

Troubleshooting Hardware Problems

In this chapter, you will learn:

- How to approach and solve a computer problem related to hardware, especially when the problem occurs during the boot
- How to troubleshoot problems with the electrical system
- How to troubleshoot problems that occur during POST before video is active
- How to troubleshoot error messages that occur during the POST
- How to troubleshoot problems with the motherboard, processor, and RAM
- How to troubleshoot hard drive problems
- How to troubleshoot problems with the monitor and video
- About protecting a computer and the environment

In the last several chapters, you have learned much about the hardware components of a system, including features and characteristics of the power supply, motherboard, processor, RAM, hard drive, I/O devices, and storage devices. You've learned how to select, install, and configure each device.

This chapter focuses on troubleshooting these various hardware subsystems and components. I've gathered troubleshooting techniques and procedures into a single chapter so you can get the full picture of what it's like to have the tools and knowledge in hand to solve any computer hardware-related problem. By the end of this chapter, you should feel confident that you can face a problem with hardware and understand how to zero in on the source of the problem and its solution. The best support technicians are good at preventing a problem from happening in the first place, so in this chapter, you'll learn some tips for protecting a computer from damage.

We begin the chapter with a general strategy for facing a computer problem and a strategy for quickly isolating the source of a problem related to booting up a computer. Then we tackle the problems and solutions for each major hardware component and subsystem.

HOW TO APPROACH A HARDWARE PROBLEM

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When an end user brings any computer problem to you, begin the troubleshooting process by interviewing the user. When you interview the user, you might want to include these questions:

- ▲ Can you describe the problem and describe when the problem first started and when it occurs?
- ▲ Was the computer recently moved?
- ▲ Was any new hardware or software recently installed?
- ▲ Was any software recently reconfigured or upgraded?
- ▲ Did someone else use your computer recently?
- ▲ Does the computer have a history of similar problems?
- ▲ Is there important data on the drive that is not backed up?
- ▲ Can you show me how to reproduce the problem?

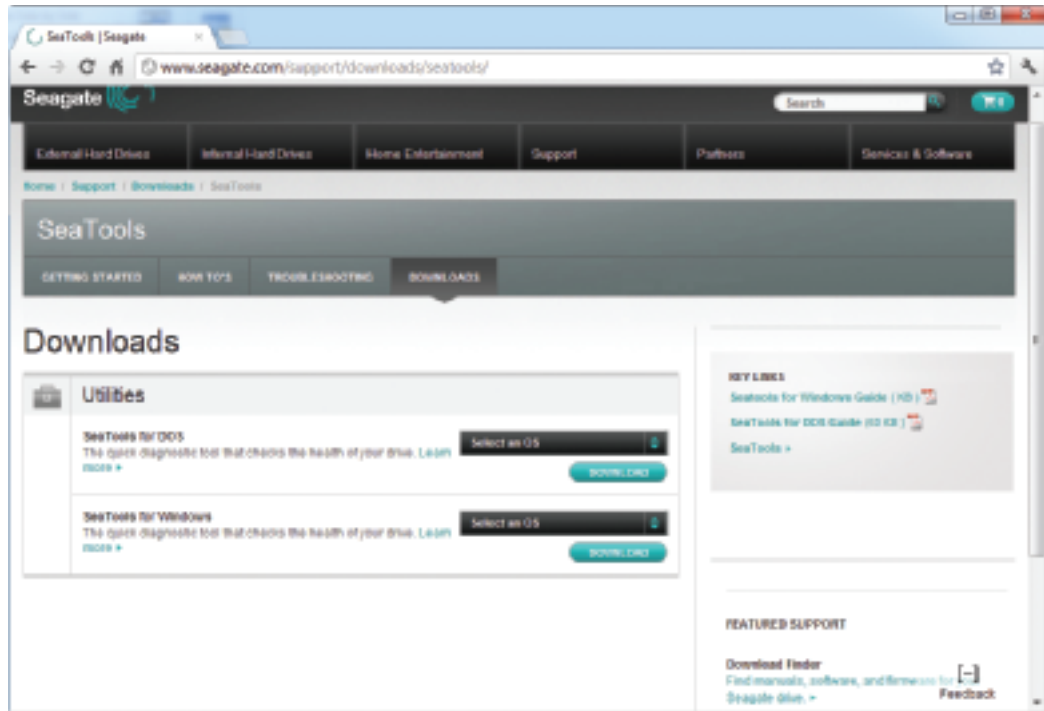
After you gather this basic information, you can prioritize what to do and begin diagnosing and addressing the problem. If the computer will not start or starts with errors so that you cannot reach the Windows desktop, setting priorities helps focus your work. For most users, data is the first priority unless they have a recent backup.

A good PC technician builds over time a strong network of resources he or she can count on when solving computer problems. Here are some resources to help you get started with your own list of reliable and time-tested sources of help:

- ▲ *User manuals* often list error messages and their meanings. They also might contain a troubleshooting section and list any diagnostic tools available.
- ▲ *The web* can also help you diagnose computer problems. Go to the web site of the product manufacturer, and search for a support forum. It's likely that others have encountered the same problem and posted the question and answer. If you search and cannot find your answer, you can post a new question. Use a search engine such as *www.google.com* to search for the error, the hardware device, the problem, the technology used, and other keywords that can help you find useful information. Youtube.com videos might help. Many technicians enjoy sharing what they know online, and the web can be a rich source of all kinds of technical information and advice. Be careful, however. Not all technical advice is correct or well intentioned.
- ▲ *Chat, telephone, or email technical support* from the hardware and software manufacturers can help you interpret an error message, or it can provide general support in diagnosing a problem. Most technical support is available during working hours by way of an online chat session.
- ▲ *Manufacturer's diagnostic software* is available for download from the web sites of many hardware device manufacturers. For example, you can download SeaTools for Windows (must be installed in Windows) or SeaTools for DOS (used to create a bootable CD that contains the software) and use the software to diagnose problems with Seagate and Maxtor drives. See Figure 8-1. Search the support section of a manufacturer's web site to find diagnostic software and guidelines for using it.



Notes Always check compatibility between utility software and the operating system with which you plan to use it.



Source: Seagate at www.seagate.com

Figure 8-1 Download diagnostic software from a manufacturer's web site

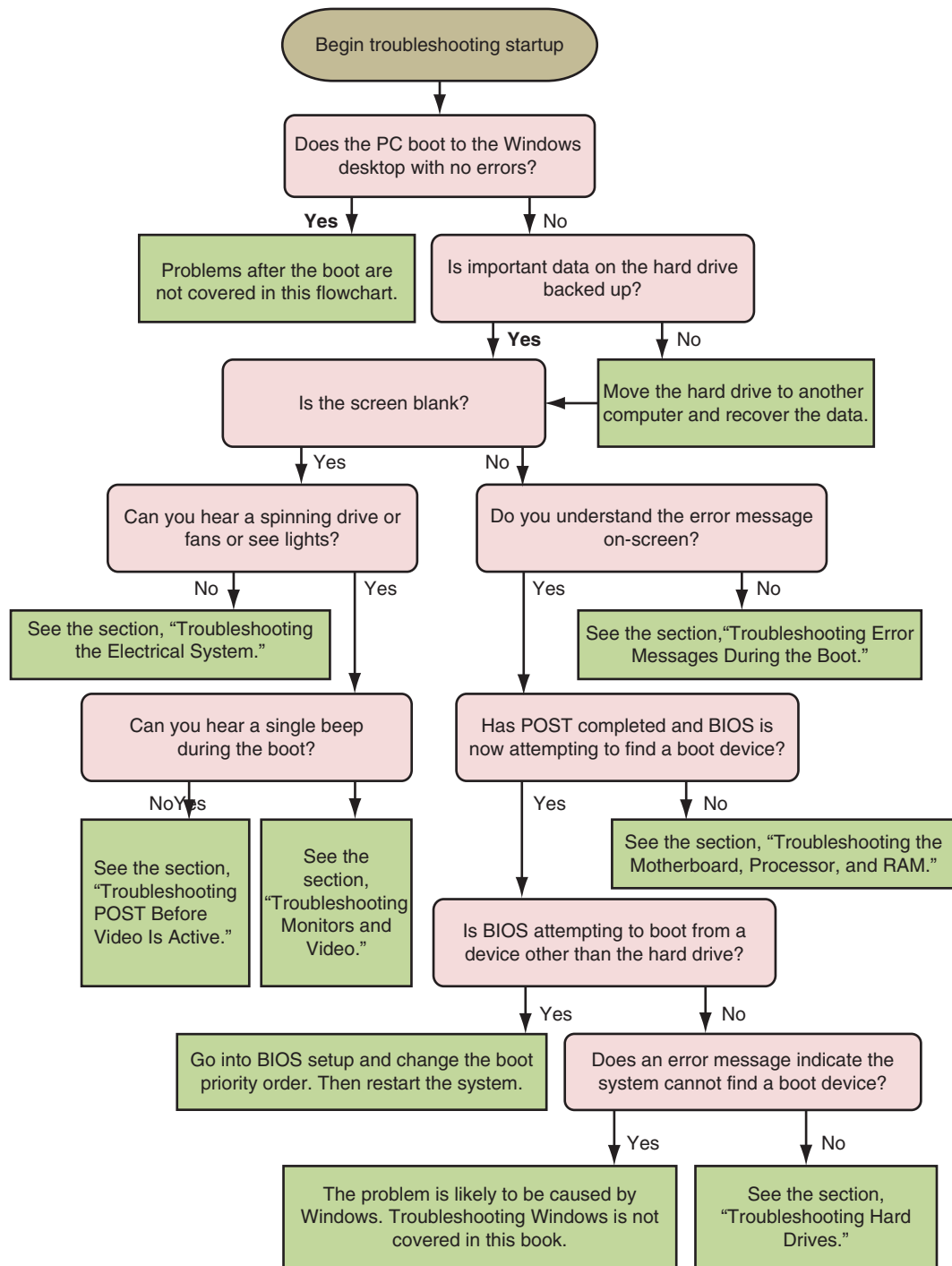
- ▲ *Technical associates in your organization can help.* Be sure to ask for advice when you're stuck. Also, after making a reasonable and diligent effort to resolve a problem, getting the problem fixed could become more important than resolving it yourself. There comes a time when you might need to turn the problem over to a more experienced technician. (In an organization, this process is called escalating the problem.)

Most PC problems are simple and can be simply solved, but you do need a game plan. That's how Figure 8-2 can help. The flowchart focuses on problems that affect the boot. As we work our way through it, you're eliminating one major computer subsystem after another until you zero in on the problem. After you've discovered the problem, many times the solution is obvious.

As Figure 8-2 indicates, troubleshooting a computer problem is divided into problems that occur during the boot and those that occur after the Windows desktop has successfully loaded. Problems that occur during the boot might happen before Windows starts to load or during Windows startup. Read the flowchart in Figure 8-2 very carefully to get an idea of the symptoms you might be faced with that would cause you to suspect each subsystem. Also, Table 8-1 can help as a general guideline for the primary symptoms and what are likely to be the source of a problem.

💡 A+ Exam Tip The A+ 220-802 exam might give you a symptom and expect you to select a probable source of a problem from a list of sources. These examples of what can go wrong can help you connect problem sources to symptoms.

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Figure 8-2 Use this flowchart when first facing a computer problem

If the hard drive has important data on it that has not been backed up, your first priority is most likely to recover the data. If a system won't boot from the hard drive, consider removing the drive and installing it as a second drive in a working system. If the file system on the problem drive is intact, you might be able to copy data from the drive to the primary drive in the working system.

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Symptom or Error Message	What to Do About the Problem
The system shuts down unexpectedly	Try to find out what was happening at the time of the shutdowns to zero in on an application or device causing the problem. Possible sources of the problem are overheating or faulty RAM, motherboard, or processor.
Error messages appear on a blue screen called a blue screen of death (BSOD)	Figure 8-3 shows an example of a BSOD error screen. These Windows errors are caused by problems with devices, device drivers, or a corrupted Windows installation. Begin troubleshooting by searching the Microsoft web site for the error message and a description of the problem.
Error messages on a black screen	These error messages, such as the one shown in Figure 8-4, are most likely caused by an error at POST. Begin by troubleshooting the device mentioned in the error message.
The system freezes or locks up	If the system locks up immediately after a BSOD error screen, begin troubleshooting by investigating the error messages on the blue screen. If the system freezes while still displaying the Windows desktop, the problem is most likely caused by Windows or an application.
POST code beeps	Startup BIOS communicates POST errors as a series of beeps before it tests video. Search the web site of the motherboard or BIOS manufacturer to know how to interpret a series of beep codes.
Blank screen when you first power up the computer, and no noise or indicator lights	Is power getting to the system? If power is getting to the computer, address the problem as an electrical problem with the computer. Make sure the power supply is good and power supply connectors are securely connected.
Blank screen when you first power up the computer, and you can hear the fans spinning and see indicator lights	Troubleshoot the video subsystem. Is the monitor turned on? Is the monitor data cable securely connected at both ends? Is the indicator light on the front of the monitor on?
BIOS loses its time and date settings	This problem happens when the CMOS battery fails. Replace the battery.
The system attempts to boot to the wrong boot device	Go into BIOS setup and change the boot device priority order.
Continuous reboots	Continuous reboots can be caused by overheating, a failing processor, motherboard, or RAM, or a corrupted Windows installation. Begin by checking the system for overheating. Is the processor cooler fan working? Go to BIOS setup and check the temperature of the processor.
No power	If you see no lights on the computer case and hear no spinning fans, make sure the surge protector or wall outlet has power. Is the switch on the rear of the case on? Is the dual voltage selector switch set correctly? Are power supply connectors securely connected? Is the power supply bad?

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Table 8-1 Symptoms or error messages caused by hardware problems and what to do about them (continues)

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Symptom or Error Message	What to Do About the Problem
Fans spin but no power gets to other devices	Begin by checking the power supply. Are connectors securely connected? Use a power supply tester to check for correct voltage outputs.
Smoke or burning smell	Consider this a serious electrical problem. Immediately unplug the computer.
Loud whining noise	Most likely the noise is made by the power supply or a failing hard drive. There might be a short. The power supply might be going bad or is underrated for the system.
Intermittent device failures	Failures that come and go might be caused by overheating or failing RAM, the motherboard, processor, or hard drive. Begin by checking the processor temperature for overheating. Then check RAM for errors and run diagnostics on the hard drive.

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Table 8-1 Symptoms or error messages caused by hardware problems and what to do about them (continued)



Source: Microsoft Windows 7

Figure 8-3 Search the Microsoft web site for information about a BSOD error

To move the hard drive to a working computer, you don't need to physically install the drive in the drive bay. Open the computer case. Carefully lay the drive on the case and connect a power cord and data cable (see Figure 8-5). Then turn on the PC. While you have the PC turned on, be *very careful* to not touch the drive or touch inside the case. Also, while a tower case is lying on its side like the one in Figure 8-5, don't use the optical drive.

Start the computer and log onto Windows using an Administrator account. (If you don't sign in with an Administrator account, you must provide the password to an Administrator account before you can access the files on the newly connected hard drive.) When Windows finds the new drive, it assigns it a drive letter. Use Windows Explorer to copy files from this drive to the primary hard drive in this system or to another storage media. Then return the drive to the original system and turn your attention to solving the original problem.

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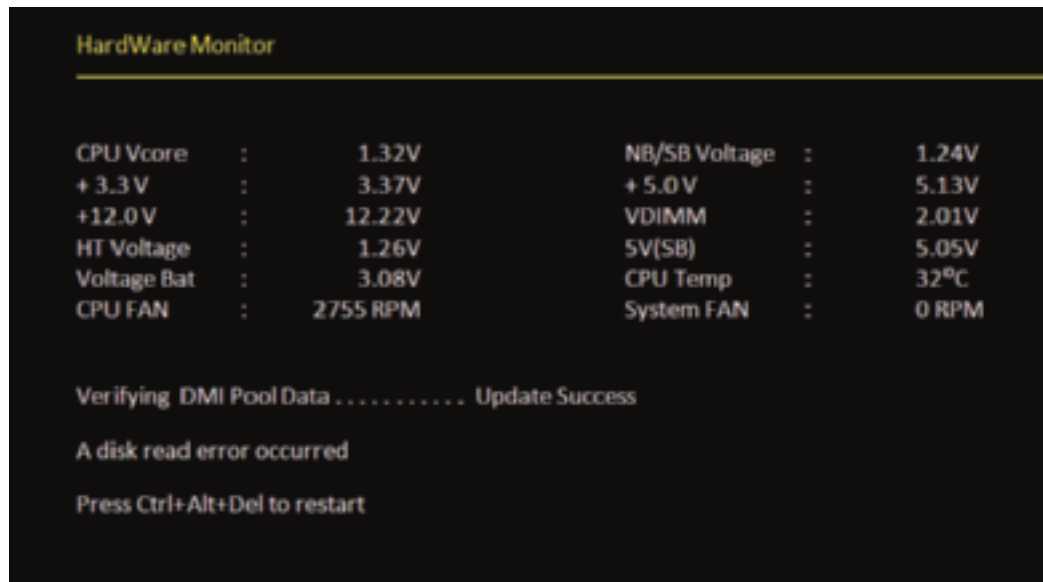


Figure 8-4 A POST error message on a black screen shown early in the boot

Source: Intel



Figure 8-5 Move a hard drive to a working computer to recover data on the drive

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An easier way to temporarily install a hard drive in a system is to use a USB port. For a PATA hard drive, use a PATA-to-USB converter. The converter kit in Figure 8-6 includes a converter for a PATA desktop and PATA laptop hard drive. Figure 8-7 shows a SATA-to-USB converter kit. The SATA connector can be used for desktop or laptop hard drives because a SATA connector is the same for both. These ATA-to-USB converters are really handy when recovering data and troubleshooting problems with hard drives that refuse to boot.

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Figure 8-6 Use an IDE-to-USB converter for diagnostic testing and to recover data from a failing PATA hard drive



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Figure 8-7 Use a USB-to-SATA converter to recover data from a drive using a SATA connector

Now that you have a general idea as to how to troubleshoot hardware errors during the boot, you're ready to look at how to troubleshoot each subsystem that is critical to booting up the computer. We begin with the electrical system.

TROUBLESHOOTING THE ELECTRICAL SYSTEM

Electrical problems can occur before or after the boot and can be consistent or intermittent. Many times PC repair technicians don't recognize the cause of a problem to be electrical because of the intermittent nature of some electrical problems. In these situations, the hard drive, memory, the OS, or even user error might be suspected as the source of the problem and then systematically eliminated before the electrical system is suspected. This section will help you to be aware of symptoms of electrical problems so that you can zero in on the source of an electrical problem as quickly as possible.

APPLYING CONCEPTS FOUR TROUBLESHOOTING RULES

Here are four important rules that can help you solve many hardware problems:

Rule 1: Check the Obvious and Check Simple Things First

Check for obvious and simple solutions first. Here are some tips:

- ▲ Is the external device plugged in and turned on? Are the data cable connections solid at both ends? Is there a wall light switch controlling the power, and is it turned on? Is the power strip you're using plugged in and turned on?
- ▲ For expansion cards and memory modules, are they seated solidly in their slots? For sound, is the volume knob turned up? For video, is the monitor getting power, turned on, connected, and is the screen resolution correct?
- ▲ Consider the application using the device. For example, if you are having problems trying to use a USB scanner, try scanning using a different application.

Rule 2: Trade Known Good for Suspected Bad

When diagnosing hardware problems, this method works well if you can draw from a group of parts that you know work correctly. Suppose, for example, video does not work. The parts of the video subsystem are the video card, the power cord to the monitor, the cord from the monitor to the PC case, and the monitor itself. Also, don't forget that the video card is inserted into an expansion slot on the motherboard, and the monitor depends on electrical power. As you suspect each of these five components to be bad, you can try them one at a time beginning with the easiest one to replace: the monitor. Trade the monitor for one that you know works. If this theory fails, trade the power cord, trade the cord to the PC video port, move the video card to a new slot, and trade the video card. When you're trading a good component for a suspected bad one, work methodically by eliminating one component at a time.

Rule 3: Trade Suspected Bad for Known Good

An alternate approach works well in certain situations. If you have a working computer that is configured similarly to the one you are troubleshooting (a common situation in many corporate or educational environments), rather than trading good for suspected bad, you can trade suspected bad for good. Take each component that you suspect is bad and install it in the working computer. If the component works on the good computer, then you have eliminated it as a suspect. If the working computer breaks down, then you have probably identified the bad component.

Rule 4: Divide and Conquer

Isolate the problem. In the overall system, remove one hardware or software component after another, until the problem is isolated to a small part of the whole system. As you divide a large problem into smaller components, you can analyze each component separately. You can use one or more of the following to help you divide and conquer on your own system:

- ▲ In Windows, stop all nonessential services running in the background to eliminate them as the problem.
- ▲ Boot from a bootable CD or DVD to eliminate the OS and startup files on the hard drive as the problem.
- ▲ Remove any unnecessary hardware devices, such as a second video card, optical drive, and even the hard drive.

Once down to the essentials, start exchanging components you know are good for those you suspect are bad, until the problem goes away. You don't need to physically remove the optical drive or hard drive from the bays inside the case. Simply disconnect the data cable and the power cable.

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APPLYING CONCEPTS

Your friend Sharon calls to ask for your help with a computer problem. Her system has been working fine for over a year, but now strange things are happening. Sometimes the system powers down for no apparent reason while she is working, and sometimes Windows locks up. As you read this section, look for clues as to what the problem might be. Also, as you read, think of questions to ask your friend that will help you.

Possible symptoms of a problem with the electrical system are:

- ▲ The PC appears “dead”—no indicator lights and no spinning drive or fan.
- ▲ The PC sometimes locks up during booting. After several tries, it boots successfully.
- ▲ Error codes or beeps occur during booting, but they come and go.
- ▲ You smell burnt parts or odors. (Definitely not a good sign!)
- ▲ The PC powers down at unexpected times.
- ▲ The PC appears dead except you hear a whine coming from the power supply.

Without opening the computer case, the following list contains some questions you can ask and things you can do to solve a problem with the electrical system. The rule of thumb is “try the simple things first.” Most PC problems have simple solutions.

- ▲ If you smell any burnt parts or odors, don’t try to turn the system on. Identify the component that is fried and replace it.
- ▲ When you first plug up power to a system and hear a whine coming from the power supply, the power supply might be inadequate for the system or there might be a short. Don’t press the power button to start up the system. Unplug the power cord so that the power supply will not be damaged. The next step is to open the case and search for a short. If you don’t find a short, consider upgrading the power supply.
- ▲ Is the power cord plugged in? If it is plugged into a power strip or surge suppressor, is the device turned on and also plugged in?
- ▲ Is the power outlet controlled by a wall switch? If so, is the switch turned on?
- ▲ Are any cable connections loose?
- ▲ Is the circuit breaker blown? Is the house circuit overloaded?
- ▲ Are all switches on the system turned on? Computer? Monitor? Surge suppressor or UPS (uninterruptible power supply)?
- ▲ Is there a possibility the system has overheated? If so, wait awhile and try again. If the system comes on, but later turns itself off, you might need additional cooling fans inside the unit. How to solve problems with overheating is covered later in the chapter.
- ▲ Older computers might be affected by electromagnetic interference (EMI). Check for sources of electrical or magnetic interference such as fluorescent lighting or an electric fan or copier sitting near the computer case.


The next step is to open the computer case and then do the following:

Video

Boot Problem 2

- ▲ Turn off the computer, unplug it, press the power button to drain residual power, and open the case. Check all power connections from the power supply to the motherboard and drives. Also, some cases require the case’s front panel be in place before the power-on button will work. Are all cards securely seated?

- ▲ If you smell burnt parts, carefully search for shorts and frayed and burnt wires. Disassemble the parts until you find the one that is damaged.
- ▲ If you suspect the power supply is bad, test it with a power supply tester.

 **Caution** Before opening the case of a brand name computer, such as a Gateway or Dell, consider the warranty. If the system is still under warranty, sometimes the warranty is voided if the case is opened. If the warranty prevents you from opening the case, you might need to return the system to a manufacturer's service center for repairs.

PROBLEMS THAT COME AND GO

If a system boots successfully to the Windows desktop, you still might have a power system problem. Some problems are intermittent; that is, they come and go. Generally, intermittent problems are more difficult to solve than a dead system. There can be many causes of intermittent problems, such as an inadequate power supply, overheating, and devices and components damaged by ESD. Here are some symptoms that might indicate an intermittent problem with the electrical system after the boot:

- ▲ The computer stops or hangs for no reason. Sometimes it might even reboot itself.
- ▲ Memory errors appear intermittently.
- ▲ Data is written incorrectly to the hard drive.
- ▲ The keyboard stops working at odd times.
- ▲ The motherboard fails or is damaged.
- ▲ The power supply overheats and becomes hot to the touch.
- ▲ The power supply fan whines and becomes very noisy or stops.

Here is what to do to eliminate the electrical system as the source of an intermittent problem:

1. **Consider the power supply is inadequate.** If the power supply is grossly inadequate, it will whine when you first plug up the power. If you have just installed new devices that are drawing additional power, follow the directions given in Chapter 2 to make sure the wattage rating of the power supply is adequate for the system.
You can also test the system to make sure you don't have power problems by making all the devices in your system work at the same time. For instance, you can make two hard drives and the DVD drive work at the same time by copying files from one hard drive to the other while playing a movie on the DVD. If the new drive and the other drives each work independently, but data errors occur when all work at the same time, suspect a shortage of electrical power.
2. **Suspect the power supply is faulty.** You can test it using either a power supply tester (the easier method) or a multimeter (the more tedious method). However, know that a power supply that gives correct voltages when you measure it might still be the source of problems because power problems can be intermittent. Also be aware that an ATX power supply monitors the range of voltages provided to the motherboard and halts the motherboard if voltages are inadequate. Therefore, if the power supply appears "dead," your best action is to replace it.
3. **The power supply fan might not work.** Don't operate the PC if the fan does not work because computers without cooling fans can quickly overheat. Usually just before a fan stops working, it hums or whines, especially when the PC is first turned on. If this has just happened, replace the power supply. After you replace the power supply, if the new fan does not work, you have to dig deeper to find the source of the problem.

You can now assume the problem wasn't the original fan. A short somewhere else in the system drawing too much power might cause the problem. To troubleshoot a non-functional fan, which might be a symptom of another problem and not a problem of the fan itself, follow these steps:

- a. Turn off the power and remove all power cord connections to all components except the motherboard. Turn the power back on. If the fan works, the problem is with one of the systems you disconnected, not with the power supply, the fan, or the motherboard.
- b. Turn off the power and reconnect one card or drive at a time until you identify the device with the short.
- c. If the fan does not work when all devices except the motherboard are disconnected, the problem is the motherboard or the power supply. Because you have already replaced the power supply, you can assume the problem is the motherboard and it's time to replace it.

POWER PROBLEMS WITH THE MOTHERBOARD

A short might occur if some component on the motherboard makes improper contact with the chassis. This short can seriously damage the motherboard. For some cases, check for missing standoffs (small plastic or metal spacers that hold the motherboard a short distance away from the bottom of the case). A missing standoff most often causes these improper connections. Also check for loose standoffs or screws under the board that might be touching a wire on the bottom of the board and causing a short.

Shorts in the circuits on the motherboard might also cause problems. Look for damage on the bottom of the motherboard. These circuits are coated with plastic, and quite often damage is difficult to spot. Also look for burned-out capacitors that are spotted brown or corroded. You'll see examples of burned out capacitors later in the chapter.

APPLYING CONCEPTS

Back to Sharon's computer problem. Here are some questions that will help you identify the source of the problem:

- ▲ Have you added new devices to your system? (These new devices might be drawing too much power from an overworked power supply.)
- ▲ Have you moved your computer recently? (It might be sitting beside a heat vent or electrical equipment.)
- ▲ Does the system power down or hang after you have been working for some time? (This symptom might have more than one cause, such as overheating or a power supply, processor, memory, or motherboard about to fail.)
- ▲ Has the computer case been opened recently? (Someone working inside the case might not have used a ground bracelet and components are now failing because of ESD damage.)
- ▲ Are case vents free so that air can flow? (The case might be close to a curtain covering the vents.)

Intermittent problems like the one Sharon described are often heat related. If the system only hangs but does not power off, the problem might be caused by faulty memory or bad software, but because it actually powers down, you can assume the problem is related to power or heat.

If Sharon tells you that the system powers down after she's been working for several hours, you can probably assume overheating. Check that first. If that's not the problem, the next thing to do is replace the power supply.



Caution Never replace a damaged motherboard with a good one without first testing or replacing the power supply. You don't want to subject another good board to possible damage.

PROBLEMS WITH OVERHEATING

As a PC repair technician, you're sure to eventually face problems with computers overheating. Overheating can happen as soon as you turn on the computer or after the computer has been working awhile. Overheating can cause intermittent errors, the system to hang, or components to fail or not last as long as they normally would. (Overheating can significantly shorten the lifespan of the CPU and memory.) Overheating happens for many reasons, including improper installations of the CPU cooler or fans, overclocking, poor air flow inside the case, underrated power supply, a component going bad, or the computer's environment (for example, heat or dust).

Here are some symptoms that a system is overheating:

- ▲ The system hangs or freezes at odd times or freezes just a few moments after the boot starts.
- ▲ A Windows BSOD error occurs during the boot.
- ▲ You cannot hear a fan running or the fan makes a whining sound.
- ▲ You cannot feel air being pulled into or out of the case.

If you suspect overheating, know that processors can sense their operating temperatures and report that information to BIOS. You can view that information in BIOS setup. To protect the expensive processor and other components, you can also purchase a temperature sensor. The sensor plugs into a power connection coming from the power supply and mounts on the side of the case or in a drive bay. The sensor sounds an alarm when the inside of the case becomes too hot. To decide which temperature sensor to buy, use one recommended by the case manufacturer. You can also install utility software that can monitor the system temperatures. For example, SpeedFan by Alfredo Comparetti is freeware that can monitor fan speeds and temperatures (see Figure 8-8). A good web site to download the freeware is www.filehippo.com/download_speedfan.

Here are some simple things you can do to solve an overheating problem:

1. If the system refuses to boot or hangs after a period of activity, suspect overheating. Immediately after the system hangs, go into BIOS setup and find the CPU screen that reports the temperature. The temperature should not exceed 38 degrees C.
2. Use compressed air, a blower, or an antistatic vacuum to remove dust from the power supply, the vents over the entire computer, and the processor cooler fan (see Figure 8-9). Excessive dust insulates components and causes them to overheat.
3. Check airflow inside the case. Are all fans running? You might need to replace a fan. Is there an empty fan slot on the rear of the case? If so, install a case fan in the slot (see Figure 8-10). Orient the fan so that it blows air out of the case. The power cord to the fan can connect to a fan header on the motherboard or to a power connector coming directly from the power supply.
4. If there are other fan slots on the side or front of the case, you can also install fans in these slots. However, don't install more fans than the case is designed to use.
5. Can the side of the case hold a chassis air guide that guides outside air to the processor? If it has a slot for the guide and the guide is missing, install one. However, don't install a guide that obstructs the CPU cooler. How to install an air guide is covered later in this section.
6. A case is generally designed for optimal airflow when slot openings on the front and rear of the case are covered and when the case cover is securely in place. To improve airflow, replace missing faceplates over empty drive bays and replace missing slot covers over empty expansion slots. See Figure 8-11.

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Source: SpeedFan by Alfredo Milani Comparetti

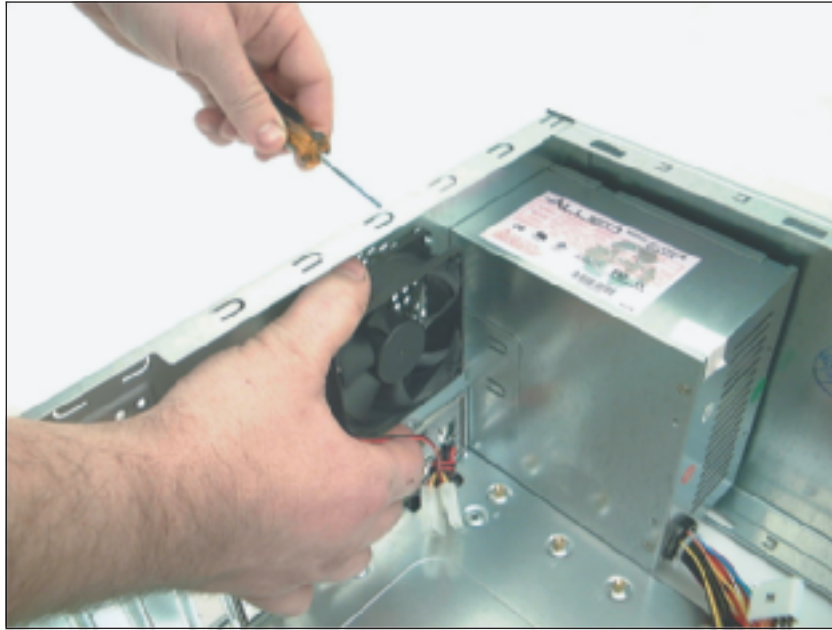
Figure 8-8 SpeedFan monitors fan speeds and system temperatures



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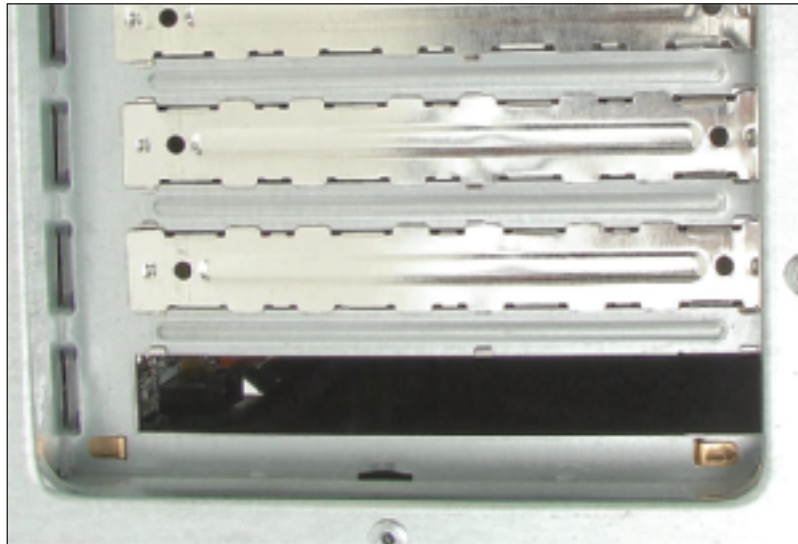
Figure 8-9 Dust in this cooler fan can cause the fan to fail and the processor to overheat

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Figure 8-10 Install one exhaust fan on the rear of the case to help pull air through the case



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Figure 8-11 For optimum airflow, don't leave empty expansion slots and bays uncovered

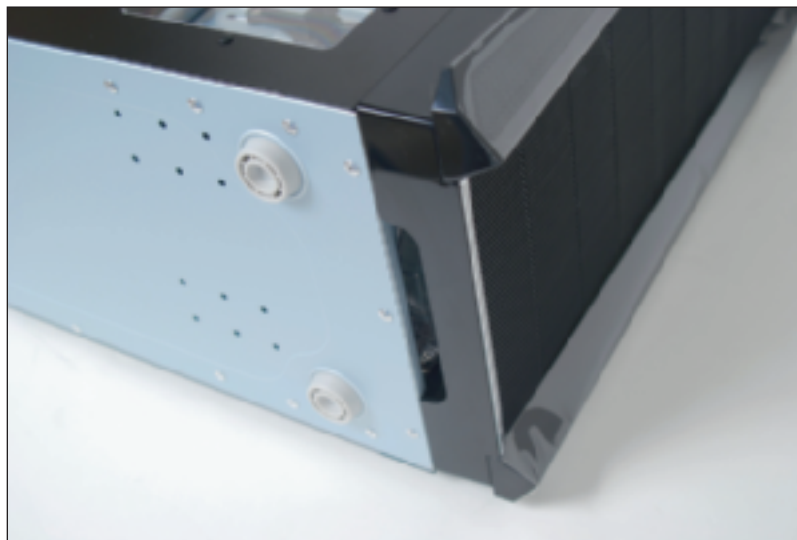
7. Are cables in the way of airflow? Use tie wraps to secure cables and cords so that they don't block airflow across the processor or get in the way of fans turning. Figure 8-12 shows the inside of a case where cables are tied up and neatly out of the way of airflow from the front to the rear of the case.
8. A case needs some room to breathe. Place it so there are at least a few inches of space on both sides and the top of the case. If the case is sitting on carpet, put it on a computer stand so that air can circulate under the case and also to reduce carpet dust inside the case. Many

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Figure 8-12 Use cable ties to hold cables out of the way of fans and airflow



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Figure 8-13 Keep a tower case off carpet to allow air to flow into the bottom air vent

cases have a vent on the bottom front of the case and carpet can obstruct airflow into this vent (see Figure 8-13). Make sure drapes are not hanging too close to fan openings.

9. Verify the cooler is connected properly to the processor. If it doesn't fit well, the system might not boot and certainly the processor will overheat. If the cooler is not tightly connected to the motherboard and processor or the cooler fan is not working,

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the processor will quickly overheat as soon as the computer is turned on. Has thermal compound been installed between the cooler and processor?

10. After you close the case, leave your system off for at least 30 minutes. When you power up the computer again, let it run for 10 minutes, go into BIOS setup, check the temperature readings, and reboot. Next, let your system run until it shuts down. Power it up again and check the temperature in BIOS setup again. A significant difference in this reading and the first one you took after running the computer for 10 minutes indicates an overheating problem.
11. Check BIOS setup to see if the processor is being overclocked. Overclocking can cause a system to overheat. Try restoring the processor and system bus frequencies to default values.
12. Have too many peripherals been installed inside the case? Is the case too small for all these peripherals? Larger tower cases are better designed for good airflow than smaller slimline cases. Also, when installing cards, try to leave an empty slot between each card for better airflow. The same goes for drives. Try not to install a group of drives in adjacent drive bays. For better airflow, leave empty bays between drives. Take a close look at Figure 8-12, where you can see space between each drive installed in the system.
13. Flash BIOS to update the firmware on the motherboard. How to flash BIOS is covered in Chapter 3.
14. Thermal compound should last for years, but eventually it will harden and need replacing. If the system is several years old, replace the thermal compound.

💡 A+ Exam Tip The A+ 220-802 exam expects you to recognize that a given symptom is possibly power or heat related.

If you try the above list of things to do and still have an overheating problem, it's time to move on to more drastic solutions. Consider the case design is not appropriate for good airflow, and the problem might be caused by poor air circulation inside the case. The power supply fan in ATX cases blows air out of the case, pulling outside air from the vents in the front of the case across the processor to help keep it cool. Another exhaust fan is usually installed on the back of the case to help the power supply fan pull air through the case. In addition, most processors require a cooler with a fan installed on top of the processor. Figure 8-14 shows a good arrangement of vents and fans for proper airflow and a poor arrangement.

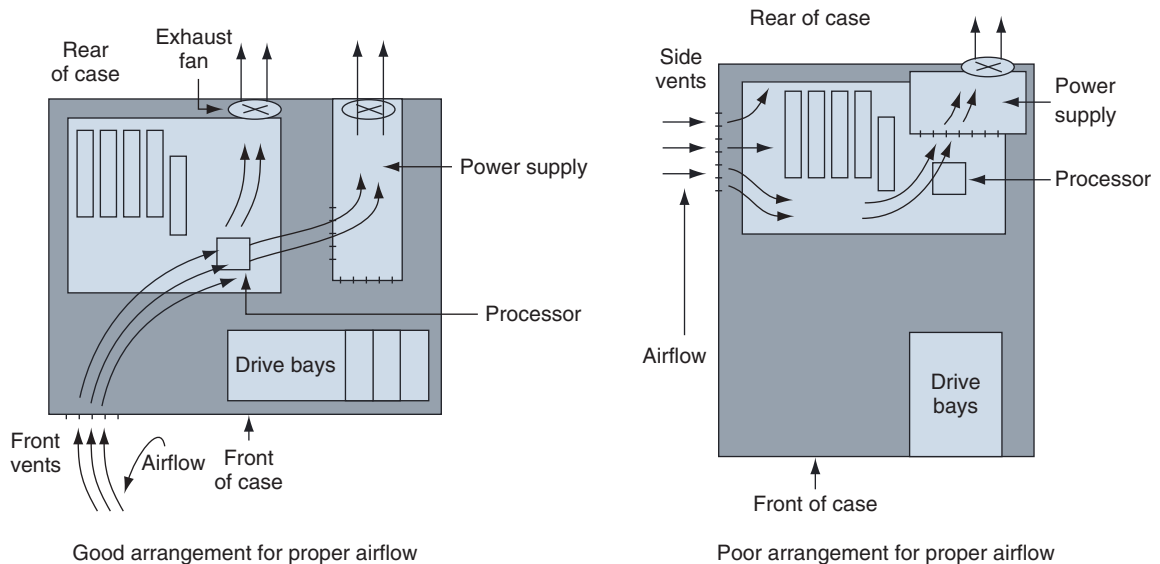


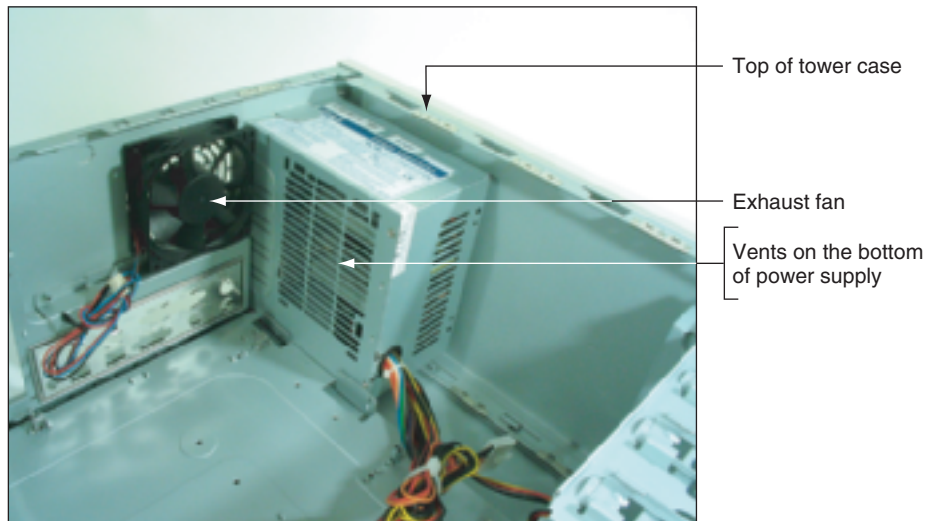
Figure 8-14 Vents and fans need to be arranged for best airflow

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For better ventilation, use a power supply that has vents on the bottom and front of the power supply. Note in Figure 8-15 airflow is coming into the bottom of the power supply because of these bottom vents. The power supply in Figure 8-10 has vents only on the front and not on the bottom. Compare that to the power supply in Figure 8-15, which has vents on both the front and bottom.

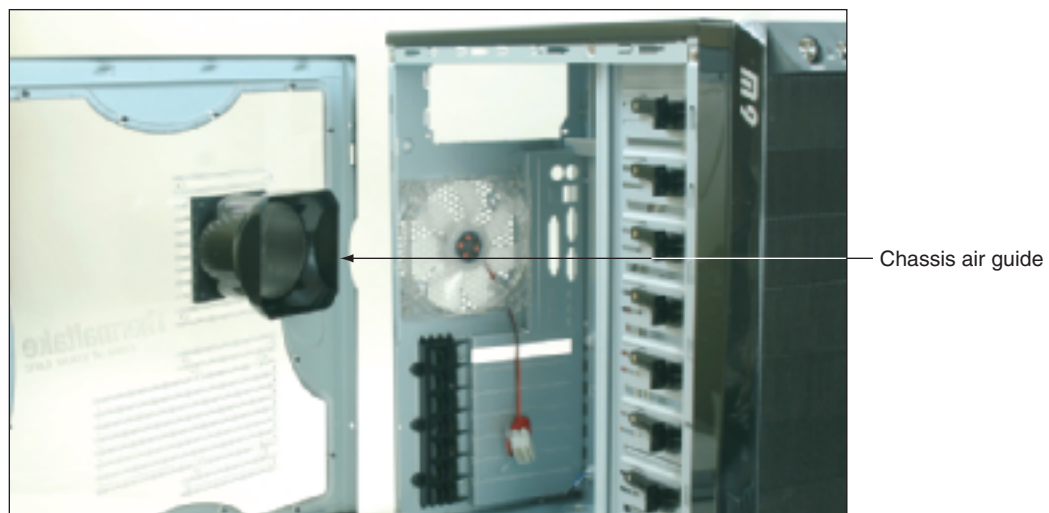
An intake fan on the front of the case might help pull air into the case. Intel recommends you use a front intake fan for high-end systems, but AMD says a front fan for ATX systems is not necessary. Check with the processor and case manufacturers for specific instructions as to the placement of fans and what type of fan and heat sink to use.

Intel and AMD both recommend a **chassis air guide (CAG)** as part of the case design. This air guide is a round air duct that helps to pull and direct fresh air from outside the case to the cooler and processor (see Figure 8-16). The guide should reach inside the case very close to the cooler, but not touch it. Intel recommends the clearance be no greater than



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Figure 8-15 This power supply has vents on the bottom to provide better airflow inside the case



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Figure 8-16 Use a chassis air guide to direct outside air over the cooler

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20 mm and no less than 12 mm. If the guide obstructs the cooler, you can remove the guide, but optimum airflow will not be achieved.

Be careful when trying to solve an overheating problem. Excessive heat can damage the CPU and the motherboard. Never operate a system if the case fan, power-supply fan, or cooler fan is not working.

TROUBLESHOOTING POST BEFORE VIDEO IS ACTIVE

Error messages on the screen indicate that video and the electrical system are working. If you observe that power is getting to the system (you see lights and hear fans or beeps) but the screen is blank, turn off the system and turn it back on and carefully listen to any beep codes or BIOS speech messages. Recall that, before BIOS checks video, POST reports any error messages as beep codes. When a PC boots, one beep or no beep indicates that all is well after

POST. If you hear more than one beep, look up the beep code in the motherboard or BIOS documentation or on the web sites of these manufacturers. Each BIOS manufacturer has its own beep codes, and Table 8-2 lists the more common meanings.



Beeps During POST	Description
One short beep or no beep	The computer passed all POST tests
1 long and 2 short beeps	Award BIOS: A video problem, no video card, bad video memory Intel BIOS: A video problem
Continuous short beeps	Award BIOS: A memory error Intel BIOS: A loose card or short
1 long and 1 short beep	Intel BIOS: Motherboard problem
1 long and 3 short beeps	Intel BIOS: A video problem
3 long beeps	Intel BIOS: A keyboard controller problem
Continuous 2 short beeps and then a pause	Intel BIOS: A video card problem
Continuous 3 short beeps and then a pause	Intel BIOS: A memory error
8 beeps followed by a system shutdown	Intel BIOS: The system has overheated
Continuous high and low beeps	Intel BIOS: CPU problem

Table 8-2 Common beep codes and their meanings for Intel and Award BIOS

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Hands-on Project 8-1 Research Beep Codes

Identify the motherboard and BIOS version installed in your computer. Locate the motherboard user guide on the web and find the list of beep codes that the BIOS might give at POST. If the manual doesn't give this information, search the support section on the web site of the motherboard manufacturer or search the web site of the BIOS manufacturer. List the beep codes and their meanings for your motherboard.

TROUBLESHOOTING ERROR MESSAGES DURING THE BOOT

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If video and the electrical systems are working, then most boot problems show up as an error message displayed on-screen. These error messages that occur before Windows starts to load apply to hardware components that are required to boot the system. Some possible error messages are listed in Table 8-3, along with their meanings. For other error messages, look in your motherboard user guide or the manufacturer's web site. You can also search the web on the motherboard brand and model and the error message.

Error Message Before Windows Starts	Meaning of the Error Message
CMOS battery low	The CMOS battery needs replacing.
CMOS checksum bad	CMOS RAM might be corrupted. Run BIOS setup and reset BIOS to default settings. If the problem occurs again, try flashing the BIOS.
Memory size decreased	Startup BIOS recognized that the amount of installed RAM is less than that of the previous boot. A memory module might be bad. Begin troubleshooting memory.
Processor thermal trip error	The processor overheated and the system has restarted.
Intruder detection error	An intrusion detection device installed on the motherboard has detected that the computer case was opened.
Overclocking failed. Please enter setup to reconfigure your system.	Overclocking should be discontinued. However, this error might not be related to overclocking; it can occur when the power supply is failing.
No boot device available Hard drive not found Fixed disk error Invalid boot disk Inaccessible boot device or drive Invalid drive specification	Startup BIOS did not find a device to use to load the operating system. Make sure the boot device priority order is correct in BIOS setup. Then begin troubleshooting the hard drive.
Missing BOOTMGR Missing NTLDR Missing operating system Error loading operating system	The Windows program needed to start Windows is missing or corrupted. This program is called the OS boot manager program.

Table 8-3 Error messages that occur before Windows starts

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If the Windows boot manager program has problems loading Windows, it gives a different set of error messages than the ones listed in Table 8-3. For example, a Windows error that occurred early in the boot is shown in Figure 8-17.

When these errors are related to hardware that is necessary for the boot, they are likely to be a BSOD error message on a blue screen such as the one shown earlier in Figure 8-3. Sometimes Windows is configured to restart immediately after a BSOD. This setting can lead to continuous reboots, and the error message might fly by so fast you can't read it. To disable these automatic restarts, press F8 as Windows starts up. The Advanced Boot Options menu appears. Figure 8-18 shows the Windows 7 menu; the Vista and XP menus are similar.

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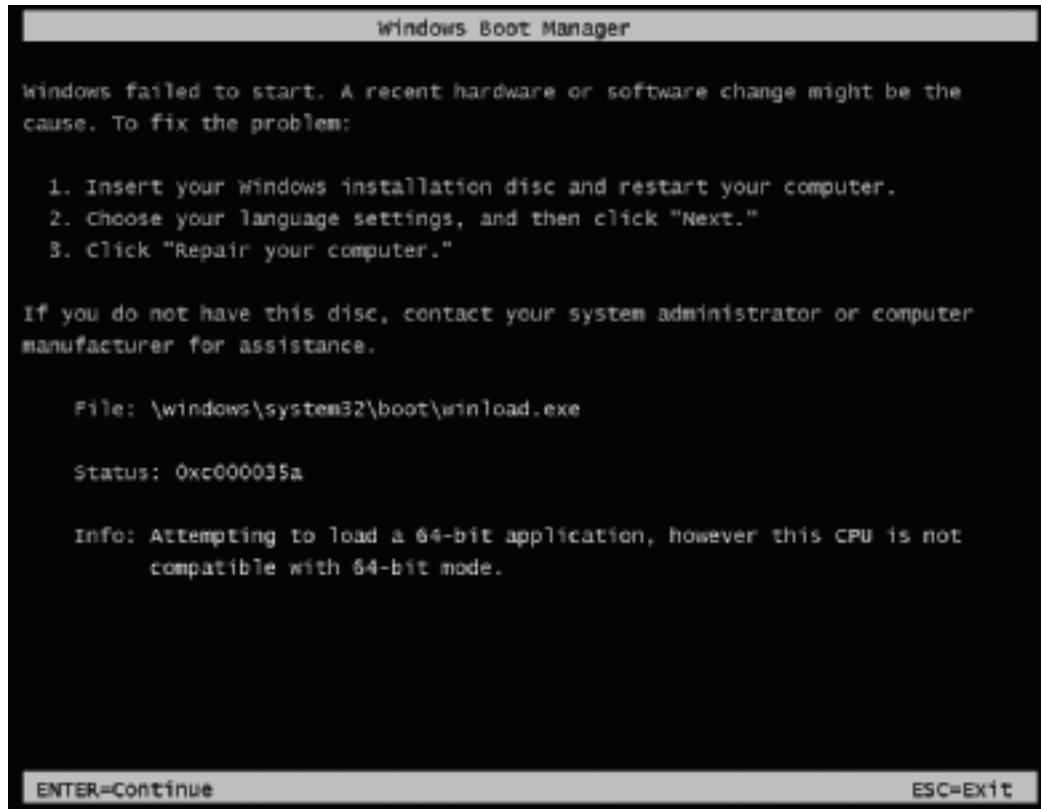


Figure 8-17 A Windows error early in the boot that is related to software

Source: Microsoft Windows 7

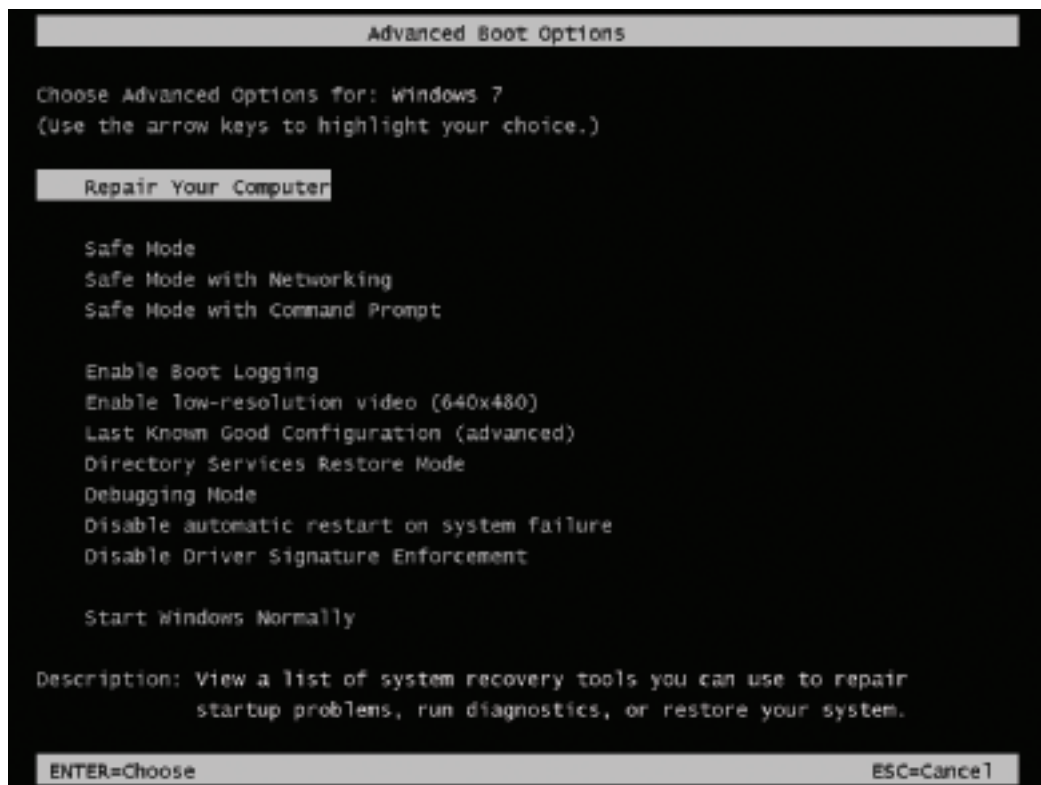


Figure 8-18 Press F8 during the boot to see the Advanced Boot Options menu


Source: Microsoft Windows 7

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Select **Disable automatic restart on system failure**. When you restart Windows, the error message stays on-screen long enough for you to read it. Search the Microsoft web sites (*support.microsoft.com* and *technet.microsoft.com*) for information about the hardware component causing the problem and what to do about it. BSOD errors might apply to the motherboard, video card, RAM, processor, hard drive, or some other device for which Windows is trying to load device drivers.

TROUBLESHOOTING THE MOTHERBOARD, PROCESSOR, AND RAM

The field replaceable units (FRUs) on a motherboard are the processor, the processor cooler assembly, RAM, and the CMOS battery. Also, the motherboard itself is an FRU. As you troubleshoot the motherboard and discover that some component is not working, such as a network port, you might be able to disable that component in BIOS setup and install a card to take its place.

 **A+ Exam Tip** The A+ 220-802 exam expects you to know how to troubleshoot problems with motherboards, processors, and RAM.

When you suspect a bad component, a good troubleshooting technique is to substitute a known-good component for the one you suspect is bad. Be cautious here. A friend once had a computer that would not boot. He replaced the hard drive, with no change. He replaced the motherboard next. The computer booted up with no problem; he was delighted, until it failed again. Later he discovered that a faulty power supply had damaged his original motherboard. When he traded the bad one for a good one, the new motherboard also got zapped! If you suspect problems with the power supply, check the voltage coming from the power supply before putting in a new motherboard.

Symptoms that a motherboard, processor, or memory module is failing can appear as:

- ▲ The system begins to boot but then powers down.
- ▲ An error message is displayed during the boot. Investigate this message.
- ▲ The system becomes unstable, hangs, or freezes at odd times. (This symptom can have multiple causes, including a failing power supply, RAM, hard drive, motherboard or processor, Windows errors, and overheating.)
- ▲ Intermittent Windows or hard drive errors occur.
- ▲ Components on the motherboard or devices connected to it don't work.


Remember the troubleshooting principle to check the simple things first. The motherboard and processor are expensive and time consuming to replace. Unless you're certain the problem is one of these two components, don't replace either until you first eliminate other components as the source of the problem.

If you can boot the system, follow these steps to eliminate Windows, software, RAM, BIOS settings, and other software and hardware components as the source of the problem:

1. The problem might be a virus. If you can boot the system, run a current version of antivirus software to check for viruses.
2. A memory module might be failing. In Windows 7/Vista, use the **Memory Diagnostics** tool to test memory. Even if Windows 7/Vista is not installed, you can still run the tool by booting the system from the Windows setup DVD. How to use the Memory Diagnostics tool is coming up later in the chapter.

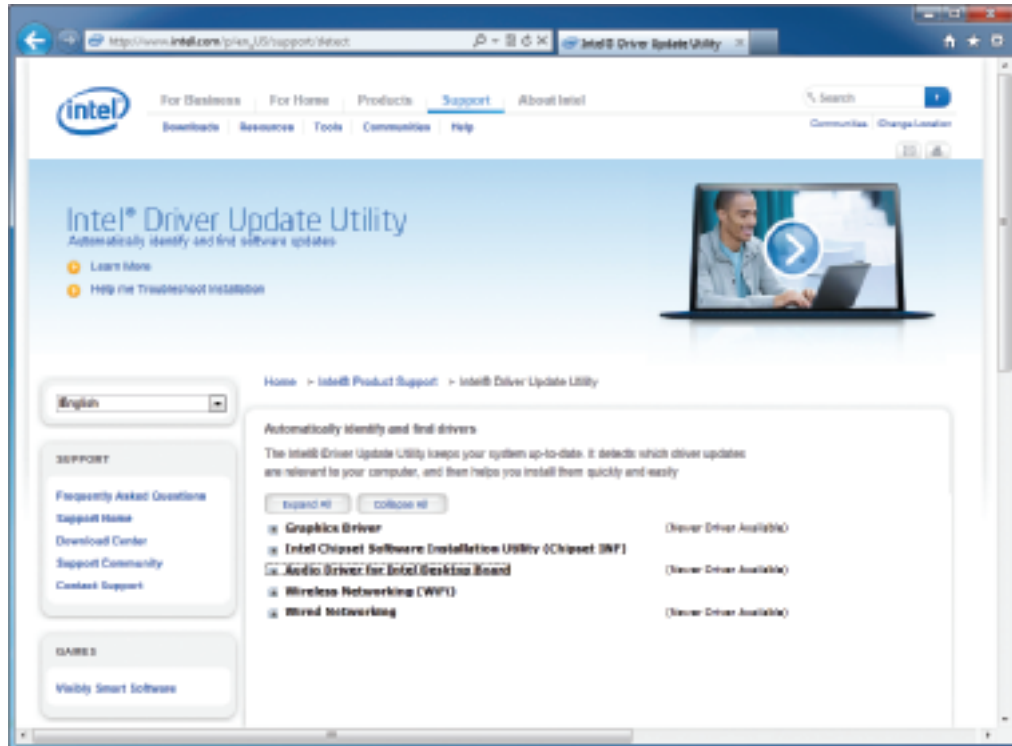
 **Notes** Other than the Windows 7/Vista Memory Diagnostics tool, you can use the Memtest86 utility to test installed memory modules. Check the site www.memtest86.com to download this program.

3. Suspect the problem is caused by an application or by Windows. In Windows, the best tool to check for potential hardware problems is Device Manager.
4. In Windows, download and install any Windows updates or patches. These updates might solve a hardware or application problem.

 **Notes** Another useful Windows tool for troubleshooting hardware problems that reports logs of hardware and applications errors is Event Viewer. For a thorough discussion of how to use Event Viewer, open Windows Help and Support and search on “How to use Event Viewer.” Alternately, you can look in the companion book, *A+ Guide to Software*. A Real Problems, Real Solutions activity at the end of this chapter helps you learn to use Event Viewer.

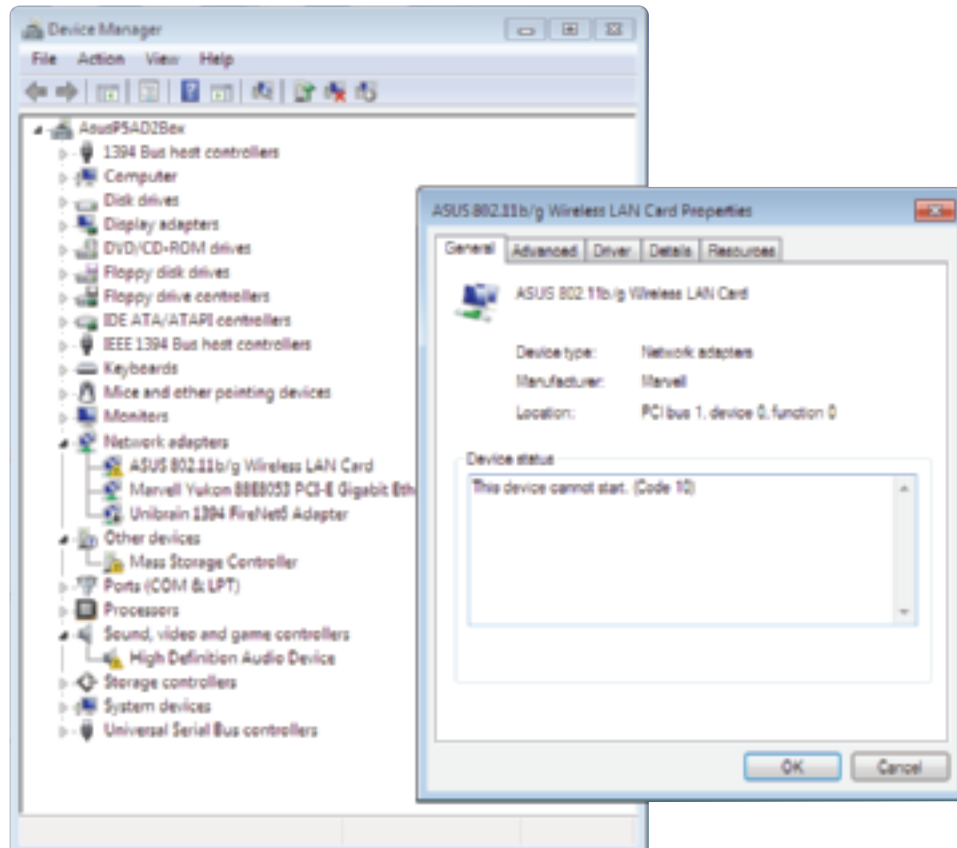
5. Ask yourself what has changed since the problem began. If the problem began immediately after installing a new device or application, uninstall the device or applications.
6. A system that does not have enough RAM can sometimes appear to be unstable. Using the System window, find out how much RAM is installed, and compare that to the recommended amounts. Consider upgrading RAM.
7. The BIOS might be corrupted or have wrong settings. Check BIOS setup. Have settings been tampered with? Is the system bus speed set incorrectly or is it overclocked? Reset BIOS setup to restore default settings.
8. Disable any quick booting features in BIOS so that you get a thorough report of POST. Then look for errors reported on the screen during the boot.
9. Following the procedures in Chapter 3, flash BIOS to update the firmware on the board.
10. Look on the CD that came bundled with the motherboard. It might have diagnostic tests on it that might identify a problem with the motherboard.
11. Update all drivers of motherboard components that are not working. For example, if the USB ports are not working, try updating the USB drivers with those downloaded from the motherboard manufacturer’s web site. This process can also update the chipset drivers. For example, for one Intel motherboard, Figure 8-19 shows updates available for the board.
12. If an onboard port or connector isn’t working, but the motherboard is stable, follow these steps:
 - a. Verify the problem is not with the device using the port. Try moving the device to another port on the same computer or move the device to another computer. If it works there, return it to this port. The problem might have been a bad connection.
 - b. Go into BIOS setup and verify the port is enabled.
 - c. Check Device Manager and verify Windows recognizes the port with no errors. For example, Device Manager shown in Figure 8-20 reports a problem with the onboard Wi-Fi adapter. Uninstall and reinstall the drivers for the device using the port.
 - d. Update the motherboard drivers for this port from the motherboard manufacturer’s web site.
 - e. If you have a loop-back plug, use it to test the port.
 - f. If the problem is still not solved, disable the port in BIOS setup and install an expansion card to provide the same type of port or connector.

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Source: Intel at www.intel.com

Figure 8-19 Update all motherboard drivers using the motherboard manufacturer's web site



Source: Microsoft Windows 7

Figure 8-20 Device Manager reports a problem with an onboard port

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13. Suspect the problem is caused by a failing hard drive. How to troubleshoot a failing drive is covered later in the chapter.
14. Suspect the problem is caused by overheating. How to check for overheating is covered earlier in the chapter.
15. Search the support section of the web sites of the motherboard and processor manufacturers for things to do and try. Then do a general search of the web using a search engine such as *www.google.com*. Search on the error message, symptom, motherboard model, processor model, or other text related to the problem. Most likely, you'll find a forum where someone else has posted the same problem, and others have posted a solution.
16. Verify the installed processor is supported by the motherboard. Perhaps someone has installed the wrong processor.

APPLYING CONCEPTS HOW TO USE WINDOWS MEMORY DIAGNOSTICS

Errors with memory are often difficult to diagnose because they can appear intermittently and might be mistaken as application errors, user errors, or other hardware component errors. Sometimes these errors cause the system to hang, a blue screen error might occur, or the system continues to function with applications giving errors or data getting corrupted. You can quickly identify a problem with memory or eliminate memory as the source of a problem by using the Windows 7/Vista Memory Diagnostics tool. It tests memory for errors and works before Windows is loaded and can be used on computers that don't have Windows 7 or Vista installed. Use one of these three methods to start the utility:

- ▲ *Method 1:* In a command prompt window, enter **mdsched.exe** and press **Enter**. A dialog box appears (see Figure 8-21) asking if you want to run the test now or on the next restart.

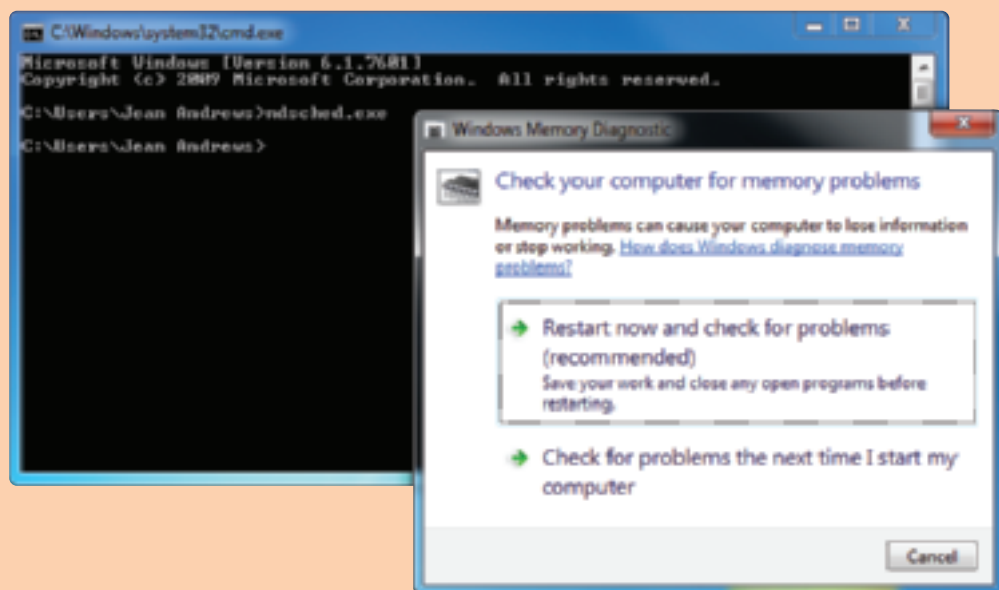
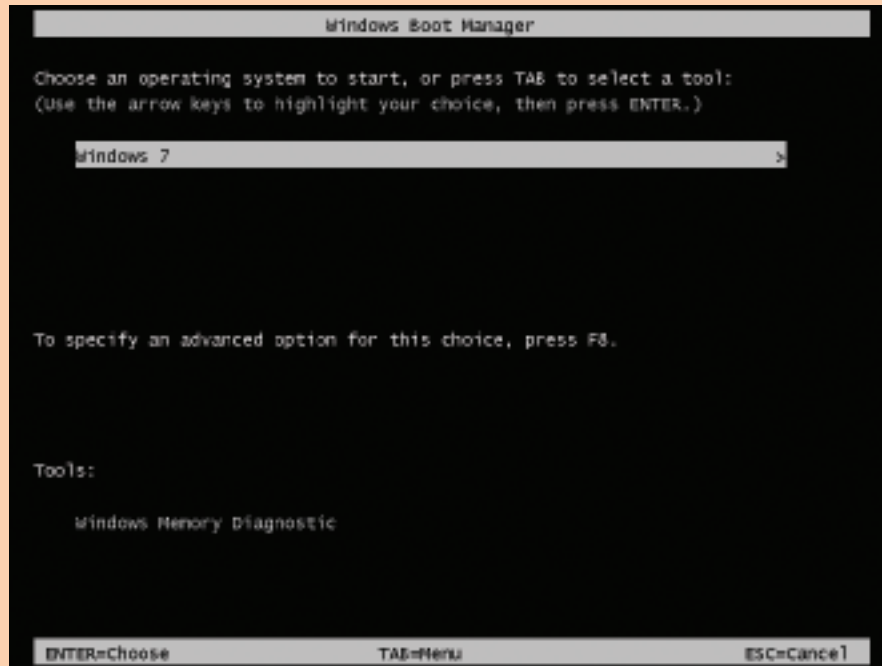


Figure 8-21 Use the mdsched.exe command to test memory

Source: Microsoft Windows 7

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- ▲ **Method 2:** If you cannot load the Windows desktop, press the Spacebar during the boot. The Windows Boot Manager screen appears (see Figure 8-22). Select **Windows Memory Diagnostic** and press **Enter**.



Source: Microsoft Windows 7

Figure 8-22 Force the Windows Boot Manager menu to display by pressing the Spacebar during the boot

- ▲ **Method 3:** If you cannot boot from the hard drive, boot the computer from the Windows setup DVD. On the opening screen, select your language. On the next screen (see Figure 8-23), click **Repair your computer**. In the next box, select the Windows installation



Source: Microsoft Windows 7

Figure 8-23 Opening menu when you boot from the Windows 7 setup DVD

to repair. The System Recovery Options window appears (see Figure 8-24). Click **Windows Memory Diagnostic** and follow the directions on-screen.

If the tool reports memory errors, replace all memory modules installed on the motherboard.

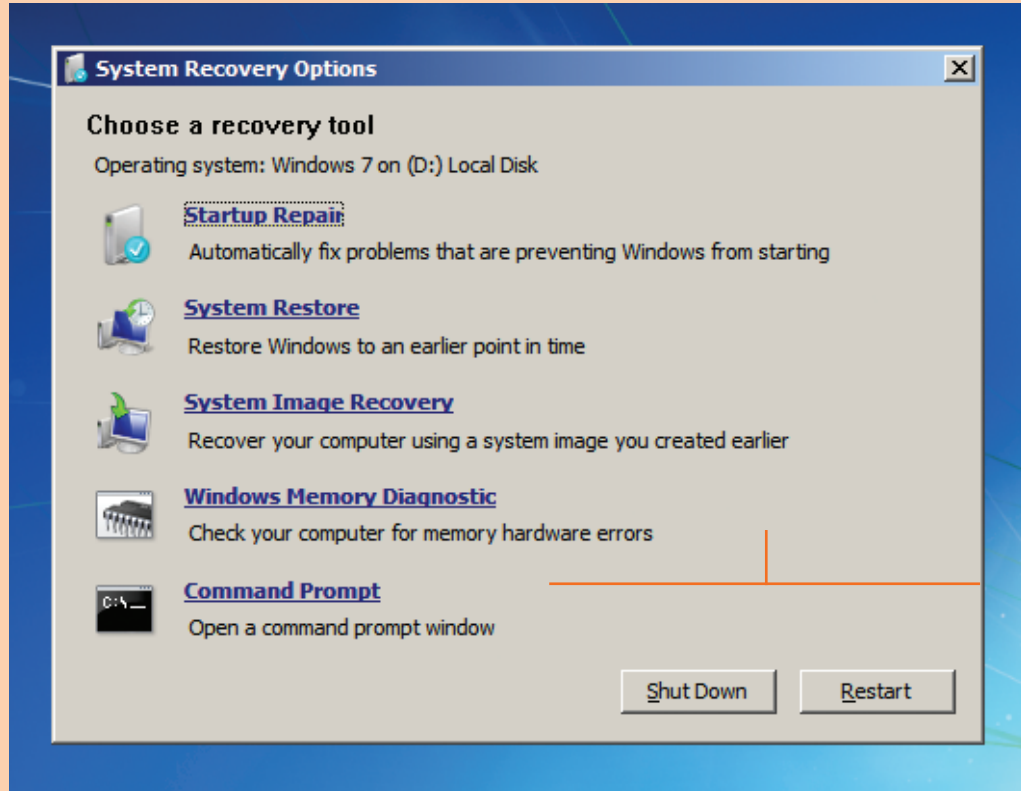


Figure 8-24 Test memory using the System Recovery Options menu

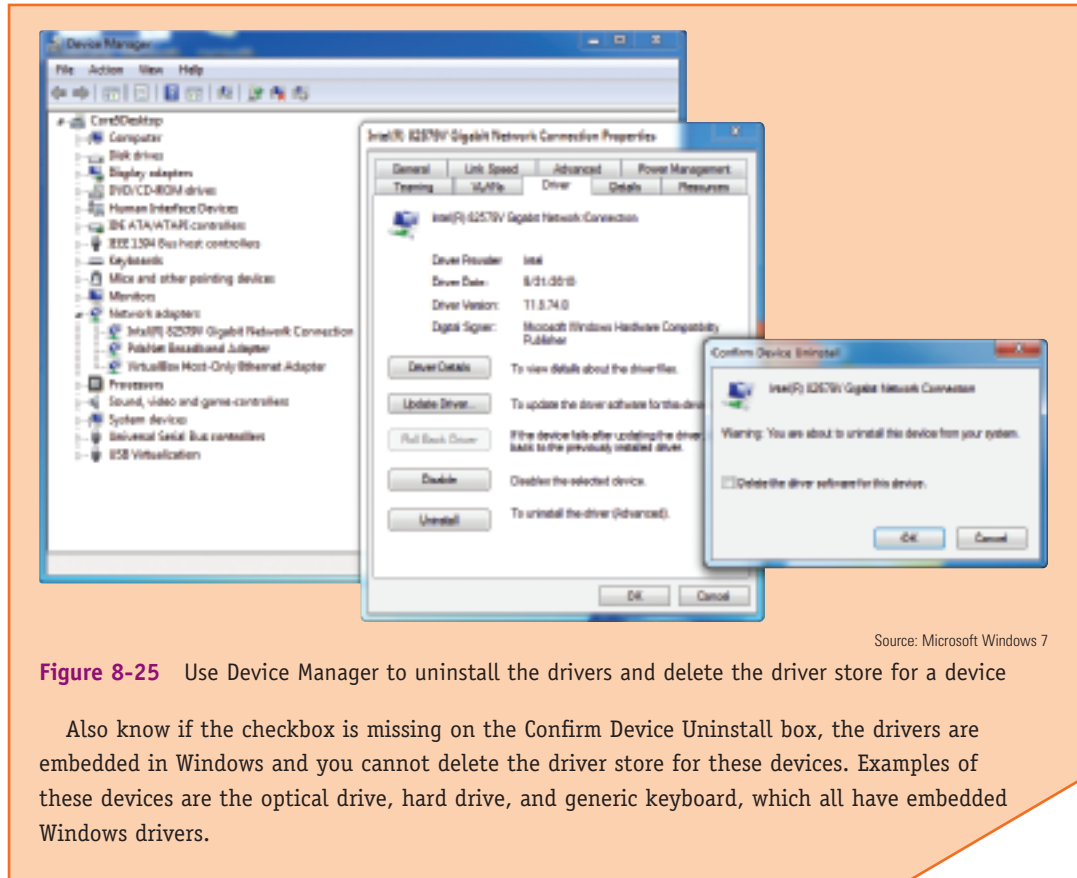
Source: Microsoft Windows 7

APPLYING CONCEPTS USE DEVICE MANAGER TO DELETE THE DRIVER STORE

One thing you can do to solve a problem with a device is to uninstall and reinstall the device. When you first install a device, Windows stores a copy of the driver software in a **driver store**. When you uninstall the device, you can tell Windows to also delete the driver store. If you don't delete the driver store, Windows uses it when you install the device again. That's why the second time you install the same device Windows does not ask you for the location of the drivers. Windows might also use the driver store to automatically install the device on the next reboot without your involvement.

All this is convenient unless there is a problem with the driver store. To get a true fresh start with an installation, you need to delete the driver store. To do that in Device Manager, open the **Properties** box for the device, click the **Driver** tab, and click **Uninstall**. In the Confirm Device Uninstall box (see Figure 8-25), check **Delete the driver software for this device**, and click **OK**. The installed drivers and the driver store are both deleted. When you reinstall the device, you'll need the drivers on CD or downloaded from the web.

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Source: Microsoft Windows 7

Figure 8-25 Use Device Manager to uninstall the drivers and delete the driver store for a device

Also know if the checkbox is missing on the Confirm Device Uninstall box, the drivers are embedded in Windows and you cannot delete the driver store for these devices. Examples of these devices are the optical drive, hard drive, and generic keyboard, which all have embedded Windows drivers.

We're working our way through what to do when the system locks up, gives errors, or generally appears unstable. After you have checked Windows and BIOS settings and searched the web for help and still not identified the source of the problem, it's time to open the case and check inside. As you do so, be sure to use an antistatic bracelet and follow other procedures to protect the system against ESD. With the case open, follow these steps:

1. Check that all the power and data cables the system is using are securely connected. Try reseating all expansion cards and DIMM modules.
2. Look for physical damage on the motherboard. Look for frayed traces on the bottom of the board or brown or burnt capacitors on the board.
3. Reduce the system to essentials. Remove any unnecessary hardware, such as expansion cards, and then watch to see if the problem goes away. If the problem goes away, replace one component at a time until the problem returns and you have identified the component causing the trouble.
4. Try using a POST diagnostic card. It might offer you a clue as to which component is giving a problem.
5. Suspect the problem is caused by a failing power supply. It's less expensive and easier to replace than the motherboard or processor, so eliminate it before you move on to the motherboard or processor.
6. Exchange the processor.
7. Exchange the motherboard, but before you do, measure the voltage output of the power supply or simply replace it, in case it is producing too much power and has damaged the board.

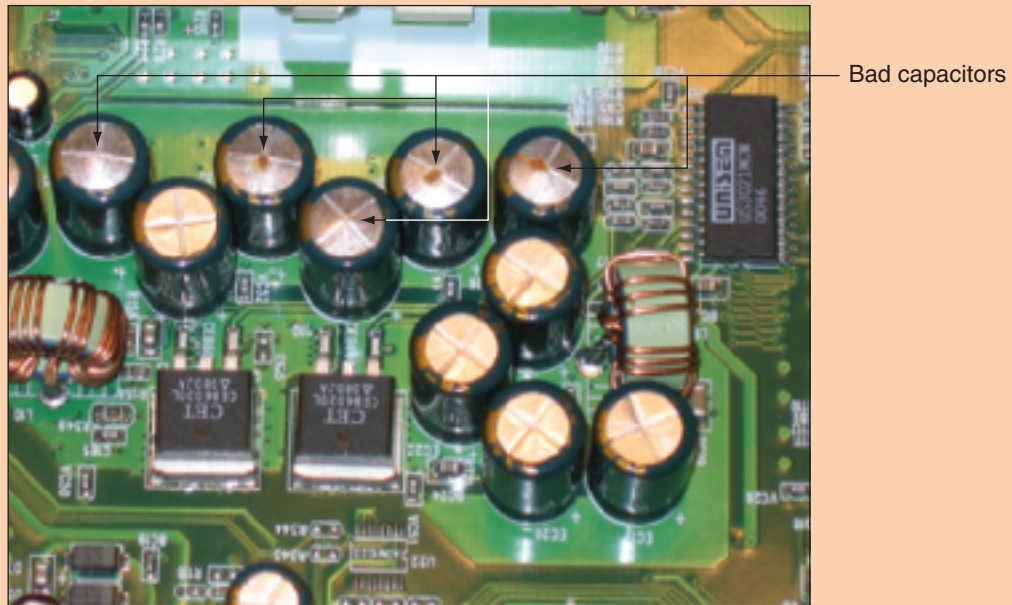
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APPLYING CONCEPTS

Jessica complained to Wally, her PC support technician, that Windows was occasionally giving errors, data would get corrupted, or an application would not work as it should. At first, Wally suspected Jessica might need a little more training in how to open and close an application or save a file, but he discovered user error was not the problem. He tried reinstalling the application software Jessica most often used, and even reinstalled Windows, but the problems persisted.

Notes Catastrophic errors (errors that cause the system to not boot or a device to not work) are much easier to resolve than intermittent errors (errors that come and go).

Then he began to suspect a hardware problem. Carefully examining the motherboard revealed the source of the problem: failing capacitors. Look carefully at Figure 8-26 and you can see five bad capacitors with bulging and discolored heads. (Know that sometimes a leaking capacitor can also show crusty corrosion at the base of the capacitor.) When Wally replaced the motherboard, the problems went away.



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Figure 8-26 These five bad capacitors have bulging and discolored heads

PROBLEMS WITH INSTALLATIONS

If you have just installed a new processor, DIMM, or other component and the system does not boot, do the following:

1. When troubleshooting an installation, it's easy to forget to check the simple things first. Are the system and monitor plugged in and turned on? Are the monitor, keyboard, and mouse connected to the system? Is the case front cover securely in place?
2. As you work inside the case, don't forget to use your antistatic bracelet. Open the case and check the installation of the new component:
 - ▲ When installing DIMMs, verify each DIMM is securely seated in the memory socket. Make sure a new DIMM sits in the socket at the same height as other modules and clips on each side of the slot are in latched positions.

- ▲ For a new processor, did you install thermal compound between the processor and the heat sink? Is the cooler securely fastened to the frame on the motherboard? If the cooler and thermal compound are not installed correctly, the CPU can overheat during the boot, causing BIOS to immediately power down the system. Is the power cable from the cooler fan connected to the correct fan header on the motherboard? Look in the motherboard documentation for the correct header.
 - ▲ For all types of installations, did other components or connectors become dislodged during the installation? Check memory modules, the P1 power connector, the 4-pin CPU auxiliary power connector, hard drive connectors, and auxiliary PCIe power connectors.
3. Try rebooting the system. If you still have a problem, verify you have installed a component that is compatible with the system. For a processor, double-check that the motherboard supports the processor installed. For memory, check that you have the right memory modules supported by your motherboard. Can your OS support all the memory installed?
 4. For a processor installation, remove the processor from its socket and look for bent or damaged pins or lands on the socket and processor. For memory, remove the newly installed memory and check whether the error message disappears. Try the memory in different sockets. Try installing the new memory without the old installed. If the new memory works without the old, the problem is that the modules are not compatible.
 5. Consider whether the case does not have enough cooling. Is a case fan installed and running at the rear of the case? Are cables and cords tied up out of the way of airflow?
 6. For memory modules or expansion cards, clean the edge connectors with a soft cloth or contact cleaner. Blow or vacuum dust from the slot. Don't touch the edge connectors or the slot.
 7. When upgrading a processor, reinstall the old processor, flash BIOS, and then try the new processor again.

Here are additional things to check if you have just installed a new motherboard that is not working:

1. If the system can boot into Windows, install all motherboard drivers on the CD that came bundled with the board.
2. Open the computer case and check the following:
 - ▲ Study the motherboard documentation and verify all connections are correct. Most likely this is the problem. Remember the Power Switch lead from the front of the case must be connected to the header on the motherboard. Check all connectors from the front of the case to the front panel header.
 - ▲ Is the BIOS jumper group set for a normal boot?
 - ▲ Are cards seated firmly in their slots? Is the screw in place that holds the card to the back of the case?
 - ▲ Are DIMMs seated firmly in their slots? Remove the DIMMs and reseal them.
 - ▲ Are all I/O cables from the front panel connected to the right connector on the motherboard? Check the USB cable and the audio cable.
 - ▲ Verify the processor, thermal compound, and cooler are all installed correctly.
 - ▲ Are standoffs or spacers in place? Verify that a standoff that is not being used by the motherboard is not under the motherboard and causing a short.
3. Check the motherboard web site for other things you can check or try.

APPLYING CONCEPTS

Lance is putting together a computer from parts for the first time. He has decided to keep costs low and is installing an AMD processor on a microATX motherboard, using all low-cost parts. He installed the hard drive, optical drive, and power supply in the computer case. Then he installed the motherboard in the case, followed by the processor, cooler, and memory. Before powering up the system, he checked all connections to make sure they were solid and read through the motherboard documentation to make sure he did not forget anything important. Next, he plugs in the monitor to the onboard video port and then plugs in the keyboard and power cord. He takes a deep breath and turns on the power switch on the back of the computer. Immediately, he hears a faint whine, but he's not sure what is making the noise. When he presses the power button on the front of the case, nothing happens. No fans, no lights. Here are the steps Lance takes to troubleshoot the problem:

1. He turns off the power switch and unplugs the power cord. He remembers to put on his ground bracelet and carefully checks all power connections. Everything looks okay.
2. He plugs in the system and presses the power button again. Still all he hears is the faint whine.
3. He presses the power button a second and third time. Suddenly a loud pop followed by smoke comes from the power supply, and the strong smell of electronics fills the room! Lance jumps back in dismay.
4. He removes a known-good power supply from another computer, disconnects the blown power supply, and connects the good one to the computer. When he turns on the power switch, he hears that same faint whine. Quickly he turns off the switch and unplugs the power cord. He does not want to lose another power supply!
5. Next, Lance calls technical support of the company that sold him the computer parts. A very helpful technician listens carefully to the details and tells Lance that the problem sounds like a short in the system. He explains that a power supply might whine if too much power is being drawn. As Lance hangs up the phone, he begins to think that the problem might be with the motherboard installation.
6. He removes the motherboard from the case, and the source of the problem is evident: he forgot to install spacers between the board and the case. The board was sitting directly on the bottom of the case, which had caused the short.
7. Lance installs the spacers and reinstalls the motherboard. Using the good power supply, he turns on the system. The whine is gone, but the system is dead.
8. Lance purchases a new power supply and motherboard, and this time, carefully uses spacers in every hole used by the motherboard screws. Figure 8-27 shows one installed spacer and one ready to be installed. The system comes up without a problem.

In evaluating his experience with his first computer build, Lance declares the project a success. He was grateful he had decided to use low-cost parts for his first build. He learned much from the experience and will never, ever forget to use spacers. He told a friend, "I made a serious mistake, but I learned from it. I feel confident I know how to put a system together now, and I'm ready to tackle another build. When you make mistakes and get past them, your confidence level actually grows because you learn you can face a serious problem and solve it."

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Figure 8-27 Spacers installed in case holes keep the motherboard from causing a short

Hands-on | Project 8-2 Troubleshoot Memory

Do the following to troubleshoot memory:

1. Open the Windows System window and record the amount of memory in your system.
2. Follow the rules outlined in Chapter 1 to protect a computer against ESD as you work. Remove the memory module in the first memory slot on the motherboard, and boot the PC. Did you get an error? Why or why not? Replace the module and verify the system starts with no errors and that the full amount of memory is recognized by Windows.
3. Use the Windows 7/Vista Memory Diagnostics tool to test memory. About how long did the test take? Were any errors reported?

Hands-on | Project 8-3 Sabotage and Repair a Computer

Open the computer case and create a hardware problem with your computer that prevents the system from booting without damaging a component. For example, you can disconnect a data cable or power cable or loosen a DIMM in a memory slot. Close the computer case and restart the system. Describe the problem as a user would describe it who does not know much about computer hardware. Power down the system and fix the problem. Boot up the system and verify all is well.

TROUBLESHOOTING HARD DRIVES

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In this part of the chapter, you'll learn how to troubleshoot problems with hard drives. Problems caused by the hard drive during the boot can be caused by the hard drive subsystem, by the file system on the drive, or by files required by Windows when it begins to load. When trying to solve a problem with the boot, you need to decide if the problem is caused by hardware or software. All the problems discussed in this section are caused by hardware.

Hardware problems usually show up at POST, unless there is physical damage to an area of the hard drive that is not accessed during POST. Hardware problems often make the

hard drive totally inaccessible. If BIOS cannot find a hard drive at POST, it displays an error message similar to these:

```
No boot device available
Hard drive not found
Fixed disk error
Invalid boot disk
Inaccessible boot device
Inaccessible boot drive
Numeric error codes in the 1700s or 10400s
```

The reasons BIOS cannot access the drive can be caused by the drive, the data cable, the electrical system, the motherboard, the SCSI host adapter (if one is present), or a loose connection. Here is a list of things to do and check before you open the case:

1. If BIOS displays numeric error codes or cryptic messages during POST, check the Web site of the BIOS manufacturer for explanations of these codes or messages.
2. Check BIOS setup for errors in the hard drive configuration. If you suspect an error, set BIOS to default settings, make sure autodetection is turned on, and reboot the system.
3. Try booting from another bootable media such as the Windows setup DVD or a USB flash drive or CD with the Linux OS and diagnostics software installed (for example, Hiren's BootCD software at www.hirensbootcd.org). If you can boot using another media, you have proven that the problem is isolated to the hard drive subsystem. You can also use the bootable media to access the hard drive, run diagnostics on the drive, and possibly recover its data. A Hands-on Project later in the chapter gives you practice doing that.
4. For a RAID array, use the firmware utility to check the status of each disk in the array and to check for errors. Recall from Chapter 5 that you press a key at startup to access the RAID BIOS utility. This utility lists each disk in the array and its status. You can search the web site of the motherboard or RAID controller manufacturer for an interpretation of the messages on this screen and what to do about them. If one of the disks in the array has gone bad, it might take some time for the array to rebuild using data on the other disks. In this situation, the status for the array is likely to show as Caution.

After the array has rebuilt, your data should be available. However, if one of the hard drives in the array has gone bad, you need to replace the hard drive. After you have replaced the failed drive, you must add it back to the RAID array. This process is called rebuilding a RAID volume. How to do this depends on the RAID hardware you are using. For some motherboards or RAID controller cards, you use the RAID firmware. For others, you use the RAID management software that came bundled with the motherboard or controller. You install this software in Windows and use the software to rebuild the RAID volume using the new hard drive.

If the problem is still not solved, open the case and check these things. Be sure to protect the system against ESD as you work:

1. Remove and reattach all drive cables. For IDE drives, check for correct pin-1 orientation.
2. If you're using a RAID, SATA, PATA, or SCSI controller card, remove and reseal it or place it in a different slot. Check the documentation for the card, looking for directions for troubleshooting.
3. For new installations, check the jumper settings on an IDE drive.

4. Inspect the drive for damage, such as bent pins on the connection for the cable.
5. Determine if the hard drive is spinning by listening to it or lightly touching the metal drive (with the power on).
6. Check the cable for frayed edges or other damage.
7. Check the installation manual for things you might have overlooked. Look for a section about system setup, and carefully follow all directions that apply.
8. Windows includes several tools for checking a hard drive for errors and repairing a corrupted Windows installation that are not covered in this book. Without getting into these details of supporting Windows, here are a few simple things you can try:
 - a. Following directions given earlier in the chapter, boot from the Windows setup DVD and load the System Recovery Options menu shown earlier in Figure 8-24. Select Startup Repair. This option restores many of the Windows files needed for a successful boot.
 - b. To make sure the hard drive does not have bad sectors that can corrupt the file system, you can use the `chkdsk` command. To use the command, select Command Prompt from the System Recovery Options menu. At the command prompt that appears, enter the `chkdsk C: /r` command to search for and recover data from bad sectors on drive C:.
9. Check the drive manufacturer's web site for diagnostic software. Sometimes this software can be run from a bootable CD. Run the software to test the drive for errors.
10. If it is not convenient to create a bootable CD with hard drive diagnostic software installed, you can move the drive to a working computer and install it as a second drive in the system. Then you can use the diagnostic software installed on the primary hard drive to test the problem drive. While you have the drive installed in a working computer, be sure to find out if you can copy data from it to the good drive, so that you can recover any data not backed up. Remember that you sit the drive on the open computer case (see Figure 8-28) or use a PATA-to-USB converter or SATA-to-USB



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Figure 8-28 Temporarily connect a faulty hard drive to another system to diagnose the problem and try to recover data

converter to connect the drive to a USB port. If you have the case open with the PC turned on, be *very careful* to not touch the drive or touch inside the case.

11. If the drive still does not boot, exchange the three field replaceable units—the data cable, the adapter card (optional), and the hard drive itself—for a hard drive subsystem. Do the following, in order:
 - a. Reconnect or swap the drive data cable.
 - b. Reseat or exchange the drive controller card, if one is present.
 - c. Exchange the hard drive for a known good drive.
12. Sometimes older drives refuse to spin at POST. Drives that have trouble spinning often whine at startup for several months before they finally refuse to spin altogether. If your drive whines loudly when you first turn on the computer, never turn off the computer and replace the drive as soon as possible. One of the worst things you can do for a drive that is having difficulty starting up is to leave the computer turned off for an extended period of time. Some drives, like old cars, refuse to start if they are unused for a long time.
13. A bad power supply or a bad motherboard also might cause a disk boot failure.

If the problem is solved by exchanging the hard drive, take the extra time to reinstall the old hard drive to verify that the problem was not caused by a bad connection.

Hard drives are sometimes stored in external enclosures such as the one shown in Figure 8-29. These enclosures make it easy to expand the storage capacity of a single computer or to make available hard drive storage to an entire network. For network attached storage (NAS), the enclosure connects to the network using an Ethernet port. When the



Courtesy of D-Link Corporation

Figure 8-29 The NAS ShareCenter Pro 1100 by D-Link can hold four hot-swappable SATA hard drives totalling 12 TB storage, has a dual core processor and 512 MB RAM, and supports RAID

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storage is used by a single computer, the connection is made using a USB or eSATA port. Regardless of how the enclosure connects to a computer or network, the hard drives inside the enclosure might use a SATA or PATA connection.

Here is what you need to know about supporting these external enclosures:

1. An enclosure might contain firmware that supports RAID. For example, a switch on the rear of one enclosure for two hard drives can be set for RAID 0, RAID 1, or stand-alone drives. Read the documentation for the enclosure to find out how to manage the RAID volumes.
2. To replace a hard drive in an enclosure, see the documentation for the enclosure to find out how to open the enclosure and replace the drive.
3. If a computer case is overheating, one way to solve this problem is to remove the hard drives from the case and install them in an external enclosure. However, it's better to leave in the case the hard drive that contains the Windows installation.

TROUBLESHOOTING MONITORS AND VIDEO

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For monitor and video problems, as with other devices, if you have problems, try doing the easy things first. For instance, try to make simple hardware and software adjustments. Many monitor problems are caused by poor cable connections or bad contrast/brightness adjustments. Typical monitor and video problems and how to troubleshoot them are described next. In Chapter 11, you learn more about troubleshooting video problems on notebook computers.



Notes A user very much appreciates a PC support technician who takes a little extra time to clean a system being serviced. When servicing a monitor, take the time to clean the screen with a soft dry cloth or monitor wipe.

MONITOR INDICATOR LIGHT IS NOT ON; NO IMAGE ON-SCREEN

If you hear one beep during the boot and you see a blank screen, then BIOS has successfully completed POST, which includes a test of the video card or onboard video. You can then assume the problem must be with the monitor or the monitor cable. Ask these questions and try these things:

1. Is the monitor power cable plugged in?
2. Is the monitor turned on? Try pushing the power button on the front of the monitor. An indicator light on the front of the monitor should turn on, indicating the monitor has power.
3. Is the monitor cable plugged into the video port at the back of the PC and the connector on the rear of the monitor?
4. Try a different monitor and a different monitor cable that you know are working.



Notes When you turn on your computer, the first thing you see on the screen is the firmware on the video card identifying itself. You can use this information to search the web, especially the manufacturer's web site, for troubleshooting information about the card.

MONITOR INDICATOR LIGHT IS ON; NO IMAGE ON-SCREEN

For this problem, try the following:

1. Make sure the video cable is securely connected at the computer and the monitor. Most likely the problem is a bad cable connection.
2. If the monitor displays POST but goes blank when Windows starts to load, the problem is Windows and not the monitor or video. Try booting Windows in Safe Mode, which you learned to do earlier in the chapter. Safe Mode allows the OS to select a generic display driver and low resolution. If this works, change the driver and resolution.
3. The monitor might have a switch on the back for choosing between 110 volts and 220 volts. Check that the switch is in the right position.
4. The problem might be with the video card. If you have just installed the card and the motherboard has onboard video, go into BIOS setup and disable the video port on the motherboard.
5. Verify that the video cable is connected to the video port on the video card and not to a disabled onboard video port.
6. Using buttons on the front of the monitor, check the contrast adjustment. If there's no change, leave it at a middle setting.
7. Check the brightness or backlight adjustment. If there's no change, leave it at a middle setting.
8. If the monitor-to-computer cable detaches from the monitor, exchange it for a cable you know is good, or check the cable for continuity. If this solves the problem, reattach the old cable to verify that the problem was not simply a bad connection.
9. Test a monitor you know is good on the computer you suspect to be bad. If you think the monitor is bad, make sure that it also fails to work on a good computer.
10. Open the computer case and reseal the video card. If possible, move the card to a different expansion slot. Clean the card's edge connectors, using a contact cleaner purchased from a computer supply store.
11. If there are socketed chips on the video card, remove the card from the expansion slot and then use a screwdriver to press down firmly on each corner of each socketed chip on the card. Chips sometimes loosen because of temperature changes; this condition is called chip creep.
12. Trade a good video card for the video card you suspect is bad. Test the video card you think is bad on a computer that works. Test a video card you know is good on the computer that you suspect is bad. Whenever possible, do both.
13. Test the RAM on the motherboard with memory diagnostic software.
14. For a motherboard that is using a PCI-Express or AGP video card, try using a PCI video card in a PCI slot or a PCIe ×1 video card in a PCIe ×1 slot. A good repair technician keeps an extra PCI video card around for this purpose.
15. Trade the motherboard for one you know is good. Sometimes, though rarely, a peripheral chip on the motherboard can cause the problem.
16. For notebook computers, is the LCD switch turned on? Function keys are sometimes used for this purpose.

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- For notebook computers, try connecting a second monitor to the notebook and use the function key to toggle between the LCD panel and the second monitor. If the second monitor works, but the LCD panel does not work, the problem might be with the LCD panel hardware. How to solve problems with notebook computers is covered in Chapter 11.

SCREEN GOES BLANK 30 SECONDS OR ONE MINUTE AFTER THE KEYBOARD IS LEFT UNTOUCHED

A Green motherboard (one that follows energy-saving standards) used with an Energy Saver monitor can be configured to go into standby or sleep mode after a period of inactivity. To wake up the computer, press any key on the keyboard or press the power button. How to configure sleep mode settings is covered in Chapter 11.

Notes Problems might occur if the motherboard power-saving features are turning off the monitor, and Windows screen saver is also turning off the monitor. If the system hangs when you try to get the monitor going again, try disabling one or the other. If this doesn't work, disable both.

POOR DISPLAY

In general, you can solve problems with poor display by using controls on the monitor and using Windows settings. Do the following:

- ▲ **LCD monitor controls.** Use buttons on the front of an LCD monitor to adjust color, brightness, contrast, focus, and horizontal and vertical positions.
- ▲ **Windows display settings.** Use Windows settings to adjust font size, screen resolution, brightness, color, and Clear Type text. Open Control Panel and in the Appearance and Personalization group, click **Display**. Use these settings to adjust the display:
 - To make sure Clear Type text is selected, click **Adjust ClearType text** and turn on ClearType (see Figure 8-30). Then follow the steps in the wizard to improve the quality of text displayed on the screen.

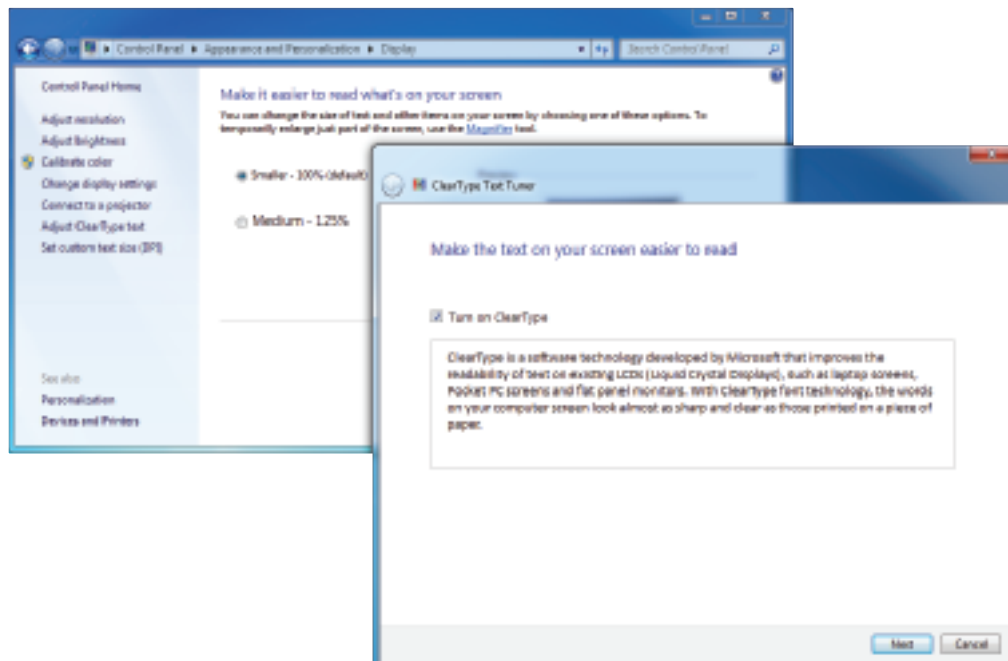


Figure 8-30 ClearType in Windows improves the display of text on the screen

Source: Microsoft Windows 7

- To adjust screen resolution, click **Change display settings** in the Display window.
- To calibrate colors, click **Calibrate color** and follow the directions on-screen. As you do so, color patterns appear (see Figure 8-31). Use these screens to adjust the gamma settings, which define the relationships among red, green, and blue as well as other settings that affect the display.

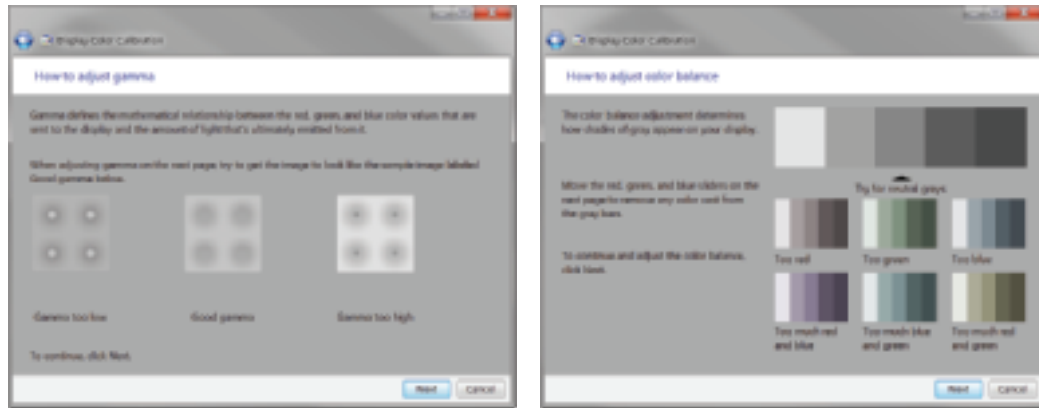


Figure 8-31 Two screens in the Windows 7 color calibration wizard

Source: Microsoft Windows 7

- ▲ **Update the video drivers.** How to do that is covered in Chapter 6. The latest video drivers can solve various problems with the video subsystem, including poor display.

Here are a few other display problems and their solutions:

- ▲ **Dead pixels.** An LCD monitor might have pixels that are not working called **dead pixels**, which can appear as small white, black, or colored spots on your screen. A black or white pixel is likely to be a broken transistor, which cannot be fixed. Having a few dead pixels on an LCD monitor screen is considered acceptable and usually not covered under the manufacturer's warranty.



Notes A pixel might not be a dead pixel (a hardware problem), but only a stuck pixel (a software problem). You might be able to use software to fix stuck pixels. For example, run the online software at www.flexcode.org/lcd2.html to fix stuck pixels. The software works by rapidly changing all the pixels on the screen. (Be aware the screen flashes rapidly during the fix.)

- ▲ **Dim image.** A notebook computer dims the LCD screen when the computer is running on battery to conserve the charge. You can brighten the screen using the Windows display settings. To do so, open **Control Panel**, and click **Display** in the Appearance and Personalization group and then click **Adjust brightness** (see Figure 8-32). To check if settings to conserve power are affecting screen brightness, note the power plan that is selected. Click **Change plan settings** for this power plan. On the next screen, you can adjust when or if the screen will dim (see Figure 8-33). If the problem is still not resolved, it might be a hardware problem. How to troubleshoot hardware in laptops is covered in Chapter 11.

A dim image in a desktop monitor might be caused by a faulty video card or a faulty monitor. To find out which is the problem, connect a different monitor. If the monitor is the problem, most likely the backlighting in the LCD monitor is faulty and the monitor needs replacing.

- ▲ **Artifacts.** Horizontally torn images on-screen are called **artifacts** (see Figure 8-34), and happen when the video feed from the video controller gets out of sync with the refresh

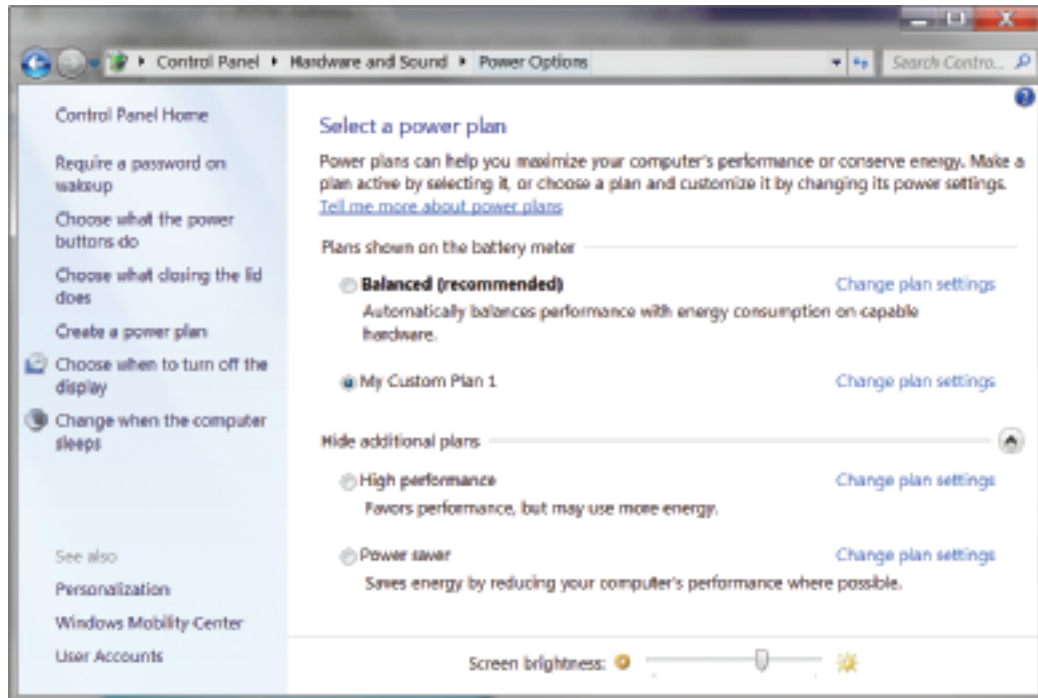
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Figure 8-32 Adjust screen brightness

Source: Microsoft Windows 7

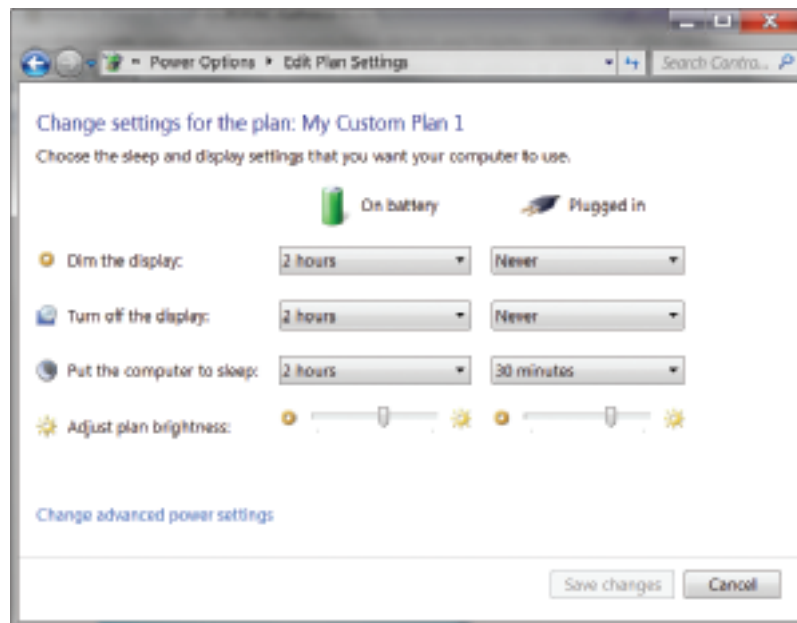


Figure 8-33 Change power plan options to affect how or if the screen dims

Source: Microsoft Windows 7

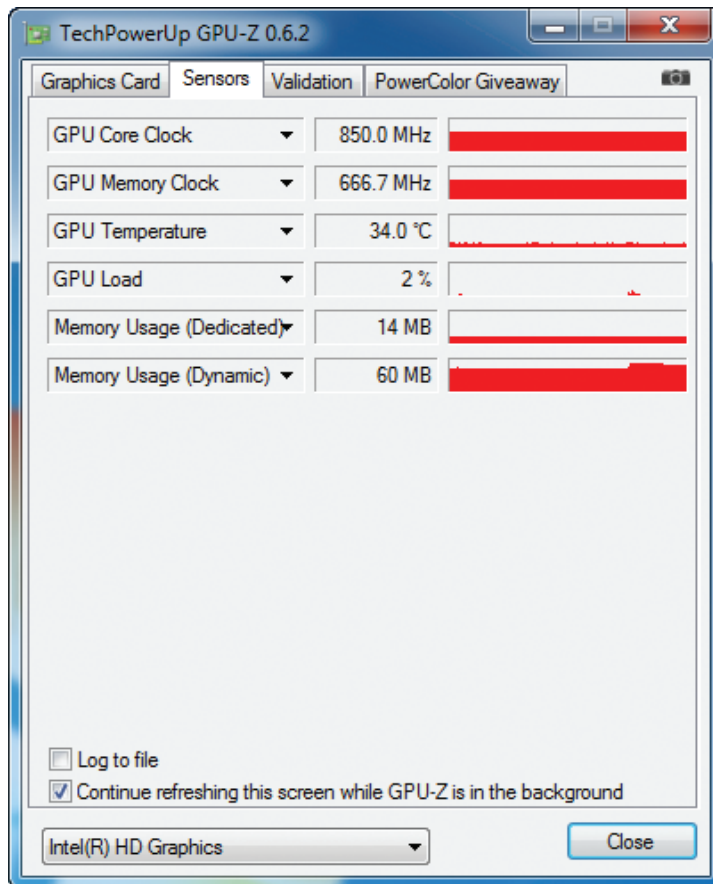
of the monitor screen. The problem can be caused by hardware or software. A common cause is when the GPU on the video card overheats. You can test that possibility by downloading and running freeware to monitor the temperature of the CPU and the GPU while you're playing a video game. If you notice the problem occurs when the GPU temp is high, install extra fans around the video card to keep it cool. Two freeware programs to monitor temperatures are CPU-Z by CPUID (www.cpubid.com/software/cpu-z.html) and GPU-Z by TechPowerUp (www.techpowerup.com/gpuz). See Figure 8-35.

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Figure 8-34 A simulation of horizontal tears on an image called artifacts



Source: GPU-Z by TechPowerUp

Figure 8-35 GPU-Z monitors the GPU temperature

 **Notes** In this book, I've given several options for various freeware utilities. It's a good idea to know about your options for several reasons. Each freeware utility has different options; owners of freeware might not update their utility in a timely manner, and web sites might decide to include adware with their downloads.

Try updating the video drivers. However, if you see artifacts on the screen before Windows loads, then you know the problem is not caused by the drivers. The problem might be caused by the monitor. Try using a different monitor to see if the problem goes away. If so, replace the monitor.

Overclocking can cause artifacts. Other causes of artifacts are the motherboard or video card going bad, which can happen if the system has been overheating or video RAM on the card is faulty. Try replacing the video card. The power supply also might be the problem.

In general, to improve video quality, upgrade the video card and/or monitor. Poor display might be caused by inadequate video RAM. Your video card might allow you to install additional video RAM. See the card's documentation.

PROBLEMS WITH CRT MONITORS

If a CRT monitor makes a crackling sound, dirt or dust inside the monitor might be the cause. Someone at a computer monitor service center trained to work on the inside of the monitor can vacuum inside it. Recall from Chapter 1 that a monitor holds a dangerous charge of electricity, and you should not open one unless trained to do so.

If the monitor flickers or has wavy lines, a distorted image, or discoloration, try the following:

- ▲ Monitor flicker can be caused by poor cable connections. Check that the cable connections are snug.
- ▲ Odd-colored blotches on the screen or a screen flicker might indicate a device such as a speaker or fan is sitting too close to the monitor and emitting electrical noise called electromagnetic interference or EMI. Move any suspected device such as a fan, bad fluorescent lights, or large speakers away from the monitor. Two monitors placed very close together can also cause problems.
- ▲ Does the monitor have a **degauss button** to eliminate accumulated or stray magnetic fields? If so, press it. If the monitor doesn't have the button, turn the monitor on and off several times to trigger a built-in degausser, which some CRT monitors have.
- ▲ If the refresh rate is below 60 Hz, a screen flicker might appear. Change the refresh rate to the highest value the monitor supports. To change the refresh rate, in the Display window, click **Change display settings**. In the Screen Resolution window, click **Advanced settings**. Then select the **Monitor** tab on the video properties box (see Figure 8-36). Make sure **Hide modes that this monitor cannot display** is selected. Then select the largest value in the drop-down list.
- ▲ For older monitors that don't support a high enough refresh rate, your only cure might be to purchase a new monitor. Before buying a new monitor, try a second available monitor to make sure a different monitor will solve the problem.

DISPLAY SETTINGS MAKE THE SCREEN UNREADABLE

When the display settings don't work, you can easily return to standard VGA settings called **VGA mode**, which includes a resolution of 640 × 480. Do the following:

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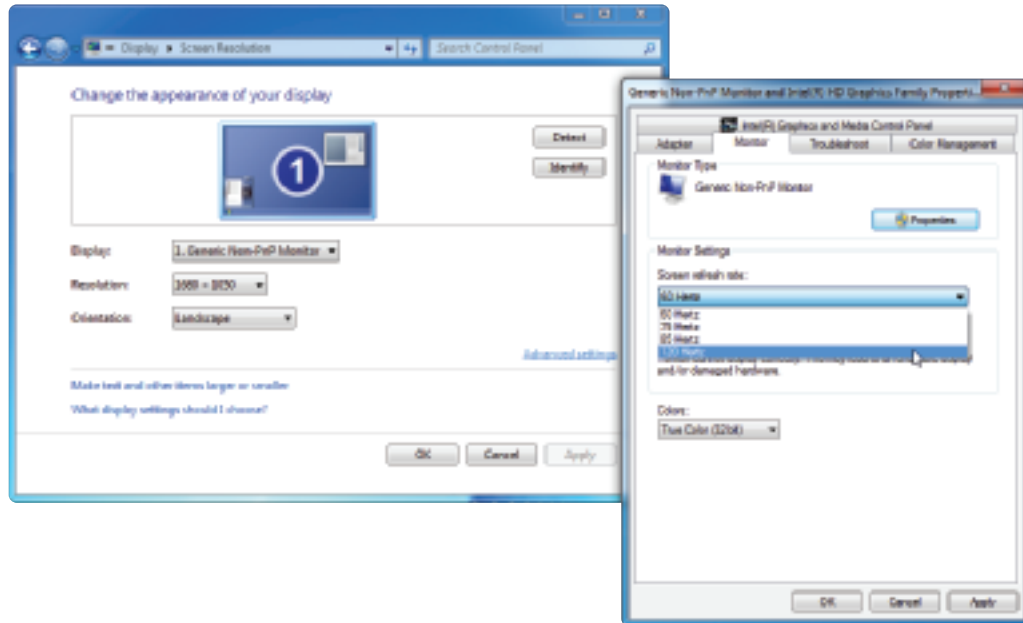


Figure 8-36 Set the refresh rate high to avoid screen flicker

Source: Microsoft Windows 7

- ▲ Reboot the system and press the F8 key after the first beep. The Advanced Boot Options menu appears (refer to Figure 8-18).
- ▲ Select **Safe Mode** to boot up with minimal configurations of Windows, which includes standard VGA mode. To boot to the regular Windows environment and use VGA mode, select **Enable low-resolution video (640 × 480)**.
- ▲ After you have changed the display settings, restart Windows.

8

Hands-on | Project 8-4 Adjust Windows Display Settings

A support technician needs to be able to instruct others how to change their display settings. To practice this skill, do the following:

1. Using the Windows 7 Display window, calibrate the color displayed on your monitor screen. Verify that ClearType text is enabled.
2. Try different screen resolutions supported by your monitor. On the Display window, click **Set custom text size (DPI)** and adjust font size. Verify the monitor is set to use the highest refresh rate it supports.
3. To view your Windows desktop in VGA mode, boot to the Advanced Boot Options menu and select **Enable low-resolution video (640 × 480)**. Then restart Windows and return your system to normal Windows display settings.

Now let's turn our attention to the final topic of this chapter: protecting a computer and the environment.

PROTECTING A COMPUTER AND THE ENVIRONMENT

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As you learn to troubleshoot and solve computer problems, you gradually begin to realize that many problems you face could have been avoided by good computer maintenance that includes protecting the computer against environmental factors such as humidity, dust, and out-of-control electricity. In addition, computer technicians need to be aware that we can do damage to the environment if we carelessly dispose of used computer equipment improperly. Both these concerns are covered in this part of the chapter.

PHYSICALLY PROTECT YOUR EQUIPMENT

Preventive maintenance can prevent certain computer problems from occurring in the first place. The more preventive maintenance work you do initially, the fewer problems you are likely to have later, and the less troubleshooting and repair you will have to do. Here is my list of dos and don'ts (you can probably add your own tips to the list) that you can do to physically protect a computer:

- ▶ *Don't move or jar your desktop computer while the hard drive is working.* Don't put the computer case under your desk where it might get bumped or kicked. Although modern hard drives are tougher than earlier ones, it's still possible to crash a drive by banging into it while it's reading or writing data.



Notes

The read/write heads on a hard drive get extremely close to the platters, but do not actually touch them. A "hard drive crash" can happen when a computer is bumped while the hard drive is operating, and a head bumps against the platter and scratches the surface. Most likely, this hard drive is now unusable.

- ▶ *Protect a computer against dust and other airborne particles.* Here are some things you can do to protect a computer when it must sit in a dusty environment, around those who smoke, or where pets might leave hair:
 - You can purchase a plastic keyboard cover to protect the keyboard. When the computer is turned off, cover the entire system with a protective cover or enclosure.
 - Install air filters over the front or side vents of the case where air flows into the case. Put your hand over the case of a running computer to feel where the air flows in. For most systems, air flows in from the front vents (refer to Figure 8-14) or vents on the side of the case that is near the processor cooler (refer to Figure 8-16). The air filter shown in Figure 8-37 has magnets that hold the filter to the case when screw holes are not available.
 - Whenever you have the case cover open, be sure to use compressed air or an anti-static vacuum (see Figure 8-38) to remove dust from inside the case. Figure 8-39 shows a case fan that jammed because of dust and caused a system to overheat. And while you're cleaning up dust, don't forget to blow or vacuum out the keyboard.



Notes

When working at a customer site, be sure to clean up any mess you created by blowing dust out of a computer case or keyboard.

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Figure 8-37 This air filter is designed to fit over a case fan, power supply fan, or panel vent on the case



Courtesy of Metropolitan Vacuum Cleaner

Figure 8-38 An antistatic vacuum designed to work inside sensitive electronic equipment such as computers and printers

- ▲ *Allow for good ventilation inside and outside the system.* Proper air circulation is essential to keeping a system cool. Don't block air vents on the front and rear of the computer case or on the monitor. Inside the case, make sure cables are tied up and out of the way so as to allow for air flow and not obstruct fans from turning. Put covers on expansion slot openings on the rear of the case and put faceplates over empty bays on the front of the case. Don't set a tower case directly on thick carpet because the air vent on the bottom front of the case can be blocked. If you are concerned about overheating, monitor temperatures inside and outside the case.

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Figure 8-39 This dust-jammed case fan caused a system to overheat

A+ Exam Tip The A+ 220-801 exam expects you to know how to keep computers and monitors well ventilated and to use protective enclosures and air filters to protect the equipment from airborne particles.

- ▲ *High temperatures and humidity can be dangerous for hard drives.* I once worked in a basement with PCs, and hard drives failed much too often. After we installed dehumidifiers, the hard drives became more reliable. If you suspect a problem with humidity, you can use a hygrometer to monitor the humidity in a room. High temperatures can also damage computer equipment, and you should take precautions to not allow a computer to overheat.

Notes A server room where computers stay and people generally don't stay for long hours is set to balance what is good for the equipment and to conserve energy. Low temperature and moderate humidity are best for the equipment, although no set standards exist for either. Temperatures might be set from 65 to 70 degrees F, and humidity between 30 percent and 50 percent, although some companies keep their server rooms at 80 degrees F to conserve energy. A data center where both computers and people stay is usually kept at a comfortable temperature and humidity for humans.

- ▲ *In BIOS setup, disable the ability to write to the boot sector of the hard drive.* This alone can keep boot viruses at bay. However, before you upgrade your OS, such as when you upgrade Windows XP to Windows 7, be sure to enable writing to the boot sector, which the OS setup will want to do.
- ▲ *Protect your CDs, DVDs, BDs, and other storage media.* To protect discs, keep them away from direct sunlight, heat, and extreme cold. Don't allow a disc to be scratched.
- ▲ *Don't leave a computer turned off for weeks or months at a time.* Once my daughter left her computer turned off for an entire summer. At the beginning of the new school term, the computer wouldn't boot. We discovered that the boot record at the

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beginning of the hard drive had become corrupted. PCs, like old cars, can give you problems after long spans of inactivity.

- ▲ *Don't unpack and turn on a computer that has just come in from the cold.* If your new laptop has just arrived and sat on your doorstep in freezing weather, don't bring it in and immediately unpack it and turn it on. Wait until a computer has had time to reach room temperature to prevent damage from condensation and static electricity. In addition, when unpacking hardware or software, to help protect against static electricity, remove the packing tape and cellophane from the work area as soon as possible.
- ▲ *Protect electrical equipment from power surges.* Lightning and other electrical power surges can destroy computers and other electrical equipment. If the house or office building does not have surge protection equipment installed at the breaker box, be sure to install a protective device at each computer. The least expensive device is a power strip that is also a surge protector, although you might want to use a line conditioner or UPS for added protection.

Lightning can also get to your equipment across network cabling coming in through your Internet connection. To protect against lightning, use a surge protector such as the one shown in Figure 8-40 in line between the DSL modem or cable modem and the computer or home router to protect it from spikes across the network cables.

Notice the cord on the surge protector, which connects it to ground.



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Figure 8-40 Surge protector by APC for Ethernet lines

An **uninterruptible power supply (UPS)** is a device that raises the voltage when it drops during **brownouts** or **sags** (temporary voltage reductions). A UPS also does double duty as a surge protector to protect the system against power surges or spikes. In addition, a UPS can provide power for a brief time during a total blackout long enough for you to save your work and shut down the system. A UPS is not as essential for a laptop computer as it is for a desktop because a laptop has a battery that can sustain it during a blackout.

A common UPS device is a rather heavy box that plugs into an AC outlet and provides one or more outlets for the computer and the monitor (see Figure 8-41). It has an on/off switch, requires no maintenance, and is very simple to install. Use it to provide uninterruptible power to your desktop computer and monitor. It's best not to connect it to nonessential devices such as a laser printer or scanner.

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Courtesy of American Power Conversion Corp.



Source: Courtesy of American Power Conversion Corp.

Figure 8-41 Uninterruptible power supply (UPS)

Notes Whenever a power outage occurs, unless you have a reliable power conditioner installed at the breaker box in your house or building, unplug all power cords to the computers, printers, monitors, and the like. Sometimes when the power returns, sudden spikes are accompanied by another brief outage. You don't want to subject your equipment to these surges. When buying a surge suppressor, look for those that guarantee against damage from lightning and that reimburse for equipment destroyed while the surge suppressor is in use.

DOCUMENT PREVENTIVE MAINTENANCE

When you first set up a new computer, start a record book about this computer, using either a file on a removable storage device or a hand written notebook dedicated to this machine. In this notebook or file, record any changes in setup data as well as any problems you experience or maintenance that you do on this computer. Be diligent in keeping this notebook up to date because it will be invaluable in diagnosing problems and upgrading equipment. Keep a printed or handwritten record of all changes to BIOS setup data and jumpers on the motherboard, and store the record with the hardware and software documentation.

If you are not the primary user of the computer, you might want to keep the hardware documentation separate from the computer itself. Label the documentation so that you can easily identify that it belongs to this computer. Keep this hardware documentation and your notes in a safe place. Some support people tape a large envelope inside the computer case; the envelope contains important documentation and records specific to that computer. On the other hand, if you're also responsible for software reference manuals, know that these manuals need to be kept in a location that is convenient for users.

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Notes We've provided the document, "Computer Inventory and Maintenance," that you can use to take an inventory of the hardware and software installed on a computer and record the ongoing maintenance, upgrades, and troubleshooting you do to the computer. To download the document, go to www.cengagebrain.com. For more information, see the Preface.

HOW TO DISPOSE OF USED EQUIPMENT

As a PC technician, one day you're sure to face an assortment of useless equipment and consumables (see Figure 8-42). Before you decide to trash it all, take a moment and ask yourself if some of the equipment can be donated or at least recycled. Think about fixing up an old computer and donating it to a needy middle school student. If you don't have the time for that, consider donating to the local computer repair class. The class can fix the computers up as a class project and donate them to young students.



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Figure 8-42 Keep, trash, recycle, or donate?

If you do decide to give away a computer, first uninstall any applications software that you intend to use on another computer and delete any private data. To completely wipe a hard drive clean without destroying it, you can use a **zero-fill utility** downloaded from the hard drive manufacturer. For Windows or other software still installed on the drive, be sure to include documentation and installation CDs or DVDs with the computer.


If you're trashing a computer or hard drive, you can use special equipment called a degausser to erase *everything* on a magnetic hard drive or you can do physical damage (such as drilling holes through the drive). For SSD drives, download and use a Secure Erase utility from the drive manufacturer. When disposing of any type of equipment or consumables, make sure to comply with local government environmental regulations. Table 8-4 lists some items and how to dispose of them.

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Part	How to Dispose
Alkaline batteries, including AAA, AA, A, C, D, and 9-volt	Dispose of these batteries in the regular trash. First check to see if there are recycling facilities in your area.
Button batteries used in digital cameras and other small equipment; battery packs used in notebooks	These batteries can contain silver oxide, mercury, lithium, or cadmium and are considered hazardous waste. Dispose of them by returning them to the original dealer or by taking them to a recycling center. To recycle, pack them separately from other items. If you don't have a recycling center nearby, contact your county for local regulations for disposal.
Laser printer toner cartridges	Return these to the manufacturer or dealer to be recycled.
Ink-jet printer cartridges, computer cases, power supplies, and other computer parts, monitors, chemical solvents, and their containers	Check with local county or environmental officials for laws and regulations in your area for proper disposal of these items. The county might have a recycling center that will receive them. Discharge a CRT monitor before disposing of it. See the MSDS documents for chemicals to know how to dispose of them.
Storage media such as hard drives, CDs, DVDs, and BDs	Do physical damage to the device so it is not possible for sensitive data to be stolen. Then the device can be recycled or put in the trash. Your organization might be required to meet legal requirements to destroy data. If so, make sure you understand these requirements and how to comply with them.

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Table 8-4 Computer parts and how to dispose of them

 **A+ Exam Tip** The A+ 220-801 exam expects you to know to follow environmental guidelines to dispose of batteries, CRTs, chemical solvents, and containers. If you're not certain how to dispose of a product, see its MSDS document.

Hands-on | Project 8-5 Safely Clean Computer Equipment

Practice some preventive maintenance tasks by following these steps to clean a computer:

1. Shut down the computer and unplug it. Press the power button to drain power.
2. Clean the keyboard, monitor, and mouse. For a wheel mouse, remove the ball and clean the wheels. Clean the outside of the computer case. Don't forget to clean the mouse pad.
3. Open the case and using a ground bracelet, clean the dust from the case. Make sure all fans move freely.
4. Verify the cables are out of the way of airflow. Use cable ties as necessary.
5. Check that each expansion card and memory module is securely seated in its slot.
6. Power up the system and make sure all is working.
7. Clean up around your work area. If you left dust on the floor as you blew it out of the computer case, be sure to clean it up.