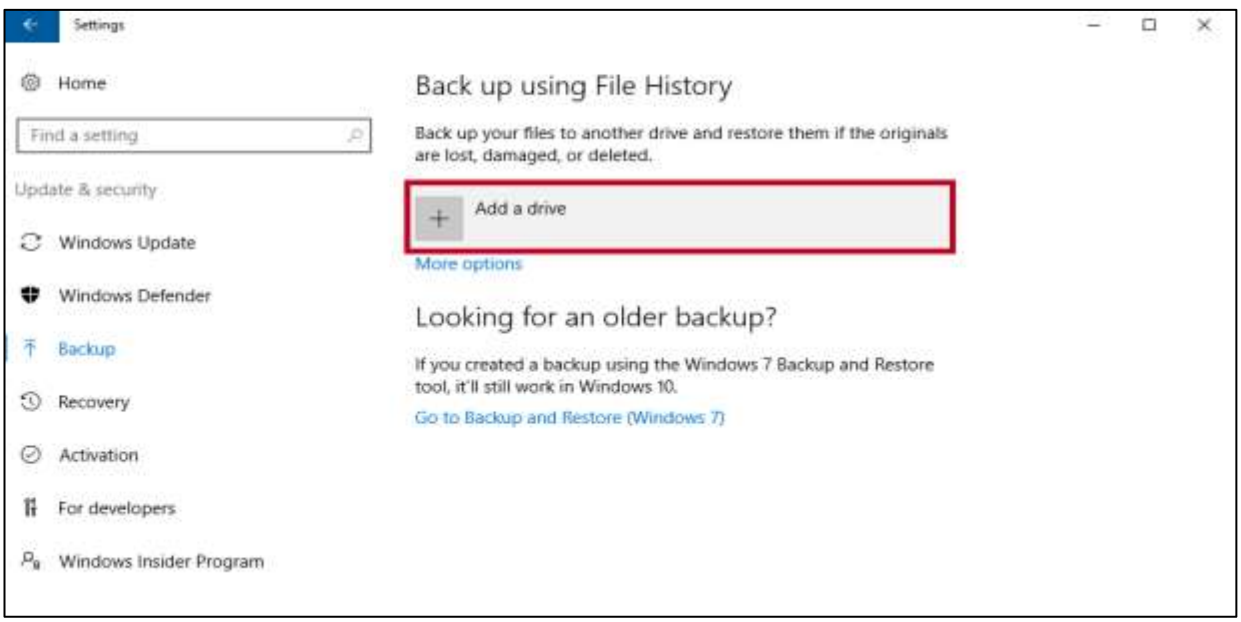


Figure 4 - Add a Drive

6. The *Select a drive* window will open to display all available drives. Click the **drive** you want to use.

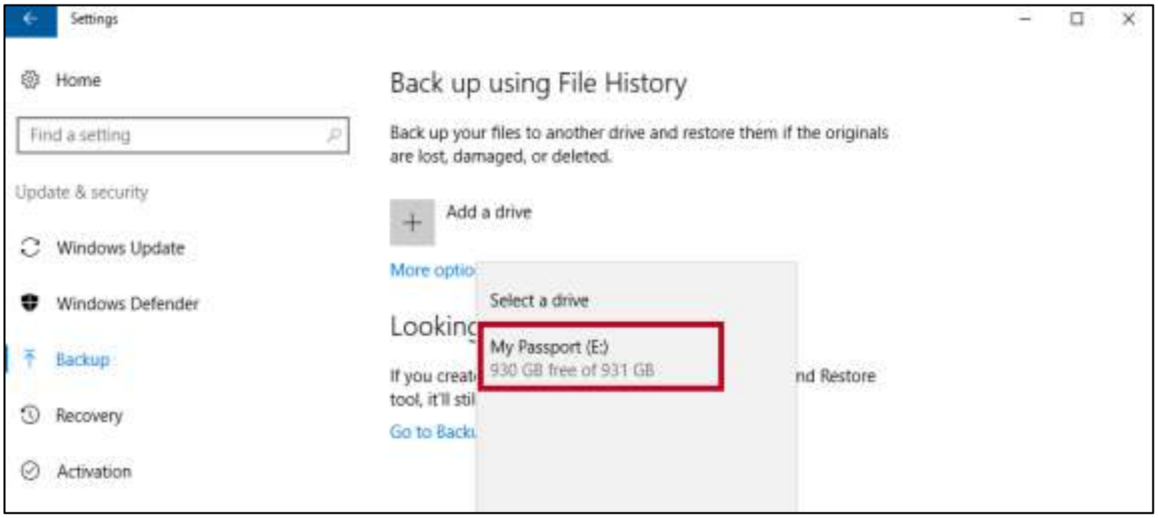


Figure 5 - Click the Drive.

7. After selecting the destination drive, Windows 10 will set Automatically back up my drives to the *On* status. If you want to configure the backup options, click **More Options**.

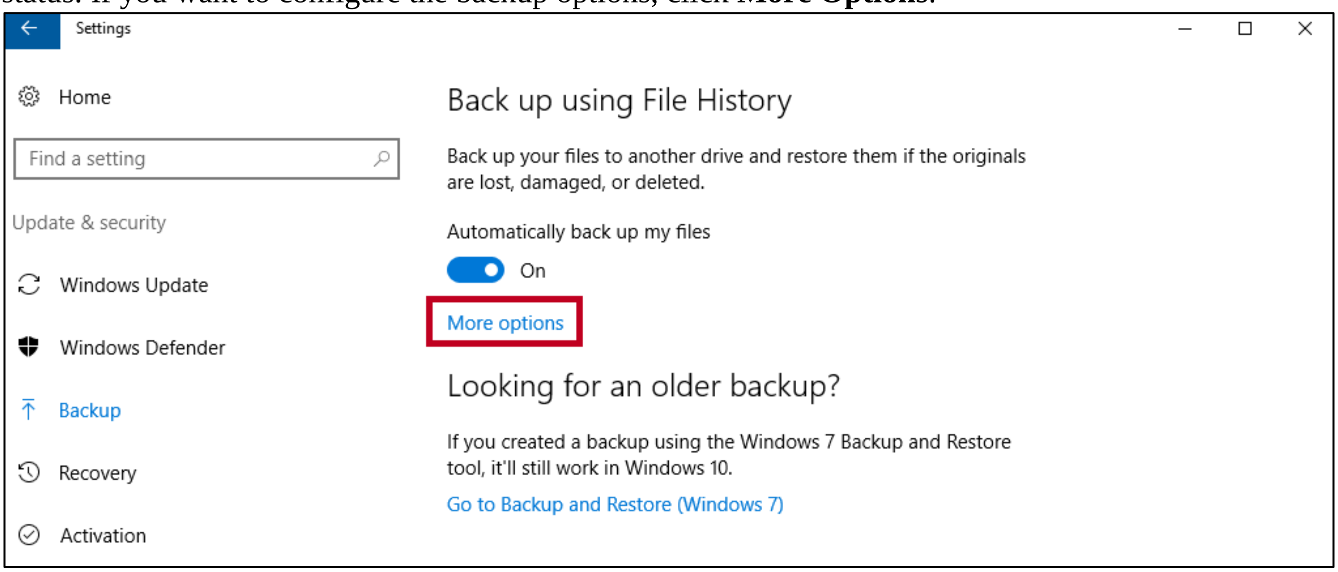


Figure 6 - More Options.

8. The *Backup options* window opens displaying the folders included in the backup as well as drop-down menus and buttons to modify settings for your backup.

a. Click **Back up now** to begin an immediate backup of your folders (See Figure 7).

b. Click the **drop-down** menu to select how often to back up your files (See Figure 7).

c. Click the **drop-down** menu to select how long to retain backups (See Figure 7).

d. Click the **Add (+)** button to add a folder to the list (See Figure 7).

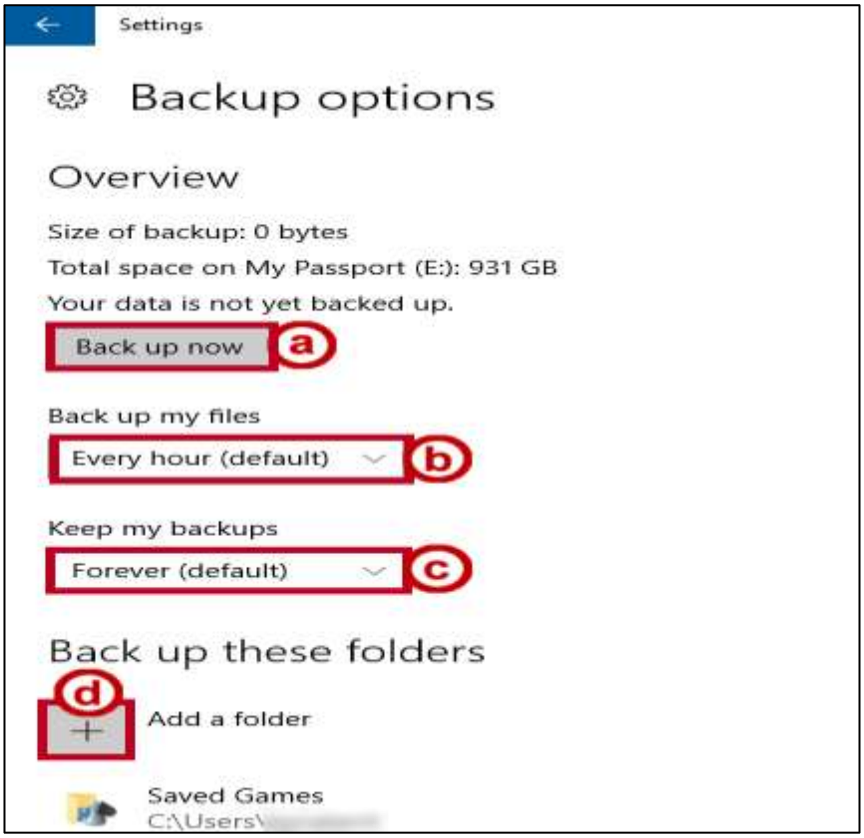


Figure 7 - Backup Options

9. A status of *Backing up your data* will appear. A backup is now being created.

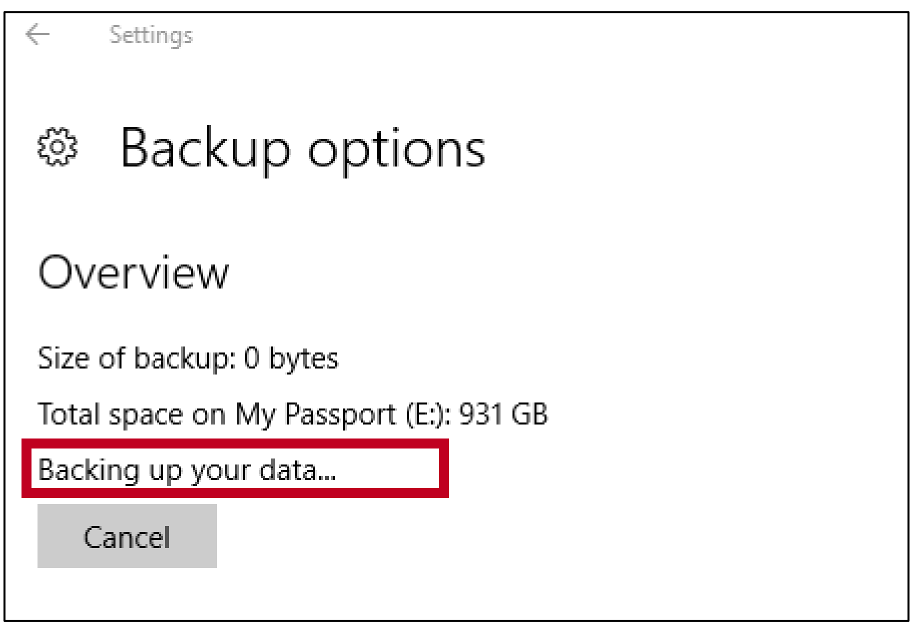


Figure 8 - Backing Up Data .

9.4.2 Restoring from your Backup

In the event that you need to recover files, you have the ability to restore data from your Windows Backup. The following explains how to recover data from your backup.

Note: You must first setup a backup in order to recover files.

1. In the search bar, type **Restore**.
2. From the resulting menu options, select **Restore your files with File History**.

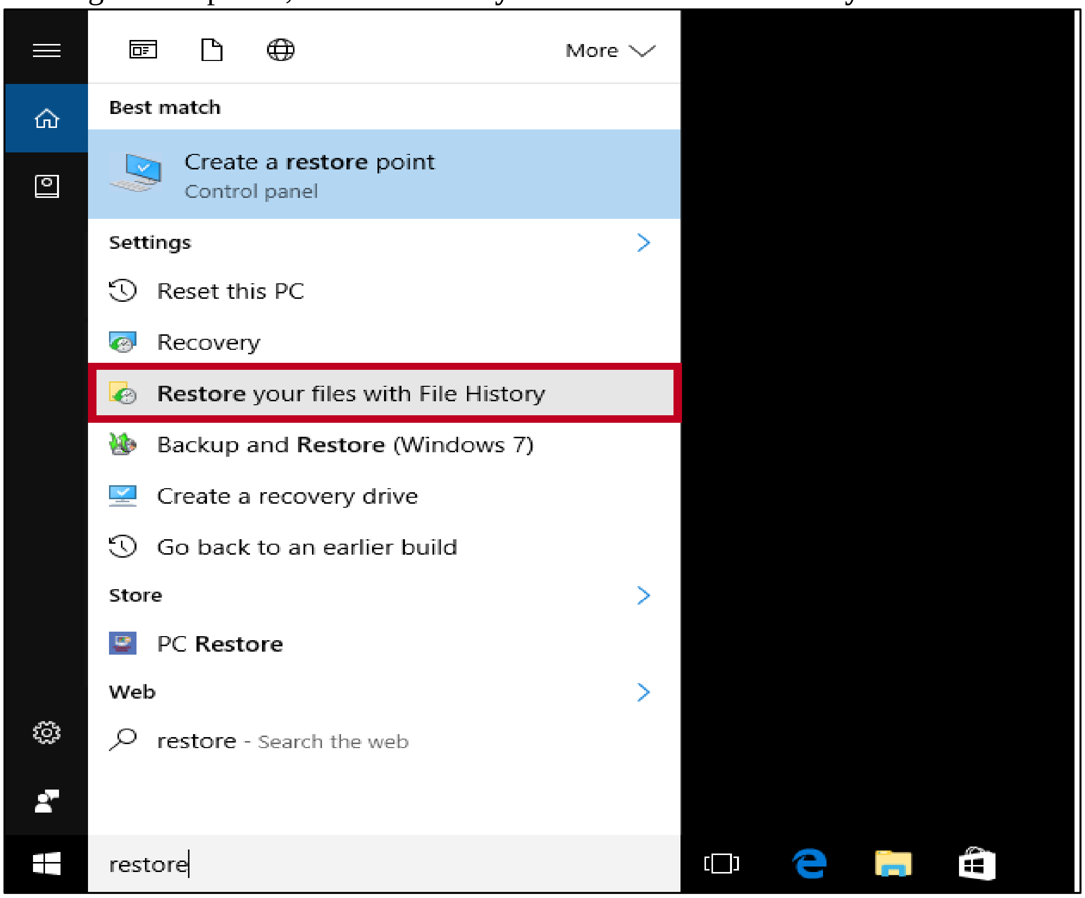


Figure 9 - Recover Your Files with File History.

3. Select the **files** you want to restore (See Figure 10).
4. Click the **Restore** button (See Figure 10).

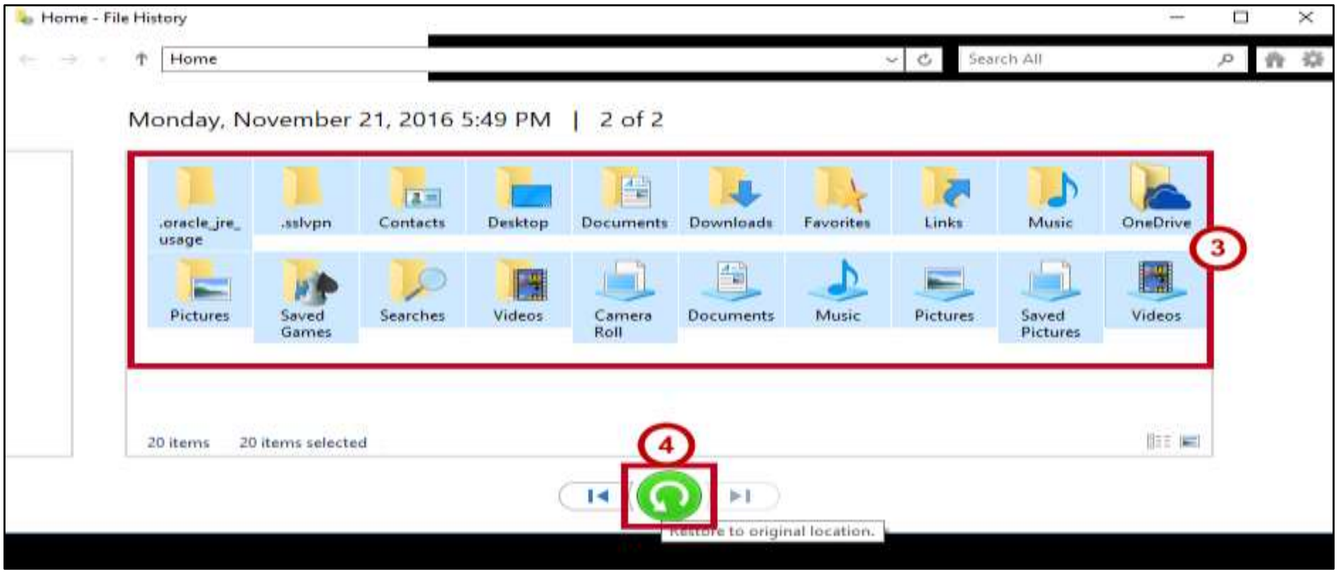


Figure 10 - Select Files and Restore

9.4.3 Recovery from a System Restore Point

Recover from a system restore point takes your computer back to an earlier point in time, called a system restore point. Windows automatically saves restore points when installing a new application, driver, or Windows update, but you can also create a restore point manually. Restoring will not remove your personal files, but it will remove applications, drivers, and updates installed after the restore point was made. The following explains how to create a system restore point manually and restore from a system restore point:

Create System Restore Point

1. In the search bar, type **Restore**.
2. From the resulting menu options, select **Create a Restore Point**.

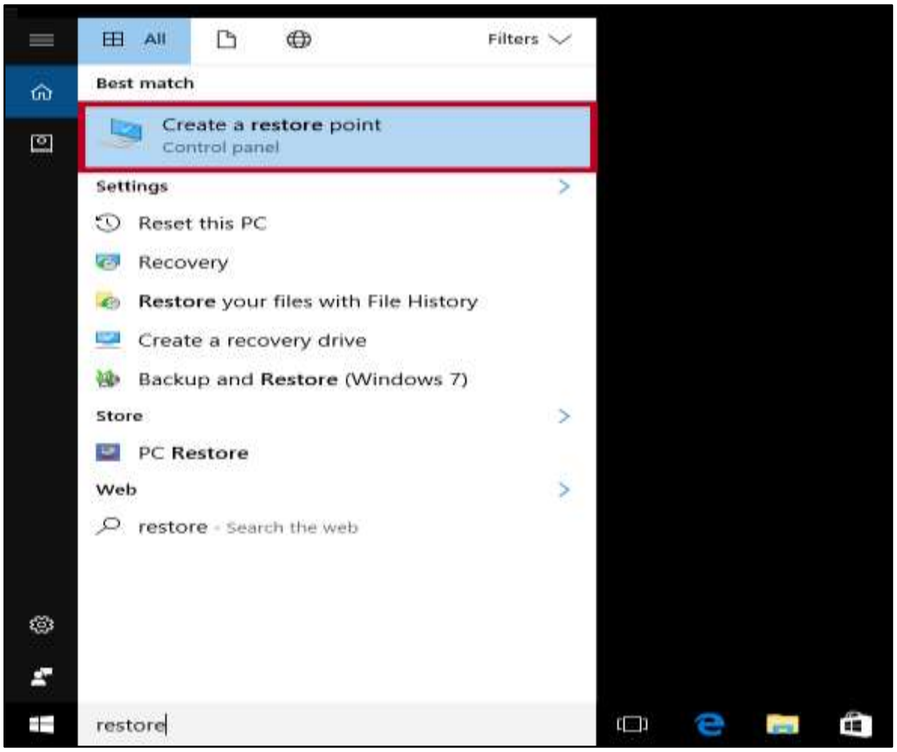


Figure 11 - Create a Restore Point

3. The *System Properties* window will open to the *System Protection* tab. Click **Configure**.

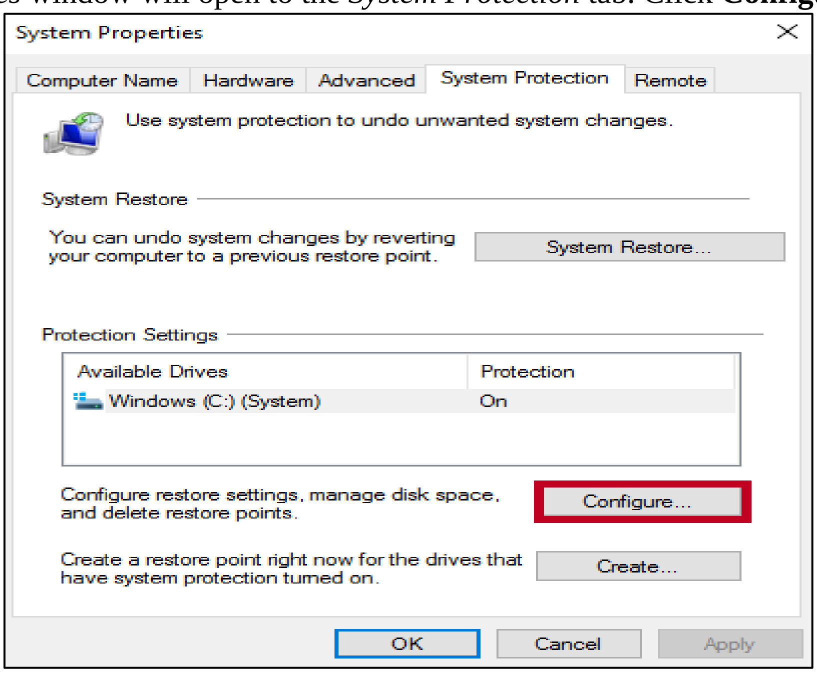


Figure 12 - Click Configure.

4. Click to enable **Turn on system protection** (See Figure 13).

5. Use the **Max Usage** slider to determine how much of your hard drive to use to store restore points (See Figure 13).

6. Click **OK** (See Figure 13).

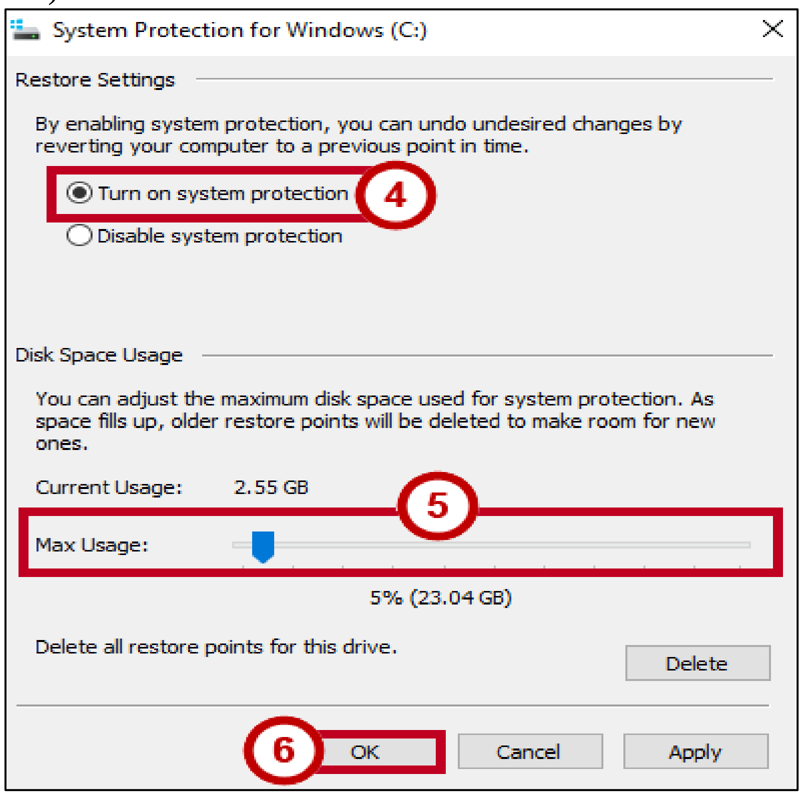


Figure 13 - Configure Restore Settings

7. Click **Create**.

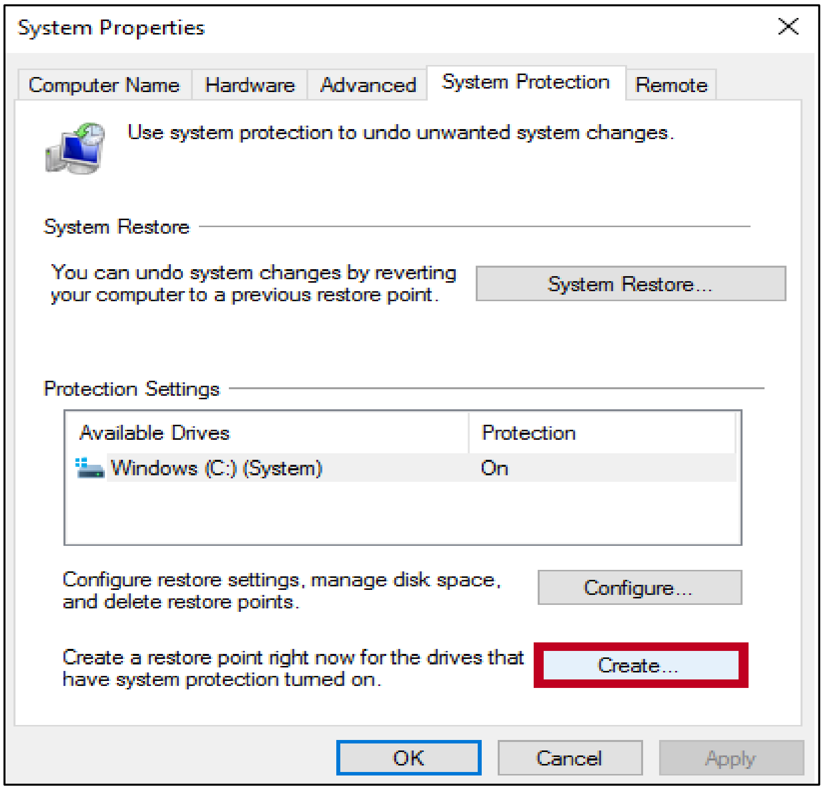


Figure 14 - Create Restore Point

8. The *Create Restore Point Description* box appears.

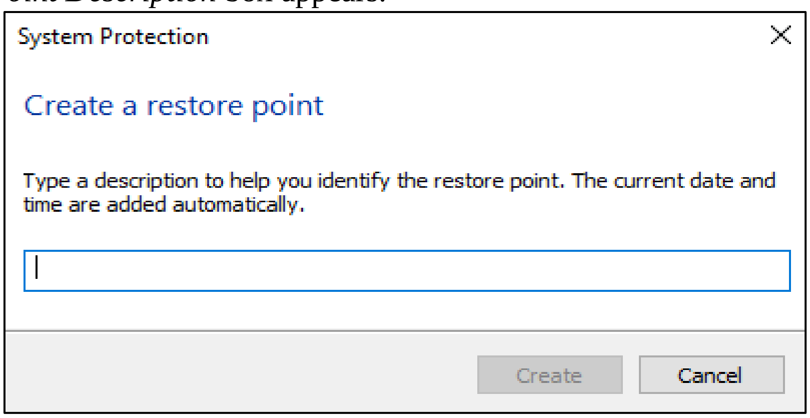


Figure 15 - Restore Point Description Box

9. Type in a **description** to help identify the restore point and click the **Create** button.

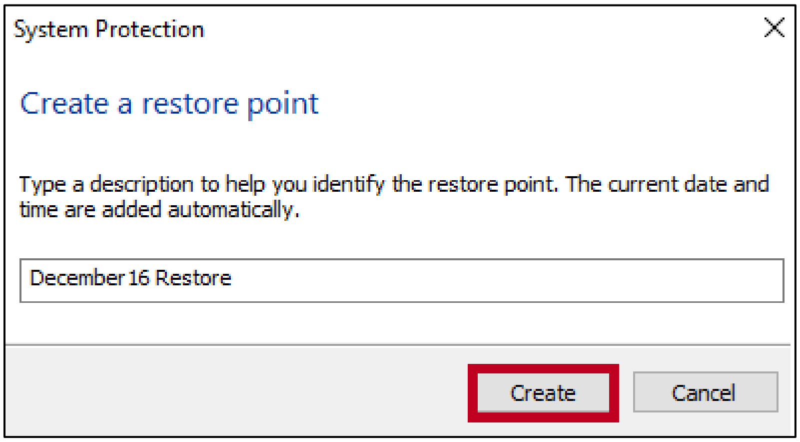


Figure 16 - Click the Create Button

10. A restore point is now being created.

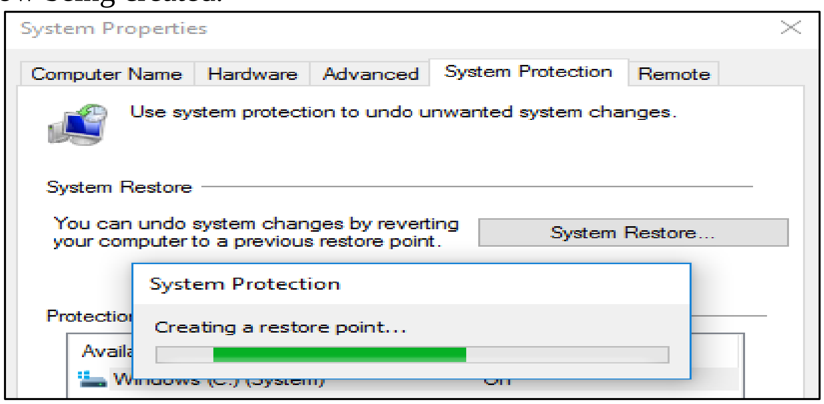


Figure 17 - Creating a Restore Point .

11. The restore point has been created successfully. Click **Close**.

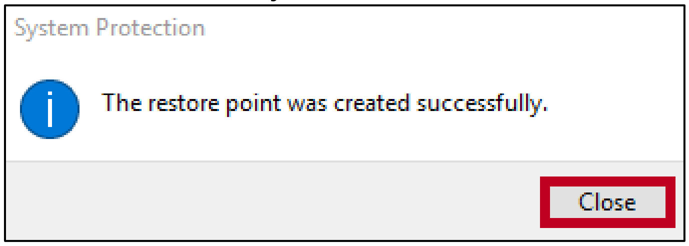


Figure 18 - Restore Point Created Successfully

9.4.4 Restore from System Restore Point

1. In the search bar, type **Recovery**.
2. From the resulting menu options, select **Recovery**.

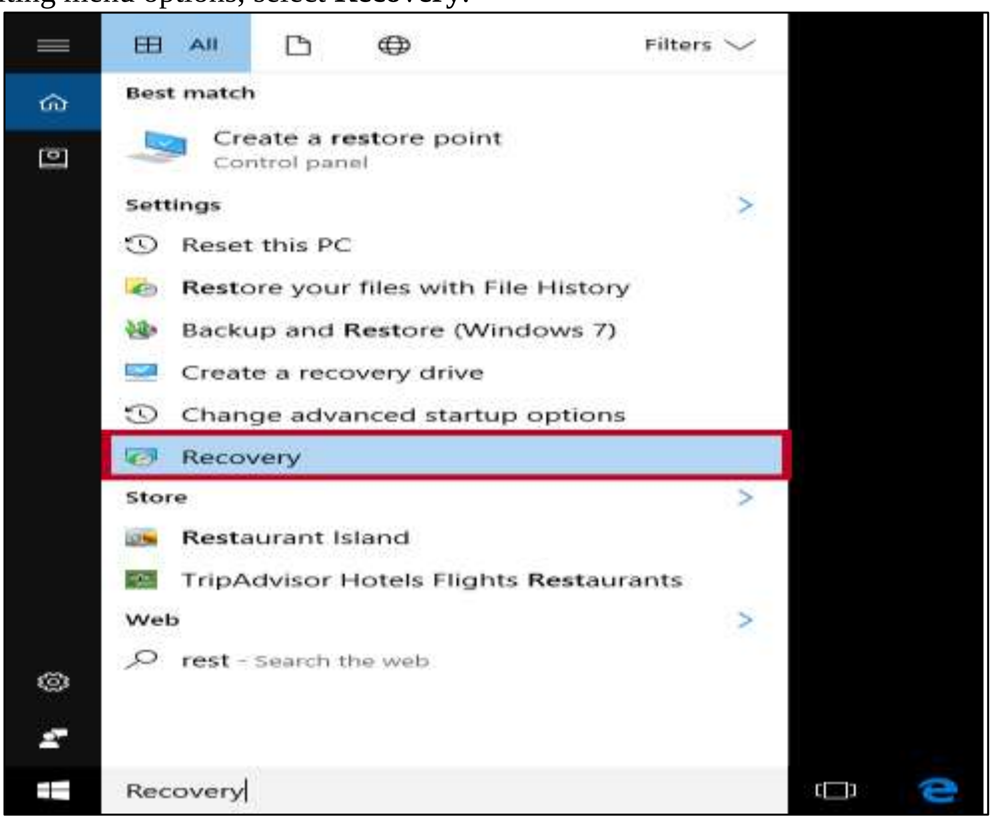


Figure 19 - System Recovery

3. The *System Properties* window will open to the *System Protection* tab. Click **System Restore**.

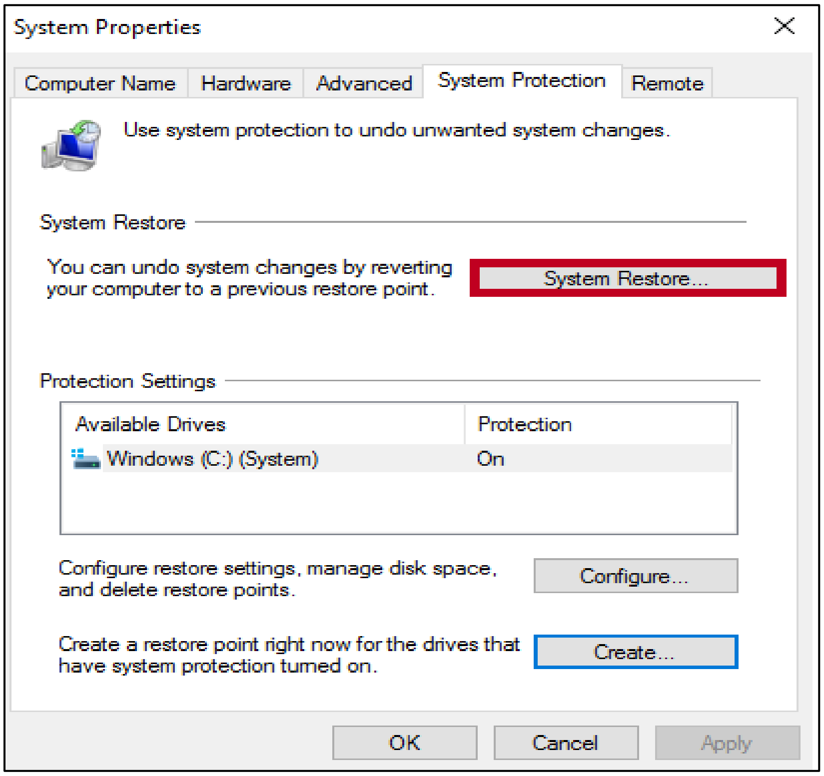


Figure 20 - Click the System Restore Button

4. The *System Restore* window appears. Click **Next** to proceed to restore options.

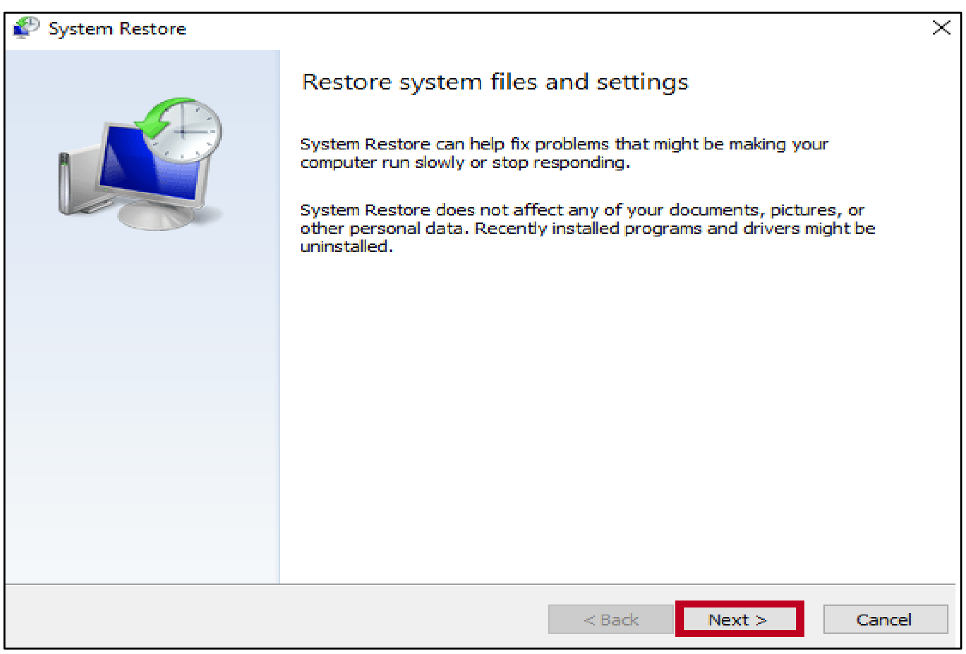


Figure 21 - Click Next

5. A list of restore points will be displayed. Click the **date** you want to use for your restore point (See Figure 22).

6. Click **Next** (See Figure 22).

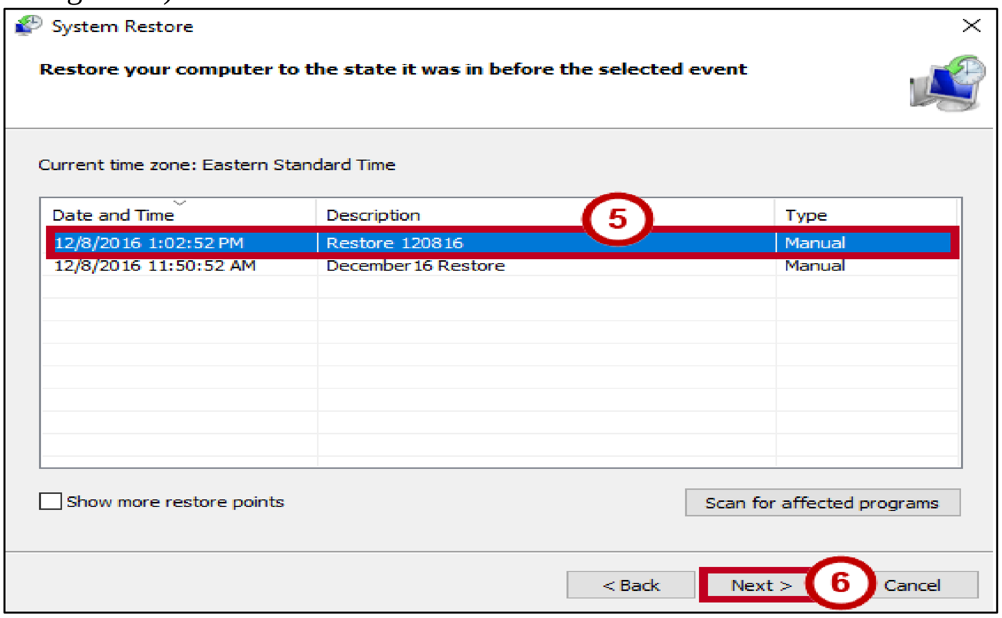


Figure 22 - Click Next

7. The *Confirm your restore point* window appears. Click **Finish** to begin the restore process.

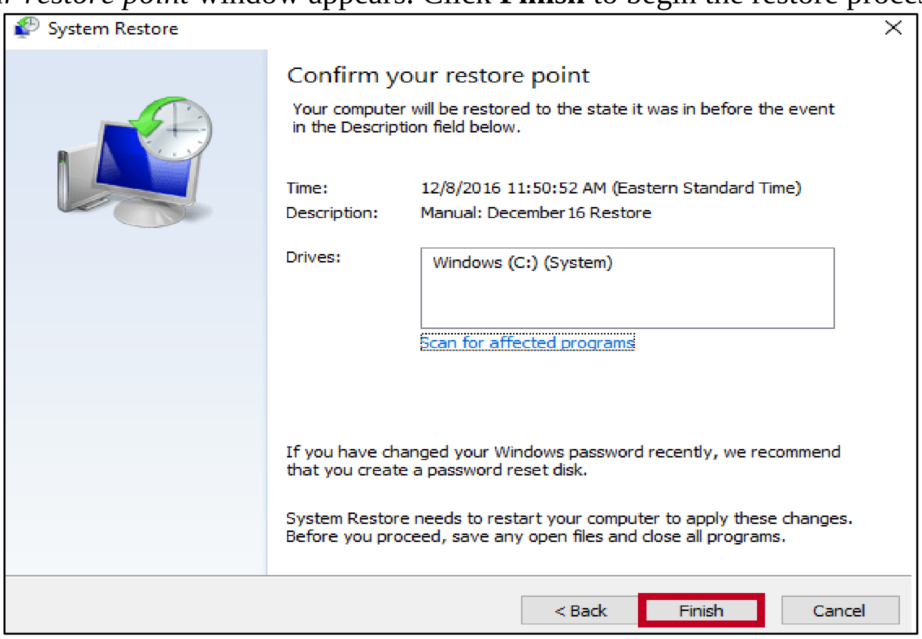


Figure 23 - Click Finish

9.5 Part two: Create a Partition in Windows 10

In this part, you will create a FAT32 formatted partition on a disk. You will convert the partition to NTFS. You will identify the differences between the FAT32 format and the NTFS format.

Note: You may need to substitute different drive letters for the letters shown in this lab.

Step 1
Log on to Windows as an Administrator.
Click **Start**.
Right-click **Computer > Manage**.

Step 2
The “Computer Management” window appears.

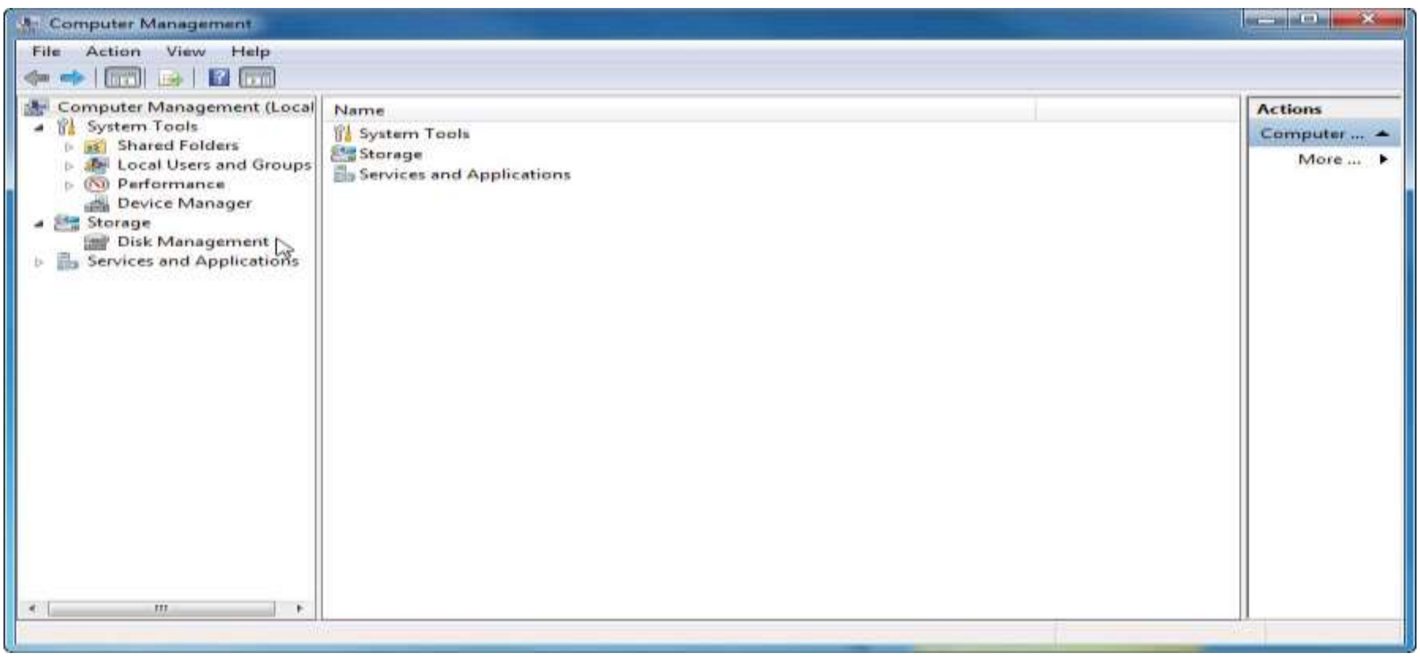


Figure 24

Click **Disk Management** on the left side of the screen.

Right-click the green-outlined block of **Free Space**.

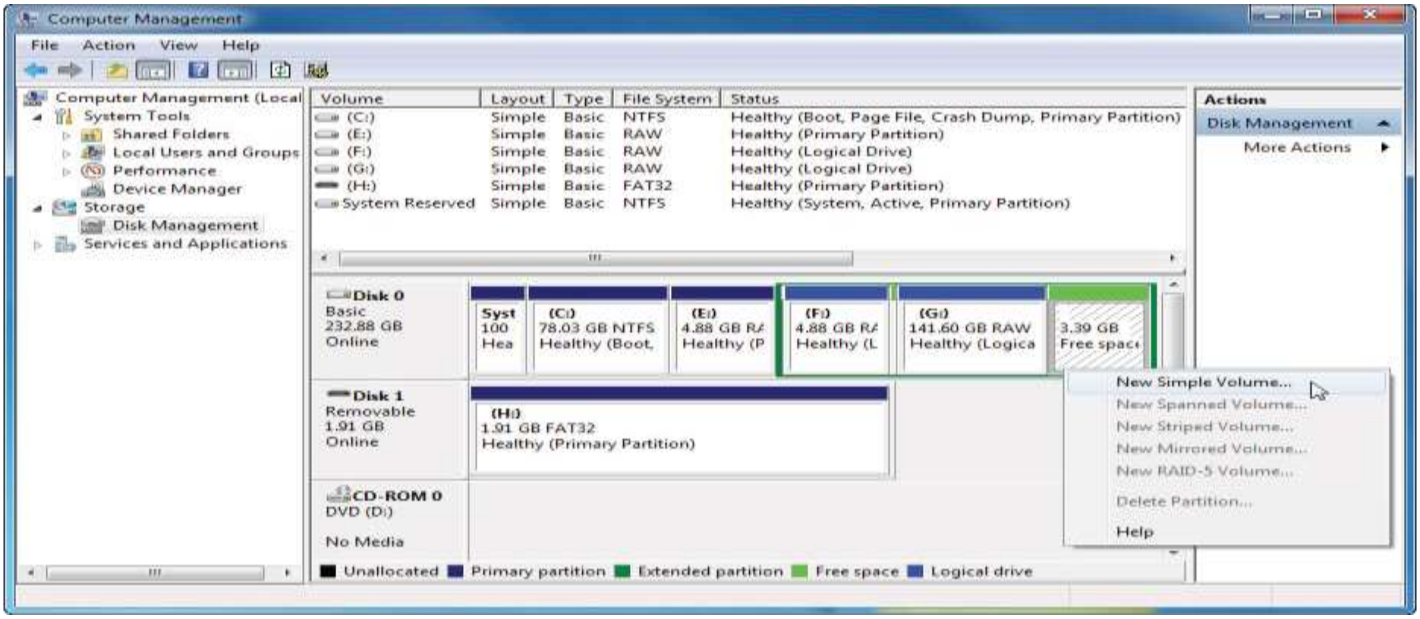


Figure 25

Click **New Simple Volume**.

Step 3

The "New Simple Volume Wizard" window appears.

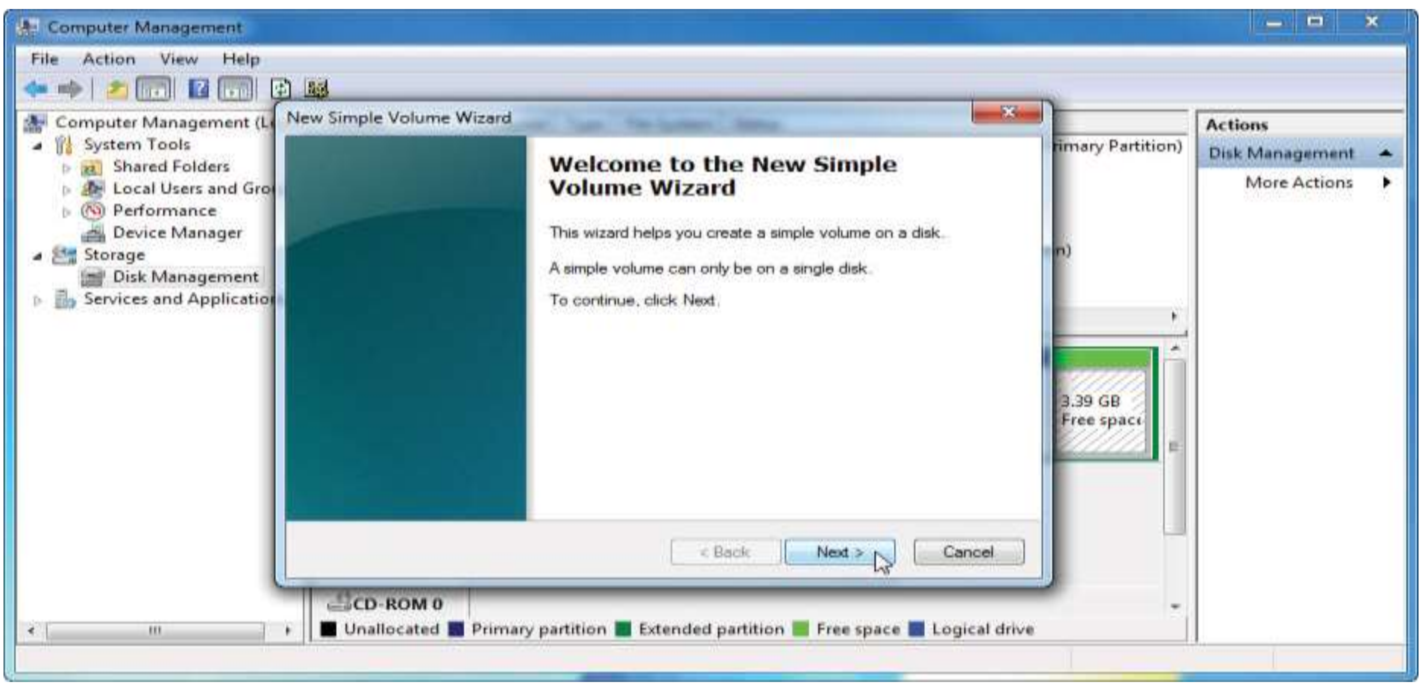


Figure 26

Click **Next**.

The “Specify Volume Size” screen appears.

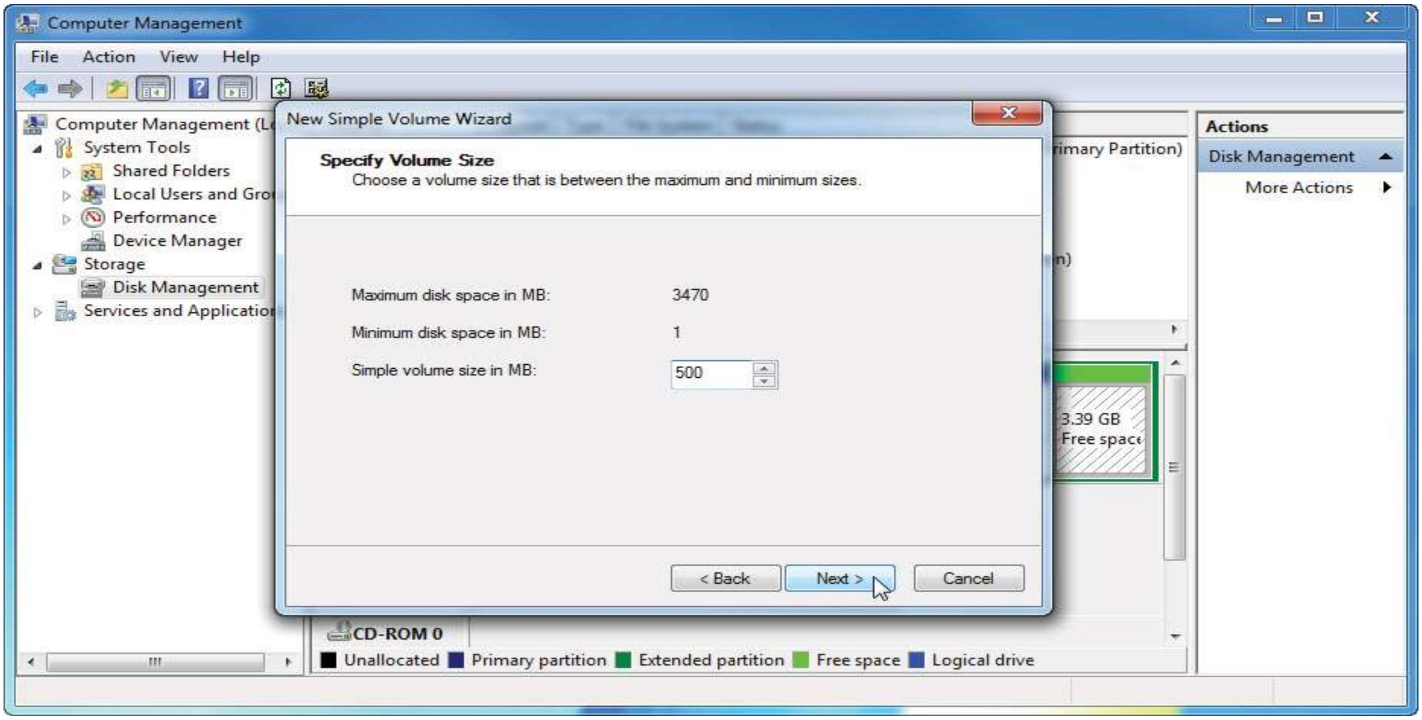


Figure 27

Type **500** in the **Simple volume size in MB**: field.
Click **Next**.
The “Assign Drive Letter or Path” screen appears.

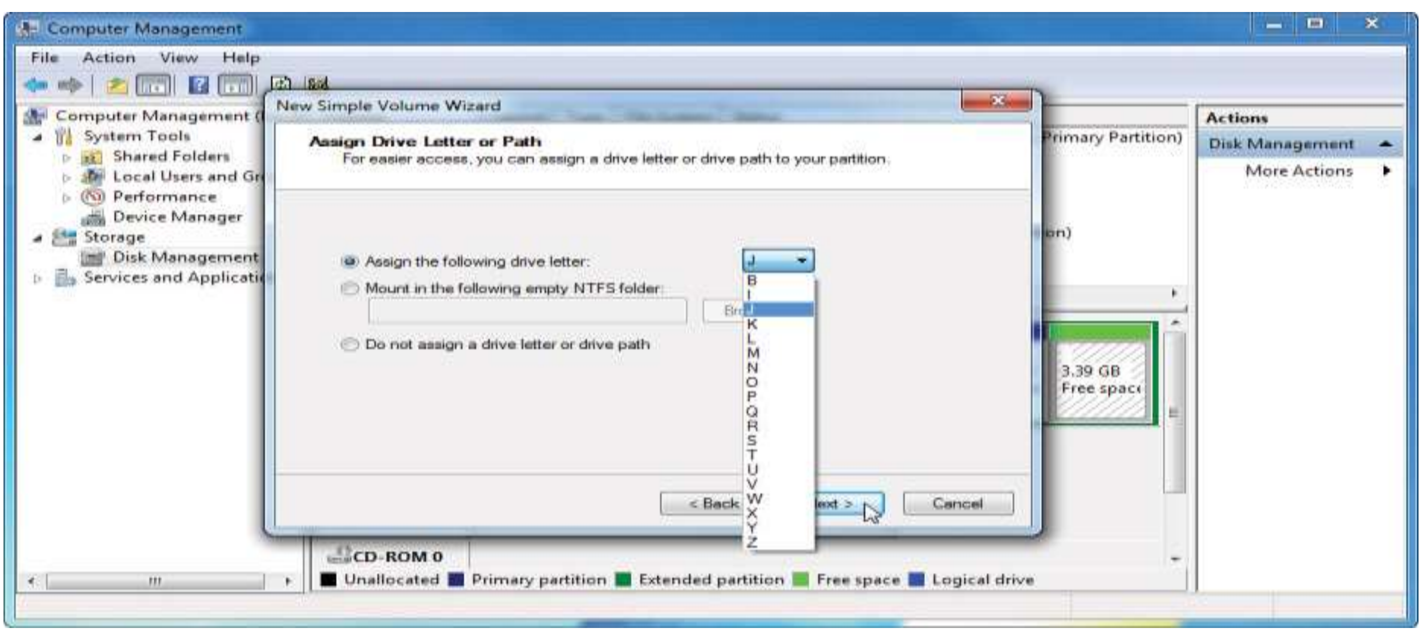


Figure 28

Click the **Assign the following drive letter:** radio button.
Select **J** from the drop-down menu.
Click **Next**.
The “Format Partition” screen appears.

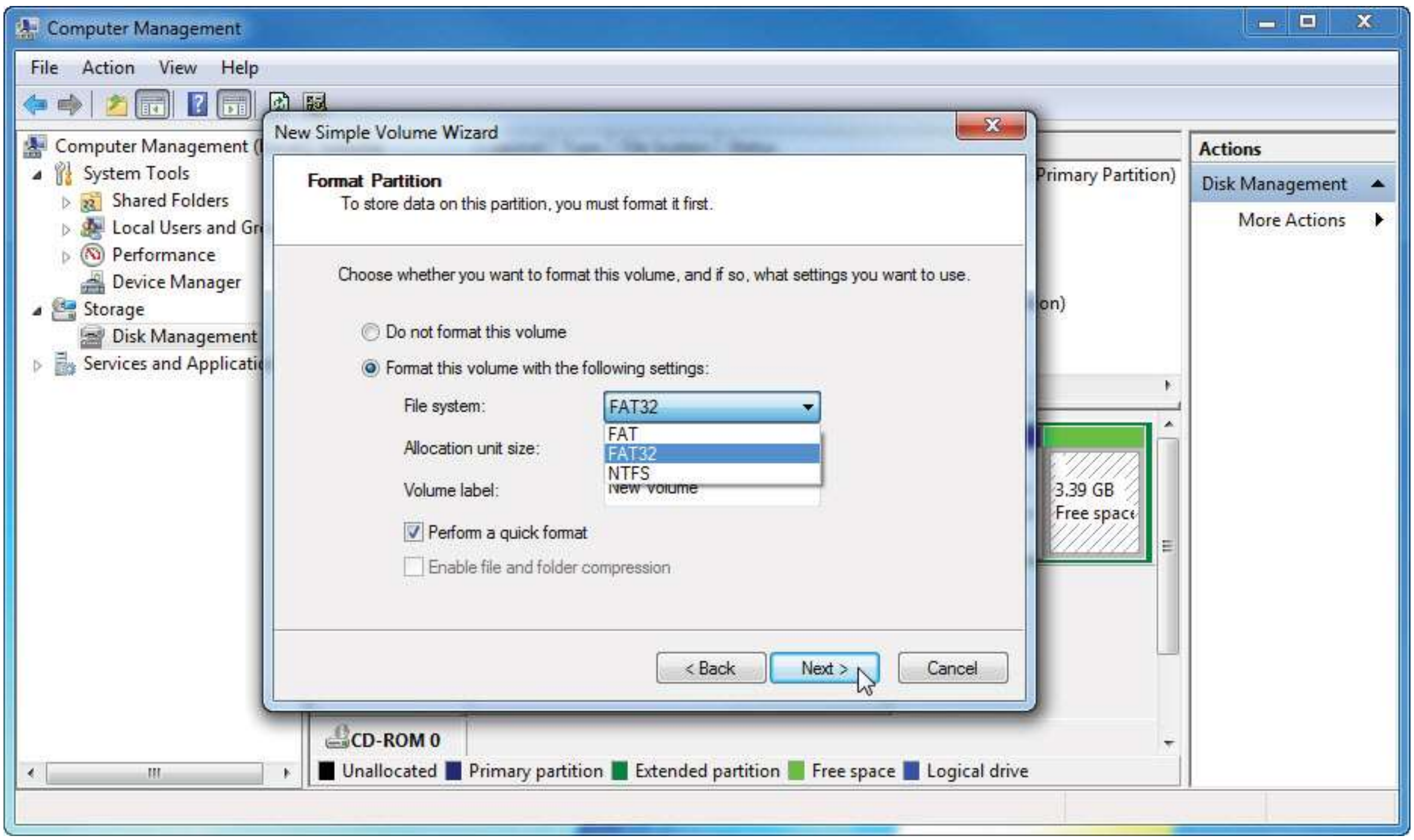


Figure 29

Click the **Format this volume with the following settings:** radio button.
Select **FAT32** from the File system drop-down menu.
Click **Next**.

The “Completing the New Simple Volume Wizard” screen appears.

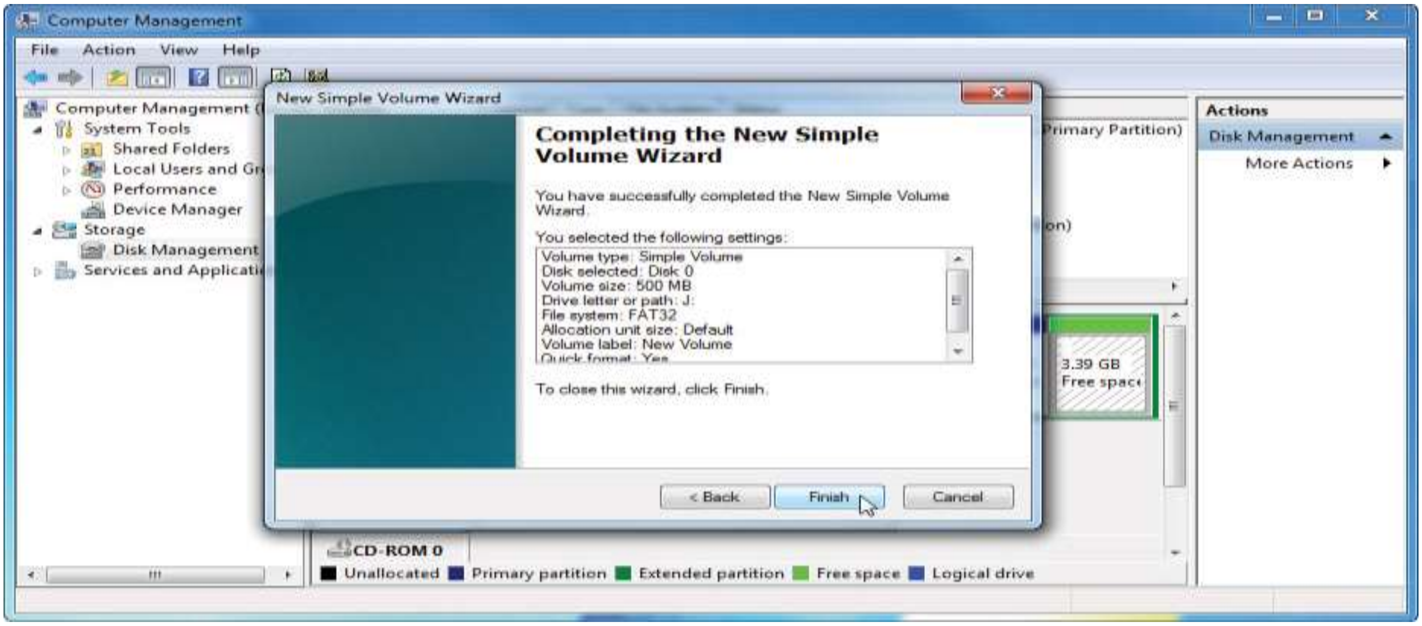


Figure 30

Click **Finish**.

Step 4

The “Computer Management” window re-appears while the new volume is formatted.

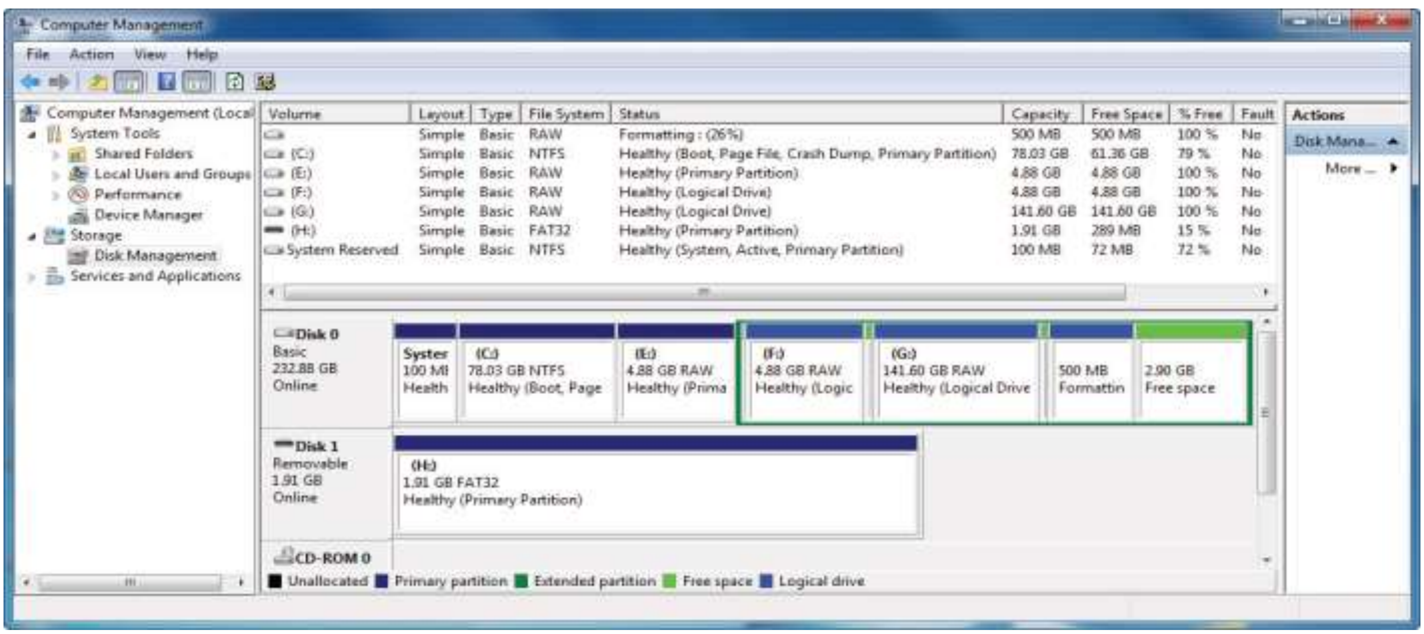


Figure 31

The “Computer Management” window shows the new **Healthy (Logical Drive)** volume.

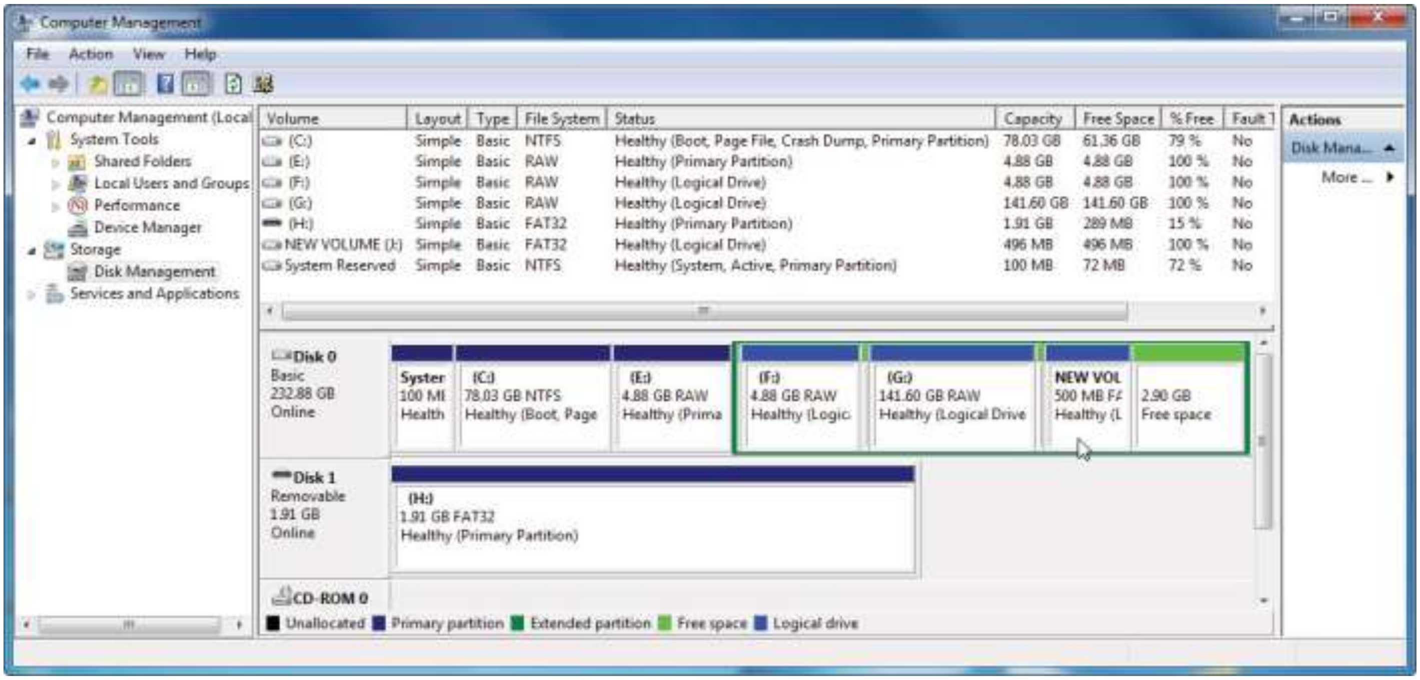


Figure 32

Step 5

Open **Computer**.

Click the **NEW VOLUME (J:)** drive.

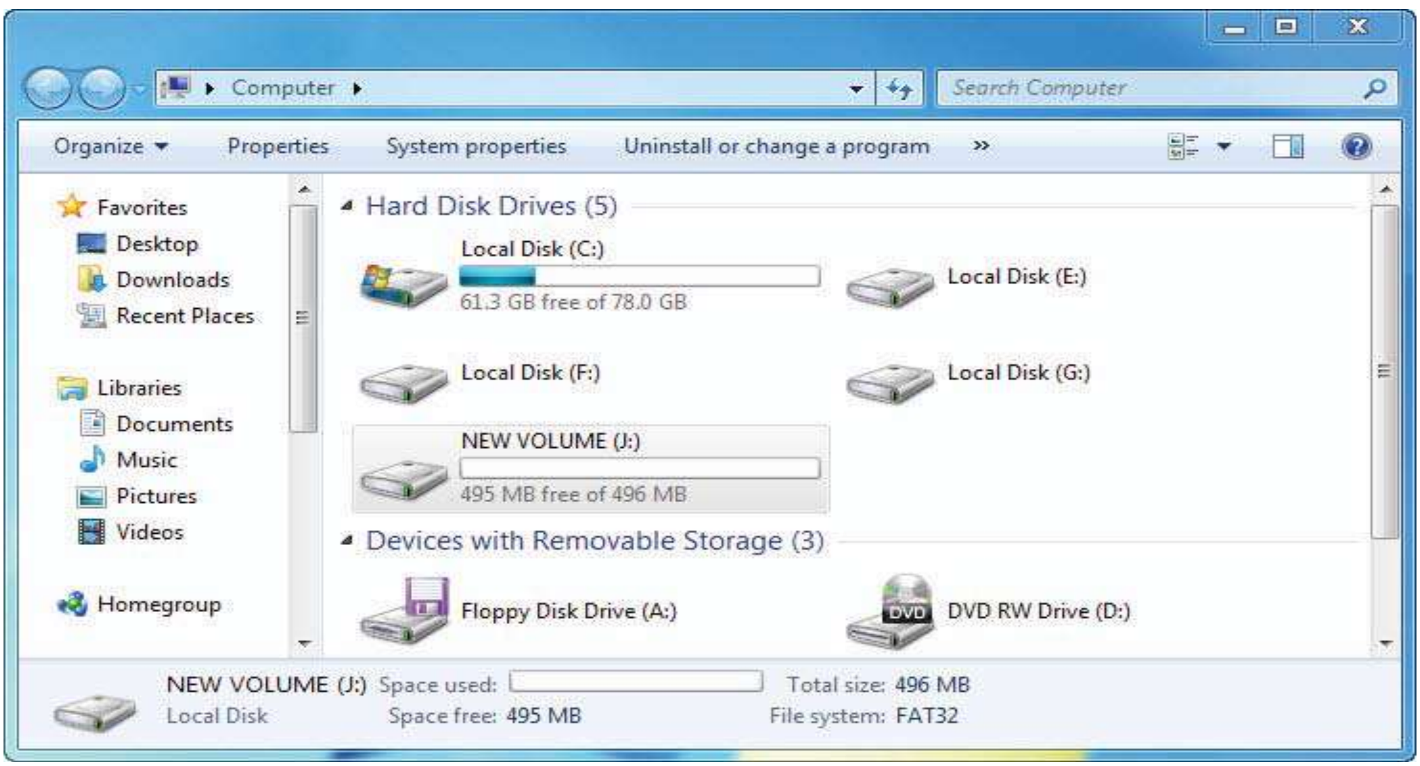


Figure 33

The **Details** area on the bottom of the **Computer** window displays information about the J: drive.

- What is the File System?
- How much Free Space is shown?

Right-click the **NEW VOLUME (J:)** drive.

Click **Properties**.

Step 6
The "NEW VOLUME (J:) Properties" window appears.

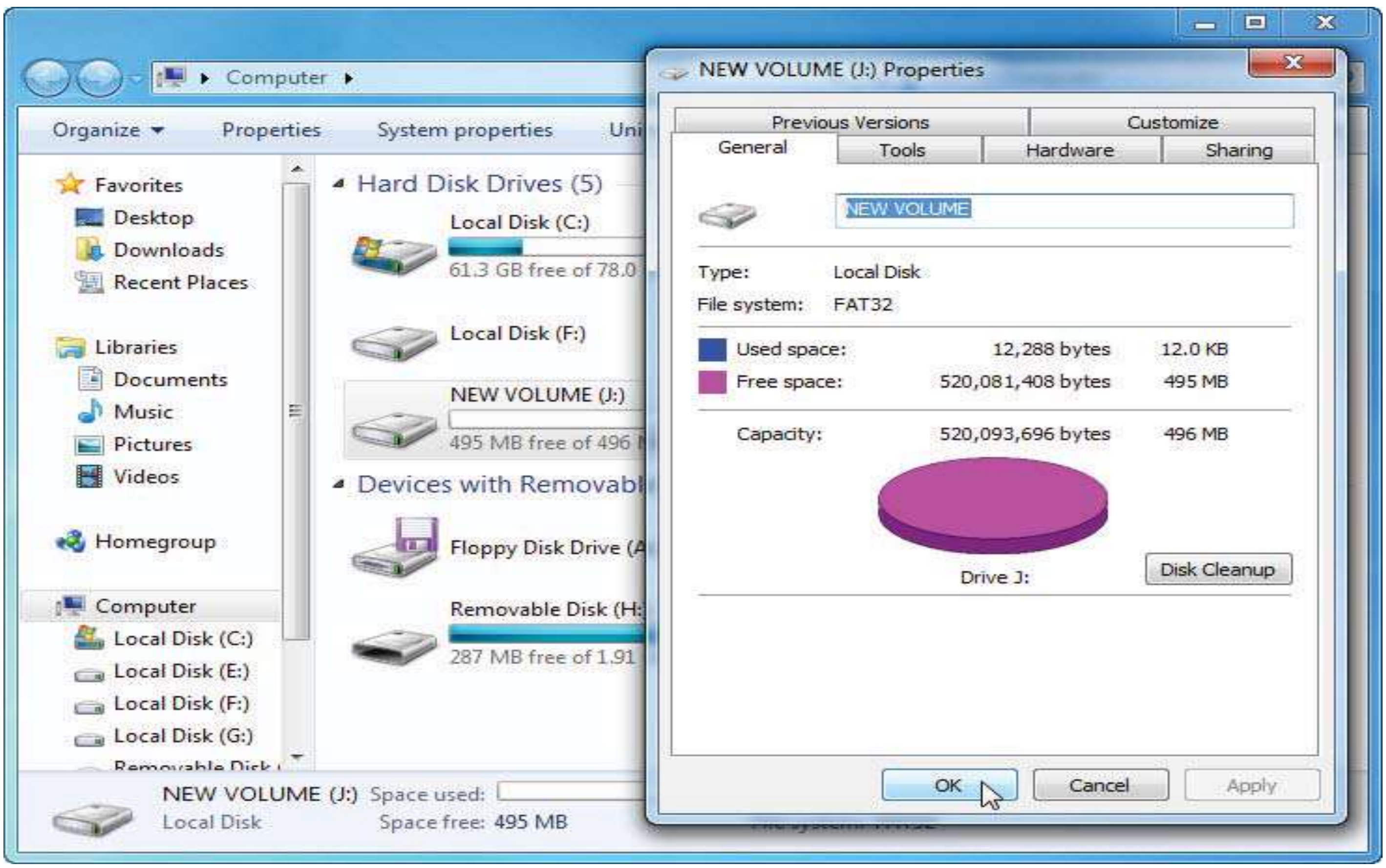


Figure 34

- What is the File system of the J: drive?
- List the tabs found in the **NEW VOLUME (J:) Properties** window?

Click **OK**.

Double-click the **NEW VOLUME (J:)** drive.

Step 7

Right-click anywhere in the white space of the window.
Click **New > Text Document**.

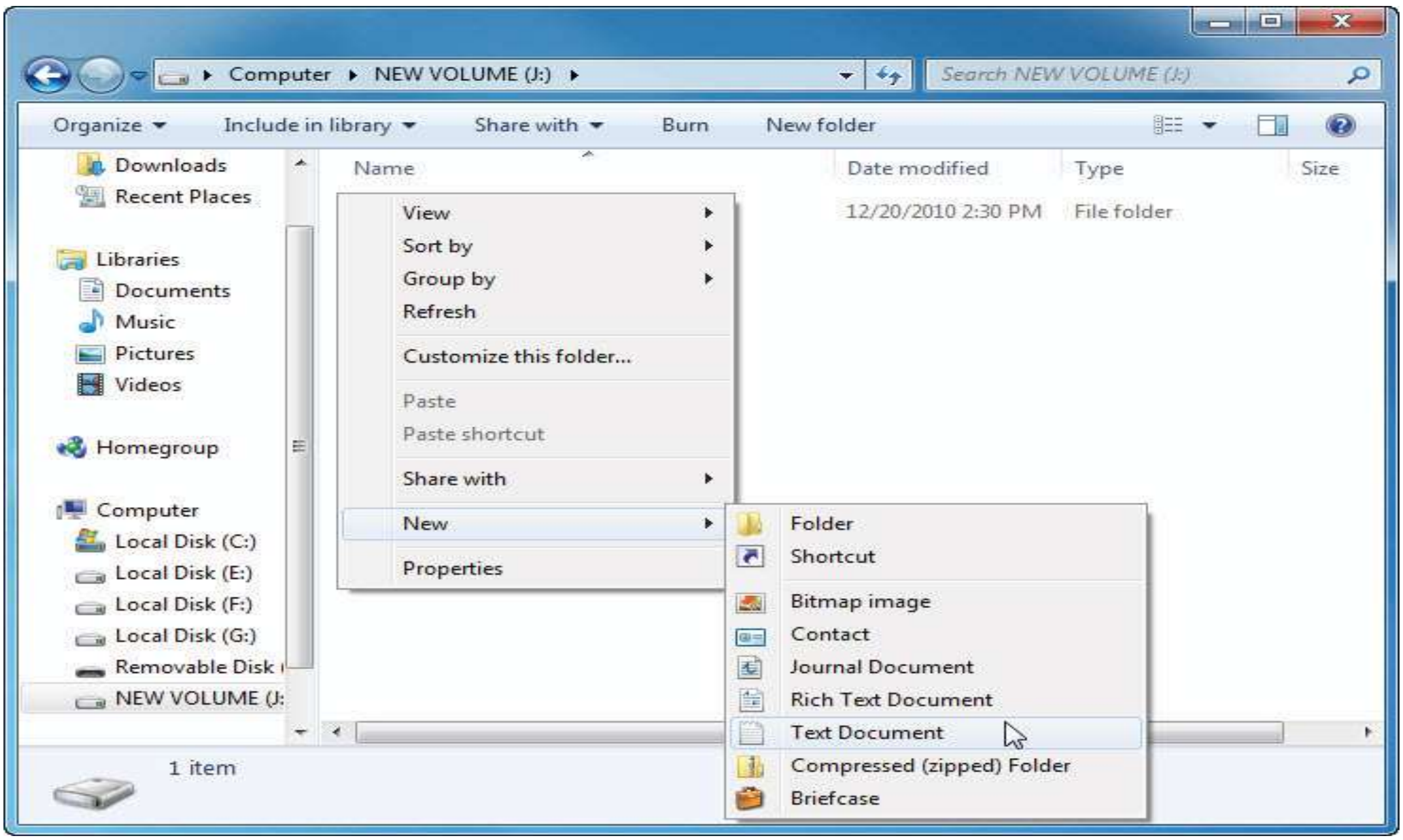


Figure 35

Type **Test** and press **Enter**.

Step 8
Right-click the **Test** document in the window and choose **Properties**.
The “Test Properties” window appears.

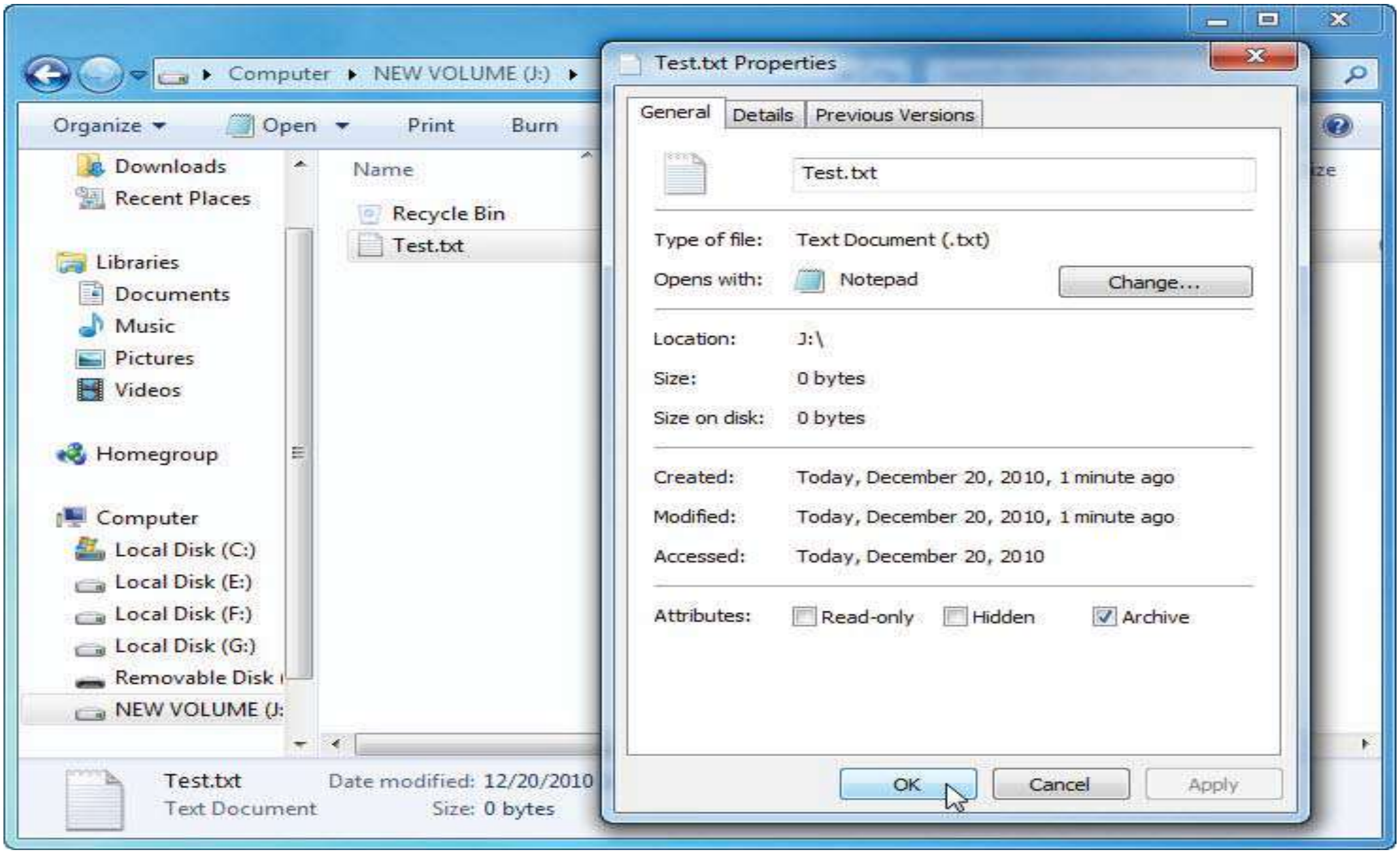


Figure 36

- List the tabs found in the **Test Properties** window?

Click **OK**.
Close any windows open for the J: drive.

Step 9
Click **Start**.
In the "Search programs and files" field, type **cmd**.

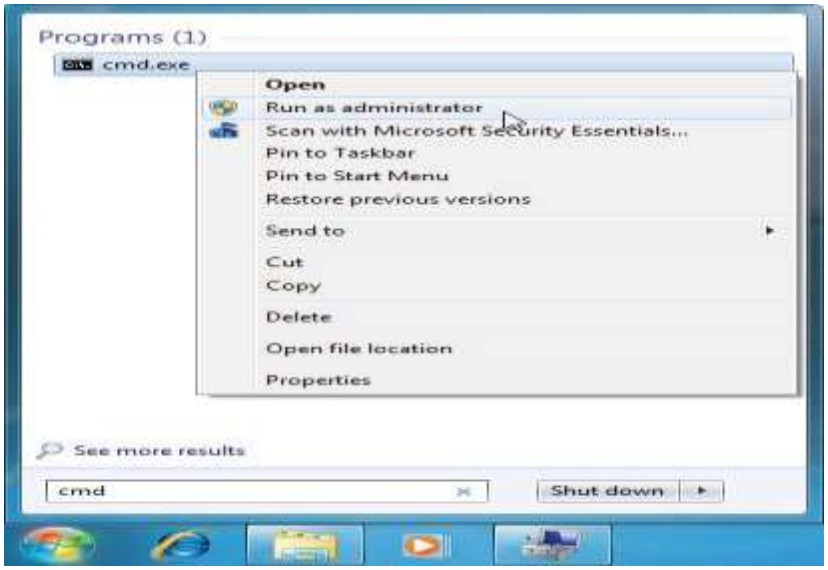


Figure 37

When the cmd program appears, right-click **cmd** > **Run as administrator**.
Click **Yes** if prompted by User Account Control.

Step 10

The “Administrator: C:\Windows\System32\cmd.exe” window appears.
The **convert** command changes the file system of a volume without losing data.

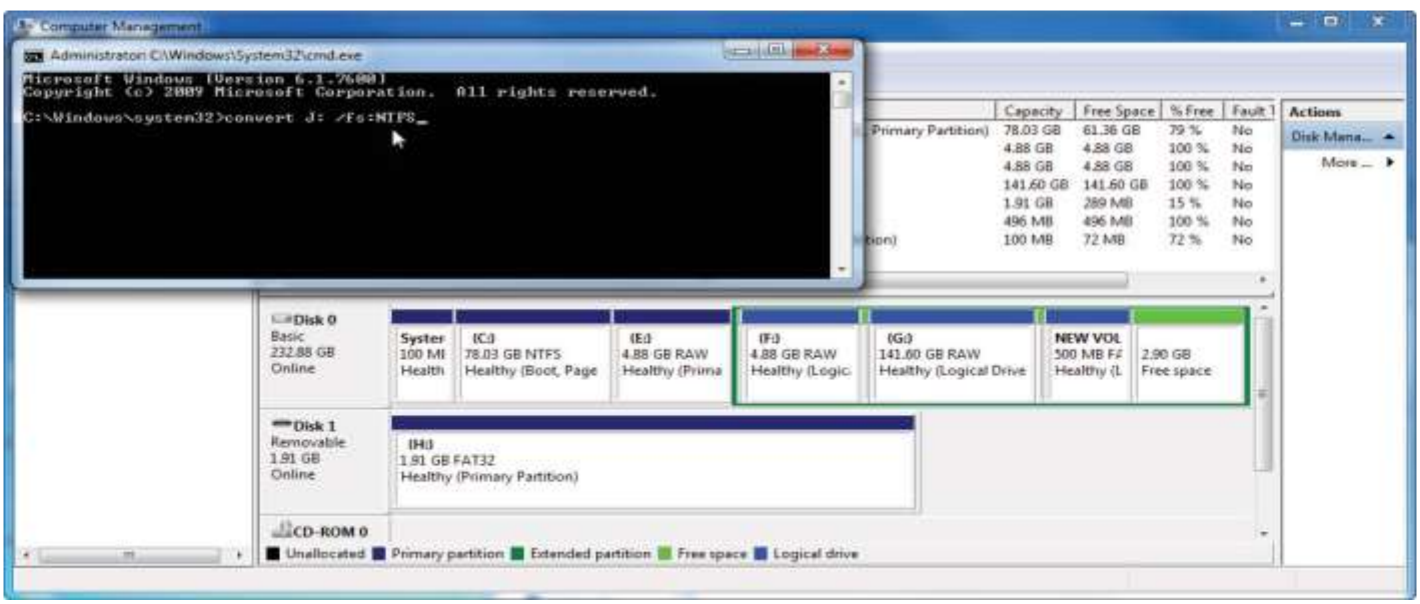


Figure 38

Type **convert J: /fs:NTFS** > press the **Enter** key.
You will be prompted to enter the current volume label for drive J:. Type **NEW VOLUME** and press the **Enter** key.

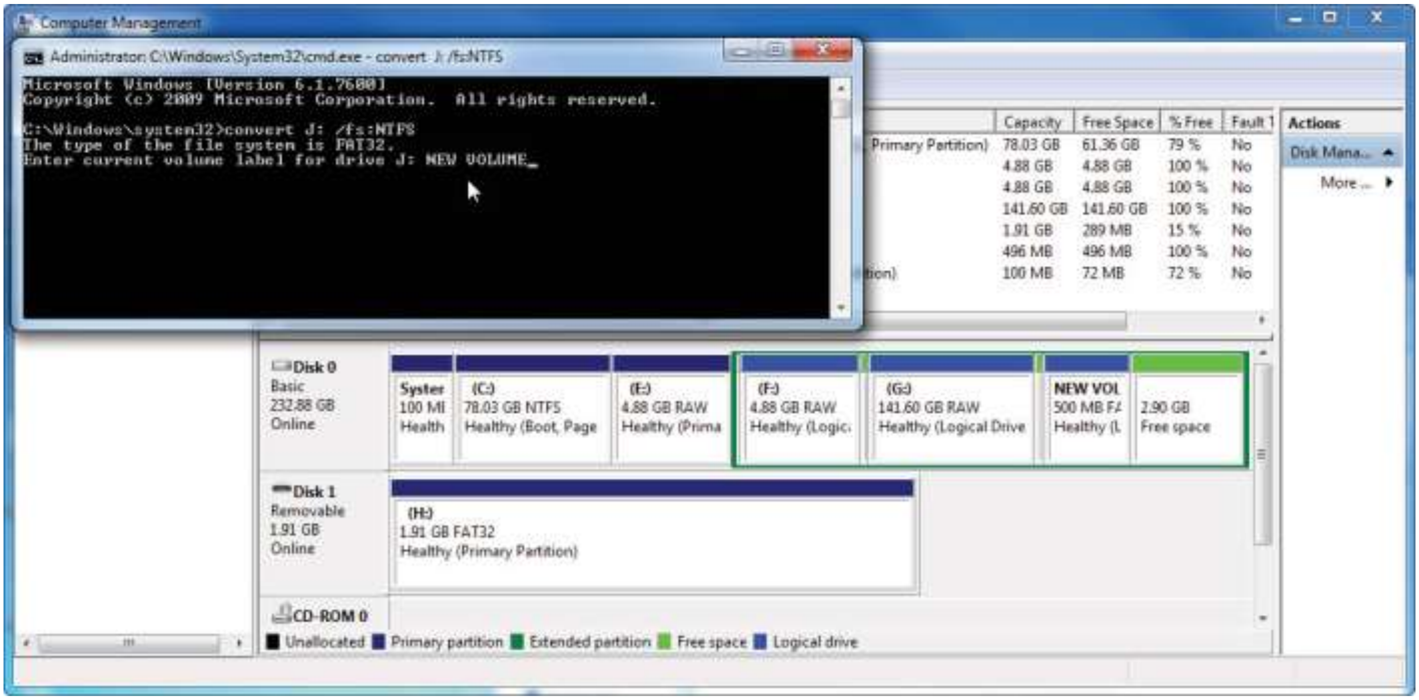


Figure 39

After the drive is converted, type **exit** in the “Administrator: C:\Windows\System32\cmd.exe” window, and then press **Enter**.

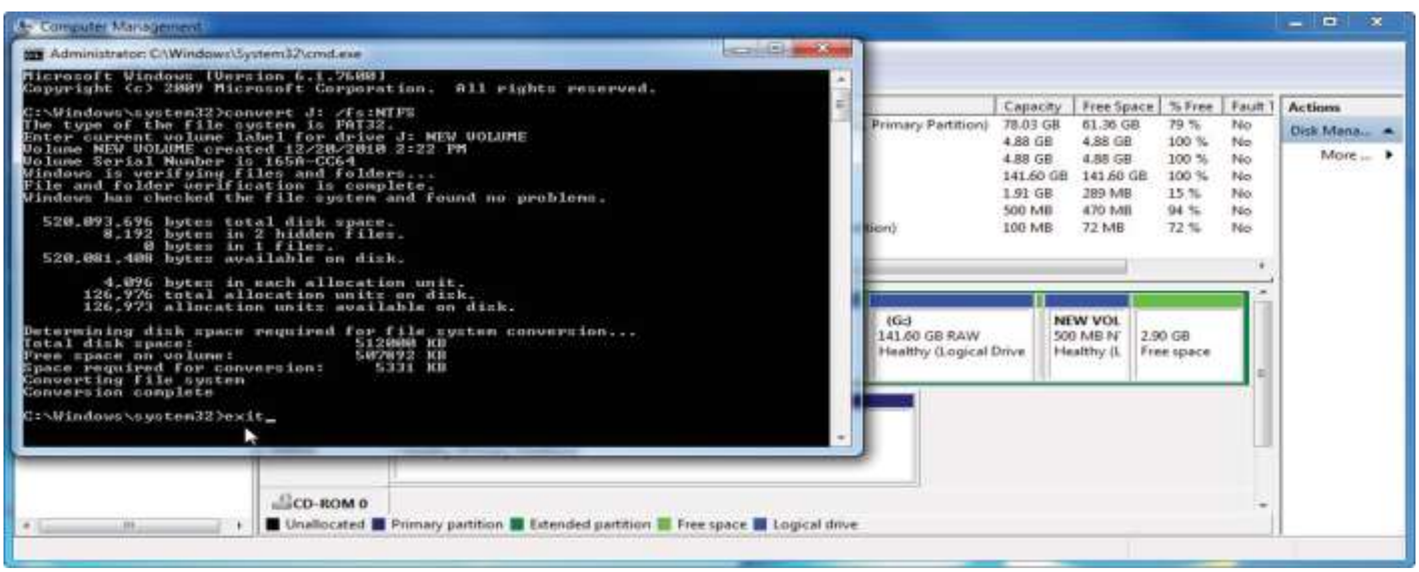


Figure 40

Step 11
The “C:\WINDOWS\System32\cmd.exe” window closes.

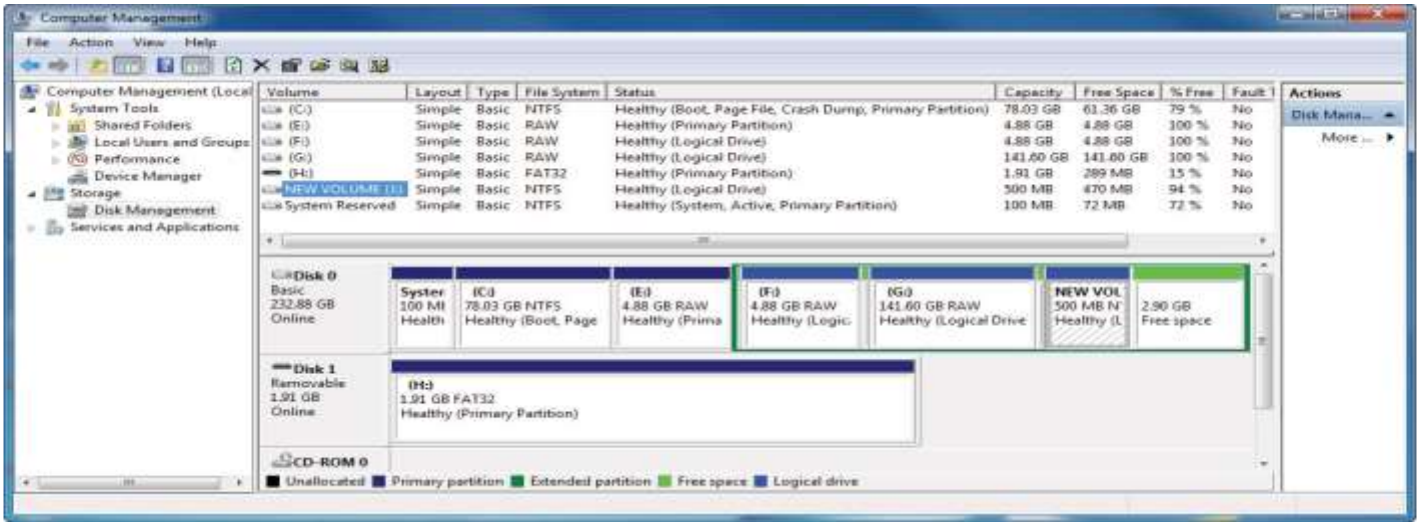


Figure 41

What is the File System of the **J:** drive?

Step 12
Open **Computer**.

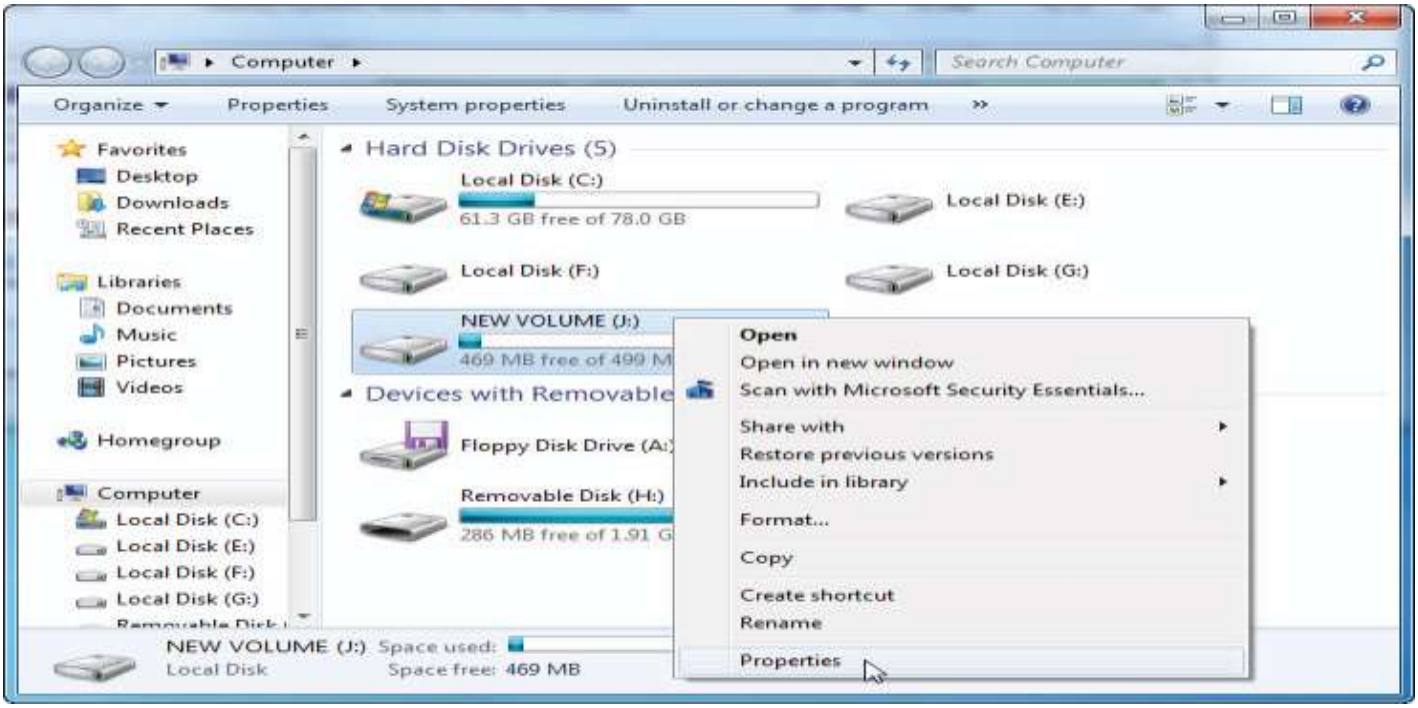


Figure42

Right-click **NEW VOLUME (J:) > Properties**.

Step 13

The "NEW VOLUME (J:) Properties" window appears.

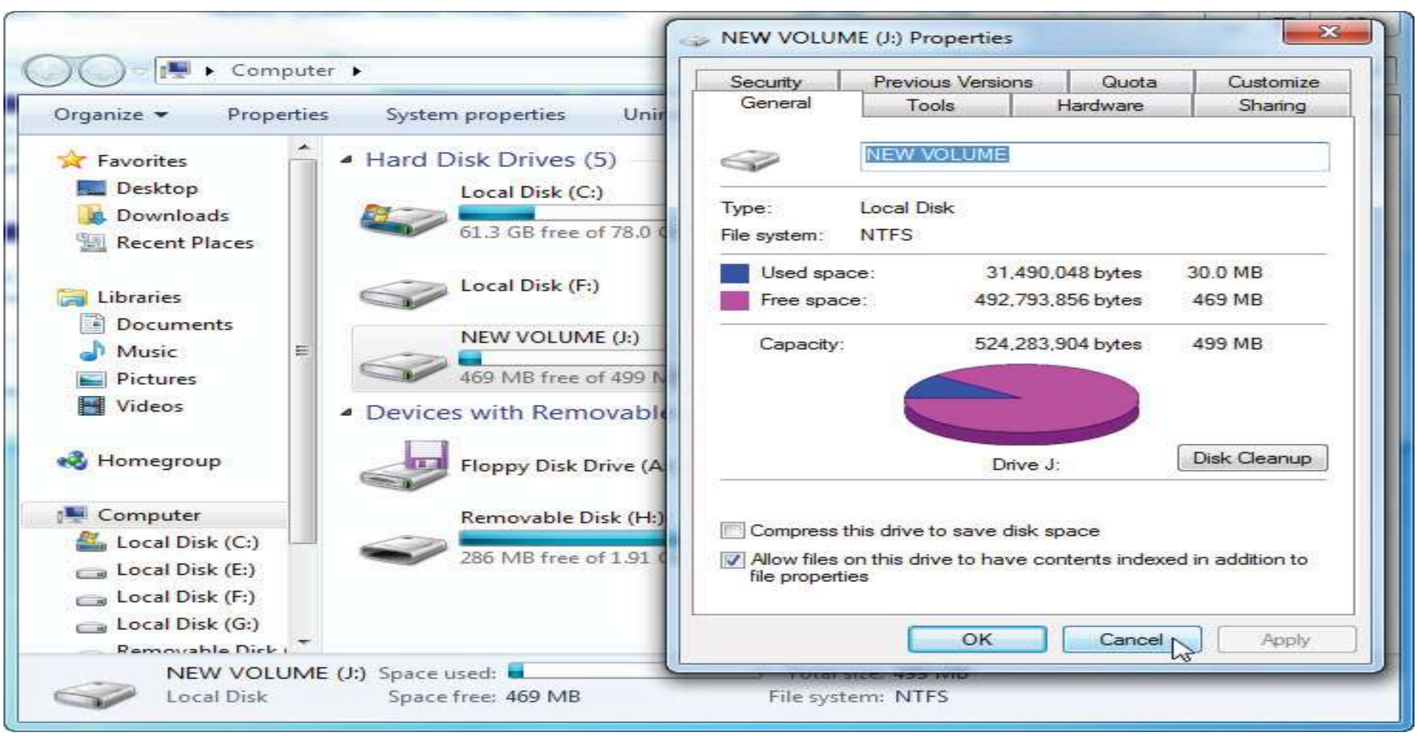


Figure 43

- What are the tabs in the **NEW VOLUME (J:) Properties** window?
- When the volume was FAT32, there were six tabs. What are the names of the new tabs that were added after the volume was converted to NTFS?

Click **Cancel**. Double-click the **NEW VOLUME (J:)** drive.

Step 14

Right-click the **Test** document > **Properties**.

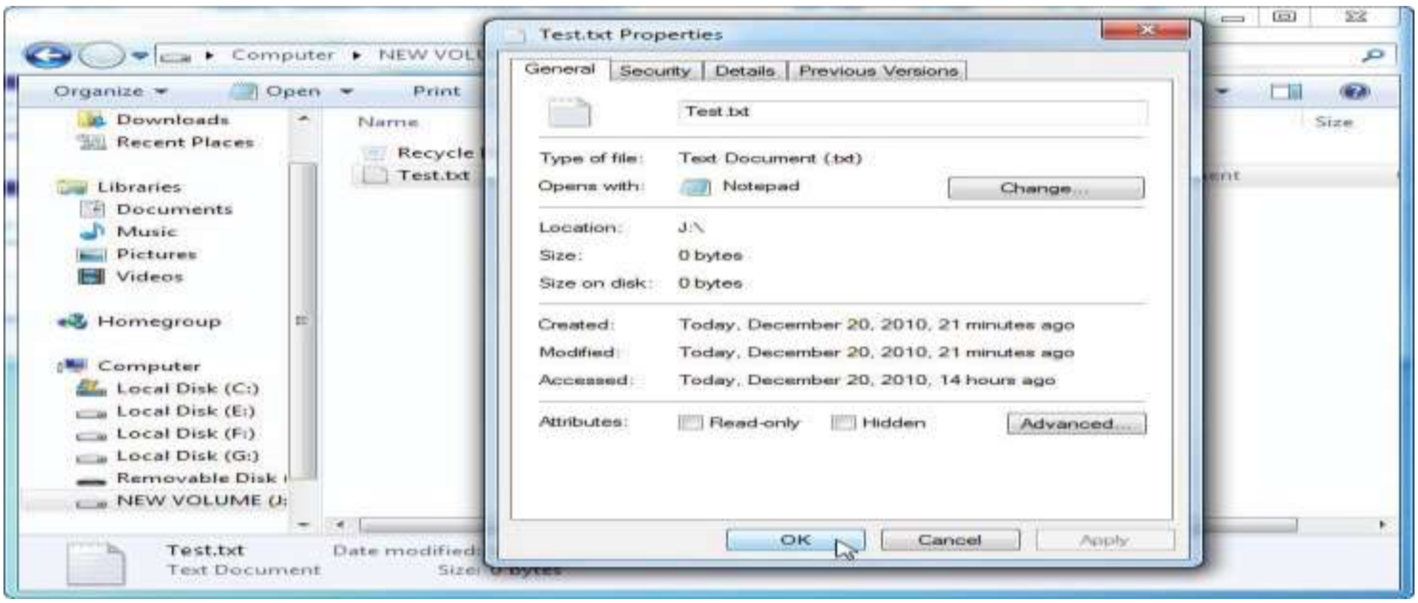


Figure 44

- What are the tabs in the **Test Properties** window?
- When the volume was FAT32, there were three tabs. What is the name of the new tab that was added
- After the volume was converted to NTFS?

Click **OK**.

8.1 REFERENCES

- https://apps.kennesaw.edu/

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- https://www.netacad.com/courses/it-essentials/.