CHAPTER 1

First Look at Computer Parts and Tools

After completing this chapter, you will be able to:

- Identify the various parts inside a desktop computer case and describe how they connect together and are compatible
- Identify the various ports, slots, and internal components of a laptop computer and explain special concerns when supporting and maintaining laptops
- Describe various hardware components in mobile devices and types of wired and wireless connections mobile devices can make
- Describe the purpose of various tools you will need as a computer hardware technician

Like many other computer users, you have probably used your personal computer to play games, update your Facebook profile, write papers, or build Excel worksheets. This text takes you from being an end user of your computer to becoming an information technology (IT) support technician able to support all types of personal computers. The only assumption made here is that you are a computer user—that is, you can turn on your machine, load a software package, and use that software to accomplish a task. No experience in electronics is assumed.

As an IT support technician, you'll want to become A+ certified, which is the industry standard certification for IT support technicians. This text prepares you to pass the A+ 220-901 and 220-902 exams by CompTIA (*www.comptia.org*). The exams are required by CompTIA for A+ Certification.

In this chapter, you learn to recognize various hardware components you'll find inside desktop computer and laptop cases and about the tools you'll need to work inside the case. Later in the text, you learn to take a desktop and laptop apart and reassemble them.

A+ Exam Tip As you work your way through a chapter, notice the green and blue A+ mapping icons underneath headings. These page elements help you know to which objectives on which exam the content applies. After studying each chapter, take a look at the grid at the beginning of this text and make sure you understand each objective listed in the grid that is covered in the chapter.

WHAT'S INSIDE A DESKTOP CASE

A+ 220-901 1.7, 1.8, 1.11

Before we discuss the parts inside a desktop case, let's take a quick look at the case and the ports and switches on it. A computer case for any type of computer is sometimes called the chassis and houses the power supply, motherboard, processor, memory modules, expansion cards, hard drive, optical drive, and other drives. A computer case can be a tower case, a desktop case that lies flat on a desk, an all-in-one case used with an all-in-one computer, or a mobile case used with laptops and tablets. A tower case (see Figure 1-1) sits upright and can be as high as two feet and has room for several drives. Often used for servers, this type of case is also good for desktop computer users who anticipate upgrading, because tower cases provide maximum space for working inside a computer and moving components around. A desktop case lies flat and sometimes serves double-duty as a monitor stand. In the chapter, "Working Inside Desktop Computers and Laptops," you learn how to work inside a tower case, desktop case, laptop case, and all-in-one case.

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Figure 1-1 This slimline tower case supports a microATX motherboard

Notes Don't lay a tower case on its side when the computer is in use because the CD or DVD drive might not work properly. For the same reason, if a desktop case is designed to lie flat, don't set it on its end when the computer is in use.

Table 1-1 lists ports you might find on a desktop or mobile computer. Consider this table your introduction to these ports so that you can recognize them when you see them. Later in the text, you learn more about the details of each port.

A+ Exam Tip The A+ 220-901 exam expects you to know how to identify the ports shown in Table 1-1.

Port	Description
	A VGA (Video Graphics Array) port, also called a DB-15 port, DB15 port, HD15 port, or DE15 port, is a 15-pin, D-shaped, female port that transmits analog video. (Analog means a continuous signal with infinite variations as compared with digital, which is a series of binary values—1s and 0s.) All older monitors use VGA ports. (By the way, the HD15 [high-definition 15-pin] name for the port is an older name that distinguishes it from the early 9-pin VGA ports.)
	An S-Video port is a 4-pin or 7-pin round video port sometimes used to connect to a television. The 7-pin port is shown on the left. The 4-pin port is missing the extra pins in the middle and is the more common type.

Table 1-1 Ports used with desktop and mobile computers (continues)

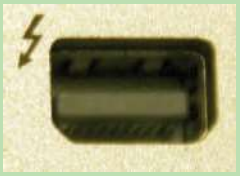
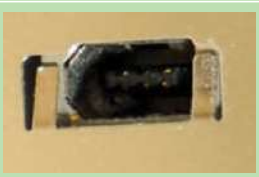
Port	Description
	A DVI (Digital Video Interface) port transmits digital or analog video. Three types of DVI ports exist, which you learn about in the chapter, "Supporting I/O Devices."
	An HDMI (High-Definition Multimedia Interface) port transmits digital video and audio (not analog transmissions) and is often used to connect to home theater equipment.
	A DisplayPort transmits digital video and audio (not analog transmissions) and is slowly replacing VGA and DVI ports on personal computers.
 Courtesy of Creative Commons Attribution 3.0, Macfan97	A Thunderbolt port transmits video, data, and power on the same port and cable and is popular with Apple computers. The port is shaped the same as the DisplayPort and is compatible with DisplayPort devices. Up to six peripherals (for example, monitors and external hard drives daisy-chained together) can use the same Thunderbolt port.
	A network port, also called an Ethernet port, or an RJ-45 port, is used by a network cable to connect to the wired network. Fast Ethernet ports run at 100 Mbps (megabits per second), and Gigabit Ethernet runs at 1000 Mbps or 1 Gbps (gigabits per second). A megabit is one million bits and a gigabit is one billion bits. A bit is a binary value of 1 or 0.
	A system usually has three or more round audio ports, also called sound ports, for a microphone, audio in, audio out, and stereo audio out. These types of audio ports can transmit analog or digital data. If you have one audio cable to connect to a speaker or earbuds, plug it into the lime green sound port in the middle of the three ports. The microphone uses the pink port.
	An S/PDIF (Sony/Philips Digital Interface) sound port connects to an external home theater audio system, providing digital audio output and the best signal quality. S/PDIF ports always carry digital audio and can work with electrical or optical cable. When connected to a fiber-optic cable, the port is called an optical connector.
	A USB (Universal Serial Bus) port is a multipurpose I/O port that comes in several sizes and is used by many different devices, including printers, mice, keyboards, scanners, external hard drives, and flash drives. Some USB ports are faster than others. Hi-Speed USB 2.0 is faster than regular USB, and Super-Speed USB 3.0 is faster than USB 2.0.
	A FireWire port (also called an IEEE 1394 port, pronounced "I-triple-E 1394 port") is used for high-speed multimedia devices such as digital camcorders.

Table 1-1 Ports used with desktop and mobile computers (continues)

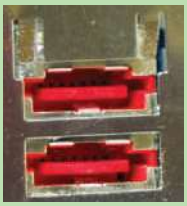
Port	Description
	An external SATA (eSATA) port is used by an external hard drive or other device using the eSATA interface. eSATA is faster than FireWire.
	A PS/2 port, also called a mini-DIN port, is a round 6-pin port used by a keyboard or mouse. The ports look alike but are not interchangeable. On a desktop, the purple port is for the keyboard, and the green port is for the mouse. Many newer computers use USB ports for the keyboard and mouse rather than the older PS/2 ports.
	An older serial port, sometimes called a DB9 port, is a 9-pin male port used on older computers. It has been mostly replaced by USB ports. Occasionally, you see a serial port on a router where the port is used to connect the router to a device a technician can use to monitor and manage the router.
	A parallel port, also called an LPT port, is a 25-pin female port used by older printers. This older port has been replaced by USB ports.
	A modem port, also called an RJ-11 port, is used to connect dial-up phone lines to computers. A modem port looks like a network port, but is not as wide. In the photo, the right port is a modem port and the left port is a network port, shown for comparison.

Table 1-1 Ports used with desktop and mobile computers (continued)

I know you're eager to open a case and work inside it, but first let's get familiar with the major components in the case and how to work with them safely so you don't fry a motherboard or bend delicate connectors. Figure 1-2 shows the inside of a computer case.

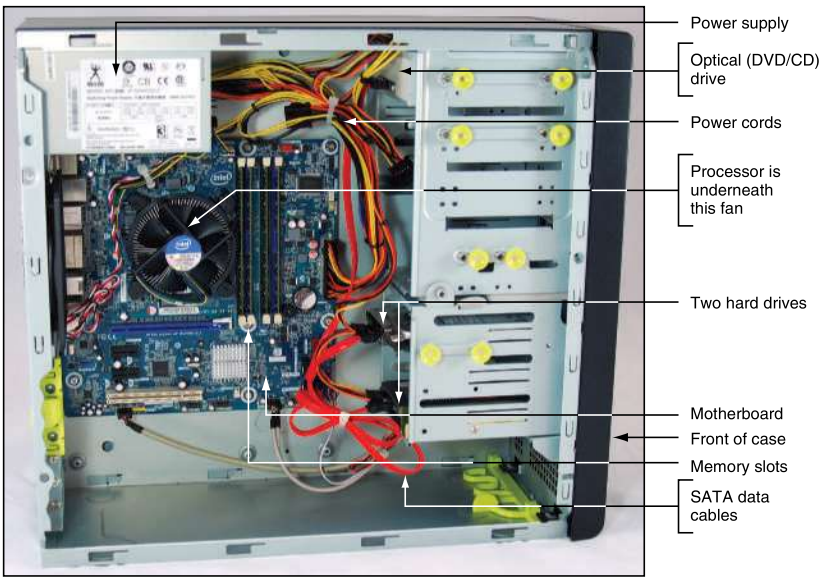


Figure 1-2 Inside the computer case

Here is a quick explanation of the main components installed in the case, which are called internal components:

- ***The motherboard, processor, and cooler.*** The motherboard, also called the main board, the system board, or the techie jargon term, the mobo, is the largest and most important circuit board in the computer. The motherboard contains a socket to hold the processor or CPU. The central processing unit (CPU), also called the processor or microprocessor, does most of the processing of data and instructions for the entire system. Because the CPU generates heat, a fan and heat sink might be installed on top to keep it cool. A heat sink consists of metal fins that draw heat away from a component. The fan and heat sink together are called the processor cooler. Figure 1-3 shows the top view of a motherboard, and Figure 1-4 shows the ports on the side of a motherboard.

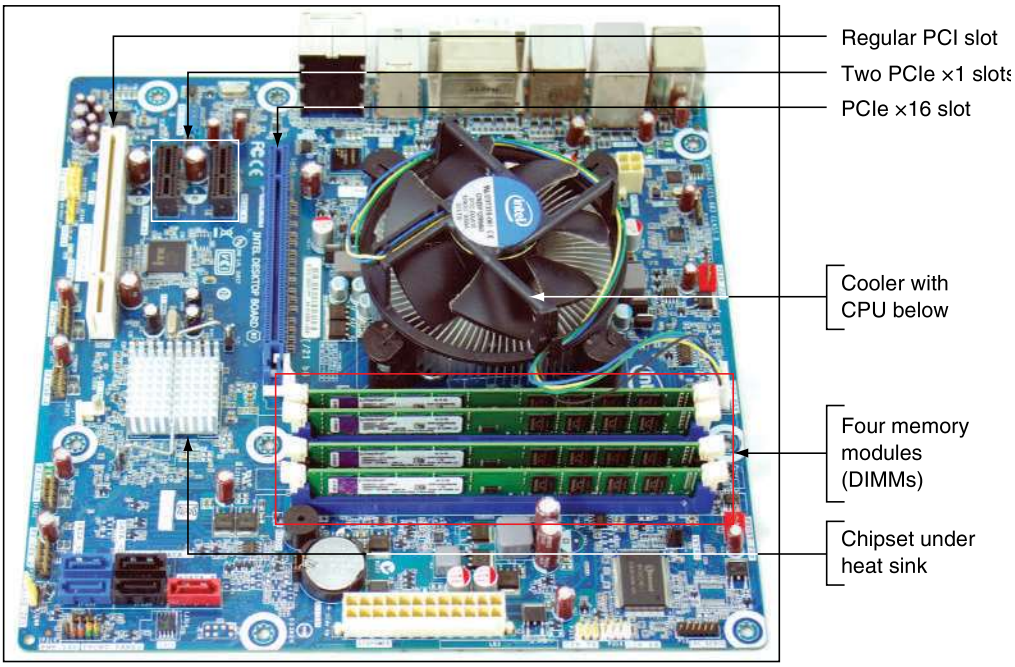


Figure 1-3 All hardware components are either located on the motherboard or directly or indirectly connected to it because they must all communicate with the CPU

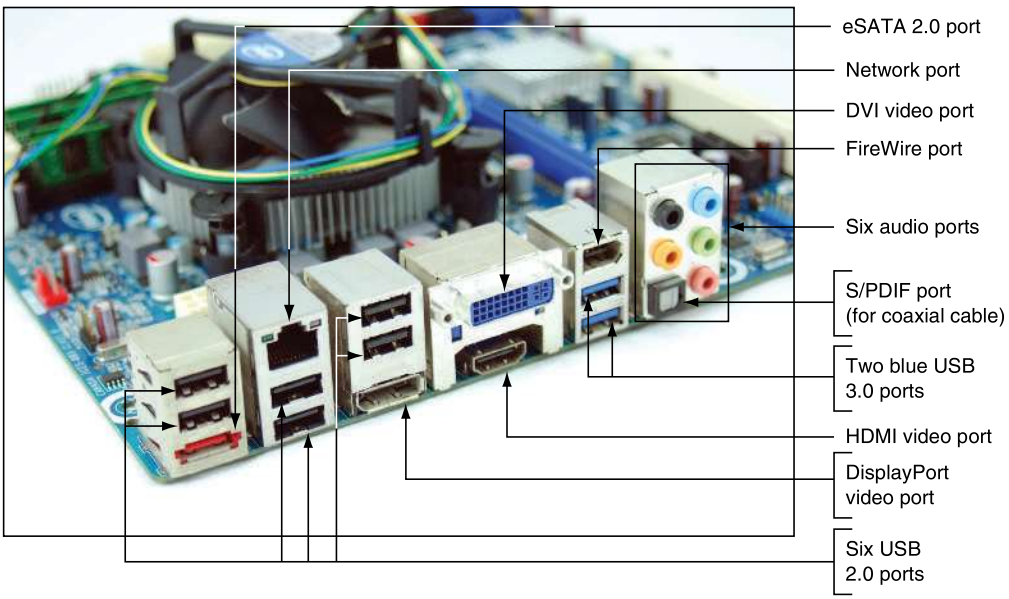


Figure 1-4 Ports provided by a motherboard

- ***Expansion cards.*** A motherboard has expansion slots to be used by expansion cards. An expansion card, also called an adapter card, is a circuit board that provides more ports than those provided by the motherboard. Figure 1-5 shows a video card that provides three video ports. Notice the cooling fan and heat sink on the card, which help to keep the card from overheating. The trend today is for most ports in a system to be provided by the motherboard (called onboard ports) and less use of expansion cards.

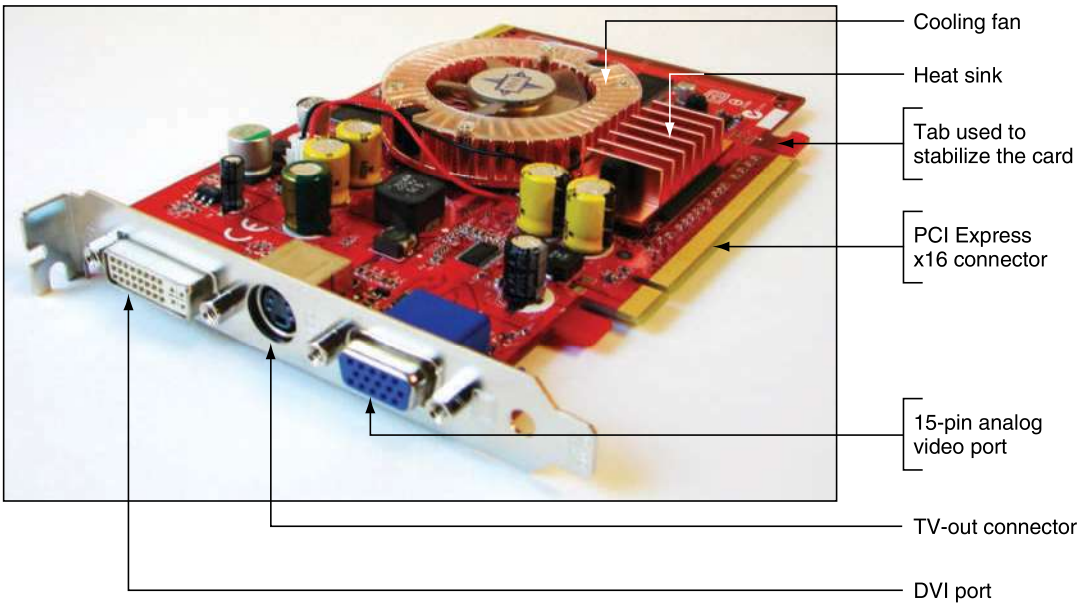


Figure 1-5 The easiest way to identify this video card is to look at the ports on the end of the card

- ***Memory modules.*** A desktop motherboard has memory slots, called DIMM (dual inline memory module) slots, to hold memory modules. Figure 1-6 shows a memory module installed in one DIMM slot and three empty DIMM slots. Memory, also called RAM (random access memory), is temporary storage for data and instructions as they are being processed by the CPU. The memory module shown in Figure 1-6 contains several RAM chips. Video cards also contain some embedded RAM chips for video memory.

Figure 1-6 A DIMM holds RAM and is mounted directly on a motherboard

- ***Hard drives and other drives.*** A system might have one or more hard drives, an optical drive, a tape drive, or, for really old systems, a floppy drive. A hard drive, also called a hard disk drive (HDD), is permanent storage used to hold data and programs. For example, the Windows 8 operating system and applications are installed on the hard drive. All drives in a system are installed in a stack of drive bays at the front of

the case. The system shown in Figure 1-2 has two hard drives and one optical drive installed. These three drives are also shown in Figure 1-7. The larger hard drive is a magnetic drive, and the smaller hard drive is a solid-state drive. Each drive has two connections for cables: The power cable connects to the power supply, and another cable, used for data and instructions, connects to the motherboard.

Figure 1-7 Two types of hard drives (larger magnetic drive and smaller solid-state drive) and a DVD drive

- ***A power supply.*** A computer power supply, also known as a power supply unit (PSU), is a box installed in a corner of the computer case (see Figure 1-8) that receives and converts the house current so that components inside the case can use it. Most power supplies have a dual-voltage selector switch on the back of the computer case where you can switch the input voltage to the power supply to 115 V used in the United States or 220 V used in other countries. See Figure 1-9. The power cables can connect to and supply power to the motherboard, expansion cards, and drives.

Notes If you ever need to change the dual-voltage selector switch, be sure you first turn off the computer and unplug the power supply.

Figure 1-8 Power supply with attached power cables

Figure 1-9 The dual-voltage selector switch sets the input voltage to the power supply

FORM FACTORS USED BY DESKTOP CASES, POWER SUPPLIES, AND MOTHERBOARDS

A+ 220-901 1.7, 1.8, 1.11

The desktop computer case, power supply, and motherboard must all be compatible and fit together as an interconnecting system. The standards that describe the size, shape, screw hole positions, and major features of these interconnected components are called form factors. Using a matching form factor for the motherboard, power supply, and case assures you that:

- The motherboard fits in the case.
- The power supply cords to the motherboard provide the correct voltage, and the connectors match the connections on the board.
- The holes in the motherboard align with the holes in the case for anchoring the board to the case.
- The holes in the case align with ports coming off the motherboard.
- For some form factors, wires for switches and lights on the front of the case match up with connections on the motherboard.
- The holes in the power supply align with holes in the case for anchoring the power supply to the case.

The two form factors used by most desktop and tower computer cases and power supplies are the ATX and microATX form factors. Motherboards use these and other form factors that are compatible with ATX or microATX power supplies and cases. You learn about other motherboard form factors in the chapter, "All About Motherboards." Following are the important details about ATX and microATX.

ATX FORM FACTOR

ATX (Advanced Technology Extended) is the most commonly used form factor today. It is an open, nonproprietary industry specification originally developed by Intel in 1995, and has undergone several revisions since then. The original ATX form factor for cases had case fans blowing air into the case, but early revisions to the form factor had fans blowing air out of the case. Blowing air out of the case does a better job of keeping the system cool.

An ATX power supply has a variety of power connectors (see Figure 1-10). The power connectors are listed in Table 1-2 and several of them are described next.

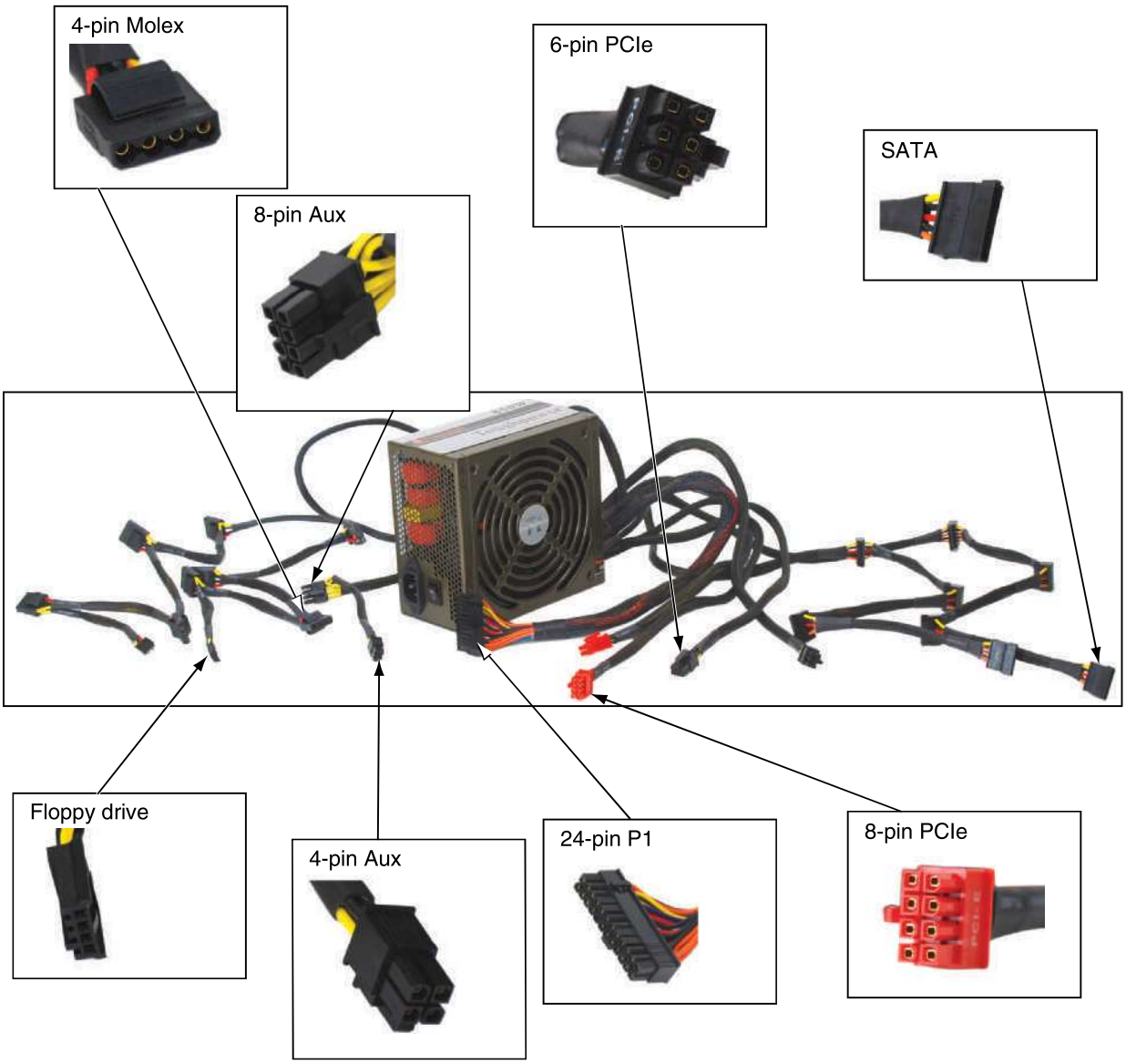


Figure 1-10 ATX power supply with connectors

Connector	Description
	The 20-pin P1 connector is the main motherboard power connector used in the early ATX systems.
	The 24-pin P1 connector, also called the 20+4 pin connector, is the main motherboard power connector used today.

Table 1-2 Power supply connectors (continues)

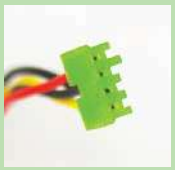
Connector	Description
	The 20+4 pin P1 connector has four pins removed so the connector can fit into a 20-pin P1 motherboard connector.
	The 4-pin 12-V connector is an auxiliary motherboard connector, which is used for extra 12-V power to the processor.
	The 8-pin 12-V connector is an auxiliary motherboard connector, which is used for extra 12-V power to the processor, providing more power than the older 4-pin auxiliary connector.
	The 4-pin Molex connector is used for older IDE (PATA or Parallel ATA) drives and some newer SATA drives. It can provide +5 V and +12 V to the drive.
	The 15-pin SATA power connector is used for SATA (Serial ATA) drives. It can provide +3.3V, +5 V, and +12 V, although +3.3 V is seldom used.
	The 4-pin Berg connector is used by older floppy disk drives (FDD).
	The PCIe 6-pin connector provides an extra +12 V for high-end video cards using PCI Express, Version 1 standard.
	The PCIe 8-pin connector provides an extra +12 V for high-end video cards using PCI Express, Version 2.
	The PCIe 6/8-pin connector is used by high-end video cards using PCIe x16 slots to provide extra voltage to the card and can accommodate a 6-hole or 8-hole port. To get the 8-pin connector, combine both the 6-pin and 2-pin connectors.

Table 1-2 Power supply connectors (continued)

A+ Exam Tip The A+ 220-901 exam expects you to know about each connector listed in Table 1-2.

Power connectors have evolved because components using new technologies require more power. As you read about the following types of power connectors and why each came to be, you'll also learn about the evolving expansion slots and expansion cards that drove the need for more power:

- ***20-pin P1 connector.*** The first ATX power supplies and motherboards used a single 20-pin P1 power connector that provided +3.3 volts, +5 volts, +12 volts, –12 volts, and an optional and rarely used –5 volts. See Figure 1-11. This 20-pin power connector was sufficient for powering expansion cards installed in PCI (Peripheral Component Interconnect) expansion slots on the motherboard (see Figure 1-12). Several versions of PCI slots evolved over time, which you learn about in the chapter, "All About Motherboards."

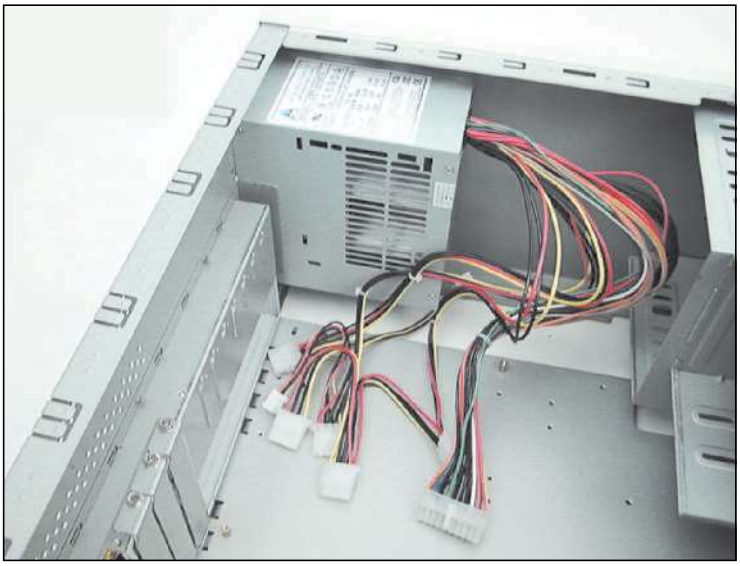


Figure 1-11 The first ATX P1 power connector used 20 pins

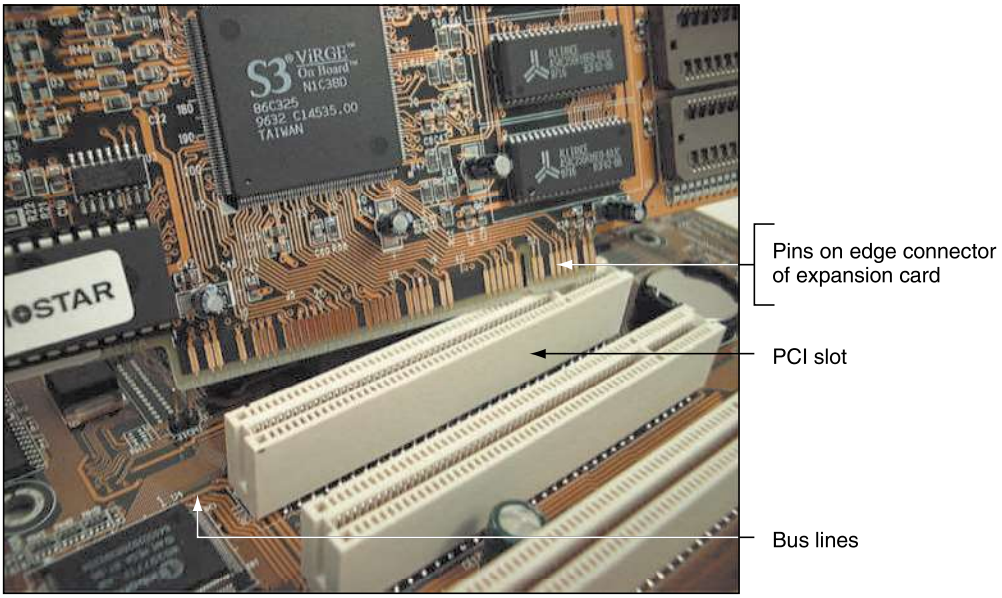


Figure 1-12 A PCI expansion card about to be installed in a PCI slot

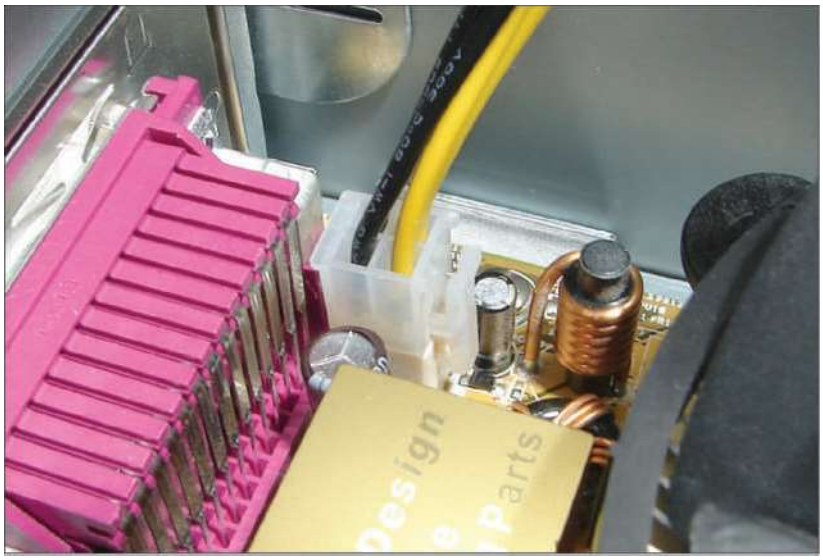


Figure 1-13 The 4-pin 12-volt auxiliary power connector on a motherboard with power cord connected

- ***4-pin and 8-pin auxiliary connectors.*** When processors began to require more power, the ATX Version 2.1 specifications added a 4-pin auxiliary connector near the processor socket to provide an additional 12 V of power (see Figure 1-13). A power supply that provides this 4-pin 12-volt power cord is called an ATX12V power supply. Later boards replaced the 4-pin 12-volt power connector with an 8-pin motherboard auxiliary connector that provided more amps for the processor.

- ***24-pin or 20+4-pin P1 connector.*** Later, when faster PCI Express (PCIe) slots were added to motherboards, more power was required and a new ATX specification (ATX Version 2.2) allowed for a 24-pin P1 connector, also called the 20+4 power connector. The 20-pin power cable will still work in the new 24-pin connector. Looking back at Figure 1-3, you can see one long blue PCIe ×16 slot (16 lanes for 16-bit transfers on this slot) that can be used by a video card and two short black PCIe ×1 slots (for 1-bit transfers) that can be used for other expansion cards that fit this type slot.

  The extra 4 pins on the 24-pin P1 connector provide +12 volts, +5 volts, and +3.3 volts pins. Motherboards that support PCI Express and have the 24-pin P1 connector are sometimes called Enhanced ATX boards. Figure 1-14 shows a 20-pin P1 power cord from the power supply and a 24-pin P1 connector on a motherboard. Figure 1-15 shows the pinouts for the 24-pin power cord connector, which is color-coded to wires from the power supply. The 20-pin connector is missing the lower four pins, which are listed in the photo and diagram.

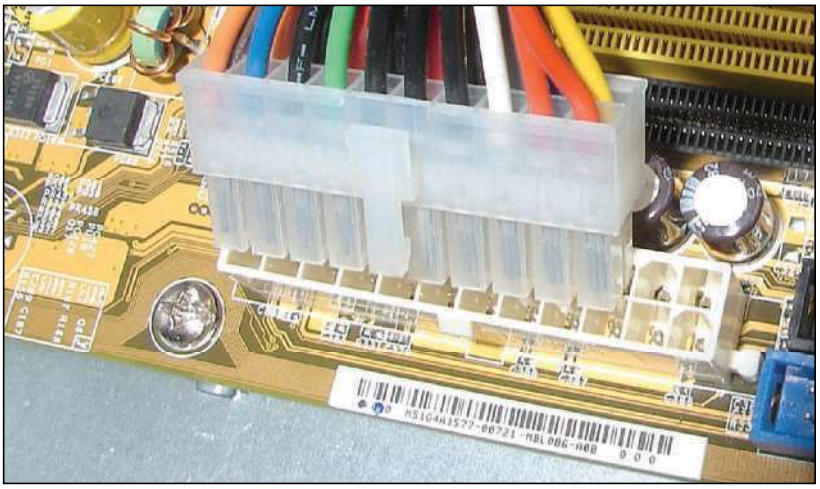


Figure 1-14 A 20-pin power cord ready to be plugged into a 24-pin P1 connector on an ATX motherboard

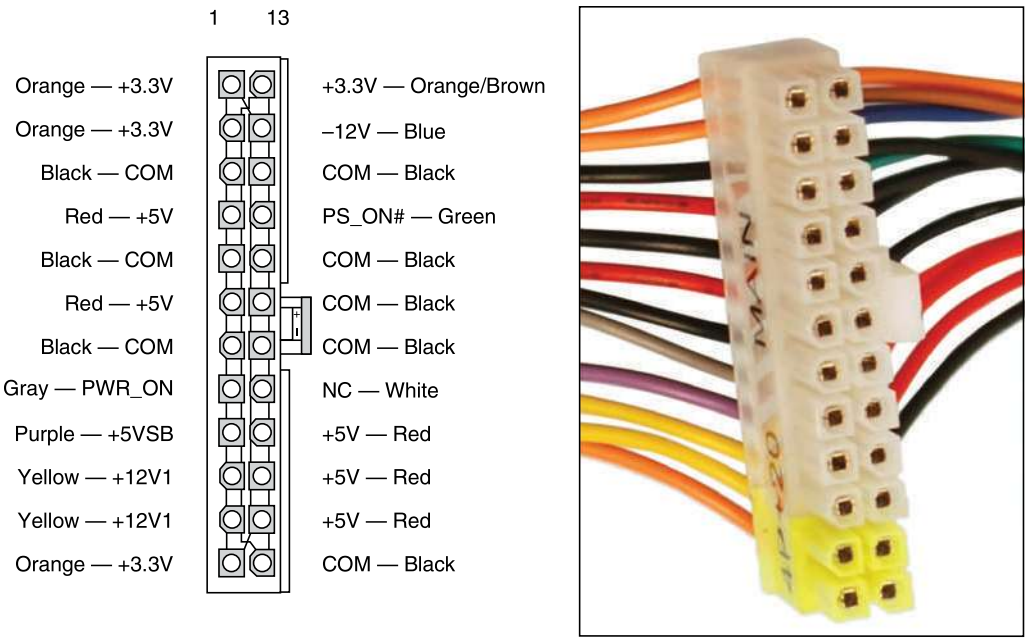


Figure 1-15 P1 24-pin power connector follows ATX Version 2.2 and higher standards

Figure 1-16 shows a PCIe ×16 video card. The edge connector has a break that fits the break in the slot. The tab at the end of the edge connector fits into a retention mechanism at the end of the slot, which helps to stabilize a heavy video card.

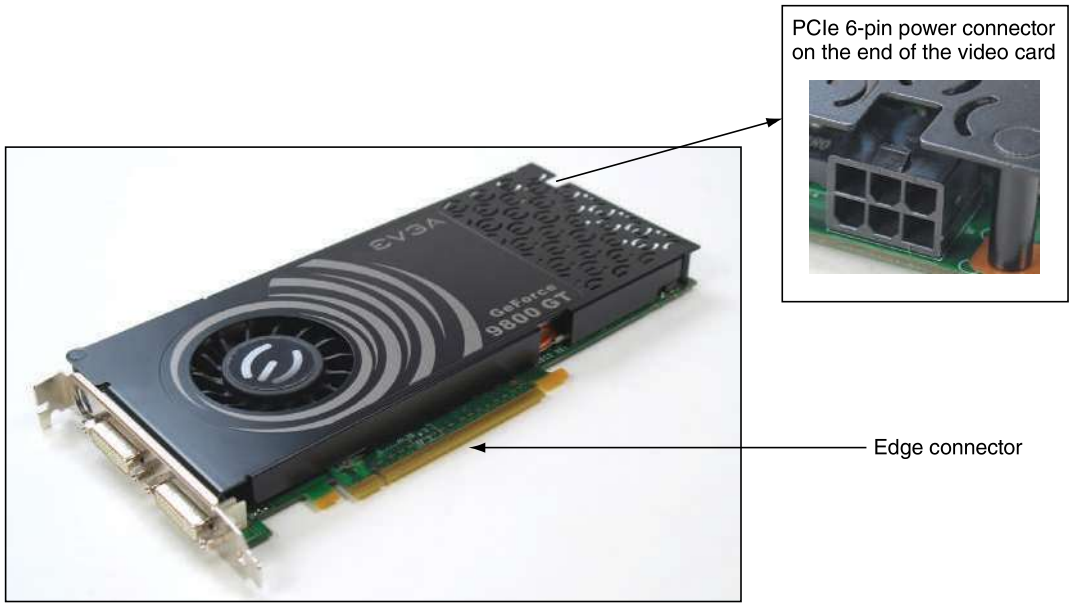


Figure 1-16 This PCIe ×16 video card has a 6-pin PCIe power connector to receive extra power from the power supply

- ***6-pin and 8-pin PCIe connectors.*** Video cards draw the most power in a system, and ATX Version 2.2 provides for power cables to connect directly to a video card to provide it additional power than comes through the PCIe slot on the motherboard. The PCIe power connector might have 6 or 8 pins. PCI Express, Version 1, defined the 6-pin connector, and PCI Express, Version 2, defined the 8-pin connector. The video card shown in Figure 1-16 has a 6-pin connector on the end of the card. A PCIe 6/8-pin connector can also be located on the motherboard to supply extra power for the video card.

Notes For more information about all the form factors discussed in this chapter, check out the form factor website sponsored by Intel at *www.formfactors.org*.

MICROATX FORM FACTOR

The microATX (MATX) form factor is a major variation of ATX and addresses some technologies that have emerged since the original development of ATX. MicroATX reduces the total cost of a system by reducing the number of expansion slots on the motherboard, reducing the power supplied to the board, and allowing for a smaller case size. A microATX motherboard (see Figure 1-17) will fit into a case that follows the ATX 2.1 or higher standard. A microATX power supply uses a 24-pin P1 connector and is not likely to have as many extra wires and connectors as those on an ATX power supply.

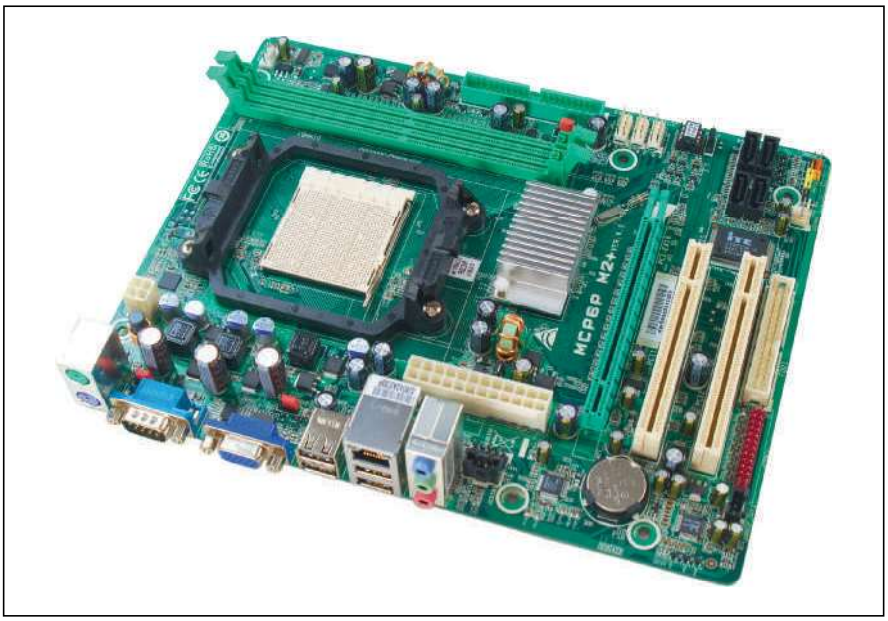


Figure 1-17 This microATX motherboard by Biostar is designed to support an AMD processor

A+ Exam Tip The A+ 220-901 exam expects you to recognize and know the more important features of the ATX and microATX form factors used by power supplies.

Hands-On Project 1-1 Identify Ports and Parts

A+ 220-901 1.7, 1.8, 1.11

Do the following to identify computer ports and parts that your instructor might have on display:

1. Look on the front and back of your computer case and list the type of ports the computer offers.
2. For a power supply, list the number and type of power connectors.
3. For a motherboard, list the number and type of expansion slots on the board. Does the board have a 20-pin or 24-pin P1 connector? What other power connectors are on the board? How many memory slots does the board have?
4. For expansion cards, examine the ports on the back of the card. Can you tell by the ports the purpose of the card? What type of slot does the card use?

Caution You can damage a computer component with static electricity if you touch the component when you are not grounded. Before you touch a sensitive computer component, you first need to dissipate any static electricity on your body. You learn how to do that in the appendix, "Safety Procedures and Environmental Concerns." For now, to protect a working component your instructor has on display, don't touch; just look.

Hands-On Project 1-2 Examine the Power Supply, Motherboard, and Expansion Cards Inside a Desktop Case

A+ 220-901 1.7, 1.8, 1.11

If you have access to a desktop computer with the case cover removed, examine its components and answer the following questions. As you look, remember to not touch anything inside the case unless you are properly grounded.

1. Identify the power supply, motherboard, and any expansion cards that might be installed on the motherboard. Remember: Don't touch a component unless you are properly grounded. If the case is plugged into a power source, don't touch inside the case even if you are grounded.
2. Identify the cooler that is installed on top of the processor. This cooler is likely to have a fan on top and a heat sink that you can't see. The processor is hidden under the cooler.
3. Identify the memory modules and memory slots. How many memory slots are there? How many of these slots are populated?
4. If an expansion card is installed, what type of ports does the card provide at the rear of the case? Find the one screw that is used to attach the expansion card to the case.
5. Locate the screws that are attaching the motherboard to the case. How many screws are used? Do you see screw holes in the motherboard that are not being used? As a general rule of thumb, up to nine screws can be used to attach a motherboard to a case.
6. How many power cables are coming from the power supply? How many of these cables are connected to the motherboard? To other devices inside the computer? Identify each type of power cable the system is using.
7. Find the screws or clips that are attaching the power supply to the case. Is the power supply attached using screws, clips, or both screws and clips?

Now let's learn about the drives you might find installed inside a system.

DRIVES, THEIR CABLES, AND CONNECTORS

A+ 220-901 1.7, 1.8, 1.11

A computer might have one or more hard drives, an optical drive (CD, DVD, or Blu-ray), tape drive, or some other type of drive. A drive receives power by a power cable from the power supply, and communicates instructions and data through a cable attached to the motherboard. Most hard drives, optical drives, and tape drives today use the serial ATA (SATA) standard.

Notes If you support older desktop computers, you might see some drives using the slower and older PATA (parallel ATA) standard, also called the IDE (Integrated Drive Electronics) or EIDE (Enhanced IDE) standard, for drive connections. PATA used a 40-pin connector on the motherboard and a wide ribbon cable that could accommodate one or two drives on the cable. Figure 1-18 shows two PATA ribbon cables, each connecting a drive to the motherboard.

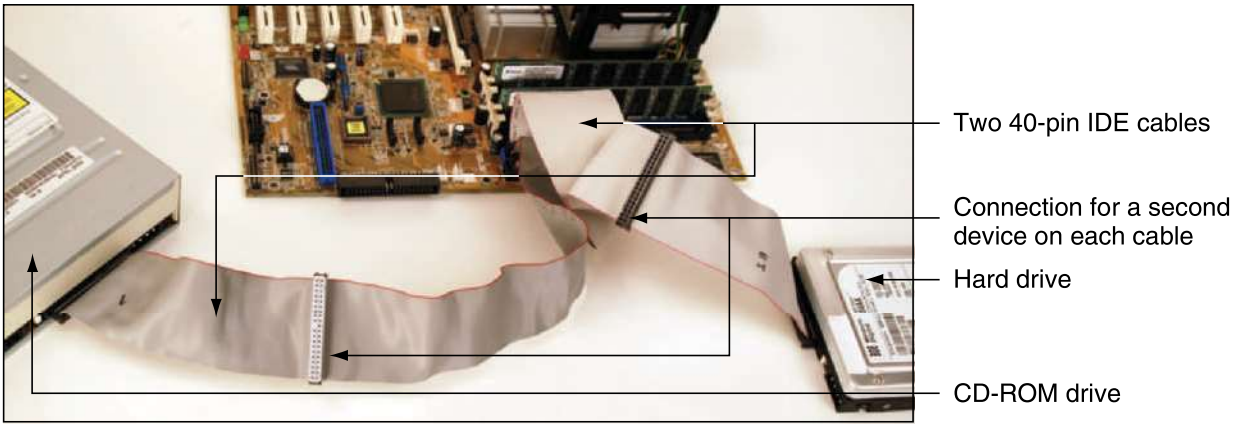


Figure 1-18 Two PATA devices connected to a motherboard using both PATA or IDE connections and two cables

SATA and PATA standards are published by the American National Standards Institute (ANSI, see *www.ansi.org*). Figure 1-19 shows a SATA cable connecting a hard drive and motherboard. SATA cables can only connect to a SATA connector on the motherboard in one direction (see Figure 1-20). SATA drives get their power from a power cable that connects to the drive using a SATA power connector (refer back to the photo in Table 1-2).

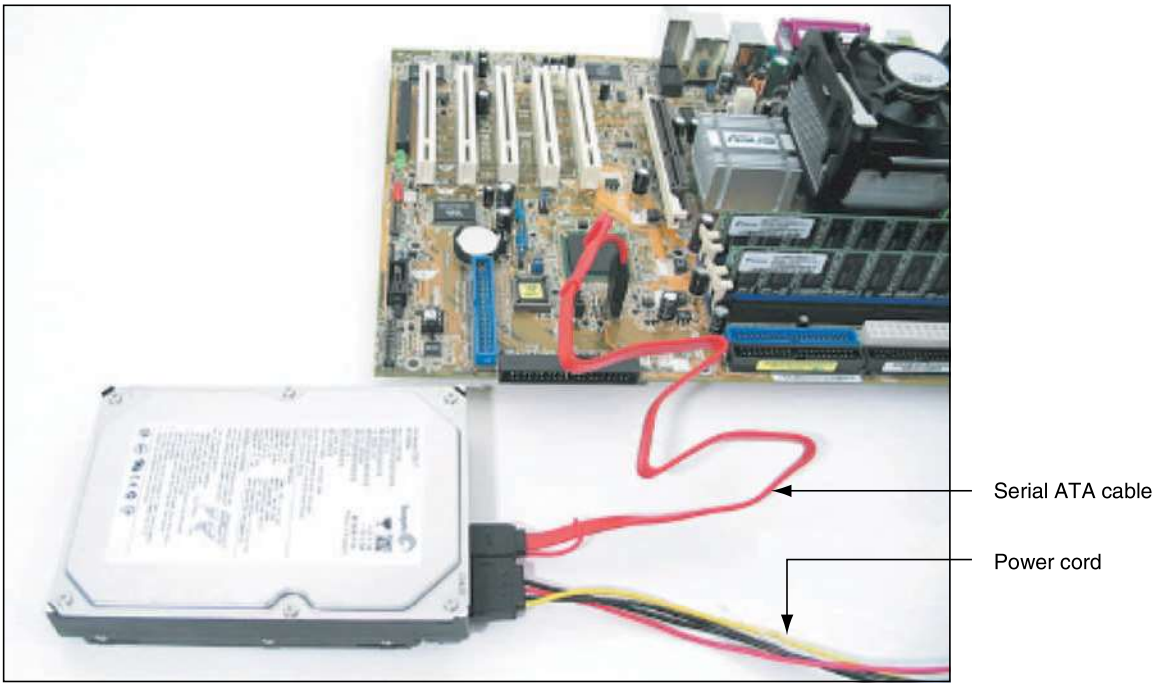


Figure 1-19 A hard drive subsystem using the SATA data cable

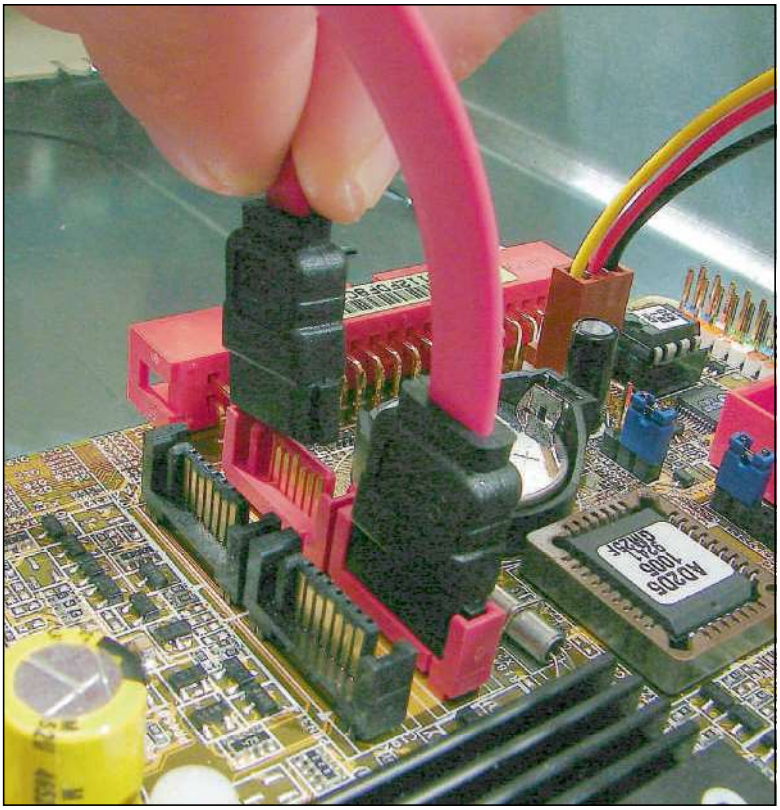


Figure 1-20 A SATA cable connects to a SATA connector in only one direction; use red connectors on the motherboard first

Hands-On | Project 1-3 Identify Drives and Their Connectors

A+ 220-901 1.7, 1.8, 1.11

If your instructor has provided a display of drives, for each drive identify the purpose of the drive (for example, a hard drive or optical drive) and the type of power connector the drive uses (for example, SATA or Molex). If you have access to a computer with the case cover removed, answer the following questions:

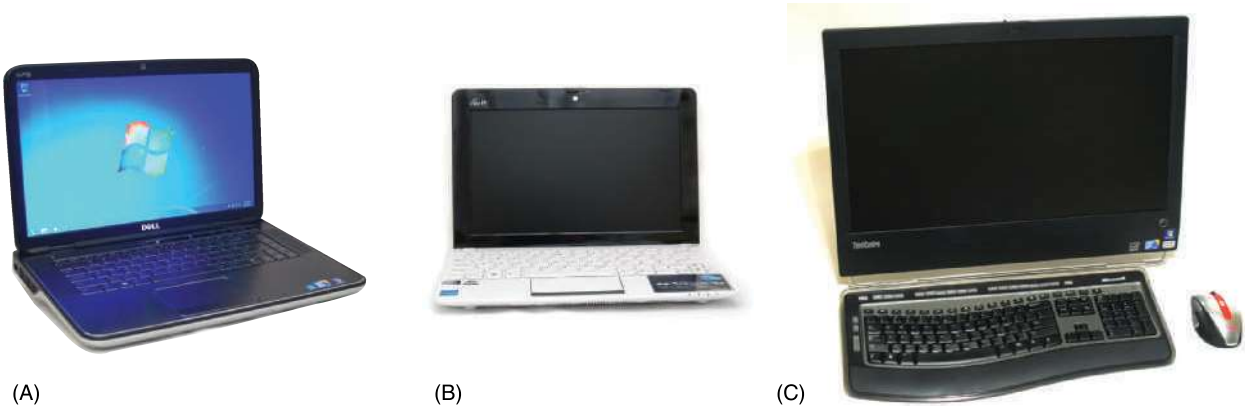
1. List the drives installed, the purpose of each drive, and the type of interface and power connector it uses.
2. How many connectors does the motherboard have for drives? Identify each type of connector (SATA or PATA).

Now that you know about what's inside a desktop computer case, let's take a look at laptop computers.

FIRST LOOK AT LAPTOP COMPONENTS

A+ 220-901 3.1, 3.3, 3.4, 3.5

A laptop, also called a notebook, is designed for portability (see Figure 1-21a and 1-21b) and can be just as powerful as a desktop computer. More than half of personal computers purchased today are laptops, and almost 30 percent of personal computers currently in use are laptops. Laptops use the same technology as desktops, but with modifications to use less power, take up less space, and operate on the move.



(A) (B) (C)

Figure 1-21 A laptop, netbook, and all-in-one computer

iStockphoto.com/Rasslava

Figure 1-22 A laptop with a rotating display can do double-duty as a tablet computer

Laptops come in several varieties, including some with a touch screen that also allows you to handwrite on it with a stylus and some with a rotating screen or removable screen that allows you to use the laptop as a tablet (see Figure 1-22). Another variation of a laptop is a **netbook** (Figure 1-21b) that is smaller and less expensive than a laptop and has fewer features. An **all-in-one computer** (Figure 1-21c) has the monitor and computer case built together and uses components that are common to both a laptop and desktop.

Because all-in-one computers use many laptop components and are serviced in similar ways, we include them in this chapter.

A laptop provides ports on its sides, back, or front for connecting peripherals (see Figure 1-23). Ports common to laptops as well as desktop systems include USB, FireWire, network, dial-up modem (seldom seen on newer laptops), and audio ports (for a microphone, headset, or external speakers). Video ports might include one or more VGA, DisplayPort, Thunderbolt (on Apple laptops), or HDMI ports to connect to a projector, second monitor, or television. On the side or back of the laptop, you'll see a lock connector that's used to physically secure the laptop with a cable lock (see Figure 1-24) and a DC jack to receive power from the AC adapter. Also, a laptop may have an optical drive, but netbooks usually don't have optical drives.

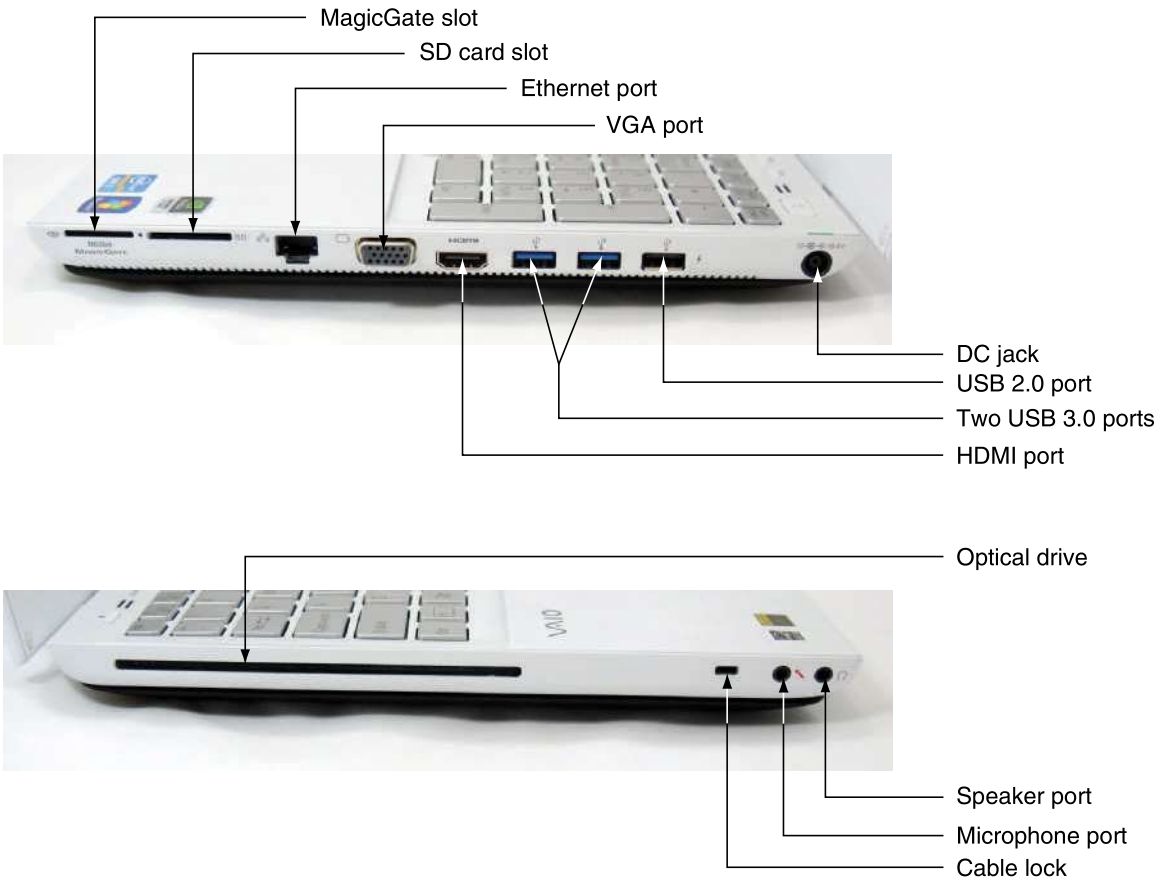


Figure 1-23 Ports and slots on a laptop computer

Source: Kensington Technology Group

Figure 1-24 Use a cable lock system to secure a notebook computer to a desk to help prevent it from being stolen

Notice the two slots in Figure 1-23 used for flash memory cards: a MagicGate slot and an SD card slot. Each can support several types of flash memory cards that you learn about later in the text.

When a laptop is missing a port or slot you need, you can usually find a USB dongle to provide the port or slot. Here are some options:

- ***Connect to a local wired network***. Figure 1-25 shows a USB to RJ-45 dongle. Plug the dongle into a USB port and plug a network cable into the RJ-45 port the dongle provides to connect the laptop to a wired network.
- ***Connect to a local wireless network***. Figure 1-26 shows a USB to Wi-Fi dongle, which allows you to connect a laptop that doesn't have wireless capability to a wireless network. Wi-Fi (Wireless Fidelity) is the common name for standards for a local wireless network.

Figure 1-25 USB to RJ-45 dongle provides a network port to connect to a wired network

Figure 1-26 This USB to Wi-Fi adapter plugs into a USB port to connect to a local wireless network

- ***Connect to a cellular network.*** Some laptops have embedded capability to connect to a cellular network. Figure 1-27 shows a USB cellular modem that can be used for a laptop that doesn't have the embedded technology. A cellular network consists of geographic areas of coverage called cells, each controlled by a tower, called a base station. Cell phones are called that because they use a cellular network.

Figure 1-27 This USB device by Sierra Wireless provides a wireless connection to a cellular network

- ***Connect to a Bluetooth device.*** When a laptop doesn't have Bluetooth capability, you can use a USB to Bluetooth adapter to connect to a Bluetooth wireless device such as a Bluetooth printer or smart phone. Bluetooth is a short-range wireless technology to connect two devices in a small personal network.
- ***Use an external optical drive.*** When a laptop or netbook doesn't have an optical drive, you can use a USB optical drive. Plug the USB optical drive into a USB port so that you can use CDs and DVDs with the laptop or netbook.

SPECIAL KEYS, BUTTONS, AND INPUT DEVICES ON A LAPTOP

A+ 220-901 3.1, 3.3, 3.4, 3.5

Buttons or switches might be found above the keyboard, and the top row of keys contains the function keys. To use a function key, hold down the Fn key as you press the function key. Here are the purposes of a few keys and buttons. Some of them change Windows settings. Know that these same settings can also be changed using Windows tools:

- ***Volume setting.*** You can set the volume using the volume icon in the Windows taskbar. In addition, some laptops offer buttons or function keys to control the volume (see Figure 1-28).

Figure 1-28 On this laptop, use the Fn and the F2, F3, or F4 key to control volume; use the Fn key and the F5 or F6 key to control screen brightness; and use the Fn key and the F7 key to manage dual displays

Figure 1-29 The touch pad is the most common pointing device on a notebook

- ***Keyboard backlight.*** Function keys can be used to control the keyboard backlight to light up the keyboard.
- ***Touch pad on or off.*** Other function keys can turn on or off the touch pad, which is the most common pointing device on a laptop (see Figure 1-29). Some people prefer to use a USB wired or wireless mouse instead of a touch pad.
- ***Screen brightness and screen orientation.*** Function keys can control the screen brightness on many laptops. Screen brightness can also be controlled in Windows display settings. Some laptops allow you to use a function key to change the screen orientation to landscape or portrait so you can use the laptop turned on its end.
- ***Dual displays.*** Most laptops use a function key to control dual displays. For example, for one laptop, the combination of the Fn key and the F7 key (refer back to Figure 1-28) displays the box shown in Figure 1-30. Use arrow keys to use only the LCD panel, duplicate or extend output to the external monitor, or use only the external monitor. Dual displays can also be managed using Windows display settings.

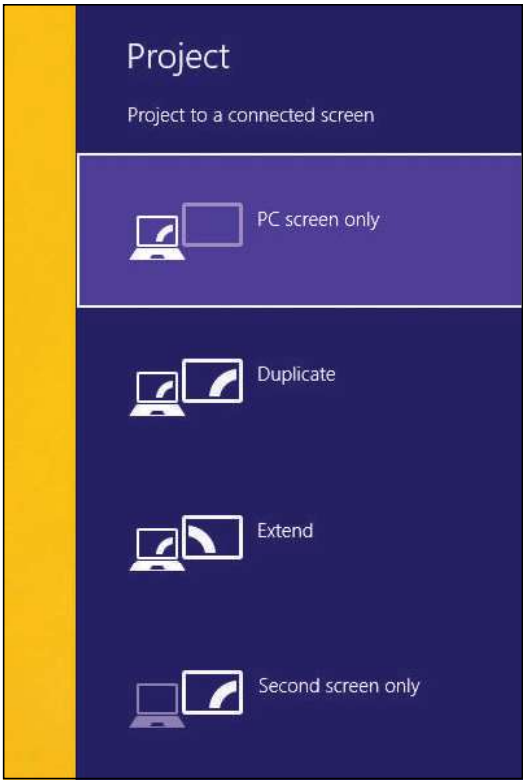


Figure 1-30 Control dual monitors on a Windows 8 laptop

- ***Bluetooth,Wi-Fi, or cellular on or off.*** Some laptops use function keys such as Fn with F5 or F6 to toggle Bluetooth, Wi-Fi, or cellular on or off, or a laptop might have a switch for this purpose. You can also control these wireless technologies using Windows settings or software utilities provided by the manufacturer. When you turn off all wireless technologies, the computer is said to be in airplane mode.
- ***Media options.*** Some laptops provide buttons or allow you to use function keys to fast forward, stop, pause, or rewind audio or video media playing in an optical drive.
- ***GPS on or off.*** If a laptop has a GPS (Global Positioning System) receiver to calculate its position on the Earth, the laptop might provide a button or function key to turn the GPS on or off. The Global Positioning System is a system of 24 or more satellites orbiting the Earth, and a GPS receiver can locate three or more of these satellites at any time and from these three locations, calculate its own position in a process called trilateration.

Notes If the keyboard fails and you're not able to immediately exchange it, know that you can plug in an external keyboard to a USB port to use in the meantime.

And now onward to ExpressCard slots and docking stations.

EXPRESSCARD SLOTS

A+ 220-901 3.1, 3.3, 3.4, 3.5

Most peripheral devices on today's laptops use a USB port to connect to the laptop. Before USB devices became so popular, a laptop offered ExpressCard slots to connect peripheral devices. See Figure 1-31. These slot and card standards were designed and supported by the PCMCIA (Personal Computer Memory Card International Association) and are sometimes called PCMCIA cards. The cards were used by many devices, including modems, network cards for wired or wireless networks, sound cards, FireWire (IEEE 1394) controllers, USB controllers, flash memory adapters, TV tuners, and hard disks. Most new laptops don't have these slots, but you still need to know how to support them because you'll see them on older laptops.

Figure 1-31 ExpressCard/54 slot has an eject button on the left side of the slot

A+ Exam Tip The A+ 220-901 exam expects you to know how to install and configure ExpressCard/34 and ExpressCard/54 cards and slots.

ExpressCard uses the PCI Express bus standard or the USB 2.0 standard. Two sizes of ExpressCards exist: ExpressCard/34 is 34mm wide and ExpressCard/54 is 54mm wide, as shown in Figure 1-32. Notice the offset in the ExpressCard/54 card. An ExpressCard/34 card can fit into an ExpressCard/54 slot, but not vice versa. An ExpressCard slot is fully hot-pluggable (you can add a card while the system is on), hot-swappable (exchange or add a card while the system is on), and supports autoconfiguration. An ExpressCard/54 card that provides two eSATA ports for external SATA drives is shown in Figure 1-33.

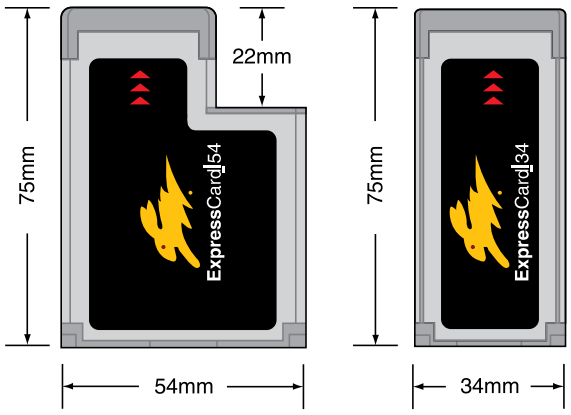


Figure 1-32 Dimensions of ExpressCard cards

Source: SIIG, Inc.

Figure 1-33 This ExpressCard/54 card supports two eSATA drives

Windows must provide two services for an ExpressCard: a socket service and a card service. The socket service establishes communication between the card and the laptop when the card is first inserted. The card service provides the device driver to interface with the card after the socket is created.

The first time you insert an ExpressCard in a laptop, Windows automatically guides you through the installation steps in which you can use the drivers provided by the hardware manufacturer or use Windows drivers. The next time you insert the card in the laptop, the card is detected and starts without help.

ExpressCards can be hot-swapped (inserted or removed while the system is on), but you must stop one card before inserting another. To stop the card, use the Safely Remove Hardware icon in the notification area of the Windows taskbar.

After you have stopped the card, push on the card, which causes it to pop out of the slot. Some ExpressCard slots have an eject button to pop out the card. Then you can remove the card.

Caution Inserting an ExpressCard while the laptop is shutting down or booting up can cause damage to the card and/or to the laptop. Also, a card might give problems when you insert or remove the card while the laptop is in hibernation or sleep mode.

DOCKING STATIONS

A+ 220-901 3.1, 3.3, 3.4, 3.5

Some notebooks have a connector, called a **docking port**, on the bottom or sides of the laptop (see Figure 1-34) to connect to a docking station. A **docking station** provides ports to allow a laptop to easily connect to a full-sized monitor, keyboard, AC power adapter, and other peripheral devices. See Figure 1-35. Laptop manufacturers usually offer a docking station as an additional option.

Figure 1-34 The docking port and sheet battery connector on the bottom of a laptop

To use a docking station, plug all the peripherals into the docking station. Then connect your laptop to the station. No software needs installing. When you need to travel with your laptop, rather than having to unplug all the peripherals, all you have to do is disconnect the laptop from the docking station.

Courtesy of Lenovo

Figure 1-35 Docking station for a Lenovo ThinkPad

LAPTOP INTERNAL COMPONENTS

A+ 220-901 3.1, 3.3, 3.4, 3.5

Figure 1-36 shows the inside of a laptop case after the cover on the bottom of the laptop has been removed. Here is a list of important components, most of which you can see in the photo:

Figure 1-36 Bottom of a laptop with cover removed

- ***Battery pack***. The battery pack is not shown because you always remove the battery first before opening a laptop case.
- ***Hard drive.*** The 2.5-inch hard drive is secured in its bay with two screws. When you remove the screws, you can use the plastic tab to lift the drive from its bay.

Figure 1-37 A DIMM used in desktops compared with a SO-DIMM used in laptop computers

- ***CPU, heat sink, and fan***. The CPU is hidden under the heat sink, which is labeled in the figure. The heat sink draws heat from the CPU and pipes it to the fan, also labeled in the figure. The fan blows the heat out of the laptop case.
- ***Memory***. Laptops use smaller memory modules than the DIMMs used in desktop computers. In the figure, you can see two SO-DIMMs (small outline DIMMs) installed. Figure 1-37 shows a DIMM and a SO-DIMM for size comparison.

- ***Wireless card***. The wireless card is installed to the left of the hard drive in Figure 1-36. You can see two wires leading to the wireless antennas, which are installed in the laptop lid.
- ***System board***. Look for the blue system board (in laptop documentation, the motherboard is usually called the system board) under the heat sink, memory, and fan. If you look carefully, you can see microchips and other components on the board.
- ***Optical drive***. The optical drive is not visible in the photo. To replace it, you first remove a single screw holding the drive in place and then slide the drive to the left and out of the case. This one screw is labeled in Figure 1-36.

Other hardware components you are likely to find in a laptop case include a small speaker and smart card reader and writer. In the chapter, "Working Inside Desktop Computers and Laptops," you learn how to disassemble and reassemble a laptop.

WHAT'S INSIDE AN ALL-IN-ONE COMPUTER

A+ 220-901 3.1, 3.3, 3.4, 3.5

An all-in-one computer uses a mix of components sized for a desktop computer and a laptop. Let's get the general idea of what's inside the case of an all-in-one by looking at the inside of the Lenovo ThinkCentre all-in-one shown earlier in Figure 1-21. Figure 1-38 shows the computer with the case cover removed. Notice in the figure the hard drive is a 3.5-inch drive appropriate for a desktop system, and the memory modules are SO-DIMMs appropriate for a laptop. So goes the hybrid nature of an all-in-one. The fan and heat sink look more like that of a laptop computer, but the processor socket on the motherboard is a desktop processor socket, another hybrid design.

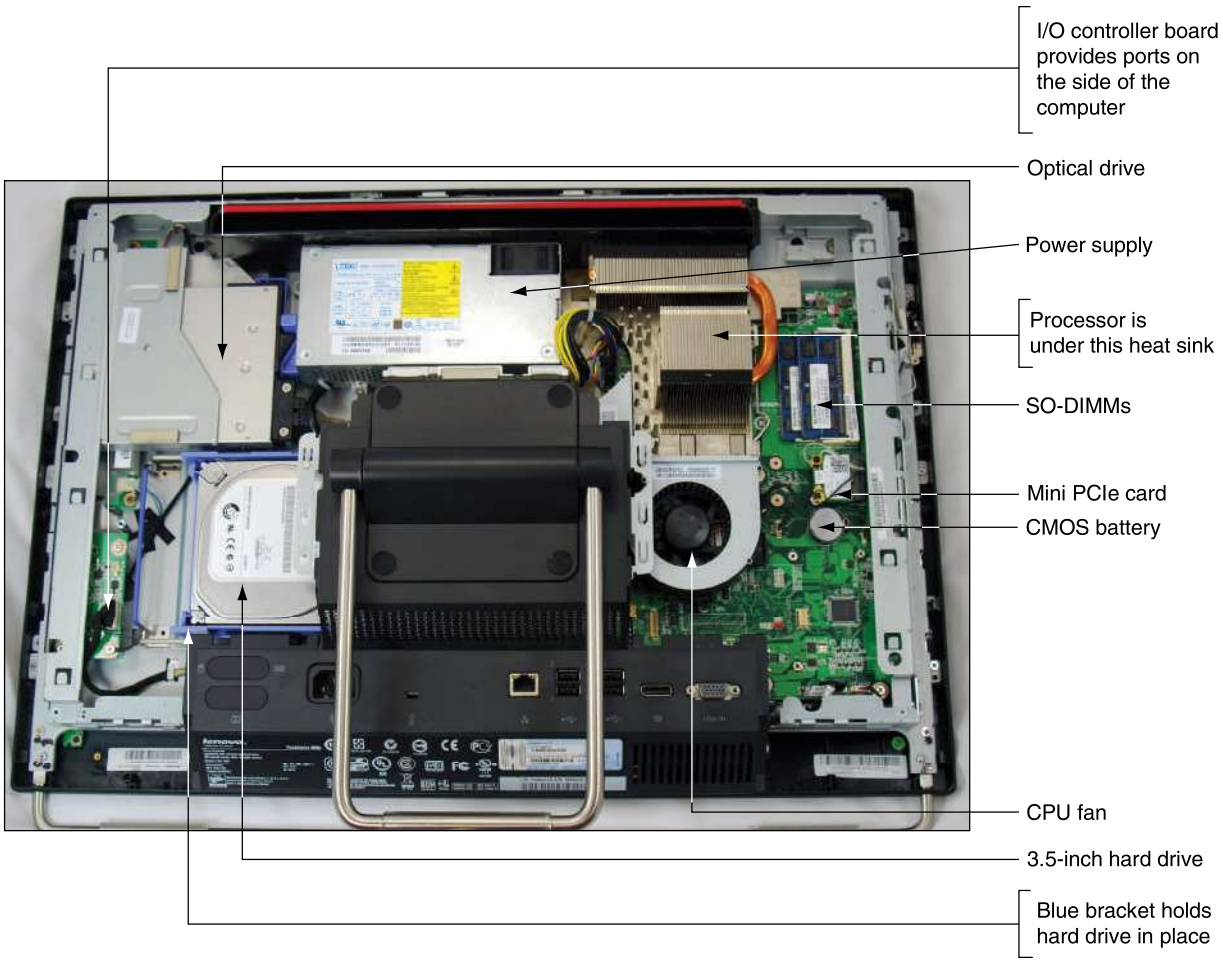


Figure 1-38 Components inside an all-in-one computer

Several components are easy to exchange in this all-in-one without further disassembly. For example, the Mini PCIe card for wireless connectivity, shown in Figure 1-39, is easy to get to, as are the SO-DIMMs you can partly see on the right side of the photo.

Figure 1-39 CMOS battery and Mini PCIe wireless card

To work inside an all-in-one, you'll need the service manual to know how to open the case and replace internal components. Also, for some components, such as the motherboard and power supply, you'll need to buy the replacement component from the all-in-one manufacturer because these components are likely to be proprietary as with many laptop components. For specific directions about replacing parts in an all-in-one, see the service manual.

MAINTAINING LAPTOPS AND MOBILE DEVICES

A+ 220-901 3.1, 3.3, 3.4, 3.5

Laptops and mobile devices tend to not last as long as desktop computers because they are portable and, therefore, subject to more wear and tear. A device's user manual gives specific instructions on how to care for the device. Those instructions follow these general guidelines:

- LCD panels on devices are fragile and can be damaged fairly easily. Take precautions against damaging a laptop or other device's LCD panel. Don't touch it with sharp objects like ballpoint pens.
- Don't pick up or hold a laptop by the lid. Pick it up and hold it by the bottom. Keep the lid closed when the laptop is not in use.
- Only use battery packs and AC adapters recommended by the laptop manufacturer. Keep the battery pack away from moisture or heat, and don't attempt to take the pack apart. When it no longer works, dispose of it correctly. For laptops, you might consider buying an extra battery pack to use when the first one discharges. You can also buy battery chargers so that you can charge one while the other is in use.
- Don't tightly pack a laptop or tablet in a suitcase because the LCD panel might get damaged. Use a good-quality carrying case and make a habit of always transporting the laptop in the carrying case. Don't place heavy objects on top of the laptop case.
- Don't move the laptop while the hard drive is being accessed (when the drive indicator light is on). Wait until the light goes off.

- Don't put the laptop close to an appliance such as a TV, large audio speakers, or refrigerator that generates a strong magnetic field, and don't place your cell phone on a laptop while the phone is in use.
- Always use passwords to protect access to your laptop or mobile device so you are better protected when connected to a public network or the device is stolen or used by an unauthorized person.
- Keep your laptop or device at room temperature. For example, never leave it in a car overnight when it is cold, and don't leave it in a car during the day when it's hot. Don't expose your laptop or device to direct sunlight for an extended time.
- Don't leave the laptop or device in a dusty or smoke-filled area. Don't use it in a wet area such as near a swimming pool or in the bathtub. Don't use it at the beach where sand can get in it.
- Don't power it up and down unnecessarily.
- Protect the laptop from overheating by not running it when it's still inside the case, resting on a pillow, or partially covered with a blanket or anything else that would prevent proper air circulation around it.
- If a laptop has just come indoors from the cold, don't turn it on until it reaches room temperature. In some cases, condensation can cause problems. Some manufacturers recommend that when you receive a new laptop shipped to you during the winter, you should leave it in its shipping carton for several hours before you open the carton to prevent subjecting the laptop to a temperature shock.
- Protect a laptop against static electricity. If you have just come in from the cold on a low-humidity day when there is the possibility that you are carrying static electricity, don't touch the laptop until you have grounded yourself.
- Before placing a laptop in a carrying case for travel, remove any CDs, DVDs, or USB flash drives, and put them in protective covers. Verify that the system is powered down and not in sleep mode, which will drain the battery.
- If a laptop gets wet, you can partially disassemble it to allow internal components to dry. Give the laptop several days to dry before attempting to turn it on. Don't use heat to speed up the drying time.
- Keep current backups of important data on a laptop or device in case it fails or is stolen.

A well-used laptop, especially one that is used in dusty or dirty areas, needs cleaning occasionally. Here are some cleaning tips:

1. Clean the LCD panel with a soft dry cloth. If the panel is very dirty, you can use monitor wipes to clean it or dampen the cloth with water. Some manufacturers recommend using a mixture of isopropyl alcohol and water to clean an LCD panel. Be sure the LCD panel is dry before you close the lid.
2. Use a can of compressed air meant to be used on computer equipment to blow dust and small particles out of the keyboard, trackball, and touch pad. Turn the laptop at an angle and direct the air into the sides of the keyboard. Then use a soft, damp cloth to clean the key caps and touch pad.
3. Use compressed air to blow out all air vents on the laptop to make sure they are clean and unobstructed.
4. If keys are sticking, remove the keyboard so you can better spray under the keys with compressed air. If you can remove the key cap, remove it and clean the key contact area with contact cleaner. One example of a contact cleaner you can use for this purpose is Stabilant 22 (*www.stabilant.com*). Reinstall the keyboard and test it. If the key still sticks, replace the keyboard.
5. Remove the battery and clean the battery connections with a contact cleaner.

Hands-On Project 1-4 Observe Laptop Features

Examine a laptop, its documentation, and the manufacturer's website, and then answer these questions:

1. What ports are on the laptop?
2. Does the laptop have an ExpressCard slot? If so, which type of ExpressCard slot does the laptop have?
3. What type of memory slots does the laptop have?
4. List the purpose of each function key on the keyboard.
5. List the purpose of each button on the top or bottom of the keyboard.
6. What is the cost of a new battery pack?

Now that you know about some of the parts and components in desktops, laptops, and all-in-ones, let's turn our attention to the components found in a few other mobile devices, including tablets, smart phones, phablets, and wearable technology devices.

FIRST LOOK AT MOBILE DEVICE HARDWARE

A+ 220-901 3.1, 3.3, 3.4, 3.5

Here's a list of the mobile devices that you, as an IT support technician, might be called on to support:

- ***Smart phone.*** A smart phone is primarily a cell phone that also includes abilities to send text messages with photos, videos, or other multimedia content attached; surf the web; manage email; play games; take photos and videos; and download and use small apps. Most smart phones use touch screens for input (see Figure 1-40) and a few have a physical keyboard and a touch screen. Some smart phones allow for voice input.

Stockphoto.com/Hocus-focus

Figure 1-40 Most smart phones don't have a keyboard and use a touch screen for input

- ***Tablets and phablets.*** A tablet is a computing device with a touch screen that is larger than a smart phone and has functions similar to a smart phone. Most tablets can connect to Wi-Fi networks and use Bluetooth or NFC (Near Field Communication) to wirelessly connect to nearby devices. Some tablets have the ability to use a cellular network for data transmissions and phone calls. Installed apps, such as Skype, can make voice phone calls, send text, and make video calls. When you can use your tablet to make a phone call, the distinction between a smart phone and a tablet is almost nonexistent, except for size.

  A phablet bridges this size exception. A phablet (pronounced "*fab*-let") has the same capabilities of a smart phone or tablet, but is smaller than a tablet and larger than a smart phone.
- ***E-readers.*** An e-reader is a mobile device that holds digital versions of books, newspapers,

magazines, and other printed documents, which are usually downloaded to the device from the web. An e-reader can connect to the Internet using a Wi-Fi wireless connection or a wired connection to a computer that is connected to the Internet. In addition, content can be stored on a flash memory card, which is inserted in the e-reader.

- ***Smart cameras.*** A smart camera is a digital camera that has embedded computing power to make decisions about the content of the photos or videos it records, including transmitting alerts over a wired or wireless network when it records certain content. Smart cameras, sometimes called vision sensors, can be used to initiate alerts for surveillance of a protected area or to monitor manufacturer automated assembly lines for potential problems.
- ***Wearable technology devices.*** Wearable technology devices, including smart watches (see Figure 1-41), wristbands, arm bands, eyeglasses, headsets, and clothing, can be used as computing devices to make phone calls, send text messages, transmit data, and check email; wearable technology fitness monitors can measure heart rate, count pool laps or miles jogged or biked, and a host of other activities. These devices can sync up with a computer for power and communication, similar to how other mobile devices work. Many people believe smart watches will eventually replace smart phones as the personal communication device of choice.

iStockphoto.com/Mutlu Kurtbas

Figure 1-41 The app screen on a smart watch by Apple, Inc.

CONNECTION TYPES

A+ 220-901 3.1, 3.3, 3.4, 3.5

Here are some ways a mobile device can connect to the outside world:

- ***Wi-Fi local wireless network and cellular network.*** Most mobile devices have Wi-Fi capability and can connect to a Wi-Fi local wireless network. In addition, smart phones and some laptops, tablets, phablets, and wearable mobile devices can connect to a cellular network. To connect to a cellular network, the device must have cellular capability and a subscription to the cellular network carrier, for example, AT&T or Verizon. Two types of technologies are used to connect to cellular networks: GSM (Global System for Mobile Communication) and CDMA (Code Division Multiple Access). With GSM networks, information about your subscription is kept on a small SIM (Subscriber Identity Module) card inserted in the device. Figure 1-42 shows the slot on the side of an Apple iPad where you can insert a SIM card so that the iPad can connect to the cellular network.

Figure 1-42 A SIM card is required for a mobile device to use most cellular networks

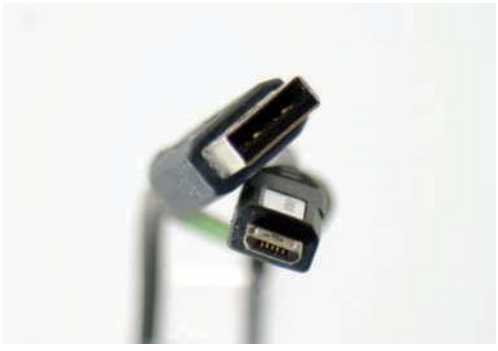
- ***Bluetooth and Infrared.*** Mobile devices might have the capability to connect to other nearby wireless devices using a Bluetooth, IR, or NFC connection. Figure 1-43 shows an iPad connected to a keyboard using Bluetooth. Infrared (IR) is a wireless connection that requires an unobstructed "line of sight" between transmitter and receiver. Smart phones and other mobile devices sometimes offer an IR interface that can be used with an app to control a television in place of its remote control.
- ***NFC.*** Near Field Communication (NFC) is a wireless technology that establishes a communication link between two NFC devices that are within 4 inches of each other. For example, when you tap your smart phone with that of your friend, the two phones can use NFC to exchange contact information. NFC can also be used to read an NFC tag, which is a small microchip that can be embedded in just about anything, including a key chain tag, printed flyer, or billboard (see Figure 1-44). The NFC tag dispenses information to any NFC-enabled smart phone or other device that comes within 4 inches of the tag.

Figure 1-43 An iPad and a wireless keyboard can connect using Bluetooth

Figure 1-44 These programmable NFC tags have sticky backs for attaching to a flat surface like a wall, desk, or car dashboard

- ***Wired connection.*** Smart phones, tablets, phablets, and wearable devices can make a wired connection to a computer. This connection can be used to charge the device, download software updates, upload data to the computer, back up data, and restore software or data. The device's port used for power and communication may be a type of USB port or a proprietary vendor-specific port. Some USB connectors used for this purpose include microUSB (see Figure 1-45a) or the smaller miniUSB (see Figure 1-45b). Newer Apple iPhones, iPods, and iPads use the proprietary Lightning port and connector for power and communication (see Figure 1-46).

(A)



(B)

Figure 1-45 Some mobile devices may connect using a (a) microUSB or (b) miniUSB port

Figure 1-46 A Lightning cable by Apple, Inc., has a USB connector for the computer end and a Lightning connector for an iPhone or iPad

- ***Tethering and mobile hotspots.*** When a mobile device is connected to the Internet by way of its cellular network, you can allow other computers and devices to use this same connection. For example, in Figure 1-47, the smart phone is tethered by USB to a laptop so that the laptop can use the cellular network to connect to the Internet. If the smart phone has Wi-Fi capabilities, the smart phone can create its own Wi-Fi hotspot for other computers and devices to connect to wirelessly. An app on the smart phone controls these connections, and your carrier subscription must allow for tethering and for providing mobile hotspots.

Figure 1-47 Tether your smart phone to your laptop using a USB cable

A mobile device can use an accelerometer and GPS receiver to sense its position. Here are brief details about each:

- ***Accelerometer.*** A gyroscope is a device that contains a disc that is free to move and can respond to gravity as the device is moved (see Figure 1-48). Three axes in the device sense how the disc moves and, therefore, can tell the direction of motion. An accelerometer is a type of gyroscope used in mobile devices to sense the physical position of the device. The accelerometer is used by the OS and apps to adjust the screen orientation from portrait to landscape as the user rotates the device. Apps such as a Compass, Carpenter's Leveler, and some game apps use the accelerometer to sense how the user is moving the device.

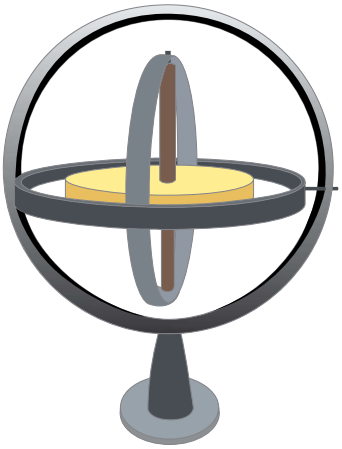


Figure 1-48 A gyroscope uses gravity to sense its relative position to the Earth

- ***GPS receiver.*** Mobile devices might contain a GPS receiver to determine its position by using the GPS satellite data or data from the position of nearby cellular towers. A cellular-enabled device with a GPS receiver is likely to use both types of data to find its position. A mobile device routinely reports its position to the owner of its operating system. For example, a device may report its position to Apple (for devices that use the iOS operating system by Apple, Inc.), Google (for devices that use the Android operating system by Google), or Microsoft (for devices that use the Windows Phone operating system by Microsoft) at least twice a day, and usually more often, which makes it possible for these companies to track your device's whereabouts, which is called geotracking. Law enforcement agencies sometimes use this data to reconstruct a person's travels.

STORAGE DEVICES

A+ 220-901 3.1, 3.3, 3.4, 3.5

Mobile devices store their apps and data on a solid-state device (SSD), a type of flash memory. In addition, a device might have an external slot where you can plug in a smart card such as an SD card or MicroSD card to provide extra storage. Figure 1-49 shows a memory card slot on an Android tablet, and Figure 1-50 shows a MicroSD card. The iPhone, iPad, and iPod don't have these external slots for a smart card.

Figure 1-49 An Android device might provide a memory card slot to allow for extra storage

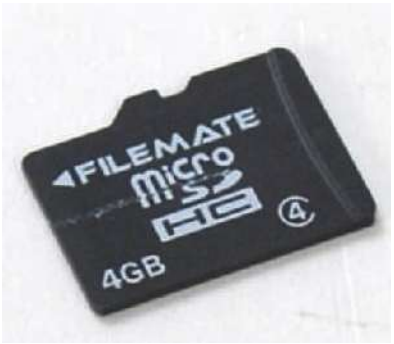


Figure 1-50 A mobile device might use a MicroSD card to add extra flash memory storage to the device

An Android or Microsoft device might also have a USB port that you can use to plug in a USB flash drive to provide extra storage or transfer files and folders to other devices. Apple mobile devices don't have USB ports.

MOBILE DEVICE ACCESSORIES

A+ 220-901 3.1, 3.3, 3.4, 3.5

You can buy all kinds of accessories for mobile devices, such as wireless keyboards, speakers, earbuds, headsets, game pads, docking stations, printers, extra batteries, USB adapters, chargers, credit card readers for accepting payments by credit card, and protective covers for waterproofing. For example, Figure 1-51 shows a car docking station for a smart phone. Using this car dock, the smart phone is a GPS device giving driving directions.

Figure 1-51 A smart phone and a car docking station

FIELD-REPLACEABLE PARTS FOR MOBILE DEVICES

A+ 220-901 3.1, 3.3, 3.4, 3.5

For the purposes of IT support technicians supporting mobile devices, know there are few field-replaceable units (FRU) in mobile devices because the cost of replacement, including parts and labor, generally exceeds the value of fixing rather than replacing the device. Although it is possible to replace the screens in some mobile devices, a support technician is not generally expected to take the time to do so. SIM cards and batteries can be replaced, and accessories such as a battery charger or earbuds can be attached.

Hands-On Project 1-5 Explore www.ifixit.com

Replacing the battery in a smart phone or tablet is a handy skill for an IT support technician to have. If you have a smart phone or tablet or know a friend who has one, find out the brand and model of the device. Search the *www.ifixit.com* website, which is a wiki-based site with tons of guides for tearing down, repairing, and reassembling all kinds of products, including smart phones, tablets, and laptops. Does the site offer a guide for replacing the battery in your device or your friend's device? If so, list the high-level steps for the repair. What tools would you need to actually make the repair?

TOOLS USED BY A COMPUTER HARDWARE TECHNICIAN

A+ 220-901 4.1

Every IT support technician who plans to repair desktop or laptop computers or mobile devices needs a handy toolbox with a few essential tools. Several hardware and software tools can help you maintain a computer and diagnose and repair computer problems. The tools you choose depend on the amount of money you can spend and the level of hardware support you expect to provide.

Essential tools for computer hardware troubleshooting are listed here, and several of them are shown in Figure 1-52. You can purchase some of these tools in a computer toolkit, although most toolkits contain items you really can do without.

Figure 1-52 Tools used by IT support technicians when maintaining, repairing, or upgrading computers

One of the more important tools is an ESD strap (also called a ground bracelet), which protects against ESD when working inside the computer case. Electrostatic discharge (ESD) is another name for static electricity, which can damage chips and destroy motherboards, even though it might not be felt or seen with the naked eye. Use the strap to connect or ground your hand to the case, as shown in Figure 1-53, and any static electricity between you and the case is dissipated.

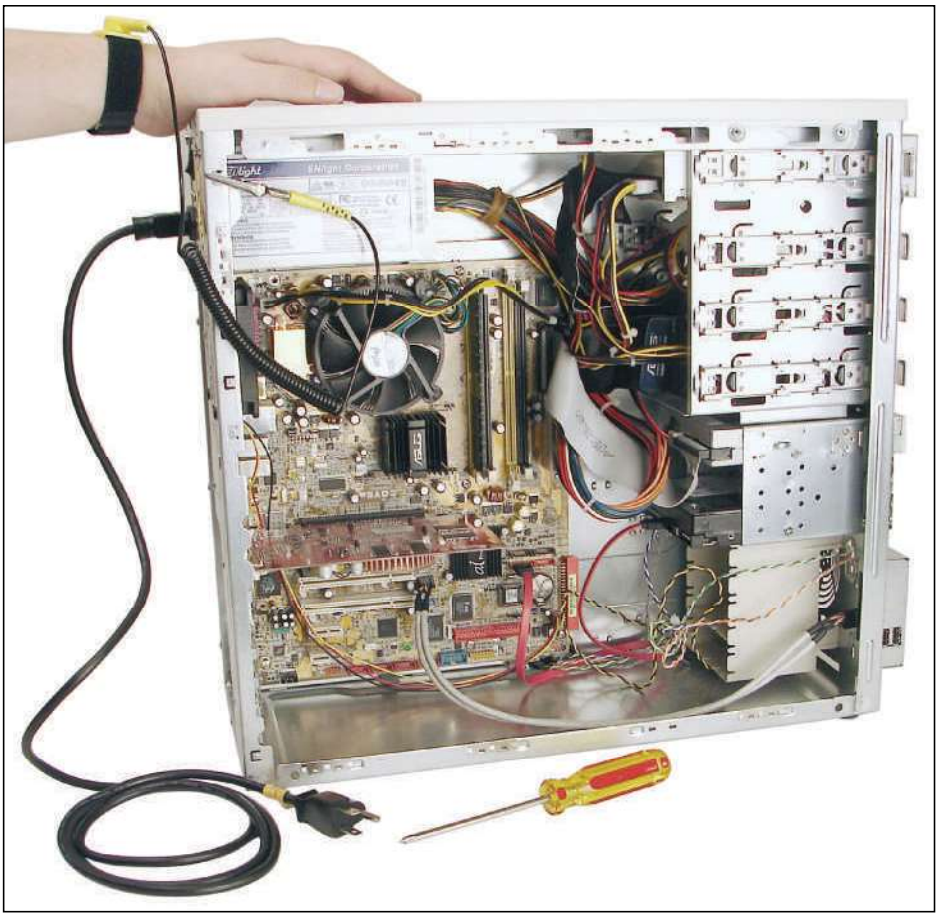


Figure 1-53 An ESD strap, which protects computer components from ESD, can clip to the side of the computer case and eliminate ESD between you and the case

Here is a list of essential tools:

- An ESD strap (also called a ground bracelet)
- Flathead screwdriver
- Phillips-head or crosshead screwdriver
- Torx screwdriver set, particularly size T15
- Tweezers, preferably insulated ones, for picking pieces of paper out of printers or dropped screws out of tight places
- Extractor, a spring-loaded device that looks like a hypodermic needle (When you push down on the top, three wire prongs come out that can be used to pick up a screw that has fallen into a place where hands and fingers can't reach.)
- Software, including recovery CD or DVD for any OS you might work on (you might need several, depending on the OSs you support), antivirus software on bootable CDs or USB flash drives, and diagnostic software

The following tools might not be essential, but they are very convenient:

- Cans of compressed air (see Figure 1-54), small portable compressor, or antistatic vacuum cleaner to clean dust from inside a computer case
- Cleaning solutions and pads such as contact cleaner, monitor wipes, and cleaning solutions for CDs, DVDs, tapes, and drives

Figure 1-54 A can of compressed air is handy to blow dust from a computer case

- Multimeter to check cables and the power supply output
- Power supply tester
- Needle-nose pliers for removing jumpers and for holding objects (especially those pesky nuts on cable connectors) in place while you screw them in
- Cable ties to tie cables up and out of the way inside a computer case
- Flashlight to see inside the computer case
- AC outlet ground tester
- Network cable tester
- Loopback plugs to test ports
- Small cups or bags to help keep screws organized as you work
- Antistatic bags (a type of Faraday cage) to store unused parts

- Chip extractor to remove chips (To pry up the chip, a simple screwdriver is usually more effective, however.)
- Pen and paper for taking notes
- POST diagnostic cards

Notes It's important to know how to stay safe when working inside computers. Before opening a computer case and using the tools described in this section, be sure to read the appendix, "Safety Procedures and Environmental Concerns." As you work inside a computer, follow all the safety guidelines discussed in this appendix.

Keep your tools in a toolbox designated for hardware troubleshooting. If you put discs and hardware tools in the same box, be sure to keep the discs inside a hard plastic case to protect them from scratches and dents. In addition, make sure the diagnostic and utility software you use is recommended for the hardware and software you are troubleshooting.

Now let's turn our attention to the details of several IT support technician tools, including diagnostic cards, power supply testers, multimeters, and loopback plugs.

POST DIAGNOSTIC CARDS

A+ 220-901 4.1

Although not an essential tool, a POST diagnostic card, also called a POST card, or motherboard test card, can be of great help to discover and report computer errors and conflicts that occur when you first turn on a computer and before the operating system (such as Windows 8) is launched. To understand what a POST card does, you need to know about the firmware, which is programs and data stored on the motherboard. Two types of firmware may be used on motherboards:

- The older BIOS (basic input/output system) contains system BIOS to manage essential devices (such as the keyboard, mouse, hard drive, and monitor) before the OS is launched, startup BIOS to start the computer, and BIOS setup to change the motherboard configuration or settings. Figure 1-55 shows an embedded firmware chip on a motherboard that contains the BIOS programs.

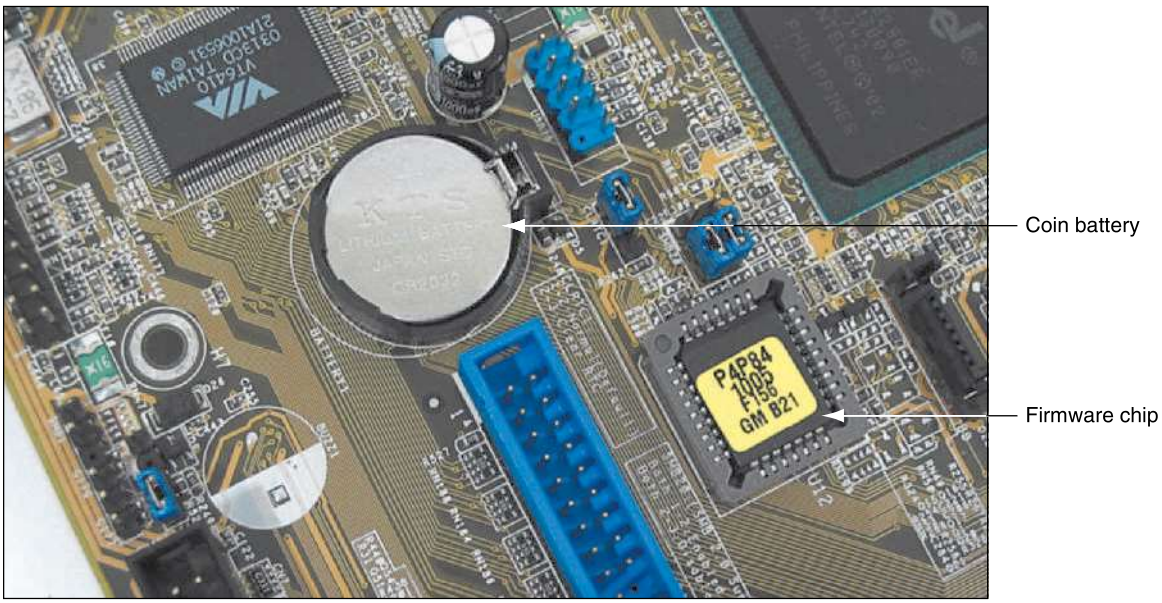


Figure 1-55 This firmware chip contains flash ROM and CMOS RAM; CMOS RAM is powered by the coin battery located near the chip

- Newer motherboards use Unified Extensible Firmware Interface (UEFI) firmware that is more robust and secure than BIOS. Just as with BIOS, UEFI is responsible for managing essential devices before the OS is launched, starting the computer, and managing motherboard settings. UEFI can also assure that the boot is secure and no rogue operating system hijacks the system.

So now back to the usefulness of a POST card. The POST (power-on self test) is a series of tests performed by the startup UEFI/BIOS when you first turn on a computer. These tests determine if startup UEFI/BIOS can communicate correctly with essential hardware components required for a successful boot. If you have a problem that prevents the computer from booting that you suspect is related to hardware, you can install the POST card in an expansion slot on the motherboard. For laptops, some cards install in a USB port. Then attempt to boot. The card monitors the boot process and reports errors, usually as coded numbers on a small LED panel on the card. You then look up the number online or in the documentation that accompanies the card to get more information about the error and its source. Figure 1-56 shows a POST diagnostic card, the Post Code Master card by Microsystems Developments, Inc. (*www.postcodemaster.com*).

Figure 1-56 Post Code Master diagnostic card by Microsystems Developments, Inc., installs in a PCI slot

Before purchasing these or any other diagnostic tools or software, read the documentation about what they can and cannot do, and read some online product reviews. Try using Google.com and searching on "computer diagnostic card reviews."

Notes Some Dell computers have lights on the case that blink in patterns to indicate a problem early in the boot before the OS loads. These blinking lights give information similar to that given by POST cards.

POWER SUPPLY TESTER

A+ 220-901 4.1

A power supply tester is used to measure the output of each connector coming from the power supply. You can test the power supply when it is outside or inside the case. As you saw earlier in Figure 1-8, the power supply provides several cables and connectors that power various components inside the computer case. A power supply tester has plugs for each type of cable. Connect a power cable to the tester, plug up the power supply, and turn on the tester. An LCD panel reports the output of each lead (see Figure 1-57).

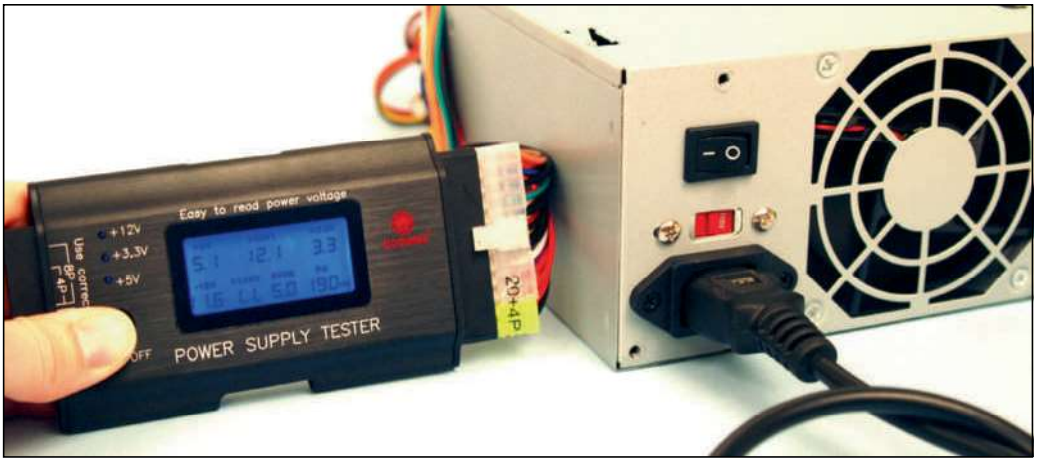


Figure 1-57 Use a power supply tester to test the output of each power connector on a power supply

MULTIMETER

A+ 220-901 4.1

A multimeter (see Figure 1-58) is a more general-purpose tool that can measure several characteristics of electricity in a variety of devices. Some multimeters can measure voltage, current, resistance, or continuity. (Continuity determines that two ends of a cable or fuse are connected without interruption.) When set to measure voltage, you can use it to measure output of each pin on a power supply connector. Set to measure continuity, a multimeter is useful to test fuses, to determine if a cable is good, or to match pins on one end of a cable to pins on the other end.

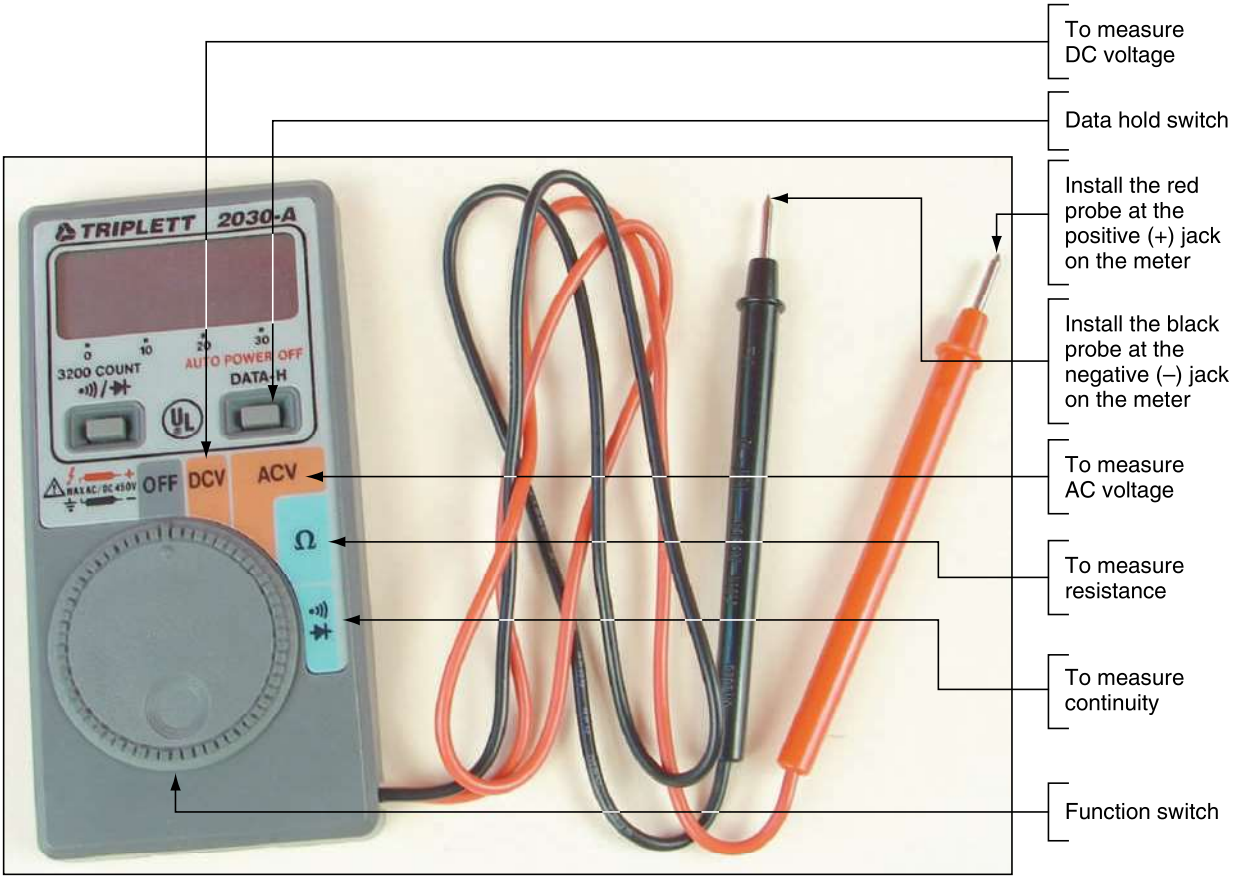


Figure 1-58 This digital multimeter can be set to measure voltage, resistance, or continuity

LOOPBACK PLUGS

A loopback plug is used to test a port in a computer or other device to make sure the port is working and might also test the throughput or speed of the port. Figure 1-59 shows a loopback plug testing a network port on a laptop. You know both the port and the network cable are good because the lights on either side of the port are lit. You can also buy a USB loopback plug to test USB ports.

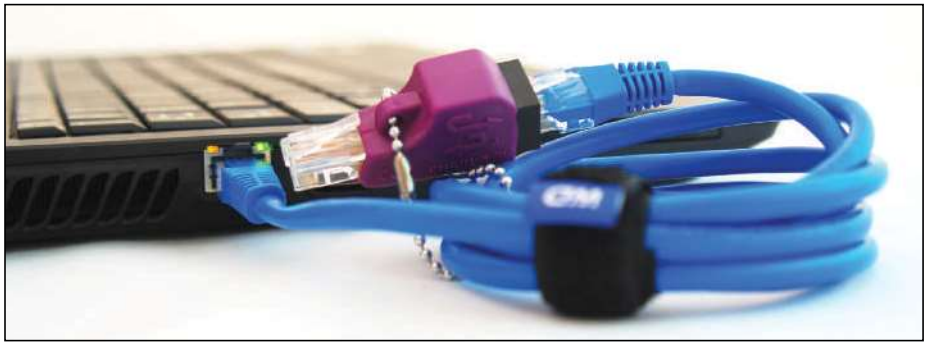


Figure 1-59 A loopback plug testing a network port and network cable

Now that you know about computer parts and their connections and the tools you need, you're ready to learn how to work inside a desktop or laptop case.

>> CHAPTER SUMMARY

What's Inside a Desktop Case

- Video ports a computer might have include the VGA, S-Video, DVI, DisplayPort, and HDMI ports. Other ports include RJ-45, audio, S/PDIF, USB, FireWire, eSATA, PS/2, serial, parallel, and RJ-11 ports. A Thunderbolt port can transmit video, data, and power.
- Internal computer components include the motherboard, processor, expansion cards, DIMM memory modules, hard drive, optical drive, tape drive, and power supply.
- Form factors used by cases, power supplies, and motherboards are the ATX and microATX form factors. The form factor determines how the case, power supply, and motherboard fit together and the cable connectors and other standards used by each.
- Power connectors used by the ATX and microATX form factors include the 20-pin P1, 24-pin P1, 4-pin and 8-pin CPU auxiliary motherboard, 4-pin Molex, 15-pin SATA, 4-pin Berg, and 6/8-pin PCIe connectors.
- The two main types of expansion slots in a desktop computer are PCI and PCI Express (PCIe).
- Most hard drives, optical drives, and tape drives today use the serial ATA (SATA) standards for the drive to interface with the motherboard and power supply.

First Look at Laptop Components

- Laptop computers use function keys to control display, volume, touch pad, media options, GPS, airplane mode, and other features of the laptop. A laptop docking station can make it easy to disconnect peripheral devices.
- A laptop may have an ExpressCard/34 or ExpressCard/54 slot for expansion. You can also use the USB ports for expansion, for example, to add a USB to RJ-45 dongle, USB to Wi-Fi dongle, Bluetooth capability, or a USB optical drive.

- Internal laptop components include the keyboard, hard drive, memory, smart card reader, optical drive, wireless card, screen, DC jack, battery pack, touch pad, speaker, system board, CPU, heat sink, and fan.
- An all-in-one computer uses a combination of components designed for desktop computers and laptops.

First Look at Mobile Device Hardware

- Mobile devices an IT support technician may be called on to service include smart phones, tablets, phablets, e-readers, smart cameras, GPS devices, and wearable technology devices such as smart watches, fitness monitors, glasses, and headsets.
- A mobile device might make a connection to the outside world using a cellular network, Wi-Fi network, Bluetooth, IR, NFC, tethering, creating its own hotspot, or wired connection. A wired connection may use a microUSB, miniUSB, or proprietary port, such as the Lightning port by Apple.
- A mobile device most likely will have an accelerometer to sense how the user is moving the device and a GPS receiver to sense the device's location and for geotracking.

Tools Used by a Computer Hardware Technician

- Common tools for a computer hardware technician include an ESD strap, screwdrivers, tweezers, flashlight, compressed air, and cleaning solutions and pads.
- Special tools a hardware technician might need include a POST diagnostic card, power supply tester, multimeter, and loopback plugs.

>> KEY TERMS

For explanations of key terms, see the Glossary for this text.

A+ Exam Tip To help you prepare for the A+ exams, the key terms in each chapter focus on the terms you need to know for the exams. Before you sit for the exams, be sure to review all the key terms in the Glossary.

4-pin 12-V connector
8-pin 12-V connector
20-pin P1 connector
24-pin P1 connector
accelerometer
airplane mode
all-in-one computer
analog
ATX (Advanced Technology Extended)
ATX12V power supply
audio port
base station
BIOS (basic input/output system)
BIOS setup
Bluetooth
cellular network
central processing unit (CPU)
chassis
DB15 port
DB9 port
DE15 port
desktop case
digital
DIMM (dual inline memory module)
DisplayPort
docking port
docking station
dual-voltage selector switch
DVI (Digital Video Interface) port
electrostatic discharge (ESD)
e-reader
Ethernet port
expansion card
ExpressCard
ExpressCard/34
ExpressCard/54
external SATA (eSATA) port
field replaceable unit (FRU)
FireWire port
firmware
fitness monitor
form factor
geotracking
GPS (Global Positioning System)
gyroscope
hard disk drive (HDD)
hard drive
HD15 port
HDMI (High-Definition Multimedia Interface) port
heat sink
hotspot
IEEE 1394 port
infrared (IR)
internal components
keyboard backlight
laptop
Lightning port
loopback plug
LPT port
main board
microATX (MATX)
microprocessor
microUSB
miniUSB
modem port
Molex connector
motherboard
multimeter
Near Field Communication (NFC)
netbook
network port
notebook
optical connector
parallel port
PCI (Peripheral Component Interconnect)
PCI Express (PCIe)
PCIe 6/8-pin connector

PCMCIA card
phablet
POST (power-on self test)
POST card
POST diagnostic card
power supply
power supply tester
power supply unit (PSU)
processor
PS/2 port
RAM (random access memory)
RJ-11 port
RJ-45 port
SATA power connector
screen orientation
serial ATA (SATA)
serial port
SIM (Subscriber Identity Module) card
smart camera
smart phone
S/PDIF (Sony/Philips Digital Interface) sound port
SO-DIMM (small outline DIMM)
startup BIOS
S-Video port
system BIOS
system board
tablet
tethered
Thunderbolt port
touch pad
tower case
Unified Extensible Firmware Interface (UEFI)
USB (Universal Serial Bus) port
USB optical drive
USB to Bluetooth adapter
USB to RJ-45 dongle
USB to Wi-Fi dongle
VGA (Video Graphics Array) port
video memory
vision sensor
wearable technology device
Wi-Fi (Wireless Fidelity)

>> REVIEWING THE BASICS

1. List six types of video ports.
2. Which is faster, a Hi-Speed USB port or a SuperSpeed USB port?
3. What type of output does an S/PDIF port provide?
4. What is the purpose of an expansion slot on a motherboard?
5. What should be the setting for a dual-voltage selector switch on a power supply when using a computer in the United States?
6. How is the best way to determine if a cable inside a computer is a data and instruction cable or a power cable?
7. What technology standard is commonly used today for hard drives to interface with the motherboard in a system?
8. How many pins did the first P1 power connector to the motherboard have that was used with the original ATX?
9. What type of expansion slot requires extra power so that 4 more pins had to be added to the older 20-pin P1 power connector on the motherboard?
10. What device might require extra power so that it uses the 12V 6-pin power connector? In what two locations might you find the connector?
11. What is the purpose of the 4-pin auxiliary connector on a motherboard?
12. What is the purpose of the 4-pin Molex connector?
13. Why are laptops usually more expensive than desktop computers with comparable power and features?
14. Which two types of buses may be used by ExpressCard slots?
15. Which port do you use to connect a docking station to a laptop?
16. Which type of memory module is used in a desktop computer? Which type is used in a laptop computer?
17. What wireless technology is used when two smart phones in close proximity exchange contact information?

18. Which tool can a computer hardware technician use when taking apart a computer to best protect computer components against ESD?
19. What is the purpose of a POST diagnostic card?
20. What are the three purposes accomplished by the motherboard BIOS?

>> THINKING CRITICALLY

1. You purchase a new desktop computer that does not have wireless capability, and then you decide that you want to use a wireless connection to the Internet. What are the least expensive ways (choose two) to upgrade your system to wireless?
   a. Trade in the computer for another computer that has wireless installed.
   b. Purchase a second computer that has wireless capability.
   c. Purchase a wireless expansion card and install it in your system.
   d. Purchase a USB wireless adapter and connect it to the computer by way of a USB port.
2. What type of computer is likely to use SO-DIMMs, have an internal power supply, and use a desktop processor socket?
3. A friend asks you for help in determining the best product to buy: a laptop, tablet, or smart phone. She is a paralegal and spends a lot of time at the courthouse researching real estate titles. She wants a device to take notes with as she works. List three questions you would ask her to help her make her decision.
4. When troubleshooting a computer hardware problem, which tool might help with each of the following problems?
   a. You suspect the network port on a computer is not functioning.
   b. The system fails at the beginning of the boot and nothing appears on the screen.
   c. A hard drive is not working and you suspect the Molex power connector from the power supply might be the source of the problem.

>> REAL PROBLEMS, REAL SOLUTIONS

REAL PROBLEM 1-1 Planning Your Computer Repair Toolkit

Research on the web to find the following tools for sale: ESD strap, set of flathead and Phillips-head screwdrivers, can of compressed air, monitor cleaning wipes, multimeter, power supply tester, cable ties, flashlight, loopback plug to test an Ethernet port, POST diagnostic card, and toolbox.

Print or save the webpage showing each tool and its price. What is the total cost of this set of tools? If you were building your own computer repair toolkit, which tools would you purchase first if you could not afford the entire set of tools? Which tools not listed would you add to your toolbox?