

Chapter 3: BIOS and CMOS Configuration

While You Read

1. Explain the difference between BIOS and CMOS.
2. If you want the computer to test the memory, which type of boot process (warm or cold) will you want the customer to perform? Why?
3. If you have computers with a Phoenix BIOS and an AMI BIOS, will they have the same beep codes? Why or why not?
4. What type of device is needed to display BIOS error codes? What do you also need to understand the codes?
5. Which CMOS setup screen might need to be adjusted when using Windows 95, 98, or 2000?
6. If you have a bootable CD-ROM containing the original system setup, what BIOS option do you adjust if you need to restore the system with its original software? What should be listed first and second?

Introduction

Next to the CPU, the BIOS is the most important chip found on the motherboard. A firmware device, the BIOS provides vital services at bootup, hardware standards for your system and, through its configuration utility, many ways to customize your system. To understand the differences between hardware, software, and firmware, see "The Essential Parts of Any Computer," page 6.

The BIOS (Basic Input Output System) chip performs a variety of important tasks during system operation. On systems that use 32-bit versions of Microsoft Windows (Windows 95 or newer), the BIOS has relatively little to do with system operation after the boot process has been completed. However, during the boot process, the BIOS is an extremely critical component. Tasks that the BIOS chip performs include

- Configuration and control of standard devices
- The power-on self test (POST)
- The location of an operating system, to which it turns over control of the system by using the Bootstrap loader

The CMOS (Complementary Metal-Oxide Semiconductor) chip stores the settings that you make with the BIOS configuration program. The BIOS offers you many different options for most system components controlled by the BIOS, but until the settings are stored in the CMOS, the system is unable to run.

The BIOS and Standard Devices

The BIOS is a complex piece of firmware ("software on a chip") that provides support for the following devices and features of your system:

- Selection and configuration of storage devices, such as hard drives, floppy drives, and CD-ROM drives
- Configuration of main and cache memory
- Configuration of built-in ports, such as IDE hard disk, floppy disk, serial, parallel, PS/2 mouse, and USB
- Selection and configuration of special motherboard features, such as memory error correction, antivirus protection, and fast memory access
- Support for different CPU types, speeds, and special features
- Support for advanced operating systems, including networks, Windows 9x, and Windows 2000 (Plug and Play)
- Power management

Storing System Settings

To enable the BIOS to perform these tasks, two other components on the motherboard work with the BIOS: the CMOS chip, also known as the RTC/NVRAM (Real-Time-Clock/Non-Volatile RAM), and the battery. The CMOS stores the settings that you make with the BIOS configuration program and contains the system's Real-Time-Clock circuit. Power from a battery attached to the motherboard is used by the CMOS to keep its settings. [Figure 3.1](#) shows a typical socketed BIOS and battery. The A+ Certification test might ask you to identify these devices on a motherboard and to explain their operation.

Figure 3.1

The CR2032 battery has become the most common removable battery on Pentium-class systems. The Award BIOS label lists support for "586" (Pentium-class) CPUs, PnP (Plug and Play for Windows 95), and PCI slots.

Most recent systems use various models of lithium batteries, which can last from two to five years. [Figure 3.2](#) shows three of the many battery types used on motherboards over the years.

The most common batteries you will see in Pentium-class and newer systems are the DS12887A-type clock/battery chip seen in [Figure 3.2](#) (left) and the CR-2032 lithium battery seen in both [Figure 3.1](#) and [Figure 3.2](#) (center). The AA-size Eternacell in [Figure 3.2](#) on the right was used in many early 286- and 386-based systems made by Zenith Data Systems and others. Knowing that battery types can vary is not as important for the A+ Certification test as it will be for your day-to-day work.

Figure 3.2

The Dallas Semiconductor DS12887A (left) clock/battery chip, CR-2032 lithium battery (center), and the AA-size 3.6 volt Eternacell (right) have all been used in computers for maintaining CMOS settings.

When the battery starts to fail, the clock will start to lose time. Complete battery failure causes the loss of all CMOS configuration information. When this takes place, the system cannot be used until you install a new battery and re-enter all CMOS configuration information by using the CMOS configuration program.

Because the battery maintaining settings can fail at any time, and viruses and power surges can also affect the CMOS configuration, you should record important information before it is lost. See "Saving and Recording BIOS/CMOS Settings," later in this chapter, for details.

POST

The POST (power-on self test) portion of the BIOS allows the BIOS to find and report errors in the computer's hardware. For the POST to work correctly, the system must be configured correctly, as you will see in "System Configuration," later in this chapter.

The POST checks the following parts of the computer:

- The CPU and the POST ROM portion of the BIOS
- The system timer
- Video display card
- Memory
- The keyboard
- The disk drives

The system will stop the boot process if it encounters a serious or fatal error (see the following "Beep Codes" section). During the POST process, the BIOS uses any one of several methods to report problems:

- Beep codes
- Onscreen error messages
- POST error codes

Beep Codes

Beep codes are used by most BIOS versions to indicate either a fatal error or a very serious error. A

fatal error is an error that is so serious that the computer cannot continue the boot process. A fatal error would include a problem with the CPU, the POST ROM, the system timer, or memory. The *serious error* that beep codes report is a problem with your video display card or circuit. Although systems can boot without video, seldom would you want to because you can't see what the system is doing.

Beep codes vary by the BIOS maker. Some companies, such as IBM, Acer, and Compaq, create their own BIOS chips and firmware. However, most other major brands of computers and virtually all "clones" use a BIOS made by one of the "Big Three" BIOS vendors: American Megatrends (AMI), Phoenix Technologies, and Award Software (now owned by Phoenix Technologies).

As you might expect, the beep codes and philosophies used by these three companies vary a great deal. AMI, for example, uses beep codes for over 10 "fatal" errors. It also uses eight beeps to indicate a defective or missing video card. Phoenix uses beep codes for both defects and normal procedures (but has no beep code for a video problem), and the Award BIOS has only a single beep code (one long, two short), indicating a problem with video.

Because beep codes do not report all possible problems during the startup process, you should not rely exclusively on beep codes to solve system problems.

You can hear some typical beep codes by using the CD-ROM included with this book.

Onscreen Error Messages

Most BIOS versions do an excellent job of giving you onscreen error messages indicating what the problem is with the system. These messages can indicate problems with memory, keyboards, hard disk drives, and other components. Some systems document these messages in their manuals, or you can go to the BIOS vendors' Web site for more information. Keep in mind that the system almost always stops after the first error, so a serious problem early in the boot process will stop the system before the video card has been initialized to display error messages.

POST Codes and POST Cards

In Chapter 1, "Basic Concepts," you learned about the different ways data passes through the system. One method, used by virtually all devices, is to send data through one of 65,535 I/O port addresses. The POST also uses an I/O port address (usually 80h), sending a series of codes indicating the progress of testing and booting. The hexadecimal codes output by the BIOS change rapidly during a normal startup process as different milestones in the boot process are reached. These codes provide vital clues about what has gone wrong when your system won't boot and you don't have a beep code or onscreen messages to help you.

To monitor these codes, you need a POST card such as the one shown in [Figure 3.3](#), available from a variety of vendors, including JDR Microdevices (<http://www.jdr.com>) or Jensen Tools (<http://www.jensentools.com>). These cards are available in versions that plug into either ISA or PCI expansion slots. The simplest ones have a two-digit LED area that displays the hex codes, whereas more complicated (and expensive) models also have additional built-in tests.

The same hex code has different meanings to different BIOSes. For example, POST code 31h means "display (video) memory read/write test" on an AMI BIOS, but it means "test base and extended

memory" on the Award BIOS, and it is not used on Phoenix BIOS. As with other types of error messages, check your manual or the BIOS maker's Web site for the meaning of any given code.

Figure 3.3

The Ultra-X PC Inspector card features POST display (1), DMA conflict detection (2), and IRQ conflict detection (3) among its many features.

The best way to learn to use a POST card is to plug it into a healthy system and watch the codes change during a normal system startup. Typically, the codes change very quickly until the final code (often "FF") is reached and the system starts. On a defective system, the codes will pause or stop when a defective item on the system is tested. The cards remove easily and need not be left in systems routinely.

To prepare yourself for the A+ Certification exam, make sure you can identify the three different methods computers use for identifying errors (beep codes, onscreen codes, and POST codes) and when each method is most appropriate for discovering why a computer cannot boot.

Transferring Control to the Operating System with the Bootstrap Loader

During the POST, drives and other standard devices have been detected. Frequently, information about the CPU, hard disk, floppy disk drive, memory size and type, and ports are displayed onscreen at the end of the POST (see [Figure 3.4](#)).

Figure 3.4

A typical Pentium-based system configuration screen displayed on system startup. Use this information for a quick view of the system's features, including CPU type and speed, RAM size and type, drive configuration, and more.

Next, the BIOS searches for an operating system on the drives listed in the BIOS configuration as bootable drives. The first drive containing an operating system will be used to start the computer, and at that point the BIOS transfers control of most of the computer to the operating system. The portion of the BIOS responsible for starting the system is called the *bootstrap loader* (from the old expression "pulling yourself up by your bootstraps").

For a more detailed look at how the startup process works after the BIOS locates the operating system, see *Upgrading and Repairing PCs, 12th Edition*, Chapter 25, "The Hardware Boot Process."

Warm and Cold Booting

A *cold boot* or *hard boot* refers to starting the computer with the power or reset switch, which runs the entire POST and bootstrap process. A warm boot or soft boot skips the POST and refers to restarting the computer with the MS-DOS Ctrl+Alt+Del key sequence or the Windows 9x/2000 Start, Shutdown, Restart menu. [Figure 3.5](#) shows a typical screen displayed during a cold boot.

Figure 3.5

The screen during a cold boot. Note the memory test at the upper-left side.

On an MS-DOS-based system whose hard disk and floppy disk drives are connected to the motherboard, the BIOS is used to operate the drives. However, for systems using Windows 95 and

newer, device drivers are loaded by the operating system to replace the BIOS. Still, without the BIOS, the system would not know what hardware was onboard or whether it was working.

System Configuration

For the BIOS to be able to start the computer, you've seen that it must find an operating system on a hard disk or floppy disk drive. But how does the BIOS know where the drives are located or what types they are?

Floppy disk drives and hard disk drives are two of the most important items that must be configured in the BIOS. If the drive types are not correctly identified in the BIOS, the BIOS will not be able to start the system. Whenever you build a system or change major components, you need to run the BIOS setup program to check or change settings.

Starting the Setup Program

On most systems built since the late 1980s, the BIOS configuration program is stored in the BIOS chip itself. On a few current systems, as with the original IBM AT, the setup program must be run from a floppy disk drive or the hard drive. The original IBM PC and PC/XT had only a few settings, and these were made by manipulating a series of small rocker or slide switches called *DIP switches*.

ROM-based setup programs are normally started by pressing one or more keys in combination within the first few seconds after turning on the computer. Although these keystrokes vary from system to system, the most popular keys on current systems include the escape (Esc) key, the Delete key, the F1 key, and various combinations of Ctrl+Alt+ another specified key. Most computers display the correct key(s) to press during the initial startup screen. Check with your system vendor for the appropriate keystrokes or to see if you need to run a program from MS-DOS or Windows to configure your system.

Because the settings you make in the BIOS setup program are stored in the nonvolatile RAM of the CMOS chip, the settings are often called *CMOS settings*.

In the following section, we will review the typical setup process, looking at each screen of a typical Pentium-class system.

Step-by-Step CMOS/BIOS Configuration

The A+ Certification exam will test your knowledge of basic CMOS/BIOS configuration. To help you prepare for the exam, this section covers the most important portions of the CMOS/BIOS setup process.

To start the CMOS setup process, press the correct key(s) during the bootstrap process or run the setup program from hard disk or floppy disk after the computer has started. On virtually all systems built since the early 1990s, you'll start with a menu screen, as shown in [Figure 3.6](#). This menu, as well as the contents of the screens listed, will vary according to your BIOS brand, version, and motherboard type.

Figure 3.6

Select the menu item from this CMOS Setup menu to examine or change settings.

Select Standard CMOS Setup to begin.

Other systems will immediately display the Standard CMOS Setup screen, which is typically used to configure drive, date, and time settings.

Standard CMOS Configuration

The standard CMOS configuration screen (see [Figure 3.7](#)) includes settings for items such as

- Date
- Time
- Floppy disk drive types for drives A: (first floppy disk drive) and B: (second floppy disk drive)
- Hard drives connected to the IDE interface

Figure 3.7

A typical standard setup screen. On this system, hard drives can be detected during the boot process ("Auto" setting), but they can also be user-defined, as shown here.

To make selections here, you normally press keys to cycle through the different options, including date and time.

The time must be entered in the 24-hour format (1:00PM = 13:00, and so on). Enable daylight savings unless your state or area (Arizona, Hawaii, and parts of Indiana) doesn't switch to DST in the spring and summer.

Change the default floppy drive types to match your current configuration if necessary. See "Floppy Disk Drives," page 191, for details on selecting the correct floppy disk drive type.

To select the correct hard drive type, you can use one of three methods:

- Manually enter the correct settings.
- Use an auto-detection feature located here or from the main menu.
- Allow the system to detect the hard drives during every system boot.

Some systems also display the amount of memory onboard on this screen, but only extremely old systems based on 386 or older processors require that you manually enter the amount of RAM in the system. On virtually all systems using a 286 processor or better, the standard CMOS configuration screens are extremely similar, varying mainly in the number and types of drives that can be used.

The standard setup screen is the single most important screen in the entire BIOS/CMOS setup process. If the drives are not defined correctly, the system cannot boot.

Automatic Configuration of BIOS/CMOS Settings

Many versions of the AMI and Award BIOS allow you to automatically configure all screens except the Standard setup screen with a choice of these options from the main menu:

- BIOS Defaults (also referred to as Original/Fail-Safe on some systems)
- Setup Defaults (also referred to as Optimal on some systems)
- Turbo

Use BIOS defaults to troubleshoot the system because these settings are very conservative in memory timings and other options. Normally, the Setup defaults provide better performance. Turbo, if present, speeds up the memory refresh rate used by the system. As you view the setup screens in this chapter, you'll note these options are listed. If you use either automatic setup after you make manual changes, all your manual changes will be overridden!

Appropriately, the graphical AMI WinBIOS uses a tortoise, a hare, and an eagle for these three options.

With many recent systems, you can select Optimal or Setup Defaults, save your changes, and exit, and the system will work acceptably. However, you might want more control over your system. In that case, look at the following screens and make the changes necessary.

Advanced CMOS Configuration

The advanced CMOS configuration screen, shown in [Figure 3.8](#), allows you to adjust optional details about the computer. In this screen, you can adjust the NumLock setting, type of video, keyboard repeats speed, settings for cache memory, and other special features. Most systems built since the early 1990s include this screen.

Figure 3.8

A typical Advanced CMOS Configuration screen, also known as the BIOS Features screen—use this screen to enable or disable anti-virus hardware features, adjust boot sequence, and adjust memory options such as cache and parity checking.

Table 3.1 lists the most important options and my recommendations.

Table 3.1 Recommended Advanced CMOS Settings

Option	Setting	Reason
Write-Protect Boot Sector, Virus Warning, or Antivirus Protection	Enable for normal system use	This doesn't really stop viruses, but it will help prevent users from accidentally FORMATting or FDISKING the hard disk.
Cache Internal	Enabled	Cache memory makes system

		faster (see and External" Adding Main and Cache RAM," page 54.
Boot Sequence	C: (first hard disk), A: (floppy disk drive), CD-ROM, C:, A:	Prevents users from booting with floppy floppy disk left in A: won't spread disks; boot sector viruses to the system; system won't stop if floppy disk is left in A:.
Shadowing	Enable for memory addresses containing firmware (BIOS) chips	Copies firmware contents such as system BIOS, video BIOS, and add-on card BIOS to RAM. Located between 640KB-1MB (upper memory blocks).
LBA mode	See "Overcoming Hard Disk Capacity Limitations with LBA Mode," page 211	

Depending on the system, you might be able to boot from CD-ROM, ZIP, or LS-120 drives in addition to the floppy disk drives and hard drives traditionally available as boot devices, as shown in [Figure 3.9](#).

Depending on the BIOS version, you might need to press the ESC key, as in [Figure 3.9](#), to return to the main menu, or use cursor keys to move directly to another menu screen.

Figure 3.9

This recent Pentium-class system offers a variety of boot options. To view the settings for any CMOS configuration option, either use the help key (F1) as shown here, or press the correct key to step through the options for the setting.

Advanced Chipset/Chipset Features Configuration

The Advanced Chipset/Chipset Features Configuration screen, like the one shown in [Figure 3.10](#), offers many advanced options that vary by the system. The following are some typical features of this menu:

- **Memory types, speed and timing**—Adjust the values here to match the memory installed in the system (such as parity, non-parity, SDRAM, EDO, and so on).
- **Cache adjustments**—Some Cyrix CPUs require the user to disable pipelining for proper operation.
- **Configuration of USB ports**—If you upgrade a system to Windows 98 or Windows 2000, you might need to enable the USB ports; systems with older versions of Windows (which didn't support USB) might not have the USB ports enabled. The USB Keyboard Support feature must be enabled if a USB keyboard is installed to allow the keyboard to operate outside of Windows.

- **Configuration of the AGP slot**—Depending on the specific AGP video card installed (if any), you might need to set the size of the memory aperture used to transfer data between the system and the AGP port and select the AGP mode (1x, 2x, and 4x).

Figure 3.10

This recent system's USB (Universal Serial Bus) and AGP (Advanced Graphics Port) options are located on the Chipset Features configuration screen, along with the usual system and memory-timing options.

Power Management Configuration

Virtually all systems built since the mid-1990s are designed to allow power management; watch for the EPA "Energy Star" logo when you start the computer.

Power management works like this: After a user-defined period of inactivity, devices such as the monitor, the hard drive, or even the CPU will go into different low-power modes:

- **Standby mode**—Shuts off the hard drive and blanks monitor screens that use Display Power Management Signaling. Move the mouse or press a key to "wake up" the system.
- **Suspend mode**—Turns off the CPU clock to save even more power. Systems that fully support suspend mode allow you to choose a special shutdown option that "remembers" what programs and files were open, and can bring the system back to that state when the power is restored.

Early power-management systems require that you, the user, keep working with the mouse or keyboard to prevent the system from going into power-saving modes, which can cause modem or network transfers to be interrupted, losing data.

On most newer systems, such as the one featured in [Figure 3.11](#), you can prevent the system from going into power-saving modes, or to wake up when activity takes place, by setting these options by either the device name (modem, hard drive, floppy disk drive, parallel port, serial port) or by the device's IRQ (see "IRQs, DMAs, I/O Port Addresses, and Memory Addresses," page 17).

I have always regarded power management as being a great idea that does not always work well in practice.

Figure 3.11

This recent system has support for both ACPI power management (used by Windows 98) and APM (used by earlier versions of Windows).

To make power management work, you need to make sure that

- Devices such as hard drives and monitors can be powered down and powered back up without loss of information.
- Power management is set to monitor network and Internet devices, such as modems and network cards, for activity to prevent the connection from being dropped.

- All devices installed in a system are monitored for activity to prevent data loss. For example, [Figure 3.11](#) does not list IRQ 15 (used by the secondary IDE host adapter in most systems) as a PM (power management) event. Activity on IRQ 15 will not wake up the system, although the computer could be reading data from devices on IRQ 15 or saving data to devices on IRQ 15.
- Users understand how power management works.

Normal signs of power management in use include

- Monitors with blinking power lights, or power lights a different color than normal, while the screen remains blank
- Keyboards that seem "dead" for a few seconds after you start typing (because the hard drive must spin up)

Users who are unfamiliar with power management might panic and reboot the computers (losing their data!) or demand that you "fix" their systems. Sometimes, the best fix is to disable power management completely or to use Windows to configure power management settings through its Power icon in Control Panel. For systems that have ACPI-compatible BIOS chips that also run Windows 98 or Windows 2000, Windows should be used to manage power.

Adjust the system to the user's requirements, and continue.

PnP (Plug-and-Play) Configuration Screen

Plug-and-Play (PnP) configuration allows either the operating system or the system BIOS to select hardware settings for PnP-compatible cards when first installed and to change those settings when new cards are installed. PnP BIOS support has been part of virtually all systems shipped with Windows 95 or newer versions of Windows, and virtually all add-on cards and other devices (such as printers, monitors, modems, and so on) also support PnP configuration.

Early versions of the Plug-and-Play Configuration screen (see [Figure 3.12](#)) were introduced with the first Pentium-based systems with PCI slots, because PCI cards could configure themselves. PnP can be used with PnP-compatible ISA cards as well as with PCI and AGP cards. If you are using Windows 95, 98, or 2000, set Plug and Play Operating System to Yes. Unless you have problems with installing cards, that is normally all you need to set. If you are having problems adding cards, you can set IRQs to be available to PnP devices (add-on cards that are set by Windows) or to ISA/Legacy devices (ports built into the motherboard or ISA cards you must set manually).

Some systems, as in this example, also allow you to enable or disable IRQ use for USB, VGA video, and ACPI power management. You can disable IRQ usage for any or all of these devices, but some devices might not work if no IRQ is assigned.

Built-In Ports/Peripherals Setup

You can enable or disable most ports built into recent systems with the Built-in Ports/Peripherals Setup screen, shown in [Figure 3.13](#). (Some systems with PS/2 mouse ports require that you adjust a jumper block on the motherboard.) On some systems, this screen also lets you adjust advanced hard

disk options, such as PIO mode and block mode.

Figure 3.12

A typical Plug-and-Play configuration screen. By changing PnP options for IRQs and DMA channels to Legacy, you can reserve selected IRQs and DMAs for non-PnP cards.

Figure 3.13

This system's COM 2 port (UART 2) is disabled to allow an internal modem to be installed as COM 2.

Generally, you disable a built-in port if you add a card containing a port that will conflict with it. For example, you can disable COM 2 (serial port 2) to allow you to install an internal modem. You can also adjust the IRQ and I/O port addresses used by the built-in parallel and serial ports. On some systems, the LBA mode setting for hard disks and USB configuration options are also found on this screen. After observing or changing the settings, return to the main menu and continue.

See "IDE Performance Optimization," page 212, for information about hard disk options PIO mode and block mode.

Security/Passwords

You can enable two types of passwords on many systems: a power-on password that must be entered to allow any use of the system, and a setup password that must be entered to allow access to the BIOS/CMOS setup. If you don't have all the settings recorded (with screen printouts or by writing them down), this can be dangerous to enable.

Why? If the passwords are lost, users are locked out of the system, and you would need to remove the battery or use the "clear CMOS" jumper on the motherboard to erase the CMOS record of the passwords—and all other settings. This would require reconfiguring the system BIOS from scratch!

Because passwords are useful to prevent tampering with system settings, record the system information first, before you enable this feature.

Saving and Recording BIOS/CMOS Settings

Most BIOSes allow you to save your changes, or discard changes you might have made accidentally, when you exit the main menu and restart the system.

A few old BIOSes automatically save any changes, even bad ones. In either case, be sure to review the standard CMOS setup screen and any others you viewed to make sure the settings are acceptable before you save and exit. You should record critical BIOS settings, such as drive type information and any other changes from a system's default settings. Many technicians find it useful to add a sticker with drive type and other information to the rear of a system or to the inside of the system cover.

Getting Support for Your BIOS

Although BIOSes are developed by just a handful of companies (IBM, Compaq, and Acer develop for

their own systems, and Phoenix, AMI, and Award for others and for "clone" motherboards), each BIOS is unique to the motherboard it's matched with. Therefore, for specific help with your BIOS (errors, configuring, troubleshooting), your best bet is to go back to the system or motherboard maker.

The relationship of BIOS makers and motherboard makers is similar to the difference between standard and custom vans.

A standard van is sold by a dealer who is associated with the van maker. This is similar to the situation with Compaq, IBM, or Acer PCs: The same company makes both the PC and its BIOS.

A custom van has been modified from a "bare-bones" cargo van and sold by a third-party company. If you're having problems with the van, it's no longer the van that Ford or Daimler/Chrysler produced. You must go back to the custom van maker for help. This is the situation with Phoenix, AMI, and Award BIOSes; they have been modified by the system and motherboard makers. The BIOS makers' Web sites can provide general help, but not the specifics of your system, because the BIOS is no longer their product after it goes on a motherboard.

BIOS Upgrades

During the lifetime of any computer, its BIOS might need to be upgraded. Upgrading the BIOS means to change its contents with software (if it is a flash BIOS) or to replace the physical chip (if it isn't a flash BIOS). Most systems sold since 1995 have flash BIOS chips that can be upgraded with software.

Because the BIOS chip bridges hardware to the operating system, you will need to upgrade the BIOS whenever your current BIOS version is unable to properly support

- New hardware, such as large IDE hard drives and ZIP/LS-120 removable-storage drives
- Faster CPUs
- New operating systems and features, such as Windows 98 and 2000, which feature ACPI power management
- New BIOS options, such as PnP support and Y2K compatibility

Although software drivers can be used as workarounds for hard drive and Y2K compliance, BIOS is best.

BIOS upgrades must be performed very carefully because an incomplete or incorrect BIOS upgrade will prevent your system from being accessed. Regardless of the method, for maximum safety I recommend the following initial steps:

- Back up important data.
- Record the current BIOS configuration, especially hard disk settings (see Chapter 7, "BIOS Configuration").

BIOS configuration information might need to be re-entered after a BIOS upgrade, especially if you must install a different chip.

Flash BIOS Upgrade

Before beginning a Flash BIOS upgrade, you must determine where to get your BIOS upgrade. The BIOS manufacturers (Phoenix, AMI, and Award/Phoenix) do not sell BIOS upgrades because their basic products are modified by motherboard and system vendors (see "Getting Support for Your BIOS" earlier in this chapter).

For major brands of computers, go to the vendor's Web site and look for "downloads" or "tech support" links. The BIOS upgrades are listed by system model.

If your system is a generic system (that is, it came with a "mainboard" or "motherboard" manual and other component manuals rather than a full system manual), you need to contact the motherboard maker. Some systems indicate the maker during bootup. Others display only a mysterious series of numbers. You can decode these numbers to get the motherboard's maker. See the following Web sites for details:

- Wim's BIOS page (<http://www.ping.be/bios/>)
- Phoenix Technologies' Award Software Manufacturers' Page (<http://www.phoenix.com/pcuser/BIOS/Award.htm>)
- American Megatrend's BIOS Support page (<http://www.ami.com/support/bios.html>)

Download the correct BIOS upgrade for your system or motherboard. For generic motherboards, Wim's BIOS page (<http://www.ping.be/bios/>) also has links to the motherboard vendors' Web sites.

You might also need to download a separate loader program, or the download might contain both the loader and the BIOS image. If the Web site has instructions posted, print or save them to a floppy disk for reference.

Next, install the BIOS upgrade loader and BIOS image to a floppy disk. Follow the vendor's instructions.

After installation is complete, restart your system with the floppy disk containing the upgrade. Press a key if necessary to start the upgrade process.

Some upgrades run automatically; others require that you choose the image from a menu, and prompt you to save your current BIOS image to a floppy disk. Choose this option if possible so you have a copy of your current BIOS in case there's a problem.

After the update process starts, it takes about three minutes to rewrite the contents of the BIOS chip with the updated information. *Don't turn off the power!* Wait for a message indicating the BIOS upgrade has been completed.

Remove the floppy disk and restart the system to use your new BIOS features.

Physical BIOS Chip Replacement/Update

On motherboards whose BIOSes can't be upgraded with software, you might be able to purchase a replacement BIOS from vendors, such as Micro Firmware (for Phoenix BIOS upgrades at <http://www.firmware.com>) or Unicore (for Award, AMI, and Phoenix BIOS upgrades at <http://www.unicore.com>).

Before you order a BIOS chip replacement, consider the following issues:

- BIOS chip upgrades cost about \$60–\$80 each.
- Although the BIOS will be updated, the rest of the system might still be out of date.
- For not much more than the cost of the BIOS chip itself, you might be able to purchase a new motherboard (without RAM or CPU) that will give you similar BIOS features as well as advanced features (PCI and AGP slots, built-in sound, and so on) that might be missing from your existing motherboard.

If you still need to update the BIOS chip itself, first verify that the vendor has the correct BIOS chip replacement. It might be a different brand of BIOS than your current BIOS. If so, make sure that you have recorded your hard drive information. You will need to re-enter this and other manually configured options into the new BIOS's setup program.

The vendor will identify the BIOS chip you need by the motherboard ID information displayed at bootup. Unicore Software offers a free download utility to display this information for you. To replace the chip, follow these steps:

1. Locate the BIOS chip on your motherboard after you open the case to perform the upgrade. It usually has a sticker listing the BIOS maker and model number.
2. The BIOS is a DIP-type chip. The vendor typically supplies a chip extraction tool to perform the removal.

To remove a DIP (used primarily for BIOS today), use the appropriately sized DIP puller tool if you have one. This tool resembles an inverted "U" with small flat hooks on each point. If a DIP puller is not available, you can use a pair of flat-bladed screwdrivers. Follow these steps:

1. Place one end of the tool between the end of the chip and the end of the socket; repeat for the other side.
2. If you are using the DIP puller, gently tighten the tool around the ends of the chip and pull upward to loosen; if you are using the screwdrivers, gently lift upward on both handles to loosen. Pushing down on the screwdriver handles could damage the motherboard.
3. Gently rock the ends of the chip to free it, and straighten any bent pins when you finish removing it.
4. Remove the existing BIOS chip carefully and put it on anti-static material in case you need to

re-use it in that system.

5. Align the new BIOS chip's dimple with the matching cutout on one end of the socket.
6. Adjust the legs on the new BIOS chip so it fits into the sockets, and press it down until the legs on both sides are inserted fully.
7. Double-check the alignment and leg positions on the BIOS chip before you start the system; if the chip is aligned with the wrong end of the socket, you'll destroy it when the power comes on.
8. Turn on the system, and use the new BIOS's keystroke(s) to start the setup program to re-enter any information. You might get a "CMOS" error at startup, which is normal with a new BIOS chip. After you re-enter the BIOS data from your printout and save the changes, the system will run without error messages.

BIOS Troubleshooting

Because the BIOS is the essential "glue" that joins hardware to the operating system, you need to know how to deal with errors. Follow these steps to solve BIOS problems.

Incorrect CMOS Configuration

If the system can't start after a BIOS upgrade or a battery replacement, the CMOS might be corrupted. Re-enter the correct settings, save changes, and restart. An onscreen error message will usually indicate a CMOS problem. Otherwise, the settings might have been adjusted by a user. Try using the BIOS Setup auto-configure options, double-check drive configurations, save changes, and restart.

Incorrect Flash BIOS or Failed Update

If you use the wrong flash BIOS file to update your BIOS, or if the update process doesn't finish, your system can't start. You might need to contact the system or motherboard maker for service. Some BIOSes contain a "mini-BIOS" that can be reinstalled from a reserved part of the chip. Systems with this feature have a jumper on the motherboard called the "flash recovery" jumper. Micro Firmware's Web site lists popular motherboards using Phoenix BIOSes that have this feature.

To use this feature, download the correct flash BIOS, make the floppy disk, and take it to the computer with the defective BIOS. Set the jumper to Recovery, insert the floppy disk, and rerun the setup process. Listen for beeps and watch for the drive light to run during this process, because the video won't work. Turn off the computer, reset the jumper to Normal, and restart the computer.

If the update can't be installed, your motherboard might have a jumper that write-protects the flash BIOS. Check the manual to see if your system has this feature. To update a BIOS on a system with a write protected jumper, you must

1. Disable the write-protection.
2. Perform the update.

3. Re-enable the write-protection to keep unauthorized people from changing the BIOS.

Summary

The BIOS contains a POST (power on self test) routine that tests memory, video, hard drives, floppy disk drives, and other important system components.

The BIOS also contains a bootstrap program that locates the operating system after the POST and transfers control to it.

The BIOS uses three methods to report errors: beep codes, onscreen error messages, and BIOS POST codes.

The BIOS contains tables of supported devices and options; the CMOS chip is used to store the options chosen with the BIOS setup program.

The CMOS chip is battery-backed.

You must verify correct floppy disk drive and hard drive configurations before a system can be started. These settings are found in the standard CMOS setup screen.

By making adjustments to other BIOS screens, you can adjust the performance of the system, configure the system for compatibility with Windows PnP-compatible boards, adjust or disable built-in ports, and control power management.

A BIOS needs to be upgraded when you want to use new hardware, new software, or new features not included in the current BIOS.

BIOS upgrades can be performed with software (flash BIOS) or by replacing the chip.

Questions and Answers:

1. Explain the difference between BIOS and CMOS.
 - A. The BIOS contains options you select from; the CMOS stores the options you choose.**
2. If you want the computer to test the memory, which type of boot process (warm or cold) will you want the customer to perform? Why?
 - A. Have the customer perform a cold boot by shutting off the system and restarting it, or by using the reset button. Cold boots run the entire POST, including the RAM test, and warm boots don't.**
3. If you have computers with a Phoenix BIOS and an AMI BIOS, will they have the same beep codes? Why or why not?

- A. They will not have the same beep codes because the BIOSes are designed to produce different beep codes.**
4. What type of device is needed to display BIOS error codes? What do you also need to understand the codes?
- A. You need a POST card to display the codes and a list of codes specific to that computer, motherboard, or BIOS version to understand them.**
5. Which CMOS setup screen might need to be adjusted when using Windows 95, 98, or 2000?
- A. The Plug and Play setup might need to be adjusted.**
6. If you have a bootable CD-ROM containing the original system setup, what BIOS option do you adjust if you need to restore the system with its original software? What should be listed first and second?
- A. Change the boot order or boot sequence option in the Advanced Setup/CMOS Features screen. List the CD-ROM first, followed by C: (first) hard drive.**

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