

Exploring Peripherals and Expansion Cards

In this chapter, you'll learn about different components that you can add to a computer and how you can do so. The most common way of connecting external devices is with Universal Serial Bus (USB) connections, but there are other methods such as FireWire, and a variety of miscellaneous connections are available at the rear of a computer. In addition to using available connections to add components, you can add expansion cards to give your computer additional capabilities.

Exam 220-801 objectives in this chapter:

- 1.4 Install and configure expansion cards.
 - Sound cards
 - Video cards
 - Network cards
 - Serial and parallel cards
 - USB cards
 - FireWire cards
 - Storage cards
 - Modem cards
 - Wireless/cellular cards
 - TV tuner cards
 - Video capture cards
 - Riser cards
- 1.7 Compare and contrast various connection interfaces and explain their purpose.
 - Physical connections
 - USB 1.1 vs. 2.0 vs. 3.0 speed and distance characteristics
 - Connector types: A, B, mini, micro
 - FireWire 400 vs. FireWire 800 speed and distance characteristics

- Other connector types
 - Serial
 - Parallel
 - Audio
- 1.11 Identify connector types and associated cables.
 - Display connector types
 - miniDIN-6
 - Device connectors and pin arrangements
 - USB
 - IEEE1394
 - PS/2
 - Parallel
 - Serial
 - Audio
 - Device cable types
 - USB
 - IEEE1394
 - Parallel
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- 1.12 Install and configure various peripheral devices.
 - Input devices
 - Mouse
 - Keyboard
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 - Barcode reader
 - KVM
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 - Biometric devices
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 - Joysticks
 - Digitizer
 - Multimedia devices
 - Digital cameras
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 - Webcam

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Peripherals and Device Drivers



A *peripheral* is any device that you connect to a computer. This term includes critical components such as keyboards, mice, and display monitors. It also includes additional components such as speakers, scanners, printers, external hard drives, and flash drives.

Chapter 2, “Understanding Motherboards and BIOS,” describes how the Basic Input/Output System (BIOS) is used when a computer is first turned on. The processor runs this program to access basic hardware such as the keyboard, display, and hard drives. It locates an operating system (such as Windows) on a disk drive and loads it. The operating system then loads additional software, including device drivers, used to access other peripheral devices.

Device Drivers



When manufacturers create hardware devices, they also create a *device driver* for different operating systems. The device drivers give the operating system the information it needs to communicate with the device. Without the correct device driver, the device doesn't work.

Windows and other operating systems include many drivers, so you can often just connect a device and it'll work. Windows does some work behind the scenes that isn't apparent. When you insert a device, Windows recognizes it, looks for a suitable driver, and associates it with the device. In most cases, this happens automatically without requiring you to do anything else.

However, sometimes Windows doesn't have the driver for the device. In these cases, you need to install it.

MORE INFO CHAPTER 15, “CONFIGURING WINDOWS OPERATING SYSTEMS”

When you need to manipulate device drivers manually, you use Device Manager in Windows-based systems. Device Manager is discussed in Chapter 15.

Install Device Drivers before Installing Device

New devices often include a CD with a device installation program. You insert the CD and follow the directions to install the drivers. In some cases, the instructions are very specific about installing the drivers *before* installing the device.

The following situation doesn't occur often, but when it does, it can take a lot of time to resolve. Specifically, it is possible for Windows to misidentify a device and install a similar but incompatible driver. The device might work partially or not at all. If you try to install the correct driver with the installation CD later, Windows might continue to use the first driver it installed.

When manufacturers are aware of this problem, they provide clear instructions to install the driver first. If you see a note saying to install the driver first, it's best to do so.

Plug and Play



Windows includes a great feature called *Plug and Play (PnP)* that automates the installation and configuration of many device drivers. Many people recognize that it is automatically installing the correct driver, but they're unaware that it is also configuring resources for the driver. Two important resources that are automatically assigned are a specific range of memory addresses used by the device and an *interrupt request (IRQ)* number.

When devices want to get the attention of the CPU, they raise an IRQ, just as you might raise your hand to get someone's attention. The CPU identifies the device based on the IRQ number and answers the request by addressing the device with the memory address.

Years ago, in addition to finding and installing the correct driver, you also had to configure the memory and IRQ settings manually, which could be quite tedious. I'm happy to say that I haven't had to configure these settings manually with Windows XP, Windows Vista, or Windows 7.

REAL WORLD FOLLOWING THE DIRECTIONS AVOIDS PROBLEMS

I know it's tempting to install first and follow directions later—I've been guilty of it a few times in the past. Manufacturers know this too and will often use special, highly visible labels saying something like, "Install software before attaching device."

I remember helping a friend with a new digital camera he had purchased. The directions clearly said to install the drivers first, but like a kid at Christmas, he just ripped the packaging open and plugged it in after taking some pictures. Unfortunately, the operating system didn't recognize it, so he went back to the directions to install the correct driver, but the operating system still used the original.

We had to go through several steps to get it working. We went into Device Manager to uninstall the driver, shut the system down, and disconnected the camera. We then rebooted and went through the process of installing the software provided with the drive. When we reconnected it, it worked.

While this ended up being a success story, it was avoidable. If the directions say to install the driver first, it's best to do so. If you're not sure, installing the driver first is always safe.

USB



The most common method of connecting peripherals to a computer is by using *Universal Serial Bus (USB)*, and a popular USB device is a USB flash drive (also called a USB thumb drive). Figure 5-1 shows a picture of a 16-GB flash drive that you can use to store all your A+ notes plus several thousand songs, pictures, and other files.

NOTE FLASH MEMORY

The memory used in USB flash drives is flash memory. This is the same type of memory commonly used to store the BIOS program on a motherboard. It is nonvolatile, meaning that it retains data without power and it is hot-swappable.



FIGURE 5-1 USB flash drive.

You've probably seen USB flash drives before, so I'm betting this is familiar to you. However, as an A+ technician, you should be aware of some important details about USB. Table 5-1 outlines some details about the three versions of USB.

TABLE 5-1 USB Versions

Version	Common Name	Speed
USB 1.1	Low Speed Full Speed	1.5 Mbps (low speed) or 12 Mbps (full speed)
USB 2.0	High Speed	480 Mbps (60 MBps)
USB 3.0	Super Speed	5 Gbps (625 MBps)

Most computers support USB 1.1 and USB 2.0, but USB 3.0 is relatively new and not as common.



EXAM TIP

Know the speeds of each of the USB versions when preparing for the exam.

USB 1.1 and 2.0 Connections

The most common USB port is the Standard Type A port. You find at least one Standard Type A port on almost every PC and laptop computer, and many devices also use the Standard Type A port. Other connection types are the Standard Type B, Mini-B, Micro-A, and Micro-B connections.

NOTE PORTS VS. CONNECTORS

In general, a port is the connection on a device and a connector is the connection on a cable that plugs into a port. For example, when you connect an external USB hard disk drive, you use a cable with two connectors. One connector plugs into the port on the computer, and the other connector plugs into the port on the external USB hard disk drive. However, don't be surprised if you see these terms interchanged.

Figure 5-2 shows a picture of the three most common USB connectors (Standard Type A, Standard Type B, and Micro-B) along with a diagram of all the connectors.

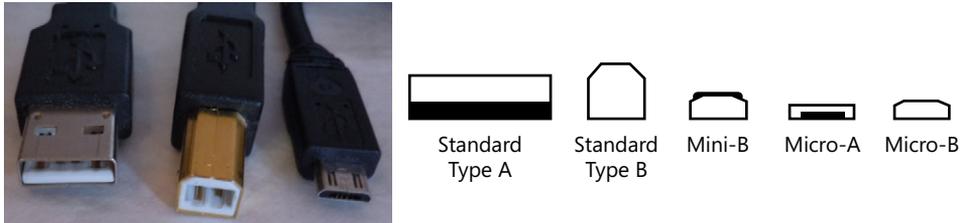


FIGURE 5-2 Common USB connectors.

Some larger devices, such as printers and video recorders, use the Standard Type B port. One end of the cable is a Standard Type A connector that plugs into the computer, and the other end of the cable is a Standard Type B connector that plugs into the device. Smaller devices, such as smartphones, digital cameras, and global positioning system (GPS) devices, need smaller connections and use the mini and micro connections. The Mini-A connector is no longer used.

Both the Standard Type A and the Standard Type B connectors have four pins and provide 5-V power to the device via pin 1. Each of the mini and micro connectors has five pins and also provides 5-V power to the device on pin 1. The extra pin is used to distinguish the host from the device.

USB 3.0 Connections

While USB 1.1 and 2.0 connectors are identical, USB 3.0 connectors have some significant differences. Despite these differences, USB 3.0 ports still accept connections from older USB devices.

Table 5-2 shows the wiring of the Standard A and B connectors for each of the versions. They are physically the same size, but USB 3.0 ports and connectors are blue to make them easily distinguishable.

TABLE 5-2 USB Standard A and Standard B wiring

Pin	1.1 and 2.0 A and B	USB 3.0 Standard A	USB 3.0 Standard B
1	VBUS (5 V)	VBUS (5 V)	VBUS (5 V)
2	Data -	Data -	Data -
3	Data +	Data +	Data +
4	Ground	Ground	Ground
5	N/A	Receive -	Transmit +
6	N/A	Receive +	Transmit -
7	N/A	Ground	Ground
8	N/A	Transmit +	Receive -
9	N/A	Transmit -	Receive +

USB 3.0 includes two additional sets of pins used to send and receive data at the same time. The A port sends data on pins 8 and 9 and receives data on pins 5 and 6. The device using the B port sends data on pins 5 and 6 and receives data on pins 8 and 9. Only newer USB 3.0 devices take advantage of the new pins. Older devices don't have the pins, so they simply aren't used.

The table also shows that pins 1 through 4 are identical for each version. You can plug any USB device into any of these ports and it will work, but you only can get 3.0 speeds when you plug a USB 3.0 device into a 3.0 port. Possible combinations include the following:

- **USB 1.1 or 2.0 device in USB 3.0 port.** This will work at the device's speed. For example, a 2.0 device will run at 480 Mbps.
- **USB 3.0 device in USB 2.0 port.** This will work at the USB 2.0 speed of 480 Mbps.
- **USB 3.0 device in USB 3.0 port.** This is the only combination that allows the full 5-Gbps speed.

In addition to the USB Standard A and Standard B connectors, USB 3.0 also has a USB Micro-B connection. It includes the exact same connector as the USB 2.0 Micro-B connection and adds an extension with five more pins, as shown in Figure 5-3.

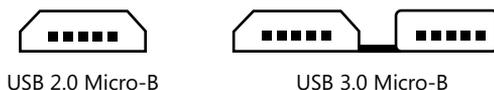


FIGURE 5-3 USB Micro-B connectors.



EXAM TIP

USB 3.0 ports and connectors are blue and are backward-compatible. You can plug older USB devices into a USB 3.0 port, and they will work normally. You can also plug USB 3.0 devices into older USB Standard Type A and B ports and they will work, but at USB 2.0 speeds.

USB Controller

Computers have one or more USB controllers used to control USB devices, and the controller is a part of the chipset on the motherboard. Each version of USB supports a total of 128 devices, including the controller. Therefore, the USB controller can support as many as 127 devices.

It's common for a desktop computer to have USB ports available at the front and in the back. These ports can be controlled by the same controller or, in some cases, by separate controllers.

The ports provide power to the devices that need it, but it's important to realize that there is a limited amount of power shared by the ports. If you plug in too many devices, one or more of the devices will stop working. For example, if you plug a camcorder (video recorder) into a USB port, your keyboard or mouse might stop working. This is rarely a problem, unless you plug in a device that draws a lot of power, such as a camcorder.

There are two solutions to this problem. The first is to provide power to the device with its own power cord. You can also connect an externally powered USB hub (like the one shown in Figure 5-4) to the computer. It plugs into a USB port and provides additional powered ports to external devices without drawing power from the computer.



FIGURE 5-4 USB hub.

In addition to sharing power, each of the devices connected to a controller shares the same bandwidth. For example, if you have a USB 2.0 controller with five USB devices connected, each device does not have 480 Mbps of bandwidth available. Instead, the devices share the 480 Mbps bandwidth.

USB Cable Lengths

When connecting devices by using a USB cable, the cable can be as long as 5 meters (about 16 feet). This is useful for devices such as printers. It's very rare to find a device with a 5-meter USB cable, but USB extension cords are available. The maximum recommended cable length for USB 3.0 is 3 meters (almost 10 feet).



EXAM TIP

Know the maximum cable lengths when preparing for the exam.

Dirty Bit



USB devices are hot-swappable, meaning that you can insert and remove them without powering a system down. However, you shouldn't remove a USB device if it has an open file. When you open and modify a file in Windows, a bit is set indicating that the disk has an unsaved file. This bit is commonly called a *dirty bit*. When all the files have been saved, the dirty bit is cleared.

If you insert a flash drive that has the dirty bit set, you'll see a message similar to this: "Do you want to scan and fix Removable Disk? There might be a problem with some files on this device or disc. This can happen if you remove the device or disc before all files have been written to it." If you choose to scan and fix it, the system will run a program called `chkdsk` on the drive and resolve the problem.

MORE INFO CHAPTER 16, "UNDERSTANDING DISKS AND FILE SYSTEMS"

`Chkdsk` can also be used to manually check disks for problems and repair them. Chapter 16 explores `chkdsk` in more depth.

You can avoid this completely by ensuring that all files are closed before removing a flash drive. Additionally, ensure that the computer is not writing to the flash drive before you remove it. If you remove a drive while a file is being modified, the system might corrupt the file.



Quick Check

1. How many devices are supported by a USB hub?
2. What is the speed of USB 3.0?

Quick Check Answers

1. 127.
2. 5 Gbps.

FireWire



FireWire was originally created by Apple and later standardized as IEEE 1394. It is a high-speed serial bus similar to USB and is often used for audio and video editing. It can transfer data between a computer and digital video cameras or external hard drives at the high speeds needed for effective editing.

When it was updated, versions became known as FireWire 400, or *IEEE 1394a*, and FireWire 800, or *IEEE 1394b*. In addition to being used as a high-speed serial bus with a computer, FireWire 800 can also be used to network computers together with common Category 5e twisted-pair cable, although this isn't common. Table 5-3 compares the two versions.

TABLE 5-3 FireWire Versions

Version	IEEE Name	Speed	Max Cable Length
FireWire 400	1394a	400 Mbps	4.5 meters (about 15 feet)
FireWire 800	1394b	800 Mbps	100 meters (about 330 feet)

NOTE **i.LINK AND LYNX**

FireWire is also called i.LINK by Sony, and Lynx by Texas Instruments.

FireWire Cables and Connections

When connecting FireWire 400 devices, the cable can be as long as 4.5 meters (about 15 feet). It's common to daisy-chain FireWire devices by plugging devices into each other. This way, a single FireWire port supports multiple devices, so FireWire can support as many as 63 devices.

You can use FireWire hubs to connect multiple FireWire devices. They work the same way as USB hubs, where you plug the hub into a FireWire port and the hub has multiple FireWire ports. You can also daisy-chain FireWire devices by connecting them to each other. You can have as many as 16 cables for a maximum cable length from the FireWire 400 port of 72 meters (about 236 feet).

There are three types of FireWire connections:

- **4-pin.** This port does not provide power. It's found on smaller devices that don't need power and on laptop computers, instead of the full-size 6-pin port.
- **6-pin alpha connector.** This port includes pins for data and power. It is the port that is most closely associated with FireWire.
- **9-pin beta connector.** This port includes the same connections as a 6-pin port but adds pins for a grounded shield. The shield prevents interference from nearby devices or cables and is required for FireWire 800.

Figure 5-5 shows the 4-pin and 6-pin FireWire 400 connectors. It also includes a diagram of all three connections, including the less common FireWire 800 9-pin connection.

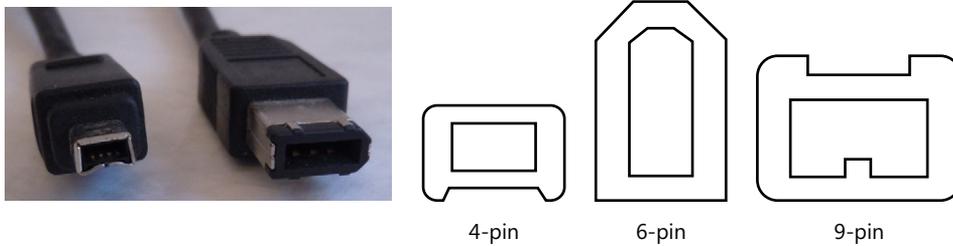


FIGURE 5-5 FireWire connectors (4-pin and 6-pin, with added diagram of 9-pin).



EXAM TIP

Know the speeds of each FireWire type and the details of each connection. The 4-pin port does not provide power, but the 6-pin port does. The 9-pin port is required for FireWire 800.

FireWire S1600 and S3200

IEEE 1394b also included specifications for S1600 and S3200, although devices aren't as readily available for them. S1600 supports speeds up to 1.6 Gbps, and S3200 supports speeds up to 3.2 Gbps. These devices use the 9-pin beta connection.

FireWire S1600 and S3200 devices have been slow to appear for desktops. However, as more USB 3.0 devices with 5 Gbps speeds come to market, it's very likely that you'll see FireWire devices using these faster speeds.



Quick Check

1. How many devices are supported by FireWire?
2. What is the speed of IEEE 1394b?

Quick Check Answers

1. 63.
2. 800 Mbps.

Miscellaneous Connections

Although they are rarely used with typical computers today, some older connections are specifically mentioned in the A+ objectives, so you should be aware of them. Figure 5-6 shows the back of an older computer with these ports, and the following list provides a brief description of each port.



FIGURE 5-6 Back of older computer.

- **PS/2.** At the far left of Figure 5-6 are the older PS/2 ports. The top port is for a mouse, and the bottom port is for a keyboard.
- **Mini-DIN.** The two PS/2 ports are 6-pin mini-DIN ports, but you might run across other mini-DIN ports. *DIN* is short for *Deutsche Industrie Norm*, the German national standards organization that created the standard.
- **1394/USB.** This computer includes one FireWire port and two USB ports.
- **Parallel.** The long, 25-pin female port on the top to the right of center in Figure 5-6 is the parallel port. It is a *DB-25* port.
- **Serial.** The 9-pin male serial port is shown at the bottom center of Figure 5-6. It is a *DB-9* port.
- **VGA.** The 15-pin, three-row port on the bottom right of Figure 5-6 is an old Video Graphics Array (VGA) port. It is a *DB-15* port.

Devices that previously used the PS/2, mini-DIN, parallel, and serial ports commonly use USB ports today. The VGA connection might be present, but other video ports are usually available and used instead. Chapter 6, “Exploring Video and Display Devices,” covers video in more depth.

NOTE D CONNECTORS

The parallel, serial, and VGA connectors are all loosely shaped like the letter *D*. Each has an official letter designation, but they are commonly called *DB connections*. The 25-pin parallel connection is called a *DB-25* (officially *DB-25*), the 9-pin serial connection is called a *DB-9* (officially *DA-15*), and the 15-pin VGA connection is called a *DB-15* (officially *DE-15*).

PS/2



The *PS/2* name comes from the original IBM personal system/2 computers that used these ports. It is a 6-pin mini-DIN connection. It wasn't originally color-coded, but later implementations used a standard of green for the mouse and purple for the keyboard. Both the connectors on the cable and the ports on the computer are color-coded.

A challenge with these ports is that they are not hot-swappable. It's possible to cause damage by plugging in a device with the power on, although most ports are configured today to help prevent damage. More often, devices that are plugged in with power just aren't recognized. If a mouse or keyboard cable comes loose, you often have to turn off the system to plug it back in.

EXAM TIP



Know the connection colors when preparing for A+ exams. The keyboard is purple, and the mouse is green. (One way to remember this is that "mouse" has five letters and "green" also has five letters.) Also, you should be able to recognize any connection by its shape.

Mini-DIN

Several different types of *mini-DIN* connections are available. Versions come with three, four, five, six, seven, eight, and nine pins. In addition to its use for the PS/2 connections, the 6-pin DIN can also be used for video and audio connections. Another common mini-DIN connection is the Separate Video (S-Video) connection, which is a 4-pin DIN used for video.

Parallel



The *parallel* port was the primary port used for printers before USB became so prevalent, and it was often called the printer port. Data was sent out by the port eight bits (a byte) at a time. Compared to the serial port, which could send data only one bit at a time, the parallel port could send data eight times faster. A ribbon cable connected the printer to the parallel port.

Parallel ports were designated as LPT (short for *line printer*). Most computers had only one parallel port, so it was identified as LPT1.

New printers use USB, FireWire, and/or network connections, and these connections are far superior to the older parallel interface. It's rare to see the parallel port on a new computer.

Serial



The *serial* port was used for devices that could handle data being sent one bit at a time. Figure 5-6 shows a 9-pin male serial port on the back of the computer.

Some computers included both a 9-pin male serial port and a 25-pin male serial port. Combined with the DB-25 parallel port, the DB-25 serial port sometimes confused techs. The

primary way to tell the difference is that the serial ports always have pins and the parallel ports always have pinholes.

There is a significant difference between serial data sent via the serial port and serial data sent through USB or FireWire ports. USB and FireWire use low voltage differential (LVD) signaling, which is described in Chapter 4, “Comparing Storage Devices.” As a reminder, LVD sends data as differences in voltages between two wires in a pair and can achieve lightning-fast speeds. It’s used for USB, FireWire, SATA, AMD HyperTransport busses, and more.



In contrast, the serial ports use RS-232. RS is short for *recommended standard*, and RS-232 is the common standard used to send serial data. RS-232 is still used in specialized equipment, but it’s rare to see a serial RS-232 port in modern computers.

Serial ports are referred to as COM ports. Each COM port has a number, such as COM1, COM2, and so on.

✓ Quick Check

1. What color is the keyboard PS/2 connector?
2. What is the purpose of a DB-9 connector?

Quick Check Answers

1. Purple.
2. Serial communications.

Sound

One of the computer outputs that many people enjoy is audio. Sound can be provided by a simple speaker, by a set of headphones, or with an elaborate 7.1 surround sound system.

MORE INFO CHAPTER 6 AND CHAPTER 7

Other output devices include video, covered in Chapter 6, and printers, covered in Chapter 7, “Exploring Printers.”

Common Sound Systems

An important piece of knowledge that you need for the A+ exam is how sound systems can be connected. A basic mono sound system has a single channel. No matter how many speakers you connect, the same sound comes out of each one. However, many sound systems include multiple channels. For example, stereo is a two-channel sound system and plays

different sounds from the left and right speakers. Some other common sound systems include the following:

- **2.1.** The 2 indicates that it is stereo, and the .1 represents a subwoofer. The subwoofer provides deep bass sounds.
- **5.1.** A 5.1 sound system is also known as a surround sound system and has five speakers and a subwoofer. It has left and right speakers in the front, left and right speakers in the rear, and a central speaker, often used for voice or dialog.
- **7.1.** A 7.1 sound system includes the same five speakers and subwoofer found in a 5.1 surround sound system and adds two speakers: one on the right side and one on the left side.

Many games and other programs use 3D sound and positional audio to play audio so that it seems as if the sound is in a specific location. For example, you might hear a dog bark from behind you, a bird singing in a tree on your right, or an explosion in front of you. Combined with the deep bass of the subwoofer, you're often able to feel many of the sounds, creating a realistic experience.

Connecting Sound Systems

Most motherboards have built-in sound capabilities as part of the chipset. They provide connections at the back of the system and sometimes at the front. These connections are color-coded and have icons that give you an idea of what they do.

For example, Figure 5-7 shows the back of a system with several ports for a 7.1 sound system, and Table 5-4 describes these ports.



FIGURE 5-7 Sound connectors for 7.1 system.

TABLE 5-4 Sound Connections

Purpose	Color	Comments
Microphone	Pink	Top left. Microphone icon.
Front speakers or headphones	Lime green	Top middle. When on front panel, it often has a headphone icon.
Line in	Light blue	Top right. This accepts sound from sources other than a microphone.
Middle speakers	Brown	Bottom left. Used only for 7.1 systems.
Subwoofer and center speaker	Orange	Bottom middle. Center speaker used for 5.1/7.1 systems and subwoofer used for any x.1 system.
Rear speakers	Black	Bottom right.

NOTE COLORS NOT ALWAYS FOLLOWED

While there are standard colors followed by most vendors, you'll very likely encounter some sound ports that differ from the standard. For example, sometimes gray is used instead of brown for the middle speakers.

Some sound cards also include a Musical Instrument Digital Interface (MIDI) connector. This is a DB-15 connector. Musicians can connect musical instruments and other electronics here to play music. Older joysticks can also plug into this connector.



Most audio connections use a *tip ring sleeve (TRS)* connector. As shown in Figure 5-8, a TRS connector has three contacts, one on the tip, one on a ring around the pin, and one on a sleeve.



FIGURE 5-8 TRS connector.



Some sound systems use a specialized connection called *Sony/Philips Digital Interconnect Format (S/PDIF)*. It is a single connection, and the digital signal includes all the channels.

Figure 5-9 shows the S/PDIF port on a motherboard. It is next to the blue line-in jack, the green front-speaker jack, and the pink microphone jack (from top to bottom).



FIGURE 5-9 S/PDIF connector next to three other sound connectors.

If you come across a system that isn't playing sound, there are a few things to check. First, check the sound controls in the operating system. The Control Panel has a Sound applet, and a sound control is usually available in the notification area on the right side of the taskbar. You can use these controls to mute/unmute the sound and adjust the volume. Next, ensure that the speakers are plugged into the correct jack. Last, ensure that the correct device drivers are installed.

✓ Quick Check

1. What does .1 indicate in a 7.1 surround sound system?
2. What is the standard color for the front speaker jack?

Quick Check Answers

1. Subwoofer.
2. Lime green.

Input Devices

The basic flow of information through a computer is input, processing, and output. Chapters 2 and 3 spend a lot of time on the motherboard and CPUs that handle much of the processing, but it's also important to be aware of the different types of input devices and how they are installed.

Keyboard

A keyboard is a primary input device used on desktop computers, but there are several variations. For example, Figure 5-10 shows an ergonomically shaped keyboard with some extra keys. The keyboard is specially shaped to encourage a more natural hand and wrist posture.

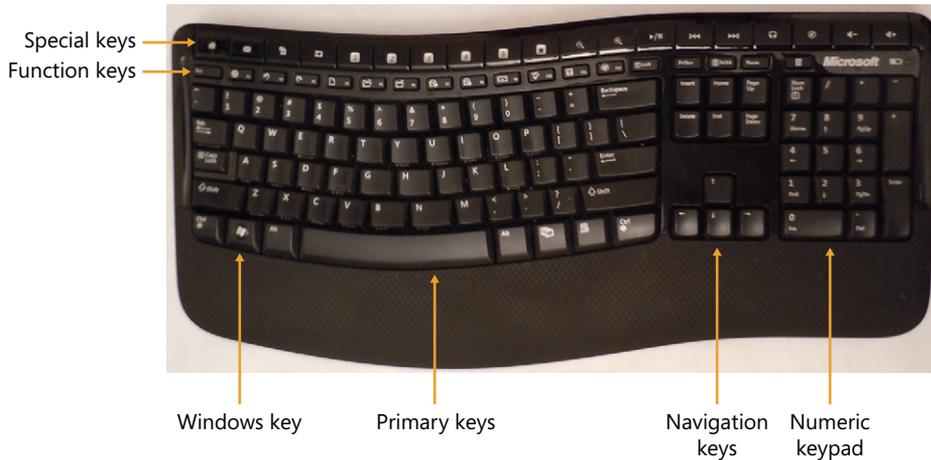


FIGURE 5-10 Ergonomic keyboard.

The special keys along the top are programmed for specific tasks, such as opening the web browser, starting the email client, or controlling audio or video playing on the system. The function keys (F1 through F12) perform specific functions in different programs. For example, F1 will usually start the Help screen, and F5 will usually refresh the display. Windows-based systems make special use of the Windows key with a variety of shortcuts. For example, you can press Windows+E to start Windows Explorer.

Navigation keys are used to move the cursor, and a numeric keypad includes numbers and basic math keys. The numeric keypad includes a Num Lock key, and by toggling it, the numeric keypad can be used for navigation.

Keyboards are very easy to install, and most are Plug and Play. You simply plug them into the purple PS/2 port or a USB port and they work. Some keyboards are wireless and come with an installation CD to install device drivers. After installing the drivers, you plug in a USB transceiver that resembles a small USB flash drive. The keyboard has batteries and can often be used from up to 30 feet away.

Mice

Older mice used mechanical components, such as a rolling ball and wheels, to track the movement. These components often got dirty, resulting in a jerky mouse movement. An improvement to the mechanical mouse is an optical mouse that uses a light emitting diode (LED) and photodiodes. The LED shines light on a surface, and the photodiodes detect movement based

on the reflections. They work well on most flat surfaces but don't work on glossy surfaces such as glass.

Many newer mice include lasers and photo sensors that can track the movement of the mouse with greater accuracy and on more surfaces. For example, Microsoft's BlueTrack Technology allows you to use a mouse on a carpet or the arm of a chair.

A mouse is as easy to install as a keyboard. Most newer mice use a USB port. Wireless keyboards often come with a wireless mouse, and after you install the keyboard, the mouse works too.

NOTE SOLITAIRE TRAINING

The card game Solitaire, often included with Windows-based systems, is used by many trainers to get new users accustomed to how a mouse works. After just a few games, using the mouse becomes second nature. (Be careful, though. It tracks how many games you've played and when you get past a hundred or so games, it's no longer considered training.)

Microphone

Microphones are used as input devices to capture audio. They are sometimes used for real-time interaction, and at other times they are used to record audio for later playback. One of the challenges with a microphone is that it can pick up other noise or sound artifacts that aren't desired. This is especially important when using the recording function. Higher-quality microphones eliminate the artifacts, resulting in better voice recordings.

Figure 5-11 shows three common types of microphones. The headphones include a microphone and are often used by gamers in multiplayer games. Players can be in different physical locations but still interact with each other. A headset microphone is often inexpensive but usually not suitable for recordings.

The middle microphone in Figure 5-11 is a desktop version that users can speak into, and the one on the right can be clipped onto a collar or shirt similarly to the microphones that some television reporters use. Both of these are of higher quality than the headset microphone on the left. You can also find very high-quality microphones similar to those that musicians use.

Typically, microphones will either plug into the pink microphone jack of the sound system using a TRS jack or use a USB connector. Microphones are so common that you usually won't have to install additional drivers.



FIGURE 5-11 Microphones.

Scanners and Digitizers



Scanners and digitizers are used to scan documents and photos and are similar to office copiers in the way they work. You can purchase a stand-alone scanner, but it's much more common to use a multifunction printer that can print, scan, fax, and copy documents. Figure 5-12 shows an HP multifunction printer that includes a document feeder and a flatbed scanner.

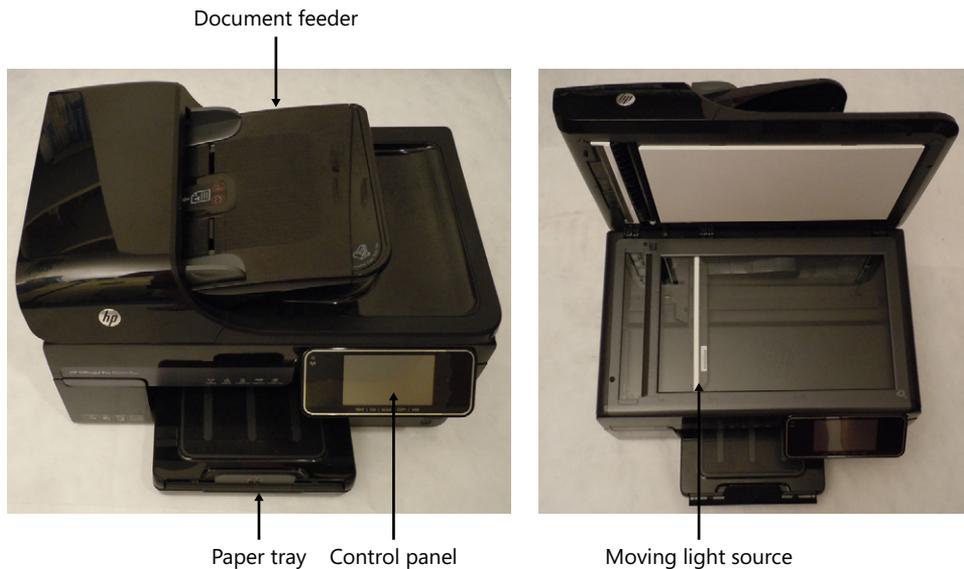


FIGURE 5-12 Multifunction printer with scanner.

You can place documents in the document feeder, or you can open the printer and place the item on the glass. This printer includes a touchscreen control panel that you can use to make a copy by simply selecting Copy. Alternatively, you can use software provided by HP to capture the image and save it as a file.

This software supports saving the file as a Portable Document Format (PDF or .pdf) file, a Joint Photographic Experts Group (JPEG or .jpg) graphics file, and several other common graphics formats. Scanners and digitizers commonly include optical character recognition (OCR) software that allows you to scan a text document and save it as editable text. Some also include intelligent character recognition (ICR) software that can read handwriting, although ICR is more commonly used on tablet devices.

Most scanners include software with drivers that you should install before connecting the device. The printer/scanner shown in the figure includes a USB connection, but you might also see scanners or multifunction printers that include FireWire connections. Additionally, printers often include a network connection, allowing you to connect a printer/scanner in a network and share it with multiple users.

MORE INFO CHAPTER 7 AND CHAPTER 21

Chapter 7 covers printers in more depth, and Chapter 21, “Comparing IPv4 and IPv6,” covers networking in more depth, including how to reserve a specific IP address for a printer.

Barcode Reader

If you’ve been to a store in the last 30 years or so, you’ve seen a Universal Product Code (UPC) barcode and barcode readers. Handheld barcode readers are available for personal computers. They use the same scanning technology as a scanner and are often used with hardware inventory systems.

For example, a barcode inventory system includes rolls of preprinted barcode stickers, a handheld barcode reader, and a database application. When a valuable piece of hardware, such as a computer, is purchased, technicians put a barcode sticker on the hardware and record its details in the inventory. Details include information such as the model, the serial number, and the location where it will be used. Periodically, technicians use the barcode reader to scan barcodes on the equipment so they can complete an inventory rather quickly.

Barcode scanners are typically connected with a USB cable, although some are available using the PS/2 connection.

NOTE SCANNER APPLICATIONS

Portable smartphones and tablet devices commonly include a camera, and applications are available for use of the camera as a barcode scanner. These are most commonly used to read Quick Response (QR) barcodes, which are specially formatted square barcodes, but they can often read traditional barcodes, too.

KVM



A keyboard video mouse (KVM) switch allows you to use a single keyboard, video monitor, and mouse with multiple computers. It is most commonly used in server rooms, allowing you to have one KVM for multiple servers in a single equipment bay, but it can be used anywhere that you have more than one computer and you need to save desktop space.

In some cases, the KVM has physical switches or buttons that you use to select a specific computer. However, in other cases, you can just press a special key combination on the keyboard called a keyboard shortcut. Some keyboard shortcuts that allow you to toggle between computers connected to a KVM are the following:

- **Ctrl, Ctrl.** Tap the Ctrl key twice.
- **Scroll Lock, Scroll Lock.** Tap the Scroll Lock key twice.
- **Alt+Ctrl+Shift+number.** The number refers to a port number on the switch. For example, if you wanted to connect to the computer by using port three, you'd press Alt+Ctrl+Shift+3.

The KVM switch has ports for a single keyboard, a display monitor, and a mouse. It also has cables for each computer. You connect the devices to the KVM instead of to a computer and then connect the computers to the KVM, as shown in Figure 5-13.

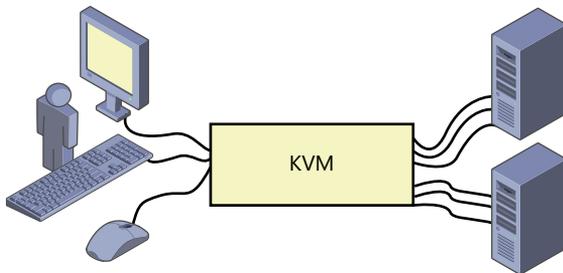


FIGURE 5-13 KVM connections.

Biometric Devices



Biometric devices identify individuals based on their physical characteristics. The most common type of biometrics in use is fingerprinting. Other types include retinal scans, which scan the retina of an eye, and iris scans, which scan the iris.

Biometrics is often used for authentication. Authentication occurs when someone claims an identity and then proves the identity with something else. For example, you can log on to a computer with a user name and password. You are claiming an identity with your user name and proving the identity with a password. Similarly, you can log on with the same user name and prove it's you by using a fingerprint. Biometrics is much more secure than passwords, but it is more expensive.

Many laptops have built-in fingerprint readers. You can also find external biometric devices that commonly connect to a USB port. It's rare for the driver to be included with the operating system, so you'll need to install it using the installation software from the manufacturer.

Joysticks

Joysticks have been used in aviation for more than a century. A joystick is connected to a base, and the pilot can pivot it to control the direction of the plane. Joysticks often include buttons. For example, fighter planes and jets require buttons to fire bullets or missiles.

Similar joysticks have been used in computer games. Users can pivot the joystick around the base to control the movement within the game. A joystick can have multiple buttons used for different purposes in games, including firing bullets and missiles.

Joysticks originally connected to the DB-15 sound card port, which is the same port used by MIDI devices. Joysticks are available with USB connectors, although they have largely been replaced by game pads.

Game Pads



For some gamers, the keyboard and mouse—or even the joystick—just aren't enough to get the gaming performance they desire. Instead, the gamers add a *game pad* to their system. A game pad is a handheld device that includes multiple controls used within games.

Popular game pads can be held with both hands and include multiple buttons and at least one analog stick. The analog stick mimics the functionality of a joystick but isn't as big and bulky. As users hold the game pad, they can manipulate the analog stick with a thumb. Figure 5-14 shows a game pad. The buttons and analog sticks are used differently, depending on the game being played.



FIGURE 5-14 Game pad.

Game pads often connect with a USB connection or with a wireless connection. Wireless connections typically use a wireless USB dongle, similar to those used with wireless keyboards and mice.

✓ Quick Check

1. What type of device can create a digital file from a paper document?
2. What is used to control multiple computers with a single keyboard and monitor?

Quick Check Answers

1. Scanner.
2. KVM switch.

Multimedia Devices

Multimedia devices include cameras, webcams, camcorders, and MIDI devices. Most multimedia devices are connected to a computer with a USB cable, but some camcorders use FireWire.

Digital Cameras

Digital cameras are easy to use and very affordable, and they provide a rich set of features. They store the pictures on flash memory sticks, and it's relatively easy to transfer the pictures to your computer or to get them printed.

Figure 5-15 shows a digital camera with a few highlights. The cover on the left is open, showing where the battery and flash memory are installed. In the middle is a Micro-B USB port. When you attach the cable from the camera to the computer, it appears as another disk drive that you can access by using Windows Explorer.

Many computers and printers include CompactFlash (CF) and Secure Digital (SD) slots. To access the photos, you can remove the memory stick from the camera and plug it into the slot instead of connecting the camera directly to the computer. Similarly, you can take the memory stick to a photo shop to get your photos printed.

MORE INFO CHAPTER 4

Chapter 4 covers the different types of flash memory used in cameras within the context of solid state drives.

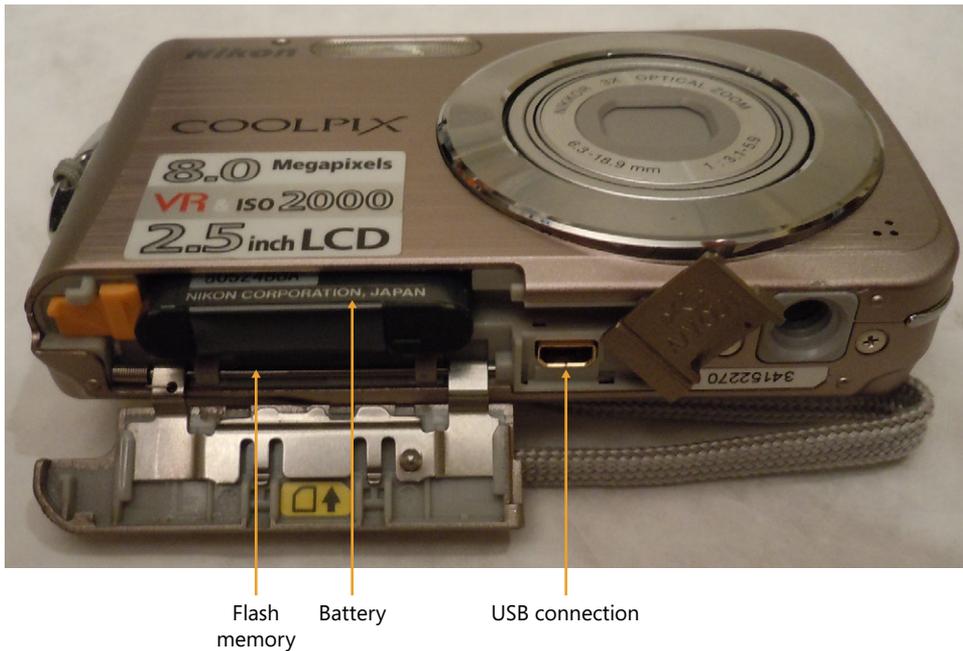


FIGURE 5-15 Digital camera.

Camcorder

A camcorder is a camera that can capture live recordings of both *audio and video (A/V)*. It has been known as a video recorder but is more commonly called a camcorder. Many digital cameras can capture A/V recordings in addition to still pictures. The difference is that a camcorder is a dedicated device that is optimized for these recordings.

One of the challenges with camcorders has been storage space because video quickly consumes a lot of space. Camcorders have been available using tapes and built-in hard drives, but many current versions use high-capacity memory sticks.

You typically have the same connectivity options with a camcorder that you have with a digital camera. You can usually connect a camcorder to a PC by using a USB cable, or you can remove the memory stick and insert it into a memory card reader on the computer. Some camcorders also have FireWire connections.

Webcam



A *webcam* is a camera attached to a computer, and it's often attached to the top of the monitor. One of the popular uses of webcams is for Skype to make real-time phone calls that include both voice and video, and they're also used with some instant messaging systems. When both parties are using a webcam, they can each look at their monitor and see the other person in real time.

Many laptops include a built-in webcam centered at the top of the display, but you can also purchase external webcams. External webcams commonly connect using USB cables.

MIDI-Enabled Devices



Musical Instrument Digital Interface (MIDI) devices can play synthesized music from a MIDI file. MIDI files include instructions about what notes to play and how to play them. In contrast, many sound files are actual recordings of music. A benefit is that a MIDI file can be much smaller than a music recording. MIDI devices can simulate just about any type of musical instrument, including pianos, drums, violins, trumpets, and oboes.

Older sound cards included a DB-15 MIDI connector used for either a MIDI device or a joystick. Most current MIDI devices use a USB interface instead.

Expansion Cards



Motherboards include expansion slots, and it's very common to add or replace an *expansion card* in desktop computers. The primary type of expansion card with which you'll be working is Peripheral Component Interconnect Express (PCIe), although you might occasionally use a traditional PCI card.

MORE INFO CHAPTER 2

Chapter 2 covers motherboards and expansion slots, including PCI and PCIe.

The three reasons to add or replace an expansion card are as follows:

- **To replace a failed component.** The chipset on the motherboard includes an expected feature, but if something fails, you can add an expansion card to provide the same feature.
- **To improve a capability.** If the chipset includes a feature but you want something better, you can often add a card. This is commonly done with graphics cards.
- **To add a capability.** If your system doesn't include a feature that you want, you can add a card.

For example, imagine that you wanted to use a computer to watch and record TV shows. This is certainly possible, but you need a *TV tuner* expansion card similar to the one shown in Figure 5-16. You could purchase the card, install it in the system, and be ready to go. However, if you're using one of the Media Center editions of Windows, you can use Media Center to manage the recordings.

NOTE TV TUNERS

The card shown in Figure 5-16 includes two tuners. This allows the computer to record one TV program while another one is being watched. It also includes connections for the TV signal.

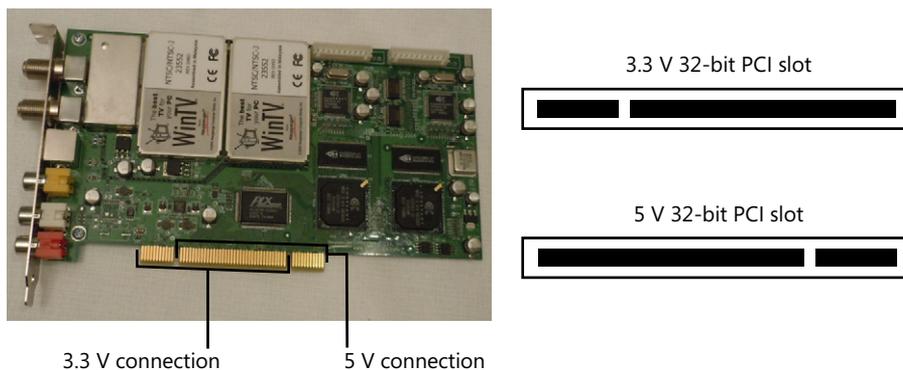


FIGURE 5-16 TV tuner expansion card.

It's extremely important that you consider your system's current motherboard configuration before purchasing a card. Chapter 2 covers the different types of slots available on a motherboard, and you want to get a board that can fit in an available slot. The card shown in the figure is a 32-bit PCI card that can plug into either a 3.3 V or a 5 V 32-bit PCI slot. That's

good if you have either one of these slots open and available, but it's not so good if you don't have any available slots.

You probably have some empty PCIe slots, but it's important to remember the differences. Figure 5-17 shows some common-sized PCIe slots. You can plug a smaller PCIe card into a larger PCIe slot. For example, if you have an empty PCIe x16 slot, you can plug a PCIe x1, x4, or x8 card into it. However, you cannot plug a larger card into a smaller slot.

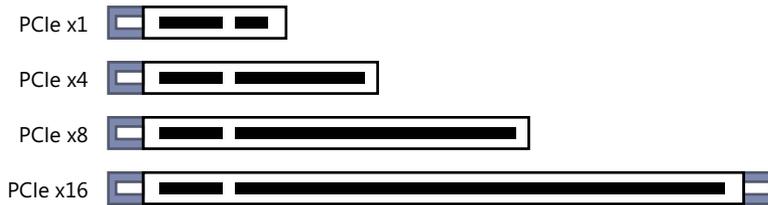


FIGURE 5-17 PCIe slot sizes.



EXAM TIP

You will need to know how to mix and match PCIe slots and PCIe expansion cards.

Expansion Card Types

Some of the different types of expansion cards that you can add include the following:

- **Video cards.** Users sometimes want a video card that includes more onboard RAM or better capabilities. You can find a wide assortment of video cards.
- **Sound cards.** Sound cards are available that provide anything from basic sound to elaborate 7.1 surround sound.
- **Network cards.** Network cards can be added to increase the throughput. You can install one that has better performance than the original or as an additional network connection.
- **Serial and parallel cards.** Many systems do not include the DB-9 serial port or the DB-25 parallel port, but they can be added with an expansion card if needed.
- **USB cards.** USB cards are available to provide additional ports using a separate hub. These ports will not share the same bandwidth of USB ports from the motherboard. USB 3.0 is not on many systems, but it is possible to add a USB 3.0 card.
- **FireWire cards.** Multipoint FireWire cards can add FireWire capabilities to a system or provide it with additional ports.
- **Storage cards.** Storage cards allow you add additional disks beyond the capabilities of the original system. For example, you can add a Serial ATA (SATA) card to support additional internal or external SATA drives. Many SATA storage cards have built-in support for a redundant array of independent disks (such as RAID-0, RAID-1, or RAID-5). While

less common for a desktop, you can also add Parallel ATA (PATA) or Small Computer System Interface (SCSI) cards.

- **Modem cards.** Many computers no longer include a modem, but if there is a need, you can add an internal modem. Modem cards include two RJ-11 ports so that the phone line can be shared. An RJ-11 port is the same type of port a typical phone line uses. One port connects the phone line to the computer, and the second connects to a standard phone. It's also possible to add external modems that plug into a USB port.
- **Wireless cards.** Wireless capabilities are included with most laptop computers. People often want to add wireless capabilities to desktop computers so that wires aren't needed. These are available as expansion cards. They're also available as a USB dongle that plugs into a USB port.
- **Cellular cards.** Cellular cards allow a computer to connect to a cellular network. This is the same network used by mobile smartphone users for Internet access with a subscription. While expansion cards are available, it is more common to use a USB port and connect a cellular card externally.
- **TV tuner cards.** These allow you to watch and record television. They include an F-type connector used to connect an RG-6 coaxial cable, similar to what is used with a TV.
- **Video capture cards.** A video capture card has the ability to capture all video going to a computer. A TV tuner is a type of video capture card that captures the television signal. Other cards can capture video from other sources, such as VCR or DVD players or gaming consoles.
- **Riser cards.** A riser card plugs into a slot and includes an identical slot configured at a right angle. You can then plug an expansion card into the riser card. The end result is that the expansion card is positioned horizontally to the motherboard. This is useful in some small-sized computer cases where the expansion card wouldn't otherwise fit.

Checklist

If you plan on adding an expansion card, you need to take several steps. You can use the following list of steps as a guide:

- **Identify an open slot.** Before purchasing an expansion card, you need to verify that the computer has space. If you purchase a PCIe x16 card but then find you don't have an open PCIe x16 slot, you might be out of some of your money.
- **Purchase the right card.** Buy a card that meets your needs and will fit in an available slot.
- **Power down and unplug the computer.** You can damage the computer or yourself if you try to replace an expansion card while the system is powered on.
- **Use electrostatic discharge (ESD) protection.** When you're ready to install the card, use ESD protection, such as an ESD wrist strap and an ESD mat.

- **Open the computer and remove components.** If you're replacing a card, you need to remove the old card. If you're adding a new card to an empty slot, you need to remove the slot cover at the back of the computer. The card's external connections will be available here.
- **Install the new card.** Follow the manufacturer's directions. Different types of cards have different connections, so you might need to connect additional cables either internally or after the card is installed. Ensure that you screw it down so that the card remains in place.
- **Consider the BIOS.** If you're replacing a feature that is built into the chipset, you might need to disable the feature in BIOS. For example, if you're adding a new sound card, you might need to disable the sound capabilities in the BIOS.
- **Install the drivers.** The manufacturer will normally provide a CD that you can use to install the drivers. If recommended, you should install the drivers prior to the installation.



Quick Check

1. What is the most common type of expansion card used in desktop computers?
2. Is it possible to plug a PCI x4 card into a PCI x2 slot?

Quick Check Answers

1. PCIe.
2. No.

Chapter Summary

- Peripherals are devices that are connected to a computer, and device drivers provide the operating system with the instructions on how to access these devices.
- USB is the most commonly used connection port. USB 1.1 can transfer data at 1.1 Mbps (low speed) or 12 Mbps (full speed). USB 2.0 supports speeds of up to 480 Mbps, and USB 3.0 supports speeds of up to 5 Gbps.
- Ports on the computer and on most devices use Standard Type A connections. Larger devices such as printers and video recorders can use the Standard Type B port. Smaller devices such as digital cameras and smartphones use the Mini-B, Micro-A, or Micro-B ports. USB 3.0 ports are blue.
- A single USB controller can support up to 127 devices, and the USB cables can be as long as 5 meters (about 16 feet).
- FireWire 400 (1394a) supports speeds of up to 400 Mbps, and the cable can be as long as 4.5 meters (about 15 feet). FireWire 800 (1394b) supports speeds of up to 800 Mbps,

and the cable can be as long as 100 meters (about 15 feet). FireWire supports up to 63 devices on a system.

- The 4-pin FireWire connector does not provide power. The 6-pin connector does provide power to devices. The 9-pin connector uses additional pins to prevent interference and is required for FireWire 800.
- The green PS/2 port is for a mouse, and the purple PS/2 port is for a keyboard. A parallel port is a DB-25 female port, and a serial port is either a DB-9 or a DB-25 male port.
- Surround sound systems include as many as seven speakers and a subwoofer (designated as 7.1). Sound connections include the following: front speakers or headphones (lime green), rear speakers (black), center speaker and subwoofer (orange), side speakers (brown), microphone (pink), and line in (light blue).
- Input devices are used to provide an input to the computer. Most use USB connections.
- Multimedia devices include cameras, camcorders, webcams, and MIDI devices. These commonly connect to USB ports.
- Expansion cards are added to a motherboard to provide an additional capability. Before purchasing an expansion card, ensure that you have an open slot to accept it.
- Most desktop computers include PCIe expansion slots. It's possible to install a smaller PCIe card (such as PCIe x2) in a larger slot (such as PCIe x8), but you cannot install a larger card in a smaller slot.
- When adding an expansion card to upgrade a computer's capabilities, you might need to access the BIOS to disable the original feature. For example, if you add a sound card, you might need to disable the sound provided from the chipset.

Chapter Review

Use the following questions to test your knowledge of the information in this chapter. The answers to these questions, and the explanations of why each answer choice is correct or incorrect, are located in the "Answers" section at the end of this chapter.

1. How many USB devices can a USB controller support?
 - A. 2
 - B. 4
 - C. 63
 - D. 127
2. You want to plug in a USB 3.0 device. What port should you use?
 - A. A blue rectangular port
 - B. A rectangular port with a curved top

- C.** A pink TRS connector
 - D.** A green PS/2 connector
- 3.** What is the maximum length of a FireWire 400 cable?
 - A.** 3 meters
 - B.** 5 meters
 - C.** 4.5 meters
 - D.** 100 meters
- 4.** You want to control two computers with a single keyboard, mouse, and monitor. What should you use?
 - A.** PCIe expansion card
 - B.** KVM switch
 - C.** MIDI device
 - D.** 7.1 system
- 5.** You need to identify a device that can create files from printed documents. Of the following choices, what would you select?
 - A.** Multifunction printer
 - B.** Biometric device
 - C.** Barcode reader
 - D.** MIDI-enabled device
- 6.** You want to watch and record TV shows on a desktop computer. What is needed?
 - A.** KVM switch
 - B.** Webcam
 - C.** TV tuner card
 - D.** Camcorder

Answers

- 1. Correct Answer: D**
 - A. Incorrect:** A controller supports more than 2 devices.
 - B. Incorrect:** A controller supports more than 4 devices.
 - C. Incorrect:** FireWire supports as many as 63 devices.
 - D. Correct:** A USB controller supports as many as 127 devices.

- 2. Correct Answer: A**
 - A. Correct:** USB 3.0 ports are blue and the same rectangular size as USB 1.1 and USB 2.0 ports.
 - B. Incorrect:** A FireWire port is rectangular with a curved top.
 - C. Incorrect:** Microphones have tip ring sleeve (TRS) connectors and plug into a pink port.
 - D. Incorrect:** The green PS/2 connector is for the mouse.

- 3. Correct Answer: C**
 - A. Incorrect:** The maximum recommended length of a USB 3.0 cable is 3 meters.
 - B. Incorrect:** The maximum length of a USB cable is 5 meters.
 - C. Correct:** The maximum length of a FireWire 400 cable is 4.5 meters.
 - D. Incorrect:** The maximum length of a FireWire 800 cable using a Category 5e twisted-pair cable is 100 meters.

- 4. Correct Answer: B**
 - A. Incorrect:** An expansion expands the capabilities of a single computer.
 - B. Correct:** A keyboard video mouse (KVM) switch is used to manage more than one computer with a single keyboard, mouse, and monitor.
 - C. Incorrect:** A Musical Instrument Digital Interface (MIDI) device is used to play MIDI music files.
 - D. Incorrect:** A 7.1 system is a surround sound system with seven speakers and a subwoofer.

5. Correct Answer: A

- A. Correct:** Multifunction printers commonly include scanners or digitizers that can scan documents.
- B. Incorrect:** A biometric device reads information about a person, such as a fingerprint or eye retina.
- C. Incorrect:** A barcode reader includes a scanner, but it can read only barcodes.
- D. Incorrect:** A MIDI-enabled device can play synthesized music from MIDI files.

6. Correct Answer: C

- A. Incorrect:** A KVM switch allows multiple computers to share a single keyboard, video monitor, and mouse.
- B. Incorrect:** A webcam is a camera attached to the computer and is used for live interactions, such as a phone call.
- C. Correct:** A TV tuner card is required to watch and record TV shows on a desktop computer.
- D. Incorrect:** A camcorder provides video recordings.