Inside the System Unit

Lesson 4

Now that you've seen the devices that connect to the PC, it's time to open up the system unit to inspect the major internal components of a typical PC. A single PC is composed of thousands of discrete components. Although no one can name every tiny bit of electronics in a PC, a good technician should be able to name the major internal components that make up the typical PC. Let's open and inspect a system unit to see these components and see what they do.

A. Cases and Cooling

The system unit's case is both the internal framework of the PC and the external skin that protects the internal components from the environment. Cases come in an amazing variety of styles, sizes, and colors. The picture(right) shows the front and back of a typical PC case. The front of the case holds the buttons for turning the system on and off, lights to tell you the status of the system, and doors for accessing removable media drives such as digital versatile disc (DVD) drives. This system also provides USB, FireWire, and audio connections in the front for easy access if you want to use a device that needs these connections.

System Unit Case- front and back view

The back of the case holds the vast majority of the system unit connections. You will also notice the power supply. Almost always at the top of the case-distinguished by its cooling fan and power plug. Note that one area at the back, the input/output (I/O) area, holds all of the onboard connections as shown in the picture(right), while another area at the back contains slots for cards. Similarly, the case uses slots to enable access to the external connectors on cards installed in the system unit.

Input/Output Area

Opening a system unit

Opening the Case

Opening a case is always exciting and interesting. There's no standard way to open a case. In general, you detach the sides of a case by removing a few screws at the back of the system unit, as shown in the picture(right). Use common sense and you won't have too many problems. Just don't lose track of your screws or where each one was inserted!

Once you've opened the case, take a look inside. You'll see metal framework, all kinds of cables, and a number of devices. As you inspect the devices, you may gently push cables to the side to get a better view. Don't forget to wear an anti-static wrist strap (attaching it to any handy metal part of the case) or touch the metal case occasionally to prevent ESD.

Inside the Case

Computer cases house many of the components in the computer. Standard personal computers (PCs) use desktop cases. Some cases are towers that stand up beside a desk, and others fit on top of a desk. The common purpose of a computer case is to house the components needed within a computer.

1. **Power supply bin**. This part is where you sit-in the power supply. When you buy a standard case type it already comes with power supply. The wires coming out of the right side of the power supply are connected to different computer components.

2. **Motherboard bay**. The large white square outlines the motherboard. Multiple components are located on the motherboard, including the CPU, RAM, and the graphics card.

3. **Case fans**. This case has two fans, a smaller one on the left and a larger one on the bottom right. These fans pull air into the case. Vents on the case are positioned so that air constantly flows over key components to keep them cool.

4. **CPU fan**. This is a dedicated fan to keep the CPU cool. The CPU is directly beneath this fan and can't be seen.

5. **Optical drive bays**. CD and DVD optical drives are located here. This system has two drives, with space for another one.

6. **Hard disk drive bays**. Hard disk drives are used for permanent storage of data. This system has two hard disk drives, with space for another one.

You can also see a variety of different cables within the case. The power supply cables are covered later in this chapter, and other cables and connectors are covered in later chapters.

Not all cases have this much space or these many components. However, the pictures below give you an idea of what you will see within a computer case.

A quick exercise you can do is to open your computer's case and peer inside. Make sure you first power the computer down and unplug the power cable. One side of the case can normally be opened by removing two thumb screws at the back of the case and pulling off the side panel. There's no need to manipulate anything inside the case at this stage, but you can look at it and compare your case with the cases shown below.

Case Types

1. **Small Form Factor (SFF) Case**. Small form factor or SFF cases are custom cases that are designed to minimize the spatial volume of a desktop computer. SFFs are available in a variety of sizes and shapes, including shoe boxes, cubes, and book-sized Pcs.

2. **Slim Line Case.** Slim line cases are simply tower cases turned on their sideways. They can hold a monitor on top of the case.

3. **Mini/Standard tower**. Mini-tower case usually have up to 2 or sometimes 3 internal drive bays. Mini-cases normally stand at a height of 12 to 18 inches (30 to 45 cm). Expandability is a problem with these cases.

4. **Mid tower**. Mid-tower cases are the most widely used computer cases. Mid Tower cases are about 18 to 24 (45 to 60 cm) inches high and they usually contain 2 to 4 internal drive bays and a similar number of external bays (for CD/DVD readers and similar).

5. **Full/High tower**. Full-tower cases are generally big with a height that is about or more than 30 inches (more than 76 cm). The number of internal drive bays inside these cases can be between 6 and 10.

B. Central Processing Unit(CPU)

The central processing unit (CPU), also called the microprocessor, performs all of the calculations that take place inside a PC. CPUs come in a variety of shapes and sizes as shown in the picture(right).

Typical CPUs

CPU with fan removed

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 as shown in the picture(left). 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.

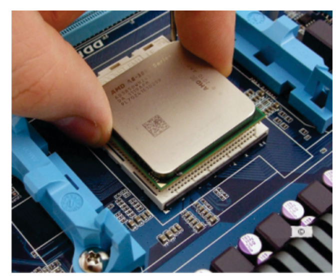
CPU Manufacturers

CPUs have a make and model, just like automobiles do. When talking about a particular car, for example, most people speak in terms of a Toyota Fortuner or a Ford Ranger. When they talk about CPUs, people say Intel Core i7 or AMD Phenom. Over the years, there have been only a few major CPU manufacturers, just as there are only a few major auto manufacturers. The two most common makers of CPUs used in PCs are **AMD** and **Intel.**

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 Duo, Core i5, Core i7, Phenom II, and AMD-FX.

CPU Socket type

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 package type is designed to fit into a particular connection called a socket. Sockets have such names as Socket AM3 or Socket B. The picture(right) shows a CPU with its matching socket.



CPU and matching socket

32-bit vs. 64-bit

CPUs are identified as either 32-bit or 64-bit. Similarly, operating systems and many applications are referred to as either 32-bit or 64-bit. Key points to remember include the following:

- Windows operating systems come in both 32-bit and 64-bit versions.
- A 64-bit CPU is required to run a 64-bit operating system.
- A 64-bit operating system is required for 64-bit applications.
- A 64-bit CPU will also run 32-bit software.

The numbers 32 and 64 refer to the address bus, it is used to address memory locations. A 32-bit CPU supports a 32-bit address bus and can address 232 memory locations, or 4 GB of RAM. A 64-bit CPU supports a 64-bit address bus and can address 264 memory locations, or about 17 EB.

Note

The CPU also uses this address bus to address devices in the system in addition to RAM. Because of this, a 32-bit system reserves some of the address space for the other devices. If you install 4 GB of RAM in a 32-bit system, you find that operating system can use only about 3.3 GB.

Operating systems and applications have gotten more sophisticated over the years. Developers have programmed extra features and capabilities, but all of these extras consume additional RAM. For many users, 4 GB of RAM simply isn't enough.

Due to the demand, developers such as Microsoft have created 64-bit versions of their operating systems. However, these 64-bit operating systems can run only on 64-bit CPUs. If you want to directly address more than 4 GB of RAM, you need both a 64-bit CPU and a 64-bit operating system.

- 32-bit and x86. You often see 32-bit operating systems and software referred to as x86. This is a reference to the long line of Intel CPUs that ended in 86 and can run 32-bit software. AMD processors have different names but are also known to be x86-compatible.

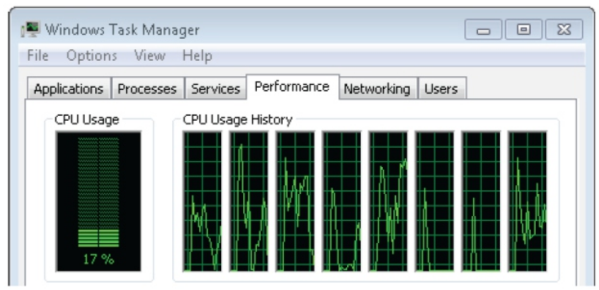
- 64-bit. Intel refers to its 64-bit processors as Intel 64, and AMD calls its 64-bit processors AMD64. Software makers often refer to 64-bit compatible software as x64.

CPU Cores

Most CPUs today have multiple cores within them. Each core is a fully functioning processor. With multiple cores, the CPU can divide tasks among each core. The result is a faster system.

Operating systems view the multiple cores as individual CPUs. For example, a single eight-core processor will appear in Task Manager as though it is eight separate processors, as shown in the picture(right).

Windows Task Manager
The picture(right) shows a partial view of Windows Task Manager. You can start it on Windows systems by pressing Ctrl+Shift+Esc.



Task Manager showing eight cores of a single CPU.

CPU Cache & Cache Types

Many computer components and software applications use some type of cache. As a simple example, web browsers use a browser cache. When you go to a website, information is transmitted over the Internet and displayed in your web browser, and it is also stored in the browser cache. If you go to the website again, data can be retrieved from the browser cache rather than downloaded from the Internet again. The browser uses different techniques to ensure that it displays current data, but if that data is on your drive, it is displayed much more quickly than it would be if it had to be downloaded again.

The CPU has cache that it uses for fast access to data. If the CPU expects to use some type of information again, it keeps that information in cache. A significant difference between the web browser cache and the CPU cache is that the CPU cache is RAM and the web browser cache is stored as a file on a hard drive.

Cache is commonly referred to as an area where data is stored for a short time for easy retrieval. It's important to realize that cache can be memory areas that are volatile or can be temporary files stored on hard drives that are kept after a system is powered down.

CPU Cache Types

The two primary types of cache used by CPUs are:

- **L1 cache.** This is the fastest, and it's located closest to the CPU. A multiple-core CPU has a separate L1 cache located on each CPU core.
- **L2 cache**. L2 cache is a little slower than L1 cache, and it is shared by all cores of the CPU. In older systems, L2 cache was stored on the motherboard, but today it is much more common for L2 cache to be part of the CPU.
- **L3 cache** is used on some systems, but it isn't as common as L1 and L2. When used, it can be on the motherboard or on the CPU. It is slower than L2 cache and is shared among all cores.

Many newer CPUs include L1 cache for each core, L2 cache for each core, and a single shared L3 cache—all on the same CPU chip.

Without cache, the CPU would have to store data in the motherboard RAM. The CPU cache is SRAM, which is much faster than the dynamic RAM used on the motherboard. Also, the motherboard RAM is physically farther away, adding more delays.

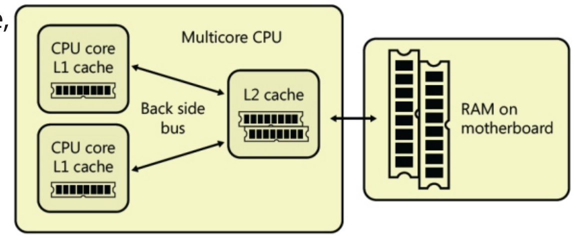


Figure 2-8 CPU and cache.

CPU Cache Sizes

The size of the CPU cache is small compared to the overall amount of memory in a system. For example, you might see cache sizes as low as 8 KB or as large as 20 MB. In contrast, most personal computers have 1 GB of RAM or more. The cache can be listed as just a total of all L1, L2, or L3 cache, or you might see it listed individually.

- L1 is smallest. L1 is sometimes stated as two numbers, such as 32 KB + 32 KB, to indicate it is using one cache for frequently used instructions and another cache for data.Sizes of 32 KB or 64 KB are common.

- L2 is larger than L1. When a CPU has separate L2 cache for each core, it is often identified as the amount per core. For example, a two-core CPU with 4 MB total L2 cache can be expressed as 2 × 2 MB, or just 2 MB per core. Sizes of 256 KB, 512 KB, and 1,024 KB are common.

- L3 is larger than L2. Sizes between 2 MB and 8 MB are common.

CPU Speed

The speed of a CPU is based on the speed of the crystal and the multiplier. For example, if the crystal speed is 100 Mhz and the multiplier is 20, the CPU has a speed of 2 GHz (20 × 100). The faster the speed, the faster the CPU.

You commonly see the speed of the processor listed as only the multiplied speed. For example, in the picture(below) shown, you can see that the processor is an Intel Core 7 CPU 870 and the clock is listed as 2.93 GHz. The system is using a 133.333-MHz clock (commonly listed as 133 Mhz) and a 22-times multiplier.

Processors are rated based on the maximum speed they can handle, and more expensive processors can handle faster speeds. You can increase the speed by increasing the clock frequency, increasing the multiplier, or both. Most motherboards have this preselected, but it is sometimes possible to manipulate the clock or the multiplier to overclock the system. In some systems, the BIOS includes a Cell menu that enables you to increase the base frequency and increase the CPU Ratio (multiplier).

Note: *Overclocking a system is not recommended, but it is frequently done. If you overclock a system, you need to take extra steps to keep it cool, such as using liquid cooling.*

CPU Versions

There is a dizzying number of different processors. You're not expected to know the characteristics of each individual CPU, but you should be able to recognize the names and know the manufacturers. The objectives specifically list the CPU socket types you should know, but for the sockets to make sense, you need to have a little bit of knowledge about the CPU versions.

The following are recent Intel and AMD code names:

■ Intel

* Core—65-nm and 45-nm process
* Nehalem—45-nm process
* Sandy Bridge—32-nm process
* Ivy Bridge—22-nm process

■ AMD

*K8—65-nm, 90-nm, and 130-nm processes
*K9—processors were never released
*K10—65-nm process
*K10.5—45-nm process

CPU Code Name and Processor

Intel and AMD use code names related to the manufacturing process and then create different processor families with the process. The manufacturing process is stated as a measurement and refers to the distance between certain components within the chip.

Intel CPU Code Name and Processor

Architecture Name	CPU Family Names
Core	Core 2 Duo, Core 2 Quad, Core 2 Extreme
Nehalem	Intel Pentium, Core i3, Core i5, Corei7, Xeon
Sandy Bridge	Celeron, Pentium, Core i3, Core i5, Core i7
Ivy Bridge	Core i5, Corei7, Xeon

The Core i3, i5, and i7 series represents a Good, Better, Best philosophy, with the i3 versions representing the basic version and the i7 versions providing the most power. The number (such as i3 or i5) doesn't refer to the number of cores.

It's also important to realize that there are significant differences between a Nehalem Core i5 and an Ivy Bridge Core i5. The Ivy Bridge versions have smaller processes and are more powerful.

AMD Processor names
Many AMD processor names give clues as to what they include. If the name includes 64, it is a 64-bit CPU. When the name has an X (such as X2), it indicates how many cores the processor has.

AMD CPU Code Name and Processor

Architecture Name	CPU Family Names
K8	Opteron, Athlon 64, Athlon 64 FX, Athlon 64 X2, Sempron, Turion 64, Turion 64 X2
K10	Opteron, Phenom, Athlon, Athlon X2, Sempron
K10.5	Phenom II, Athlon II, Sempron, Turion II
Bulldozer	FX (Zambezi), Interlagos Opteron

CPU Socket Types

A CPU plugs into a socket on the motherboard. There was a time when just about every motherboard had the same socket type, but that certainly isn't the case today. Instead, there are a wide variety of different socket types for different types of CPUs. If you ever need to replace a CPU, it's important to recognize that there are different types of sockets.

Intel CPU Socket

The following list describes recent Intel sockets

- **LGA 775**. 775 pins. Also called Socket T. Replaced Socket 478.
- **LGA 1366**. 1,366 pins. Also called Socket B and designed to replace LGA 755 in highend desktop computers.
- **LGA 2011**. 2,011 pins and released in 2011. Also called Socket R. It replaces LGA 1366 sockets in high-end desktop systems.
- **LGA 1156**. 1,156 pins. Also called Socket H or Socket H1.
- **LGA 1155**. 1,155 pins. Also called Socket H2 and replaces LGA 1156 in basic desktop systems. LGA 1,156 CPUs will work in LGA 1155, but the BIOS may need to be upgraded.

The table below lists the common Intel sockets along with some CPUs used with them, busses they support, and supported DDR channels.

Type	CPUs, Busses, DDR Channels
LGA 775 **(Socket T)**	Pentium 4, Pentium D, Core 2 Duo, Core 2 Quad, Celeron, Xeon Front side bus, single channel DDR2 and DDR3 RAM
LGA 1366 **(Socket B)**	Core i7, Xeon, Celeron QPI, triple channel DDR3 RAM
LGA 2011 **(Socket R)**	Core i7, Xeon QPI, DMI, quad channel DDR3 RAM
LGA 1156 **(Socket H or H1)**	Core i3, Core i5, Core i7, Celeron, Pentium, Xeon DMI, dual channel DDR3 RAM
LGA 1155 **(Socket H2)**	Core i3, Core i5, Core i7, Celeron, Pentium DMI, dual channel DDR3 RAM

AMD CPU Socket

The following list describes recent AMD sockets

- Socket 940. 940 pins (PGA).
- Socket AM2. 940 pins (PGA). Not compatible with Socket 940.
- Socket Am2+. 940 pins (PGA). Replaces AM2. CPUs that can fit in AM2 can also fit in AM2+.
- Socket AM3. 941 pins (PGA). Replaces AM2+. Supports DDR3. CPUs designed for AM3 will also work in AM2+ sockets, but CPUs designed for AM2+ might not work in AM3 sockets.
- Socket Am3+. 942 pins (PGA). Replaces AM3. CPUs that can fit in AM3 can also fit in Am3+.
- Socket FM2+. 906 pins (PGA). Used for accelerated processing units (APUs).
- Socket FM2. 904 pins (PGA). Used for accelerated processing units (APUs). CPUs are compatible with FM2+.
- Socket FM1. 905 pins (PGA). Used for accelerated processing units (APUs).
- Socket F. 1,207 pins (LGA). Used on servers and replaced by Socket C32 and Socket G34.

The table on the right lists the common AMD sockets along with some CPUs used with them, busses they support, and supported DDR channels.

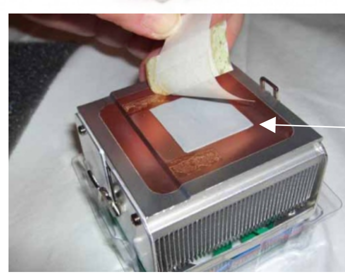
Socket	CPUs, Busses, DDR Channels
940	Opteron and Athlon 64 FX FSB with HyperTransport version 1, single channel DDR2 RAM
AM2	Athlon 64, Athlon 64 X2, Athlon FX, Sempron, Phenom, Opteron FSB with HyperTransport version 2, single channel DDR2 RAM
AM2+	Athlon 64, Athlon 64 X2, Athlon II, Sempron, Phenom, Phenom II, Opteron FSB with HyperTransport version 3, single channel DDR2 RAM
AM3	Phenom II, Athlon II, Sempron, Opteron FSB with HyperTransport version 3, single channel DDR2 and dual channel DDR3 RAM
AM3+	Phenom II, Athlon II, Sempron, Opteron FSB with HyperTransport version 3, dual channel DDR3 RAM
FM2+	Kaveri and Godavari APUs FSB with HyperTransport version 3.1, dual channel DDR3 RAM
FM2	Trinity and Richland APUs FSB with HyperTransport version 3.1, dual channel DDR3 RAM
FM1	Fusion and Athlon II APUs FSB with HyperTransport version 3, dual channel DDR3 RAM
F	Opteron, Athlon 64 FX FSB with HyperTransport version 3, single channel DDR2 RAM

List of AMD sockets along with some CPUs used with them & busses

CPU Cooling

CPUs have millions—and sometimes billions—of miniaturized transistors within them, all connected with extremely small wires. If these transistors or wires get too hot, they can easily break, rendering the CPU useless. Manufacturers spend a lot of time designing these chips, and one of their goals is to keep temperatures within acceptable limits. However, most of the cooling occurs externally.

Heat Sinks, Fans, and Thermal Paste



- **Heat sink**. A heat sink is a piece of metal that draws heat from the CPU and dissipates it into the air. Heat sinks have multiple fins to increase the surface area and to allow air to easily flow through them. The fins are usually flared to allow more air through.
- **Fan**. A fan is attached to the heat sink to increase the airflow around the fins. These are called CPU fans. They aren't attached to the CPU but usually plugged into the motherboard close to the CPU. Many CPU fans have variable speeds and spin faster when the CPU gets hotter.
- **Thermal paste**. Heat sinks commonly have clamps to secure them to the motherboard and provide a better connection with the CPU. However, there are microscopic gaps in the metal on both the CPU and the heat sink, so it isn't possible to get 100 percent contact between the components. Thermal paste is used to improve this connection.
- This paste fills these microscopic gaps and also helps draw heat from the CPU into the heat sink.

C. Random Access Memory(RAM)

Two DIMMs

Random access memory (RAM) stores programs and data currently being used by the CPU. The maximum amount of programs and data that a piece of RAM can store is measured in units called bytes. Modern PCs have many millions, even billions, of bytes of RAM, so RAM is measured in units called megabytes (MB) or gigabytes (GB). An average PC will have from 1 to 4 GB of RAM, although PCs may have more or less. Each piece of RAM is called a stick.

Types of RAM

Most RAM is volatile. This doesn't mean that it's explosive; it means that data in RAM is lost when power is removed. A PC takes only one type of RAM, and you must know the type so you can add or replace RAM when needed.

Below are list of commonly used types of RAM.

- **Dynamic RAM(DRAM)**. Dynamic refers to how bits are stored in an electrical component called a capacitor. The capacitor holds the bit as a charge, but the capacitor needs to be regularly refreshed to hold the charge. This configuration uses very few components per bit, keeping the cost low, but the constant refresh reduces the speed.
- **Synchronous DRAM(SDRAM)**. SDRAM is synchronized with a clock for faster speeds. Almost all primary DRAM used in computers today is SDRAM, but it's often listed as DRAM to avoid confusion with SRAM.
- **Static RAM(SRAM)**. Static RAM uses switching circuitry instead of capacitors and can hold a charge without a constant refresh. It requires more components per bit so it is more expensive, but due to how the switching works, it is quicker than DRAM. Due to the speed, SRAM is commonly used for CPU cache (described later in this chapter) but is rarely used as the primary RAM because of its cost.

SRAM vs. SDRAM

SRAM and SDRAM are often conflated; however, they are different, and the S makes the Because of its speed, SRAM is used for CPU cache. SDRAM is used as the primary RAM in computer (PCs). Almost all DRAM in personal computers is SDRAM.

USB Flash drive

Flash memory is very popular, but not as the primary RAM used in a system. USB flash drives, solid-state drives (SSDs), and memory cards used in cameras and other mobile devices all use flash memory. Flash memory is used for BIOS in many motherboards. Unlike DRAM and SRAM, flash memory is not volatile and retains data without power.

Double Data Rate SDRAM (DDR SDRAM)

While the original SDRAM versions were quick and efficient for their time, manufacturers have steadily improved them. Double data rate (DDR) is one of the improvements and is used in almost all SDRAM.

The following list provides an overview of the different DDR versions:

- **Double Data Rate (DDR) SDRAM**. DDR uses double pumping to double the data rate of SDRAM.
- **DDR2.** The second generation SDRAM, DDR2 doubles the data rate of DDR. In addition to double pumping, it modifies the way that data is processed and can transfer twice as much data as DDR SDRAM.
- **DDR3**. The third generation SDRAM, DDR3 doubles the data rate of DDR2. It uses double pumping and further modifies the way that data is processed. It can transfer four times as much data as DDR and eight times as much data as SDRAM.
- **DDR4**. The fourth generation SDRAM, DDR4 is four times the data rate of DDR3. It includes higher module density and lower voltage requirements, coupled with higher data rate transfer speeds.

RAM Compatibility and Speed

An important point about DDR, DDR2, and DDR3 is that they aren't compatible with each other. You can't use any version in a slot designed for another type. For example, you can use DDR3 DIMMs only in DDR3 slots. From a usability perspective, that's not so great, but if you're trying to remember which types are compatible, it's a lot easier. You can't mix and match them.

Compatibility

The picture below shows a comparison of the keyings of DDR, DDR2, DDR3 and DDR4, with a dotted line as a reference through the middle of each one. You can see that the notched key at the bottom of the circuit card is different for each. The standards aren't compatible, and this keying prevents technicians from inserting a DIMM into the wrong slot.

Speed

Some RAM is faster than other RAM, and with faster RAM you often see faster overall performance. As you would expect, faster RAM is more expensive. If you're shopping for RAM, you want to ensure that you buy exactly what you need. This includes the correct DDR version, the correct number of channels if your motherboard supports multiple channels, and the correct speed.

The speed of RAM is expressed as the number of bytes it can transfer in a second (B/s) or, more commonly, as megabytes per second (MB/s). However, the speed of most RAM isn't listed plainly. Instead, it's listed using standard names and module names such as DDR3-800 or PC3-12800, respectively. These names indicate their speed, but not directly. If you need to shop for RAM, you need to understand these names and how they relate to the speed.

Below are lists of DDR Standard Names and Module Names

	100 MHz	166 2/3MHz	200 MHz
DDR Standard Name	DDR-200	DDR-333	DDR-400
DDR Module Name	PC-1600	PC2700	PC-3200
DDR Standard Name	DDR-200	DDR2-667	DDR2-800
DDR Module Name	PC-1600	PC2-5300	PC2-6400
		PC2-5400	
DDR Standard Name	DDR3-800	DDR3-1333	DDR3-1600
DDR Module Name	PC3-6400	PC3-10600	PC3-12800
DDR Standard Name	DDR4-1700	DDR4-1920	DDR4-21300
DDR Module Name	PC4-17000	PC4-19200	PC4-24000

A key consideration when purchasing RAM is to ensure that the RAM speeds are supported by the motherboard. If the speeds don't match, the motherboard defaults to the slower speed. For example, if your motherboard has a 100-MHz clock and you install PC3-12800 RAM, the RAM will run at 100 MHz instead of 200 MHz. It still works, but you won't get the benefit of the higher-speed RAM.

Buying for RAM

When shopping for RAM, you need to determine the clock speed of your computer and then determine the DDR name. You can boot into BIOS, as shown in Chapter 2, "Understanding Motherboards and BIOS," to identify the clock speed used by RAM and then plug it into the formula to determine the standard name and module name.

If you have access to the Internet, there's an easier way. You can go to one of the memory sites, such as Crucial.com or Kingston.com, and use one of their tools. You can enter the make and model of your computer, and the tool will tell you what memory is supported. Crucial.com also has an application that you can download and run to identify your motherboard, the type and speeds of supported RAM, how much RAM is installed, and recommendations for upgrading the RAM. Another tool that can help is CPU-Z.

D. Motherboard

You can compare a motherboard to the chassis of an automobile. In a car, everything connects to the chassis either directly or indirectly. In a PC, everything connects to the motherboard either directly or indirectly. A motherboard is a thin, flat piece of circuit board, usually black, green, brown or gold, and often slightly larger than a typical piece of notebook paper as shown in the picture(right).

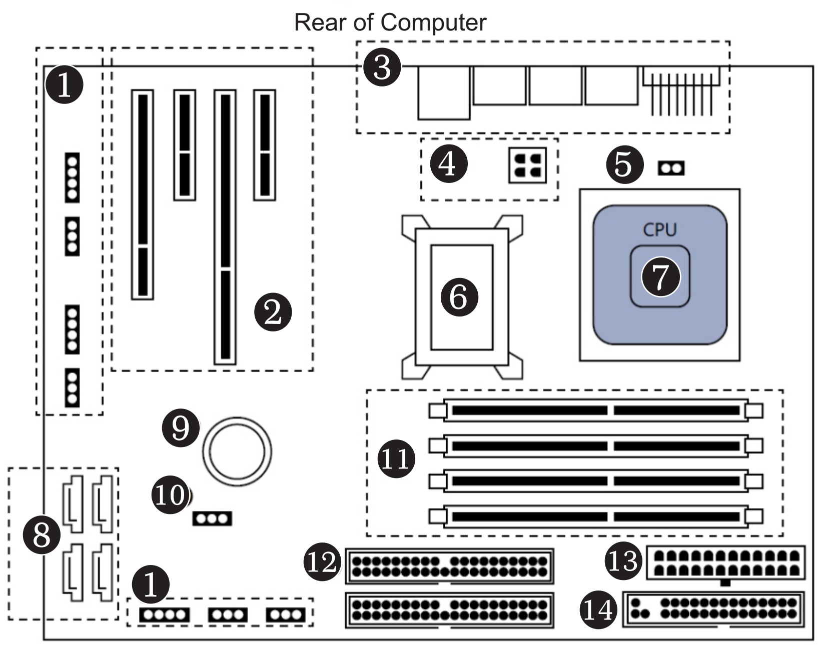
A motherboard contains a number of special sockets that accept various PC components. The CPU and RAM, for example, plug directly into the motherboard. Other devices, such as floppy drives, hard drives, and CD and DVD drives, connect to the motherboard sockets through short cables. Motherboards also provide onboard connectors for external devices such as mice, printers, joysticks, and keyboards.

Motherboards are created by using form factors that define their size and the components on the motherboard. Similarly, cases are built to support one or more motherboard form factors.

Typical motherboard

Motherboard Components Identification

All of the relevant components of a motherboard are presented within this chapter. The image(below) shows the outline of a motherboard with several key components identified. You won't find all of these components on every motherboard or in exactly the same location. However, the figure gives you an idea of common components and how to identify them.



1. **Miscellaneous connectors and jumpers.** Connectors are available to connect to a speaker, to fans, and to the front of the case for power and displays. They can be located in different places on the motherboard.

2. **Expansion slots**. Expansion slots allow you to add additional cards to a motherboard for additional capabilities. Several different types of expansion slots are available, including Peripheral Component Interconnect (PCI), Accelerated Graphics Port (AGP), and more.

3. **Rear connectors**. Several connectors are attached to the motherboard and are accessible via the rear of the computer. These include connectors for audio and video Universal Serial Bus (USB) devices and more.

4. **CPU 12-V power**. A 4-pin plug from the power supply plugs into here to provide power to the Central Processing Unit (CPU). On systems with multiple CPUs, this can be two 4-pin plugs or an 8-pin plug.

5. **CPU Fan**. CPUs generate a lot of heat, so it's common to attach a fan on top of them. A connection on the motherboard provides power for the fan. CPU fans are often variable speed so that they can spin faster when the CPU gets hotter.

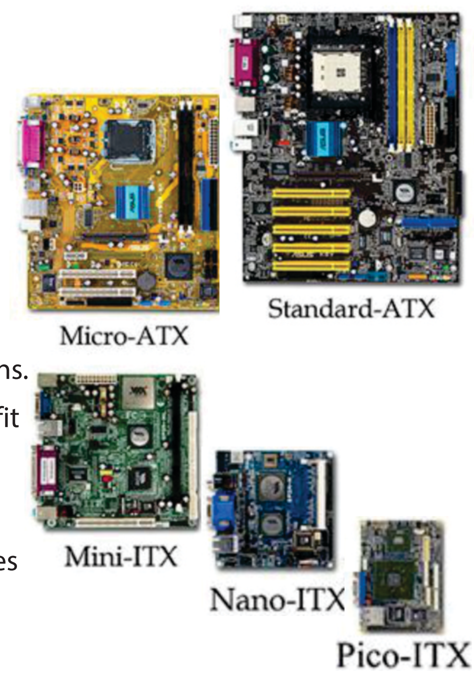
6. **Chipset**. This consists of one or more integrated circuits (ICs) that connect the CPU with other components and devices on the system. Chipsets are designed to work with specific CPUs and are soldered into the motherboard. They can get hot and often have heat sinks on top of them designed to dissipate heat.
7. **CPU**. The majority of work done by a computer occurs within the processor. The motherboard includes a CPU socket into which a CPU is plugged, and the CPU is normally covered with a heat sink and a cooling fan.

8. **SATA connectors**. Most computers support Serial Advanced Technology Attachment (SATA) drives. SATA connectors have a distinctive L shape. SATA connectors come in different versions, and these different versions are identified with different colors. However, there isn't a standard with the colors between motherboard manufacturers.
9. **Battery**. The battery provides power to the Basic Input/Output System (BIOS) so that certain settings are retained. The battery is often circular but can have a barrel shape.
10. **BIOS jumper**. There is often a jumper close to the battery. Shorting the two pins on this jumper will reset the BIOS password or return the BIOS settings to the factory defaults.
11. **RAM**. Motherboards usually have at least two RAM slots, and many have four or six. RAM slots are very specific and will accept only certain types of RAM based on the specifications of the motherboard. Chapter 3 covers RAM.
12. **IDE connectors**. Extended Integrated Drive Electronics (EIDE) connectors are used for EIDE devices such as hard drives and optical drives. Many systems have replaced EIDE drives with SATA drives, but you still might see the connectors. When the board includes them, you'll see two connectors labeled IDE1 and IDE2, or sometimes IDE0 and IDE1.
13. **P1 power connector**. The primary power connection from the power supply is either a 20-pin connector or a 24-pin connector.
14. **Floppy drive connector**. This is for 3.5-inch floppy drives. They are rare today, but if the system has a floppy connector, it is usually by the IDE connectors.

Motherboard Sizes

While computer cases come in a wide variety of sizes, you'll find that most motherboards follow a form factor standard and conform to specific sizes. The following are some of the common motherboard form factors in use today:

- **Advanced Technology Extended (ATX)**. This has been the standard used in many systems since 1995 and is still used today. It added capabilities and improved on the original AT motherboard design.
- **Micro-ATX (mATX or µATX)**. This is a smaller version of the ATX and is very popular with desktop computers. It is designed to be backward-compatible with the ATX form factor so that it can fit in any ATX case and has the same power connectors. Because it is smaller, it has fewer expansion slots.
- **ITX**. ITX motherboards originated with VIA technologies and come in several different small form factor (SFF) designs, including mini-ITX, nano-ITX, and pico-ITX. They are referred to as embedded boards and consume very little power compared to ATX based boards. They don't need to be cooled with fans.
  - **Mini-ITX**. These are envisioned for use in home theater systems. They can fit into any case by using standard ATX mount points.
  - **Nano-ITX**. These small boards are designed for smaller devices such as digital video recorders (DVRs) and set-top boxes.
  - **Pico-ITX**. These extremely small boards can be embedded in different types of mobile devices. The Pico-ITX has been adopted as an open standard by the Small Form Factor Special Interest Group, or SFF-SIG.



The table below shows the sizes of common motherboard standards, organized from the largest form factors to the smallest.

Form Factor	Size in Inches	Metric Size
ATX	12 x 9.6	305 mm x 244 mm
Micro-ATX	9.6 x 9.6 largest 6.75 x 6.75 smallest	244 mm x 244 mm 171.45 mm x 171.45 mm
Mini-ITX (VIA)	6.7 x 6.7	17 cm x 17 cm
Nano-ITX (VIA)	4.7 x 4.7	120 mm x 120 mm
Pico-ITX	3.9 x 2.8	10 mm x 7.2 mm

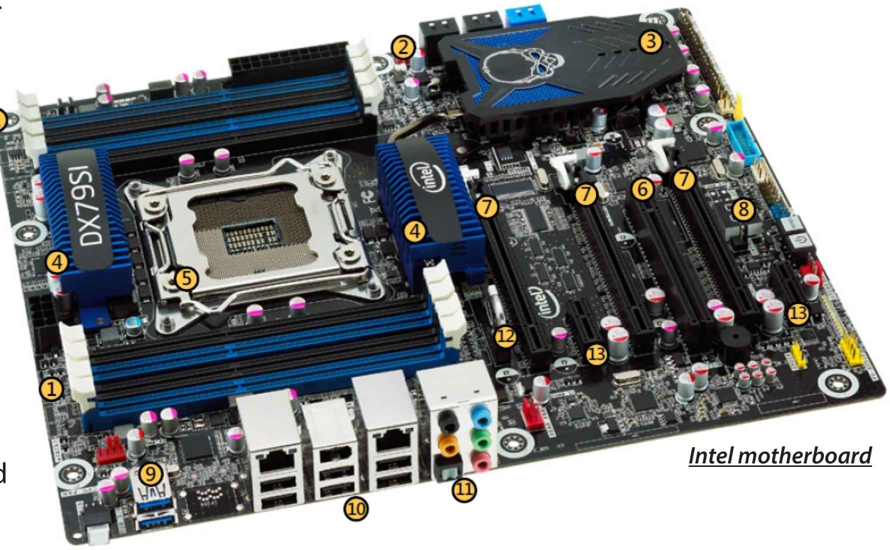
Note

Micro-ATX form factor
The Micro-ATX form factor is the only one that comes in different sizes. However, it is designed so that it will fit into any case that supports an ATX motherboard.

Viewing an Actual Motherboard

Earlier in this chapter, you saw a line drawing of a motherboard with an explanation of many of the components. The picture below shows a picture of an Intel DX 79SI Extreme series motherboard with the individual components identified. It's a newer motherboard, so it doesn't have some of the older components, such as AGP slots or IDE connectors.

1. **RAM slots**. This motherboard includes eight dual in-line memory module (DIMM) slots for double data rate type 3 (DDR3) memory.
2. **SATA ports**. Four SATA 3 GB/s ports and two SATA 6.0 GB/s ports are included. It's not apparent in the figure, but the 3 GB/s ports are black and the 6 GB/s ports are blue, so that they can be distinguished from each other.
3. **Intel X79 Express Chipset**. This chipset uses the Direct Media Interface (DMI) as an interface to the CPU.
4. **Voltage regulators covered by heat sinks**. The heat sinks keep the voltage regulators cool. One is providing power for the CPU, and one is providing power to the chipset.
5. **CPU socket**. This socket is for an Intel Core i7 processor with either four or six cores.



Intel motherboard

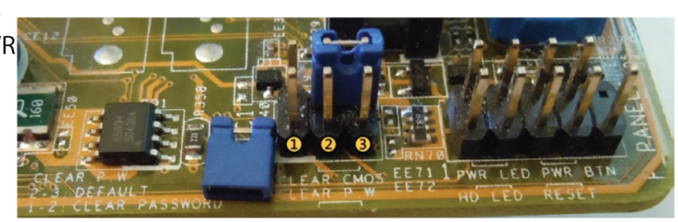
6. **One PCI expansion slot**. This is for earlier-version PCI cards.
7. **Three PCI e 3.0 x 16 expansion slots**. These are for newer PCIe boards.
8. **Power-on self test (POST) decoder**. This displays different numbers as the system progresses through the startup cycle. It can be used for troubleshooting the motherboard in place of a PCI or PCIe card used for providing the same information.
9. **USB ports 3.0 ports**. These are accessible via the back panel. Other connectors on the board can be routed to USB connectors on the front panel.
10. **Back panel ports**. This group includes two RJ-45 network interface connections, one IEEE 1394 firewall connection, and six USB 2.0 connections.
11. **Audio back panel ports**. This group includes multiple connections for different types of audio, including 7.1 systems.
12. **CMOS battery**. This motherboard is using a circular battery, but the battery is inserted sideways into a battery slot.
13. **PCI e x1 expansion slots.** These are for smaller x1 cards.

Front Panel Connectors

Motherboards commonly have connectors that are used to run wires to the front panel. If you look again at the picture(below), you can see several front panel connectors on the motherboard (to the right of the password jumper). Wires are plugged into these connectors with the other ends going to the appropriate connection on the front panel. Some common connectors include the following:

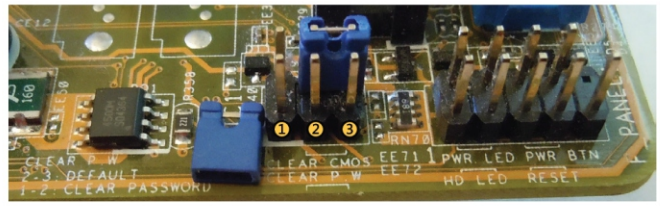
- Power light. This indicates when the system is turned on from the front panel power button. In the picture(below) it's labeled as PWR LED for power light emitting diode (LED).

- Power button. This turns the power on for the computer and is labeled as PWR BTN in the figure. This is different from a power switch on the back of the computer. If there is a power switch on the back of the computer, it turns on the power supply but not the computer.



Front Panel Connectors

- **Drive activity lights**. When the disk drive is actively reading or writing data, these lights will blink. They are typically red LEDs. The picture(right) shows this labeled as HD LED for hard disk drive LED.
- **Reset button**. Many systems include a reset button that will force the computer to restart. Whenever possible, it's better to logically shut down and restart a computer, but if the computer isn't responsive to any keyboard or mouse commands, you can force a restart by pressing the reset button.
- **USB**. On the rear panel, motherboards commonly include USB connections that are connected directly to the motherboard. However, USB devices are very popular with users and users often want access to USB ports on the front panel. Wires run from the
- **USB ports** on the front panel to connectors on the motherboard.
- **Audio**. Many systems include one or more audio outputs on the front panel that are connected from the motherboard. A headphone or speaker jack is usually a lime green color and includes a headphones icon. Some systems also have a microphone jack, commonly a pink color, with a microphone icon.



Motherboard Outline

Clear CMOS label
This motherboard also has a jumper labeled as CLEAR CMOS. This will reset all of the BIOS settings to the factory default. In the picture(top), this jumper is connected to pins 2 and 3, but moving the jumper to pins 1 and 2 will reset the BIOS settings.

Expansion Slots in Motherboard

Motherboards include expansion slots so that you can add expansion cards. For example, your motherboard can have basic video capabilities built into it, but you might want video that is faster and crisper. You can purchase a top-of-the-line video card with onboard RAM, install it in an expansion slot, and enjoy some awesome graphics.

Before you buy any expansion card, you should know what expansion slots are available in your computer. You don't want to buy a card only to find that it isn't supported by your computer or that the slot is already occupied by another expansion board.

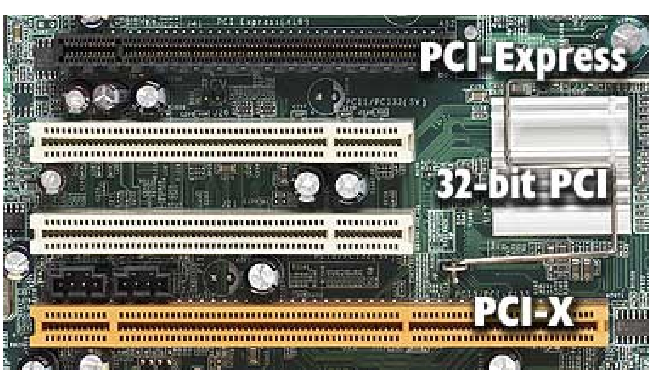
The following sections cover the common types of expansion slots you should know. The standards are as follows:

- Peripheral Component Interconnect (PCI). This comes in 32-bit and 64-bit versions and reaches speeds up to 533 MB/s. Newer motherboards might still include a PCI slot.

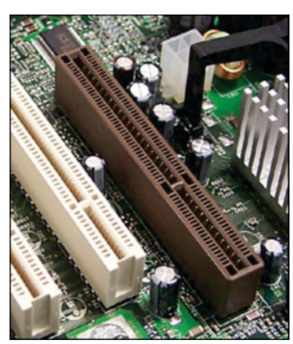
- Accelerated Graphics Port (AGP). AGP was introduced as a dedicated slot for a graphics card. It allowed high-end graphics to transfer data at speeds up to 2,133 MB/s without competing with other PCI device data transfers.

- PCI -Extended (PCI -X). This was an improvement over PCI and could reach up to 1,064 Mb/s. It is primarily used in servers.

- PCI Express (PCIe). This is the primary standard in use today and replaces PCI, AGP, and PCI-X on many motherboards. It can reach speeds up to 2 GB/s on multiple lanes simultaneously.



PCI-e, PCI, PCI-X Slots



AGP Slot

E. Basic Input/Output System(BIOS)

The Basic Input/Output System (BIOS) includes software code that provides a computer with basic instructions so that it can start. When a computer is turned on, it runs the program within BIOS to do some basic system checks, locate the operating system on a disk, and start.

For example, most computers have the operating system on a hard disk, and BIOS provides the initial instructions on how to locate the hard disk and start the operating system. The programming provided by BIOS is referred to as the bootstrap programming, and starting a computer is commonly called booting a computer. The BIOS allows the computer to start without any user intervention other than turning it on.

The program within BIOS is stored in a chip (see picture: right) on the computer that can be rewritten. Older computers used an electrically erasable programmable read-only memory chip (EEPROM) for the BIOS. Read-only memory (ROM) has gone through several iterations over the years, from programmable read-only memory (PROM), to erasable read-only memory (EPROM), and then to EEPROM. New computers use a type of flash memory similar to what is used with USB thumb drives.

BIOS on a motherboard

FIRMWARE DEFINITION

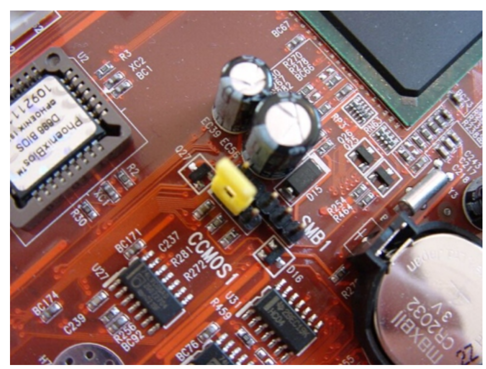
The BIOS is often referred to as firmware. It is a hardware chip that you can physically see and touch, and it includes software that runs code on the computer. The combination of hardware and software is firmware.

BIOS also includes a BIOS setup application you can use to configure different settings for your computer. For example, you can set the time of the computer, identify which drive to boot to, configure the CPU to support virtualization technologies, and more.

BIOS vs. CMOS

As you study computers, you're likely to come across the term complementary metal oxide semiconductor (CMOS). When referring to BIOS and CMOS, there are differences.

- **BIOS**. This is the firmware. It stores the instructions for starting the computer and includes a program that can be used to change some settings. The firmware can be updated in a procedure referred to as flashing the BIOS (covered later in this chapter).
- **CMOS**. This holds only the user-configurable BIOS settings, such as the current time. Users can change these settings by accessing the BIOS application. CMOS is volatile, meaning that the data is lost if the system is turned off. Motherboards include a CMOS battery to retain the CMOS data even if the system is turned off.



BIOS & CMOS Battery

That's probably clear to you: BIOS is the application, CMOS is the data, and a CMOS battery keeps CMOS powered to retain the settings.

Accessing the BIOS Application

When you first turn on a computer, you'll see one or more screens flash onto the screen, providing bits of information. One of these screens gives you a message to press a specific key to access the setup options or the setup utility.

BIOS CAN MEAN DIFFERENT THINGS IN DIFFERENT CONTEXTS

Primarily, BIOS refers to the bootstrap code used to start the computer without user intervention. However, technicians commonly use the term BIOS to refer to the setup application or setup utility. If you're asked to access the BIOS, you're being asked to get into the setup application or setup utility.

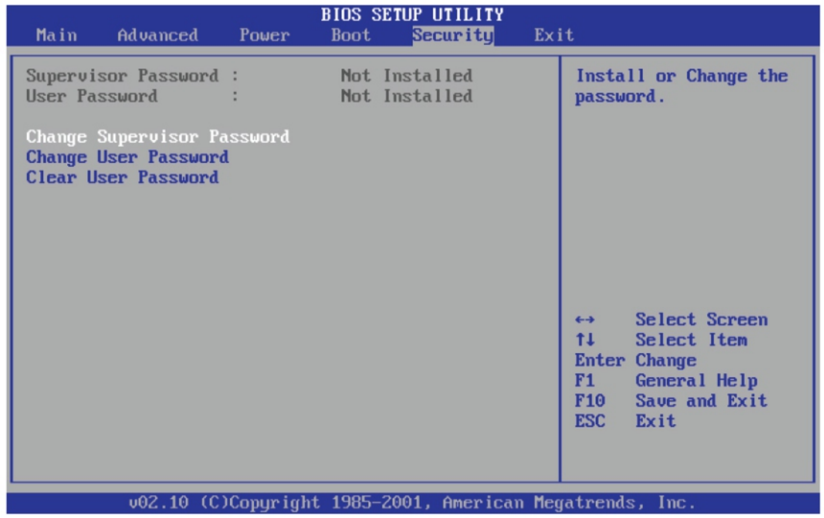
Keys to Access

The only sure way of knowing what key to press is by reading the screen. For example, if the screen says to press the <F2> key to enter the setup utility, you'll need to press the F2 function key. Other common keys or key combinations are: F1, F10, Del (delete key), Ctrl+Alt+Esc keys (pressed at the same time), and Ctrl+Alt+Enter keys. On some laptops, you press the Fn+Esc or FN+F1 keys.

Admittedly, that's a lot of combinations. Just remember that what you really need to do is read the messages on the screen as the system starts.

Starting up the BIOS on a computer and go through these settings is highly recommended. Your BIOS might not use the same words, but you'll be able to see the settings. You can change settings in the BIOS, and as long as you don't save your changes, they won't apply.

After the BIOS starts, it will look similar to the picture(right) shown. The mouse cannot be used in most BIOS utilities; instead, you have to use the keyboard and arrows to navigate. Somewhere on the screen, each BIOS utility will have directions about how to navigate through the program, how to select individual settings, and how to change them. In the figure, these instructions are in the right pane.



BIOS Setup Interface

BIOS Component Information

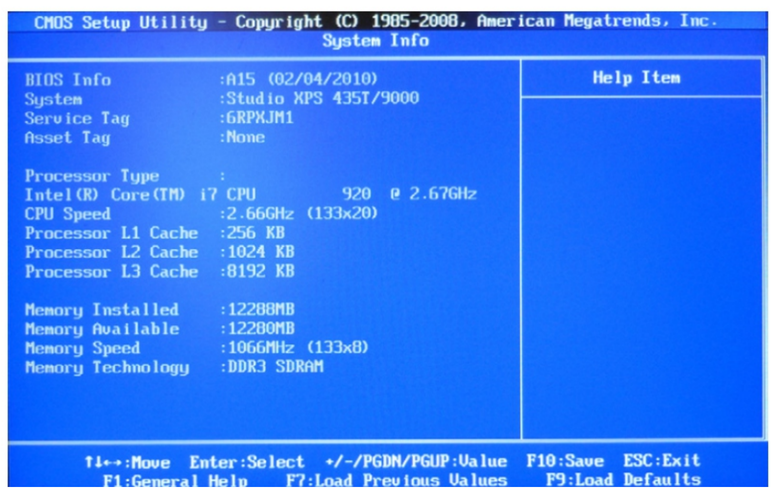
You can use the BIOS to verify the different components that are installed on a system. This can be useful to ensure that the system is recognizing newly installed hardware. For example, if you install new RAM but it's not recognized, the BIOS can sometimes give you insight into the problem.

The picture(below) shows a screen from a different BIOS version with the system information page selected.

This page shows information about the processor type, processor cache, and memory. You can see that the processor is an Intel Core i7, with a 133-MHz clock multiplied by 20, giving a CPU speed of 2.66 GHz.

You can also see that the system has 12 GB (12,288 MB) of RAM installed. The RAM has a speed of 1,066 MHz (using a 133-MHz clock multiplied by 8) and is DDR3 SDRAM.

Additionally, most BIOS systems will automatically detect the presence of different drives and report their presence within BIOS. This includes hard disk drives and different types of optical drives, such as DVD drives. Sometimes these settings are reported in the Standard CMOS Features page, if it exists, and other times the settings are on a dedicated page for the drives.



BIOS Setup Interface

Drives might be reported as SATA1, SATA2, and so on if the system is using a SATA interface. If the system is using an EIDE interface, they might be reported as IDE, EIDE, or as hard disk drives.

This can be useful if you've installed a new drive but find that it's not recognized after starting. Go into BIOS, find the drive settings, and ensure that the new drive is recognized by BIOS. If it's not recognized, you need to check the hardware such as the cables or configuration.

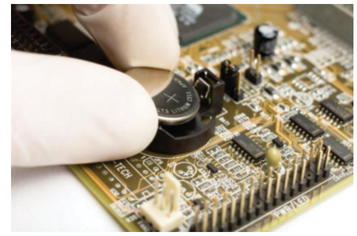
BIOS Configuration

There are a few configuration settings that are important to understand. Changes you make in the configuration will remain in the system even after the system has been powered off.

Time and Date

A very basic setting for the BIOS is the time and date. You'll often see these settings on the very first page of BIOS, which is sometimes called the Main page or the Standard CMOS Features page.

The computer keeps time with a real-time clock, and the CMOS battery keeps the clock ticking even when the system is turned off. You rarely need to change this except when the CMOS battery is failing. If the battery is failing, the real-time clock is slow and needs to be reset often.



When replacing the battery as shown in the picture(right), make sure that you replace it with the correct type. Motherboard manufacturers warn that the wrong battery could explode. Also, always follow local regulations when disposing of the original battery.

Replacing a CMOS battery

Boot Sequence

One of the most important BIOS settings for a PC technician to understand is the boot sequence. The boot sequence setting tells the computer the device from which it should try to boot first.

The picture(right) shows the boot sequence screen in BIOS. Currently, it's set to boot to the hard drive. If the hard drive doesn't have a bootable operating system, it will look for a bootable operating system on the CDROM, then on a floppy drive, and then by using PXE. As configured, it will never boot using the CDROM drive unless the hard drive failed. If you want to boot using a bootable CDROM drive, you need to change the configuration as shown in the dialog box of the said picture..

BIOS Setup : Boot menu

Enabling and Disabling Devices

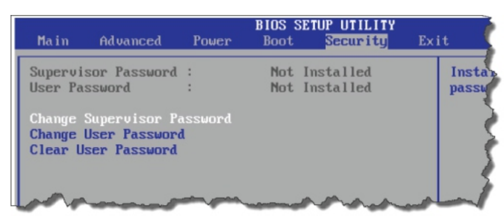
You can often enable and disable devices in BIOS. As shown in the immediate above picture, one of the selections in the Options menu is Disabled. If you want to disable any of the devices, you can select Disabled.

Different types of BIOS allow you to enable and disable devices from different menus. Other devices that can sometimes be enabled or disabled from a BIOS menu include the following:

- **USB controller**. Disabling this prevents USB devices from working.
- **Onboard 1394 (Firewire) controller**. Disabling this prevents Firewire devices from working.
- **Onboard graphics**. This disables graphics capabilities from the chipset. You would disable this on systems that have a dedicated graphics card.
- **Onboard audio**. This disables audio capabilities from the chipset. You would disable this on systems that have audio cards installed in an expansion slot.
- **Onboard network card**. This disables network capabilities from the chipset. You would disable this on systems that have a network interface card installed in an expansion slot.

Security

Many BIOS utilities include security settings, and the most common security setting is related to BIOS passwords. In the picture(right) you can see the settings for a supervisor password and a user password. When set, the supervisor password provides full control over any BIOS settings and is sometimes set by administrators to ensure that they can override any changes made by a user.



BIOS Setup : Security menu

F. Power Supply

The power supply, as its name implies, provides the necessary electrical power to make the PC operate. The power supply takes standard electrical power and converts it into power your PC can use. Most power supplies are about the size of a shoebox cut in half and are usually black, gray or metallic in color as shown in the picture(right)

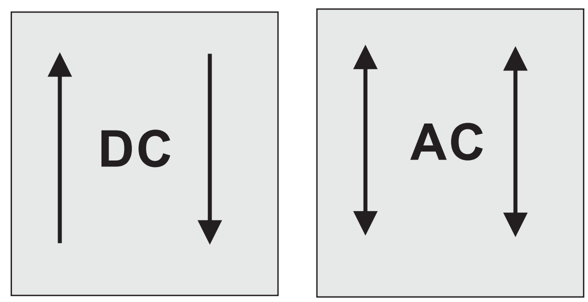
Power supply unit(PSU)

Understanding Electricity

Electricity is a flow of negatively charged particles, called electrons, through matter. All matter enables the flow of electrons to some extent. This flow of electrons is very similar to the flow of water through pipes; as in electricity electricity sits in the wires, from source which is your electric company.

Electricity is a flow of negatively charged particles, called electrons, through matter. All matter enables the flow of electrons to some extent. This flow of electrons is very similar to the flow of water through pipes; as in electricity electricity sits in the wires, from source which is your electric company.

Electricity comes in two flavors: direct current (DC), in which the electrons flow in one direction around a continuous circuit, and alternating current (AC), in which the flow of electrons alternates direction back and forth in a circuit as shown in picture(right). Most electronic devices use DC power, but all power companies supply AC power because AC travels long distances much more efficiently than DC.



Constant voltage in one direction

Voltage in both directions constantly switching back and forth

Diagrams showing DC and AC flow of electrons

Powering the PC

Your PC uses DC voltage, so some conversion process must take place before the PC can use AC power from the power company. The power supply in a computer converts high-voltage AC power from the wall socket to low-voltage DC. The first step in powering the PC, therefore, is to get and maintain a good supply of AC power. Second, you need a power supply to convert AC to the proper voltage and amperage of DC power for the motherboard and peripherals.

Every PC power supply must have standard AC power from the power company, supplied steadily rather than in fits and spurts, and protection against accidental blurps in the supply. The power supply connects to the power cord (and thus to an electrical outlet) via a standard IEC-320 connector. Here in the Philippines and the rest of the world uses 220-240 VAC, so most power supplies are dual-voltage and compatible with both. In United States, standard AC comes in somewhere between 110 and 120 V, often written as ~115 VAC (volts of alternating current). Power supplies with voltage-selection switches are referred to as fixed-input. Power supplies that you do not have to manually switch for different voltages are known as auto-switching. Figure 10.3 shows the back of a power supply. Note the three components, from top to bottom: the hard on/off switch, the 115/230 switch, and the IEC-320 connector.

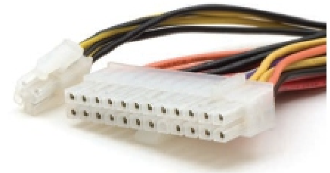
After knowing that the power supply unit (PSU) takes over, converting high-voltage AC into several DC voltages (notably, 5.0, 12.0, and 3.3 V) usable by the delicate interior components. Power supplies come in a large number of shapes and sizes, but the most common size by far is the standard 150 mm × 140 mm × 86 mm desktop PSU shown in picture(right).

Power supply unit(PSU)

Powering the Peripherals: Molex, Mini and SATA

Many devices inside the PC require power. These include hard drives, floppy drives, optical drives, and fans. The typical PC power supply has up to three types of connectors that plug into peripherals: Molex, mini, and SATA.

Molex Connectors. The most common type of power connection for devices that need 5 or 12 V of power is the Molex connector (picture:right). The Molex connector has notches, called chamfers, that guide its installation. The tricky part is that Molex connectors require a firm push to plug in properly, and a strong person can defeat the chamfers, plugging a Molex in upside down. Not a good thing. Always check for proper orientation before you push it in!

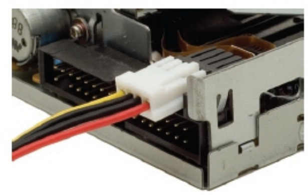


Molex Connector

Mini Connectors. All power supplies have a second type of connector, called a mini connector shown in the picture(right), that supplies 5 and 12 V to peripherals, although only floppy disk drives in modern systems use this connector. Drive manufacturers adopted the mini as the standard connector on 3.5-inch floppy disk drives. Often these mini connectors are referred to as floppy power connectors.

Mini Connector

Be extra careful when plugging in a mini connector! Whereas Molex connectors are difficult to plug in backward, you can insert a mini connector incorrectly with very little effort. As with a Molex connector, doing so will almost certainly destroy the floppy drive. The picture(right) depicts a correctly oriented mini connection, with the small ridge on the connector away from the body of the data socket.



SATA Power Connector

SATA Power Connectors Serial ATA (SATA) drives need a special 15-pin SATA power connector. The larger pin count supports the SATA hot-swappable feature and 3.3-, 5.0-, and 12.0-V devices. SATA power connectors are L shaped as shown in the picture(left), making it almost impossible to insert one incorrectly into a SATA drive. No other device on your computer uses the SATA power connector.

Molex Splitter

Splitters and Adapters. You may occasionally find yourself without enough connectors to power all of the devices inside your PC. In this case, you can purchase splitters to create more connections (see Figure 10.18). You might also run into the phenomenon of needing a SATA connector but having only a spare Molex. Because the voltages on the wires are the same, a simple adapter will take care of the problem nicely.

G. Hard Drive

A hard drive stores programs and data that are not currently being used by the CPU. Although RAM storage is measured in megabytes and gigabytes, a PC's hard drive stores much more data than a typical PC's RAM—hundreds of gigabytes to terabytes. A terabyte is 1000 gigabytes. An average PC has one hard drive, although most PCs accept more. Special PCs that need to store large amounts of data, such as a large corporation's main file-storage computer, can contain many hard drives—8 to 16 drives in some cases.

The two most common types of hard drives seen in today's PCs are the older Parallel Advanced Technology Attachment (PATA) and the more modern Serial Advanced Technology Attachment (SATA). PATA drives use a ribbon cable very similar to the one used by floppy drives, whereas SATA drives use a very narrow cable. The picture(right) shows a SATA drive (left) next to a PATA drive (right). Most motherboards only come with SATA connections, but if you look around, you can find one that supports PATA as well.

SATA and PATA drives showing data connectors

Hard drives come in two major types. The most common type has moving parts; the newer and more expensive technology has no moving parts. Let's look at both.

Standard Platter-Based Hard Drives

A traditional hard disk drive (HDD) is composed of individual disks, or platters, with read/write heads on actuator arms controlled by a servo motor—all contained in a sealed case that prevents contamination by outside air as shown in the picture(right).

Hard drives run at a set spindle speed, measured in revolutions per minute (RPM). Older drives ran at a speed of 3600 RPM, but new drives are hitting 15,000 RPM. The faster the spindle speed, the faster the controller can store and retrieve data. Here are the common speeds: 5400, 7200, 10,000 and 15,000 RPM.

Faster drives mean better system performance, but they can also cause the computer to overheat. This is especially true in tight cases, such as minitowers, and in cases containing many drives. Two 5400-RPM drives might run forever, snugly tucked together in your old case. But slap a hot new 15,000 RPM drive in that same case and watch your system start crashing right and left!

Inside a platter type hard drive(HDD)

Solid-State Drives(SSD)

Booting up a computer takes time in part because a traditional hard drive needs to first spin up before the read/write heads can retrieve data off the drive and load it into RAM. All of the moving metal parts of a platter- based drive use a lot of power, create a lot of heat, take up space, wear down over time, and take a lot of nanoseconds to get things done. A solid-state drive (SSD) addresses all of these issues nicely.

In technical terms, solid-state technology and devices are based on the combination of semiconductors, transistors, and bubble memory used to create electrical components with no moving parts. It is 10x faster than the standard hard drive.

SSDs can be PATA, SATA, eSATA, SCSI, or USB for desktop systems. Some portable computers have mini-PCI Express versions. You can also purchase SSD cards built onto PCIe cards (which you would connect to your PC like any other expansion card).

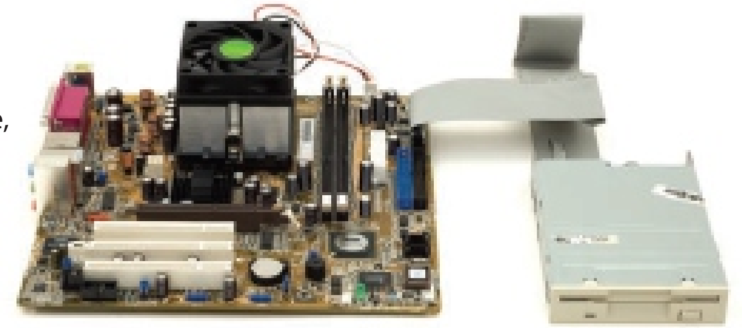
Inside a solid state drive(SSD)

SSDs are more expensive than traditional HDDs. Less expensive SSDs typically implement less reliable multi-level cell (MLC) memory technology in place of the more efficient single-level cell (SLC) technology to cut costs.

H. Floppy Drive

The floppy drive enables you to access removable floppy disks. The floppy drives used in today's PCs (you'll have trouble finding a floppy drive on most modern computers) are 3.5-inch floppy drives. Floppy drives only store a tiny amount of data and have all but disappeared from PCs.

Floppy drives connect to the computer via a ribbon cable, which in turn connects to the motherboard. The connection to the motherboard is known as the floppy drive controller, see the picture(shown).



Floppy drive connected to the motherboard

I. Optical Drives

Optical drives enable a computer to read one or more types of optical discs, such as CD, DVD, or Blu-ray Disc. CDs store around 700 MB and come in three varieties: CD-ROM (read only memory: you can't change the data on them), CD-R (recordable: you can change the data once), and CD-RW (rewritable: you can change the data on them over and over). DVDs store much more data—the smallest capacity DVDs store around 4 GB, enough for a Hollywood movie—and come in even more varieties: DVD-ROM, DVD+R, DVD-R, DVD+RW, and DVD-RW, just to name the more famous ones. Blu-ray Discs are popular for high-definition movies, but there are also Blu-ray Discs for storing data with capacities starting at 25 GB.

Assorted optical discs

All of these optical discs require an optical drive that knows how to read them. If you want to do anything with a CD-RW disc, for example, you need a CD-RW drive. If you want to use a DVD+R disc, you need a DVD+R drive. Luckily, most optical drives support many different types of discs, and some support every common type of optical disc available. The picture(right) shows typical optical drives. Note that some of them advertise what disc types they use. Others give no clue whatsoever.

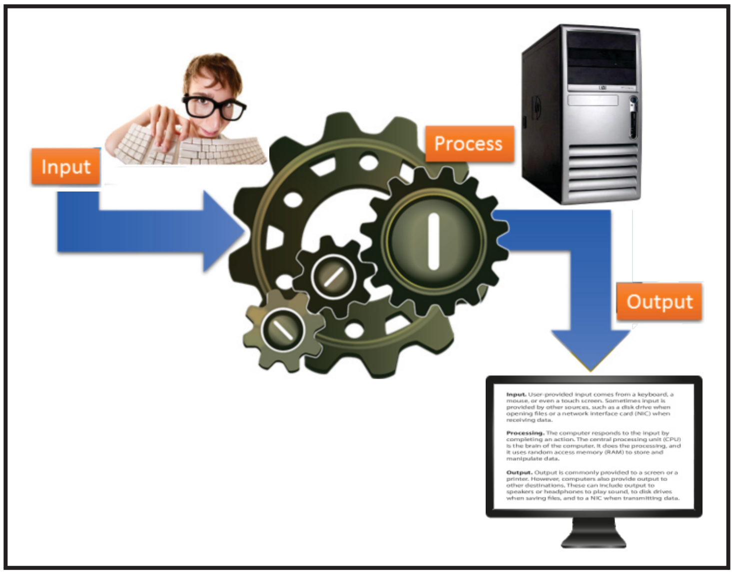
Optical drives

Know Your Parts

The goal of this chapter was to get you to appreciate the names and functions of the various parts of the PC: peripherals, connectors, and components. In the next chapters you will surely understand at great depth how each component works and how it interconnects with the PC system as a whole.

Chapter 2
Laboratory Manual

COMPUTER BASICS and ITS PERIPHERALS



Laboratory Activities

2.01 Exploring the Functions and Components of a PC
2.02 Examining User-Accessible Components
2.03 Recognizing External Connections
2.04 Identifying CPU Characteristics
2.05 Recognizing CPU Sockets
2.06 Cooling Your CPU
2.07 Exploring CPU Specifications with CPU-Z

Chapter 2.08 Analysis and Written Test

2.09 Determining the Amount of RAM in a PC
2.10 Identifying Types of RAM
2.11 Exploring RAM Specifications with CPU-Z

Chapter 2.12 Analysis and Written Test

2.13 Researching New Motherboards
2.14 Identifying Motherboard Features
2.15 Exploring Motherboard Features with CPU-Z
2.16 Identifying BIOS ROM
2.17 Accessing BIOS via the CMOS Setup Program
2.18 Configuring and Clearing CMOS Setup Program Passwords
2.19 Configuring BIOS Settings

Chapter 2.20 Analysis and Written Test

2.21 Electricity
2.22 Power Supply Output
2.23 Power Protection

Chapter 2.24 Analysis and Written Test

2.25 Installing Parallel ATA Hard Drives
2.26 Installing Serial ATA Hard Drives
2.27 Configuring CMOS Settings
2.28 Comparing Solid-State Drives and Magnetic Hard Drives

Chapter 2.29 Analysis and Written Test

Lab Activity 2.04 Identifying CPU Characteristics

Ms. Labitad the computer teacher wants to replace the CPU in his machine with this new one she bought on EasyPC, and she wants you to help her. When you're the resident computer tech geek, your coworkers will expect you to be able to deal competently with a situation like Ms. Labitad.

Staying on top of the many developments in CPU technology can be challenging, but it's also a necessary part of your job as a PC technician. By this point, you know that you can't just plug any CPU into any motherboard and expect it to work you have to match the right CPU to the right motherboard. To accomplish this, you need to identify important CPU characteristics such as form factor, clock speed, and bus speed, as well as things like voltage settings, clock multiplier configurations, and cooling requirements.

Learning Objectives

In this lab, you'll practice identifying CPUs and CPU fan components.

At the end of this lab, you'll be able to

- Recognize the different kinds of CPUs
- Recognize different CPU fan attachments
- Identify the basic specifications of different classes of CPUs

Lab Materials and Setup

The materials you need for this lab are

- a notepad and pencil to document the specifications
- Optional: access to a working computer with a word processing or spreadsheet application installed and access to the Internet, to facilitate research and documentation of the CPU specifications

Let's Get the Lab Started

In the following steps, you'll review your knowledge of CPU specifications, and then examine the CPU and fan attachment on a PC.

Step 1 A good tech not only will learn the specifications of different CPU chips, but also will master the use of reference tools such as the Internet, manufacturers' Web sites, product documentation, and reference books. A quick search of the Web or your motherboard manual will generally yield a full list of specs for a given CPU.

See how many CPU chip features you can fill in given the maker and CPU type:

CPUs have very short production lives. If some of these CPUs have become obsolete, use the extra rows provided to add more modern processors to the assignment.

Maker	CPU Type	Package	Clock Speed (GHz)	Wattage Consumption	L2 Cache	L3 Cache	Number of Cores
Intel	Core 2 Quad Q9650						
AMD	Phenom II X3 710						
AMD	FX-8150						
Intel	Core i5-2500K						
AMD	Athlon X2 7550 Black Edition						
Intel	Pentium 4 650						
Intel	Core i7-3960X						
AMD	A8-3850						
Intel	Core i7-960						

Step 1 Look at the CPUs pictured in Figure 2-3, making note of the differences you see. In particular, do the following:

a. Distinguish between pin grid array (PGA) and land grid array (LGA) packages by writing LGA or PGA on top of the processor 's picture.

b. Circle the orientation guides in the corner of each CPU.

Step 2 Many users argue that Intel is better than AMD or vice versa. What do you think? Do some research and prepare a recommendation for selecting either an Intel processor or an AMD processor. Check multiple Web sites, read different articles online, and then write a short comparison/contrast essay on which CPU manufacturer you think is better. Be sure to cite your sources!

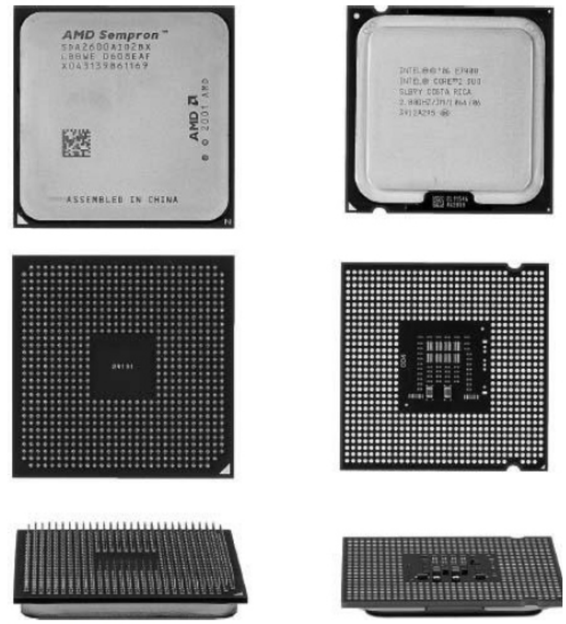


FIGURE 2-3 Identifying Sockets