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# System Boards and Component Identification

## THE SYSTEM BOARD

In this section of the study unit, we're going to learn about the *system board*. The system board is the main *printed circuit board (PCB)* in a PC that enables the interaction and control of all other components and devices in a computer system. A system board can be compared to a mass transit system in a large city. Mass transit in a city has interconnected streets, avenues, and highways that are used for transportation. Similarly, with a system board, data and information is transported via the bus, which can have numerous components attached to its "roadways." In a city, we have stop lights, stop signs, and other ways of controlling traffic, as well as people who use the transportation system to get from place to place. If we didn't have ways to manage the traffic, we might get lost, end up in a traffic jam, or be involved in an accident. Similarly, the system board has a *system clock* to synchronize the operation of the bus and other components. The system clock keeps data and information flowing smoothly to its correct destination, and hopefully without error.



### **Professional Tip**

Don't confuse the system clock with the *operating system (OS) clock* in Windows. The OS clock is a software component of the Windows operating system, and uses the *Real-Time Clock/Calendar (RTCC) chip* to display and adjust the date and time.

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The system board may also be referred to as the *motherboard* or *planar board*.

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The system board is the most important module and the main PCB in the computer. A system board is the physical component in a computer that contains the computer's basic circuitry and parts. On a typical system board, the circuitry is imprinted or affixed to the surface of a firm planar surface (usually fiberglass) and typically is manufactured in a single step. A *planar surface* is flat and two-dimensional. Fiberglass is typically used because it's light, durable, and slightly flexible, yet firm enough to drill holes, mount chips, or imprint traces. While the system board connects directly or indirectly to every part of the computer, it's the hardware that's mounted on the system board that does all the work.

Though there are many types of system boards, they typically contain most of the same elements. These are

- A *CPU*, or central processing unit
- A *BIOS*, or binary input/output system
- Memory (RAM, ROM)
- Mass storage interfaces (for optical, hard, and floppy drives)
- Connection ports (USB, IEEE 1394, parallel)
- Controllers for peripheral devices (floppy drive, hard drive, keyboard, monitor/graphics)
- Connectors or slots for adapter or other daughter boards
- A collection of chips

Newer boards have more embedded components for video, audio, and networking. An *embedded* component is one that's included in the architecture of the board, where previously you had to have a separate adapter card for that function. The *ATX system board* is the most common type of system boards available. Specific system board components will be discussed in more detail later in this unit.

## System Board Basics

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So many system board types are available that we couldn't possibly describe them all to you. Moreover, manufacturers are redesigning them every day. What we'll do is give you the skills necessary to identify the critical components of a system board. In other words, we'll provide the intellectual tools you'll need so that you can confidently work with virtually any system board you encounter.

Although every computer has a system board, not every system board looks the same or is located in the same place in the system unit (**Figure 1**). In most desktop computers, the system board occupies the majority of the space in the bottom or side of the PC. It's held in place by several screws and is separated from the chassis by plastic or metal spacers. The disk drives and the power supply sit above or to one side of the system board. *System board modularity* means that the dimensions of slots, connectors, sockets, and the board itself (form factor) are standardized, making it easier to repair or upgrade cards, memory, CPUs, and peripheral devices.



**FIGURE 1**—The system board's location depends on the make and model of the computer.

Today, many manufacturers promote the *modularity* of their system boards. This means that the system board can be removed from the computer and replaced with a new and improved version.

Many system boards manufactured today are *integrated* units with discrete components that can't be replaced without returning the system board to the manufacturer. These boards include many of the components that would previously have been found on adapter cards. Today, drive controllers (hard drive, floppy, optical, and zip), video adapters, I/O ports (serial [COM], universal serial bus [USB], and parallel [LPT]), integrated audio, network adapters, and even modems are built into the system board. This type of system board is referred to as an *integrated system board* because all the major functions can be found on the system board itself.

Most modern integrated system boards have a series of jumpers or BIOS settings on them that allow the technician to enable or disable a particular function that fails, so a replacement or upgraded card can be plugged into an available bus slot. However, some earlier version system boards didn't have this particular feature. Your only alternative when repairing these older computers is to replace the entire system board with another of the same type, if it's still available. This could be an expensive proposition, depending on the number of functions that the integrated system board was responsible for. Chances are, it would be better and less expensive to buy a new PC.



#### **Professional Tip**

Before removing an existing system board, record the position of any *dual inline package (DIP)* switches or jumpers. Ensure that the replacement system board has these identical settings and jumper positions selected.

Some components located on the system board can be replaced without sending the entire board back to the manufacturer. These components include the CPU, ROM BIOS chip, CMOS battery, and random-access memory (RAM). Each replaceable component is called a *field replaceable unit (FRU)*; that is, it can be easily repaired or upgraded.

Before replacing a system board, you must ask yourself several questions:

1. Is it more cost-effective to upgrade the PC or simply replace it? You'll have to determine why the existing PC is no longer adequate. Is the present system unable to run the latest operating systems and/or applications? You'll find that sometimes just replacing the system board won't achieve the desired results. All the components in the PC must be properly matched to achieve maximum performance. For example, installing a fast system board with insufficient memory or slow hard drive will result in poor performance.
2. What type of system board is needed, and how many expansion slots are required? The types of system boards available include peripheral component interconnect (PCI), peripheral component interconnect express (PCI-Express) and accelerated graphics port (AGP) or VL-bus. Does the system board allow for future CPU upgrades?
3. Can devices that presently require an adapter card (e.g., the hard drive) connect directly to the new system board, thereby freeing expansion slots and increasing overall system speed?
4. Will the new system board be able to fit inside the existing case?
5. How much and what type of memory (RAM) will the system board accommodate?

If you decide to replace an existing system board, consider the following selection options:

1. **The type and speed of the CPU.** Different CPUs require different socket sizes and shapes (Table 1.0). Therefore you'll need a system board that's right for the processor you choose. Each system board description will tell you what processors are supported. At Intel and AMD Web sites, you can see what system boards are recommended.

Table 1.0		
Types of Sockets		
Socket Name	Number of Pins	Processors
Socket 754	754	AMD Athlon 65/ Sempron/Turion 64
Socket 939	939	AMD Athlon 64/ FX/X2/Opteron
Socket T (LGA 775)	775	Intel Pentium 4/D/Celeron/ Core 2 Duo/ Core 2 Quad
Socket M	478	Intel Core Solo/Duo/ Dual-Core Xeon/ Core 2 Duo
Socket AM2	940	AMD Athlon 64/X2
Socket AM2+	940	AMD Athlon 64/X2/ Phenom/Phenom II
Socket P	478	Intel Core 2
Socket B	1366	Intel Core i7 (900 series), Xeon (35xx, 36xx, 55xx, 56xx series)
Socket AM3	941	AMD Phenom II/ Athlon II/Sempron

2. **The chipset installed.** The chipset is the group of chips affixed to a system board that are responsible for control and functionality of the system board and associated peripheral devices. There are two primary chip architectures, the Northbridge/Southbridge and the Hub. In the Northbridge/Southbridge scheme, the “North bridge” controls operations of the CPU to memory, the secondary L2 cache controller, the real-time clock, the PCI bus and

AGP (accelerated graphics port) functionality. The “South bridge” controls all I/O (input/output) functions, such as BIOS, the hard-drive controller, and USB and serial ports. Hub architecture is a newer technology and renames the “North bridge” the *memory controller hub (MCH)*, while the “South bridge” becomes the *I/O controller hub (ICH)*. The main difference is that the hub interface is twice as fast as the PCI interface, and PCI bus communication is faster because it doesn’t have to share bandwidth with the “South bridge” chip.

Chipset manufacturers include Intel, Via Technologies, Acer Labs, Silicon Integrated Systems, AMD, and OPTi. Chipset design is determined by the other components in the system. Some of the criteria affecting chipset construction are CPU type/speed, memory (RAM) type, memory bus speed, PCI/PCI-E support/bus width, AGP support, USB functionality, and mouse type.

#### **Technical Note**

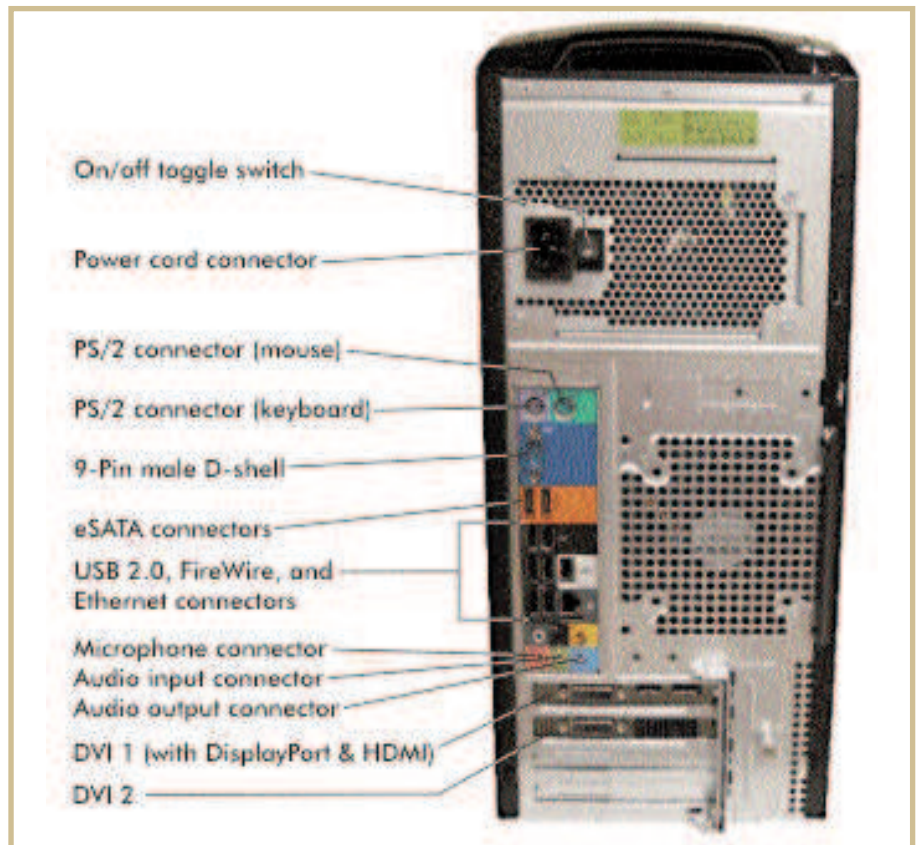
Since chipset technology and applications change at a rapid rate, we recommend that you keep well-informed on the latest chipset/system board configurations.

### **3. The number and style of external connectors or ports.** These ports can have metal pins (male) or metal sockets (female) integrated into the system board.

- For the keyboard and mouse, most PCs you’ll encounter will use USB ports, although older PCs may have a *DIN* (an acronym for the German Institute for Standardization) connector.
- The video connection will either be a 15-pin female D-shell connector or a 29-pin DVI connector.
- The printer (not on a network) will use either a USB port or a 25-pin female D-shell connector.
- Serial ports come in 9-pin male and 25-pin male D-shell configurations to connect a variety of input devices (e.g., mice, trackballs, and digitizers).

Figure 2 shows the various types of ports that you'll find on modern system boards.

**FIGURE 2—Some of the External Connections on a System Board**



System boards are available with integrated video, sound, and modem as well as other components. Embedded video, sound, and network connectivity have steadily improved in quality and performance and are generally less expensive than add-on boards, or *adapter cards*. But for flexibility, adaptability, performance, and overall higher quality, adapter cards are preferred. Even when you're dealing with embedded functions, there are slots on the system board for external adapter cards. Most expansion slots today come in one of three types, PCI/PCI-E, ISA, or AGP.

The oldest currently used architecture is the *PCI (peripheral component interconnect)* bus. This is 32 or 64 bits wide and supports Plug and Play, which allows easy configuration for new devices that support it. PCI cards don't have jumpers or switches, and configuration is done automatically via software. The *AGP (accelerated graphics port)* bus allows direct communication with main memory for handling

graphics. A 3-D graphics accelerator card has its own built-in graphics CPU, called a *GPU*, that can communicate directly with the monitor, bypassing the CPU for fast, graphic-intensive “gamer” video. Finally, the PCI-Express bus, or PCI-E, is a newer, related technology to PCI, but isn’t backward-compatible with it. PCI-E slots connect to both the South and North bridges, unlike PCI, which connects only to the South bridge, allowing for much faster transfer rates. PCI-E slots come in four sizes as of 2011—x1, x4, x8 and x16—which refer to the number of actual paths for data.

What these trends suggest is that you’ll be doing a lot of “seat-of-the-pants” servicing in the future. You might be asked to repair or upgrade a computer with which you’re not familiar. Or you might be asked to advise a client about the advantages of a new design. At first, you might be unsure about such a situation. But with common sense and the skills you’ll learn, you’ll do very well. As always, if you have any questions about a computer, you should first check the manual that came with the computer.

You should also read everything you can about computer design. In addition, spend some time on a regular basis in a computer store looking at various system board configurations. If a computer technology show comes to your area, try to go to it. This is called “keeping up with technology,” and it’s a requirement of most professions. The extra effort you take to keep up with what’s happening in technology will ensure that your career as a technician is long and profitable.

## Identifying System Board Components

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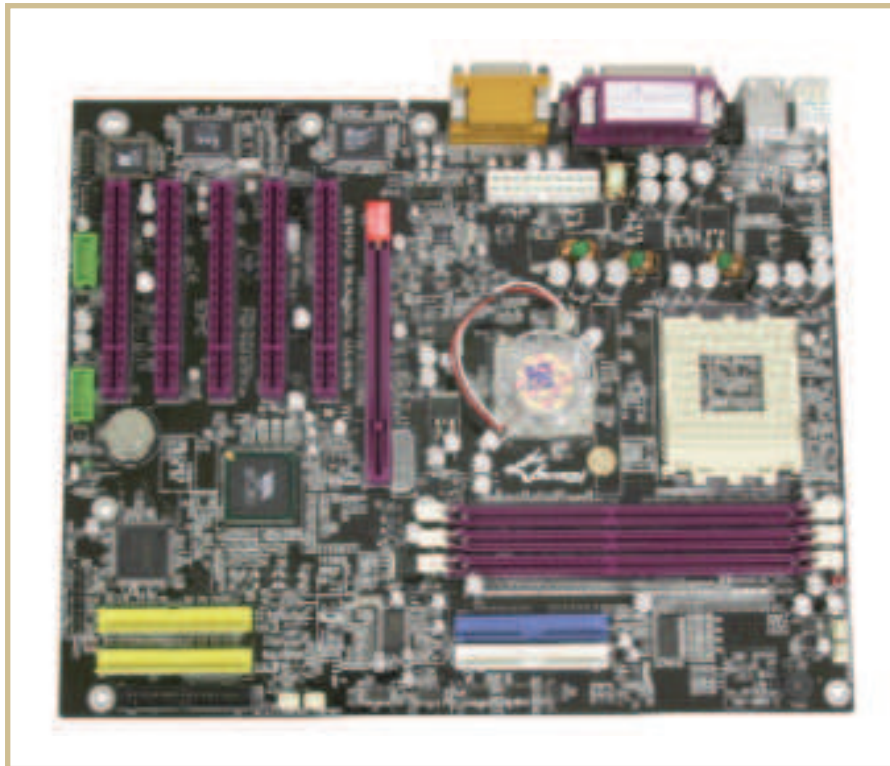
As we mentioned earlier, the system board itself is a PCB made of fiberglass. System board form-factor dimensions are standardized and designed to accommodate the various PC case sizes and configurations. The system board is multi-layered (as many as six) and etched with fine copper traces, some of which are designated data paths, or buses, for BIOS, memory, the CPU, and other board components; others are voltage- and ground-return paths. The traces are sandwiched between the layers, and you’ll find that most board components aren’t *field replaceable units*, or *FRUs*. If an embedded function fails, you may be able to turn it off in the BIOS and

restore functionality with an adapter card. However, because of the complexity of a system board, a failing or “bad” board generally isn’t analyzed and repaired, but simply replaced.

Manufacturers make hundreds of tiny holes in the system board on the bus. Chips, sockets, and other electronic components are then inserted into these holes. They’re held in place by solder joints applied on the underside of the PCB. Several other holes are drilled into the system board for spacers and screws that fasten it to the system unit case. If you encounter a system board that’s outside of its system unit case, spend a few minutes examining it. Look closely at both sides and try to get a good feel for the “geography” of the top and the bottom. Most importantly, note the difference between socketed chips and soldered chips.

Whenever you encounter a new system board, it’s a good idea to review the manual that came with the unit so that you can become familiar with the parts. Sometimes additional information and support can be found on manufacturer sites such as [www.asus.com](http://www.asus.com), vendor sites, online forums, or tech sites such as [www.geek.com](http://www.geek.com). You can also find cutting-edge information and reviews in hardcopy PC magazines and shopper guides.

Let’s look at some of the typical components you may find on a modern system board ([Figure 3](#)). Although every system board you encounter will be laid out differently and will have different hardware, we’ll discuss the function of some typical components. Don’t worry too much about getting all this information down right now; we’ll discuss some of these components in more detail later.



**FIGURE 3—A Typical System Board**

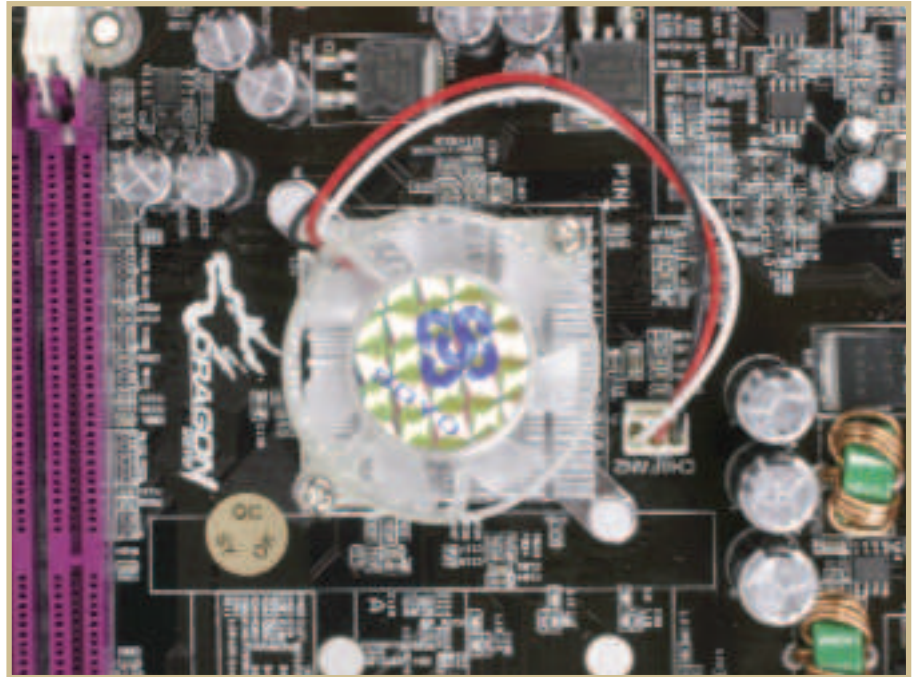
#### **Technical Note**

Every CPU has a rated speed, for example, 2.0 GHz. If you run a 2.0 GHz chip at a speed higher than its rating, you may damage the chip and render the entire system board useless.

## **The Central Processing Unit**

The *central processing unit (CPU)* is the brain of the computer. That's why computers are referred to by the type of CPU they contain, such as 8088, 8086, 286, 386, 486, Pentium, Pentium II, etc. The CPU is located underneath its own cooling fan and/or heat sink (Figure 4).

**FIGURE 4—The CPU contains its own cooling fan.**



## The Basic Input/Output System

The *basic input/output system (BIOS)* is a chip that contains the startup programs, such as *power-on self-test (POST)*, and drivers of the computer. This chip gets the computer system running and interfaces with the system hardware and the operating system. BIOS is referred to as firmware. The term *firmware* suggests that the chips are neither hardware nor software but contain elements of both. Almost all computers include *flash ROM* to store the BIOS. (We'll discuss ROM later in this study unit.) Flash ROM allows you to erase and upgrade the BIOS software.

## Expansion Slots

The *expansion slots* enable the CPU of the computer to communicate with peripheral devices that expand the capabilities of the computer. Different cards can be plugged into these slots to enhance the computer, such as adding a video card to make graphics redraw faster on the monitor.

## The Battery

The *complementary metal oxide semiconductor*, or *CMOS*, is an onboard semiconductor chip used to store system configuration settings, such as hard-drive parameters, memory configurations, and the system's date and time. It's used by the BIOS and located with the real clock in the system board chipset or in a separate clock chip. The small amount of power CMOS requires is used to retain its contents. For this purpose, the system employs a battery when it's turned off. Batteries vary in shape, voltage, and composition—alkaline, nickel/cadmium, or lithium. Lithium batteries can last up to ten years, depending on how much they're used and environmental conditions. If a system battery goes dead, crucial system information and functionality can be lost. Thus, it's always a good idea to write down your CMOS settings.

## Chips

Newer system boards have fewer chips than older ones. In the past, individual chips were needed to perform specific functions. Today, these functions are being performed by a single chip with more built-in circuitry or by the chipset. The best example of this trend is the change that has taken place in RAM chips. Early PCs had as many as eight banks of nine chips each, for 256 KB (or K) of RAM. Today, a one GB dual inline memory module (DIMM) can take the place of these 72 chips and more. We'll discuss RAM and DIMMs and related items later in this study unit.

The major chips on the system board are supported by a number of other *integrated circuit (IC)* chips. These chips include the system controller, the page mode memory controller, the data controller, the address controller, and the peripheral controller. The *direct memory access (DMA)* circuitry is often included in the peripheral controller chip. The user's manual sometimes contains the chip numbers for these ICs. If you buy a system board from a supplier, it will almost always contain enough documentation for you to identify the chips that perform specific functions.

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A *byte* is eight bits.

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A *megabyte* (MB) is equal to 1,048,576 bytes.

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A *megabit* (Mb or Mbit) is equal to 1,048,576 bits.

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A *gigabyte* (GB) is equal to one billion bytes.

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A *gibibit* (GiB) is equal to 1,073,741,824 bits.

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## The Integrated Drive Electronics

The *integrated drive electronics (IDE)* controller is responsible for controlling all IDE and serial ATA (SATA) interface disk drives.

## The Power Supply and Other Connectors

A variety of connectors may exist on a system board. Such connectors are used for plugging into equipment such as the power supply and keyboard. In older AT PCs, two power cables (often labeled P8 and P9) are attached to the system board by a multiconnector socket and prongs. On newer ATX PCs a single power connector (P1) connects the power supply to the system board using 20 or 24 pins.

Pentium IV (P4) system boards have an extra 4-pin connector that's used to connect to the power supply. This ATX12V or SFX12V power supply gives an extra 12 volts to the P4 board. A system board that doesn't have this connector is probably a non-P4 ATX board and shouldn't be used with that processor. An Intel-based system won't boot until the 12V 2X2 connection is made to the system board. Failure to use the right power supply or connect the 4-pin power cable may result in damage to the system board and/or the power supply.

### Technical Note

In electronics, the source of power has a *female* connector and the device receiving power has a *male* connector. A wall outlet, for example, is female. The plug at the end of an appliance, such as a lamp, is male. This configuration greatly reduces the risk of shock.

## SIMMS and DIMMS

The *single inline memory module (SIMM)* replaced *dual in-line package (DIP)* chips. Instead of having multiple memory DIP chips, SIMMs and *dual inline memory modules (DIMMs)* replaced these individual memory chips. SIMMs, which were replaced in turn by DIMMs, are considered to be one large memory chip, which is actually composed of many small memory chips. If a problem develops, the entire SIMM or

DIMM is replaced instead of having to determine which individual chip is responsible for the problem, as was done with DIPs.

## Ports

Computer ports allow external devices to be connected to the system board. There are a number of different ports that may be found on a system board, including parallel, serial, *universal serial bus (USB)*, and *small computer system interface (SCSI)* bus. Parallel ports act as printer adapters. Serial ports support a number of low-speed peripherals, including modems, some scanners, “serial” mice, and digital cameras. USBs are able to support up to 127 devices, far more than a traditional serial port; they’re also much faster and can support a number of devices, including cameras, printers, external drives, and Web cams. A SCSI bus can support a number of peripherals, including hard disks, tape drives, CD-ROM drives, scanners, and other devices.

## Resistors, Capacitors, and Diodes

At various places on the system board, you’ll see resistors and capacitors. You might even see a set of resistors in something known as a *resistor pack*. The resistors and capacitors help maintain the appropriate voltage and current for system board components. If you look carefully, you’ll see very small devices that look like resistors, except they don’t have the identifying colored bands. These devices are *diodes*.

## The Evolution of the System Board

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As computer systems have evolved, more devices have been integrated into the system board. As a general rule, the parts of the system board that are more subject to change, such as RAM or CPU, tend to be integrated into sockets or slots so that they can easily be removed and replaced with upgrades. Over time, different manufacturers have had various design approaches on how to best make an easily-upgradable system board.

Since you'll encounter many different types of systems, we'll give you some of the history of the evolution of system boards and then show you some illustrations so you can see just how much they've changed. But first, let's discuss the common forms, or *form factors*, used for system boards. By common forms, we mean the size and shape of the boards, because the size of the board dictates what kind of case the system board will fit into.

## Full-Size AT

The full-size AT system boards are large in order to accommodate a lot of circuitry (Figure 5). Full-size AT system boards fit into full-size AT desktop and tower cases. They won't fit into mini-towers or slimline-type cases. While a baby-AT can replace a full-size AT system board, a full-size board can't replace a baby-AT board due to size constraints. For the most part, full-size AT system boards are no longer being produced. With advances in microprocessor technology, components are getting smaller, allowing for smaller system boards.

**FIGURE 5—An AT System Board Design for a 486 Computer**



## Baby-AT

From 1983 to 1996, the baby-AT form size was the most popular system board because it would fit into a number of different case designs. In fact, today you can still get system boards of this design with any processor installed, from the original 8088 to a Pentium. The baby-AT design was replaced by the ATX design in 1996.

## LPX

The LPX-type design is a semiproprietary system board design used mostly in the slimline-type case designs and also in some tower case designs. Because of their proprietary nature, LPX and other proprietary designs, such as backplane systems, are difficult to repair and upgrade. If something breaks on one of these designs, you have to go back to the original manufacturer for replacement parts. Such replacement parts or upgrade parts are very expensive. In these cases, you're often better off purchasing a brand-new system that has a nonproprietary design.

## ATX

The ATX system board improved upon the baby-AT and LPX designs (Figure 6). ATX designs aren't compatible with AT designs, because the system board is turned sideways in the case and has a different power supply connector and location. Thus, ATX system boards use an entirely different case design. This case design allows for longer boards and increases airflow to reduce heat inside the case.

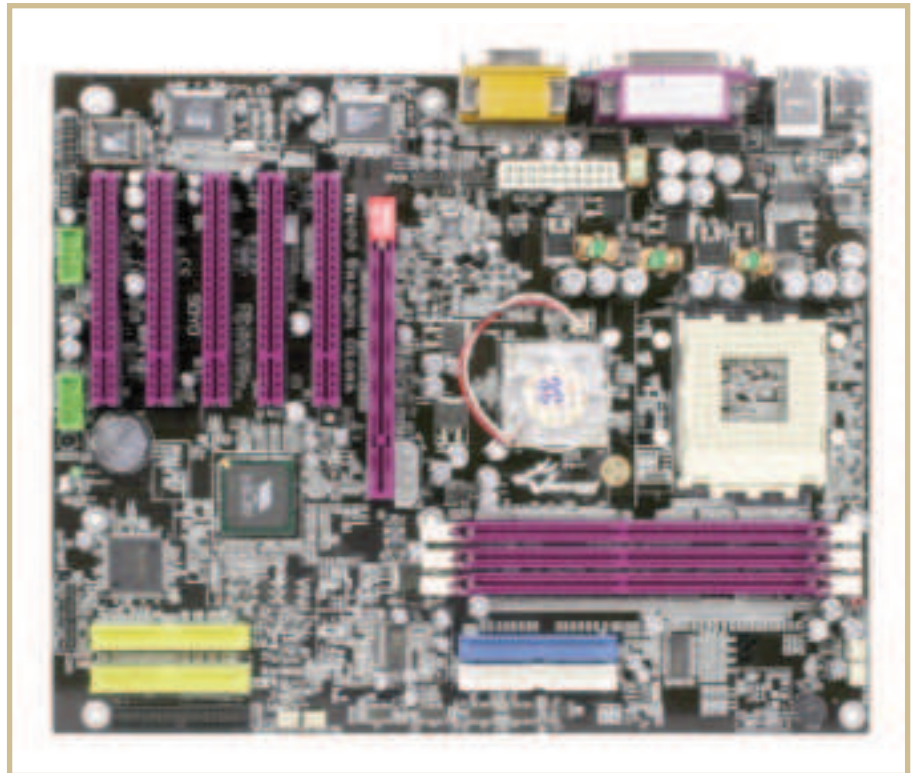
Initially, the airflow design used a positive-pressure cooling system, blowing air into the case across the system board. However, newer processors run at higher speeds and produce more heat; the positive-pressure cooling system usually requires secondary heat sinks or system board fans to dissipate that heat. As a result, manufacturers are migrating back to the more effective *negative-pressure* (air blowing out) method that's used in the AT.

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A *backplane* consists of connector blocks and wiring units that form system circuitry.

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**FIGURE 6**—The ATX system board is designed for the Pentium and later CPUs.



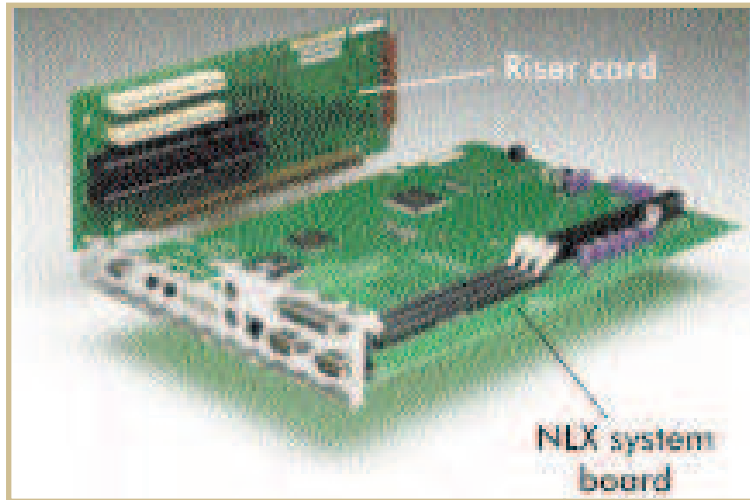
Another change from the AT was a new 20-pin keyed power connector. This replaced the P8 and P9 connectors, which, if reversed, could burn out your system board. The keyed design also helps in that the connector can only go in one way.

Unlike the original AT, which required only 5 or 12 volts, the ATX supports the lower voltages of newer processors (3.3 V and below). Less voltage equates with less heat and less power consumption. In addition, the ATX power supply can be turned on or off with software for scheduled startups or shutdowns.

Just as the AT system board has its baby-AT form factor, the ATX also has other form factors. The first is the mini-ATX, which uses the same power supply and case as the full-size ATX board, with the exception of being about an inch shorter on each side (11.2 in.  $\times$  8.2 in.). The microATX (9.6 in.  $\times$  9.6 in.) and FlexATX (9 in.  $\times$  7.5 in.) are smaller-board versions. These form factors are for low-end PCs, have their own power supplies (which supply a constant 90 W), and support only socket-type CPUs. ATX is the most popular design of newer systems and is easily upgradable and repairable.

## NLX/Micro-ATX

Another type of system board form factor we're going to discuss is the NLX (Figure 7A). Introduced by Intel in 1997, the NLX format is smaller than some of the other form factors, making it well suited for low-profile desktop cases.



**FIGURE 7A—An NLX System Board with Riser Card**

The NLX is designed with an emphasis on easy maintenance. All expansion slots, power cables, and peripheral connectors are located on an edge-mounted riser card to allow easy removal of the system board (which is mounted on rails in the chassis). The NLX uses a full-width input/output (I/O) shield to allow for different combinations of rear-panel I/O. The NLX also has the ability to support the latest processor technologies. The processor can be easily accessed and receives greater cooling than those with a closed-in layout. The NLX will support a Pentium II system single-edge contact cartridge and is designed for greater flexibility in the face of rapidly changing processor technologies. Its backplane-like flexibility is built into the form by allowing a new system board to be easily and quickly installed without having to disassemble the entire system.

The last type of system board to be discussed here is the micro-ATX (Figure 7B). Released around the same time as the NLX factor, the micro-ATX has experienced more success than many of its fellow factors, as it is backward-compatible with the ATX, which remains the most popular form factor as of 2011. The micro-ATX uses less power than a full ATX board, mainly due to the integration of many of the functions of a PC, such as a

**FIGURE 7B—Micro-ATX  
System Board**



video adapter chip and NIC, in addition to reducing the number of available expansion slots. Most current micro-ATX boards use the latest version of the ATX standard, including the 24-pin P1 power connector that carries wider voltage ranges and support for PCI-E slots.

System board design is constantly changing. These previous illustrations should give you a good start in understanding the major differences between form factors. As a technician, you'll often come upon system boards and features you haven't seen before. Take it in stride and refer to the user's manual. Look carefully at the system board before you begin working, and you'll soon figure it out. Remember that anytime you have an opportunity to inspect or read about a system board, take advantage of it, especially if an expert is present to lend a hand. Despite the apparent complexity of a system board, it's actually less complicated than a map of a typical large city. Learning to read a map takes a while, and so does learning to read a system board. With practice, however, you'll acquire the skills you need.



### ***Real-Life Situation***

A friend of yours has a Super Micro SUPER P4SPE system board. Using the Internet as a resource, answer the following questions.

1. How many and what types of CPUs does the system board support?
2. What's the form factor for this system board?
3. What chipset does this system board use?
4. What's the speed of the system (frontside) bus?
5. What type of audio does this system board have?
6. Does this system board support desktop management interface (DMI)?
7. What's the minimum recommended power rating for the power supply?
8. How many USB ports does this system board have?
9. What type of keyboard connector is on the system board?
10. How much RAM is supported by the system board?

**Check your answers with those on page 78.**

Now take a moment to review what you've learned by completing *Self-Check 1*.



# Self-Check 1

**At the end of each section of *System Boards and Component Identification*, you'll be asked to pause and check your understanding of what you have just read by completing a "Self-Check" exercise. Answering these questions will help you review what you've studied so far. Please complete *Self-Check 1* now.**

1. *True or False?* The battery that's responsible for the time and date information will last about four years.  
\_\_\_\_\_
2. What's a disadvantage in buying a computer that has an LPX system board form factor?  
\_\_\_\_\_
3. What's a DIMM, and what function does it perform?  
\_\_\_\_\_
4. What system board design replaced the AT design?  
\_\_\_\_\_
5. What separates the system board from the chassis?  
\_\_\_\_\_

**Check your answers with those on page 77.**

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