Basic PC Components and Elements

Before you can build a PC properly, it's important to understand the pieces and parts that go into creating a working personal computer. It's also important to understand the roles that components play, and how various factors in one component can impose requirements and trade-offs on selection of other components. In part, you can understand what's inside a PC (and by extension, what's needed when putting a PC together) by cracking open the case and inspecting its contents. Though the actual components themselves may vary, here's a list of the kinds of things you will always find in or around a PC:

➤ The PC case or enclosure

➤ The PC electrical system, including power supply and cabling

➤ The CPU

➤ Various forms of storage that vary in speed and capacity, including:

  ▪ RAM

  ▪ Hard disks

  ▪ Optical drives, including CD and DVD drives

  ▪ Floppy disk drives (these are uncommon on many PCs nowadays, especially Home Theater PCs)

➤ A motherboard

➤ One or more interface cards that plug into the motherboard (At a minimum this usually includes a graphics card—and at least a TV tuner card—on a Home Theater PC.)

➤ Input devices, such as a keyboard and a mouse

in this chapter

☑ Cracking the PC's case

☑ Understanding a PC's innards

☑ User input devices

☑ PC output devices

☑ PC cooling and ventilation

☑ The PC boot process

➤ Output devices — for example, a monitor, speakers for sound, a printer for printed output, and so forth

➤ Cooling and ventilation elements

All kinds of other elements appear in many computer systems, but this chapter describes a minimal set of PC components at a basic level of detail. Chapters in Part II of this book cover these same items in detail and tackle only one or two of them in any given chapter. That's where you'll find the most information, vital statistics, tips, and suggestions for researching, selecting, purchasing, installing, and troubleshooting PC components.

Here, you're looking at a fairly generic homebrew desktop PC. In other words, it's stocked with the basic components that any PC typically includes but not the full complement of components that some PCs could include. In the next chapter, you'll see what kinds of components must be added to a generic PC to turn it into a Home Theater PC (HTPC). To facilitate this process, you'll see photos intended to illuminate the discussion of PC component elements, and to illustrate the current focus.

Before Taking a PC System Tour

If you want to take a tour of your own PC, you're certainly welcome to do so. But before you start, you'll want to complete the following steps:

1. Save any work in progress, close all open applications, and then shut down your PC.

2. If the Windows shutdown doesn't turn off the power to your PC (it will on newer systems, but not on older ones), turn off the power yourself. This means finding the power switch for the power supply, which is normally a rocker switch somewhere on the front or back of the unit.

3. Disconnect all cables attached to the PC. If you're not sure you can put things back where you found them later on, draw a diagram that shows where cables go and then label the cables to match that diagram.

Tip

A piece of tape secures a small piece of paper to each cable, if you like (we like 3M invisible tape for this job because it's easy to remove and leaves no sticky residue). When labeling lots of cables, however, we like to use Post-It Flags for this purpose — indeed, 3M even makes Durable Tabs that "are made to last and easy to write on" that are perfect for labeling cables and leaving those labels attached. You can buy Post-It Flags (including Durable Tabs) at most office supply stores like Office Depot or OfficeMax.

4. Examine the PC case to determine what kind of tool(s) you'll need to open it up. Most cases—like the example used in this chapter to illustrate PC components and internals—use machine screws of some kind. Some require a flat head screwdriver, others a Phillips head screwdriver, and still others are best handled with hex drivers or small wrenches. See what you've got, and then pick the best tool for the job. Remove the screws that hold the case together (and re-apply the diagramming advice from the previous step if needed). Slide the case shell off, and you're ready to tour your own system while reading about and looking at the one depicted in this book.

Tip

Whenever you remove screws or other small items from a case, or other computer assembly, store them temporarily in a paper cup, an envelope, or other small container so you can find them when you need to put things back together. If you're taking several things apart (or have small parts from several disassembled components to deal with), be sure to label what's what.

Of course, if you're an experienced PC veteran and have already seen enough PC innards to identify what you see and to know what's where, simply follow along without taking anything apart. There will be plenty of opportunities to take things apart and put them back together later in this book!

After you've cracked the case and removed the shell, don't be surprised if you find some dust and dirt inside the case along with the components you're about to survey. If you want to clean up, you might want to equip yourself with a can of compressed air to blow things clean before you put them back together. You can find single cans and multi-packs at most computer stores (such as Fry's or CompUSA) for $3 or so and up per can.

Caution

Be sure that the power to your PC is completely off before disconnecting any cables. Unplug the power cable from the wall socket before unplugging it from your computer case, just to make doubly sure you're not risking an unpleasant shock or worse. Exercise caution when working inside your PC; although you'd have to work at it to expose yourself to outright hazard, such hazards are there and are best avoided. Don't touch anything you don't have to or aren't instructed to as you follow along in this book.

Figure 1-1 shows the insides of a generic homebrew PC right after the case was opened (and the inside cleaned). Note how the ribbon cables that attach various drives to the motherboard and a SCSI controller obscure much of the inside view. This is typical inside many PCs so don't be surprised if the inside view into your own PC is likewise obstructed.

After removing the cables from the two CD players (one SCSI, the other IDE), the floppy drive, and the hard disk, the PC's innards are much easier to see, as shown in Figure 1-2. This figure serves as the basis for the rest of the tour, with callouts to help you identify various pieces and parts.

FIGURE 1-1: A first look inside the case shows mostly cables, plus glimpses of other odds and ends.

Caution

CAUTION

Unless you're sure you can put things back exactly the way you found them, you might want to label your cables as you remove them. Pay attention to how and where they hook up, so you can replace them correctly. Most drive cable connectors use slots or guides so that connections seat properly only when inserted with the right orientation. But you must pay attention and be gentle when removing or reinserting cable connectors: excess force can damage the connectors on a drive, a controller, or your motherboard. Take our word for it: although it's easy and cheap to replace a cable, you don't want to replace any of those other items (none of them costs less than $25 or $30; some can cost hundreds of dollars).
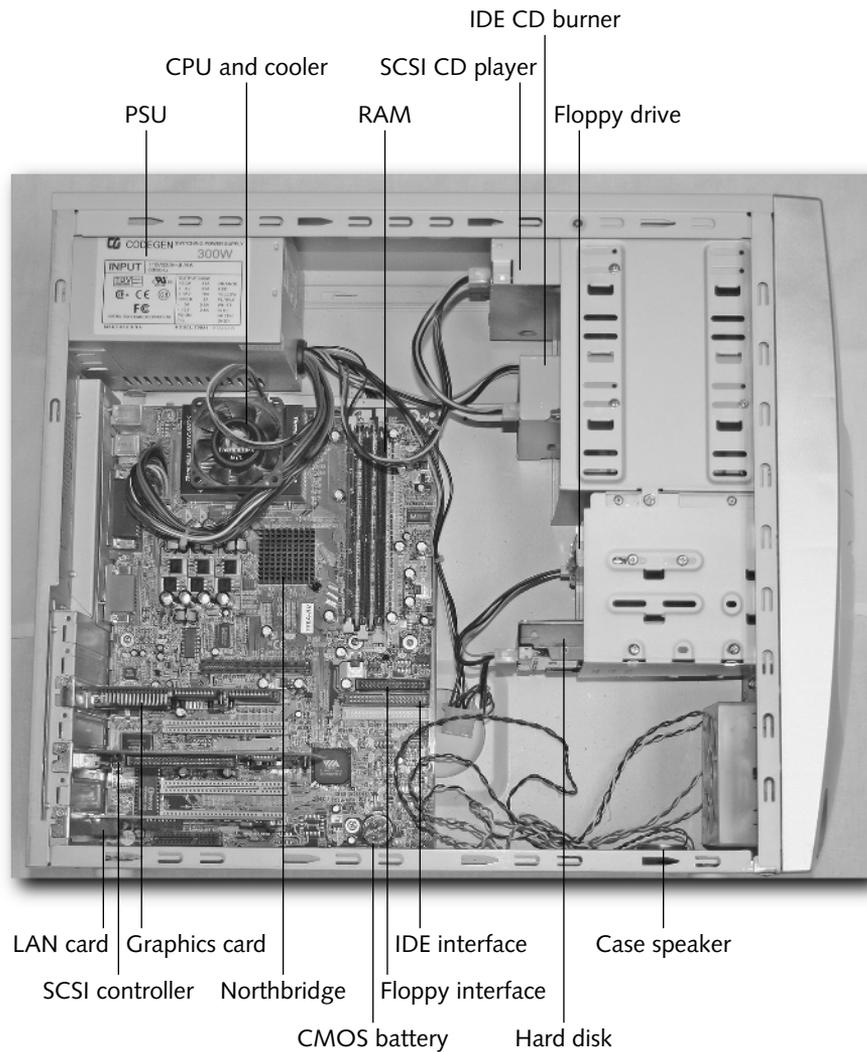
FIGURE 1-2: Once the ribbon cables are out of the way, you can see more of the PC's innards.

First Tour Stop: The Big Picture

Please take another look at Figure 1-2. Careful examination reveals the following:

- The power supply at the upper left, with typical red, yellow, and black wires in bundles that attach to the drives and the motherboard. Notice that the power supply is clearly rated at 300 watts at the upper right of its enclosure.

- The motherboard sits beneath the power supply and extends all the way down to the bottom of the case. A large black plastic fan assembly atop the CPU cooler covers the CPU, and three vertically aligned memory sockets appear to its right. Though you can't see one in this view, the power supply also has its own built-in fan.

- A whole series of connectors that service devices built into the motherboard appear in an integrated block at the upper left, immediately to the left of the CPU cooler. Here's where you'll find USB and DIN-9 connectors for keyboard, mouse, and other devices, as well as serial, parallel, and audio ports.

- The interface cards (and various empty card slots) appear in the lower half of the motherboard, on the left (this lets connectors fit into standard spacers at the back of the case so as to accommodate external cables where needed). There are three interface cards emplaced. From top to bottom they are: a graphics card, a SCSI controller, and a network interface card.

- From the upper-right corner to down below the middle of the case, you see two sets of drive bays. On top, there's room for up to four standard 5.25" devices (of which two slots are occupied with CD drives: player above, burner below; the other two slots are empty). Underneath, there's room for two 3.5" devices: the floppy drive is above, a hard disk below (no empty 3.5" slots, in other words).

- The drive cables connect into rectangular pin blocks at the motherboard's right center, just to the right of the topmost interface card (SCSI controller). The shorter block on top is where the floppy drive's cable plugs in; the two longer blocks beneath it are IDE (integrated drive electronics) connectors. All three of these sockets can support one or two devices, so although this PC uses only one device for each one, the number of devices could double were that necessary or desirable. The ribbon cable for the SCSI CD-ROM player at the very top of the 5.25" drive bay attaches to the SCSI controller card at the lower left, as shown in Figure 1-1.

- The various fine wires at the lower right hook up to controls on the front of the case, including an on-off switch and the reset button, but also to a small loudspeaker mounted in the case at the very bottom beneath the (empty) fan housing.

Notice that all items mentioned at the outset of this chapter in the first recitation of PC components are shown in Figure 1-2, or their presence is indicated by ancillary equipment (as with the CPU cooler, which indicates the presence of a CPU at the same time it hides the CPU from direct view). All of them are also mentioned in one way or another in the preceding list that calls out various elements of the figure. The sections that follow take a closer look at these various elements and give you a chance to understand what role they play in a PC and its operation.

The Case Is Home Base

A recurring question on quiz shows is "What's the largest organ in the human body?" The answer to that question is "the skin," and that's both as obvious and hard to notice as the case is for a PC. Nevertheless, as the outer shell that protects a PC from dirt and jostling, and its users from the sharp points and shock hazards that PC innards present, the case is a key component

in any computer. If you look very carefully at Figure 1-2 at the area above the motherboard connector block, you'll see a series of small holes drilled into the plastic housing. That's one of two air vents on the case depicted. The other is at the lower right, where the empty fan housing is situated. In a hotter running PC, it would be a good idea to install a fan there as well. This particular PC contains few enough components that extra cooling isn't necessary.

As we cleaned this case to photograph it, the vent near the CPU cooler was covered in dust, indicating strong air intake (and the CPU cooler's fan is the obvious culprit here). Proper ventilation and sufficient room for a PC's components are the only inarguable must-haves in a PC case. But as you learn in the next chapter (which deals with HTPC requirements) and in Chapter 3 (which covers cases and power supplies), aesthetics, form, materials, extras, and layout can all be important when choosing the right case for any PC — but especially for an HTPC.

Power Makes the PC Go

Many but not all PC cases are sold with power supplies already installed. The power supply is a key PC component because it converts alternating current from the wall socket into direct current (using a transformer) and also delivers various voltage levels to PC devices (common voltage levels inside PCs include 3.3 V, 5 V, and 12 V, among others).

A power supply must be able to provide sufficient power to handle all devices at peak load. Each device on a PC is rated in terms of peak wattage. What's most desirable is that the sum of all device peaks be less than the peak wattage rating for the power supply. What's absolutely mandatory for the PC to work properly is that the sum of all device peaks be no more than the peak wattage rating for the power supply. On the PC depicted in Figures 1-1 and 1-2, total peak wattage for all devices is about 180 watts, or 40 percent lower than the peak wattage for the power supply. That's a comfortable and workable margin and leaves room to add one or two more devices without cause for concern.

When a system vendor or aftermarket system builder puts a PC together, they'll routinely create a power budget for all of the devices that the unit includes (and if there are empty bays or unused interface card or memory sockets, devices that the unit *could* include as well). That's how they make sure the power supply is adequate for the PC they sell. If you build your own PC, this kind of planning becomes your responsibility. That said, you'll find plenty of information in this book to help you plan adequately and to help you stay within your power budget through add-ons and upgrades.

The CPU Does All the Real Computing

A PC's central processing unit, or CPU, is where actual computation takes place in a PC. Though there are plenty of smart chips elsewhere on the motherboard, on interface cards, and even built into storage devices, when you run a program on your PC, it loads and executes on the CPU. That explains why CPU speed and power ratings are so important, and why those who build computers often spend hundreds of dollars on such chips. It also explains why they're willing to spend between $50 and $100 for the best available chip coolers to keep CPUs working at optimal performance levels. The laws of physics and solid state devices pretty much

decree that the faster and more powerful a CPU, the more heat it will produce — and hence, the more important cooling becomes.

Beneath the fan and the Thermaltake cooler you can see in Figures 1-1 and 1-2 (it's hard to miss) you'll find a 32-bit Socket A Athlon CPU that runs at 1 GHz. Those in the know can recognize a vintage 2002 CPU from this description, one that today is pretty much obsolete and more deserving of pity than respect. Windows XP Professional requires only a 300 MHz CPU or better, but even so this relative old-timer pokes along as compared to its more modern brethren.

CPU issues are raised again in the next chapter, when important trade-offs between quiet operation and performance are covered. They also provide a key focus in Chapter 5, which takes CPUs as its primary subject (and keeping them cool as a secondary subject).

Everything Lives in Storage

PCs come equipped with many and varied forms of storage. Even CPUs incorporate some relatively small amounts of storage where they keep upcoming data and instructions close at hand so they can grab and use them quickly, and as a place to store the results of current computations or operations. On a computer, storage may be organized into a hierarchy by speed and size, where items that persist over time reside primarily in bigger but much slower storage devices. While programs are executing or data is being processed, however, it tends to flow through smaller, faster elements in the hierarchy at extremely rapid rates (see Table 1-1).

Table 1-1   Elements in a Computer Storage Hierarchy

Speed/Size	Type/Name	Description
Fastest/ Smallest	CPU registers	Where instructions and data that the CPU will use next or is using now reside, and where immediate results of computation are deposited.
	CPU caches: L1 cache L2 cache	Storage space built onto the CPU chip. Pre-fetched instructions and read-ahead data stored for imminent use. Local data and operating context maintained here.
	RAM	Where programs that are running and data being used reside, sometimes in whole, often in part (other parts may be on disk, particularly large programs or data sets too big to fit into RAM).
	Disk	Where programs reside when not running, and where data, documents, and other items reside when not in use.
	Optical media	Where programs or data reside when not stored on disk, or as archived for protection, distribution, or playback (as with music CDs or movies on DVD).
Slowest/ Largest	Tape	Archival medium designed for backup, long-term storage, or to meet records retention requirements. Seldom, if ever, used on most PCs.

Drives also form their own subhierarchy within this larger hierarchy. Disk drives are faster than optical or floppy drives, so the former are used for active data storage, whereas the latter tend to be used for archiving, program or data distribution, and playback of large recorded works (such as music on CD or movies on DVD).

Storage essentially provides room for computers to work in at the smaller, faster end of the hierarchy and room for computers to store programs and data in at the bigger, slower end of the hierarchy. But nearly all elements in the hierarchy are important (the advent of very large, cheap disk and optical drives is slowly but surely pushing tape out of this picture) and hence nearly all of them get significant coverage in this book.

A typical home user Windows XP PC is perfectly adequate with 512MB to 1GB of RAM, 80 to 120GB of hard disk space, and a CD or DVD burner or player (note: if you buy a burner, you automatically get a player as well). In the next chaper, you'll learn more about how these requirements change in the face of large digital media collections on an HTPC. In Chapters 6, 7, and 8 you'll learn more about what that means for RAM, hard disks, and optical storage devices, respectively.

Everything Plugs Into the Motherboard

If the CPU is the brains of a PC (as the analogy so often goes) the motherboard is its Grand Central Station. Everything on its way into or out of the PC travels through the motherboard at some point or another. It's also where most devices ultimately attach and it provides the sockets or connections where RAM, interface cards, and the CPU all plug themselves in, as well as home to the connectors for user input devices such as a mouse and keyboard.

These days, more and more functions that used to require interface cards are built into motherboards. This doesn't mean you can't elect to use a higher quality, more capable interface card to perform some task or deliver a specific capability, but it certainly makes it cheaper and easier to use plain-vanilla built-in implementations where quality and performance may not be terribly important.

Three common examples of built-in functionality on modern motherboards include the following:

- **Audio:** What used to require installing a sound card is now part and parcel of most modern motherboards. Users with special audio requirements or who want the highest possible fidelity may still elect to disable onboard sound and install a high-end sound card instead.

- **Graphics:** Most motherboards include basic built-in graphics, on a level with what you'd get from a $40 PCI graphics card with 64MB of video RAM. That's not good enough for HTPC use, though it is adequate for people who don't play animated games, watch DVDs, or do other things on their PCs that require more graphics "oomph."

■ **Network access:** Most motherboards include one or more network interfaces these days; often this means two 10/100 Ethernet links, or a 10/100 and Gigabit Ethernet, or some combination of wired and wireless Ethernet connections. Except for servers or other PCs that require lots of network links or extremely high performance, hardly anybody installs network interfaces in PCs any more.

For typical desktop use at home or in the office, PC buyers are happy to save money and use built-in capabilities instead of buying additional interface cards. For a Home Theater PC, this certainly applies to networking (if the right kind is available), but it may not apply to sound, depending on how the HTPC will be used. Graphics and video cards are covered in Chapter 9, sound cards in Chapter 10, and network connections in Chapter 13.

User Input: Keyboard, Mouse, and . . .

For most home and office desktop users, a keyboard and a mouse are the only user input devices needed. Today, an emerging question for how these devices connect to the PC then becomes "Stay wired or go wireless?" But because the built-in connectors required for a Windows mouse and keyboard are built into all PCs, only the type, look and feel, and cost of these devices typically come into play. Gamers may also add a game controller to their user input device collection, but that's usually about it.

This changes dramatically when you're considering an HTPC, as you learn in the next chapter. That Chapter 14 devotes itself in part to infrared remote controls should tell you something about what's involved in that change!

Computer Output: Monitor, Printer, and . . .

For all computer users some kind of display is essential to tell them what their computer is doing and also what they're doing with their computers (as the characters popping up on my own monitor as I type this and every sentence for this book continually remind me). For most home and office desktop users a 15- or 17-inch cathode-ray tube (CRT) or liquid crystal display (LCD) is adequate; power users may up the size of the display to 19 inches or beyond. Some gonzo types may even elect to use multiple monitors so they can multitask more effectively, or simply because modern Windows versions let them do so.

Many computer users also have at least one printer available to them, often attached using the universal serial bus (USB) or perhaps a parallel printer port (although this is less common nowadays, even modern PCs still include parallel ports in the battery of standard connectors). Whether that printer is a laser or an inkjet or prints in color or monochrome, most offices and households keep at least one printer around.

Things change on an HTPC, as you learn in the next chapter, both in terms of displays (think TV and home theater) and in the lesser likelihood that a printer is attached to such a PC (although there may be one attached to another PC somewhere else on the network).

Cool Runnings

No PC will work without some cooling and ventilation. Even the relatively old model photographed for Figures 1-1 and 1-2 requires airflow of 50 cubic feet per minute (cfm) over its poky CPU. More modern CPUs require even more airflow, as do the bigger power supplies necessary to feed them the electricity they consume. The same is true for more powerful graphics cards, which now include fans to cool their fast and powerful GPUs (graphics processing units) as a matter of course.

In general, the more stuff you have inside your PC, the more important cooling becomes. It's not unthinkable that added ventilation would be needed in the PC depicted earlier in this chapter were it to house an additional hard disk or two, more memory, and a high-end graphics card, all of which it could accommodate with relative ease.

Cooling deserves even more attention in HTPCs than in ordinary desktops for all kinds of reasons. That's why the topic of cooling is revisited in the next chapter, and covered in Chapters 3 (cases and power supplies), 5 (CPUs), and 9 (graphics cards) as well.

Putting All the PC's Pieces to Work

In the conclusion to this introductory chapter, we want to follow what happens to the various parts of a PC as you turn the power on, and the machine starts up. This will allow you to understand how and when the various parts of the PC come into play. It will also provide an opportunity to introduce other parts of the system, including some items on the motherboard to which you've not yet been introduced. So buckle up, don your hardhat and safety goggles, and let's walk through what happens during initial startup on a PC.

Step 1: Turn On the Power

Many modern PCs have two power switches: one on the front and one on the back. Either way, when you first switch on the power, the power supply comes up and begins to feed voltage into the rest of the system — in fact, as you look at the insides of your PC you can see exactly where that power goes by following the wire bundles from the power supply to their destinations. In the machine depicted in Figures 1-1 and 1-2, power goes to four places: the motherboard, the CD-ROM drive, the floppy drive, and the hard disk. The interface cards draw power from the motherboard, which delivers power through its onboard circuitry to the interface card sockets. Likewise, the CPU and RAM also draw power from the motherboard, as do all other devices built into or mounted onto the motherboard.

Tip If your PC has two power switches, it's for a good reason. The one on the back is usually built right into the power supply, whereas the one on the front is controlled through the motherboard. In that case, the switch on the front lets you turn the machine on when you want. But after Windows starts, such PCs usually turn control of that switch over to the motherboard, which in

turn grants control to Windows. That explains how and why some machines can power themselves off when you perform a Windows shutdown. The switch on the back lets you turn the PC off even when it's hung or crashed because it basically controls access to A/C power directly. Thus, it's smart to think of (and use) the switch on the back only in cases of dire emergency, when you're sure you'll need to reboot in any case.

Step 2: Power-On Self-Test Routines

You've probably noticed that when you turn your PC on, several sequences of character text parade across the screen before the actual operating system boot-up begins. What's going on is that all those interface cards and the motherboard that come equipped with a basic input/output system, or BIOS, run a set of diagnostic routines to make sure they're working okay and that all parts are functional and accessible. These are known as Power-On Self-Test or POST routines and serve to prevent a PC from hurting itself (or its data) by trying to operate when the system doesn't check out properly. If it helps you to think of POST routines as a mandatory pre–boot-up check, feel free to look at them that way.

During the POST phase the little speaker you saw attached to motherboard and the bottom right of the case in Figures 1-1 and 1-2 really comes into its own. Though it can be forced to play real audio, its primary job is to make "beep codes" audible. Different BIOSes have different beep codes, so if you'd like to know more about how to interpret them, check the Cross Reference later in this section. Here and now, it suffices to say that when something goes wrong during the POST sequence, beep codes permit the PC to inform you about its status and provide clues as to the source of the problem(s) involved.

A more detailed look at the POST sequence runs as follows:

1. Test the power supply to make sure it's turned on and has released its reset signal (indicates proper operation: no beep means power supply OK).

2. CPU exits its reset status mode and confirms that it can execute instructions (no beep means CPU OK).

3. BIOS performs self-test to make sure it's readable and that its checksum is valid (calculated value matches stored value, indicating no corruption or damage; no beep means BIOS OK).

4. A special form of computer memory called CMOS performs a self-test to make sure it's readable and that its checksum is also valid (no beep means CMOS OK). (CMOS stands for complementary metal-oxide semiconductor, but what's important about this battery-powered memory is that it contains the current and correct configuration information that the PC needs to identify all installed devices, interface cards, and so forth.) Note: You can see the CMOS battery in Figure 1-2 at the bottom right of the motherboard; it's the circular metal disk that looks like a coin. Its job is to provide continuous power to the CMOS even when the PC is shut down, to keep current configuration data available for the next boot-up.

5. CPU performs a memory check on the motherboard, and checks its memory controller, the memory bus, and all installed memory modules (no beep means memory hardware checks out OK).

6. The first 64K of memory is checked for read/write capability; if it checks out OK, it will have the remaining POST code copied to it, and will run from that memory afterward (no beep means memory read/write check is OK).

7. The I/O bus and controller are checked to make sure they're accessible and working properly. (This is what the computer uses to communicate with other devices in the PC, including interface cards, storage devices, and so forth; no beep means I/O hardware check is OK.)

8. The I/O bus must be able to read/write from the video subsystem and be able to read video RAM (this is when the BIOS on a graphic card will perform its own POST, if applicable) and when actual screen output during the boot process can begin (no beep means video subsystem checks out OK).

Only if your PC reports OK status on all checks mentioned here will it actually begin the boot process. But first, if other interface cards have BIOSes on board, their POST routines must also complete successfully. Hopefully, it's also obvious that if you hear no beeps but your PC does nothing that something is wrong with delivery of power to the motherboard, making some kind of power supply problem the most likely culprit.
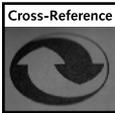
Cross-Reference Lots of potential sources about POST beep codes are available online. One especially good one is at www.computerhope.com/beep.htm. You'll find a complete explanation of the POST process there, plus pointers to beep codes for major varieties of PC BIOS (and the Macintosh).

Step 3: The Boot Load Process

When the POST completes succesfully on any Intel *x*86-compatible computer (which includes pretty much anything that identifies itself as a PC nowadays), the CPU reads the CMOS to identify a boot drive. The first sector on this drive (cylinder 0, head 0, sector 1) includes two very special items of information:

- A small but very special program called a *boot loader*, which seeks the bootable partition on the boot drive and loads the first sector of that partition into memory to continue the boot process

- The *partition table* for the boot drive, which indicates how the drive is divided up into one or more independent group of sectors called partitions

Together, these items comprise the first sector of the boot drive, which is often called the Master Boot Record, or MBR. It's one of the most important keys to a successful system boot on a PC.

When the boot loader executes, it checks the partition table to look for an entry with the "bootable" or "active" flag set to identify where the next program to control the booting process is located. The boot loader reads the first sector of the boot partition into memory (which is known as the Boot Sector, not to be confused with the MBR) and then turns control over to the program that begins there.

The program in the Boot Sector looks for the operating system kernel, loads it into memory, and starts it running. This is the point at which the real software boot process begins, and the boot loader ceases operation. On modern Windows operating systems (Windows NT Workstation, Windows 2000 or XP Professional, Windows XP Home, and all related Server versions, plus Windows 2003 Server) a program named NTLDR takes over for the operating system boot.

Step 4: (Windows) Operating System Boot-Up

NTLDR reads a special data file called boot.ini. If multiple operating systems are present on the PC, it offers a menu that allows users to select the operating system they'd like to boot (but defaults to a specific item after a timeout period expires). It's also possible to force Windows to boot into one of various modes at this point (Safe mode, Safe mode with networking, Last Known Good Configuration, and so on) to override normal boot behavior.

After those selections are made or a timeout expires, operating system boot-up begins in earnest. Windows then begins to load and execute operating system kernel files, which make up the core of the operating system. Next, NTLDR causes a program named NTDETECT.COM to execute. It probes the system completely to build a list of all installed hardware components found. After this, NTLDR loads the CPU-specific portion of the operating system kernel along with device drivers for all devices marked as boot devices. After these processes complete successfully, NTLDR turns control over to the primary Windows kernel program NTOSKRNL.EXE, which in turn completes loading basic services needed for minimal operation. At this point, Windows switches from character mode (only text characters show on screen, as in the command window) to graphics mode and displays a graphical screen with a status bar to show load progress.

When the final operating system load completes, Windows displays a login window. Only after a user logs in to the system successfully is Windows boot-up considered complete. After that, the PC is yours to do whatever you want it to, subject only to the limits of your imagination, the Windows operating system, and the programs at your disposal.

Cross-Reference The best and most comprehensive description of the Windows XP boot process resides on the dot-netjunkies Web site at http://dotnetjunkies.com/WebLog/unknownreference/articles/12284.aspx. It's cited as having been copied from a course handout at Quinebaug Valley Community College in Connecticut, but because the original is no longer available, this copy will have to suffice. If you want to know more you should definitely read this run-through.

Wrapping Up

Although Home Theater PCs and more ordinary PCs — like the ones you've read about in this chapter — have a lot in common, numerous and important differences exist between an ordinary home or office desktop and a Home Theater PC. In this chapter, you learned what kinds of parts and components the two types of PCs share; in the next chapter, you learn how the components in an HTPC can differ from their more ordinary counterparts, as well as what kinds of parts an HTPC is likely to incorporate that an ordinary PC might not.