

Chapter 6

Basic Input Output System (BIOS) & Complementary Metal Oxide Semiconductor (CMOS)

- **BIOS and CMOS Overview**
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- **BIOS Configuration**
- **Upgrading of BIOS**
- **Types of BIOS & Beep Codes with Solutions**
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BIOS - Basic Input/Output System

- Basic Input/Output System (BIOS) is added on ROM ICs to provide an **interface between the raw PC hardware and the standardized operating system**—BIOS gives an OS access to a standard set of functions.
- As a result, every system uses a slightly different BIOS, but each **BIOS contains the same set of functions which an OS can interface to.**
- This chapter explains the internal workings of a typical BIOS, illustrates some means of identifying BIOS versions, and shows you the many features that a modern BIOS must support.
- what happens when a new video card is developed that the system BIOS does not know how to work with or when an advanced drive-controller board becomes available? It is common in computer design to include a BIOS ROM for major sub-systems, such as video and drive control. One of the early steps of system initialization is to check for the presence of other valid BIOS ROMs located in upper memory (between 640KB and 1024KB). These are usually referred to as “expansion” or adapter BIOS. When another BIOS is located, it is also checksum-tested and used by the PC. In general, a PC can be fitted with up to five or more BIOS ROMs:
- **System (motherboard) BIOS**
- **Video BIOS**
- **Drive-controller BIOS**
- **Network-adapter board BIOS**
- **SCSI-adapter BIOS**

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BIOS - Basic Input/Output System

- Every computer with a motherboard includes a special chip referred to as the **BIOS or ROM BIOS (Read Only Memory Basic Input/Output System)**. The BIOS includes **instructions on how to load basic computer hardware**. The BIOS also includes a **test referred to as a POST (Power On Self Test)** which will ensure that the computer **meets requirements to boot up properly**.
- **If the computer does not pass the POST, you will receive a combination of beeps indicating what is malfunctioning within the computer.**

In most Personal Computer's, the BIOS has **4 main functions**:

- **POST - Test computer hardware**, ensuring hardware is properly functioning before starting process of loading operating system.
- **Bootstrap Loader** - Process of **locating the operating system**. If capable operating system located, BIOS will pass the control to it.
- **BIOS-Software/Drivers** which **interfaces between the operating system and your hardware**. When running DOS or Windows you are using complete BIOS support.
- **BIOS/CMOS Setup** - Configuration program which allows you to **configure hardware settings including system settings such as computer passwords, time, and date**.

BIOS - Basic Input/Output System

- BIOS stands for Basic Input Output System but it could also have been meaning "**Basic Initial Operating System**" and it would have been true because the **BIOS is what is first loaded when you start your computer**. As a matter of fact the BIOS is where are kept **all you computer hardware's basic information's** which are the first information's read and required when you first turn on your computer.
- **The BIOS information's are stored in a CMOS chip** which is kept under constant voltage supply by the computer **backup battery**. This way the information's contained in the **CMOS are always alive even if the computer power is turned off**.

The listing below is showing all the information's stored into the BIOS;

- ❖ Time and Date
- ❖ Number of Floppy Disk Drives Floppy Disk Drives information's (size, number of track, sectors, head, etc)
- ❖ Number of Hard Disk Drives Hard Disk Drives information's (size, number of track, sectors, head, mode, etc)
- ❖ Number of CD-ROM Drives CD-ROM Drives information's (operating mode, etc)
- ❖ Boot sequence (Enable the user to decide what disk will be checked first when booting)
- ❖ Cache Memory information's (size, type, timing, etc)
- ❖ Main Memory Information's (size, type, timing, etc)
- ❖ ROM Shadowing information's (Enabling or disabling of Video and System ROM shadow)
- ❖ Setting of PCI and ISA slots
- ❖ AGP Port Settings (aperture size, etc)
- ❖ Virus Protection Warning
- ❖ Setting of COM Ports (Enabling or disabling of Com port 2 for instance)
- ❖ Password Protection (enable the user to set his password)

BIOS - Basic Input/Output System Beep Codes

- When you power on your computer, the motherboard's basic input/output system (BIOS) first detects the computer's internal hardware configuration and then performs the power-on self-test (POST). The POST executes several diagnostic tests that check the basic functionality of the power supply, motherboard, CPU, I/O Bus Controller, RAM, keyboard, and video components. If the computer passes the POST, it will usually return a single short beep or two short beeps, depending on the BIOS manufacturer. If the POST detects any problems, it will halt the boot process and return an error message either visually on the screen and/or audibly through a series of beeps.
- Unfortunately, there is **no official standard for beep codes**. Depending on the BIOS manufacturer, a keyboard controller failure could be **three, four, five, or six beeps**.
- While this lists are **common BIOS manufacturer beep codes**, you should always consult your motherboard's documentation, the manufacturer's Web site, and the BIOS manufacturer's Web site for a definitive beep code list for your particular BIOS. The information contained in the following lists was gathered from the main BIOS manufacturers' Web sites. For further knowledge about beep codes please visit the manufacturers website.

BIOS - Basic Input/Output System

Phoenix - AwardBIOS CMOS Setup Utility

▶ **Standard CMOS Features**

▶ Advanced BIOS Features

▶ Advanced Chipset Features

▶ Integrated Peripherals

▶ Power Management Setup

▶ PnP/PCI Configurations

▶ PC Health Status

▶ Frequency/Voltage Control

Load Fail-Safe Defaults

Load Optimized Defaults

Set Supervisor Password

Set User Password

Save & Exit Setup

Exit Without Saving

Esc: Quit

F10: Save & Exit Setup

↑↓→← : Select Item

Time, Date, Hard Disk Type...

BIOS - Basic Input/Output System Beep Codes

AMI BIOS beep codes http://www.ami.com/support/bios.html		
Number of beeps	Problem description	Troubleshooting recommendation
1	Refresh error	Reseat memory or replace with known good chips.
2	Parity error	Reseat memory or replace with known good chips.
3	Base 64K memory failure	Reseat memory or replace with known good chips.
4	Timer not operational	Repair/replace motherboard.
5	Processor error	Repair/replace motherboard.
6	8042—gate A20 failure	Reseat keyboard controller chip, replace keyboard controller chip, check for a keyboard fuse, or try a different keyboard.
7	Processor exception interrupt error	Repair/replace motherboard.
8	Display memory read/write failure	Replace video card or video card memory.
9	ROM checksum error/Faulty BIOS chips	Replace chips or motherboard.
10	CMOS shutdown register read/write error	Repair/replace motherboard.
11	Cache memory bad	

Award BIOS beep codes http://www.phoenix.com/pcuser/awardbios/award_error_codes.html		
Number of beeps	Problem description	Troubleshooting recommendation
1 long & 2 short	Video error	Check the video card.
Any other beeps	RAM problem	Reseat the RAM or replace with known good chips.

BIOS - Basic Input/Output System Beep Codes

PhoenixBIOS beep codes

<http://www.phoenix.com/pcuser/PDF-Files/bios-postcode.pdf>

Unfortunately, PhoenixBIOS beep codes are significantly more complicated than other BIOS manufacturers. Instead of a single beep code set, PhoenixBIOS codes consist of a series of beep code sets separated by a short pause. Older Phoenix BIOS Plus and PhoenixBIOS 1.x systems used a series of three sets, while the new PhoenixBIOS 4.x systems use a series of four sets. The codes listed below are only some of the more than 100 codes for the newer PhoenixBIOS 4.x. For a complete list of Phoenix BIOS POST task routines and beep codes, please visit their Web site or review your motherboard's documentation.

Number of beeps	POST routine description/problem	Troubleshooting recommendation
1	One short beep before boot	Normal operation
1-1-1-3	Verify real mode	A problem exists with the CPU and/or motherboard. Check and replace if necessary.
1-1-2-1	Get CPU type	A problem exists with the CPU and/or motherboard. Check and replace if necessary.
1-1-2-3	Initialize system hardware	A problem exists with the motherboard. Check and replace if necessary.
1-1-3-1	Initialize chipset with initial POST values	A problem exists with the motherboard. Check and replace if necessary.
1-1-3-2	Set IN POST flag	A problem exists with the motherboard. Check and replace if necessary.
1-1-3-3	Initialize CPU registers	A problem exists with the CPU and/or motherboard. Check and replace if necessary.
1-1-4-3	Initialize I/O component	A problem exists with the I/O port hardware or a device connected to an I/O port. It could also be an expansion device in the PC or the motherboard.
1-2-2-1	Initialize keyboard controller	An error has occurred with the keyboard or keyboard controller. Try a new keyboard or replace the keyboard controller on the

BIOS - Basic Input/Output System Beep Codes

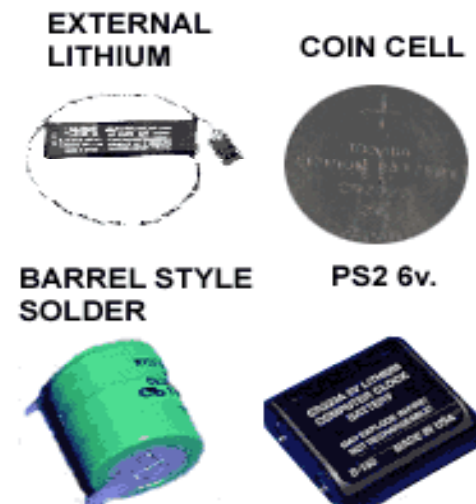
		motherboard.
1-2-2-3	BIOS ROM checksum	Replace either the BIOS ROM chip or the motherboard.
1-2-3-3	8237 DMA controller initialization	Check the motherboard and any expansion cards that use DMA.
1-3-1-1	Test DRAM refresh	Check the first bank of memory and the motherboard.
1-3-1-3	Test 8742 keyboard controller	An error has occurred with the keyboard or keyboard controller. Try a new keyboard or replace the keyboard controller on the motherboard.
1-3-4-1	RAM failure on line xxxx	Check the first bank of memory and the motherboard.
1-3-4-3	RAM failure on data bits xxxx of low byte memory bus	Check the first bank of memory and the motherboard.
2-1-3-1	Check video configuration against CMOS	Check the video card or video card memory.
2-1-3-2	Initialize PCI bus and devices	A problem exists with the I/O port hardware or a device connected to an I/O port. It could also be an expansion device in the PC or the motherboard.
2-2-1-3	Test keyboard	An error has occurred with the keyboard or keyboard controller. Try a new keyboard or replace the keyboard controller on the motherboard.
2-2-3-1	Test for unexpected interrupts	Check for a faulty motherboard or expansion card.
3-1-2-1	Detect and install external parallel ports	A problem exists with the I/O port hardware or a device connected to an I/O port. It could also be an expansion device in the PC or the motherboard.
3-1-4-1	Initialize floppy controller	Check your hard drive(s), floppy drive(s), and motherboard.
3-2-1-1	Initialize hard-disk controllers	Check your hard drive(s), floppy drive(s), and motherboard.
3-2-1-2	Initialize local-bus hard-disk controllers	Check your hard drive(s), floppy drive(s), and motherboard.
3-3-1-1	Set time of day	Check the motherboard's real-time clock (RTC).
4-2-4-3	Keyboard controller failure	An error has occurred with the keyboard or keyboard controller. Try a new keyboard or replace the keyboard controller on the motherboard.

Upgrading BIOS - Basic Input/Output System

- Occasionally, a computer will need to have its BIOS updated. This is especially **true of older machines**. As new devices and standards arise, the BIOS needs to change in order to understand the new hardware. Since the BIOS is stored in some form of ROM, changing it is a bit harder than upgrading most other types of software.
- To change the BIOS itself, you'll probably need a special program from the computer or BIOS manufacturer. **Look at the BIOS revision and date information displayed on system startup or check with your computer manufacturer to find out what type of BIOS you have.** Then go to the BIOS manufacturer's Web site to see if an upgrade is available.
- Download the upgrade and the utility program needed to install it. Sometimes the utility and update are combined in a single file to download.
- Copy the program, along with the BIOS update, onto a floppy disk.
- Restart your computer with the floppy disk in the drive, and the program erases the old BIOS and writes the new one. You can find a BIOS Wizard that will check your BIOS at BIOS Upgrades.
- As with changes to the CMOS Setup, be careful when upgrading your BIOS. **Make sure you are upgrading to a version that is compatible with your computer system. Otherwise, you could corrupt the BIOS, which means you won't be able to boot your computer.**
- **Note :** - If in doubt, check with your computer manufacturer to be sure you need to upgrade.

CMOS - Complementary Metal-Oxide Semiconductor

- Also known as a **RTC/NVRAM** or **CMOS RAM**, CMOS is short for **Complementary Metal-Oxide Semiconductor**. CMOS is an **on-board semiconductor chip** powered by a **CMOS battery** inside computers that stores information such as the **system time and system settings for your computer**.
- Types of CMOS batteries - The following is a listing of the types of batteries found in computers to power the CMOS memory. The most common type of battery is the Coin cell battery (Lithium Battery). The coin cell battery is the size of a dime, as shown below.
- **Life time of a CMOS battery** - The standard lifetime of a CMOS battery is around **10 Years**; however, this amount of time can change depending on the use and environment that the computer resides.



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CMOS - Complementary Metal-Oxide Semiconductor

Question:

- **What is the difference between BIOS and CMOS?**

Answer:

- Often the BIOS and CMOS can be confused because instructions may either indicate to enter the "BIOS Setup" or the "CMOS Setup". Although the **setup for BIOS / CMOS is the same, the BIOS and CMOS on the motherboard are not.**
- If you have already read the above BIOS and CMOS definition you should now know that the BIOS and CMOS are two different components on the motherboard. The **BIOS on the motherboard contains the instructions on how the computer boots and is only modified or updated with BIOS updates, the CMOS is powered by a CMOS battery and contains your system settings and is modified and changed by entering the CMOS Setup.**
- Although the setup is often referred to as the BIOS and CMOS setup, we suggest you only refer to the setup as "**CMOS Setup**" as it is more appropriate. We often refers to the setup as BIOS and CMOS Setup to help students who are looking for one instead of the other.

Question:

- Each time the computer boots I receive a prompt for the time and date.

Answer:

Cause:

- Missing autoexec.bat / config.sys.
- Bad or missing CMOS / RTC battery.
- If your computer has been able to keep the time and date in the past and has suddenly started prompting you for the time and date, and you are running **Microsoft Windows 95, Windows 3.x, or MS-DOS, verify that the computer has an autoexec.bat and config.sys file.** If this file is missing it will need to be recreated or restored from a backup.
- It is common for computers using an Intel 80286 and lower processor to not have a CMOS/RTC battery. If your computer does not have a CMOS/RTC battery, it is functioning as designed.
- If you have a computer later than a 80286 or a computer that has been built in the last few years, **it is likely that your CMOS or RTC battery has died.** Contact your computer and/or motherboard manufacturer to purchase a replacement battery or if you have a coin cell battery on your motherboard you may also want to simply find a replacement online or through a local electronics store such as Radio Shack.

Question:

- How to enter the BIOS or CMOS setup.

Answer:

Reasoning:

- IBM compatible users may need to enter the BIOS or CMOS setup to change how their computer's is currently configured.

Solution:

- Because of the wide variety of computer manufacturers and BIOS manufacturers over the evolution of computers, there have been numerous different ways to enter the BIOS or CMOS Setup. Below is a listing of the majority of these methods as well as other recommendations for entering the BIOS setup.

New computers

- Thankfully, computers that have been manufactured in the last few years will allow you to enter the CMOS by pressing one of the below five keys during the boot. Usually it's one of the first three.
- **F1, F2, DEL, ESC or F10**
- A user will know when to press this key when they see a message similar to the below example as the computer is booting. Some older computers may also display a flashing block to indicate when to press the F1 or F2 keys.
- **Press <F2> to enter BIOS setup**

Tip: If your computer is a new computer and you are unsure of what key to press when the computer is booting, try pressing and holding one or more keys the keyboard. This will cause a stuck key error, which may allow you to enter the BIOS setup.

Older computers

- Unlike the computers of today, older computers had numerous different methods of entering the BIOS setup. Below is a listing of general key sequences that may have had to be pressed as the computer was booting.
- **CTRL + ALT + ESC, CTRL + ALT + INS, CTRL + ALT + ENTER, CTRL + ALT + S, PAGE UP KEY or PAGE DOWN KEY**

Question:

- **How to clear an unknown BIOS password?**

Answer:

- If you have mistakenly forgot or lost your BIOS password or you receive a password at boot that you do not know, you will need to clear the BIOS password by one of the below methods.

Precaution: When inside the computer please be sure of the potential of ESD.

- There are utilities designed to help bypass BIOS passwords.
- On the computer motherboard locate the BIOS clear / password jumper or dipswitch and change its position. Once this jumper has been changed, turn on the computer and the password should be cleared. Once cleared, turn the computer off and return the jumper or dipswitch to its original position.
- The location of the jumpers or dipswitches may vary; however, here are general locations where these jumpers / dipswitch may be located.

On the edge of the motherboard - Most jumpers are located on the side of the motherboard for easy accessibility, verify by looking at all visible edges of the motherboard.

By the CMOS battery - Some manufactures will place the jumper to clear the CMOS / BIOS password by the actual CMOS battery.

By the processor - Some manufactures will place the jumpers by the processor of the computer. However, note that in some cases these jumpers will be to change the processor and not the password.

Other visible location - While it is possible that the jumpers / dipswitches may not be in a visible location, most manufactures try to make things easier by placing the jumpers / dipswitches in another visible location.

- Additionally, when looking for the jumper / dipswitch the label of that switch can be anything; however, in most cases will be labeled CLEAR - **CLEAR CMOS - JCMOS1 - CLR - CLRPWD - PASSWD - PASSWORD - PWD.**
- On the computer motherboard locate and remove the **CMOS battery for at least 10 minutes** allowing the computer to lose its information. Note: this will not work on all computers.
- If your manufacturer has a bypass password this can be entered and allow you access to the BIOS and/or computer. Because of the security risk of a bypass password, generally only older computers will have this option. In addition, it is likely that this information will only be able to be obtained from the computer, motherboard or BIOS manufacturer.

Abby Hemede

Question:

- **How can I reset CMOS / BIOS settings?**

Answer:

- If your computer is having issues booting, has errors during boot, after adding hardware is running into issues, and/or you're having other abnormal system behaviors that cannot be resolved through any other method it may be necessary to reset the CMOS settings and/or load the default or fail-safe defaults as explained below.

Load / Reset defaults

- In CMOS setup look for an option to reset the CMOS values to the default setting or an option to load the fail-safe defaults. With many CMOS setup screens there will be a function key to do this; for example, the F6, F11, or F12 key. Other setups may actually list an option that you can arrow over to using the arrow keys and press Enter.
- When found and selected you'll likely be asked if you're sure you wish to load the defaults press Y for yes or arrow to the yes option.

Reset Configuration Data

- In addition to restoring the system defaults if you've recently added new hardware or resetting the default values did not help resolve your boot issues you may also want to reset the configuration data. Below are some examples of how this can be done. Keep in mind that unfortunately all CMOS screens are different and these instructions may not be exact steps for your CMOS.

Under advanced

- If you're working on a computer with a Phoenix BIOS that has Main - Advanced - Security - across the top of the screen you can get to this setting by using the right arrow to move over to Advanced and under Advanced arrow down to Reset Configuration Data and changing the value from Disabled/No to Enabled/Yes.
- Once the above has been done press the F10 key and save and exit CMOS setup.

In PnP/PCI Configurations

- If you're working with a Phoenix BIOS that has several different options and one of them is PnP/PCI Configuration move the cursor down to this option and press Enter. Within the PnP/PCI Configurations change the Reset Configuration Data from Disabled to Enabled.
- Once the above has been done press the F10 key and save and exit CMOS setup.

Hard reset the CMOS

- If the above steps do not work and/or you're unable to enter CMOS to reset it to the factory settings it may be necessary to perform a hard reset on the CMOS using a jumper or dipswitch on the motherboard. Unfortunately because all motherboards are different the steps on how to do this can only be found through your motherboard manufacturers documentation.

Abby Hemede

Question:

- **Prompt to enter CMOS when booting computer.**

Answer:

- This issue can occur because of one of the below reasons.
 - **Recently added hardware.**
 - **CMOS values are not entered correctly.**
 - **CMOS battery is dead.**

Solution:

Recently added hardware

- If you have recently added hardware into the computer enter CMOS and either enter the new configurations for that added hardware or verify that these settings have been entered for you. Once verified, save and exit the computer.

CMOS values are not entered correctly

- If the values within CMOS are entered improperly the computer will prompt you to enter CMOS because these values are either incorrect in correspondence to the hardware within your computer; or these values may be conflicting with other settings within your CMOS, such as an IRQ conflict.
- It is also important to realize that if a hardware device goes bad within the computer, the CMOS will prompt you indicating that CMOS conflicts because the device is setup within CMOS but not being found.

CMOS battery is dead

- If you are finding that your CMOS values are becoming lost each time you reboot your computer it is likely that your CMOS battery may be dead. This can be easily determined if you notice that the time and or date are being reset to the date of the BIOS.

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Question:

- **Prompt to enter CMOS when booting computer.**

Answer:

- Like any battery the computer CMOS battery can fail or lose its charge.

Solution:

- If your computer is losing its time or date settings, or you are receiving a message **CMOS Read Error**, **CMOS checksum error**, or **CMOS Battery Failure**, first attempt to leave the computer on for 24 hours. In some cases this can charge the battery and resolve your issue. This often resolves CMOS battery related issues when a computer has been left off for several months. If this does not resolve your issue follow the below steps.

Write down all system settings

- Ensure that the information within your CMOS, if not already lost, is written down. If you're getting a CMOS error message or your time is not being saved your settings are already lost.

Locate your CMOS battery

- Open the computer case and find the battery on the computer motherboard, verify that it will be accessible and that it can be removed.

Obtain battery information

- Unfortunately, most manufacturers will not list the exact type and model of your CMOS battery; therefore, once you have located the battery, write down all information about the battery (Voltage, chemistry, wiring, and packaging). If possible, remove the battery and take it to the location you plan on purchasing a new battery from.

Removing the battery

- **Caution:** While in the computer make sure you're aware of Electro Static Discharge (ESD), your computer is off, and that you're properly grounding yourself. Especially before removing the battery.
- If your computer is using a coin cell battery. Removing the battery is relatively simple. Simply use your fingers to grab on the edge of the battery and pull it up and out of the container holding it. Some motherboards have a clip holding the battery down. If your computer has this clip you may need to use one hand to move the clip up and the other hand to pull the battery out.
- Unfortunately, not all CMOS batteries are removable; some manufacturers will only allow a replacement battery to be added. If you're not using a coin cell battery and are not able to determine how to remove it refer to your motherboard or computer documentation and/or contact your computer manufacturer for additional assistance in removing the battery or how to insert a new replacement battery.
- Users with computers that do not have removable batteries only options to install a new battery will most likely also need to set a jumper when adding the new battery into their computer.

Insert the new battery

- Once you have purchased a new battery, remove the old battery (as instructed above) and replace it with the new battery.

Enter CMOS values

- Once the battery is replaced turn on the computer and enter all values back into CMOS or set the values back to the default settings.
- After the values have all been entered make sure to save the settings before exiting. Many CMOS setups allow you to press a key (such as F10) to save values and exit all in one action.

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Question:

- NVRAM cleared by jumper.

Answer:

- **Cause:**
- When jumper is set in position to clear the CMOS password, the message "NVRAM cleared by jumper" will appear on the screen.
- **Solution:**
- Once this message is displayed, turn off the computer and place that jumper back into its original position. If you are unaware of where the NVRAM / CMOS clear jumper is located on your motherboard, refer to your computer or motherboard documentation and/or contact the manufacturer of the computer or motherboard.