Chapter 1

Mastering the Motherboard

IN THIS CHAPTER

The *motherboard*, also known as the system board, main board, or planar board, is a large printed circuit board that includes or provides an interconnect to most of the essential components of the PC:

- Microprocessor (see Chapter 2)
- Expansion bus (see Chapter 2)
- Chipset (see Chapter 3)
- Memory sockets and RAM modules (see Chapter 6)
- Cache memory (see Chapter 7)
- Integrated Drive Electronics (IDE), Enhanced IDE (EIDE), or Small Computer System Interface (SCSI) controllers (see Chapter 11)
- Mouse and keyboard connectors (see Part VI)
- Parallel and serial ports (see Parts V and VI)

As this list shows, there is more to working with a motherboard than I can cover in just this one chapter. Motherboards are the glue that binds the PC's components together. I can safely say that virtually every component, internal or peripheral, that's installed on or connected to a PC has some connection (no pun intended!) to the motherboard.

Motherboard manufacturers attempt to differentiate their products and increase their value by integrating a varying combination of devices and controllers into their boards. The upside of including more on the motherboard is a wider compatibility to a wider range of systems and potentially a deeper list of features. The downside is that unless you're very careful when selecting a new motherboard, you might not get the combination or quality of processor or peripheral support that you intended.

Although I assume that you have some background in working with PCs and their components, I want to be sure that you and I are on the same page when it comes to motherboards. In the following sections, I cover what is likely some fundamental material. However, when it comes to motherboards, I'd rather be safe than sorry.

Differentiating Motherboard Designs

If PCs had only a single type and style of motherboards, the task of working with them would be greatly simplified. However, even though most of today's PCs use the ATX (see "Creating the new standard: The ATX" later in this chapter), you can expect to encounter different motherboard form factors on the job. If, after all else has failed, you decide to replace a PC's motherboard, you must match the form factor of the motherboard to the case and its mountings.

Laying out the mainboard

Essentially, the two basic design approaches to PC motherboards are the mainboard (or the true mother-of-all-boards) design and the backplane design.

A *mainboard* design, like the one in Figure 1-1, incorporates the PC's primary system components on a single circuit board. This type of motherboard contains most of the circuitry of a PC and acts as the conduit through which all the PC's operations flow.

On a typical motherboard (see Figure 1-1), you will find the microprocessor, the Basic Input/Output System (BIOS) ROM, the chipset, RAM, expansion cards, perhaps some serial and parallel ports, disk controllers, connectors for the mouse and the keyboard, and possibly a few other components as well.

TIP

Mainboard motherboard designs, although somewhat standard, do vary in the inclusion and placement of system components and interfaces. Before you charge down the road to diagnose, troubleshoot, or replace any motherboard, be very sure that you can at least identify the components indicated in Figure 1-1 on your PC's mainboard.

Connecting to the backplane

There are actually two types of backplane mainboards: passive and active. A *passive backplane mainboard* is only a receiver card with open slots into which a processor card (which contains a central processing unit [CPU] and its support chips) and input/output (I/O) cards that provide bus and device interfaces are plugged. These add-in cards are referred to as *daughterboards*.

The backplane interconnects the system components through a bus structure and provides some basic data buffering services. The backplane design is popular with server-type computers because it can be quickly upgraded or repaired. The backplane design provides the advantage of getting a server back online with only the replacement of a single slotted card, instead of replacing an entire mainboard!

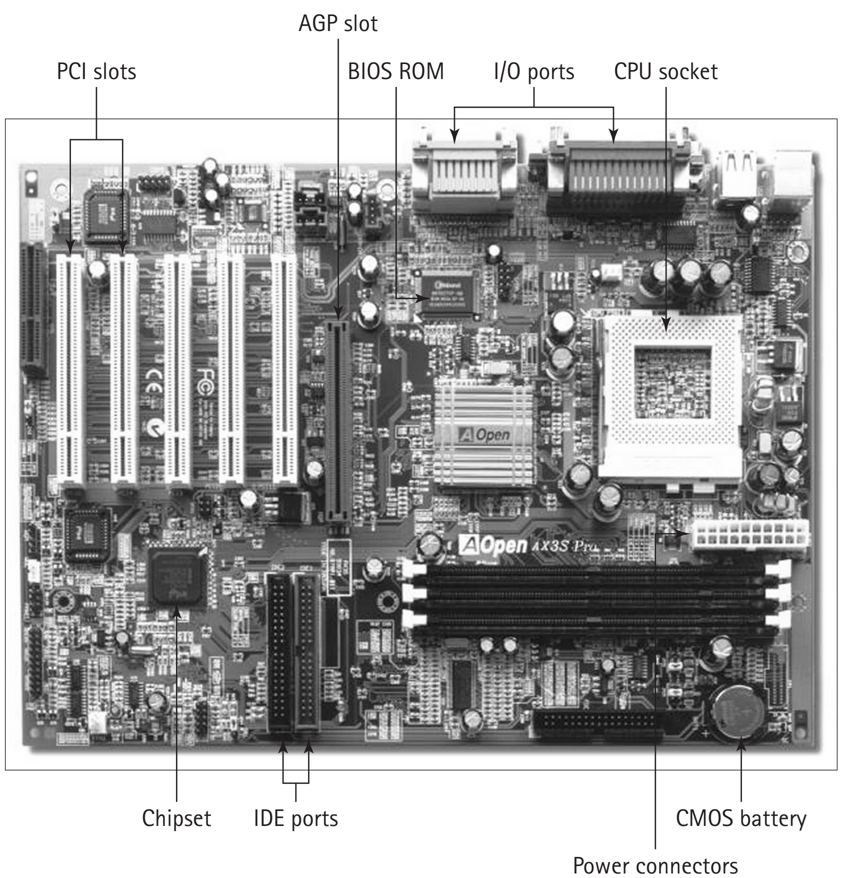

Figure 1-1: The essential (and most common) mainboard components.

Photo courtesy of AOpen, Inc.

An *active backplane* design, also called an *intelligent* backplane, adds some CPU or controller-driven circuitry to the backplane board, which can speed up the processing speed of the system. Even on an active backplane, the CPU is on its own card to provide for easy replacement.

The utility of the backplane design is being challenged by newer motherboards that incorporate the slot-style mountings of Pentium-class processors. The advantage of the active backplane is that the processor can be easily accessed and replaced, but the slot-style motherboards also offer this same advantage.

NOTE

For purposes of clarity and because they are the most commonly used in PCs, when I refer to a motherboard, I am referring to the mainboard design. When referring to a backplane design, I will specifically say so.

Factoring in the motherboard form

When the original IBM PC was introduced in 1981, it had a simple motherboard designed to hold an 8-bit processor (the Intel 8088), five expansion cards, a keyboard connector, 64–256K RAM (from individual memory chips mounted on the motherboard), a chipset, BIOS ROM, and a cassette tape I/O adapter for permanent storage. The PC was designed to be a desktop computer, and its system case layout dictated the first of what are now called motherboard form factors. Simply, a *form factor* defines a motherboard's size, shape, and how it is mounted to the case. However, form factors have been extended over time to include the system case, the placement and size of the power supply, the power requirements of the system, external connector placements and specifications, and case airflow and cooling guidelines.

Table 1-1 lists the common form factors that have been and are being used in PCs.

TABLE 1-1 MOTHERBOARD FORM FACTORS

Style	Width (inches)	Length (inches)	Design	Case Type
IBM PC	8.5	13	Mainboard	IBM PC
IBM PC XT	8.5	13	Mainboard	IBM PC XT
IBM PC AT	12	11–13	Mainboard	Desktop or tower
Baby AT	8.5	10–13	Mainboard	Desktop or tower
LPX	9	11–13	Backplane	Desktop
Micro-AT	8.5	8.5	Mainboard	Desktop or tower
ATX	12	9.6	Mainboard	Desktop or tower
Mini-ATX	11.2	8.2	Mainboard	Desktop
Mini-LPX	8–9	10–11	Backplane	Desktop
Micro-ATX	9.6	9.6	Mainboard	Desktop
NLX	8–9	10–13.6	Backplane	Desktop
Flex-ATX	9	7.5	Mainboard	Desktop or tower

SETTING THE STANDARD: THE IBM AT

When IBM released its first 16-bit computer, the PC AT, the circuitry added to the motherboard of its predecessor (the PC XT) increased the size of its motherboard and case to 12 inches wide by 13 inches deep. During this time, many clone (non-IBM) manufacturers also began releasing XT-compatible motherboards, which included keyboard connectors, expansion slots, and mounting holes to fit into AT cases. The AT's size, shape, and mounting placements became the first motherboard form factor standard, a standard that has essentially continued through today. Nearly all present-day motherboard form factors are a derivative of the early AT standard.

BRINGING UP THE BABY AT

It wasn't long before clone manufacturers began releasing their own 16-bit PCs and motherboards with higher integration in the supporting chipsets that allowed their motherboard to take a smaller form. This smaller form was called the Baby AT, shown in Figure 1-2, a more compact motherboard that was compatible with AT cases. The Baby AT became very popular because of its size and flexibility and joined the AT motherboard as a de facto standard.

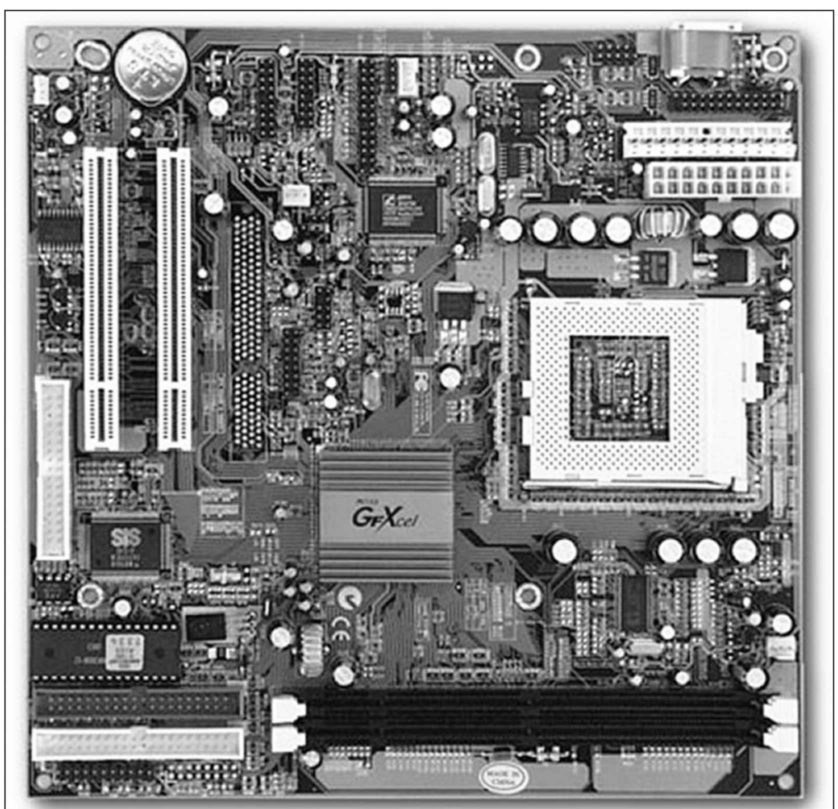

Figure 1-2: A Baby AT motherboard.

TAKING THE STANDARD ONE STEP SMALLER

Most of the PC cases manufactured between 1984 and 1996 were made to house a Baby AT motherboard. However, with still higher integration and further miniaturization of the processor, chipset, and other support components, it became possible to produce an even smaller version of the AT form factor. The Micro-AT motherboard (see Figure 1-3), which is nearly half the size of the Baby AT mainboard, is also compatible with the motherboard mountings in AT and Baby AT cases.

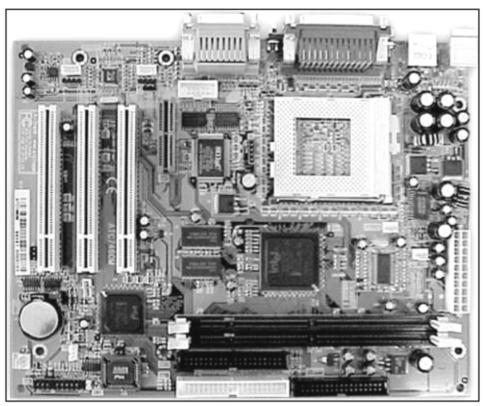

Figure 1-3: A Micro-AT motherboard.

WORKING WITH A LOW PROFILE: LPX AND MINI-LPX

Originally created by Western Digital to provide slimline cases to the consumer market, the LPX and Mini-LPX form factors have produced many variations. Actually, the LPX and Mini-LPX specifications are more of a general motherboard category than a specific form factor with a standard specification, like that of the AT and its derivatives. Manufacturers such as Packard Bell and Compaq used their own proprietary configurations for LPX motherboards in their PCs. Unfortunately, this practice guarantees that their customers cannot typically upgrade their computers without swapping the motherboard.

TIP One quick note on the meaning of form factor names: There aren't any. If the form factor names ever had meanings, they are lost to time.

The LPX style is characterized by a *riser card* that has plugs into a slot in the middle of the motherboard. LPX riser cards typically have two or three expansion slot sockets on them, but the number of sockets available depends on the size of the riser card and whether it has expansion slots on both sides. The motherboard is mounted flat in the LPX case, and the riser card is inserted perpendicularly. This arrangement allows the expansion cards mounted in the riser card to be placed parallel to the motherboard, which allows for a much slimmer case design.

CREATING THE NEW STANDARD: THE ATX

In 1995, Intel released its “next best thing” with the ATX form factor. The ATX is an improvement over preceding form factors because of its published and continuously maintained standard, which guarantees compatibility among all ATX motherboards and cases.

The ATX form factor, shown in Figure 1-4, is based on the Baby AT but is rotated 90 degrees and incorporates unique mounting locations and power supply connections. Unlike many of the previous motherboard form factors, ATX locates its I/O connections so that they’re accessible through the back of an ATX case.

The ATX form factor specification incorporates solutions to the performance issues associated with Baby AT and LPX forms. ATX places the CPU and RAM slots out of the way of expansion cards and near the power supply fan, which improves the airflow over the CPU and RAM chips.

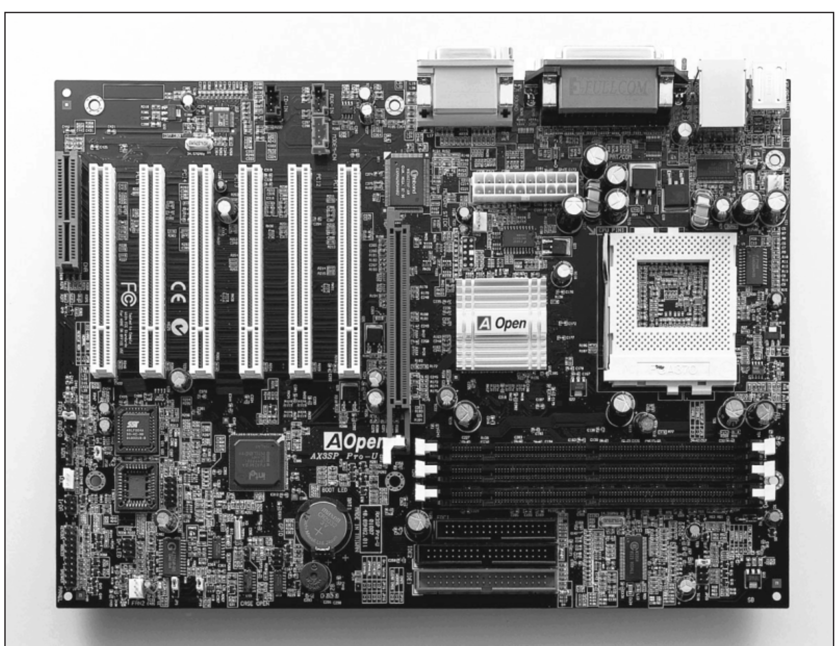

Figure 1-4: An ATX motherboard.

Photo courtesy of AOpen, Inc.

Changing the Way the Wind Blows

The original specification for the ATX form pulled air into the system case and inward through the power supply, over the CPU, and out the case vents. The idea was to supposedly eliminate the need for separate CPU fans. The downside was that dust and other airborne particles entered the case and settled inside, which required more preventive maintenance. The lesson learned is that air inflow is less efficient than air outflow; and instead of eliminating fans, many still required additional fans to cool the CPU properly.

More recent ATX versions push the airflow out so that the power supply fan is now venting the case. However, if this still doesn't solve a particular cooling problem, ATX cases typically allow for installing additional case fans. PCs with 3-D video accelerators and other high-heat producing cards or those with multiple hard disk drives might require additional case fans to be installed.

The ATX specification also defines the Mini-ATX sub-specification, which has a board size of 11.2 inches by 8.2 inches. Other sub-specifications of the ATX form factor that you might encounter are the Micro-ATX and the Flex-ATX.

SLIMMING DOWN WITH NLX

NLX is a newer format and standardized low-profile motherboard form factor. It is designed to support a number of current and emerging microprocessor technologies along with many newer developments, including support for Accelerated Graphics Port (AGP) video adapters and tall memory modules (such as dual inline memory modules, or DIMMs). The NLX form provides more flexibility for the system-level design and for easy removal and replacement of the motherboard, allegedly without tools. The NLX motherboard measures about 8 inches by 13.6 inches and uses a plug-in riser board for its expansion bus support. The riser board attaches to the edge of the mainboard, as shown in Figure 1-5.

Three primary influences were behind the development of the NLX standard: processor and system cooling requirements, the number of connectors needed by multimedia hardware, and a further reduction of interior cable clutter. The size and thermal characteristics of newer microprocessors, especially those configured into multiple processor sets, along with the addition of high-performance (and high-heat) graphics adaptors, forced a new look at the airflow in slimline cases. As multimedia systems became more common, the need for more connectors from the motherboard to the outside world also increased. As more internal adapters and controllers were added to the motherboard, the interior of the system case was cluttered with cabling, which impeded repair or upgrade activities.

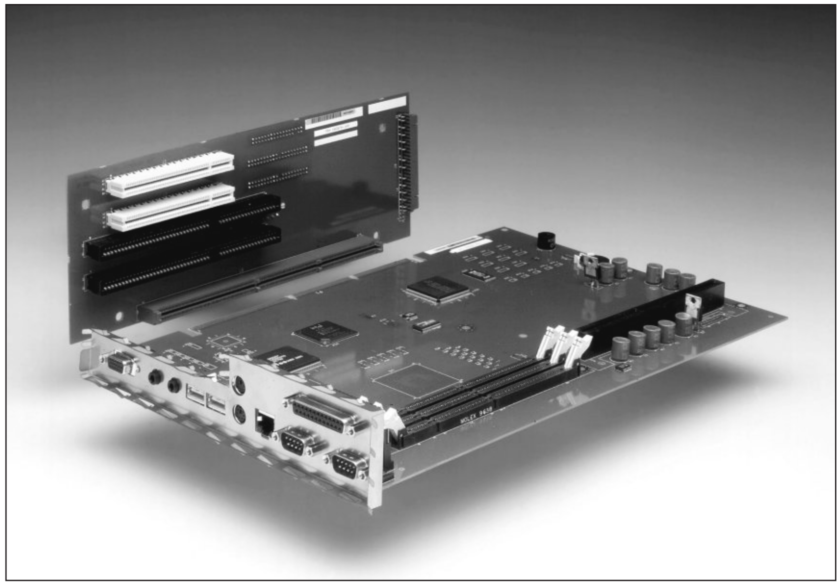

Figure 1-5: The Intel NLX form factor motherboard.

Photo courtesy of Intel Corporation.

Working with the Motherboard

In the vast majority of situations, the problem that you're trying to track down on a PC is not likely to be specifically caused by the motherboard itself. Actually, if the problem is a bad motherboard (not a common event), your only course of action is to replace it. However, sometimes maybe — just maybe — you can check out the motherboard and isolate the problem.

TIP

If you do remove an allegedly bad motherboard, you really should test it in a test bed PC before throwing it out. It could actually still be good. And even if a new motherboard fixed its PC's problems, the solution might be more coincidental than anything else.

Using the right tools

The following is a list of the tools that you should have in your toolkit for removing or installing a motherboard:

- *Dental mirror:* A dental mirror-like tool can be purchased from most tool suppliers, so you don't have to beg your dentist for one. A dental mirror is perfect for seeing around corners in an assembled system, like when you need to see a detail being blocked by a disk drive cage. It can also come in handy when you're trying to attach a connector or a power cord to the back of a PC.

- *Digital multimeter:* If the motherboard is running strangely, some of the first places to look are its power connections. A multimeter or a digital voltmeter is a good tool to have for testing the continuity of power cables and the power supply's output.
- *Electrostatic discharge (ESD) mat and wrist (or ankle) strap:* If you don't have access to an ESD mat on which you can set any static-sensitive parts that you remove (such as expansion cards or a motherboard), by all means wear an ESD wrist or ankle strap and have plenty of anti-static bags available. Even with an ESD strap in use, never stack unprotected cards or parts on top of one another and always ground yourself to the system case's metal as often as possible.
- *Penlight or mini flex-type flashlight:* Having some light to help you see small identifying marks on the motherboard, its chips, and expansion cards can prevent a serious error and save the time removing and reinserting the wrong parts. You might want to consider spare batteries as well.
- *Screwdrivers:* Your toolkit should include a collection of screwdrivers that has at least one of each of the following screwdrivers: a standard (slot), a mini-head Phillips (cross-head recess), a standard-size Phillips (magnetic tip optional), and a Torx. Magnetic screwdrivers can be potentially dangerous if used incorrectly, such as gouging the motherboard or blowing an integrated circuit (IC) chip. However, they can come in handy for retrieving a dropped screw or for starting a screw in an inaccessible place.
- *Software system testing utilities:* As long as you are able to boot into some operating system, a set of diagnostic utilities (like Norton Utilities) can be among the best tools in your kit. Use these software aids to diagnose a number of suspected motherboard or system performance problems, such as system slow-downs and inexplicable crashes.
- *Your eyes, ears, and nose:* Your senses are among your best tools. As corny as that might sound, your senses are probably the tools most often used when you first begin your troubleshooting.

Troubleshooting the motherboard

Before you do anything else, you must remove enough of the case cover so that you can see the CPU and the BIOS ROM. Then get out your penlight and your notebook and pen or pencil. As you move through the next few steps, write down every bit of information that you identify.

1. Identify the processor's class and model.

   What kind of processor is in use? For example, is it an AMD Athlon or an Intel Pentium II or III? What type of mount is in use?

2. Identify the BIOS manufacturer and its revision level.

   Make a note of the Basic Input/Output System (BIOS) in use: for example, a Phoenix BIOS I4HS10 rev 4.05.10. This information can be obtained during the boot sequence (if you're fast!) or from a label on the BIOS ROM chip itself. If the motherboard doesn't have a model number printed on it, motherboard manufacturers commonly have custom BIOS versions for each chipset and motherboard combination, so a motherboard's model number can often be derived from the BIOS serial number and vice versa. Check the BIOS manufacturer's Web site for details. Some sites even offer search tools specifically for this sort of look-up.

3. Identify motherboard manufacturer and model.

   Near an edge of the motherboard, you should find a block of printed information that identifies the manufacturer, the model number, and possibly a revision level. This information is typically silk-screened right on the board.

4. Identify the bus type.

   Which expansion buses are supported on the motherboard, or are any riser boards in use?

Identifying motherboard problems

Three general types of failures are directly related to the motherboard. Failures relating to the motherboard are often disguised as component failures during the boot sequence. (See Chapter 5 for more information on the system boot process.) Motherboard-related failures are typically identified during the Power-On Self-Test (POST) process by a BIOS beep code and any related messages. I've named the three primary boot sequence failure modes: no beep-no boot, beep-no boot, and beep-boot-bam.

To begin the identification process, power on the PC, listen and look, and then go to the section below that most approximates what you think you heard or saw.

NO BEEP-NO BOOT

The PC's power is on, you can see lights on the front panel, but as near as you can tell, the POST process did not run.

1. Check the main power cord, especially where it connects to the back of the PC, to make sure that it's fully pushed into the connector or receptacle.

   Inspect the power cord for cuts or crimps that might have damaged the inner wires. Inspect the plug head and the female connector of the cord for corrosion or metal damage. Take a look at the connector on the back of the PC to make sure that the prongs aren't bent over and not connecting properly.

2. Check the power source outlet for proper voltage with a multimeter or digital voltage meter (DVM).

   You might find it easier to try plugging the PC into a different outlet (not on the same source). If it works on a different outlet, the problem was the source. If the PC is plugged into a surge suppressing plug strip, the plug strip's varistor could've been blown out by an electrical surge. On those plug strips that have a fuse or circuit breaker, try resetting it.

3. Check the power supply's fan to see whether it's turning.

   If it's not turning, the problem could be in the power supply, and you need to troubleshoot it. See Chapter 9 for information on troubleshooting the power supply.

4. Check the motherboard's power connection.

   If the power supply fan is spinning but nothing else is happening, the power to the motherboard could be faulty. For example, you might have a +12 volts (v) source but no +5v or +3.3v supplies. Possibly the power-good line from the power supply to the motherboard is being set on for some reason. The processes used to diagnose these conditions are covered in Chapter 9.

5. Verify that the power connectors from the power supply are firmly seated and in the correct position.

   Check to make sure that the power connector to the motherboard from the power supply is firmly seated. The type of connector or connectors in use varies with the motherboard's form factor. AT and Baby AT power supplies have two 6-wire connectors that must be connected just so, and an ATX (or any of its derivatives) typically has a single 20-wire connector. See Chapter 9 for more information on the motherboard's power connection.

   The power connectors on an AT or Baby AT motherboard, usually labeled as P8 and P9, attach to the motherboard side-by-side. The trick to making sure that you have them in the right positions is to have all four of the black wires, or ground wires (two on each plug), placed together in the middle. However, be very cautious when connecting the power cable to these connectors; if the orientation of the connectors is wrong, it could damage the motherboard.

   The power connection on ATX or later form factors is keyed with a prong, lip, or finger that prevents it from being connected incorrectly.

6. Confirm that the motherboard's voltage setting jumpers are correctly positioned for the PC's motherboard and CPU combination.

   See the motherboard's documentation for the proper settings of these jumpers.

7. Check for a mismounted or missing processor.

   If the processor has been installed very recently, check how well it's seated in its mounting. Under the heading of *It Could Never Happen:* If the PC is in a public area, such as a laboratory, student lab, library, or another open and unsecured location, there could be a missing processor, memory, or expansion card. Unfortunately, theft is common on PCs to which there is public access.

8. Look for smoke and smell for burnt wire smells.

   A running joke among PC technicians is that the smoke is the magic that makes all electronic and electrical parts work. If the smoke gets out, the PC stops working. Examine the board, chips, and trace pathways for scorch or burn marks or bubbling in the motherboard's substrates that could be associated with excessive heat damage. You might want to use a small magnifying glass to examine the motherboard and its components for heat damage.

9. Reseat expansion cards, memory modules, and, if the PC is older, the ROM BIOS chip.

   You might want to check the mounting of any socket-mounted chips on the motherboard. All chips are subject to *chip creep*, which is the very slight movement of a device out of its socket. Chip creep is the result of thermal shifts caused by powering a PC on (heating it up) and off (cooling it down). If you discover any chips that need to be reseated, you should remove them and check for corrosion on the connector edges — if you find some, use contact cleaner before reinstalling them.

10. Check for electrical shorts.

    Look for anything that could be shorting the motherboard, drives, peripheral cards, or power supply. Screws that fall into the case can lodge under or behind the motherboard or the board retainer tray (if the case has one) and ground the electrical system. In most cases, removing the loose part should solve the problem without any damage to the motherboard or other circuits. If you find a loose screw or the like, or if the motherboard is in contact with the case (where it shouldn't be), don't assume that no damage occurred. Use chipset/memory/CPU test and diagnostic software, such as SiSoft's Sandra, TweakBIOS, or CTCHIPZ, to verify the motherboard's functions.

11. Check the motherboard standoffs.

    If your motherboard is mounted on brass standoffs that hold it off the case tray, verify that paper or plastic washers are inserted between the standoff and the motherboard. If you don't have the little paper or plastic washers, use a small piece of electrical tape over the end of the standoff where it contacts the motherboard. If the standoff is contacting the motherboard directly, it can cause a short in some instances.

12. Disconnect all external connectors — serial, parallel, Universal Serial Bus (USB), keyboard, mouse, and so on — and reboot the system.

    If the system boots, begin a cycle of replacing the connectors one at a time and cold booting the PC each time until the problem reoccurs. If the system fails after a certain device is attached, troubleshoot the connector or the device. See Parts III–VI for information on troubleshooting the connectors and ports for a specific device.

BEEP-NO BOOT

If the PC powers up but the POST process appears to halt after sounding one or more beep, follow this troubleshooting procedure:

1. Make sure that the PC's monitor is on, connected, and operating okay.

   Don't laugh; this head-slapper has stumped more than one experienced tech.

2. Look up the pattern used on the BIOS in your PC.

   Each BIOS manufacturer uses a different and unique pattern of beep tones to signal errors. After you know what you're listening for, attempt to write down the pattern of the beep tones. Remember that tones are short or long with varying-length pauses inserted between beep series. After you are sure of the beep signal pattern (you might need to reboot several times to hear it all), consult your motherboard's documentation or visit the BIOS manufacturer's Web site for the meaning of the beep pattern and a suggested procedure to correct the problem. Understand that every manufacturer has a different meaning for a certain signal pattern, and it can even differ for different revisions of a BIOS from a single manufacturer.

3. Check to make sure that the Complementary Metal-Oxide Semiconductor (CMOS) battery jumper is in the correct position.

   Surprisingly, many new PCs and motherboards are shipped with the CMOS battery jumper in the wrong setting. Check the motherboard's documentation for the correct settings.

4. Inspect the CMOS battery for leaks, corrosion, or burns.

   Depending on the age of the motherboard, the CMOS battery is either a little blue barrel (see Figure 1-6) or something like a big watch battery (a flat silver disk like that shown in Figure 1-7). In either case, it is located on the motherboard near the CMOS chip. You should also check the battery with a multimeter. Maybe it's just time for a new battery. These batteries can go bad and leak chemicals on the motherboard, which can short or melt circuit traces. On that note, look for broken circuit traces on the motherboard or solder blobs accidentally connecting two circuit trace paths.

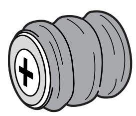

Figure 1-6: The blue barrel-style CMOS battery.

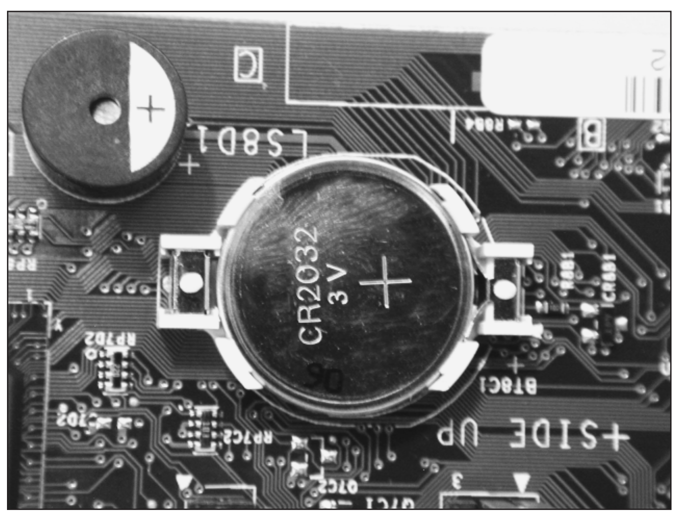

Figure 1-7: The lithium watch-style CMOS battery.

5. Check the video card by removing and reinstalling it.

   If the beep codes are for something very generic, the problem could be that you just can't see the display. If reinstalling the video card doesn't work, try swapping it out for another video card of the same type, if available.

6. Check for a text message.

   Depending on when the POST detects the error, you might get a text message as a part of the BIOS information. If so, study the information displayed; it can usually provide clues on where the problem is occurring.

If you are familiar with the PC, you should know the sequence of the POST process and what should occur immediately following the last displayed action — the likely point of failure. Otherwise, check with the BIOS or motherboard manufacturer for information on the boot sequence.

7. Remove the RAM chips or modules and try booting with different combinations of memory modules in different slots on the board.

   Memory modules have been known to work great in one (or more) slot(s) but hang the system in another. If the PC includes Level 2 (L2) cache boards, try booting the PC without it.

8. Verify that the RAM chips or modules in use are compatible with the motherboard, chipset, and processor.

   Also be sure that the modules are installed in the proper slot or slots. Some PCs allow single modules, some require module pairs, and still others require four of the same module type to be installed to work. Remember that you can't mix and match memory module types. See Chapter 6 for more information on memory modules.

9. Check the IDE/ATA connection on the motherboard and the boot disk drive.

   You might also want to verify the jumper settings on the disk drives themselves to make sure that the master/slave configuration is properly set.

10. Reseat the expansion cards (see Step 9 in the No Beep-No Boot procedure).

    If the system uses an expansion card IDE controller and you have a spare, replace the installed card with it.

11. Confirm that the motherboard's voltage setting and motherboard speed (multiplier) jumpers are correctly positioned for the PC's motherboard and CPU combination.

    See the motherboard's documentation for the location and proper settings of these jumpers.

12. Verify the system configuration settings in CMOS.

    If you can access the BIOS' set-up program by pressing the access key (usually Delete or a function key), use its reset function to reset the CMOS settings to their default values and reboot. Only do this after you have written down the current settings of the CMOS contents. After resetting the CMOS values, you can begin changing the default settings back to their original values one (or more, but not more than a few related settings) at a time.

13. Remove all the expansion boards, except the video adapter, and reboot.

    If the system reboots, the problem is probably one of the boards or the expansion bus on one of the expansion slots. Begin replacing the boards one at a time, rebooting after each card is installed. If the system fails on a particular card, put it in a different slot and reboot to isolate whether it's the card or the slot that has the problem.

14. Disconnect the system speaker, which could be shorting to the board.
15. Disconnect each of the case-to-motherboard wires, such as the connections to the front panel light-emitting diode (LED) lights and switches.

    Do these one at a time and reboot after removing each one.
16. Check keyboard and mouse connections.

    Verify that they are securely connected to the motherboard.
17. Check whether the keyboard fuse is blown.

    This fuse can blow if a serial mouse is connected to a PS/2 connector through an adapter or if there is an electrical short somewhere in the keyboard. And, if all else has failed, try a different keyboard.

BEEP-BOOT-BAM

In this situation, the PC is powered on, the POST completes and signals an all-clear, but the PC fails at the beginning of the startup sequence or right after the boot completes.

1. Study the BIOS information displayed on the monitor and verify that the boot drive sequence is set correctly.

   If the correct drive is set as the first boot drive, check its power and data connections. If the PC's BIOS supports it, set the boot drive setting to Auto Detect.
2. Check the hard disk drives to ensure that you have only one master disk and one slave disk on each IDE cable.

   If you wish to boot from a hard disk drive (the most common choice), be sure that it is the master disk on the primary IDE channel. See Chapter 10 for more information on IDE disk drives.
3. Check any Small Computer System Interface (SCSI) connections.

   If your primary disk drive is a SCSI drive, be sure that the end device on each chain (internal and external) is terminated. Verify that the SCSI BIOS and the motherboard's BIOS are set to allow a SCSI disk drive to be the boot disk. Verify that the SCSI device ID assigned to the disk drive matches that in the BIOS and also make sure that the SCSI controller is connected to the SCSI drive. Check all SCSI connectors to ensure that they're pushed all the way in.

4. Try a different boot disk drive.

   If the boot still fails, change the boot sequence in the BIOS and attempt to boot off an alternate media (floppy or CD-ROM).

5. Rebuild the master boot record.

   If you can boot with a DOS floppy disk, try using the `FDISK /MBR` command to rebuild the master boot record.

6. Replace the controller card of the boot disk and reboot.

   This, of course, assumes that the boot disk drive is connected to an expansion card controller. If the boot drive is connected to a motherboard (meaning chipset) interface, check the connection. Alternatively, you might want to test the boot drive in another PC.

7. Check the processor fan or heat sink.

   If the disk drives are not the problem, the CPU could be overheating and shutting down. Verify that the processor, processor fan, and heat sink are properly installed. If thermal grease is in use, verify that the fan and/or heat sink are in their proper positions. If thermal grease is not in use, you might want to consider applying it.

8. Check the memory modules as described in Steps 7 and 8 in the "Beep-No Boot" section earlier in the chapter.

9. Confirm that the CPU and chipset are compatible with the operating system.

   You should be able to get this information from either the CPU manufacturer (which might or might not be the chipset manufacturer) or the operating system publisher.

10. Review your motherboard manufacturer's Web site for bulletins of known problems or incompatibilities.

    I had a problem with a VIA chipset motherboard and the AGP video adaptors that I would have never been able to figure out had I not visited the manufacturers' Web sites.

TIP

Find out which chipsets the motherboard manufacturer is using for video, audio, and SCSI, if it is an option. Always go with well-known companies, such as ATI, Creative Labs, and Adaptec, if you have a choice. Generally, information about any known flaws in peripheral controller chipsets is readily available on the Internet or in technical hardware-related magazines. Study up on the components on the motherboard. This will save you from disabling parts of the motherboard in the BIOS or through a jumper or wasting an expansion slot with a redundant replacement card.

Removing a Motherboard

Nothing in a PC has as much potential for disaster as the act of removing or installing its motherboard. However, if you proceed methodically and carefully, you really have nothing to fear and usually much to gain.

Working by the rules

Follow these six general rules when removing a motherboard (or any other component of a PC, for that matter!):

1. Proceed cautiously.

   When working on a PC, proceed as if any action you take has the potential to destroy the system — because it can! This is especially true of motherboards.

2. Write everything down.

   Even if you've worked on hundreds of PCs and can field strip a PC blindfolded in less than 60 seconds, every PC should be approached as if it is totally unique. Write down every action that you take and make a note of each removed part (and where you store it) so that later when you're trying to reassemble the PC, you can simply reverse your actions and know where you put all the parts.

3. Draw pictures.

   Making quick sketches of connector orientations, jumper locations, and the like can be very helpful. Relying on your memory for such things can lead to failed boots, blown components, and fried motherboards.

4. Label parts.

   Label each component removed or disconnected from the system in a way that's meaningful to you. You might want to number or letter parts, connectors, and cables and also reference them in your notes — or maybe just label devices by their relationship to other components, such as Drive0, Drive1, and so on.

5. Protect everything from ESD.

   And this means you (too)! I don't need to tell you of the dangers of ESD, so this is just a gentle reminder to protect the system and its components whether in or out of the PC.

6. Use the right tools correctly.

   Even though you like to use your tweaker for virtually everything, often there is a better and more appropriate tool for any task. Your first task is to protect the motherboard, and using the wrong tool can result in gouged traces, stripped screws, and metallic debris in the system.

Opening the case

The type of system case in use can make removal and installation of a motherboard a snap. On the other hand, a case might be designed for efficient manufacturing but not for ease of repair.

On many newer cases, almost every component is removable — often without the need for the use of many tools beyond a screwdriver. Manufacturers are always looking for ways to reduce the number of hard connectors (such as screws and clips) that hold cases and components together to simplify production and lower costs.

So, under the assumption that opening the case (see the manufacturer's documentation for this activity) is not a big problem, here are some generic guidelines to opening a PC case.

1. Remove all cables from the ports on the back, side, or front of the PC, including the monitor, speakers, and the serial cables, parallel cables, and USB cables of external devices.

   I recommend that you label the cables as to which connector they were attached to *and* create a diagram illustrating the connections and cables.

2. Remove the case cover.

   Every PC case is a little unique, even between models of the same manufacturer. Usually the case is secured with screws around the edge of the rear panel of the PC. However, you'll find new breeds of PCs on which the motherboard, CPU, and memory modules are exposed by simply lifting off the front or side panel, usually without tools. If your PC is one of these, the front or side panel is held in place by spring latches or friction retainers. You might need to slide a locking handle or lift the panel, but typically a strong and steady pull should release the panel. Watch for protruding floppy disk and CD-ROM drives or interior cables that could catch on the panel and be dislodged or damaged in the process. If the panel won't pull off without significant effort or possible damage, stop and look for screws securing it to the chassis.

   Most newer computers have separated the sides of the case to allow only one side to be removed. This exposes the motherboard and its components, which is usually enough for normal maintenance. On others, the entire case slips off the rear of the PC, exposing the motherboard on all sides. Regardless, because complete access is needed to remove the motherboard, remove enough of the case cover to expose both sides of the motherboard, if possible.

3. Remove the retaining screws in the expansion cards.

   Also remove the cables connecting the cards to the computer, such as the drive cables from IDE or SCSI cards and the CD-ROM audio cables on sound cards. Label each cable with a piece of masking tape or with a fine-point marker as to what it is and its orientation. The disk drive data cable should have a red or blue edge to indicate its Pin 1 location. Draw a diagram that shows which expansion card went into which expansion slot. Mark each slot with a number and then label each card with a piece of tape on which you've written the slot number from which it was removed. Include the connecting cables and the device to which each was attached in the diagram.

4. Mark or label the cables that connect directly into the connectors integrated into the motherboard, including the power supply, floppy disk controller, IDE controller, and possibly the sound controller.

   Indicate the device, which is usually printed on the motherboard surface next to each socket, as shown in Figure 1-8. Create a diagram for these cables that indicates the source, destination, orientation, and any special markings on the cable that will be important at reassembly time.

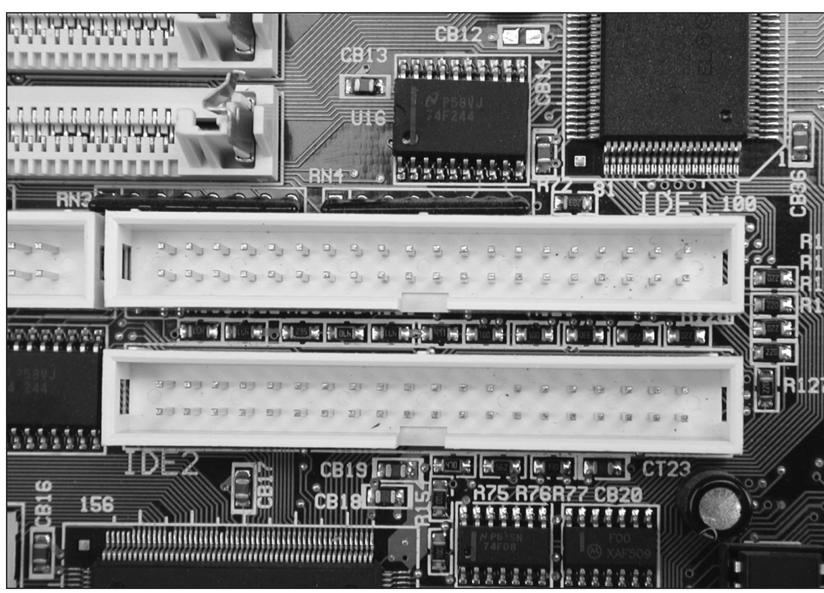

Figure 1-8: The device type is printed on the motherboard for integrated controllers.

Photo courtesy of Intel Corporation.

5. Remove the motherboard's mounting screws.

   Locate the heads of the screws that secure the motherboard to the chassis, and remove the motherboard mounting screws and store them where you can find them later. Be careful not to lose any paper or plastic washers that are on these screws.

6. Lift out the motherboard.

   Some PCs have a mounting plate from which the screws must be removed to swing the motherboard out of its mounting. Hold the motherboard by its edges, being careful not to put pressure on or to soil either side of the board. Place the board on an anti-static mat or on an anti-static shipping bag and document any other connectors or mountings that you've not previously noted.

   If the motherboard is mounted on brass standoffs that are used to lock the motherboard to the case, remove the screws attaching the board to the brass standoffs and slide it to unlock the standoffs. Lift the board out of the standoff keys and place it on an anti-static surface.

7. To reinstall or replace the motherboard, use your diagrams and notes and reverse the order of operations.

Other considerations

As I describe in this chapter, problems that could be associated with a motherboard are typically problems with one or more of the components mounted on or connected to the motherboard. You'll find the specific information for each of these components in other chapters of this book.

As a general guideline for diagnosing what you think could be motherboard problems, start with the power supply and work through the other components before you begin suspecting the motherboard itself.